Women's Fertility and Labor Force Dynamics

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ABSTRACT

Seulki Choi: Women's Fertility and Labor Force Dynamics
(Under the direction of Ted Mouw)

This dissertation consists of three papers on low fertility and its implication. The first two chapters are social demographic studies and the last chapter is a formal demographic study.

The first paper explores the wage gap between mothers and non-mothers, which is called the motherhood wage penalty. Previous researches have focused on the loss of job experience due to motherhood as a key reason of the penalty. On the contrary, this paper focuses on discrimination against motherhood. Using data from the 1982-2006 National Longitudinal Study of Youth with residual analysis, I find that women are experiencing 2% of motherhood wage discrimination per child. It is roughly one-third of the gross motherhood wage gap. I also find that the sizes of the discrimination are different by the location in the occupational hierarchy. Managers/professionals are not suffering from wage discrimination. Whereas, manual workers are suffering from the discrimination, 3% per child. In their gross penalty, 70% could be linked to discriminatory factors. It implies that gender wage discrimination may seem to decrease in spite of continued discrimination against worker-mothers. Instead, discrimination may just be modified or may happen at a different boundary, from women vs. men, to mothers vs. non-mothers.

The second paper studies how women's hourly wages affect childbearing using data from the 1982-2006 National Longitudinal Study of Youth. The results of discrete time hazard model show that a negative relationship between women's hourly wage and fertility. But they are not consistent across education levels. Women who have a high school diploma or less are less likely to have children when their wages increase. But women who have some college experience or a

college degree are likely to have children when their wages increase. It means that only for highly educated women who are likely to be in high paying decent jobs, the rise of income can be used as a resource for reconciling the mother's and worker's roles. Or, for less educated women who are likely to be in the low paying jobs, the rise of income is not large enough to lessen role incompatibility. It also could mean that when their income rises, less educated women have a bigger substitution effect, whereas highly educated women have a bigger income effect.

The third paper explores the recent decline of Total Fertility Rates in South Korea. TFR is composed of the interplay of two components; a change of the number of births (quantum) and the shift of the timing of those births (tempo). But previous research on the fertility decline in Korea has been conducted with a quantum driven perspective, and little has been conducted based on the tempo perspective. Using Bongaarts and Feeney method, I find that adj-TFRs(tempo-free TFRs) do not indicate the declines till 2000, unlike the decline of the conventional period TFR. It suggests that the decline is a tempo-driven phenomenon. After 2000, the size of the tempo effects is shrinking, though still sizable. Adj-TFRs with variance effect show that the tempo effect is somewhat exaggerated.

To Taeim

for her endless support and confidence even when progress was slow

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CHAPTER 1

Motherhood and Wage Discrimination

Introduction

Do mothers experience wage discrimination when compared to non-mothers in the work place? Women have been regarded as being less skilled, less experienced, and reluctant to do overtime or night work (Goldin 1994). These stereotypes mainly originate from the fact that a woman is a mother or might be a mother who is expected to be the primary caregiver of children and to do household chores. These stigmas have played a role in justifying gender discrimination.

Fortunately women's status has improved in recent decades especially in the work place. The labor force participation rate of women aged 16 and over has increased from 34 percent in 1950 to 60 percent by the late 1990s, then it has receded slightly to 59.4 percent in 2006 (CPS 2007). Among mothers with children under age 18, 67 percent were in the labor force in 2006 (CPS 2007). Women also are increasingly occupying higher paying occupations. By 2002, one-third of women worked in managerial or professional occupations; in 1983, this figure was only 22 percent (CPS 2004). In 2006, among all management, professional, and related occupations, women accounted for 50.6 percent, though the share of women varies significantly by the specific occupation categories. For example, among engineering managers, only 7 percent are women, whereas 83 percent of social workers are women (CPS 2007).

At the same time, the wage gap between men and women has narrowed. Female full-time workers' median weekly earnings were 62% of men's in 1979, but had increased to 81% by 2006 (CPS 2007). Any reduction in the gender wage gap could imply reduced gender discrimination. Some scholars even argue that the current gender wage gap is entirely attributable to productivity differences, and to women's choices (O'Neill 2003).

The reduction in the wage gap between men and women, however, may not be because gender discrimination has decreased, but because of increased heterogeneity within the female workforce. There are two kinds of female workers. One is a mother, who has the double burden of being both a mother following traditional women's norms and a worker who is required to fulfill all the expectations in the workforce. The other is a non-mother who only chooses to assume the worker's role like her male counterparts. A non-mother may be regarded as showing equal commitment to work and displaying a productivity that is indistinguishable from that of her male counterparts. Therefore, she may be able to successfully avoid discrimination. The female worker with a child, however, is often assumed to have inferior worker attributes.

It is thus possible that gender discrimination happens mainly to women who have children. In other words, gender discrimination may *seem* to decrease in spite of continued discrimination against worker-mothers, but merely appears to have decreased because more women choose to defer childbearing or remain permanently childless, thus resulting in an underestimation of the amount of discrimination due to motherhood. Discrimination may just be modified or may happen at a different boundary, from women vs. men, to mothers vs. non-mothers.

Figure 1.1. here

The wage gap between mothers and women without children is called the family gap (Hardoy and Schøne 2004; Waldfogel 1997; Waldfogel 1998b) or the motherhood wage penalty (Budig and England 2001; Correll, Benard, and Paik 2007). It is different from the gender gap in that it compares wages earned across women. The "family gap" is not clear in that it fails to specify who has the burden. Unlike women, fathers earn more than men without children (Lundberg and Rose 2000).

Figure 1.1 shows that a sizable wage gap continues between mothers and non-mothers. At age 30, the average hourly wage of women with no children was $17.21 in 2006 dollar. Women

who had one child earned $15.24, which is 88.5% of non-mothers' hourly rate. Women who had two children earned much less, $12.24, 71.1% of the childless rate; this represents a $4.92/hour reduction.

The motherhood wage gap has been reported in the U.S.A. (Anderson, Binder, and Krause 2002; Anderson, Binder, and Krause 2003; Budig and England 2001; Glauber 2007; Waldfogel 1997; Waldfogel 1998a) and many other industrialized countries like Britain (Waldfogel 1998a), Norway (Hardoy and Schøne 2004), and Denmark (Gupta and Smith 2000). But previous researchers have tried to explain the wage gap mainly by the decline in productivity that is due to motherhood. Considerable attention has been paid to explain the wage gap among races and genders in terms of discrimination. But surprisingly, this discrimination perspective is hard to find in the research on the motherhood wage gap.

The first question of this paper is whether any motherhood wage discrimination exists. Assuming an affirmative answer to this question, the second question is: which women are the most vulnerable to motherhood wage discrimination? According to one's location in the occupational hierarchy, workers live in different situations; which may make them experience different degrees of the wage gap and with different reasons. Even though the size of the motherhood wage gap looks similar, the causes can be different. I expect that we will find different amounts and reasons for the wage gap according to the worker's position in the occupational hierarchy.

My research builds on Budig and England's 2001 study. They use a fixed effect model to control for unobserved but constant individual characteristics which can affect both wages and fertility. Their study is focusing on relatively young women using the data, NLSY79:1982-1993. I will use NLSY79: 1982-2006. As this data has longer periods, I expect it covers the entire period of women's reproductive ages. I will use the same fixed effects model but focus on productivity measures to differentiate discrimination from the wage gap.

Motherhood Wage Discrimination. Why Does It Matter?

Discrimination is said to happen when otherwise identical people are treated adversely not because of a productivity differential, but because of a group identity which has no direct effect on their productivity (Heckman 1998). Motherhood wage discrimination arises when mothers earn lower wages than non-mothers while exhibiting the same productivity.

Mothers could be discriminated against in securing jobs, placement in those jobs, and/or promotion in the work place. Mothers may more often be relegated to low-paying jobs than are non-mothers. Most high-paying jobs have been traditionally reserved for males. In the past, such jobs were regarded as fit only for men. Since more and more women are securing employment and competing with men, some employers may acknowledge that it is an old fashioned idea that women are inferior to men. Instead, they may think that lower productivity by women derives not from their sex, but from motherhood. For these reasons, some employers may discriminate specifically against mothers. For the same reason, they may assign mothers to lower paying duties with reduced advancement potential. The discrimination could arise not only from the behavior of employers, but also from that of coworkers and/or customers. For example, a customer may dislike a saleswoman who has a child because s/he thinks such a saleswoman is more likely to be absent due to frequent emergency calls from her child/caretakers, and because it may be difficult to contact such a female employee when s/he need.

The discrimination is malicious because it hurts equity. It is unfair in that the same level of work is treated unequally. It also is unfair in that the costs for childbearing and rearing are paid mainly by mothers, but the benefits are shared with all non-mothers. Child bearing and childrearing are socially beneficial acts (England and Folbre 1999; Folbre 1994). They entail costs, time and effort, interruption in job experience which lowers human capital, and even discrimination. The problem is that mothers pay the majority of the costs and others in the society are free-riders.

It also could link to positive externality issue[1]. In economics, an externality happens when

[1] Positive externality issue is not limited to discriminatory part of motherhood wage gap but happens at the entire motherhood wage gap. That is why the wage gap should be cared about in the name of penalty.

prices do not reflect the full costs or benefits in production or consumption of goods or services. If there is no regulation – such as governmental intervention, negative externalities (for example pollution) are easy to be overproduced, while positive externalities (for example education and public safety) are easy to be underproduced. Childbearing and rearing is a case of positive externality. The most duties are burdened by women called mothers but the benefits are not limited to them.

The discrimination could be malicious not only because it disadvantages mothers, but also because all of society is hurt when it results in inefficiency. All prejudicial discrimination is inefficient. If the ablest person is a mother and she will not work at a given lower wage due to discrimination, it will makes commodities or services either unavailable or more costly. In contrast, *statistical discrimination*, may not be inefficient. Statistical discrimination happens when an employer judges a person based not on her individual productivity but on a group image. An employer may have incomplete or imperfect information on an employee because gathering employee information is not without cost. For convenience, an employer may judge an employee not by her individual productivity, but by her group's productivity. If the group information is true, using statistical discrimination in evaluation is an efficient way at least to individual employers.

Review of the Research on the Links between Motherhood Wage Gaps and Productivity

If all wage gaps are examined from the perspective of productivity differences, any given wage gap could be legitimate. In other words, even if there are wage differences, it is not discrimination when these are underlain by productivity differentials. Discrimination happens only at the residual wage differences that cannot be explained by the productivity differentials.

To separate discrimination from a wage gap, all the productivity related characteristics should be controlled. Audit study uses a quasi-experimental methodology to identify discrimination. Correll, Benard and Paik (2007) looked at motherhood discrimination through laboratory

experiments and an audit study. In the laboratory experiment they held constant the potential job applicants' characteristics and varied only their motherhood, then asked fictitious employers to evaluate them. They found that employers regarded mothers as less competent and recommended starting salaries which were lower by 7.9% than the salaries they offered non-mothers. In the audit study, they sent real employers fictitious resumes which were otherwise identical except for their motherhood status, then checked the likelihood of receiving callbacks. They found that mothers received fewer callbacks. Their study suggests that motherhood discrimination exists, but there are several limitations to these studies. In the laboratory experiment, the fictitious employers were all college students. If students are more likely to be egalitarian than real employers, then discrimination would be underestimated. If these student "employers" acted based on stereotypes more often than real employers would, then discrimination would be overestimated. More importantly their study is limited to job offering and starting salary. It cannot study the wage differentials in the view of discrimination hereafter.

Statistical residual analysis is another method to identify discrimination. In statistical residual analysis, all the characteristics related with productivity but not with discrimination should be included in the model. Then the unexplained wage gap left over in the residuals after controlling for productivity measures in the model is regarded as the *discrimination effect*. This paper will use this method.

The causes of the motherhood wage gap can be broken down into four factors: (1) loss of human capital, (2) "compensating differentials" for motherhood-friendly jobs, (3) less "work effort" and (4) discrimination against mothers. Or the gap may be attributable to a spurious relationship due to some unmeasured heterogeneity (Budig and England 2001). Human capital is a measure of productivity potential. The compensating differential and work efforts are measures of voluntary reduction of productivity.

There are other variables known to affect wages, such as occupation, industry, and union status. But these variables may be questionable to the extent that they are associated with

discrimination (Blau and Kahn 2000). As adding these variables could underestimate discrimination, this kind of variables should not be added in the model.

Table 1.1 here

Previous studies have shown that there is still a large unexplained residual even after controlling for human capital. After controlling for human capital, unobserved heterogeneity, and the part-time/full time variables, Waldfogel (1997) reports that 66 percent of the wage gap is still unexplained for one child, Budig and England (2001) report 70 percent, and Anderson et al. (2002) report 85 percent. (See Table 1.1) But it is not credible that all of these residuals are due to discrimination. There is always the possibility of measurement error in productivity measures, especially measures of human capital, and many studies fail to consider the possible effect of voluntary reduction of productivity. If such measurements of productivity are incomplete, then discrimination could be overestimated.

Productivity Potential: Loss of Human Capital

The human capital model is the most influential economic theory explaining wage differentials in the labor market (Becker 1985; Mincer and Ofek 1982). Human capital can be divided into two types – general human capital and firm-specific human capital. General human capital consists of any common and transportable ability. It can be inborn cognitive ability, health, physical strength, and so on. It also can be obtained during general education. A high school diploma could be one example. Job-based human capital is obtained through job experience. This type of human capital is mostly blamed for the wage gap. Since motherhood hampers career-continuity, differences in the length of job experience and relocation to a new job after childbirth link to the loss of human capital.

Career discontinuity is likely to restrict the accumulation of human capital in three ways.

First, mothers cannot accumulate additional human capital during their maternity leaves. Second, during such leaves, their human capital is likely to depreciate since their skills and qualifications may become obsolete in the workplace, or skills may be forgotten due to disuse. Third, if a mother cannot return to the same company after a birth, her firm-specific experience she acquired earlier would no longer be valid. If she changes her occupation, occupation-specific skills and experience would be adjusted downward significantly.

Human capital is usually measured by cognitive skills, age, the length of education, and job-experience. Especially regarding job experience, it has been measured by all accumulated work years (Waldfogel 1997), work years at the occupation at an industry (Anderson, Binder, and Krause 2002), or all working years and work years at a company (Budig and England 2001). Waldfogel and Budig and England divide the measures further into full time and part time work years. In this study, I will measure two kinds of job experiences – overall job experience and firm-specific experience. The former will be measured by years of all job experience. The latter will be measured by years of employer-specific job experience (which is called tenure).

Depreciation of human capital is also an important factor. Even though two workers have the same amount of job experience and education, their human capital could be different if one was out of the labor market recently. If the leave is longer, the amount of depreciation will be larger. To capture this, Budig and England (2001) use the number of breaks in their model, and Anderson *et al*.(2002) consider the time out of the labor market (=age-edu-experience-6). But the number of breaks cannot measure the duration leave before having this job. Moreover, the breaks may not be related with motherhood. If it is from taking another job offer or pursuing advanced education, the leave is more likely to be associated with a wage increase. The time out of the labor market is an incomplete measure in that it fails to differentiate the recent leaves from the previous ones. For example, two elementary teachers with the same age and job experiences could have different amounts of skills. Imagine that one took 4 years to be a teacher after graduation has worked for 4 years without interruption while the other became a teacher right after graduation and worked for 4

years and just returned from 4 years of maternity leave. The former's experience will be fully appreciated while the latter's experience will be partially appreciated. In this study, to measure the amount of depreciation of human capital, years of leave during the recent four years will be used.

Voluntary Productivity Reduction: Compensating Differential for Motherhood-friendly Job Characteristics and Less Work Effort

Unlike non-mothers, mothers are likely to have difficulty in realizing their full productivity potential. Even with the same amount of human capital, mothers can show less productivity by preferring motherhood-friendly jobs or jobs requiring less work effort (Becker 1985; Budig and England 2001).

Mothers also may not pursue the maximum wage that corresponds to their productivity level. They may barter away better wages for a baby-friendly working environment; this is called a "compensating differential." Or they may retreat from full productivity at the work place in order to spare energy for their home responsibilities; this is called less "work effort." Women may choose a job which will lessen their commuting hours, one which offers more lenient work rules (such as flexible working hours, fewer demands for evening work, etc.), or they may choose one that can give non-pecuniary amenities (such as on-site day-care services) even though the wage may not be the best. If a woman has children, it means she has a double burden, which is not easy to handle. Especially when the child is young, intense caretaking is needed. Sometimes she may need to leave early to respond to baby emergencies. She may not do her best at work in order to conserve energy later in the day for child care and other housework chores. Or taking care of the children before work begins may leave her already exhausted, so that she cannot work at peak capacity. Mothers may choose part-time jobs instead of full time jobs to save time and energy, even though part-time jobs are usually limited in their advancement possibilities and pay lower hourly wages.

Anderson *et al.* (2003) found that the wage gap diminishes as the youngest child grows older, and the wage gap for women who have a 0-2 year-old child is significantly larger than the wage gap for mothers with an older child. These findings show that the compensating differentials

and work effort could affect the wage gap.

What if Productivity is Endogenous to Discrimination?

Productivity and discrimination were assumed to be independent in the previous chapter. But productivity could be endogenous to motherhood discrimination. If this is the case, then discrimination could be underestimated.

What if a woman is forced to leave her job or cannot return to her work place after a birth because of discrimination? The reduced job experience and relocation, which is a direct result of motherhood discrimination, will lower her human capital and make her earn less.

The same logic could apply to voluntary productivity reduction. For example, a mother could choose a part-time job because she needs flexible work hours and cannot make a full-time commitment to work. But she may be forced to choose a part-time job because full-time jobs are not open to mothers as much as non-mothers. If there is job segregation against mothers and they have no choice but to overcrowd into lower paying jobs, their choice is actually forced and it should be regarded as discrimination. Correll, Benard and Paik (2007)'s laboratory experiments and audit study find that at the job searching and interview procedure, mothers are suffering from discrimination.

Anderson et al(2003) find that the wage gap diminishes as children grow older. A mother with an infant/toddler must devote more efforts to child caring and is more eager to have motherhood friendly working environment. Therefore she would accept lower wage to save work efforts and compensating differentials. The incompatibility between worker's role and mother's role will shrink as her child grows. But the declining wage gap could be explained by discrimination. An employer may discriminate more against a mother with younger children. An employer may believe that a mother of a teenager has a similar work ethic to a non-mother but a mother of an infant/toddler gives more priority to her own child. Also, an employer may simply dislike the smell of breast milk or diapers.

Budig and England (2001) add various job characteristics obtained from the Dictionary of Occupational Titles (U.S. Department of Labor 1977) to examine the effects of compensating differential and work effort in their regression model. They find that the effect is small, and argue that making a distinction between choice and discrimination does not matter.

Why Does The Wage Gap Differ By Position in the Occupational Hierarchy?

A few investigators have paid attention to diversification in the motherhood wage gap. Using the 1968-1988 NLSY, Waldfogel (1997) found that the motherhood wage gap tends to rise with educational level. Using the 1982-1993 NLSY, Budig and England (2001) studied the effects of skilled/non-skilled worker, years of education, and hierarchy of jobs. They argue that there is no clear evidence that more skilled or committed women experience a wider wage gap. They did report that women hired in full time jobs suffered a bigger wage gap. Using 1968-1988 NLSYW data, Anderson et al. (2002) analyzed the wage gap by educational level. They reported that: 1) low-skilled workers (without a high school diploma) experience the smallest wage gap since they have less human capital but the amount of human capital is not as important as in other higher paying jobs; 2) highly-skilled workers (college graduates) suffer from the biggest wage gap, (which can be explained by the number of years out of the workforce); and 3) high school graduates fall mid-way between these two groups. Anderson et al. (2003) found that high school dropouts only suffer from a wage gap when their children are very young, and this does not last when the children grow up.

