ABSTRACT

Title of Dissertation: LABOR SUPPLY, FERTILITY, AND THE ECONOMY

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This dissertation creates a dynamic population and labor supply model. The model is linked with the LIFT economic model of the INFORUM research group. The estimated equations for the fertility and participation rates are created from both a cross-section study of the U.S. decennial censuses, and from a time-series analysis of age-specific fertility and participation rates.

The cross-section analysis includes a detailed study of the effects of the Earned Income Tax Credit (EITC) on fertility. Across a number of specifications and samples the EITC is found to positively effect the probability of observing a birth.

A number of simulations of the model are presented and show that there are important relationships between the economy and population that can only be addressed with a fully endogenous population model. The DPM model is compared with the 1997 Social Security

Administration (SSA) projections for fertility and participation rates. The simulations show that the SSA boundaries are in fact bounds on reasonable forecasts of fertility and labor force participation. However, the simulations call into question the ability to use SSA forecasts for policy analysis.

Finally, this dissertation explores the effects of the 1997 Family Tax Relief Act enacted by Congress. The act, among other things, created a $500 child tax credit for families with dependent children and less than $110,000 in income. The simulations suggest that the credit (if allowed to grow with prices) will increase fertility in 1998 by 9% and in 1999 by 21%. These increases have profound impacts on the population and the economy. The young increasingly dominate the population. The economy initially experiences a decline in growth due to reductions in the female labor force participation rates. However, later in the forecast the economy experiences increased growth and a change in the distribution of output.

Labor Supply, Fertility, and the Economy

By

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DEDICATION

I dedicate this dissertation to my wife, Nancy Atwell, and my son, Connor Dowd. This work never would have been completed without their unending patience, encouragement, and understanding.

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LIST OF ABBREVIATIONS

2Kids	2+ Children in the Household
AO	Age by Occupation Wage Matrix
ASFR	Age-Specific Fertility Rates
ASPR	Age-Specific Participation Rates
CGE	Computable General Equilibrium
CTC	Child Tax Credit Simulation
CTCCON	Child Tax Credit Simulation with Constant Federal Surplus
CTCHALF	Child Tax Credit Simulation with Half of the EITC Effect
DPM	Demographic Projections Model
EITC	Earned Income Tax Credit
Exp()	Exponential Function
F*	Cross-Section Predicted Fertility Rates
Fert[x]	Fertility Rate for Age X
Fertlag[x][y]	Fertility Rate for Age X in Year Y
Frwage	Female Wage Relative to Wage of 39 year-old Males
GDP	Gross Domestic Product
Heckit	Heckman Sample Selection Correction Method
Hhld	Household
HI	Household Income Relative to Average Household Income
HIAG	Household Income Matix by Age, Gender, and Marital Status
Hj	Hours Worked
HS	High School
Husb.	Husband
INFORUM	Inter-Industry Forcasting at the University of Maryland
IPUMS	Integrated Public Use Micro-Data Sets
LIFT	Long-Term Interindustry Forecasting Tool
Lj	Leisure Demand
Ln	Log
Logit	The Logistic Distribution, P=Exp(XB)/(1+Exp(XB))
MDM	Denton and Spencer Demographic Model
NCHGT5	Number of Children Greater Than 5 Years of Age
NCHLT5	Number of Children Less Than 5 Years of Age
NCHS	National Center for Health Statistics
NIPA	National Income and Product Accounts
OASDI	Old Age, Survivors, and Disability Insurance
OASI	Old Age, and Survivors Insurance
OBRA	Omnibus Reconciliation Act 1993
OI	Occupation by Industry Wage Matrix
OLS	Ordinary Least Squares

P*	Cross-Section Predicted Participation Rates
PCE	Personal Consumption Expenditures
PI	Personal Income
PIPH	Personal Income per Household
Probit	Normal Distribution Probability Model
Prtf20	Female Participation Rate of 20-65 Year-Olds
Prtm20	Male Participation rate of 20-65 Year-Olds
PUMS	Public Use Micro-Data Sets
Ret67	Retirement at Age 67 in 2014 Simulation
Retcon	Retirement at Age 67 Simulation Under Constant Federal Surplus
SSA	Social Security Administration
Std. Dev.	Standard Deviation
TFR	Total Fertility Rate
Tobit	Tobin Probability Model
TWOKID	2+ Children in the Household
Unem	Unemployment Rate
Wagehat	Sample Selection Corrected Predicted Wage
Wj	Market Wage Rate for Individual j
Wjr	Reservation Wage Rate for Individual j
Zfertlag	Zero-Mean Fertility for Women in the previous year
Zfrwage	Zero-Mean Female Relative Wage Rate
Zmrwage	Zero-Mean Male Relative Wage Rate
Zsevsix	Zero-Mean Dummy Variable for years prior to 1976
Zunem	Zero-Mean Unemployment Rate

Chapter 1 **Introduction**

The Problem

In 1968 Paul Ehrlich stunned and incited the country with his book *The Population Bomb*. In his book he argued that the population explosion over the last several decades would result in huge populations in the future and precious resources would be depleted. Ehrlich's book was instrumental in educating the populace about issues related to population. However, Ehrlich fell into the same trap that economists have fallen into since Malthus' time. By not taking into account the changing economic conditions and social norms of the society, Ehrlich and, to a lesser extent Malthus, failed to recognize that population growth is the result of a myriad of economic and non-economic decisions. When making these decisions, individuals and families take into account the effect of the changing demand for the world's resources and the wealth of the people. Fertility decisions and, therefore, population growth are dynamic.

Economists today continue to make similar mistakes. One type of mistake occurs when demographers forecast the population without taking into account expected changes in the economy. Perhaps an even graver mistake occurs when economists assume that these population projections are exogenous and then base their economic forecasts upon them. At this point the circle of errors is complete. Both the population projections and the economic forecasts are likely to be inaccurate and cannot respond to changing population distributions, economies, or natural resources.

