Chapter Two

2. Determinants of Total Fertility

Introduction

As the previous chapter notes, the demographic transition in Venezuela during the 1970s and 1980s presents certain deviations from the norm. Its decline stalls and reverses twice, first from 1973 to 1978 and then again from 1987 to 1991. Since these stalls and reversals seem to defy the natural decline in fertility expected from a typical demographic transition, it is hypothesized that the anomalies in the period fertility rates are not associated with changes in total fertility, but with an acceleration of childbearing. Certain circumstances, such as extreme or unusual changes in economic conditions, can cause an acceleration in childbearing that distorts the period fertility rate in Venezuela, but leaves the total fertility rate almost unchanged or at a lower level. If this were the case, the period fertility rates could have increased considerably and later decreased, leaving the total fertility rate at the same or a lower level. To mechanize this argument, a simple two period model of fertility is developed in chapter three. It illustrates how females may change their fertility timing preferences by responding to temporary changes in income, caused by either changes in wages or changes in the amount of transfers, thereby leaving their total fertility after the two periods at a lower level or unchanged.

Before the two period model is developed, two aspects of the mid 1970s and early 1980s need to be explored empirically to determine the true nature of the increases in the period fertility rates presented in Chapter one. To answer the question of whether the stall and increase in the period fertility rates during the 1970s are associated with changes in total fertility or whether they are associated with changes in the timing of births, a look at total fertility and the timing of fertility is needed. This chapter, therefore, concentrates on exploring total fertility and its determinants during the period in question. By estimating a model of total fertility by union cohort, the hypothesis that the total fertility did not increase (as suggested by the increases in period fertility rates), but instead has decreased for every subsequent cohort since 1967, is tested. In other words, is it possible to associate the increase in the period fertility rate during the mid 1970s, presented in

Chapter one, with changes in total fertility for females, even after controlling for individual characteristics of females? To do this, a model of total fertility is estimated and union cohort dummies are used to detect changes in the total fertility for different union cohorts.

2.1. The Theory of Demand for Children

According to the theory of demand for children, people who decide to have a child weight the benefits of an additional child against the additional cost. The theory's framework is the maximization of utility; if greater utility can be obtained from an alternative to an additional child, then that alternative will be chosen. Decline in fertility thus implies that the relative price of a child has increased, couple incomes have fallen or there has been a change in the shape of the couple's utility function for children versus other goods (Becker 1981).

Most theoretical explanations for changes in fertility based on the demand theory focuses on a shift in the price (or cost) of a child. In 19th century Europe, costs of children rose with the advent of compulsory education (Caldwell 1981), which places a new emphasis upon the quality of children rather than their quantity and also leads to increases in the costs of children. The indirect or opportunity costs of having children (lost market earnings due to having children) are contingent upon the feasibility of combining market work with children. Where mothers are unable to work if they have children, the indirect costs of having children are high. However, when the labor force participation rates of mothers increase, as they have done in many places in recent decades, the indirect costs of children fall (Chapman et al. 1999). Consecuently, the indirect costs rise as potential market incomes rise. When the birth of the first child is delayed, women are able to increase their potential market income through education and the accumulation of on-the-job skills and experience, thereby increasing the indirect costs of having a child.

In the context of contemporary low fertility, Coleman states that, while the cost of children can be figured in dollar terms, there are no dollar benefits. Instead, the benefits or utility of children consists of dimensions of a psychological nature that are not readily quantifiable. He refers to these benefits as 'immanent values' (Coleman 1998: 20). One way to think about the utility of a child in this circumstance is in terms of net benefit thresholds (the psychological benefits less the psychological costs). That is, people make some calcullation of the psychological gain (utility) to them of having the next child. If the costs of children rise or if the shape of the utility function shifts in favor of other goods, some individual benefit thresholds will be crossed and decisions will be made not to have the next child. There is also an argument that delaying the first child enhances tastes for goods other than children, thereby shifting the utility function towards goods other than children.

Surprisingly little in known about the determinants of the utility of children despite its crucial status in the determination of present-day fertility levels. However, utility does vary from individual to individual. There are some who are willing to subject themselves to the most torturous privations in order to have a child while others are unwilling to have a child or another child under any circumstances.

It also needs to be remembered that children come in highly discontinuous lumps and that the utility of having a child will vary according to the birth order of the child. Having the first child provides the benefits of the status of being a parent, of 'being a family', of having offspring who will carry on the family name, of meeting expectations of others, of having a baby who will be fun and will grow loving his her parents, of fulfilling childhood dreams, of providing vicarious pleasure from the child's success, and so forth. The decision to have a second child can result form the notion that each child should have at least one sibling or to the desire of having a child of the opposite sex. It is possible that those who have a third child believe it takes at least three children to make a 'real' family, or they may be still trying for the other sex that they do not have yet. Those who have a fourth child may simply love children, or the child may have been a mistake. It is likely that the level of the net threshold of psychological benefits falls as the birth order rises. That is, the highest psychological threshold relates to the first child. Also, it is very likely that the level of the threshold falls as people grow older. In other words, it is possible that a woman at age 29 years feels more inclined to have a second child than a woman at age 39 years. Psychological costs probably rise with age or, perhaps, as argued above, increased age leads to shifts in the utility function towards other goods.

Accordingly, as ages at childbearing increase, people will be less likely to have additional children.