Why does the motherhood wage gap differ by position in the occupational hierarchy? Wright argues that there are complexities among the working class. (Wright 1979; Wright 1997; Wright and Perrone 1977) Workers' bargaining power could differ according to their location in relation to authority and to scarce skills. Workers who are in charge of management could earn bargaining power by dominating other workers within production. As managerial behavior is relatively hard to monitor and is needed more for creative behavior, higher earnings, so called "loyalty rent", could be provided. Like managers, employees who have a high level of skills or

expertise are also in a privileged location in product relations. As skills and expertise are frequently scarce in the workplace, they command a better reward, or "skill rent". Because professionals have more specialized and irreplaceable knowledge of their work, they also are hard to monitor. Because they have greater authority and autonomy in the workplace, managers and professionals can earn a higher income and fight against discrimination successfully in the working place.

I will divide the occupational hierarchy into three categories---managers/professionals, non-manual workers, and manual workers. The characteristics of manual workers are not limited to their physical condition (Gagliani 1981). They are more subject to surveillance and suffer from higher unemployment rates. The situation of non-manual workers is closer to manual workers in that they also are under surveillance and have less bargaining power. But they have a comparatively open ladder to promotion and can become managers/professionals in the future.

The loss of human capital can be quite different by one's position in the occupational hierarchy. To manual workers, a leave means only the duration without wages, since they have limited chances for promotion by work experience. So when they return to the work force, their human capital changes little. But human capital is crucial to managers/professionals. Anderson et al. (2002) found differences in the size of the gross wage gap by education, and reported that highly educated mothers are more vulnerable to loss of human capital.

Work effort and compensating differentials also differ by position in the occupational hierarchy. Lareau (2003) argues that there is a different child-rearing culture in the middle class vis-à-vis the working class. She says middle class parents emphasize "concerted cultivation" through organized leisure activities, while working class parents emphasize "natural growth" and are more likely to believe that children can enjoy leisure activities by themselves. Managers/professionals have more monetary resources. They can buy more convenient home appliances, or employ maids and babysitters to lessen the burden of work in the home. Thus, they can devote almost their full energy to their work productivity, like non-mothers. I assume that manual workers spend less time caring for their children than do non-manual workers. Then I can

hypothesize that manual work does not have much impact on their work effort when they have children, whereas non-manual workers should have. The resources that managers/professionals have make their environment more mother-friendly and give them greater bargaining power to make their working environments more favorable.

Having a bias against mothers is not a sufficient condition for discrimination. Another requisite is that the discriminatees are weaker than the discriminators. The discriminator should be strong enough to be able to show his/her distaste towards mothers. So discrimination can only happen in the context of an uneven power relationship. In the labor market, even among employees, the power is not equally distributed and some employees have sufficient power to fight against their employers. An employee who has a higher rank or who has professional skills can fight against discrimination using its assets or rents. An employee who has a lower rank and can be easily interchanged with another worker is the most vulnerable to discrimination.

I expect that the mother who has more power, the managers/professionals will be less vulnerable to discrimination. They usually have more authority and autonomy and enjoy better earnings, including the rents. Using this resource, they can resist discrimination more efficiently. Manual workers have fewer resources and less bargaining power in the labor market. They could be the weakest victims of discrimination. I expect that human capital has more explanatory power in the case of the managers/professionals' motherhood wage gap. In the case of work effort, non-manual workers will be the most vulnerable. In short, according to his/her location in the occupational hierarchy, each worker has a different wage gap and for different reasons.

Table 1.2 here.

Data, Measures and Models

Data

I use the 1982-2006 waves of the National Longitudinal Survey of Youth, a nationally

representative longitudinal sample of individuals who were age 14-21 on December 31. 1978. These individuals were interviewed annually though 1994, and are currently interviewed biannually. Black and Hispanics are excluded to simplify the analysis as they are vulnerable to race and ethnicity discrimination. The data is further limited to women whose jobs are not military, self-employed nor family business because their wages are not market based. Observations at age less than 18 are dropped. Since a fixed effects model requires at least two observations for each person, if a respondent reported her wage only once, she was dropped from the current study. The final dataset is 3,087 women and 32,964 measures.

To see the change in motherhood wage discrimination by occupational hierarchy, the dataset will be divided into three subsamples: managers/professionals, non-manual workers, and manual workers based on the 1970 Census Occupational Classification System. Professionals mean professional specialty occupations such as physicians, registered nurses, lawyers, scientists, engineers, and teachers. Managers include executive, administrative and managerial occupations. Supervisors and foremen are added into managers as they have a limited authority in the work place. Non-manual workers are sales workers and clerical occupations. Manual workers consist of craft workers, operatives, laborers and service workers.

If most women have childbearings before they established professional jobs or promoted to managerial jobs, managers/professionals may have not enough variation in the number of births. As average ages of managers/professionals are higher than others, it could be a legitimate concern. Among respondents who have experienced managers/professionals more than once, there are 2100 births. Among the 2100 births, 944 births happened when their mothers are managers/professionals.

Statistical Model

$$\begin{aligned}\text{Log Hourly Wage}_{it} = \alpha_i &+ \beta_1 (\text{Number of Children})_{it} \\ &+ \beta_2 (\text{Demographic Variables})_{it} \\ &+ \beta_3 (\text{Measures of Human Capital})_{it} \\ &+ \beta_4 (\text{Measures of Work Effort and Compensating Differentials})_{it} \\ &+ \mu_i + v_t + w_{it}\end{aligned}$$

where i indexes individual women and t indexes time (1982,1983,…,2006)
μ is the individual component of error,
v is the timewise component of error, and
w is the random error.

I will use a fixed effects regression model. Effects are fixed for periods and individuals. Period fixed effects are expected to control for year-specific characteristics. Individual fixed effects are expected to control for personal characteristics, which are constant during each measurement.

It is hypothesized that motherhood affects women's wages but the causal relationship could be spurious. There is a possibility that extraneous variables affect childbearing and wage at the same time and there are no or less direct causal effects between them. Examples of this might be physical strength, health and cognitive ability, or individual preferences for babies or careers. If a woman has higher academic skills, she may be more likely to pursue a career-oriented life and delay having a family as she knows her opportunity costs are relatively larger. If she has poor health, she may be more likely to have children and spend less effort on her career, because she knows the opportunity costs are relatively less. If a woman has a tendency to build a family at an early age, this can make her have more children as well as earn less. On the contrary, if she has a tendency to succeed professionally, this will make her earn more, and have less or no children.

Previous studies have dealt with this problem using a fixed effects model. (Waldfogel 1997, Budig and England 2001, Anderson et al. 2002, Glauber 2007) Many of these extraneous heterogeneities are unobservable or hard to measure. But if it can be assumed that such characteristics are pre-set or constant at least during the working years, then they could be removed by person fixed effects which absorb any time-invariant and unobserved variables. This research also adopts a fixed effects model.

If decisions to leave the labor force are due to childbearing, or if the decisions to come back into the labor force after the leave are not random, the sample selection could be biased. Considering the decent fringe benefits and higher opportunity costs that exist for higher earners, they may be more likely to come back into the labor force after childbearing. Considering the

significance of the mother's contribution to the family income in the case of lower earners, they also may be likely to come back. So, female workers in the middle class are probably more likely to leave the labor force forever. Because wages are only observable for women who are working, the resulting biased sample could underestimate the motherhood wage discrimination if women who would be subject to the biggest discrimination are the most likely to remain out of the labor force. Glauber (Glauber 2007), who used the same dataset that I do (NLSY79: 1982-2004) to study the moderating effects of race and marriage on motherhood wage gap, checked selection bias using the Heckman Selection Model and found no bias.

Table 1.3 here

Measures

The dependent variable will be the natural log of the hourly wage of the respondent's current job. The hourly wage is a measure of earning potential. Monthly or biweekly wages may change even when the hourly wage remains constant by changing working hours. Because the primary purpose of this study is to determine the effect that discrimination has on the wage gap between mothers and non-mothers, earning potential should be a better measure than the total income. The hourly wage will be adjusted to the currency value in 2006 dollars. If it is less than $2 or more than $100, then it will be considered on an outlier and thrown out. Only 1.9% of wages are smaller than $2 and 0.2% of wages are bigger than $100. Moreover most wages more than $100 are not consistent from wages of adjacent years of the individuals.

The dependent variable will be in its log-transformed state instead of its original metric state. Since women's hourly wages have a positively skewed distribution, the log functions transforms it to a more normal distribution. More importantly, it enhances the interpretability. That is, one unit change in the independent variable results in a 100* beta coefficient percent change in women's hourly wage when all other variables in the model are held constant.

Control variables are categorized into three groups. Demographic variables such as age and marital status will be used to control for basic demographic characteristics. Human capital variables will measures the productivity potentials using intrinsic ability, health issue, education and job experience. Voluntary reduction of productivity will be measured by a dummy variable of part time/full time, a dummy variable of if she has more than one job.

Intrinsic ability is measured by Armed Forces Qualification Test (AFQT) scores which were administered in 1980. As it is not a time-varying variable, it is added only in an OLS model while it is absorbed into individual fixed effects in FEM.

A dummy variable of having health problem asks if the respondent is "limited in the kind of work she (could) do on a job for pay because of her health as of survey date." Among entire measures, 5% responded that they had a health problem.

Job experience is measured in three ways. General job experience is measured by years of education and entire years of work experiences. Firm-specific job experience (tenure) is measured by years of job experience from a particular employer. As most job experience is obtained during the early stages of work, the squared years of job experiences will be added. To capture the depreciation of job experience during the leave, the duration out of working place in recent 4 years is used.

Voluntary reduction of productivity is measured in two ways. They are (1) a dummy variable of whether the interviewee is at full time job (more than 35 hours per week) and (2) a dummy variable of whether the interviewee has more than two jobs simultaneously at the interview date.

Results

Does a woman with children have less productivity potentials in the work place? Table 1.4. presents the average wages and various productivity measures by number of births in Non-Hispanic, Non-Black individuals from NLSY79:1980-2006.

Table 1.4 here

Before age-standardization shows average measures with no adjustment. The hourly wages of women with no children is 14.36 dollars. These are slightly higher than those of women with children by .11 dollars when compared to women with one child and .23 dollars when compared to women with two or more children. Non-mothers have longer years of education, shorter years of recent unemployment and higher proportion of full time jobs. Interestingly their job experiences are shorter than mothers. Compared to non-mothers, mothers with two or more children have 4.02 more years of total work experience and work 1.49 more years for the current employer on average.

But mothers' longer job experiences may result from the fact that mothers are typically older than non-mothers. To make a true comparison, it is desirable that mothers and non-mothers have the same age composition. 'After age-standardization' shows the mean measures when each group has the same proportionate age composition, which is calculated using the average of the three groups' age composition (For the details, see Preston, Heuveline, and Guillot 2001. pp.24-30). The differences of wages, education, and years of the leave among groups widen. If she has no children, a woman would earn $15.12. If she has a child, her hourly wages would decline to $13.26 and further to $11.67 with two children. Mothers are more likely to have shorter years of education and longer years of recent unemployment than non-mothers. The differences of proportion of full time jobs among groups gets smaller after the standardization, though non-mothers are still more likely to have full time jobs.

Unlike before age-standardization, after age-standardization shows that years of work experience and tenure of mothers are shorter than non-mothers'. Non mothers have longer work experience than mothers with one child by .82 years and mothers with two or more children by 1.55 years. Non mothers also have worked for the current employer longer than mothers with one child by .22 years and mothers with two or more children by .53 years.

The only exception is the proportion that has multiple jobs. Non-mothers are more likely to have multiple jobs than mothers, which would affect their wages negatively.

The number of births is negatively associated with hourly wage and most productivity measures. If the age effect is neutralized, non-mothers enjoy higher wages, which may be justified by their better education, longer job experiences and higher proportion of full time jobs. But it is still not certain whether the entire wage gap could be justified or whether there is discrimination. To answer this question, residual analysis is suggested.

Table 1.5 here

Table 1.5 presents outputs of various regression analyses. The key interest is at the coefficient of number of births. It shows how wage changes when a woman has an additional child holding all other variables constant, which is the size of motherhood wage penalty.

Model 1-3 is OLS models and Model 4-6 is Fixed Effects models. OLS models include year dummies. AFQT is added only at model 2 and 3. As an AFQT is assumed not changing during her lifetime and measured only once, it cannot be added in fixed effects models. Its effect is expected to be absorbed in the fixed effects.

The gross penalty is the coefficient of number of births when there are no controls other than demographic variables (age and marital status) and person-specific /year-specific fixed effects. Model 4 shows that gross wage penalty for each child is 5.8%. The penalty from the comparable OLS model (model1) is 12.4% and it suggests that there is sizable negative selectivity into having children on unobserved characteristics.

Adding human capital measures in model 5, the penalty declines to 2.8%. Further adding voluntary reduction of productivity potentials at model 6, the penalty, assumed to the size of discrimination is 2%. Table 5 shows that half of the gross penalty could be explained by the reduced human capital (52%=1-2.8/5.8). Productivity differentials could explain 65% (=1-2/5.8) of

motherhood wage gap. One thirds of the wage gap still exists unexplained and it is attributable to discriminatory factors.

When adding a dummy variable of whether there is a infant/toddler in the household at model 6, the coefficient of number of births is -.024, which is statistically significant at $p<.001$.(this result is not shown in the table) Infant/toddler is defined a child under age 3. It is not limited to a biological child but includes any step/adopted children. As a measure of work effort, it is expected to be associated with voluntary reduction of productivity. Even though it is known as an effective measure of work effort(Anderson, Binder, and Krause 2003), it is also directly connected with discrimination. A woman with an infant or toddler is more easily identifiable as a mother than a woman with a teenager, and she is likely to be a target of the discrimination.

Figure 1.2 here

Is the motherhood wage discrimination different by the location in the occupational hierarchy? Figure 1.2 shows LOWESS graph of hourly wages of managers/professionals, non-manual workers and manual workers in NLSY79:1982-2006. In all three groups, women without children earn the highest wages. It clearly shows that having a child is negatively associated with women's wages. The absolute wage gap looks wider for managers/professionals. Compared to manual workers, non-manual workers have a wider wage gap in their mid thirties. The graphs after age 40 are not as meaningful for the sample sizes are not sufficient there.

Table 1.6 here

Table 1.6 presents only the coefficient of number of births at the various models by three occupational groups. Each column is equivalent to Table 1.5.

The gross penalty is the largest for non-manual workers. In the fixed-effects model, the

gross penalty of non-manual workers is 5.1% and that of the manual workers is the second largest at 4.2%. The managers/professionals have only a 3.5% gross penalty. Interestingly the gross penalty in the OLS models is the largest at managers/professionals. The huge size gap between OLS and FEM in managers/professionals suggests that the effects of unobserved characteristics which could affect fertility and wages together are the highest to managers/professionals. It implies that women who would like to be managers or professionals have higher tendency to develop their careers and fertility plans together.

After controlling for human capital measures, the penalty for managers/professionals is reduced to 1.4%. At the full model, it shrinks further and changes to be statistically insignificant. Managers and professionals look to be suffering less from motherhood discrimination. For non-manual workers, the wage penalty decreases to one third of the gross penalty after controlling for productivity measures but still shows 1.7% of a discriminatory wage penalty at the full model. Quite differently to other two groups, manual workers show less change in the penalty size when adding productivity measures. Productivity measures could explain only 28.6% of the penalty and the unexplained portion could link to discrimination. Their gross penalty is in the middle, but their discriminatory wage penalty is the largest.

These findings support my hypothesis. For Managers/professionals, the wage gap is explained by a loss of human capital. With the help of their authority and autonomy in the working place, they could defeat motherhood discrimination. For non-manual workers, the wage gap is the largest and the explanatory power of loss human capital is somewhat smaller than to managers/professionals. But their wage gap is explained mainly by productivity measures as well. Manual workers are at the lowest rank and have the least resources to fight against motherhood discrimination.

Table 1.7 here

Table 1.7 presents that authority and autonomy are important even among manual workers. At table 1.7, manual workers are divided into three groups by the degree of skills – craft workers, operatives, and laborers/service workers. Craft workers are relatively high skilled manual workers. They need extensive periods of training, have comprehensive knowledge of the process and are sometimes allowed exercising a considerable amount of independent judgment. Carpenters, plumbers, and tailors are in this category. Operatives are semiskilled. They operate machines and usually require a few weeks of training. Assemblers, riveters and drivers are in this category. Laborers and service workers are unskilled manual workers. Their duties can be mastered within a few days and ask no independent judgment. Miscellaneous construction laborers, waitress, and maids are in this category. Table 1.7 shows that for laborers/service workers, more than 90% of the motherhood wage gap comes from discriminatory factors.

Discussion

Mothers earn less than non-mothers. Less job experiences, lower education and less commitment can be a partial reason. But there is still an unexplained portion from productivity differentials.

Using residual analysis I find that women are experiencing 2% of a motherhood wage discrimination per child. It is roughly one-third of the gross motherhood wage gap. The sizes of the discrimination are different by the location in the occupational hierarchy. Managers/professionals are not suffering from motherhood wage discrimination. Non-manual workers are suffering from the largest motherhood wage penalty but two-thirds of these are attributable to loss of human capital and voluntary reduction of productivity; only one third (1.7% per one child) are linked to discriminatory factors. Manual workers are suffering from the discrimination, 3% per child. Loss of human capital could explain the majority of the wage penalty typically but it is not the case to manual workers. In their gross penalty, 70% could be linked to discriminatory factors. Laborers/Service workers are the most vulnerable to the discrimination. Their wages get lowered by

5.5% per child because of discrimination.

The size of discrimination is different by the degree of power in the working place. Having authority and autonomy is a key factor explaining why workers in the higher location in the occupational hierarchy are suffering less from the discrimination. Manual workers, especially laborers/service workers who have no skills are the most vulnerable to the discrimination.

This study may overestimate the discrimination if the productivity measure is incomplete so much as to fail to isolate the discriminatory factors into the residuals. On the contrary, it may underestimate the discrimination if productivity measures are associated with discrimination.

There is a possibility that years of job experience and having a full/part time job or multiple jobs are associated with the discrimination. But at least these variables are a legitimate excuse to an individual employer who already hired mothers with lower but 'market-oriented' wages compared to non-mothers. In this sense, this paper gauges the size of motherhood discrimination in a conservative way. In a broader perspective, motherhood wage discrimination would be larger and more complicated.

Nonetheless this study clearly shows that 1) sizable portion of the wage gap is originated from motherhood wage discrimination, 2) the amount and the reason of motherhood wage penalty and motherhood discrimination were different by the location in the occupational hierarchy. I fail to find the discriminatory wage gap from professionals and managers. Their authority and autonomy could make them resist the discrimination. The unfair treatments occur mainly at the bottom of the labor force. They are mothers with less or no skills.

Figure 1.1. Lowess Graph of Hourly Wages by Number of Children, NLSY 79:1982-2006

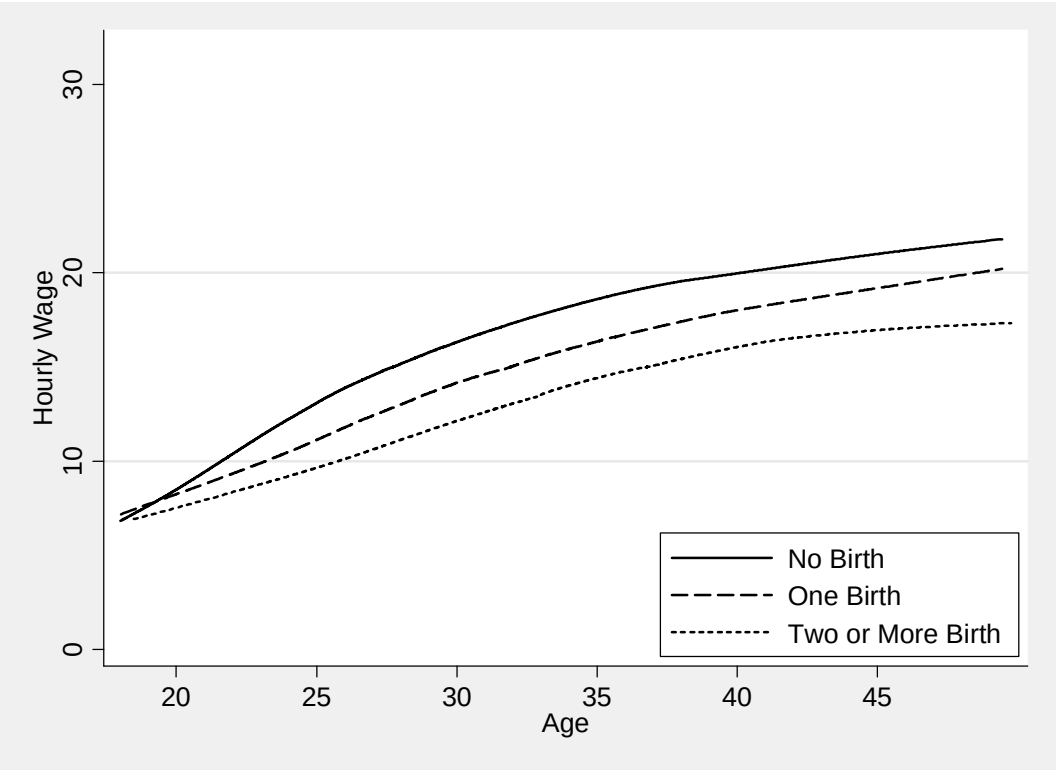

Table 1.1. Previous Research.