The Social Security Administration (SSA) provides an excellent example of these types of error-prone forecasts. The SSA is charged with monitoring the health of its trust funds. In order to do this, it makes forecasts of the population and the economy, but does not join them. In 1998 its forecasts of the population state that "the assumed ultimate fertility rate of 1.9 children per woman is attained in 2022 after a gradual decline from the preliminary estimate for 1997 of 2.03 children per woman." (Board of Trustees, Federal Old-Age and Survivors Insurance Trust Funds (1998), p.59.) The SSA makes no attempt to consider the effect of their projected economies on fertility or vice-versa.[1]

In a highly critical appraisal of demographic projections, Norman Ryder (1990) suggested that demographic projections needed to be performed in the context of a larger model incorporating economic and other variables. The solution to the presented forecasting problem is to recognize that people make decisions about family size, how much to work, and how and when to consume, taking into account the changing environment and economics. In other words, forecasts of both the population and the economy should be performed

[1] To be fair, the economic and demographic projections are meant to provide high and low ranges on the solvency of the trust fund. Therefore, the SSA argues, that they need only provide a range of possible outcomes and need not concern themselves with the causality of fertility or the economy. However, even given this limited objective some of the SSA projections do not even bound the actual outcomes. In 1952 Myers and Rasor (1952) made 4 different population projections. All of their projections fell short of the actual population in 1990. Their closest projections were off by 7%. In addition to under-forecasting the population the actual population distribution was off the mark as well. They predicted that the under 20 population would make up 34% of the population while in actuality it made up 29%. The difference between their projections and reality was made up in the population between the age of 20 and 64, which they predicted would make up 54% of the population in 1990 while in actuality it was closer to 59%. Their projections were characterized by slower fertility than was witnessed in the 60's and faster than what was witnessed in the 70's. These fertility projection differences lead to the population differences seen in percentage terms. The variations in fertility witnessed since their projections have had important impacts on the economy. While this example uses a projection from 1952 the techniques used to make population forecasts have not changed substantially since that time.

simultaneously, allowing changes in the population to influence the economy and vice versa. This dissertation is in many ways a response to Ryder's criticism. By incorporating the demographic projections into a larger model of economic behavior, simultaneous impacts of the population on the economy and the economy on the population are possible.

Population Forecasts

Frequently population forecasts involve some trend analysis on the determinants of population growth (fertility rates, mortality rates, and net immigration). After looking at historical data demographers usually forecast cohort specific fertility and survival rates. Meaningful socio-economic variables are rarely allowed to have an influence on the cohort fertility and survival rates. Rather it is often assumed that a balanced equilibrium steady-state will naturally come about. This natural state is one where the population distribution is pyramid shaped, with the oldest population cohorts representing the smallest proportion of the population, and fertility is sufficient for replacement.

In a review of the SSA assumptions Macunovich (1994b) argued that fertility projections needed to be upgraded in light of recent trends in the total fertility rate. Macunovich's critique highlights an important fact about demographic forecasting. Neither the forecasts, nor the recommended upgrading of the forecasts, take into account the expected future changes in the economic environment that women and families will face.

Economic Forecasts

While demographers do little to incorporate economic variables, economists typically fall prey to a deeper and more pernicious mistake. Economists make forecasts of the economy using the population projections of demographers. Because economic growth is easily decomposed into productivity growth and labor force growth, one of the major drivers of projections is the exogenous population assumption. For some time, economists have recognized the link between population and the economy. However, they have been slow to explicitly model these links in empirical models. Economic theories have shown that there are crucial insights to be gained from recognizing the interdependence of the population and the economy (i.e. Paul Samuelson's Over-lapping Generations Model (Samuelson, 1958), Coale and Hoover's analysis of the effects of population growth on the Indian economy (Coale and Hoover, 1958), Gary Becker's household production framework applied to fertility (Becker 1965), and more recently Auerbach, Gokhale, and Kotlikoff (1994) analyze the effects of fiscal policies on different generations).

In an attempt to put these insights on the interdependence of the economy and the population to use in a simulation model, Denton and Spencer (1988) created the MDM model. They found that comparing endogenous fertility results with exogenous ones could have a large impact on the economy, especially a few decades after a major fertility shock. They reach this conclusion by doing simulations with a Computable General Equilibrium (CGE) model, and by assuming reasonable values for the utility and production functions.

A few econometric models have demographic-economic linkages. Both DRI and Wharton have models that allow some feedback from the economy to demographics. However these models, tend to be top-down models that impose total birth or marriage rates, estimated as reduced form auto regressive equations (e.g. the Wharton model forecasts total births as a function of the female participation rate, income, the ratio of males to females, and lagged births in the form of children under the age of 5) on the age-specific components.[2] This work differs from these models in that here the equations are built up from estimation at the individual level and then at the age-specific level.[3]

This dissertation, like the MDM model and the Anker and Knowles model, creates a functioning model of the population and the economy. The model presented will link a population and labor supply model with the Long Term Inter-Industry Forecasting Tool (LIFT).[4] This dissertation breaks with previous research in its use of age-specific fertility equations that are estimated using the U.S. Census data. The equations are then incorporated into an econometric macro-economic model of the U.S. economy. This methodology allows population to be endogenously determined with empirically estimated equations.

Structure of the Dissertation

The dissertation is organized in the following manner. The remainder of this chapter briefly discusses the overall methodologies used in creating a demographic and economic model of the United States. Chapter two presents a discussion of the theoretical and empirical issues related to family decisions on fertility and labor supply. Chapter three presents the empirical

[2] See Ahlburg (1987) for a discussion of competing econometric based models of population and the economy.

[3] Anker and Knowles (1983) created an economic-demographic model starting from micro-econometric analysis of Kenyan survey data, and building up to an economic model with endogenous population. Like the Wharton and DRI models the Anker and Knowles model endogenously determines the TFR and then distributes it among the five-year age groups.

[4] LIFT is the primary U.S. economic forecasting model of the Inter-Industry Economic Research and Forecasting group at the University of Maryland. See McCarthy (1991) for a detailed description of the model and Dowd, Monaco, and Janoska (1998) for an application of the model to population distribution issues.

results from the cross-section estimation of fertility, and discusses in detail the impact of the Earned Income Tax Credit on fertility. Chapter four presents the empirical results from the cross-section estimation of labor force participation, and annual hours of work. Chapter five discusses in more detail the techniques used to create a simulation model of population and labor supply. The results of historical estimation are then used in conjunction with the cross-section estimates to create a functioning demographic model. Basic economic linkages to LIFT are discussed. Chapter six presents the results of the model and discusses the impact of economic variables on the population. After calibrating the model to match the SSA 1997 economic assumptions, the demographic results are then compared to SSA demographic assumptions. Chapter seven analyzes the effects of changing the eligibility age for full retirement benefits, and the effect of the $500 Child Tax Credit enacted by Congress in 1997. Chapter eight concludes the dissertation and discusses areas of possible further research.