The demand theory implies that, if there is to be a positive impact on fertility decision-making, it is necessary to try to reduce the economic costs of children, increase parental incomes or shift the utility function towards children and away from other goods. Therefore, increases in market incomes would increase the opportunity costs of children unless there are provisions in place that allow parents, both mothers and fathers, to combine market work with children. Also, raising incomes of parents with government transfer payments to those who have children or subsidies of child costs, particularly of services such as health and education, would increase fertility.

2.2. A Poisson Model of Total Fertility

Individual household fertility decisions are modeled in various ways in the literature. Barmby and Cigno (1990) estimate fertility patterns using a sequential probability model. Sobel and Arminger (1992) use a non-linear simultaneous probit model. In recent years, the modeling of household fertility decisions has utilized Poisson type models. Caudill and Mixon (1995) have developed censored regressions for fertility data. Winkelmann and Zimmermann (1994) have developed the generalized event count model, which subsumes the Poisson, the negative binomial, and the binomial models.

In many empirical studies of fertility, the number of children in a household is modeled as a function of other social and economic variables, such as a female's education level and family income. The commonly used models include the standard Poisson and negative binomial regression models. These models account for the fact that the number of children in a family is non-negative. Under the Poisson regression model, the conditional mean and variance of the dependent variable are constrained to be equal for each observation. This is sometimes referred to as equi-dispersion. In practice, this assumption is not satisfied, because the variance can be either larger or smaller than the mean. If the variance is not equal to the mean, the estimates in Poisson regression models are still consistent but inefficient. Therefore, an inference based on the estimated standard errors is no longer valid. The negative binomial regression model is more flexible than the standard Poisson model and is frequently used to study count data with over-dispersion. For example, Cameron and Trivedi (1986) have analyzed factors affecting how often a person visits the doctor. Other examples included Goodwin and Sauer (1995), Englin and Shonkwiler (1995), and Winkelmann and Zimmermann (1995).

As Winkelmann and Zimmermann (1994) have noted, the number of children in a household often exhibits under-dispersion when the mode is two. Therefore, the standard Poisson regression model, which assumes equi-dispersion, and the negative binomial regression, which accommodates over-dispersion, do not account for cases of under-dispersion. However, more recently Wang and Famoye (1997) have estimated a generalized Poisson regression model of household fertility decisions to accommodate under-dispersion as well as over-dispersion. Therefore, to model fertility behavior using the standard Poisson regression model seems a good starting point. However, assessing the validity of equi-dispersion is necessary to account for either over or under-dispersion.

2.3. Data and Variable Definitions

Becker (1960) has stimulated most of the research on household fertility decisions by developing an economic theory of the family. In his seminal work, he suggests that children can be viewed as durable goods, yielding primary psychic income to parents, in the neoclassical economic framework. Household fertility decisions are determined by female wage and family income, which are supposed to measure the time cost of raising children and earnings potential (Becker 1960; Becker and Lewis 1973). Several subsequent empirical analyses (Leibowitz 1974; Heckman and Walker 1990; Caudill and Mixon 1995; Wang and Famoye 1997) support the Becker-Lewis hypothesis.

With this neoclassical framework in mind, the 1998 National Survey of Population and Family collected in Venezuela by The Central Office of Statistics and Information is used to model household fertility decisions by estimating a data count model. The present study, however, deviates somewhat from the standard modeling of household fertility, because its objective is to model the household fertility decision for a group of females that entered a first union between 1967 and 1982. The 1998 National Survey of Population and Family contains complete birth histories that allow computing the number of children born to each female during the first 14 years after entering the first union. It is hypothesized that entering a first union signals the desire to have children in a planned context. Since all females are observed over the same amount of time, comparisons of total fertility between union cohorts are appropriate.

As is true of most surveys, different households have different probabilities of being selected for the sample either by design or by accident. In the 1998 National Survey of Population and Family, some females are overrepresented relative to others as part of the design. This creates a bias problem, because if females in the sample have different probabilities of being selected for the sample, sample means will be biased estimators of population means. To undo this bias, the sample data need to be re-weighted to make them representative of the sample. When estimating total fertility, observations are weighted according to the survey weights coming from its particular design.

Also the 1998 National Survey of Population and Family was collected in two stages, first with the selection of sampling clusters and then with the selection of households from within each cluster. This is a very common two stage stratification design. It is well known that this design affects the sampling variability of estimates, because households within clusters are often similar to one another in their relevant characteristics. It is, therefore, frequently the case that clustering can increase variability when compared to simple random sampling. It can be a serious mistake to treat two-stage sample as if it were a simple random sample. Therefore, when estimating the parameter the two-stage design is also taken into account.

The purpose of this chapter is to compare all first union cohorts between 1967 and 1982 to ascertain if these cohorts followed a lower fertility pattern as the demographic transition suggests or if any subsequent cohort ended with a higher fertility level than a previous one during the first 14 years after entering the first union. The former would suggest that the stalls and reversals presented in the first chapter are caused by changes in the timing of births and not by changes in total fertility levels.