	Data	Total Wage Gap[1]	Residual Gap[2]
Waldfogel (1997)	NLS Young Women: 1968-1988	6% for one child 13% for two or more children	4% for one child 12% for two or more children
Budig and England (2001)	NLSY79: 1982-1993	7% per child	5% per child
Anderson et al. (2002)	NLS Young Women: 1968-1988, Non Hispanic White women only	4% for one child 8% for two or more children	3.4% for one child 5.6% for two or more children

[1] Total wage gap means gross wage gap which controls only marital status (Waldfogel 1997 used OLS to obtain the total wage gap, whereas other studies used FEM)

[2] Residual gap means the wage gap after controlling for Human Capital, Part-time Employment, Unobserved Heterogeneity, etc..

Table 1.2. List of Hypotheses on Motherhood Wage Penalty by Occupational Hierarchy.

Occupational Hierarchy	Hypothesis
Managers/Professionals	The main reason for the wage gap is loss of human capital.
Non-Manual Workers	The main reason for the wage gap is less work effort and compensating differentials.
Manual Workers	The main reason for the wage gap is discrimination.

Table 1.3. Descriptive Statistics: NLSY79, 1982-2006

Variable	Mean	Std. Dev.	Minimum	Maximum
Number of Birth	1.037	1.18	0	10
Hourly Wage	14.26	8.73	2.00	96.02
Log Hourly Wage	2.51	0.53	0.69	4.56
Demographic Variables				
Age	30.83	7.04	18.01	49.75
Dummy of Currently Married	0.61	0.49	0	1
Human Capital Variables				
AFQT score	54.50	25.68	1	99
Dummy of having Health Problem	0.05	0.21	0	1
Years of Education	13.43	2.23	4	20
Years of Work Experience	9.90	6.11	0.02	28.67
Years of Tenure	3.74	4.23	0.02	28.52
Years of Unemployment Period	0.38	0.76	0	4
Voluntary Reduction				
Dummy of Full Time Job	0.74	0.44	0	1
Dummy of More than Two Job	0.20	0.29	0	1
Average Waves per Person	13.12			
Number of Persons	3,087			
Number of Observations	32,964			

Note: Standard errors in parentheses.

Table 1.4. Mean Measures before and after Age-Standardization: NLSY79, 1982-2006

	Before Age-Standardization			After Age-Standardization		
	No Birth	One Birth	Two Births+	No Birth	One Birth	Two Births+
Age	27.55	31.00	35.17			
Hourly Wage	14.36	14.25	14.13	15.12	13.26	11.67
% Married	0.32	0.62	0.74	0.36	0.61	0.73
Years of Education	13.93	13.10	12.94	14.14	13.08	12.27
Years of Work Experience	8.09	10.31	12.11	10.99	10.17	8.62
Years of Tenure	3.07	3.89	4.56	3.80	3.58	3.05
Years of Unemployment Period	0.28	0.37	0.51	0.24	0.40	0.64
% of Full Time Job	0.80	0.74	0.65	0.77	0.73	0.67
% of More than Two Jobs	0.22	0.18	0.20	0.23	0.18	0.18

Table 1.5. Effects of Number of Children on Women's Wage, NLSY79, 1982-2006

	OLS			FEM		
	Model1	Model2	Model3	Model4	Model5	Model6
Number of Births	-0.124***	-0.026***	-0.020***	-0.058***	-0.028***	-0.020***
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
Age	0.033***	-0.001	-0.002	0.028***	-0.015***	-0.015***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.002)	(0.002)
Married	0.052***	0.017**	0.017**	0.067***	0.023***	0.024***
	(0.006)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)
AFQT		0.003***	0.003***			
		(0.000)	(0.000)			
Health Problem		-0.078***	-0.076***		-0.044***	-0.042***
		(0.012)	(0.012)		(0.011)	(0.011)
Education		-0.100***	-0.093***		-0.136***	-0.139***
		(0.010)	(0.010)		(0.020)	(0.020)
$(Education)^2$		0.006***	0.006***		0.007***	0.007***
		(0.000)	(0.003)		(0.001)	(0.001)
Work Experience		0.026***	0.026***		0.057***	0.055***
		(0.002)	(0.002)		(0.003)	(0.003)
$(Work\ Experience)^2$		0.000	-0.000***		-0.001***	-0.001***
		(0.000)	(0.000)		(0.000)	(0.000)
Tenure		0.040***	0.038***		0.033***	0.032***
		(0.002)	(0.002)		(0.001)	(0.001)
$(Tenure)^2$		-0.001***	-0.001***		-0.001***	-0.001***
		(0.000)	(0.000)		(0.000)	(0.000)
Unemployed Period		-0.051***	-0.045***		-0.040***	-0.037***
		(0.004)	(0.004)		(0.003)	(0.003)
Full Time Job			0.097***			0.068***
			(0.006)			(0.005)
More than Two Job			-0.085***			-0.062***
			(0.008)			(0.007)
Year Dummies	*Year Dummies are Not shown*					
Constant	1.523***	2.312***	2.220***	1.665***	2.884***	2.888***
	(0.030)	(0.074)	(0.074)	(0.011)	(0.143)	(0.142)
N	32,964	31,938	31938	32,964	32,964	32,964
LL	-2.36E+04	-1.83E+04	-1.81E+04	-1.08E+04	-8991.18	-8860.88

Note: Standard errors in parentheses. *p<.05 **p<.01 ***p<.001

Figure 1.2. Lowess Graph of Hourly Wages by Three Locations in the Occupational Hierarchy, NLSY 79:1982-2006

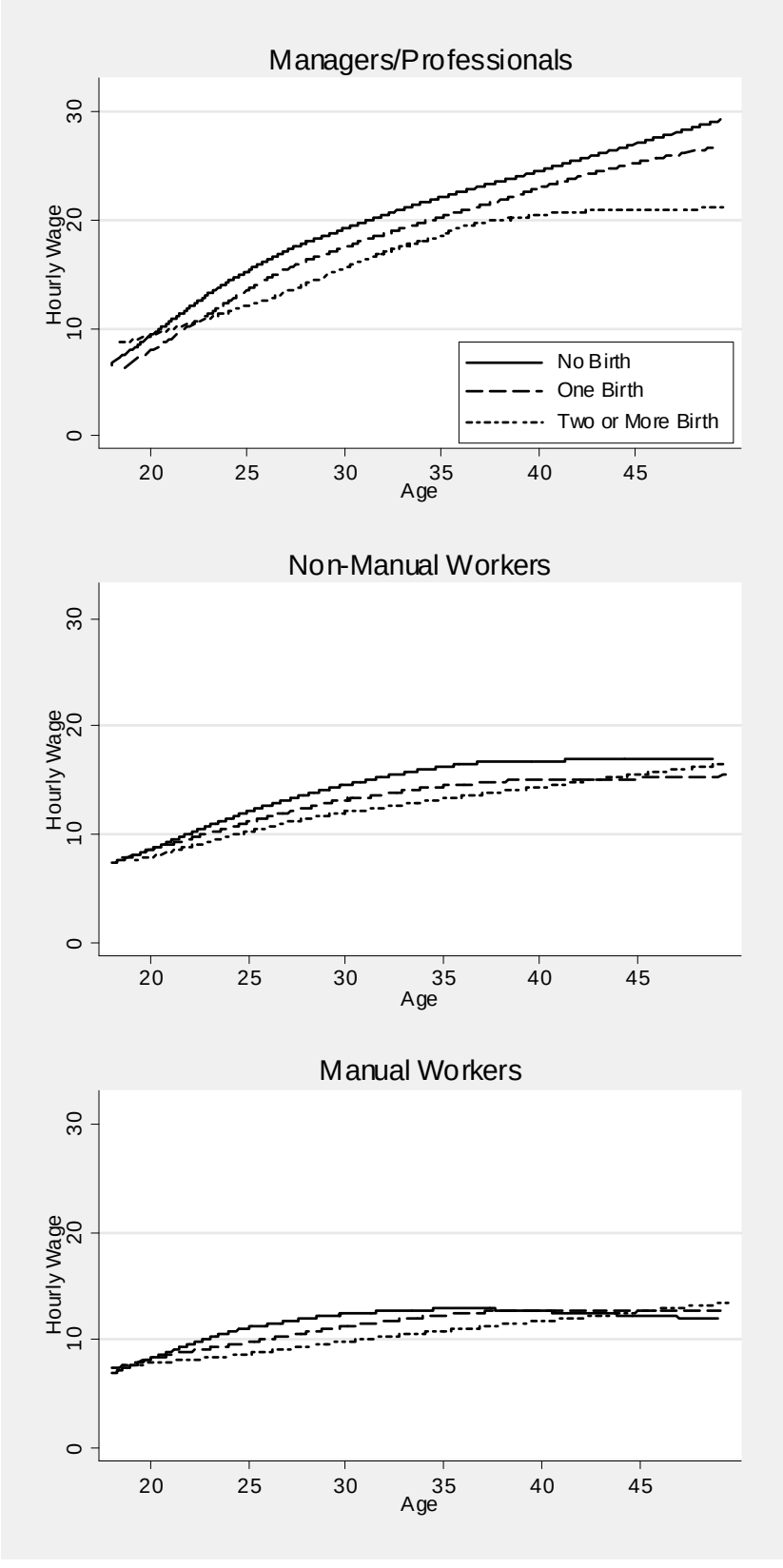

Table 1.6. Estimated Wage Penalty with Motherhood by Three Locations in the Occupational Hierarchy, NLSY79, 1982-2006

Controls	Managers/ Professionals	Non-Manual Workers	Manual Workers
OLS			
Gross Penalty[1]	-0.087***	-0.081***	-0.080***
Above+Human Capital[2]	-0.016***	-0.017***	-0.035***
Above+Voluntary Reduction[3]	-0.012**	-0.005	-0.034***
FEM			
Gross Penalty[4]	-0.035***	-0.051***	-0.042***
Above+Human Capital[5]	-0.014*	-0.024***	-0.031**
Above+Voluntary Reduction[6]	-0.009	-0.017**	-0.030**
Penalty explained by Human Capital (%)	60.0%	52.9%	26.2%
Penalty explained by the full Model (%)	74.3%	66.7%	28.6%
Unexplained Penalty (%)	25.7%	33.5%	71.4%
Number of Observations	10,927	11,204	9,367
Number of Women	1,673	1,835	1,663

Notes:[1] The penalty is equivalent to the coefficient of number of birth at model1 in Table 1.5.
[2] The penalty is equivalent to the coefficient of number of birth at model2 in Table 1.5.
[3] The penalty is equivalent to the coefficient of number of birth at model3 in Table 1.5.
[4] The penalty is equivalent to the coefficient of number of birth at model4 in Table 1.5.
[5] The penalty is equivalent to the coefficient of number of birth at model5 in Table 1.5.
[6] The penalty is equivalent to the coefficient of number of birth at model6 in Table 1.5.
*p<.05 **p<.01 **p<.001

Table 1.7. Estimated Wage Penalty with Motherhood among Manual Workers, NLSY79, 1982-2006

Controls	Craft Workers	Operatives	Laborers & Service Workers
OLS			
Gross Penalty	-0.046*	-0.030***	-0.101***
Above+Human Capital	-0.023	0.007	-0.055***
Above+Voluntary Reduction	-0.016	0.008	-0.055***
FEM			
Gross Penalty	-0.047	-0.010	-0.061***
Above+Human Capital	-0.038	-0.005	-0.055***
Above+Voluntary Reduction	-0.034	-0.005	-0.057***
Penalty explained by Human Capital (%)	19.1%	50.0%	9.8%
Penalty explained by the full Model (%)	27.7%	50.0%	6.6%
Unexplained Penalty (%)	72.3%	50.0%	93.4%
Number of Observations	449	2,121	6,076
Number of Women	119	443	1,286

*p<.05 **p<.01 **p<.001

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CHAPTER 2

WOMEN'S WAGE, CHILDBEARING AND EDUCATION

Introduction

Does a woman's wage influence her fertility? Does an increasing woman's wage booster or lower her fertility? Is the association the same across educational groups? This paper will research how women's wages affect childbearing.

Using June 1990 and June 1995 U.S. Current Population Surveys (CPS), Martin (2000) finds a widening educational gap in fertility. It shows that highly educated women have a higher probability of having their second child after age 30. Accepting education as a proxy of income, it implies that women's wages have a positive association with fertility at least among women who postpone their childbearing until 30. Vere (2007) finds that college-educated women born in the 1970s are having more children as well as participating less in the labor market than their counterparts born in the end of the baby boom using data from the March Supplement to the CPS 1964-2006. Increasing heterogeneity within women may imply that women in different life chances would react differently when their wages are changing. McLananhan (2004) shows that greater disparities occur in resources for childbearing in the second demographic transition that began in 1960s. She argues that the first transition is relatively universal by social class, whereas the second transition has affected classes differently. The negative relationship could change, at least to a specific group.

This research uses the discrete time hazard model using the National Longitudinal Study of Youth 1979: 1981-2006. The data has two merits. In the NLSY79, ages at the first interview were 14-22 and they were 41-47 at 2006 wave. As the respondents reached their 40's, the data could show the entire trajectory of their fertility. It helps to answer the question – who succeeded in

catching up with delayed childbearing at later ages and who did not? The other merit is that NLSY79 has detailed information on women's work history. It records the first and last week of women's job and their hourly wages at every wave. This enables to study the effect of "time-varying" current income on their fertility.

My hypothesis is that only those who are highly compensated among highly educated women can have children at older ages, which shows that only the economically successful women who postpone their childbearing for increased education and a successful career can have as many children as less educated women who have childbearing from the earlier ages.

How do Women's Wages Affect Their Fertility?

Sociological Approach: Role Incompatibility

Sociologists have focused on role incompatibility between workers and mothers (McDonald 2000; Morgan 2003; Rindfuss and Brewster 1996). Women are working in two greedy institutions – their family and their job (Coser 1974). These institutions demand considerable depth of efforts which is indivisible and frequently asks a full-time commitment.

In modern societies, the workplace is not child-friendly and usually does not allow children to be present. The workplace is geographically separated from home. It is ruled by a strict work ethic and the time regulation. Most women must leave home at a given hour and cannot take care of their child at their job.

Childrearing demands the time and attention of the caregivers. This demand is the highest in infancy and diminishes as the child grows up. Especially for the first few months after childbirth, in the United States, the Family and Medical Leave Act passed in 1993 allows workers to enjoy up to 12 weeks of unpaid leave without worrying about job security for the birth and care of the newborn child or adoption. But the regulation applies only to full-time workers (at least 1250 hours of service during the previous year) who are employed in a business which has 50 employees or more. Workers in a small company or part-time workers are not eligible to take the leave. They are

also likely to be at low-paid jobs. In the United States, maternity leave is nearly always unpaid (Waldfogel 1998). So, even among eligible workers, if they cannot afford the unpaid leave, they cannot use it. The average duration of the leave is 20 weeks on an average in the United States; (Waldfogel 1998). After the leave, mothers must decide if they wish to return to their jobs or if they wish to find alternative resources to complete a mother's work - taking care of her children.

The role incompatibility could be lessened if a mother could access resources to aid in childbearing, childrearing and related household chores. Rindfuss et al (2007) find a positive effect of child care availability on childbearing using Norwegian register data. In the United States, child care is readily available and acceptable, but affordability is in question. According to the annual report of National Association of Child Care Resource & Referral Agencies, average prices for a 4 year old child in a child care center in the United States is $3,794 to $10,920 a year in fees in 2006 (NACCRRA 2007). The price for an infant is even higher than that; $4,388 to $14,647. They report that the average childcare fees for two children exceed the median rent cost and average monthly mortgage payment. In order to afford to use daycare or to hire a nanny, women must postpone childbearing until after they save enough money or to move into higher-paying jobs.

Sociological Approach: Value of Children

How can it be explained that low income women decide to have children, even though they must pay a sizable amount of costs? Friedman and her colleagues (Friedman, Hechter, and Kanazawa 1994) answer this puzzle using the parent's desire for children. They maintain that having a child gives parents many values such as uncertainty reduction and enhancement of marital solidarity. Becoming a parent is an irreversible event and it will reduce uncertainty by establishing recurrent and tied social relations. Children might reduce some types of uncertainty but at the same time they could generate others types. When people become parents, they would start to worry about their children's health, academic achievement, his or her career and so forth. However, there is a biased cognitive tendency that actors downplay risks or hazards which they experience

voluntarily and/or are somewhat controllable. Most parents choose to become parents before conception or during pregnancy. Parents believe they could help their children and guide them in the right direction. In this way, the perceived reduction of uncertainty could be larger than the concerns on newly generated uncertainty.

Becker's economic theory on fertility concerns the fertility of "people who already have decided to have children". But, before the decision, "rational people must compare the expected value of a child with that of other goods" (Friedman, Hechter, and Kanazawa 1996). Another interesting argument is that the need for this value is different across actor's economic situations. Low income women who have fewer alternative pathways for reducing uncertainty may be more vulnerable to external changes. It may lead them to bear children in early ages. The more the value of children is preferred, the more women are likely to decide to have children. Friedman and her colleagues apply this theory only to developed countries where children represent a net economic cost to their parent.

Economic Approach: Substitution Effect (Opportunity Cost) vs. Income Effect

The question of how each woman distributes her time between childbearing and market work can be analyzed within a framework of the New Home Economics (Becker 1974; Becker 1991). The New Home Economics maintains that the time of the family member is a scarce resource and that economic theory could be applicable to behavior outside of the monetary market, for example, the decision to have children. The factors affecting childbearing could be divided into demand side and supply side.

On the demand side, women's income has two kinds of effects on fertility, which have opposing directional effect. The one is *income effect* and the other is *substitution effect*. Children are not free. Parents need to buy food and clothes for their children. They may need to hire a babysitter, pay the fee for a daycare center, and visit medical services. An increasing woman's income means she has more power to afford such resources and therefore increase the likelihood of having more

children.

At the same time, growing women's income could lower the likelihood of having more children. Substitution effect is that when the price of one good increases, a consumer will buy different goods since the first one has become relatively expensive. In the New Home Economics, the former is the price of having a child measured by opportunity cost. That is, the relative price of childbearing is mainly decided by changes in the value of the mother's time, because mother's time and efforts are the major component of the cost for the childbearing and rearing. If the value of the mother's time is increasing, the relative price of children will rise. If a mother is expecting an increase in her wages, the relative price of children will go up and therefore, she will be likely to reduce her fertility. Women's opportunity cost consists of current wage as well as future wages which may be penalized by motherhood. During the leave for childrearing, her human capital could depreciate and her skills could become out-dated. This could cause her to lose a matching-job rent, which is enjoying at the current job. If the substitution effect is bigger than the income effect, a woman would decide not to have children when her wage grows and vice versa.

Usually less educated women have a larger substitution effect. This may originate from the fact that the weight of the substitution effect is different. The expected income of less educated women will be smaller. They are more prone to marry less educated men who also suffer from low wages. Then, working for the woman may not be an option but mandatory in order to make two ends meet. But if her husband already has enough income to support them both, or if the family had enough income from their wealth, the increased amount of women's wage does not have the substitution effect at the full degree. That is, substitution effect is a function of not only women's income but also the degree of significance of women's income on total family income. For less educated women, growing income may be fully reflected in the substitution effect, which is bigger than the income effect. It makes them have fewer children when they earn more. To highly educated women, growing income will have substitution effect in part, so their substitution effect could be smaller than the income effect. This will make them have more children when they earn more.