Modeling Techniques and Assumptions

The goal of this dissertation is to have a model of the economy that allows for endogenously determined fertility and population. The first step in reaching this goal is to understand the decisions that families make about the number of children to have and how much to work. This dissertation first investigates these issues at the theoretical level and then empirically. The empirical estimation of fertility and labor supply is done first at the cross-section level and then at the time-series level. The estimation is done at the cross-section level in order to capture important relationships between labor supply, fertility and other economic variables. Time-series estimation is done using the cross-section estimates as independent variables in the time-series. Finally, the cross-section and time-series equations are combined to create equations of the age-specific fertility and labor force participation. These equations are then incorporated into a model of population. Chapter two covers in more detail the theoretical and empirical issues involved in estimating fertility and labor supply at the cross-section level.

Chapter 2 Theoretical and Empirical Issues Related to Models of Fertility and Labor Supply

In this chapter a theoretical model of family fertility and labor supply is presented. The theoretical model illustrates the difficulty in predicting the effect of changes in wages on labor supply. It also discusses how the Earned Income Tax Credit (EITC) is expected to impact both fertility and labor supply. Next the data used for the cross section analysis is described. Because of the simultaneous nature of the decisions that individuals make about fertility and labor supply, careful attention is paid to the estimation methodology employed in understanding these decisions. In addition to the simultaneous nature of these decisions, there is a problem of sample selection for a number of key variables. Therefore, a detailed description of the estimation techniques used to determine the relationships between fertility, labor supply, and economic and demographic data are presented, with particular attention paid to the Generalized Tobit Procedure.

Theoretical Model of Fertility and Labor Supply

Over the last thirty years, the economic theory of the family and empirical work on family decisions have made substantial contributions to our understanding of decision making on fertility, marriage, and labor supply. Starting with the celebrated work of Gary Becker (1965), economists have been modeling these decisions in terms of a household production model. The household production model assumes that children are demanded as an intermediate good. Equally important to the production framework, Becker and Lewis (1973) suggested that children influence parental utility in two ways: first, the number of children increases utility, and second, the quality of children increases utility. In keeping with the productive nature of parents, they suggested that quality of children is produced in the home with a combination of purchased inputs and parental time.

Typically a joint utility function for the parents is maximized subject to a full income budget constraint incorporating male and female wages and the production technologies for the production of children, Z^N, and quality of children, Z^Q. The maximization results in a set of demand equations for inputs into the production functions and final demand goods. Performing the cost minimization dual to the utility maximization allows for comparative static analysis of the Slutsky decomposition.[5]

Comparative Statics

An important variable in the analysis of fertility and labor supply is the wage rate. Whether a change in the wage rate raises or lowers home production time is ambiguous. The increase in the wage rate increases the price of an additional unit of home production time, while at the same time it increases income. If the home-produced services are normal goods, then the increase in income will induce an increase in the services demanded which may result in an increase in home production time.

LABOR SUPPLY

Given a change in the wage rate, the consequent change in parental time devoted to home production has two components. The substitution effect will reduce the amount of time devoted to home production. Through the increase in full income, the income effect will tend to increase the time devoted to home production. Looking at the time spent in the home production of children, Z^N, and noting that the Marshallian demand can be inverted, yields the equality between the Hicksian and Marshallian demands: $h^H(P,W,U)=g^H(P,W,C(\bullet))$, where g is the uncompensated demand, h is the compensated demand, H represents time devoted to home production, P and W are prices and wages, and U and C are utility and the cost function. Noting that labor, L, supplied to the market by individual j is equal to the total time available, T, less leisure, *l*, and the different time devoted to home production, H^N and H^Q, $L_j=T-l_j-H_j^N-H_j^Q$, the effect of a change in the own wage rate or the spouse's wage rate can be decomposed in the following manner:

1) $$\frac{\partial g^{H_j^N}}{\partial W_i} = \left.\frac{\partial h^{H_j^N}}{\partial W_i}\right|_U + \frac{\partial g^{H_j^N}}{\partial M} \cdot L_i \,.$$

There are two differences between equation 1 and a typical Slutsky decomposition for a good. First, note that the second term on the right is multiplied by labor supplied to the market. This occurs because the change in income is the change in the wage rate multiplied by labor supply. The opportunity cost of an additional unit of leisure or home production is the lost wages from labor supplied to the market. Second, the income effect is added to the substitution effect rather than subtracted.[6]

[5] Upon request, a detailed theoretical model of labor supply and fertility can be provided by the author.
[6] For a detailed example of the Slutsky decomposition with respect to labor supply see Deaton and Muellbauer (1996) pp. 89-93.

Equation 1 indicates that the change in home production time due to an increase in the wage of individual i, equals a compensated price effect and an income effect. By assuming a concave cost function, the equation implies that the utility compensated effect is negative if it is own wages (i.e. i=j). Assuming that the demanded goods are normal implies that the income effect is positive. Hence, the change in home production time due to a change in the own wage rate is ambiguous. If the substitution effect dominates, then increases in the wage rate will cause decreases in time devoted to home production. Conversely, if the income effect dominates, then the increase in the wage rate will increase the time devoted to home production. Analyzing the effect of changes in the spouse's wage (i.e. i≠j) then the utility-compensated effect is negative if the spouse's time in the production of children is a complement to individual j's own time, and positive if it is a substitute.

There are two other equations similar to equation 1 for leisure and home production time for quality of children, Z^Q. Combining the three equations, and using the relationship between total time and labor supplied to the market, the Slutsky decomposition for labor supplied to the market can be written as equation 2.

$$2) \qquad \frac{\partial L_j}{\partial W_i} = -\left.\frac{\partial h^{l_j}}{\partial W_i}\right|_U - \left.\frac{\partial h^{H_j^N}}{\partial W_i}\right|_U - \left.\frac{\partial h^{H_j^Q}}{\partial W_i}\right|_U - \left[\frac{\partial g^{l_j}}{\partial M} + \frac{\partial g^{H_j^N}}{\partial M} + \frac{\partial g^{H_j^Q}}{\partial M}\right] \cdot L_i \,.$$

Equation 2 indicates that the change in labor supply due to a change in the own wage rate, i=j, will be influenced by various factors. The three different substitution effects will tend to increase labor supply, while the three different income effects will tend to decrease labor supply.