On the one hand, females entering a first union during the period between 1967 and 1975 experienced the sharp increase in economic activity fueled by sharp increases in the price of oil. On the other hand, females entering a first union after 1975 experienced most of the sharp decline or bust that followed after 1978. All females are observed for 14 years and the total number of children born in the 14 years after a woman enters the first union is recorded and viewed as a proxy for total fertility. To assess if increases in period fertility rates documented in the first chapter are associated with total fertility increases, the total fertility for females that entered first union during these years is explored. The sample consists of 2,038 females whose ages ranges from 26 to 49 years at the time of the survey. The dependent variable, the total number of children born during the first 14 years after a woman enters her first union, is a non-negative integer ranging from 0 to 10 in the sample. In line with the neoclassical theory of fertility developed by Becker (1960) and Becker and Lewis (1973), explanatory variables common to fertility studies are included. An introduction of the explanatory variables used in this analysis follows in the next five subsections.

2.3.1. Place of Residence and Migratory Experience

The place of residence (*dominio*) generally tends to have a notable impact on fertility, as it reflects major differences in a series of economic conditions faced by families. For instance, urban families will have fewer children than rural families, because it costs less to raise children on a farm. Also, rural communities lag behind urban centers in the distribution of contraceptive knowledge. Table 2.1, which presents a distribution of the variables of place of residency, length of residency (*lenres*), and place of socialization (*chood*), shows that of the total of females in the sample, 25.07% live in the Caracas Metropolitan Area, a little more than one-half (54.76%) reside in a city with 25,000 or more people, while 20.17% reside in urban centers of less than 25,000 people or in rural areas.

Like the place of residence, a migratory experience can influence the change of fertility to the extent that migrants can broaden the channels of dissemination by being carriers of new ideas and modern lifestyles, which they can transfer to their counterparts in the places where they are received or of origin, as the case may be. Although, there have been periods of extensive spatial mobility in the Venezuelan population, it is not known how this process bears on reproductive behavior changes. Information about the length of residence and the place of socialization allow a limited examination of how the migratory experience of females affects household fertility decisions. Also, Table 2.1 shows that of the total number of females in the sample, 58.39% stated they had had some migratory experience, while 41.61% said they had always lived in the current place of residence. An examination of this behavior by participant age reveals, as expected, that the percentage of migrants is greater among the older women, with almost more than two out of every three (63.63%) having changed residence at least once.

Table 2.1 Distribution of place of residency, length of residency, and place of socialization

Variable	Frequency	Percent
Place of residence (*dominio*)		
Caracas Metropolitan Area	511	25.07
Cities with 25,000 people or more	1,116	54.76
Urban centers with less than 25,000 people or rural areas	411	20.17
Total	2,038	100.00
Length of residence (*lenres)*		
Always	848	41.61
Less than 1 year	51	2.50
1 to 4 years	100	4.91
5 to 9 years	147	7.21
10 years or more	892	43.77
Total	2,038	100.00
Place of socialization (*chood*)		
Caracas	360	17.66
Another city	963	47.25
A town	360	17.66
Farm	183	8.98
Abroad	172	8.44
Total	2,038	100.00

Place of socialization, which has been defined as the place where the interviewed females spent the first 12 years of their lives, is important because it reflects the differences in the behavior of females, as it is related to the transmission of norms and values. For instance, modern guidelines for family size, reproductive behavior, and contact with other reproductive alternatives would have the greatest influence on those who spent their youths in urban areas and, as a result, affect fertility negatively. Among the group of females interviewed, nearly two out of every three (64.91%) spent most of their early years in Caracas or another urban area, while the cultural characteristics of a town or farm influenced the early socialization experience of 26.64% of the sample.

Finally, 8.44% of the females spent the first 12 years of their lives abroad. These women took part in the major migratory current that occurred in the country during the 1970s. Since this is a retrospective study of fertility during the 1970s and 1980s, it is important to include the effect that these migratory currents can have on fertility.

2.3.2. Family Income

According to neoclassical economic theory, the effect of family income on fertility is ambiguous. Since children are treated as durable goods, an increase in the family income will have a positive effect on fertility (income effect). However, family income can also have a negative substitution effect (price effect). Becker and Lewis' (1973) quantity-quality approach predicts that a substitution effect is likely from quantity to quality of children with a rising family income. An increase in quality per child implies an increase in the cost of raising a child, which, in turn, decreases fertility. The net effect of income on fertility depends on the relative strength of the income effect when compared to the substitution effect. Becker (1960) argues that the substitution effect can be large compared to the income effect. Unfortunately, the survey used in this study lacks a direct measure of family income or information on wages of females or heads of households. Nevertheless, an attempt is made to determine the family's level of income using characteristics regarding the house and households where females reside, because these normally reflect the level of income of the family. These characteristics are the type of house (*thouse*) and profession of the head of the household (*profe*).

Table 2.2 Distribution of type of house and profession of head of household

Variable	Frequency	Percent
House type		
House	470	23.06
Apartment	414	20.31
Slum, rural house, urban/rural shack	1,154	56.62
Total	2,038	100.00
Profession of head of household		
University educated professional	206	10.11
Technician	159	7.80
Employee, no university education	491	24.09
Specialized laborer	540	26.50
Specialized worker	642	31.50
Total	2,038	100.00

Table 2.2, which shows the distribution of these variables, reveals that about a quarter of the sample (23.06%) live in a house, 20.31% live in an apartment and 56.62% live in a slum, a rural house or an urban/rural shack. Also, Table 2.2 shows that 42.00% of the sample reside in a household where the head is either a university educated professional, technician or employee with no degree. However, the rest (58.00%) reside in a house where the head is laborer or worker. A natural way to proceed is to explore these variables to find out how they reflect the level of income which affects, in theory, household fertility decisions.