Supply Sides: How Long Can We Wait?

Women's wage can be associated with the supply side of fertility. Borg (Borg 1989) argues that household income and fertility seem negatively associated. But when the net price of having a child and the supply sides are controlled, the household income effect becomes positive.

Women's fecundity has a limited life span from menarche (early teens) to menopause (late forties or early fifties) assuming there is no extraneous cause of sterility (Bongaarts and Potter 1983). To stock human capital for higher earnings, women may postpone childbearing at young ages and choose better education and career establishment. During the delay, the risks of reproductive impairment could increase. This risk rises moderately until the mid-thirties and then it increases sharply (McFalls 1990). Though many women could have a healthy childbearing in their late thirties and even forties, some of them will be childless or have fewer children than they expected due to the impaired fecundity during the delay.

Though most conception difficulties and miscarriages arise from unknown reasons and are indifferent to economic status, some of them could be prevented by proper medical treatments. For example, *fibroid tumors of the uterus,* which is found often in women in their 30s and 40s can generate a miscarriage if the tumor is large and bulges into the uterine cavity. These fibroid tumors can be easily diagnosed in gynecological exam and removed by medical surgery without impairment to fecundity. In this sense, women who delays childbearing and have affordable preventive and proper medical services are likely to bear children at later ages as they expected.

Data and Method

I will use the data from National Longitudinal Study of Youth 1979. It is a national longitudinal sample of 12,686 men and women in the United States. The data has been collected annually until 1993 and then bi-annually from then on. At every round, it asks for the respondents' work history – the first and the last days of the jobs they have had between surveys and their hourly

wages, and fertility history - date of each childbearing.

The data is limited to women with 22 or over. Considering 2 years of a wait time until the conception and gestation period, childbearing before 22 is assumed to be intended before 20. As the purpose of this study is to find a causal effect of wage on fertility, unintentional childbearing should not be considered. Assuming that most teenage pregnancies are unintentionally, many teenagers are not employed and therefore there is lack of wage information, any childbearing before the age of 22 is excluded from the sample. After further excluding military oversample, the final sample size will be 3544 women and 42197 measures.

It should be noted that the data has a specific time span of cohorts who were born during the years 1957 through 1964. At the first survey in 1979, they were 14 to 21 and at the most recent survey in 2006, they were 41 to 47. Many of them have reached menopause or are very close to it. It is a very unique opportunity which enables the researcher to trace if a respondent simply postpone childbearing to her later ages or whether she has forgone having children altogether until she arrives at the end of the fecundible period.

Left-truncation could be problematic because of the observational study setting. Left-truncation happens where "the times individuals become at risk do not necessarily coincide with the start of the observation period" (Rabe-Hesketh and Skrondal 2005). Respondents, who have previously had a child, are not eligible for the study. If there is no correction, there will be sample selection - the sample will consist only of survivors and it will make the hazard of childbearing underestimated. To avoid this bias, women who were older than 22 at the start of the observation period are excluded from the sample.

Table 2.1 here

Model Specification and Measures

$$\text{logit } h(t_{ij}) = \beta_0 + [\alpha_1(Age_{ij}-21) + \alpha_2(Age_{ij}-21)^2] + \beta_1 X_{1i} + \beta_2 X_{2ij}$$

Where i indexes individual women and j indexes time.
X_{1i} are time-invariant covariates and are X_{2ij} time-varying covariates.

I will use a discrete time hazard model. The duration begins at age 22, which is equivalent to the first year of duration. As the baseline hazard increases toward their mid-20s then decreases thereafter, squared duration is added. It is simpler and shows a statistically significant better fit than the model with age-dummy variables according to log likelihood test.

Variables are constructed as of May 1st instead of the interview date to balance the data. As NLSY79 recorded each week of employment status and their wage, and the exact date of childbearing, the variable modification can be accomplished easily.

The dependent variable will be the probability of having a second child. Women who suffer from economic hardship or who expect a higher standard of living compared to their wages may have one child but fail to have a second. Having a second child means achieving average fertility in the United States. In this sense, the second birth should draw more notice (Torr and Short 2004). Among 3544 women, 2825 women have experienced their first birth during the survey period and 2098 women have experienced their second birth. 185 women who reports inconsistent dates of childbearing are dropped.

As independent covariates, race and education will be used. Race is categorized into three groups – Hispanic, Black, and Non-Hispanic & Non-Black. The reference category will be Non-Hispanic & Non-Black.

Instead of current education, education at age 30 is used. Assuming that most young women, who past their 20s, can predict how long they plan to be in school and can adjust their life plan including childbearing accordingly, education at 30 can be a better measure of expected education. There is also less change in education over 30. Education is categorized into four groups – Less than high school (less than 12 years), high school diploma (12 years), some college experience (13 to 15 years), and college degree or higher (more than 16 years).

How to Measure Wages: Current Income vs. Permanent Income

A key independent covariate will be women's wage. Women's wage will be measured in two ways – current wage and wage at 40. Wage at 40 is a time-invariant covariate and current wage is a time-varying covariate. All the wages will be converted to log hourly wages in 2006 dollars. If the hourly wage is less than 1 dollar or more than 200 dollars in 2006 dollars, it will be regarded as an outlier.

There is a disagreement over which income is more critical to decide a current consumption. Keynes postulates that a current consumption depends only on a current income, while Milton Friedman postulates that a permanent income is the relevant determinant of a current consumption (Bhalla 1979; Friedman 1957).

Freedman and Thornton (Freedman and Thornton 1982) study the relationship between husband's current income and expected fertility. They point out the complexity in formulating a permanent income because young couples may give different values to the expected income at different points in time. Heckman and Walker (Heckman and Walker 1990) study the relationship between current female wage and the timing and spacing of births. They maintain that wages are uncertain and current wages are sufficient for measuring future wages.

On the contrary, Friedman (Friedman 1957) notices the volatile characteristics of wages and argues that the changing wage consists of two parts – permanent and transitory. An individual tends to maintain a steady standard of living offsetting temporarily fluctuation. If an individual expects to her wage to increase in the future, her living standard could be higher than if a rise income were not expected. He called such an income as a permanent income.

There are many ways to measure a permanent income. The accumulated total wage till age 40 is one way. The expected wage at age 40 is another. Fleisher and Rhodes (Fleisher and Rhodes Jr 1979) use an average lifetime wage. They measure women's median earnings in the longest held job prior to the first child's birth as permanent income. Bollen et al. (Bollen, Glanville, and Stecklov 2002) suggest using the latent variable to measure the permanent income.

A current wage is likely to be unstable and transitory. But an individual's consumption is limited by the level of her current wage. When a woman suffers from the economic hardship, it is be a reasonable assumption that she will postpone or lessen expenditures.

More importantly, wage at 40 is vulnerable to reversed causality. The overall negative relationship between wage and childbearing may happen not because high wages yield less childbearing but because motherhood lowers women's wages. It is known that having a baby has a negative effect on woman's wage that is called *motherhood wage penalty* (Anderson, Binder, and Krause 2002; Budig and England 2001; Waldfogel 1997). Anderson et al (Anderson, Binder, and Krause 2002) find that college graduates suffer from a large motherhood wage penalty while women who do not have a high school diploma do not receive much of the penalty.

Most childbearing happens before age 40, when the permanent income is measured. It is illogical to assume that future income affects any past decisions of childbearing. On the contrary, the volatile characteristic of current income suggests that the future is uncertain, and any decision should be made based on the current situation.

In this sense, current wages are preferred to trace the causality with childbearing as they appear in a timely fashion. Current wage will lag by two year considering a 9 month gestation period plus several months of waiting until conception to avoid simultaneity of cause and effect.

Another reason that current (lagged) wage is not popular in studying the relationship between wage and fertility is data availability. It is not available in cross sectional data. Even in a longitudinal data, wage variable is likely to be not answered. Fortunately, NLSY79 is a longitudinal data set with a relatively small number of missings at hourly wage. Among measures of which age is 20 or more and employed, only 3.2% is missing.

Two methods are adapted to estimate current hourly wage when it is not available. One is used when a respondent is not employed. In this case, it is assumed that her earning potential is the same as the most recent wage job. For example if she earned 8 dollars per hour 2 years ago from the most recent previous job and has not employed hereafter, her current earning potential will be 8

dollars per hour. As her human capital is likely to depreciate during the leave from the labor market, it could exaggerate her earning potential. If she has never held a wage paying job in any previous years, her wage will be 0. The other is used when a respondent does not provide an answer for her wage even though she has paid jobs. In this case, if her previous and next wages are available, her current wage will be the average of them. If her wage is missing more than two rounds in a row, she will be dropped from the sample.

This paper will use wage at age 40 as a proxy of permanent income, and two year lagged hourly wage as a proxy of a current income.

What if There is an Extraneous Variable Which Affect Her Wages and Childbearing: Endogeneity Issue

Endogeneity happens when an independent variable is correlated with the error term. Wages could be endogenous to fertility if extraneous variables affect the childbearing and women's wages. NLSY79 contains variables which measure attitude on respondents' future fertility and job aspiration. I will use 4 of them. Except for the desired number of children which was measured in 1982, all other variables are measured in 1979. The desired number of children by a respondent measures fertility expectation by asking the question: "HOW MANY CHILDREN DO YOU WANT TO HAVE ALTOGETHER?" The average is 2.24 children. Attitude on traditional family role is rated by the woman's response to the statement: "IT IS MUCH BETTER FOR EVERYONE CONCERNED IF THE MAN IS THE ACHIEVER OUTSIDE THE HOME AND THE WOMAN TAKES CARE OF THE HOME AND FAMILY." If she strongly disagrees, she should choose 1. If strongly agrees, she should choose 4. The average score is 1.99 which is the middle of the two stances. The question to measure future expectation is "WHAT WOULD YOU LIKE TO BE DOING WHEN YOU ARE 35 YEARS OLD?" Zero is coded for having a job and one is coded for married, stay with family. Most respondents choose zero and only 20% choose MARRIED, FAMILY. The question to measure ability expectation to achieve occupation aspiration at age 35 is "WHAT DO YOU THINK YOUR CHANCES ARE OF GETTING INTO THIS TYPE OF WORK

/DO YOU THINK THEY ARE EXCELLENT, GOOD, FAIR OR POOR?" 1 represents excellent and 4 represents poor. The average score is 2.07.

By adding these variables, I expect attitudes, which could affect fertility and career aspiration, are controlled.

Results

Table 2.2 shows the Pearson correlation coefficients between number of births and women's hourly wages by education from National Longitudinal Study of Youth79 (NLSY79): 1979-2006. As they include the observations after the events of interest such as the second birth, the number of measures is much larger than that in the regression model. The first two rows are from longitudinal data of which age is limited to 22 or over. This signifies that respondents could be counted multiple times. Wages at 40 and 2 year lagged wages are negatively associated with number of births but, the decreasing linear relationship is weaker in 2 year lagged wage. When the data is broken down by education, the negative correlation of wage at 40 and fertility is the largest for the least educated group and the smallest for the group with only a high school diploma. The correlation between 2 year lagged wage and fertility shows monotonous trends by education. The least educated group shows the most negative relationship and its effect decreases towards the more educated group. The group with a college degree or higher even shows a positive correlation.

The next three rows shows correlations gauged in three points of ages – 30, 35, and 40. As it is a correlation of a specific age, respondents are counted only once. Overall it is clear that there is a negative association. The relationship is stronger at a younger age. The shrinking negative correlation implies that women with a higher income may postpone their childbearing until after building their career or until after they can lessen the difficulty of childbearing using their earned income in later years. Interestingly, the correlations are different by education. Among the least educated women, the correlation is neither substantially nor statistically significant at age 30 and 35. Unlike other groups, the negative correlation grows toward old ages. The largest correlation is

found for women with some college experience. They spend their early 20s in the school but may not be rewarded for their investment in the labor market. High school graduates who enter the labor market in early ages could build their careers and families quickly.

Table 2.2 here.

Figure 2.1 shows the smoothed hazard estimates and Kaplan-Meier survival estimates of having a second child by education. The plot of smoothed hazard estimates shows that all four estimates draw unimodal trend. The difference is when the peak is and how big it is. Women who have less than a high school education have the highest hazard estimates of second childbearing at their mid 20s (.1349 at 25), which is approximately four times larger than the hazard of women with a college degree or higher until 27 (.122 vs. .037 at 27). In their late 20s, high school graduates and some college experienced women record the peak of hazard (.093 at 27 vs. .074 at 28) and then the modest declines of a similar magnitude. Unlike the other three groups of whose graphs are positively skewed with the long right tales, women with a college degree or higher show low hazard estimates in their 20s. Instead, from the age of 30, their hazard estimates are the largest. After recording the peak at 32, their hazard estimates remain notably larger than the other three groups' for all of the 30s.

Kaplan-Meier survival estimates show that the number of women not having a second child decreases sharply as education decreases. It generates a sizable gap between highly educated women and less educated women during their late 20s and early 30s. From their 30s, women with a college degree or higher lower their survival estimates. Therefore, from the late 30s the gap gets smaller, even though more education connects to the higher probability of remaining not-having second childbearing.

Figure 2.1 here.

Table 2.3 and Table 2.4 show the coefficients from the discrete hazard model of a second childbearing on hourly wage and other control variables[2]. At each table, model 1 is the basic model including wage, duration and race dummy variables. Model 2 adds attitude variables. Model 3 adds the education dummy variables excluding wage. Model 4 incorporates wage and education at the same time. Model 5 has the interaction terms between wage and education assuming that wage effects are different by education.

Table 2.3 here.

Table 2.3 shows second childbearing and wage at 40. At model 1, I regress the probability of having a second childbearing on wage at 40, controlling for duration and race dummy variables. It turns out that wage at 40 is negatively associated with first birth. The coefficient of wage at 40 is -.018 and it is highly significant ($p<.001$). It is .982 in odds ratio. The wage effect is almost the same after controlling for attitude variables additionally. Model 3 shows that how education is associated with the probability of having a second childbearing. To some college experienced women, the estimated odds of having a second childbearing are 75% of the odds for women with a high school diploma. Women with a college degree or higher are more negatively associated with fertility when compared to high school graduates. The odds for the least educated women are 27% higher than the odds for high school graduates. In model 4, the negative coefficient of wage at 40 decreases by 40% compared to model 2. It is reasonable because part of the wage effect can be explained by education effect; less educated women who have a higher probability of having a second childbearing are likely to earn smaller wages. Model 5 adds interactions but its model fit does not significantly improve from model 4 according to the Log Likelihood test ($p=.86$).

[2] The discrete time hazard models of a first childbearing on hourly are found at the appendix.

Table 2.4 here.

At Table 2.4, hourly wage is a time-varying covariate, 2 year lagged. Unlike wage at 40, time-varying wage shows a small positive but statistically insignificant effect at model 1 and 2. An interesting finding is at model 4 and 5. At model 4, hourly wage has a positive effect (β= .013, p<.001). But after adding the interaction terms, the coefficient changes to the negative effect (β = -.018, p=.009). The model fit of model 5 is significantly improved from model 4 according to the Log Likelihood test (p<.001). Considering the interaction terms, the direction of hourly wage is different from education. The combined coefficient is at the lowest for women with a high school diploma (β = -.018). For women with less than a high school diploma, the combined coefficient is still negative (β = -.006). For women with some college experience, the combined coefficient is positive (β = .010). For women with a college degree or higher, the positive effect is more larger (β = .034)

Figure 2.2 here

Plots of survival function of a second childbearing for the high (75th percentile) and the low (25th percentile) wages among the same education level are presented in figure 2.2. It is a predicted probability made from the model 5 in table 2.4. It is not recommended to use observed distribution among the remaining women in each time period because it could artificially lower the hazard in the later years by sample selection (Singer and Willett 2003). Instead, the 75th percentile and the 25th percentile wages in each education category are obtained not from the person-period data but from the original full data which does not remove any individual who experiences the event – second childbearing. Race is set to Non-Hispanic Non-Black, and attitudes are set to the average of each education group. The solid line represents the 75th percentile hourly wage and the dashed line represents the 25th percentile hourly wage from the bottom in the same educational

attainment group. The survival functions of the 75th percentile and the 25th percentile earner are not much different except for women with a college degree or higher. Among women with a college degree or higher, a 75th percentile earner would have sizably lower predicted probability of having second child than a 25th percentile earner.

Discussion

Using a nationally representative data from NLSY79: 1979-2006, I have researched how women's hourly wages affect their childbearing. I found a negative relationship between women's hourly wage and fertility. But the findings are not consistent across education levels. Women who have a high school diploma or less are less likely to have children when their wages increase. But women who have some college experience or a college degree are likely to have children when their wages increase. In other words, when their income rises, less educated women have a bigger substitution effect, whereas highly educated women have a bigger income effect. Or, for less educated women who are likely to be in the low paying jobs, the rise of income is not large enough to lessen role incompatibility. Only for highly educated women who are likely to be in high paying decent jobs, the rise of income can be used as a resource for reconciling the mother's and worker's roles.

Less educated women are likely to start having children in their earlier ages and have a larger number of children altogether. Some college-experienced or college-educated women are likely to postpone the childbearing and have a smaller number of children. Among them, only highly compensated women are likely to have children at older ages. It is much clearer among college educated women. The gap of predicted probability to have a second child between high earner (75th percentile from the bottom within the same education category) and low earner (25th percentile) is the largest in the group with college degree or higher.

The findings mainly come from the relationship between fertility and 2 year lagged income. I fail to find an interaction between education and wage at 40. 2 year lagged income is a

measure of current income, while wage at 40 is a measure of permanent income. Even though the correlation with fertility is stronger in the case of wage at 40, I recommend using 2 year lagged income. Future is uncertain; to the contrary, current wage set the boundary women can consume. More importantly, 2 year lagged income is in timely fashion of cause and effect. A study using future wages as a permanent income may exaggerate the negative relationship between fertility and women's wage.

It should be noted that this study is built on the data of which respondents were born in 1957-1964. They were 41-47 years old as of 2006, at the last year of the survey. The more recent cohorts may have different reaction when their income changes.

Table 2.1. Descriptive Statistics of Variables

	Mean	S.D.	Min	Max
Year	1992	6.63	1981	2006
Age	30.19	6.45	22	47
First Childbearing	0.07	0.26	0	1
Second Childbearing	0.05	0.21	0	1
Hourly Wage, time-varying	13.38	9.01	0	98.5
Hourly Wage at 40	18.20	11.94	0	97.8
Attitude				
Number of Desired Children	2.24	1.35	0	16
Attitude on Traditional Family : 1=least, 4=strong	1.99	0.51	1	4
Expectation at 35: 0=job, 1=family	0.20	0.40	0	1
Expected Ability for Aspired Occupation at 35: 1=excellent, 4=poor	2.07	0.79	1	4
Race				
Hispanic	0.16	0.37	0	1
Black	0.27	0.44	0	1
White: reference category	0.57	0.50	0	1
Education				
Less than High School	0.08	0.27	0	1
High School: reference category	0.38	0.48	0	1
Some College Experience	0.28	0.45	0	1
College Degree or Higher	0.26	0.44	0	1
Number of Women	3544			
Number of Measures	42197			

Table 2.2. Pearson Correlation Coefficients between Number of Births and Women's Hourly Wages, NLSY79: 1979-2006

	All	Less than High[1]	High School[2]	Some College[3]	College[4]
At Longitudinal Setting[5]					
Wage at 40	-.235***	-.137***	-.092***	-.123***	-.120***
2 Year Lagged	-.106***	-.080***	-.031***	-.015*	.174***
At A Specific Age					
At 30	-.241***	-.022	-.140***	-.168***	-.137***
At 35	-.183***	-.042	-.104***	-.170***	-.072*
At 40	-.161***	-.132*	-.086**	-.141***	-.080*
Number of Women/Measures					
Wage at 40	68173	9277	29125	17338	12219
2 Year Lagged	80307	10640	32730	19506	14815
30	4444	459	1838	1171	976
35	3797	379	1591	1042	785
40	3474	350	1474	945	705

* p<.05; ** p<.01; *** p<.001

[1] Less than High means she does not have high school diploma.