The effect of a change in the spouse's wage is also ambiguous. If the spouse's time is complementary to own time in leisure and the production of Z^N and Z^Q then the effect of a change in the spouse's wage rate is the same as a change in the own wage rate. Conversely, if, as one might suppose, spouse's time is a substitute for own time in some of child production, then some of the first three terms may be negative. If the husband's time can be substituted for the wife's time in the production of Z^N, then the demand for the husband's time devoted to Z^N will increase with increases in the wife's wage. The increased demand for home production time will have a negative impact on the labor supply of the husband. These results imply that with increased opportunities for women, we should see decreased labor force hours and participation for men. Similarly, cross price effects and the effects of increases in the initial number of children can be decomposed into the Slutsky equation.

A number of studies have analyzed the effects of the Earned income Tax Credit (EITC) on labor supply.[7] Briefly, the EITC acts like a change in the realized wage rate by providing a credit to working individuals within certain income levels. The EITC, therefore, has both substitution and income effects. Both effects work in the same direction in the phase-out range (the range of income over which the credit amount is slowly reduced), where increases in income reduce the value of the credit. The increased income from the EITC results in an increased demand for leisure, while reductions in the credit amount caused by increased income are a drag on wages and work through the substitution effect to reduce labor supply. In the phase-in range (the range of income over which the credit is increased until it reaches its

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[7] The EITC is described in more detail in chapter three.

maximum), where the credit amount increases with income, the increases in income reduce labor supply by increasing consumption of leisure, and the increases in the realized wage will increase labor supply. Finally, in the flat portion of the EITC (where there is no change in the credit for increases in income) only the negative income effect is relevant.[8]

FERTILITY

Fertility is defined as the number of births that a family chooses to have in any given period. The choice of how many children to have depends on the price of births, and on the marginal productivity of the infant in producing home produced services (Z^N, Z^Q). If the price of births rises, then in order to observe a birth there must be an increase in the marginal utility derived from Z^N, or an increase in the marginal product of infants, or both. Holding everything else constant, an increase in the marginal utility of child services is associated with a decline in the level of child services. This decline in the level of child services must be from a change in the number of infants. In other words, an increase in the price of having a baby leads to a decline in the optimal number of infants desired, or conversely, decreases in the price of births will lead to increased fertility.

The Slutsky decomposition of the demand for births, B, is:

3) $$\frac{\partial g^B}{\partial P^B} = \left.\frac{\partial h^B}{\partial P^B}\right|_U - \frac{\partial g^B}{\partial M} B .$$

[8] This dissertation does not fully model the effects of the EITC on labor supply. Only income effects are empirically estimated.

The change in births due to a change in the cost of births is equal to the compensated change, which is negative, minus the income effect from the increase in prices. Therefore, an increase in the price of births reduces the number of infants desired.

An increase in the wage rate effects fertility in a similar way to the decomposition for home production time.

4) $$\frac{\P g^{B}}{\P W_{j}} = \left.\frac{\P h^{B}}{\P W_{j}}\right|_{U} + \frac{\P g^{B}}{\P M} \cdot L_{j} \,.$$

Equation 4 shows that the change in the number of infants due to a change in the wage rate of individual j is equal to the compensated change and the income effect. The first term on the right hand side is positive if the demand for births, B, and parental time, H_j, are net substitutes. Conversely the first term on the right hand side is negative if B and H_j are net complements. The second term is positive; increases in income, assuming the goods are normal, will increase the demand for births. It seems reasonable that infants and parental time in home production are net complements; an increase in the parental time devoted to child services is likely to increase the healthiness of infants. Assuming net complementarity, an increase in the home production time of parent j increases the marginal productivity of infants in producing home-produced goods. The two terms on the right hand side of equation 4 have different effects, and so the total effect of an increase in the wage of individual j on the demand for births is ambiguous. If the substitution effect dominates, then an increase in the female wage rate decreases the number of births. Alternatively, if the income effect dominates then increased wages will increase fertility.

The exception is if no labor is supplied to the market. In this case the second term on the right vanishes and the effect of an increase in the wage rate is unambiguously negative. This implies that parents who do not work, and have higher opportunity costs of time spent in leisure or home production, should have fewer children.

Essentially, the EITC affects fertility by acting as a subsidy to parents for having children (albeit a subsidy that is dependent on the total earned income in the household).[9] Therefore, the EITC's effect on fertility can be modeled as a reduction in the price of infants. Here the price is dependent on the family's income, work status, and the number of children in the household. An increase in income in the phase-in range of the EITC results in a decrease in the price, while an increase in income in the phase-out range results in a decrease in the subsidy. However, given the income of the household, an increase from no children to one or more children will result in an increase in the subsidy for eligible families. The EITC should unambiguously increase fertility.

The previous analysis shows that one's own wage, cross wage, and public policy variables can be important for both labor supply and fertility. The empirical analysis presented later will use the spouse's labor force participation to provide information about the household production functions for child services. Particularly, the analysis presented here uses both the spouse's labor force participation and the interaction between the spouse's labor force participation and indicators for the number of children in the family. The spouse's participation is used as a proxy for time that can be devoted to home production.

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[9] See Chapter 3 for a more detailed discussion of the EITC program.

Data

The data sets used for analyzing fertility and labor supply are the Integrated Public Use Micro-data Sets (IPUMS). IPUMS is an integrated set of the PUMS data sets issued by the Census Bureau and maintained by the University of Minnesota.[10] These data sets were created from the long-form questionnaire of the decennial censuses of the United States. The IPUMS are available for census years 1850 through 1990. The IPUMS data sets are "integrated" in the sense that a given variable has the same coding for different years. This allows for quick and manageable analyses across years. This research concentrates on the data from 1970, 1980, and 1990.

The 1990 data set is more likely to capture the current relationships between fertility and labor supply. The earlier data sets will pick up important movements in the variables of interest. For example over the last 30 to 40 years female labor force participation increased dramatically from 33% in 1950 to 57% in 1989 (male labor force participation fell steadily from 83% in 1950 to 78% in 1989). At the same time, the total fertility rate for the U.S. fell from 3,770 births per 1,000 women in 1956 to a low of 1,738 births per 1000 women in 1977.[11] The three data sets capture important changes in the society and economy.

All of the data sets have information on the income, hours worked, and weeks worked of the individuals in a household. Children are linked to their parents, allowing analysis of family

[10] See Ruggles and Sobek (1995).