2.3.3. Work

In the neoclassical framework, labor activities of the interviewed females (*work*) are expected to be related to fertility decisions. At the time of this survey, 56.38% of females in the sample were working. A female's participation in the labor force is expected to be negatively related to fertility.

According to neoclassical theory (Becker 1981), working wives have a higher opportunity cost of time than non-working wives. Therefore, households with working females are expected to have fewer children than those with non-working females. Table 2.3, which presents the distribution of this variable, shows that 56.38% of the sample worked at the time of the survey.

When work status is looked at by area of residency, some differences in the levels emerge. In the Caracas Metropolitan Area, the percentage of females who work totals 63.80%. In cities with 25,000 or more people, it totals 58.15%, while in the rest of the country it drops to 42.34%. These figures show that the percentage of females who work is distinctly higher the more urbanized the area of residence is.

When the level of education completed is considered, major differences arise in the levels of work status. Females who have reached a higher level of education can develop greater skills and abilities that make the incursion into the labor market easier. Females who have no education have a participation rate of 39.32%. However, participation increases to 48.51% for females who have a middle school education and 65.56% for those who have attended high school. Participation reaches 77.70% when the education level is an university undergraduate degree and 95.34% when the education level is equal to a graduate degree.

Table 2.3 Distribution of work status, work status by area of residency, and by level of education

Variable	Frequency	Percent
Work status (*work*)		
Working	1,149	56.38
Not working	889	43.62
Total	2,038	100.00
Work Status by Area of Residency		
Caracas Metropolitan Area		
Working	326	63.80
Not working	185	36.20
Total	511	100.00
Cities with 25,000 people or more		
Working	649	58.15
Not working	467	41.85
Total	1,116	100.00
Urban centers with less than 25,000 people or rural areas		
Working	174	42.34
Not working	237	57.66
Total	411	100.00
Work Status by Female's Level of Education		
None		
Working	46	39.32
Not working	71	60.68
Total	117	100.00
Middle School		
Working	587	48.51
Not working	623	51.49
Total	1,210	100.00
High School		
Working	238	65.56
Not working	125	34.44
Total	363	100.00
University (undergraduate)		
Working	237	77.70
Not working	68	22.30
Total	305	100.00
University (graduate)		
Working	41	95.35
Not working	2	4.65
Total	43	100.00

2.3.4. Education

The educational attainment of the female is predicted to be directly related to her opportunity cost of time and inversely related to her fertility decision. The inverse relationship is expected to be stronger, the higher the female's educational attainment. Therefore, illiteracy, the level of formal education reached (*ledu*) and the number of years of schooling completed (*yedu*) by females are important variables to consider in the analysis of fertility.

Table 2.4 Literacy rates and distribution of literacy by area of residence

Variable	Frequency	Percent
Literate		
Yes	1,891	92.79
No	147	7.21
Total	2,038	100.00
Caracas Metropolitan Area		
Literate		
Yes	490	95.89
No	21	4.11
Total	511	100.00
Cities with 25,000 people or more		
Literate		
Yes	1058	94.80
No	58	5.20
Total	1116	100.00
Urban centers with less than 25,000 people or rural areas		
Literate		
Yes	343	83.45
No	68	16.55
Total	411	100.00

Table 2.4, which tabulates literacy rates and literacy by area of residence, shows that a total of 147 females, representing 7.21% of the total females in the sample, said they did not know how to read or write. Most often the illiterate women are older, and their illiteracy reflects greater restrictions of access to education in the past and is closely related to the place of residence, with a 4.11% rate of illiteracy in the Caracas Metropolitan Area, 5.20% in cities of 25,000 people or more and 15.55% in the rest of the country. In the less urbanized parts of the country, the percentage of illiterate females is almost four times (3.78) greater than in the Caracas Metropolitan Area. By the same

token, the percentage of illiterate females is three times (2.99) greater in the cities of 25,000 people or more than in the Caracas Metropolitan Area.

Table 2.5 Distribution of level of education

Variable	Frequency	Percent
Level of formal education reached (*ledu*)		
None	117	5.74
Middle School	1,210	59.37
High School	363	17.81
University (undergraduate)	305	14.97
University (graduate)	43	2.11
Total	2,038	100.00
Level of education reached by area of residency		
Caracas Metropolitan Area		
None	10	1.96
Middle School	258	50.49
High School	95	18.59
University (undergraduate)	126	24.66
University (graduate)	22	4.31
Total	511	100.00
Cities with 25,000 people or more		
None	51	4.57
Middle School	667	59.77
High School	226	20.25
University (undergraduate)	152	13.62
University (graduate)	20	1.79
Total	1,116	100.00
Urban centers with less than 25,000 people or rural areas		
None	56	13.63
Middle School	285	69.34
High School	42	10.22
University (undergraduate)	27	6.57
University (graduate)	1	0.24
Total	411	100.00

In order to explore the level of education reached by a Venezuelan female, a brief overview of the Venezuela formal educational system follows to allow a better understanding of what the levels mean. The Venezuelan formal educational system is divided into five levels, kindergarten, basic, diversified and professional, technical superior, and university. Kindergarten is required for children under the age of six and usually lasts about two years. Basic, which is also obligatory, is for children over six years old. It is divided into three stages of three years each and lasts nine years. Diversified and professional, the third level of education, prepares students for higher education or for the labor market. It lasts two years and offers two options. The diversified option offers concentrations in sciences, humanities, and technologies such as agriculture, industry, commerce, health, administration, and art and is intended for students who plan to continue their formal education. The professional option offers concentrations in agriculture, industry, commerce, health, and administration and is intended for students who plan to join the labor force after completion of this third level. The technical superior level, which can be compared to a two-year college, is usually offered by polytechnic institutes. Finally, there is the university level.