[2] High School means she has a high school diploma.

[3] Some College means she has some college experiences but does not graduate it.

[4] College means she has a college degree or higher.

[5] Individuals are limited to age 22 or over. Due to its longitudinal setting, they could be counted multiple times.

Figure 2.1. Plots of Women's Hazard Estimates and Survival Estimates of Second Childbearing by Education, NLSY79:1979-2006.

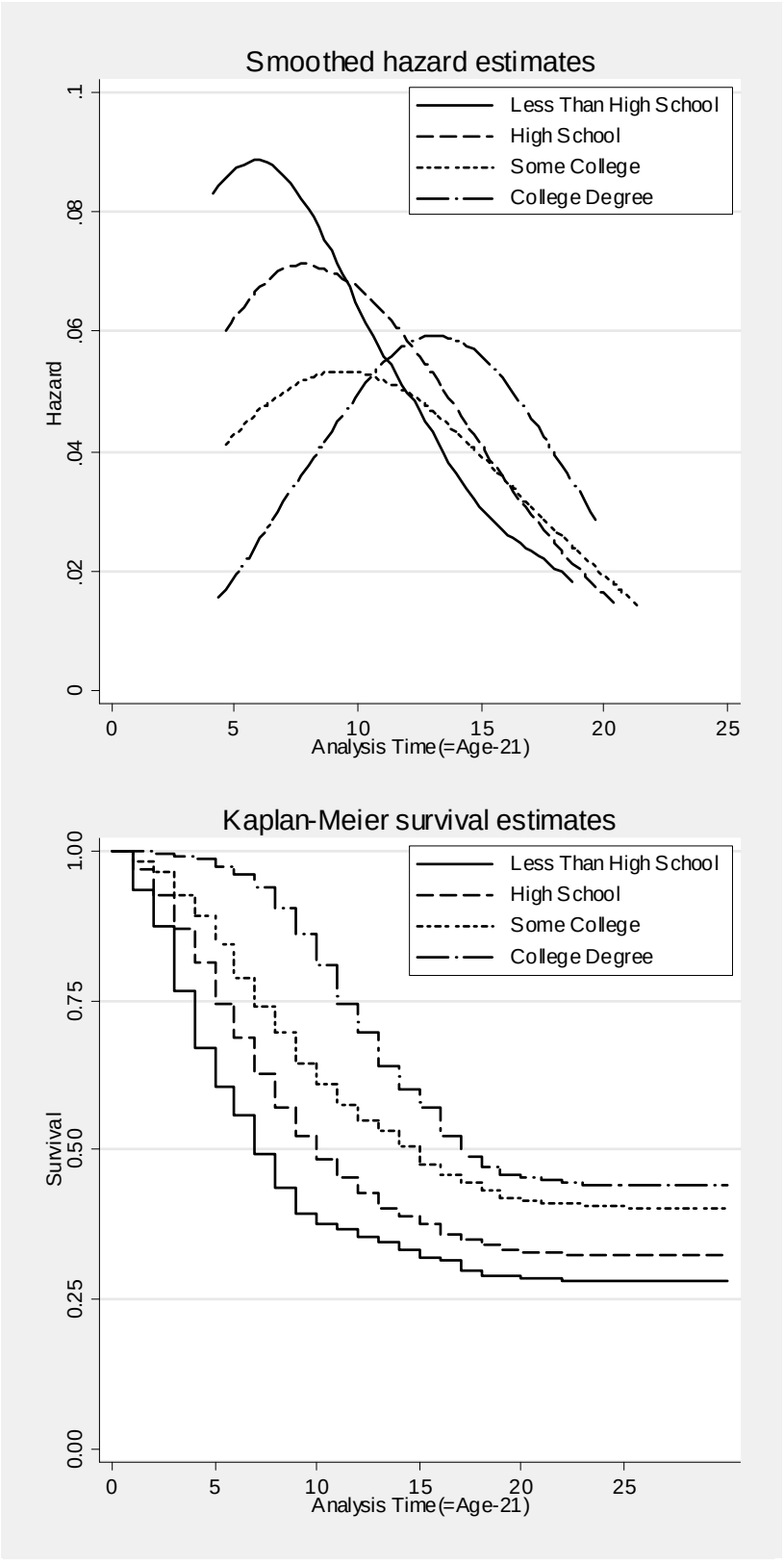


Table 2.3. Coefficients from Discrete Hazard Model of Second Birth on Hourly Wage at 40 and Control Variables

	Model 1	Model 2	Model 3	Model 4	Model 5
Wage at 40	-0.018***	-0.017***		-0.010***	-0.009
	(0.003)	(0.003)		(0.003)	(0.005)
(Age-21)	0.167***	0.179***	0.172***	0.184***	0.184***
	(0.018)	(0.019)	(0.018)	(0.019)	(0.019)
(Age-21)2	-0.012***	-0.013***	-0.012***	-0.013***	-0.013***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Black	-0.125*	-0.126	-0.092	-0.139*	-0.140*
	(0.060)	(0.065)	(0.061)	(0.066)	(0.066)
Hispanic	0.189**	0.173*	0.08	0.139	0.137
	(0.066)	(0.073)	(0.068)	(0.074)	(0.074)
White (Reference Category)		-	-	-	-
Number of Expected Birth		0.073***	0.099***	0.090***	0.090***
		(0.017)	(0.017)	(0.018)	(0.018)
Attitdue on Traditional Family		0.140*	0.128*	0.075	0.077
		(0.056)	(0.052)	(0.057)	(0.058)
Expectation at 35		0.12	0.087	0.074	0.072
		(0.067)	(0.062)	(0.068)	(0.068)
Expected Ability at 35		0.002	-0.009	-0.021	-0.022
		(0.035)	(0.032)	(0.035)	(0.035)
Less than High School			0.235**	0.184	0.322
			(0.089)	(0.099)	(0.192)
High School (Reference Category)			-	-	-
Some College Experience			-0.299***	-0.283***	-0.269*
			(0.062)	(0.068)	(0.136)
College Degree or Higher			-0.538***	-0.430***	-0.401*
			(0.069)	(0.080)	(0.156)
Wage * Less than High School					-0.013
					(0.016)
*Wage * High School (Reference Category)*					-
Wage * Some College Experience					-0.001
					(0.007)
Wage * College Degree or Higher					-0.002
					(0.007)
Constant	-2.848***	-3.392***	-3.485***	-3.202***	-3.226***
	(0.085)	(0.172)	(0.149)	(0.175)	(0.185)
N	35984	31002	36241	31002	31002
LL	-6559	-5662	-6715	-5641	-5640

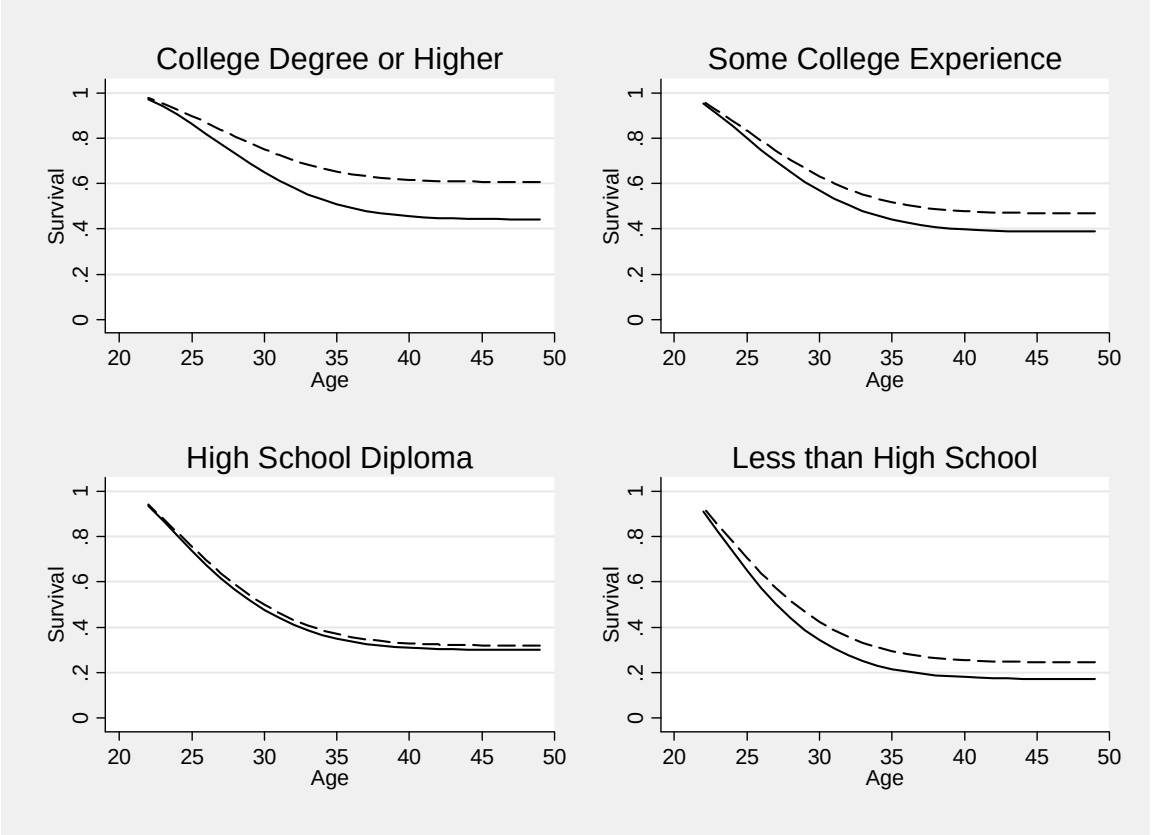
Note: Standard errors in parentheses. *p<.05 **p<.01 ***p<.001

Table 2.4. Coefficients from Discrete Hazard Model of Second Birth on Lagged Hourly Wage and Control Variables

	Model 1	Model 2	Model 3	Model 4	Model 5
Hourly Wage, 2 Year Lagged	0.003	0.004		0.013***	-0.018**
	(0.003)	(0.003)		(0.003)	(0.007)
(Age-21)	0.148***	0.159***	0.172***	0.160***	0.164***
	(0.017)	(0.018)	(0.018)	(0.018)	(0.018)
(Age-21)2	-0.012***	-0.012***	-0.012***	-0.012***	-0.012***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Black	-0.027	-0.042	-0.092	-0.064	-0.093
	(0.056)	(0.061)	(0.061)	(0.061)	(0.061)
Hispanic	0.181**	0.134*	0.08	0.083	0.085
	(0.061)	(0.067)	(0.068)	(0.068)	(0.068)
White (Reference Category)		-	-	-	-
Number of Expected Birth		0.077***	0.099***	0.098***	0.099***
		(0.017)	(0.017)	(0.017)	(0.017)
Attitdue on Traditional Family		0.243***	0.128*	0.145**	0.128*
		(0.051)	(0.052)	(0.052)	(0.053)
Expectation at 35		0.138*	0.087	0.084	0.095
		(0.061)	(0.062)	(0.062)	(0.062)
Expected Ability at 35		0.04	-0.009	-0.004	-0.008
		(0.032)	(0.032)	(0.032)	(0.032)
Less than High School			0.235**	0.266**	0.087
			(0.089)	(0.090)	(0.162)
High School (Reference Category)			-	-	-
Some College Experience			-0.299***	-0.319***	-0.609***
			(0.062)	(0.062)	(0.124)
College Degree or Higher			-0.538***	-0.595***	-1.326***
			(0.069)	(0.070)	(0.128)
Wage * Less than High School					0.012
					(0.016)
*Wage * High School (Reference Category)*					
Wage * Some College Experience					0.028**
					(0.009)
Wage * College Degree or Higher					0.052***
					(0.008)
Constant	-3.164***	-3.990***	-3.485***	-3.614***	-3.247***
	(0.070)	(0.148)	(0.149)	(0.153)	(0.167)
N	42197	36241	36241	36241	36241
LL	-7875	-6758	-6715	-6707	-6682

Note: Standard errors in parentheses. *p<.05 **p<.01 ***p<.001

Figure 2.2. Predicted Probability of Remaining Not-Having Second Childbearing of Women from Table 2.4, Model 5. The Solid line is for 75th Hourly Wage and the Dashed line is for 25th Hourly Wage from the Bottom in the Same Educational Attainment Group, using NLSY79: 1979-2006.



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CHAPTER 3

TEMPO CHANGES AND LOW FERTILITY IN SOUTH KOREA

Introduction

In the 2000s South Korea has experienced a plummet in total fertility rates around 1.1. It has caused many social concerns – a rapidly aging population with an increasing burden of medical and pension resources for the elderly, a shortage in the labor force, especially young workers and an ebbing vitality in economy with declining effective demands.

A Total Fertility Rate (TFR) is the most common measure of fertility level. It is composed of the interplay of two components; a change of the number of births (quantum) and the shift of the timing of those births (tempo). When the timing of births is deferred, the TFR would decrease; when the timing of births advances, the TFR would increase. In this way, a TFR may change even though there is no quantum change as long as there is a tempo change. Previous research on the fertility decline in Korea has been conducted with a quantum driven perspective, and little has been conducted based on the tempo perspective (Choe, Retherford, and Kim 2004; Eun 2002; Eun 2006; Kim 2005).

Tempo effect is one of the key reasons causing the lowest-low fertility[3] in Southern and Eastern European countries (Bongaarts 2002; Lesthaeghe and Willems 1999; Lutz, O'Neill, and Scherbov 2003; Lutz and Skirbekk 2005; Philipov and Kohler 2001; Sobotka 2004). They agree that the current low fertilities are exaggerated by sizable negative tempo effects. Lutz, O'Neill and Scherbov (2003) suggest that the tempo effect is around .3 births in 10 EU countries. If the tempo effects were removed instantly, European countries could escape from the lowest-low fertility rates.

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[3] Lowest-low fertility is defined as a level of the total fertility rate at or below 1.3 (Kohler, H. P., F. C. Billari, and J. A. Ortega. 2002. "The Emergence of Lowest-Low Fertility in Europe During the 1990 s." *Population and Development Review* 28:641-680.)

It should be noticed that all fertility declines are not necessarily accompanied by negative tempo effects. A fertility decline could happen if a quantum decline is very large and a negative tempo effect does not fully offset it. In Russia the fertility decline in the early 1990s happened while the mean mothers' age at birth decreased (Philipov and Kohler 2001). A similar phenomenon could be found in Korea in the early 1980s when its TFR arrived at the replacement level for the first time.

The research purpose of this paper is to quantify the tempo effect on the recent fertility decline. Has the tempo effect served for the recent fertility decline in South Korea? If then, how important is it? By answering these questions, this paper will suggest the extent to which the current fertility decline is a tempo-driven phenomenon. I expect the disentanglement between quantum and tempo effects will serve for a better understanding of recent fertility changes.

I will decompose the tempo and quantum effects by estimating adjusted TFR introduced by Bongaarts and Feeney (Bongaarts and Feeney 1998). Adjusted TFR could show a counterfactual fertility rate in a given year when there is no tempo change comparing to adjacent years. The assumptions on the Bongaarts and Feeney method are tested, and adjusted TFR with variance effects suggested by Kholer and Philipov (Kohler and Philipov 2001) is also estimated.

Figure 3.1. here

Figure 3.2. here

South Korean Context

During the industrialization in the 1960s and the 1970s, South Korea tried to lower its fertility to the replacement level and achieved this goal successfully by the mid 1980s. After Korea reached a TFR of 2.1 in 1983, its TFR has modestly fluctuating for a decade. From 1995 it resumed the decline with a slow pace. Demographers widely had accepted that the first fertility transition came to an end and a new stage of stability would begin (Kim 2005). However, from 2000, it

started to plummet and reached a TFR of 1.08 in 2005.

During the relative stability of the TFR after the mid 1980s, age-specific fertility rates (ASFRs) are undergoing remarkable changes. In 1985, the ASFR for ages 25-29 reached a peak and the ASFR for ages 20-24 reached to the second highest. In 1995, the ASFR for ages 20-24 decreased to the half of that in year 1985. Instead the ASFR for ages 25-29 and 30-34 increased approximately by .2 births. In 2005 the ASFRs for ages 20-24 and ages 25-29 decreased by half but the ASFR for ages 30-34 increased slightly compared to the ASFR in 1995. During the past two decades, the ASFR for women in their 20s has declined significantly and the ASFRs for those in their 30s have shown little change or growth.

Until the late 1990s there was less concern for the low fertility in South Korea. The lack of attention to declining fertility originated from the facts that (1) South Korea had suffered from rapid population growth for decades, 2) its TFR was fluctuating at a modest low fertility level of around 1.6, and (3) there was a belief that the current low fertility was indebted to the strong family planning program and prevailing induced abortions. However, low fertility has become one of the hottest issues in South Korea, since it has plummeted into the lowest low fertility from year 2001.

Most demographers agree that the economic crisis in 1997 made a huge effect on the current low fertility in South Korea (Choe, Retherford, and Kim 2004; Eun 2002; Eun 2006; Kim 2005; Kim 2003; Tsuya and Bumpass 2004)**.** Yet there is no consensus on how it yields any further decline. Some give more weight to ideological changes and others to structural changes.

Some scholars (Choe, Retherford, and Kim 2004; Kim 2003; Tsuya and Bumpass 2004) stress the change of values and norms toward less or no children in the 1990s. Choe, Rethorford, and Kim (2004) found that men and women were less likely to believe that marriage is necessary in 2000 (24 percent) compared to 1991 (30 percent)**.** Women's ideal age at their first marriage also shifted from 25.3 in 1991 to 26.7 in 2003. Kim et al. (2003) reported that the percent of people who think it is necessary to have children declined dramatically from 90% in 1991 to 58% in 2000. Their theories are similar to the second demographic transition (Van De Kaa 1987) in that South Korea

experienced a swing from altruistic to individualistic marriage and a greater stress on pairs rather than children, though cohabitation and childbearing out-of-wedlock is relatively rare in South Korea

Other scholars (Eun 2002; Eun 2006) give more weight to structural changes. The facts that there is less change in the ideal number of children and that many women still expect to have two children support this theory. More women are well-educated and are participating in the labor force which is hampering childbearing due to an unchanged traditional women's role. Eun (2002) argues that the changing labor market after the economic crisis is the most significant factor in explaining the rapid decline of fertility. The decreasing full-time/stable jobs and the increasing flexibility of the labor market makes youth take more time to establish careers and therefore, young adults are likely to postpone their marriage. Economic crises also threaten family economics and married people are likely to get divorced due to economic reasons. Consequently, economic crisis may lower fertility. Similar cases can be found in Central and Eastern European countries after the falls of Communist regimes (Kohler and Kohler 2002; Ranjan 1999).

Both sides agree that the delayed marriage and childbearing is a key characteristic of the current fertility decline, but their perspectives are all quantum driven. They regard the delay as an intermediate variable and pay less attention to tempo effects separately. If a cohort TFR is of interest, tempo changes would have only transient effects and would not matter. But if a period TFR is of interest, tempo changes would have its own effect.

Period TFR vs. Cohort TFR: Why Does the Tempo Effect Matter?

A total fertility rate is the sum of age-specific fertility rates (ASFRs). There are two kinds of TFR: cohort TFR and period TFR. Following a woman from the beginning to the ending of her reproductive years is cohort completed fertility (cohort TFR). It shows the average number of children that women have during their lifetime. It can be recorded only after the subject group has passed the end of their reproductive years – usually in their late 40s. Therefore the cohort TFR is

useful to research the past changes but not suitable to examine the current situation.

Period TFR is the sum of age-specific fertility rates recorded for a given population in a given year. It is calculated from a synthetic group of women who would follow the given ASFRs through their reproductive years. In this way, period TFR is able to record the current fertility level.