[11] The total fertility rate is the number of births that a 1000 women would have today if they were to age instantaneously through the child bearing years and have the number of children that the current women in those ages are currently having. Fertility as opposed to fecundity is the realized outcome of childbearing decisions; fecundity is the capacity to have children.

decisions about fertility and the effects of children on parental labor supply. There is a wealth of information in the data sets including, but not limited to, state of residence, education level, occupation, age, gender, race, immigration status, language proficiency, mortgage and rental rates, and birthplace.

The data sets are in a hierarchical form, where all the records for a given household are grouped together. The first line of the data contains household level data relevant for all members of the household, for example state of residence. The next lines are individual level data containing individual variables like age and marital status. This hierarchical form allows the researcher to attach children to parents and husbands to wives. [12]

Most variables in the data sets have data quality flags. Data quality flags indicate whether or not variables have "allocated" values. Many variables have missing or incorrect data. Often when there is a missing variable for an observation the Census Bureau creates the data by allocating a value to it. There are three types of allocation: logical edits, hot deck allocations, and cold deck allocations. Logical edits are edits for a variable that has a missing or inconsistent value. An example of a logical edit is that if marital status for a person under the age of 12 is missing, he or she is given a value of "never married". Hot deck allocations search the files for a donor record. A donor record is a record in the data set that has similar characteristics to the record with the missing value. If hot deck allocation fails, then cold deck allocation is used. Cold deck allocation randomly assigns a value from a predetermined

[12] For a detailed description of the data see Steven Ruggles and Mathew Sobek, *Integrated Public Use Microdata Series: Version 1.0*, Minneapolis: Social History Research Laboratory, University of Minnesota, 1995.

distribution. In this study, all variables with a hot deck or cold deck allocation are set to "missing".[13] This eliminates any contamination of the data by donor records or a propagation of unknown distributions. The regressions exclude all observations in which any of the dependent or the independent variables are missing. The implication is that sample sizes may change slightly with changing specifications.

The federal tax rates, exemptions, and the amount of the EITC are obtained from the 1989, 1979, and 1969 editions of *Your Federal Income Tax* Department of the Treasury, Internal Revenue Service.

Table 2-1 shows the sample size for three different samples, females, married men, and single men. The table also shows the sample sizes for the fertility, and labor supply regressions. The size of the samples for the regressions differs because a number of observations lacked data for one or more of the variables. For example, in 1970 the female sample for fertility (women ages 16-55) has 512,604 observations. The fertility regression uses 421,180 observations of the 512,604 possible observations. Similarly, the number of observations for the full sample (women 16 years and older) is 706,833 in 1970. The participation regression used 598,357 observations of the possible 706,833 observations. Similarly, the annual hours regression and wages regressions used only 228,493 observations.

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[13] For more details on the methodology and the variables with allocated values see Ruggles and Sobek (1995) pp. E-1 - E-14.

Table 2-1 IPUMS Sample Sizes (1970, 1980, 1990)

Sample	Female	Married Male	Single Male
1970			
Total Observations for Fertility Sample	512,604		
Fertility	421,180		
Total Observations	706,833	428,257	212,828
Participation	598,357	354,939	189,235
Annual Hours and Wages	228,493	263,877	86,334
1980			
Total Observations for Fertility Sample	632,199		
Fertility	487,705		
Total Observations	881,492	493,628	306,907
Participation	663,544	377,997	223,102
Annual Hours and Wages	360,144	299,761	151,968
1990			
Total Observations for Fertility Sample	699,460		
Fertility	572,702		
Total Observations	993,487	540,461	365,035
Participation	804,845	438,392	277,601
Annual Hours and Wages	433,141	319,069	176,870

Overview and other studies

Cross-sectional empirical estimations of the relationships between fertility, and labor supply, using the household production framework have had some success. The relationship between female labor supply and fertility is well documented, and most of the analyses indicate that higher fertility is associated with lower labor supply.[14] For the most part, this recent work has been concerned with the simultaneous nature of the decisions. Families make joint decisions about labor supply and fertility. Consequently, most of the observable variables are important in both decision processes. This simultaneity makes it difficult to identify a simple relationship between fertility and labor supply.

[14] See Browning (1992) and Macunovich (1996) for surveys of the effects of children and fertility on female labor supply. See Killingsworth and Heckman (1986) for an excellent review

Although there has been considerable attention to the fertility and female labor supply relationship, there has been little analysis of the relationship between fertility and male labor supply.[15] However, the theory of the family applies equally well to men and women. The focus of much of the work on male labor supply has been to explain the recent reduction in labor supply of married men. Over the last several decades, as female labor supply has been increasing, the labor supply of men has been slowly declining. This decline has led to an emphasis on the relative sizes of the income and price elasticities for male and female labor supply. The studies have obtained mixed results, with the wage elasticity of labor supply estimated to be positive for women and roughly 0 for men.[16] For male labor supply, the income and price elasticities do not explain very much of the decline in participation.

Estimation Methodology

We are interested in estimating four equations. The first equation is the probability of observing a birth in a household. The second is the probability that an individual participates in the labor force. The third is an estimate of the hourly wage rate. Finally, the fourth equation is an estimate of the annual hours of work. The four equations are:

1. Probability of Birth (fertility) = f(X,W,ε);
2. Probability of Labor Force Participation (part) = f(X,W,ε);

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of the empirical literature on female labor supply. For a review of male labor supply with particular attention paid to the effect of wages, see Pencavel (1986).

[15] There are two recent exceptions. One is a working paper by Angrist and Evans (1996). They consider the effects of fertility on male labor supply and find little evidence of a strong relationship. In an analysis of male labor supply in Sweden, Carlin and Flood (1997) find that the presence of young children significantly reduce the hours worked of men by 2.6 to 3.4 hours a week.

[16] For an excellent discussion of empirical results see Pencavel (1986).

3. If individual works, wage (W) = f(X,ε), else wage is not observed;
4. If individual works, annual hours of work (hours) = f(X,W,ε), else hours are not observed.

All four of these equations are related to each other through the independent variables and the error term, ε. This is a simultaneous system of equations, complicated by sample selection (individuals self-select into the working sample) in the wages and hours equations.

Briefly, the process is to estimate a Logit of the probability of observing a birth in a household. Next, a probit of the probability of participating in the labor force is estimated using the predicted probability from the fertility estimation instead of actual fertility outcomes.[17] Using the standard "Heckit" procedure, the probit is used to get an estimate of the inverse Mills Ratio. The inverse Mills Ratio (lambda) is then included in the OLS regression of wages and annual hours. The inclusion of lambda in the two OLS regressions effectively eliminates the bias associated with estimating the wages and hours regression on only the working sample.[18] The following sections will explain the process in slightly more detail. First, there is a discussion of the relationship between fertility and labor supply, paying particular attention to the methods used in this study to determine the effects of fertility on labor supply. Next a discussion of the methods used to estimate the labor supply decisions of families is presented. This section

[17] The probability of observing a birth is very small and lends itself more easily to the Logit specification with its larger tails. The probability of participating in the labor force more closely resembles the normal distribution, and therefore is modeled using the Probit.