For the purpose of the following table and the rest of the analysis, kindergarten is merged with the no education category. Basic is called middle school; diversified and professional are grouped and called high school; technical superior and undergraduate university are grouped and called university (undergraduate); and the rest are called university (graduate). Table 2.5, which tabulates the distribution of level of education according to this new grouping, shows that 18.65%, or approximately one out of every four females in the sample, stated that she completed some year of higher education, 18.47% reached high school, and 57.58% completed middle school. Only 5.31% of those interviewed stated they had no access to school. When grouped by age, the results are similar to those for literacy. Older females show lower achievement levels that are associated with the greater restrictions of access to education that existed in the past.

It is possible that the more or less urban nature of the place of residence influences the number of years a female spends in school, because there are more opportunities to study in the more urbanized areas. Consequently, the educational profile of females residing in the Caracas Metropolitan Area is higher, with 28.97% having attended universities as undergraduate or graduate students, compared to 17.08% for the entire sample. Conversely, the educational profile of females residing in small urban centers or rural areas is much lower, with 6.81% having attended universities as undergraduates or graduates, compared to the 17.08% for the entire sample.

2.3.5. Age

Since older women have had a longer time to reproduce than younger women, it is reasonable to expect younger females to have a lower fertility than older females. Therefore, a female's age is included as an explanatory variable, because age (*Age*) reflects characteristics of the life cycle and can, therefore, condition some of the explanatory variables mentioned above. Table 2.6, which tabulates the distribution of age, shows that 99.17% of the sample is at least 30 years old, while 87.34% of the sample is at least 35 years old.

The mean age at first union is 18.82 years and the mean age at the fourth child is 28.17 years. These numbers reveal that most of the fertility in this sample takes place early in the life cycle of females. In general, females enter their first union young and have most of their children in their twenties. This fact means that using the number of children born during the first 14 years after entering the first union as a proxy for total fertility is appropriate.

Table 2.6 Distribution of age

Age group	Frequency	Percent
25-29	17	0.83
30-34	241	11.83
35-39	618	30.32
40-44	690	33.86
45-49	472	23.16
Total	2038	100.00

Table 2.7 Frequency distribution of the number of children born during the first 14 years after entering the first union

Number of children	0	1	2	3	4	5	6	7	8	9	10
Frequency	59	226	514	561	336	186	101	35	16	2	2

Finally, it is important to consider the distribution of the dependent variable, the number of children born during the first 14 years after entering the first union. Table 2.7, which tabulates the distribution of the children born during this period, shows that most of the females have three children after the first union. It also shows that the frequency of having 7, 8, 9 or 10 children is very small by comparison.

2.4. The Poisson Regression Model and its Estimation

The dependent variable is the number of children a female gives birth to over the course of the first 14 years after entering her first union. Ordinary Least Squares (OLS) has been frequently used to estimate the parameters in models of this type, where the dependent variable is an integer describing a count. Despite its wide use in this situation, the OLS estimation has several weaknesses. When the dependent variable is a count, the OLS estimation is inefficient, and estimates of standard errors are inconsistent. It is also possible that the estimation by OLS could lead to negative count predictions. These problems have pushed researchers to seek alternatives.

A popular solution when the dependent variable, is a count is found in the estimation of either a Poisson regression model or a negative binomial regression model. Coleman (1964) outlines the basic idea of a Poisson regression. Goodwin and Sauer (1995) have recently employed these models to estimate publication by an economist over the life cycle; Ozuna and Gomez (1994) have used them to estimate a model of recreational demand; Michener and Tighe (1992) have utilized them to estimate highway fatalities; and Mayer and Chappell (1992) have employed them to estimate net entry in several industries.

Although the estimation of Poisson regression models and negative binomial models is common, the development of an interest in the negative binomial regression model arises from dissatisfaction with the extreme assumptions of the Poisson regression model. The major difficulty with the estimation of Poisson regression models is that the mean and variance are constrained to be equal for each observation. In practice, this assumption is frequently false, because usually the variance exceeds the mean. This situation is known as over-dispersion, and its consequence for parameter estimates in Poisson regression models is like the problem of heteroscedasticity in linear models. The regression parameters are consistently estimated, but the standard errors are biased downward leading to the rejection of too many false null hypotheses. Therefore, several tests for over-dispersion have been developed. And if there is evidence of over-dispersion, the less restrictive negative binomial regression model provides an alternative to the Poisson model.