Unlike cohort TFR which is decided solely by quantum changes, period TFR includes another factor - tempo changes. Figure 3 shows how tempo effect is related to period TFR and cohort TFR. Figure 3.a is a Lexus diagram which shows the way of calculating period TFR and cohort TFR. The cell of a column is the ASFR of a given time. For simplicity, it is assumed that there are no births before age 19 and after age 45. As the age category has 5 year intervals and the columns have also 5 year intervals, a cohort TFR is obtained by summing diagonal ASFRs. For example the cohort TFR of t-20 cohort (women who are 20-24 years old at time t-20) is the sum of grey ASFRs (2.0=5*(.1+.1+.1+.1+0)). A period TFR is the sum of column ASFRs (sum of a column=5*(.1+.1+.1+.1))

Before time t, all births happen when mothers are at age 20-39 with the same ASFRs. Let us imagine that there is a war at time t and every woman decides to shift towards later childbearing by 5 years and keeps the shift hereafter – all births will happen when mothers are at ages 25-44 with the same ASFRs. The ASFRs at time t would be 0. Therefore the period TFR in time t will be also 0. From time t+5, the period TFR rebounds and continues to 2.0. Interestingly there is no change in the cohort TFRs at those times. It is because that there is no change in the number of children women would have during their lifetime. The war at time t made women simply postpone their childbearing and they have childbearing in later years. Like this, a change in mother's mean age at birth could affect period TFR but not cohort TFR

Figure 3.3 here.

It is unrealistic that all the delay will finalize in later childbearings. Some women will give

birth at later ages, but others will have fewer children than expected or may forgo having a child. Figure 3.b shows such a scenario. What if women still want to have two children in their lifetime? Due to the growing concerns to build a career and to evade current economic difficulty, they may decide to postpone having children. What if 80% of them finally succeed in having babies in their 30s or even their 40s? The data in figure 4.b from year 1975 to 2005 is from the real vital statistics in South Korea but the data from after year 2005 is assumed arbitrarily in that the cohort TFRs should converge to 1.6. While the cohort TFR decreases gradually from 2.36 (1975 cohort) to 1.6 (2005 cohort) by year 2025, the period TFRs have dropped rapidly to 1.08 in 2005 then rebound to 1.6. This scenario shows that period TFR could be sizably different from cohort TFR and is volatile to tempo changes.

Tempo perspective is useful not only to understand the current fertility changes but also to predict the future fertility. The postponement of childbearing cannot last forever. Women should decide whether to have children or not before they arrive at infecundible age. Low fertility driven by the tempo effect could rebound later when the tempo effect disappears or decreases if all other things remain constant. The fertility recoveries of the United States in the 1990s from the decades of below replacement level to the above replacement level fertility (Bongaarts and Feeney 1998) and of the Netherlands from 1.53 in the mid-1990s to 1.72 in the early 2000s (Sobotka 2004) are accomplished while the rise of the mean age at birth stops. Thus the size of the tempo effect shows the potential of fertility rebound in the future.

Two things should be considered. First, even if the postponement is likely to have a time limit, it is hard to tell when that limit will be reached. Japan has experienced the postponement of childbearing for decades though the speeds of this postponement have been fluctuating (Suzuki 2006). The mean age at childbearing rose from age 28.1 in 1984 to 29.8 in 2003 and it is still growing.

Secondly, it is too optimistic to think that the period TFR could rebound as much as the size of the tempo effect in the long run. The current decision of postponement of childbearing could

be finalized in simply delayed childbearing as well as fewer or no children than they expected.

However, tempo-free TFR would be a better indicator of the level of the cohort TFR based on current fertility. It should be noted that tempo-free TFR is not a substitute of cohort fertility but still a period measure. Though, it is a better approximation of the cohort TFR (Sobotka 2004) and can give more information on the future of fertility changes than a conventional period TFR.

Methods and Data

Adj-TFR using Bongaarts and Feeney Methods

Bongaarts and Feeney (1998) suggest adjusted TFR which shows "an accurate estimate of the total fertility rate that would be observed in the absence of changes in the timing of childbearing"(Bongaarts 2002). Adjusted TFR is a kind of counterfactual TFR which indicates TFR when tempo effects are removed. A conventional period TFR would be the same to an adj-TFR insofar as the childbearing ages are constant.

As the mean age at childbearing could be affected not only by the change of timing but also composition of parity (birth order), Bongaarts and Feeney suggested applying their adjustment by parity separately. As a higher parity is likely to happen at later ages, a mean age at childbearing can be younger even when childbearing is delayed; if the effect of declining higher parity is greater than the effect of actual delay of childbearing.

Their formula estimating a parity specific adjusted TFR is as below:

$$\text{Adj-TFR}_{it} = \text{TFR}_{it} / (1 - r_{it})$$

Where r_{it} is the change in mean age at childbearing at parity *i* between the beginning and the end of the year t.

$$r_{it} = dMAC(t)/dt$$

$$= (MAC_{t+1,i}+MAC_{t,i})/2 - (MAC_{t-1,i} +MAC_{t,i})/2 \quad = [(MAC_{t+1,i} - (MAC_{t-1,i})/2]$$

where $MAC_{t,i}$ is the mean age at childbearing at year t and parity i.

To get the MAC at the beginning and end of year of t, the average of MAC at t and t-1 is calculated. Therefore, adj-TFRs of the beginning year and the last year in the dataset cannot be

estimated.

While some researchers criticize the Bongaarts and Feeney method (Kim and Schoen 2000; van Imhoff and Keilman 2000) in that its assumption is easy to be violated and it is not a true cohort measure. But many others support it because 1) the violation of the assumption is not critical and in many cases, adj-TFR is not sensitive to the assumption (Yi. and Land 2001), 2) Bongaarts and Feeney do not argue that adj-TFR is a substitute of cohort TFR and they admit it is a kind of a period measure (Bongaarts and Feeney 1998; Bongaarts and Feeney 2000) and 3) it is simplistic and useful to detangle quantum changes in period TFR from tempo effect (Kohler and Philipov 2001; Lesthaeghe and Willems 1999; Lutz and Skirbekk 2005; Sobotka 2004; Yang and Morgan 2003; Yi. and Land 2001).

Assumptions Tests

Bongaarts and Feeney's adj-TFR is based on the assumption that there is no age-period interaction. That is, when there is a shock to fertility, each age group should receive similar effects and its fertility should adjust in a proportionate way to keep the shape of the fertility schedule invariant. If the shape was modified, adj-TFR would be biased. Though the assumption is somewhat unrealistic, according to Zeng and Land(Yi. and Land 2001)'s sensitivity analysis, adj-TFR is robust to the assumption. If the change in the shape is expected or the tempo changes more than .25 years(Yi. and Land 2002), the adjustment could be exaggerated.

To justify the assumption, two approaches will be employed. First, the assumption of no age-period interaction will be tested as Philpov and Kholer (Philipov and Kohler 2001) did in their study about the tempo effects and the fertility decline in Eastern European countries. In their study, the fertility schedule is regarded as a survival schedule and compared with adjacent years' schedules. If there is a crossing of the curves, it means an age group will act differently against extraneous impacts and the shape of fertility schedule will be changed. As the crossing may happen as a result of the random fluctuations, the statistical test will examine whether two survival

functions are equal.

Secondly, adj-TFR with a variance effect (Kohler and Philipov 2001) that allows the inclusion of the effect of changing variance at the fertility schedule will be suggested.[4] The increase of the mean age at childbearing is likely to go along with the increase in the variance of the fertility schedule. The variance change could imply a modification to the shape of the fertility schedule – the violation of non age-period interaction assumption. By incorporating variance changes in the TFR adjustment, a more robust adj-TFR can be obtained.

Data

To estimate adjusted-TFRs, age-specific data on the women's population and data on the number of births by mothers' age and birth orders are needed.

The Korean government has used registered population data from 1992 to calculate the official TFR. As the registered population is the population at the end of a given year, mid-year population is available from 1993. On before 1993, the Korean government had used estimated population from its Census. I will use the same dataset from 1985 to 2006

The numbers of births by mothers' age and birth order from year 1985 to 2006 are obtained from the Korean Women's Development Institute (http://www.kwdi.re.kr). The birth order is in four groups; first birth, second birth, third birth, and fourth or later birth. If birth order or mother's age is unknown, such births are excluded. It makes the estimated TFRs smaller than the official TFRs but the difference is negligible.

Results

Figure 3.4 shows that the mean ages of childbearing (MAC) by birth order in South Korea have been growing from the mid-1980s continuously. The fourth or later birth is not shown in the

[4]Hans-Peter Kohler's programs (http://www.ssc.upenn.edu/~hpkohler/data-and-programs/bfvariance/bfvarianceprograms.html) are used to calculate the adjusted TFR with variance effect

graph. For details, see the appendix. The first MAC was 24.9 in 1985 and rose to 29.3 in 2006. The second MAC also rose from 26.5 in 1985 to 31.3 in 2006. The slope of first births gets steeper from 1996, which means that women postponed their first childbearing with faster speed. The slope of second births gets steeper from 2000. The rising MAC implies a positive "r" of the Bongaarts-Feeney method and a negative tempo effect.

Figure 3.4. here

As shown in Figure 5, "r" from all three birth orders decreased till the mid 1990s and then grew again till 2003. "r" of the first births tripled from .1 in 1991 to .3 in 2002. "r" of .1 means that a TFR without the tempo effect would be higher by 11% (=1/1-r) than the original TFR at the birth order. "r" of .2 means the TFR would be higher by 25%, and "r" of .3 means it would be higher by 43%. "r" of the second births followed a similar pattern. In 1995, it recorded the lowest point at .12 and then increased to .3 in 2003 and 2004. 1995 is when the TFR began to decrease from ten years of a standstill at around 1.6. The stable fertility with the declining tempo effects from 1985 to 1995 implies that the fertility rates (quantum only) were actually on the decline. The growing negative tempo effect after 1995 implies that the recent fertility declines were tempo-driven phenomena and the declining speed was not as steep as the conventional period TFR showed. 2004 and 2005 show interesting phenomena. "r" of the first and second births shrinks to .2 while South Korea is still recording around 1.1 of the TFR. It is necessary to pay attention to see if it makes any further trend.

Figure 3.5. here

Figure 3.6 shows the adj-TFRs and the original TFRs from 1985 to 2005 in South Korea. The gap between the adj-TFR and the original TFR narrowed to .25 births by the mid 1990s when the tempo effect was the smallest. After 1995, the gap widened to .53 births in 2000. So if there is

no tempo distortion, its TFR would be around 2.0 and close to replacement level fertility till 2000. Such a huge tempo effect is larger than those in 10 countries in the European Union – .3 births (Lutz, O'Neill, and Scherbov 2003) and comparable to that of the Czech Republic in the mid 1990s (Philipov and Kohler 2001). [5] After 2000, the absolute size of the gap shrank to .41 births in 2004 and .3 births in 2005. If the tempo effects are removed, Korean fertility will be well above the lowest-low fertility. But adj-TFRs are also on the sharp decline. It implies that the recent fertility decline into the lowest-low fertility level is accomplished initially by the surge of negative tempo effects.

Figure 3.6. here

Is the assumption that there is no age-period interaction violated? If the fertility schedule is changed, there is a crossing among the birth-free survival curves. I tested the first births curves and the second births curves from 2000 to 2003 when the differences between adjacent MACs are the largest; the difference ranges .28 to .31 years for the first birth and .22 to .35 for the second birth. As Figure 6 shows there is no crossing which means that as the extraneous impact changes each age group in the same way, the shape of fertility schedule is not changed. A Log-rank test and the Wilcoxon test for equality of survival functions are also performed. Holding the hypothetical sample size at 10,000, the null hypothesis that the survival functions are the same cannot be rejected.[6]

[5] A comparison of the adj-TFRs between countries needs a special attention. The volume of tempo effects depends not only on r but also on TFR. Even though r is the same, the larger TFR would make a bigger gap between TFR and adj-TFR. So the comparison of tempo effects is reasonable only among countries where their TFRs are similar. Both of the low fertility countries in the Europe and Korea are at the lowest-low fertility.

[6] If the sample size is set at 100,000, the null hypothesis is rejected. The statistical tests are sensitive to the sample size. Large sample size could prove that the small differences exist and they are statistically significant.

Figure 3.7. here

Figure 3.8. here

What will happen to adj-TFR if the variance change is considered? Figure 3.8 shows the gamma of the Kholer-Philipov method (Kohler and Philipov 2001), which is equivalent to r of the Bongaarts-Feeney method. At the first birth, the gamma is larger than the r from 1998 to 2000 and it is significantly smaller than in the early 2000s. At the second birth the gamma is smaller than r after 1996. Both of them are converging to r in 2005. It implies that at the first birth, r after 2000 is overestimated and it is attributable not to tempo changes but to variance changes. Figure 3.9 shows adj-TFR with variance effect by birth orders. During the recent fertility decline after 2000, adj-TFR is a bit higher than adj-TFR with variance effect. It means that the fertility schedule changes toward a concentration with smaller variance; women are more likely to have children at the specific later ages, like their mid 30s. It exaggerates the tempo effects and true tempo-free TFR should be smaller than the estimated adj-TFR.

Figure 3.9. here

Will the Negative Tempo Effect decrease?

The current negative tempo effect will decline for two reasons insofar as there are no further social changes. First, if the mothers' age at childbearing is postponed by the effect of economic crisis and there is no further social change, it would be stabilized when the social causes that make women delay childbearing are fully reflected. To continue the further delay, successive social impact towards late childbearing is needed. Secondly, the choice of delayed childbearing should consider the "biological limit". Women who want to postpone childbearing but not forego having children will do so before reaching the "biological limit". It is known that a woman's fecundity starts to decline from their mid 30s (McFalls 1990). If the current delay of childbearing

comes mainly from the postponement, not from permanent childlessness, the delay will slow down before arriving the biological limit.

Will the negative tempo effects in South Korea disappear eventually? It is hard to estimate accurately how much women could delay childbearing while approaching the biological limit. Japan has been experiencing fertility decline for more than 40 years with delayed childbearing, but its TFR is still in decline. So, even though the current size of the negative tempo effect in South Korea may not be sustained in a long term, it is not easy to predict when it will start to decrease in a short term.

There is at least one factor which could slow down the negative tempo effect. This is the change of educational attainment. If mothers who have higher degrees have babies at later ages, the increase in the proportion of mothers with higher educational attainment may generate tempo effects and depress TFR even without an actual delay of childbearing. That is, a mean age at childbearing could be delayed by two forces. One is late childbearing within each educational group. The other is the increase of the relative size of college educated mothers who have children later than mothers who have a high school degree or less.

Table 3.1. at here.

Recently a mother's educational attainment in South Korea has increased remarkably (See Table 3.1). In 1993, almost two thirds of mothers were high school graduates when they have their first baby. However, the majority has become college graduates in the 2000s. In 2005, 61 percent of mothers had college degrees or higher and high school graduates comprised only 37 percent. At the second birth, the proportion of mothers with at least a college degree was 53 percent. This number is 8 percent smaller compared to the first birth, but the overall trend is similar to the first birth. The proportion of mothers who had a middle school education or less was around 10 percent in 1993, whereas it was less than 3 percent in 2005.

Figure 3.2 shows the average mother's age at the first birth and the second birth separately. At the first birth, mothers with a college degree or more have children at age 28.9, whereas mothers with a high school diploma do so at age 28.1 in 2005. The difference is .8 years and in 1993 it was 1.5 years. Mothers with high school diplomas have postponed their childbearing much more than college graduates so high school graduates would have bigger tempo effects.

Figure 3.10 here.

Figure 3.10 suggests another interesting hypothesis. The slopes in the graph were changed at 1999 especially among college graduate mothers at the first birth. The aftermath of the economic crisis in 1997 may have made college graduates take more time establishing their careers, causing them to postpone having a baby. High school graduates have been adjusting their norms and values of childbearing similar to college graduates.

As the educational attainment is determined in earlier years than those of childbearing, the tempo effects driven by compositional change of a mother's educational attainment is predictable in a degree. Table 3.2 shows how many graduates entered a higher academic institution. Practically all the elementary and middle school graduates entered a higher school in circa 2000. College education is getting much more popular nowadays. Less than one fourth of high school graduates went on to college in 1980, whereas more than 80 percent of high school graduates did in 2005. The changes are more rapid in recent years. For 10 years from 1985 to 1995, 15.7 percent points increased**,** whereas 30 percent points increased between 1995 and 2005.

Table 3.2 here.

The increase in the proportion of college educated women is about to stabilize in a few years. From 1990, the proportion of college graduates has increased by 3 percent on average per

year. If the past speed of increasing college education is constant, all high school graduates will enter college 6 years from now and the increase will stop. Recently the speed is slowing down. The difference between 2004 and 2005 is only 1.1 percent.

It is doubtful that universal college education is sustainable. If the percent of college educated women starts to reduce, more women could get jobs at earlier ages, married earlier, and eventually have children earlier than the older generation does. As most women enter college in their late teens, the tempo effects by a compositional change could last for a while. But it suggests that the current tempo effects could decrease gradually in a few years. All other things constant; the decreasing tempo effects will boost fertility.

Discussion

Has the tempo effect accounted for the recent fertility decline in South Korea? The findings in this paper suggest the positive answer. The fertility decline from 1995 is due to the negative tempo effects. More specifically it could be divided into two periods; the tempo-driven era (1995-2000) and the quantum and tempo mixed era (2000-2005).

The restart of the fertility decline during the former period is fully explained by the tempo effects. The TFR has declined from 1.71 in 1995 to 1.47 in 2000. The tempo effect has grown from .25 births in 1995 to .53 births in 2000 as much as the conventional period TFR dropped. Unlike the decline of the conventional period TFR, these adj-TFRs do not indicate the declines till 2000. It suggests that the decline is not a quantum-driven but a tempo-driven phenomenon.

The decline during the latter period is different in two ways. First, the speed of the decline is sharper and its fertility enters into the lowest-low level. Secondly, it is accompanied by the mix of quantum and tempo effects. The recent drop to lowest-low fertility was initiated in 2000 along with the sizable tempo effects. The TFR has declined from 1.47 in 2000 to 1.08 in 2005. After 2000, the size of the tempo effects is shrinking, though still sizable. Adj-TFRs with variance effect show that the tempo effect is somewhat exaggerated during the latter period.

Considering taking the several months to a conception plus the 9 months of gestation period, 2000 is when women began to adopt a new lifestyle originating from the aftermath of the economic crisis. Social and economic changes after the crisis make women not only postpone childbearing but also have less number of children.

The scenario in Figure 3.3.b is unlikely to be realized. Recent extremely low fertility does not result solely from tempo effects which could vanish and cause a rebound in the future. Not to mention that some delay of childbearing could result in permanent childlessness or fewer children than women expected, current fertility declines are related with significant quantum declines as well.

Stressing the significance of tempo effect is relevant to finding a policy to boost fertility recovery (Lutz, O'Neill, and Scherbov 2003; Lutz and Skirbekk 2005; Yi. 2007). If the childbearing delay slow down or stop, it could be helpful boosting fertility. More positively, if women's childbearing age is advanced, it could generate the positive tempo effect and work for the rise of the period TFR. Compared to quantum policy, tempo policy is more acceptable. It is a merit of tempo policy. Not because it aims at changing the number of births but because it tries to shift the childbearing ages ahead, tempo changes are more acceptable to mothers and fathers.

Figure3.1. Trends of Total Fertility Rates, 1980-2006, South Korea.