[18] See Maddala (1994) for a detailed explanation of the competing methodologies.

digresses with a discussion and Monte Carlo example of the "Heckit" procedure as well as a discussion of the Probit algorithm.[19]

Fertility and Labor Supply

In addition to the simultaneity of decisions, we do not observe all characteristics of the people in the sample. In particular, we do not observe the wage rate for individuals who do not work. The problems that result from not observing the wage rate are particularly relevant for fertility and labor supply. Persons who have little interest in participating in the labor force may find it more desirable to have children than those who have a strong interest in labor force participation may. Preference for participating in the labor force is also not observed it is part of the error term in both the fertility equation and the labor force supply equation. Hence, the error terms in equations estimating fertility and labor supply are correlated. Both errors capture the desire to work in the market. The correlation of the error terms may result in an overestimate of the effect of fertility on labor force participation or wages on fertility.

The simultaneity of the decisions combined with the unobserved heterogeneity of the families requires that we find some exogenous variable that is correlated with fertility but not correlated with labor supply decisions. Assuming that we have a variable, z, that is correlated with fertility and not correlated with work hours, we can estimate the fertility and labor supply equations using the two-stage least squares method. In the first stage, fertility is estimated on z and other regressors. In the second stage, work hours is regressed on the estimated value of

[19] For readers familiar with the Heckit procedure this section can be skipped. Although, the Monte Carlo example is helpful in understanding the reasoning behind using the Heckit procedure.

fertility and other regressors not including z. The result is an estimate of the effect of fertility on work hours.

This study uses instruments, i.e. z variables, for fertility that have been shown to work in the past. Specifically, the probability of observing a birth is estimated on the occurrence of twins at first and second birth, the gender of the children already in the family, and for the 1980 and 1970 samples, the quarter in which the mother was first married.[20] Twins at first and second birth are a random occurrence that is not correlated with the error term in the labor supply equations. Twins will only influence labor supply through their impact of the additional child.[21] The gender of children already in the household is also unlikely to be correlated with labor

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[20] Rosenzweig and Wolpin (1980) use twins at first birth. Angrist and Evans (1996) use twins at first and second birth and the gender of children already in the household. Lehrer (1996) analyses the effects of religion on fertility raising the possibility of religion as an instrument. Unfortunately, religion is not available in the IPUMS data sets. For a review of the literature on fertility and labor supply, and references to studies using this general approach see Browning (September, 1992). The classic example in the literature on fertility is Rosenzweig and Wolpin (1980), who used twins at first birth as exogenous variation. See Angrist and Evans (September 1996) for a more recent example of this approach using the gender mix of children as an exogenous variable correlated with fertility, but not correlated with labor supply.

[21] For the 1980 and 1970 samples twins at first and later births are calculated by comparing the age in quarters of children in the house. Quarter of birth is not available for the 1990 sample, consequently twins at first and second birth are calculated using age in years. My estimates from the 1980 sample suggest that there is a 2% error in using age in years to calculate twins. The 2% error captures children who were born less than a year apart but who are not twins. Given a 9 month gestation period, in order for two children to be born less than a year apart the mother must become pregnant within three months of delivery. Non-lactating mothers on average begin menstruating between four and eight weeks, while lactating mothers begin menstruating, on average, somewhere between 3 and 4 months (Essenberg, Murkoff, and Hathaway (1991)), suggesting that a pregnancy within the first three months after delivery may be an accident and related to variations in individual fecundity levels. Being a more fecund woman in the first three months after delivery is an exogenous shock much the same as twins are and is just as likely to be uncorrelated with the error in the labor supply equations.

supply. However, families with two children of the same gender are more likely to have a third child than those with two children of different genders. Finally, the quarter in which the woman was first married has an impact on family fertility decisions. Women married in the second and third quarters are more likely to have a birth than women married in the first and fourth quarters are.

Before estimating fertility, a number of variables need to be constructed. An important economic variable in the analysis of fertility and labor supply is total household income. However, household income will rise and fall depending on the decisions that the family makes about labor supply. In particular, it is not unusual for the mother of a newborn to stay at home. The decision to stay at home will, obviously, reduce household income by the forgone wages of the parent. Therefore, using household income as a regressor in the fertility equation is likely to capture the contemporaneous labor supply effect as well as the income effect. Consequently, all other sources of income except the mother's are used as the regressor for household income.

Because of the simultaneous nature of fertility, labor supply, and income, an estimate - not the actual value- of household income is used to calculate the value of tax rates and the EITC. The estimate of household income is necessary because income may be temporarily low after a birth; it is not unusual for the mother of a newborn to temporarily drop out of the labor force. This simultaneity in the birth outcome and labor supply would confound the effects of the tax rate and the EITC variables constructed from actual income. Therefore, an OLS estimate of household income based on the age of the head of the household, the occupation of the head of the household, state of residence, number of persons in the household, and durable goods, is used to construct the tax rate and EITC variables.[22] The estimate of household income uses durable goods, automobiles for the 1980 and 1990 samples, and household appliances for the 1970 sample, to insure identification. This procedure eliminates any simultaneity from using the actual household income in calculating the tax rates and the EITC. Table 13-8 in Appendix A shows the estimates of household income for the years 1970, 1980, and 1990. The number of trucks and automobiles has a positive effect on the observed household income, while other durables generally have a positive effect on household income for 1970.

As suggested in the theoretical section, the female wage is an important economic determinant of fertility. Wages are the price of time spent in household production and leisure. Unfortunately, we do not observe wages for all individuals. Therefore, we can not use observed wages. The first set of estimates for fertility use an OLS prediction of the log of hourly wages estimated using variables such as experience, education, occupation, state of residence, etc., on the sample of women who worked. A final set of estimates for fertility uses the sample-selection-corrected predicted log of hourly wages (see Appendix A).