The dependent variable Y_i, which is a count variable, is defined as the number of children born to a female during the first 14 years after entering the first union. Although this period is smaller than the entire number of childbearing years, it can be viewed as a proxy for total fertility, because in Venezuela during the 1970s and 1980s, most of the pregnancies took place in the very early years of the female's childbearing years. Following Famoye (1993), the probability function of Y_i is given by:

$$f_i(y_i;\mu_i) = \frac{e^{-\mu_i}(\mu_i)^{y_i}}{y_i!} \text{ where } y_i = 0,1,2,...,14$$

and $\mu_i = t_i\mu_i(x_i) = e^{ln(t_i)+\beta_0+\beta_1 x_{1,i}+...+\beta_k x_{k,i}} = e^{\ln(t_i)+x_i\beta}$, where x_i is a $(k-1)$ dimensional vector of explanatory variables including personal characteristics of both female and husband or partner as well as some demographic attributes of the family, and β is a k dimensional vector of regression parameters. The mean and the variance of y_i are given by

$$E(Y_i \mid x_i) = V(Y_i \mid x_i) = \mu_i$$

The likelihood function of the Poisson regression model is

$$L(\beta \mid y, X) = \prod_{i=1}^{N} f_i(y_i;\mu_i) = \prod_{i=1}^{N} \frac{e^{-\mu_i}(\mu_i)^{y_i}}{y_i!}$$

After taking the natural log, numerical maximization can be used to find a maximum and estimate the coefficients. Since the likelihood function is globally concave (Maddala, 1983), if a maximum is found, it will be unique.

2.5. Results

The model is estimated using a Poisson regression. The estimation results are presented in Table 2.8, which shows that place of residency, place of socialization, type of house, conjugal status, level of education, age, and union cohort seem to be significant determinants of fertility. In particular, the result most relevant to this work is that compared to the 1967-1968 union cohort, all subsequent union cohorts have a lower total fertility after 14 years of entering the first union. However, this result is only statistically significant for the 1973-1974 through the 1981-1982 union cohorts.

This raises the possibility that the period fertility rate stalls and reversals presented in the first chapter are not be associated with rises in total fertility for females entering a union during the period considered, because they did not end with more children when compared with previous union cohorts. The first stall and reversal takes place in the mid 1970s, but females entering their first union during this period have fewer children than previous cohorts 14 years after the first union.

Table 2.8 Determinants of fertility

Variable			**IRR**		
Place of Residency	**Coef.**	**IRR**	**Std. Err.**	**z**	**P>z**
Caracas Metropolitan Area (omitted)					
Cities with 25,000 people or more	0.1252	1.1333	0.0414	3.42	0.001
Urban with < 25K people or rural areas	0.1876	1.2063	0.0550	4.11	0.000
Migratory Experience					
Never moved	-0.0228	0.9775	0.0266	-0.84	0.402
Place of Socialization					
A city (omitted)					
A town	0.0183	1.0185	0.0358	0.52	0.602
Farm	0.0877	1.0917	0.0501	1.91	0.056
Abroad	-0.1341	0.8745	0.0462	-2.54	0.011
House Type					
House (omitted)					
Apartment	-0.0883	0.9154	0.0427	-1.89	0.058
Slum, rural house, urban/rural shack	0.0750	1.0779	0.0360	2.24	0.025
Conjugal Status					
Widowed/divorced/separated	-0.1060	0.8995	0.0296	-3.22	0.001
Work					
Working at time of survey	-0.0405	0.9603	0.0263	-1.48	0.138
Level of Education					
None (omitted)					
Middle School	-0.1070	0.8986	0.0446	-2.15	0.031
High School	-0.2350	0.7905	0.0476	-3.90	0.000
University (undergraduate)	-0.3220	0.7247	0.0483	-4.83	0.000
University (graduate)	-0.4273	0.6522	0.0812	-3.43	0.001
Demographic Control					
Age	-0.0202	0.9800	0.0039	-5.07	0.000
Union Cohort					
67-68 (omitted)					
69-70	-0.0726	0.9300	0.0613	-1.10	0.271
71-72	-0.1022	0.9029	0.0600	-1.54	0.124
73-74	-0.2287	0.7956	0.0533	-3.41	0.001
75-76	-0.2517	0.7775	0.0523	-3.74	0.000
77-78	-0.3552	0.7011	0.0484	-5.15	0.000
79-80	-0.3608	0.6971	0.0497	-5.06	0.000
81-82	-0.4547	0.6346	0.0483	-5.97	0.000
Constant	2.2716				

2.6. Assessing the Fit

For the Poisson distribution, the mean and the variance are equal, which implies that the deviance and the Pearson statistic divided by the degrees of freedom should be approximately one. Values greater than one indicate over-dispersion, meaning that the true variance is bigger than the mean; values smaller than one indicate under-dispersion, meaning that the true variance is smaller than the mean. Evidence of under-dispersion or over-dispersion indicates the inadequate fit of the Poisson model. Corrective measures include using the deviance or Pearson chi-square divided by degrees of freedom as an estimate of the dispersion parameter instead of setting it to one, or, in the case of over-