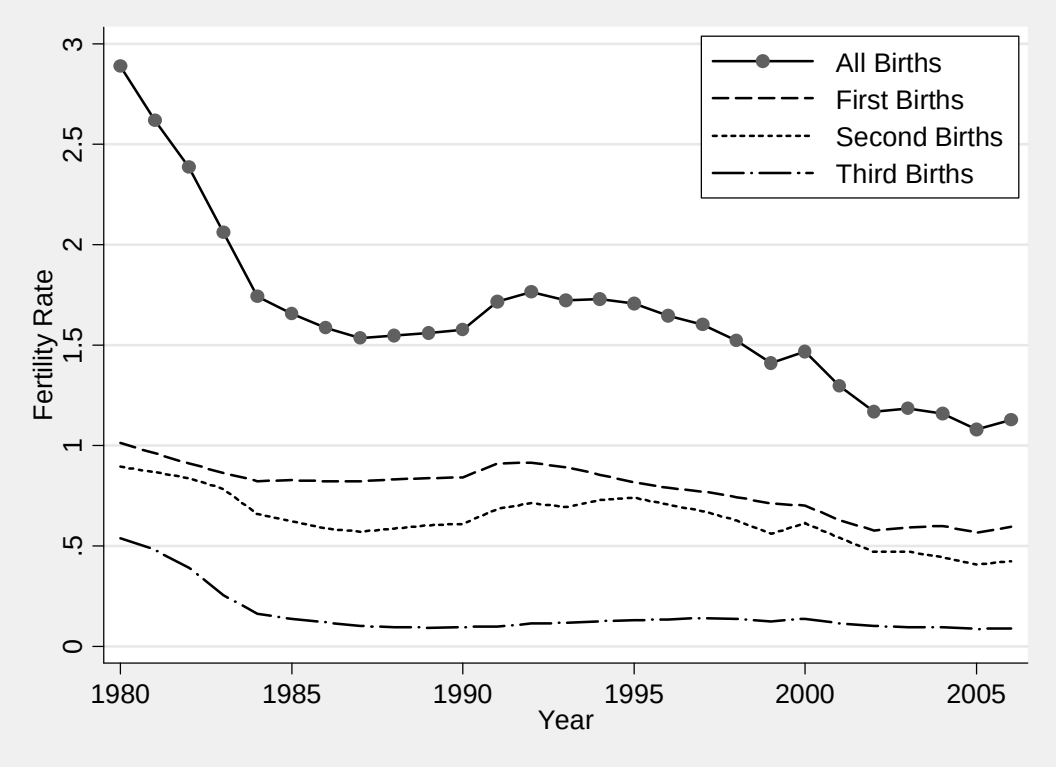


Figure3.2. Age-specific Fertility Rates, 1985, 1995, 2005, South Korea

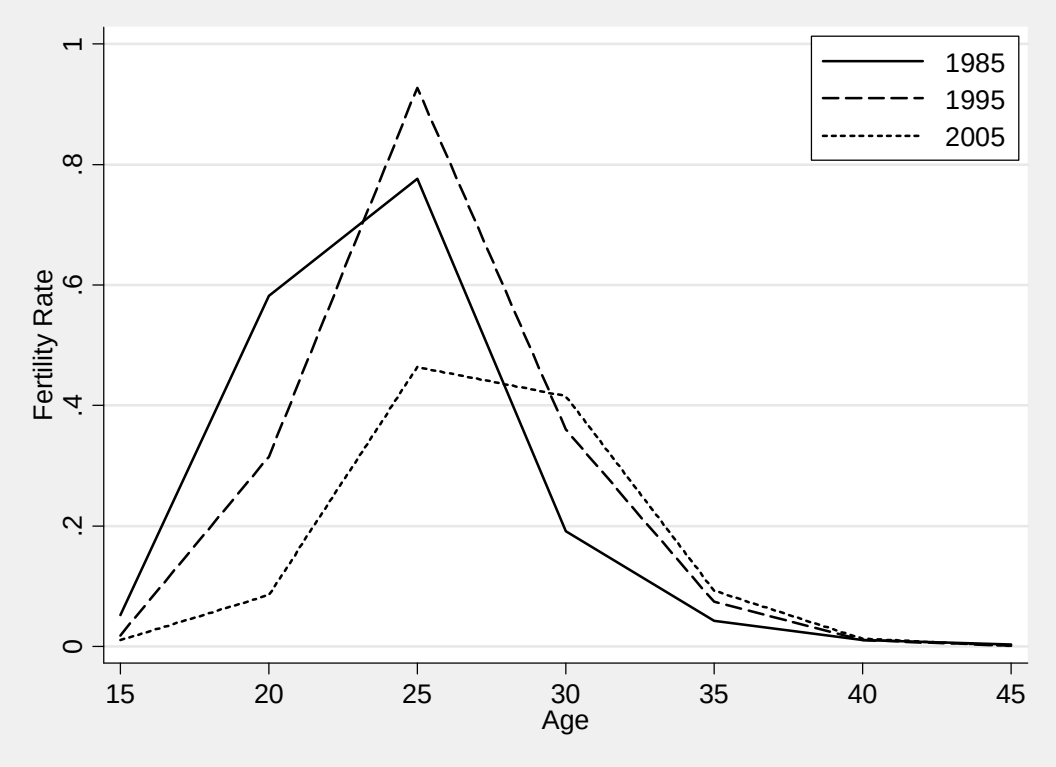


Figure 3.3. Lexus Diagram of Age-specific Fertility Rates, Period TFR and Cohort TFR.

a.

Age	t-30	t-25	t-20	t-15	t-10	t-5	t	t+5	t+10	t+15	t+20
20-24	0.1	0.1	0.1	0.1	0.1	0.1	0.00				
25-29		0.1	0.1	0.1	0.1	0.1	0.00	0.1	0.1	0.1	0.1
30-34		0.1	0.1	0.1	0.1	0.1	0.00	0.1	0.1	0.1	0.1
35-39		0.1	0.1	0.1	0.1	0.1	0.00	0.1	0.1	0.1	0.1
40-44							0.00	0.1	0.1	0.1	0.1
Period TFR		**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**0.00**	**2.0**	**2.0**	**2.0**	**2.0**
Cohort TFR					**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**

b.

Age	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025
20-24	0.17	0.15	0.13	0.09	0.07	0.04	0.02	0.02	0.02	0.02	0.02
25-29		0.25	0.16	0.17	0.19	0.15	0.09	0.08	0.08	0.08	0.08
30-34		0.12	0.04	0.05	0.07	0.08	0.08	0.10	0.12	0.12	0.12
35-39		0.04	0.01	0.01	0.02	0.02	0.02	0.03	0.06	0.06	0.06
40-44		0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.04
Period TFR		**2.89**	**1.69**	**1.58**	**1.71**	**1.48**	**1.08**	**1.20**	**1.50**	**1.55**	**1.60**
Cohort TFR					**2.36**	**1.89**	**1.93**	**1.92**	**1.75**	**1.62**	**1.60**

At a, cohort TFR is obtained by summing up the grey cells
At b, black is from the real dataset – South Korea, 1975-2005, while red is from a fictitious dataset.

Figure3.4. Mean Age at Childbearing by Birth Orders, 1985-2006, South Korea

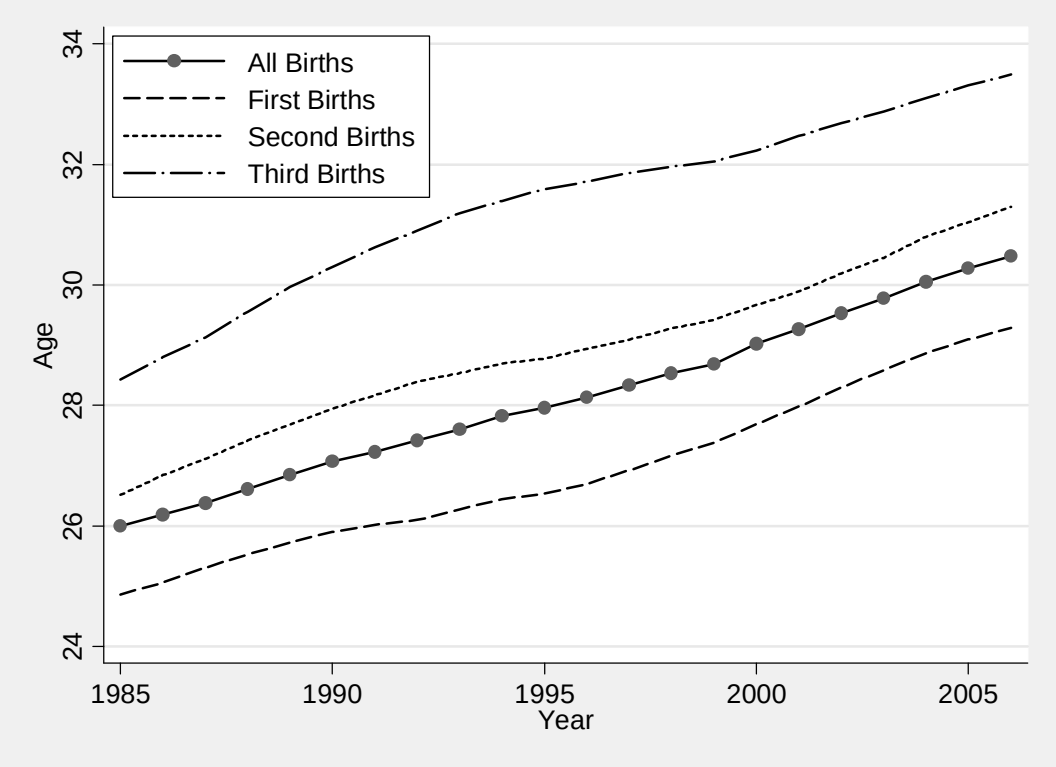


Figure 3.5. r of Bongaarts-Feeney Method, 1985- 2005, South Korea

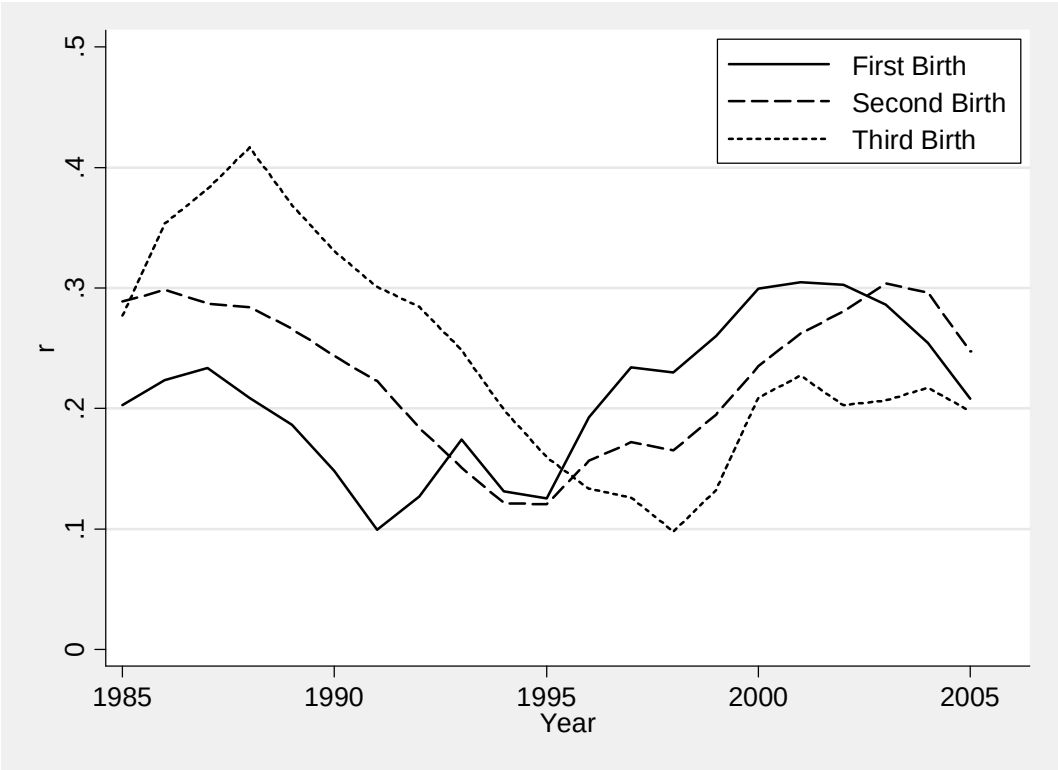


Figure 3.6. Adjusted Total Fertility Rates, 1985- 2005, South Korea

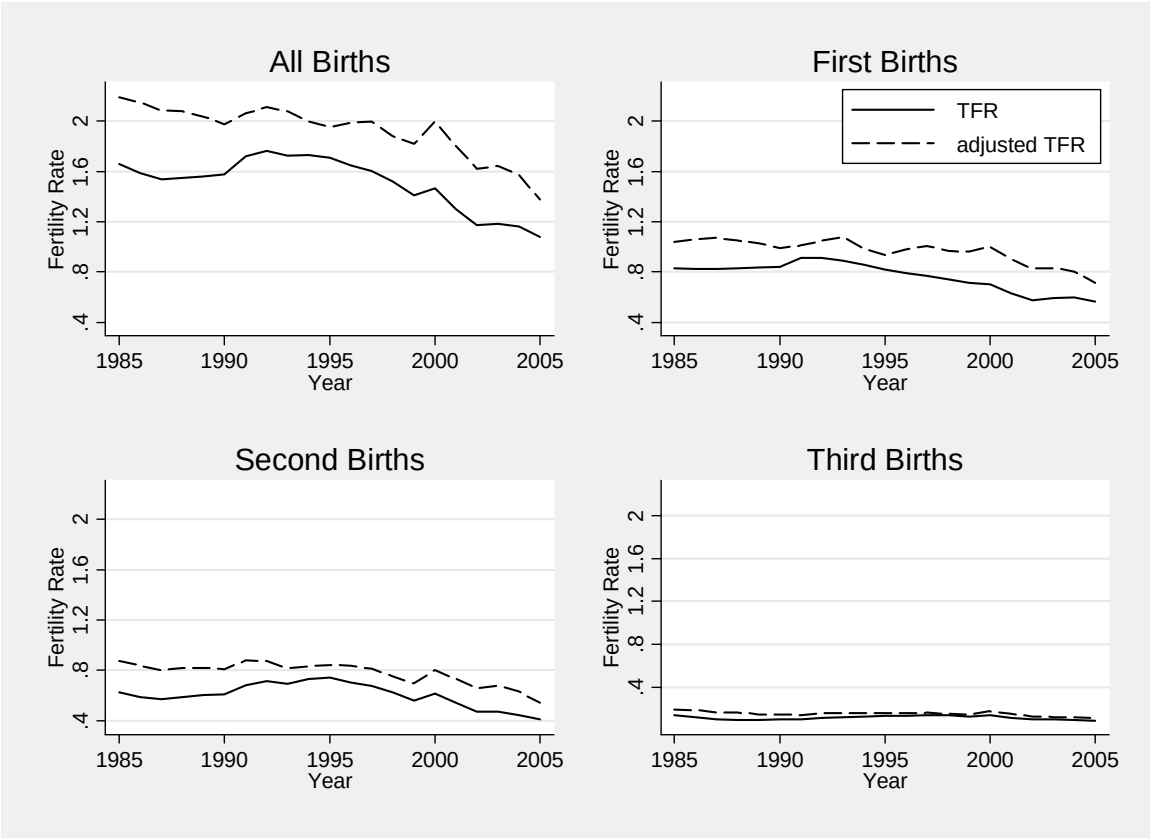
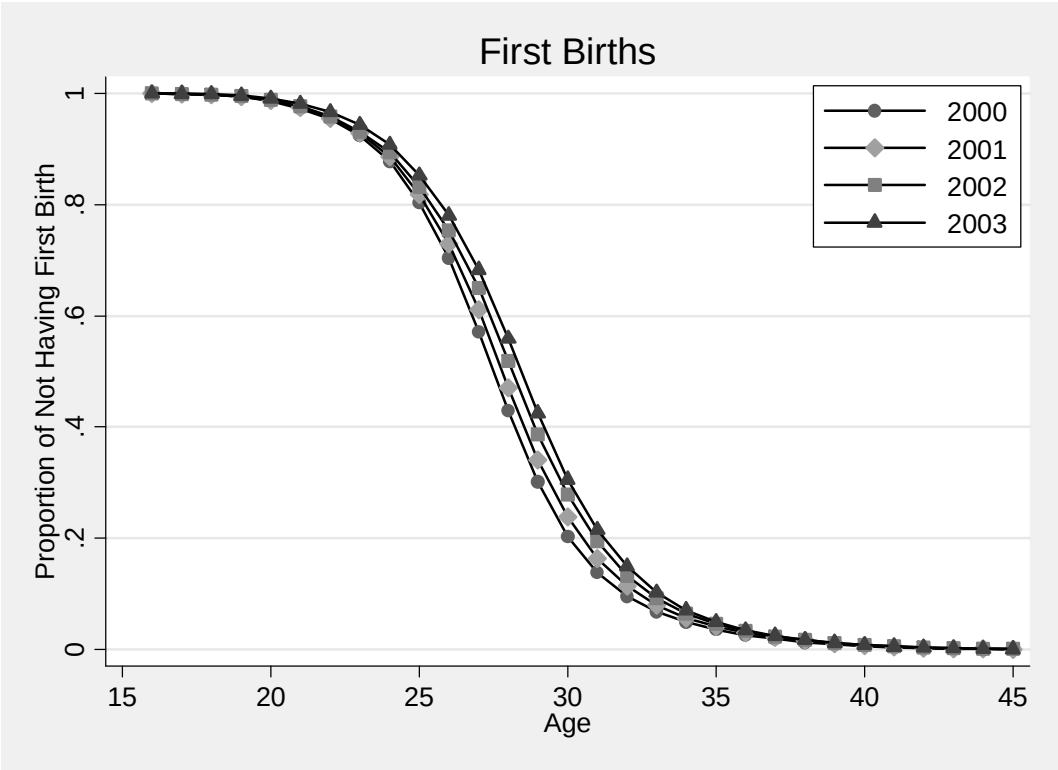


Figure 3.7. Birth-Free Survival Curves, 2000-2003, South Korea



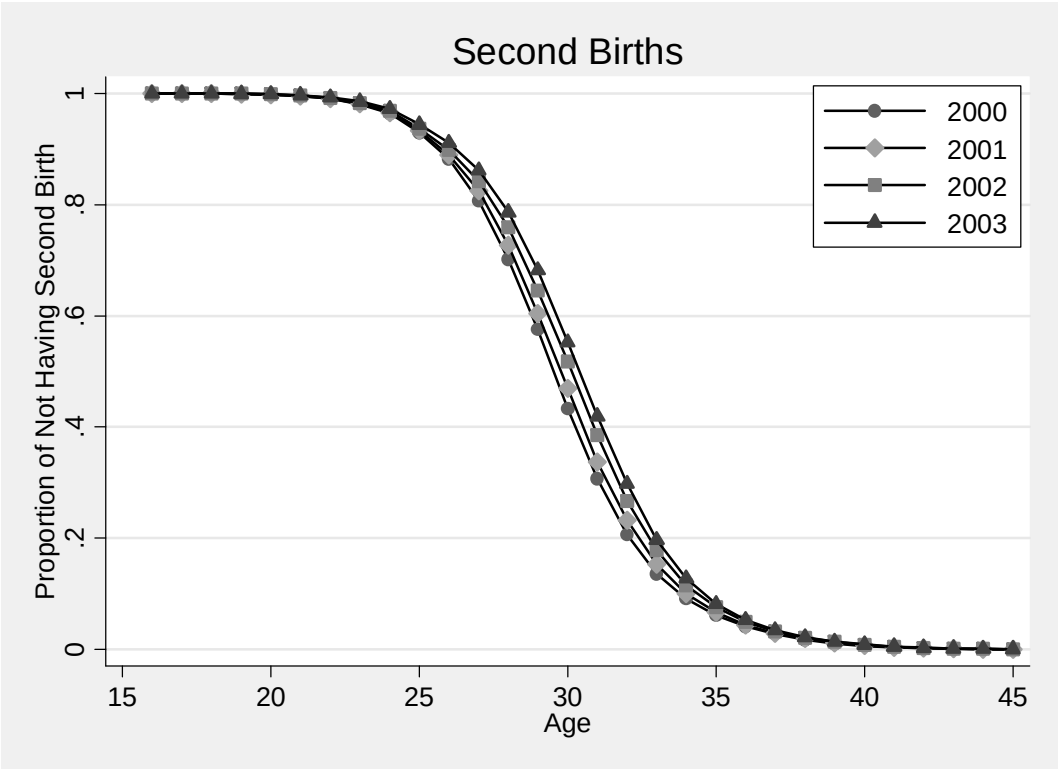
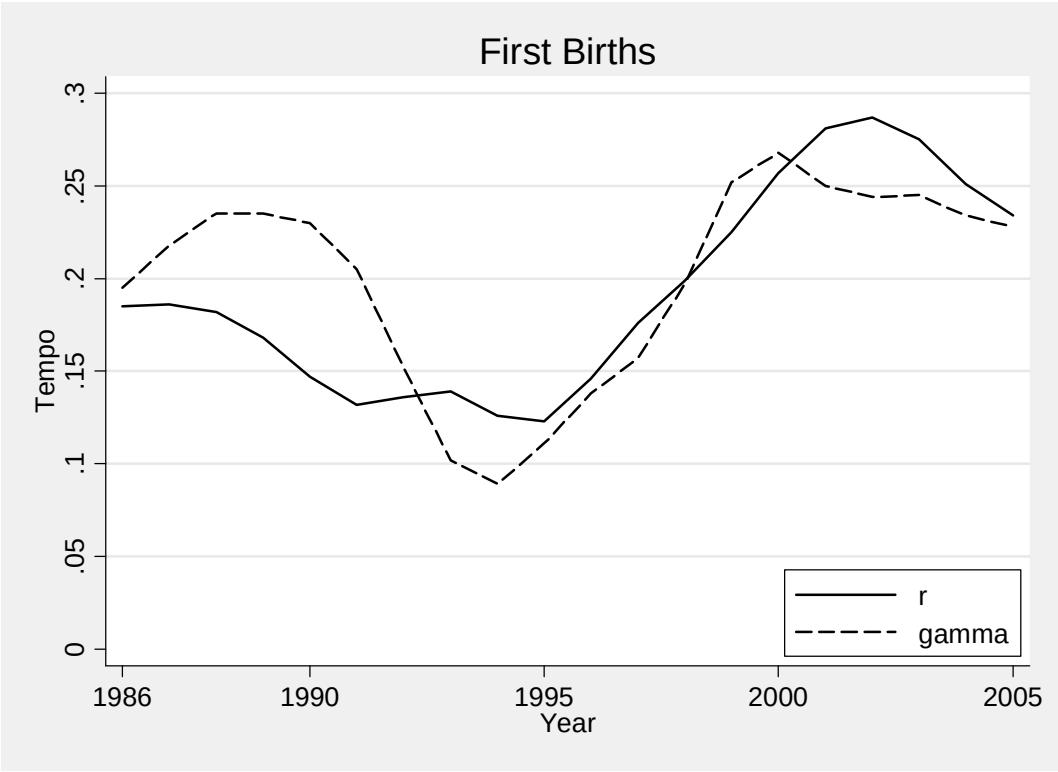