Labor Supply

Assuming that the fertility component of the analysis has been dealt with by using instruments, we can focus on the estimation of the labor supply equations. There are two distinct labor supply decisions: whether to work and how much to work. Early research done on labor

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[22] The constructed EITC variable using the estimate of household income for the fertility results is set to 0 for all women who have a child in the household. Strictly interpreting, the credit only provides income to households with 1 or more children, and the value is the same regardless of how many children are in the household. However for the labor analysis the variable is the scheduled value for all families with children in the household or a positive probability of birth.

supply estimated the participation decision and the hours to work decision independently. However, recent research has recognized the dependence of these two decisions, and the inherent sample selection issues involved in looking at hours of work and wages independent of the participation decision. Independently estimating the participation, annual hours, and wage equations results in biased estimates of the parameters. The bias is a result of estimating hours and wages using the working sample, a non-random sample, because people with high potential wages are likely to be in the labor force. Heckman (1979) proposes a method to deal with this sample selection bias. The procedure is to initially estimate a probit of the probability of participating in the labor force and then use the estimated values to create the inverse Mills Ratio (lambda). [23] Lambda is then inserted as an independent regressor in the wage and hours estimation. The inclusion of lambda controls for the sample selection inherent in the estimation of wages and hours for individuals who worked. This procedure is often referred to as the "Heckit" or the generalized "Tobit", and is explained in more detail in the following section.

Heckit or Generalized Tobit

In this section, the Heckit procedure is explained. First, a Monte Carlo example motivates the need for the Heckit correction, and then the Heckit correction is illustrated using the Monte Carlo data. Next, a detailed discussion of the Heckit procedure follows paying particular attention to issues that arise in labor supply. Finally, the section concludes with a brief

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[23] The inverse Mills Ratio is the truncated probability distribution function for the probability of observing the individual in the working sample. The density function for the truncated normal distribution of y with mean u, variance σ_y^2, and the truncation occurring at c is:
$f(y|y<c) = \frac{1}{s_y}\left(f(\frac{y-u}{s_y}) \middle/ \Phi(\frac{c-u}{s_y})\right)$. See Maddala (1994) p. 5.

outline of the Probit algorithm. Although, the Monte Carlo example is an interesting application of the Heckit techniques, readers familiar with the Heckit procedure may choose to skip the rest of this section.

Interpreted loosely, the Heckit procedure estimates the probability of observing the individual in the working sample, and then includes the probability in the hours worked regression. This procedure will account for the sample selection problem in the hours regression. Another complication in the analysis of labor supply decisions is that we do not observe a wage for all individuals; individuals who do not work, do not have an observed wage. One solution is to estimate the wage equation for the individuals who do work and then using the parameter estimates calculate predicted wages for the entire population. This procedure also has a sample selection problem; the sample for wages are individuals who work. The correction procedure for estimating wages is the same "Heckit" procedure used for the hours worked estimation. The next section illustrates the problem of sample selection and truncation with a Monte Carlo example.

Monte Carlo Example

In order to provide a concrete example of the problems of sample selection and truncation, we can look at the results from a Monte Carlo for a multi-variate normal distribution. X and Y are observed variables that are made with a combination of independently and identically distributed (i.i.d.) variables. Y is hours of work. X is education or some other choice variable that influences hours of work. Let ε_X, and ε_Y, be normal (0,1) error terms. Z is some observed variable that influences Y and not X, and W is an unobserved variable representing pre-disposition towards labor force attachment that influences both Y and X. Both Z and W are i.i.d. normal (0,1) variables. Thus, Y depends on X, Z, W, and an the error term ε_Y, and X depends on W and an the error term ε_X; $X = 0.75*W + \varepsilon_X$, and $Y=0.5*X + 0.5*Z + W + \varepsilon_Y$. In addition to this setup, observed values of Y are only available when W is positive. The researcher observes X, and Z at all times and the value of Y when W is positive, and never observes W although she does observe Y when W is positive.

Figure 2-1 Joint Normal Distribution (Cov= 0.5)

```
            Plot of Y*X.  Legend: A = 1 obs, B = 2 obs, etc.
  Y ,
    ,
  8 ˆ
    ,
    ,
    ,                                                              A
    ,                                                              A    A  A
  6 ˆ                                                    A   A          AAA A
    ,                                                     A  A A    ABA
    ,                                                  A  AAAAC AA B  B  A   A
    ,                                              ABAABCB CBACACBBABBAAA
    ,                                              AA ACCBCCDCECBDEFDB  A A A
A
  4 ˆ                                            AABADBCHGAHCCHCFCGAABCBA  A
    ,                                           AB ACBCJJOKNKNMGFEEDFA B
    ,                                         BABCCFBHJFNHMQGFJLDEECC B  A
    ,                                    A A AB CEFIHLSOVZYUPOZLKGCFDAACAAA
    ,                                     A  ACBDNKSXUZZSXXVZYKJJGEEEAB   B
  2 ˆ                                   ABABBDEGKKRRZZZZZZZZZWMNLPCCAAAAA
    ,                                 AAAABBCEMKYZZZZZZZZZZZZWIOJGHCBA    A
    ,                                    BEFHJOYZZZZZZZZZZZZZZPNGDABC
    ,                                B  AFHOOJZZZZZZZZZZZZZZOTHJFFCBCB
    ,                           A   BA CDGIMZZZZZZZZZZZZZZZZQQOGEJA
  0 ˆ                               AADFDIIKTZZZZZZZZZZZZZZWWNJEBCBB
    ,                              AACHDMMTTTZZZZZZZZZZZZZPMNICBABAA
    ,                          A  AA CFLLQZZZZZZZZZZZZZZZRWPJHCBA
    ,                            CADDFJKPJXUZZZZZZZZZZZZWKLBBBAA
    ,                      A    ADBBCFINSZZTZZZZZZZZZZXPHGECC
 -2 ˆ                           BCCBEFPMZSZZZZZZZZVZROMJBDBAA
    ,                        AA ABGEBDJLRTWZZZYZVSSQKMEFAA
    ,                      A  AAA FECHGNKUUZSPSUUMQIIDECBBA A
    ,                        A   EDEGFIJJJGOLQIIMHDECFA
    ,                       A  ABADBDHDJLIJIEHFAKCBBC
 -4 ˆ                       A    CDEDDEDJIEGKCFBCB  A
    ,                       B AA AACCBCCFCBBFBC A  A
    ,                        A    AA  ABABBCAAA  A
    ,                         A B AAA E BAB A AA
    ,                           A     AAA AA
 -6 ˆ                          A  A
    ,                                  A
    ,                     A         A
    ,
    ,                                 A
 -8 ˆ
```