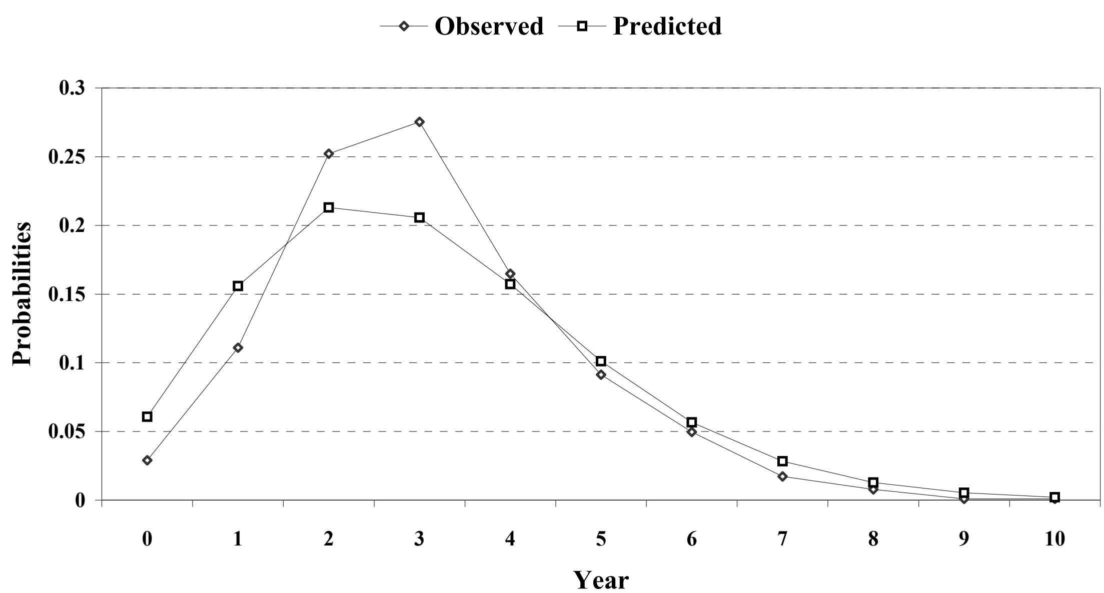

Figure 2.1 Observed and Predicted Probabilities

dispersion, running the negative binomial regression instead of the Poisson regression. Figure 2.1, which graphs the observed and predicted probabilities for this Poisson model, seems to suggest an adequate fit.

Table 2.9 Assessing goodness of fit

Criterion	DF	Value	Value/DF
Deviance	1,695	1180.50	0.6965
Pearson Chi-Square	1,695	1073.02	0.6330
Log Likelihood		-2706.83	

Table 2.9 shows that the deviance and the Pearson chi-square statistic in the Poisson estimation are 1,180.501 and 1,073.018, respectively, and the degrees of freedom are 1,695. Dividing the deviance and the Pearson Chi-Square statistic by the degrees of freedom obtains 0.7 and 0.6, respectively. These results indicate a somewhat adequate fit and, therefore, offer some evidence that the fit of the Poisson model is somewhat adequate.

2.7. Interpreting the Results

The factor or percentage change in the expected count $E(y|x)$ can be computed simply from the parameters of the model so that

$$E(y|x,x_k) = e^{\beta_0+\beta_1 x_1+...+\beta_k x_k+...+\beta_K x_K} = e^{\beta_0} e^{\beta_1 x_1} ... e^{\beta_k x_k} ... e^{\beta_K x_K}$$

where $E(y|x,x_k)$ makes explicit the value of x_k. If x_k changes by δ, then

$$E(y|x,x_k+\delta) = e^{\beta_0+\beta_1 x_1+...+\beta_k x_k+...+\beta_K x_K} = e^{\beta_0} e^{\beta_1 x_1} ... e^{\beta_k x_k} e^{\beta_k \delta} ... e^{\beta_K x_K}$$

The factor change in the expected count for a change of δ in x_k equals

$$\frac{E(y|x,x_k+\delta)}{E(y|x,x_k)} = \frac{e^{\beta_0} e^{\beta_1 x_1} ... e^{\beta_k x_k} e^{\beta_k \delta} ... e^{\beta_K x_K}}{e^{\beta_0} e^{\beta_1 x_1} ... e^{\beta_k x_k} ... e^{\beta_K x_K}} = e^{\beta_k \delta}$$

Therefore, for a change of δ in x_k, the expected count changes by a factor of e^{β_k}, where all other variables remain constant. This is the so-called incidence rate. Alternatively, the percentage change in the expected count for a δ unit change in x_k, when all other variables remain constant, can be computed as

$$100\left[\frac{E(y|x,x_k+\delta)-E(y|x,x_k)}{E(y|x,x_k)}\right] = 100(e^{\beta_k \delta}-1)$$

The factor changes or incidence rate for each variable is presented in Table 2.8. However, since most of the variables in the model are indicator variables, the discrete change in the expected value of y for a change in x_k starting at x_S and ending at x_E seems a better way to interpret the effect of these variables. This discrete change equals

$$\frac{\Delta E(y|x)}{\Delta x_k} = E(y|x,x_k=x_E) - E(y|x,x_k=x_S)$$

Therefore, for a change in x_k from x_S to x_E, the expected count changes by $\Delta E(y \mid x)/\Delta x_k$, when all other variables remain constant. Then, the effect of a binary variable is obtained by letting x_k change from 0 to 1. Table 2.10, which presents these descrete changes, confirms that the place of residence generally tends to have a notable impact on fertility, as it reflects major differences in a series of economic conditions faced by families. Urban families will have fewer children than rural families, because it costs less to raise children on a farm. Also, rural communities lag behind urban centers in the distribution of contraceptive knowledge. Residing in cities with 25,000 people or more increases the expected count by 0.3691 children compared to the more urban metropolitan area of Caracas. Further, residing in urban centers of less than 25,000 people or rural areas also increases the expected count by 0.5890 children when compared to the metropolitan area of Caracas.