Figure 3.8. r of Bongaarts-Feeney Method vs. Gamma of Kholer-Philipov Method, 1986-2005, South Korea



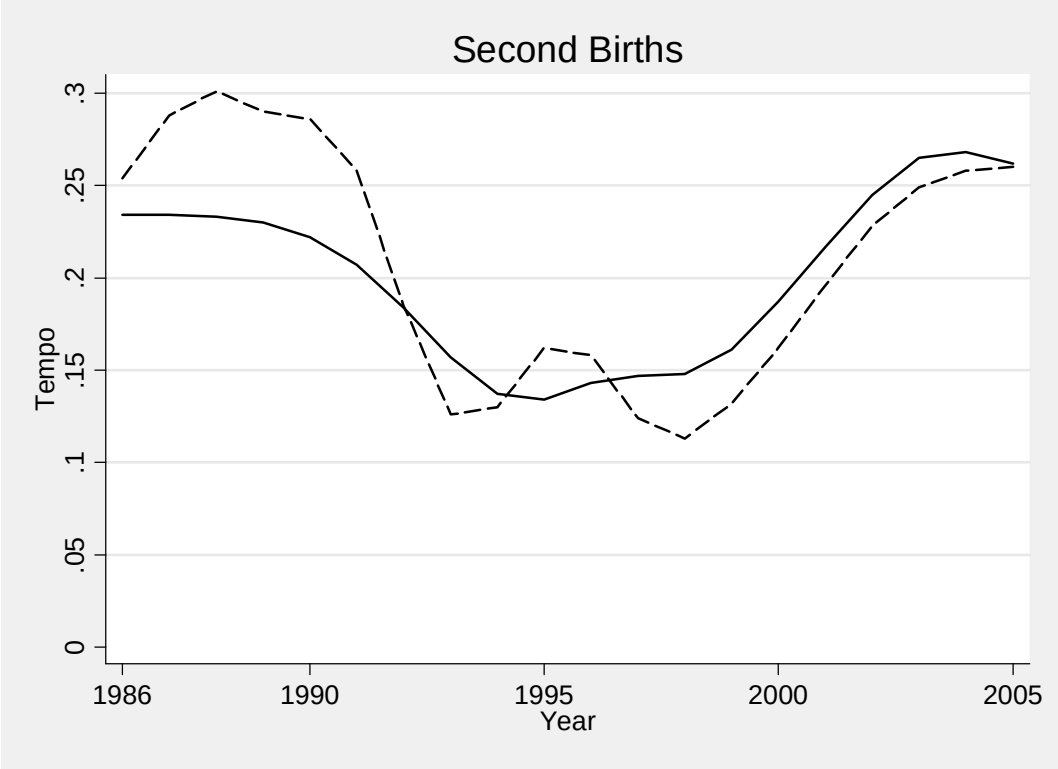
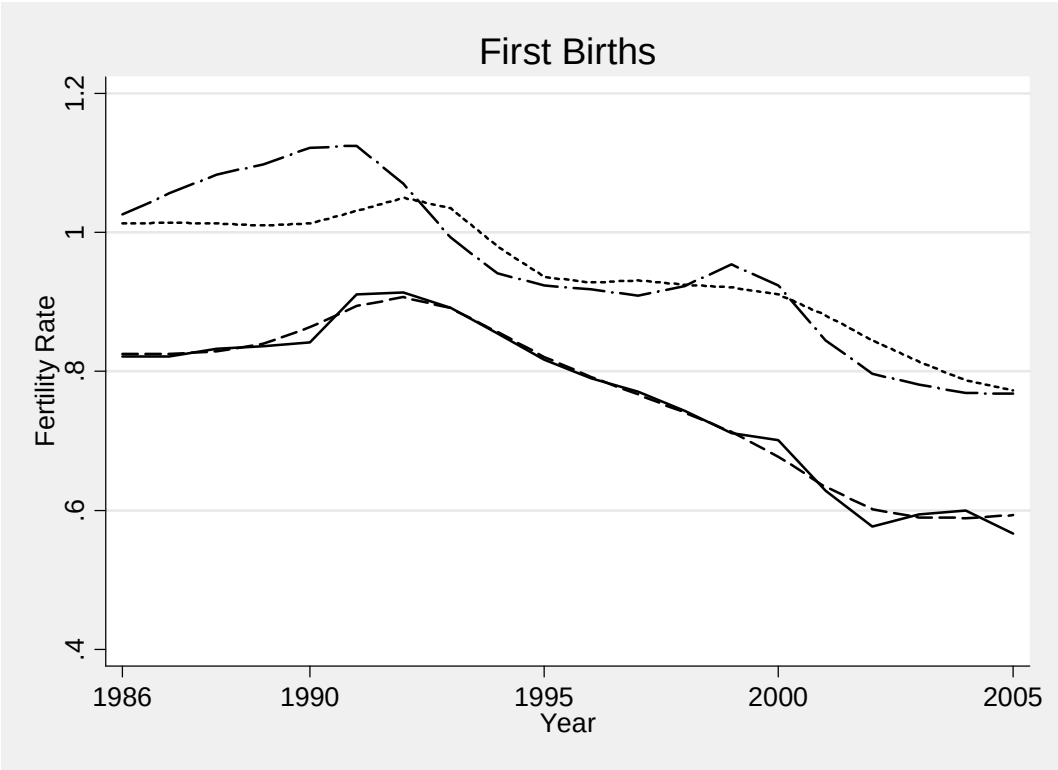


Figure 3.9. Adjusted Total Fertility Rates with Variance Effect, 1986-2005, South Korea



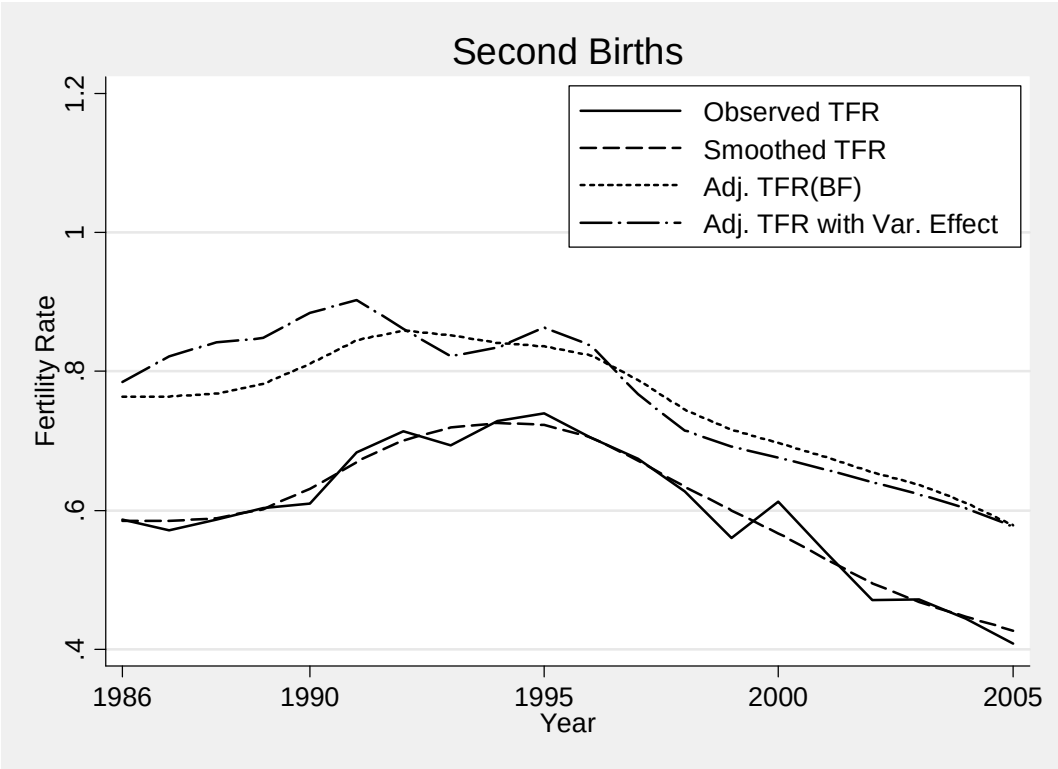


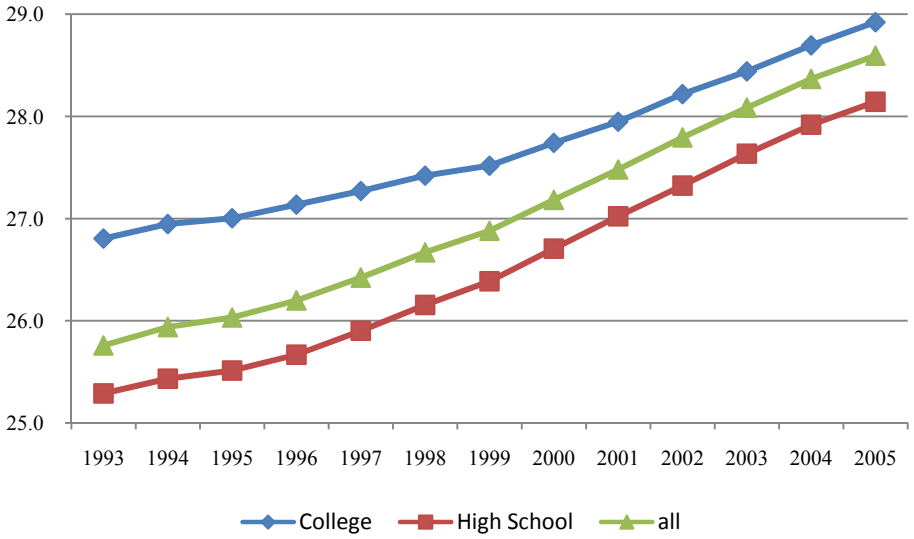
Table 3.1. Ratio of Mother's Education, First Births and Second Births, 1993-2005, South Korea

	1993	1995	1997	1999	2001	2003	2005
Mother's Education at the First Birth							
College Graduates or More	25.9	28.5	32.6	39.3	46.5	54.8	61.1
High School Graduates	64.2	64.7	62.2	57.0	50.7	43.0	36.7
Middle School Graduates or Less	9.9	6.8	5.2	3.7	2.9	2.3	2.3
Mother's Education at the Second Birth							
College Graduates or More	21.9	24.4	27.7	32.0	38.1	45.8	53.3
High School Graduates	63.8	66.0	65.7	63.5	58.8	52.0	44.9
Middle School Graduates or Less	14.3	9.6	6.6	4.5	2.6	2.2	1.8
Proportion of the First Births	52.1	48.4	48.4	50.1	47.7	49.6	51.8
Proportion of the Second Births	39.9	42.9	41.7	40.1	42.3	41.0	38.6
Proportion of the third or Later Births	8.1	8.7	9.9	9.8	10.1	9.5	9.6

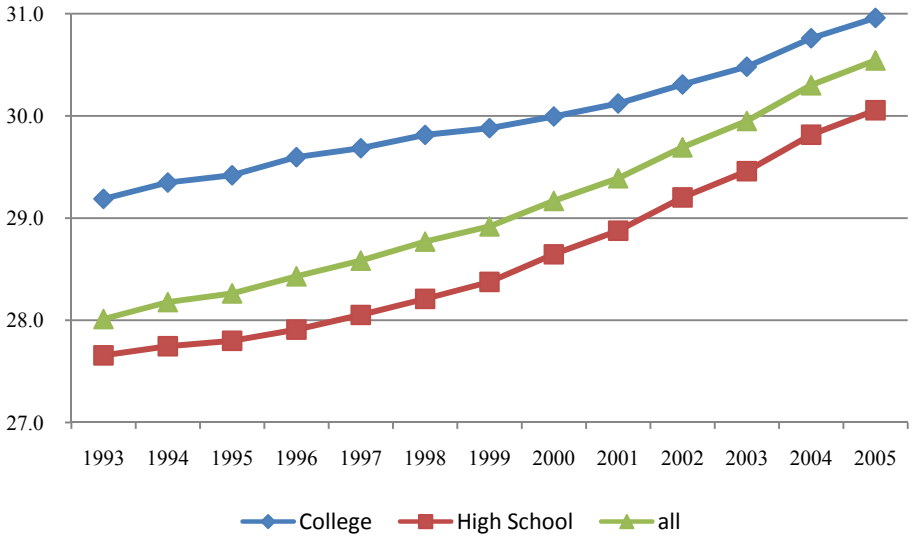
Source: Birth Register of South Korea, estimated by the author

Figure 3.10. Average Mother's Age at the First Birth and the Second Birth by Educational Attainment, 1993-2005, South Korea

The First Birth



The Second Birth



Source: Birth Register of South Korea, estimated by the author

Table 3.2. Ratio of Students who go on to a Higher Stage of Education, 1980-2005, South Korea[1]

	From Elementary School to Middle School		From Middle School to High School		From High School to College[2]	
	All	Female	All	Female	All	Female
1980	95.8	94.1	84.5	80.8	23.7	22.5
1985	99.2	99.1	90.7	88.2	36.4	34.1
1990	99.8	99.8	95.7	95.0	33.2	32.4
1995	99.9	99.9	98.5	98.4	51.4	49.8
2000	99.9	99.9	99.6	99.6	68.0	65.4
2004	*99.9*	*99.9*	*99.7*	*99.7*	*81.3*	*79.7*
2005	99.9	99.9	99.7	99.8	82.1	80.8

[1] Ratio = Number of students who go on to a higher stage of education / Number of graduates * 100
[2] College includes 2-year Colleges, and educational Colleges.
SOURCE: http://nsportal.stat.go.kr/static/teen/teen03/1172953_1498.jsp

APPENDIX A

Coefficients from Discrete Hazard Model of First Birth on Hourly Wage at 40

	Model 1	Model 2	Model 3	Model 4	Model 5
Wage at 40	-0.013***	-0.014***		-0.010***	-0.018**
	(0.002)	(0.003)		(0.003)	(0.006)
(Age-21)	0.136***	0.143***	0.129***	0.146***	0.146***
	(0.020)	(0.021)	(0.019)	(0.021)	(0.021)
(Age-21)2	-0.011***	-0.011***	-0.011***	-0.012***	-0.012***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Black	-0.226**	-0.222**	-0.172*	-0.235**	-0.239**
	(0.070)	(0.075)	(0.070)	(0.076)	(0.076)
Hispanic	0.062	0.057	0.04	0.045	0.045
	(0.076)	(0.084)	(0.077)	(0.085)	(0.085)
White (Reference Category)			-	-	-
Number of Expected Birth		0.060**	0.078***	0.072***	0.072***
		(0.020)	(0.019)	(0.020)	(0.020)
Attitdue on Traditional Family		0.063	0.064	0.027	0.022
		(0.062)	(0.057)	(0.063)	(0.063)
Expectation at 35		0.133	0.126	0.103	0.105
		(0.076)	(0.069)	(0.076)	(0.077)
Expected Ability at 35		-0.085*	-0.099**	-0.098*	-0.100*
		(0.040)	(0.036)	(0.040)	(0.040)
Less than High School			0.013	0.1	-0.112
			(0.134)	(0.145)	(0.244)
High School (Reference Category)				-	-
Some College Experience			-0.191**	-0.212**	-0.248
			(0.069)	(0.076)	(0.153)
College Degree or Higher			-0.390***	-0.289***	-0.540***
			(0.070)	(0.081)	(0.156)
Wage * Less than High School					0.017
					(0.017)
*Wage * High School (Reference Category)*					
Wage * Some College Experience					0.003
					(0.008)
Wage * College Degree or Higher					0.013
					(0.007)
Constant	-2.359***	-2.513***	-2.578***	-2.358***	-2.234***
	(0.088)	(0.185)	(0.160)	(0.189)	(0.205)
N	20701	18014	21335	18014	18014
LL	-4986	-4320	-5223	-4312	-4310

Note: Standard errors in parentheses. *p<.05 **p<.01 ***p<.001

APPENDIX B

Coefficients from Discrete Hazard Model of First Birth on Lagged Hourly Wage

	Model 1	Model 2	Model 3	Model 4	Model 5
Hourly Wage, 2 Year Lagged	0.013***	0.014***		0.018***	-0.012
	(0.003)	(0.003)		(0.003)	(0.008)
(Age-21)	0.099***	0.106***	0.129***	0.108***	0.111***
	(0.018)	(0.020)	(0.019)	(0.020)	(0.020)
(Age-21)2	-	-	-	-	-
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Black	-0.12	-0.106	-0.172*	-0.134	-0.159*
	(0.065)	(0.070)	(0.070)	(0.071)	(0.071)
Hispanic	0.1	0.082	0.04	0.043	0.052
	(0.069)	(0.076)	(0.077)	(0.077)	(0.077)
White (Reference Category)			-	-	-
Number of Expected Birth		0.061*	0.078***	0.076***	0.077***
		(0.019)	(0.019)	(0.019)	(0.019)
Attitdue on Traditional Family		0.150*	0.064	0.089	0.069
		(0.056)	(0.057)	(0.057)	(0.057)
Expectation at 35		0.161*	0.126	0.121	0.132
		(0.069)	(0.069)	(0.069)	(0.069)
Expected Ability at 35		-0.062	-0.099**	-0.090*	-0.096**
		(0.035)	(0.036)	(0.036)	(0.036)
Less than High School			0.013	0.062	0.048
			(0.134)	(0.135)	(0.257)
High School (Reference Category)				-	-
Some College Experience			-0.191**	-0.210**	-0.402**
			(0.069)	(0.069)	(0.141)
College Degree or Higher			-	-	-
			(0.070)	(0.071)	(0.132)
Wage * Less than High School					-0.009
					(0.027)
*Wage * High School (Reference Category)*					
Wage * Some College Experience					0.019
					(0.010)
Wage * College Degree or Higher					0.049***
					(0.009)
Constant	-	-	-	-	-
	(0.072)	(0.155)	(0.160)	(0.163)	(0.183)
N	24597	21335	21335	21335	21335
LL	-6048	-5232	-5223	-5210	-5188

Note: Standard errors in parentheses. *p<.05 **p<.01 ***p<.001

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