The discrete changes presented in Table 2.10 also confirm that place of socialization reflects differences in the behavior of females, as it is related to the transmission of norms and values. Modern guidelines for family size, reproductive behavior, and contact with other reproductive alternatives have the greatest influence on those who spent their youths in urban areas and, as a result, affect fertility negatively. As Table 2.10 shows, having socialized in a town increases the expected count by 0.0546 children compared to having socialized in a city. Further, having socialized on a farm increases the expected count by 0.2697 children compared to having socialized in a city. A very interesting result is that having socialized abroad decreases the expected count by 0.3764. This finding suggests that females that immigrate into Venezuela have different guidelines for family size and reproductive behavior.

The results for the type of house, also depicted in Table 2.10 and intended to capture family income, show that living in an apartment decreases the expected count by 0.2556; however, living in a slum, rural house or urban/rural shack increases the expected count by 0.1626. The results of educational attainment confirm the hypothesis that the educational attainment of the female is directly related to her opportunity cost of time and inversely related to her fertility decision, and the inverse relationship is expected to be stronger, the higher the female's educational attainment. When compared to no level of education, middle school, high school, university (undergraduate), and university (graduate), decrease the expected count by 0.3205, 0.6475, 0.8564, and 1.0403 children, respectively.

Table 2.10 Discrete change in expected values

Variable	**Disc.**
Place of Residency	**Change**
Caracas Metropolitan Area (omitted)	
Cities with 25,000 people or more	0.3691
Urban with < 25K people or rural areas	0.5890
Migratory Experience	
Never moved	-0.0675
Place of Socialization	
A city (omitted)	
A town	0.0546
Farm	0.2697
Abroad	-0.3764
House Type	
House (omitted)	
Apartment	-0.2552
Slum, rural house, urban/rural shack	0.2212
Conjugal Status	
Widower/divorced/separated	-0.3052
Work	
Working at time of survey	-0.1204
Level of Education	
None (omitted)	
Middle School	-0.3205
High School	-0.6475
University (undergraduate)	-0.8564
University (graduate)	-1.0403
Demographic Control	
Age	-1.4754
Union Cohort	
67-68 (omitted)	
69-70	-0.2089
71-72	-0.2906
73-74	-0.6219
75-76	-0.6833
77-78	-0.9392
79-80	-0.9561
81-82	-1.1756
Constant	

Finally, every subsequent cohort reduces the expected count, without exception, when compared to the 1967-1968 union cohort. This last is a key result in the context of this study, because if the number of children born during the first 14 years of entering the first union is used as a proxy for the total fertility of a female, the result means that every cohort that entered an union had fewer children than the previous one in relation to the 1967-1968 cohort. Therefore, increases in the period fertility rate in the mid 1970s do not seem to be associated with increases in total fertility. Hence, the fertility decline was never really interrupted as the stalls and reversals of the period fertility rates examined in the first chapter suggest. This last hints that the stall and reversal of the period fertility rates during the 1970s is in fact due to changes in the timing of childbearing.

2.8. Summary

Poisson regression results appear to indicate that the independent variables are useful in explaining differences in the number of children a female has. The results show that place of residence, place of socialization, type of house, conjugal status, level of education, age, and union cohort are significant at the 0.10 level or better. The coefficient of each of the highly significant variables has the predicted sign, including place of residency, place of socialization, work, level of education, and union cohort.

Place of residence generally tends to have a notable impact on fertility, as it reflects major differences in a series of economic conditions faced by families. Urban families will have fewer children than rural families, because it costs less to raise children on a farm. Also, rural communities lag behind urban centers in the distribution of contraceptive knowledge. Place of socialization reflects differences in the behavior of females, as it is related to the transmission of norms and values. Modern guidelines for family size, reproductive behavior, and contact with other reproductive alternatives have the greatest influence on those who spent their youths in urban areas and, as a result, affect fertility negatively. The educational attainment of a female is directly related to her opportunity cost of time and inversely related to her fertility decision, and the inverse relationship is stronger as the female's educational attainment increases. Conjugal status reduces the expected number of children, because it reflects the lower risk that widowed, divorced or separated females have of childbearing. Also, age is an important determinant of fertility, because it reflects differences in life cycles among females.

Finally, every subsequent cohort reduces the expected number of children, without exception. This last is a key result in the context of this study, because if the number of children born during the first 14 years after entering the first union is used as a proxy for the total fertility of a female, this result means that every cohort that entered an union had fewer children than the previous one in relation to the 1967-1968 cohort. Therefore, increases in the period fertility rate in the mid 1970s do not seem to be associated with increases in total fertility. This finding is consistent with the hypothesis that changes in the timing of births could have taken place as suggested by the period fertility rates presented in the first chapter. However, since increases in the period fertility rate in the mid 1970s did not change the total fertility, the fertility decline was never really interrupted, as the period fertility rates suggest. This is further evidence that the distortions in the period fertility rates introduced in the first chapter are the result of changes in fertility timing and not changes in total fertility, and there is circumstantial evidence to suggest that the oil based boom and bust may have induced households to change the timing of births.