Figure 2-1 represents 100,000 observations of Y and X, showing the y variable on the vertical axis and the x variable on the horizontal axis. Clearly, there is a positive relationship between Y and X, and the means for both Y and X appear to be zero (the means are in fact 0.0 with standard deviation of 1.2 for X and 1.8 for Y). The researcher

Figure 2-2 Plot of Y and X (Y,X|W>0)

```
           Plot of Y*X.  Legend: A = 1 obs, B = 2 obs, etc.
  Y ,
    ,
  8 ˆ
    ,
    ,
    ,                                                              A
    ,                                                              A    A  A
  6 ˆ                                                    A   A          AAA A
    ,                                                     A  A A    ABA
    ,                                                  A  AAAAC AA B  B  A   A
    ,                                              ABAABCB CBACACBBABBAAA
    ,                                              AA ACCBCCDCECBDDFDB  A A A
A
  4 ˆ                                            AABADBCHGAHCCHCFCGAABCBA  A
    ,                                           AB ACBCJJOKNKLMGEEEDFA B
    ,                                         BABCBFBHJFLHMQGFJLDEECC B  A
    ,                                    A A AB CECIGKSOUZXUPOXLKFCFDAACAAA
    ,                                        ACBDLKRUSWZQVWTZVJGJGEEEAB   B
  2 ˆ                                   AAABBBDGIIQMZYZZZZZXYWMNJOBC AAAA
    ,                                 AA ABBCCHIUWUZWZZZZZZZZVINIGHCBA    A
    ,                                    ACDAELOXXZZZZZZZZZUXZKNFDABC
    ,                                A  ACEGEEQZNZZZZZZZZZZZLOFIEECBCA
    ,                               AA  ACADORSZWYZZZZZZZZPUNPKEAE
  0 ˆ                                 BCAACDFQXQUZZZZZZZZTYSLIEDBBAB
    ,                                AB ACFIDIQQXWZWZQXZUNJHGEBA A A
    ,                          A  A   BBDDCIGNPUQMTRUVEIJJGCDAAA
    ,                               A DCA DDFJHJLKQIJEIPECEA A
    ,                                  B EBCEALGHEKECGFBBA AC
 -2 ˆ                           A     ABB CECCBHGBCGEBDBAAA A
    ,                                    CC A ABC ABAABB
    ,                                         BA   ACAA
    ,                                A       A A A
    ,                                  A  A   A
 -4 ˆ
    ,
    ,
    ,
    ,
 -6 ˆ
    ,
```

actually only observes the value of Y if W is positive, consequently, the apparent relationship between Y and X is slightly different than above. The sample is truncated so that we only observe Y for those observations where W is greater than zero, and we get a substantially different picture. This result can be seen more clearly by looking at the above figure.

Figure 2-2 represents the truncated distribution of y and x, where the truncation occurs at zero for values of W. The mean of x, given that W is greater than zero, is now 0.6 and the mean of y is 1.1. Additionally, as we might expect, the standard deviations for both x and y have gone down from 1.8 to 1.5 for Y and from 1.2 to 1.1 for X. As can be seen from the figure, the distribution of y is now substantially different. The values of y are no longer centered around zero and they tend to be positive. This change in the observed mean and the relationship captured in the figures is precisely what we are trying to correct with the Heckit procedure. The error in the estimation of the hours decision is correlated with the error in the education decision. This correlation between the errors and the truncation of the hours worked sample will result in biased estimates of the effect of education on hours of work.

The Heckit correction applied to this example is to create a binary variable (p) that is one when Y is observed and zero when it is not. A Probit regression is then run with P as the dependent variable and X and Z as the regressors. The results of the Probit are then used to create the inverse Mills ratio (lambda), which is then included in the OLS regression of Y on X and Z.

Table 2-1 reports OLS and Heckit estimates using 100 draws of 1000 observations each from the 100,000 observations in the sample. Table 2-1 shows the parameter estimates and standard errors for the parameter on X in an OLS and Heckit regressions of Y on X and Z. The first column shows the results of the OLS regression, and the second column shows the Heckit results. Both estimates assume that the researcher does not observe W. The last column tries to correct for the sample selection by including lambda as an independent variable. The simple OLS estimate results in a parameter estimate of 1.0 that is statistically different from the actual coefficient of 0.5. The Heckit estimate results in a parameter estimate of 0.7 that is statistically different from 1.0 but not from 0.5, the actual coefficient. Thus the Heckit correction while still larger than the actual coefficient is much closer than the OLS estimate.

Table 2-1 Monte Carlo Estimation Results (OLS and Heckit)

Regression of	Observations with W > 0	
Y=B*X+C*Z		+γ*Lambda (Heckit)
Parameter on X	0.982	0.692
Standard Error	0.119	0.213

The following sections explain in more detail the sample selection problem for estimation, illustrate the "Heckit" correction method, and outline the estimation procedure.

Sample Selection and Estimation Procedure

This section draws heavily from chapters 1, 6, and 8 of G.S. Maddala (1994*) Limited Dependent and Qualitative Variables in Econometrics*. Estimates of the participation and the hours-worked equations are of primary interest in this section. First, let us assume that there are N total people, N_1 of whom work (N_1<N). Individuals know their market wage rate (W_j), but researchers only observe W_j for the N_1 working individuals. All individuals also have a reservation wage (W^r_j). The reservation wage is the wage at which the individual is willing to work exactly zero hours. The reservation wage is the value that an individual attaches to their time at zero hours of work. Unfortunately, we never observe the reservation wage, regardless of

work status. The two wage equations, market wage and reservation wage, are of the following form:

5.0) $$\begin{aligned} W_j &= X_{j1}B_1 + u_{j1} \\ W_j^r &= X_{j2}B_2 + u_{j2} \end{aligned}.$$

In the above equations, X represents exogenous regressors and B is a set of parameters. U represents normally distributed random error terms resulting from heterogeneity in preferences and endowments. The market wage is related to a number of variables, X_1, which indicate the value the individual has in the labor market. A priori, we have expectations about the sign of the effects for some of the variables; experience and education will both positively influence the market wage rate, while rural status may lead to lower wages due to fewer opportunities. The reservation wage is derived from utility maximization, and is the wage at which the individual desires to work exactly zero hours. Separate from market valuation, people place a value on their time. This value, though equal to W_j when hours worked are positive, is not necessarily equal to W_j when hours worked are zero.

Figure 2-3 Leisure Demand Schedule

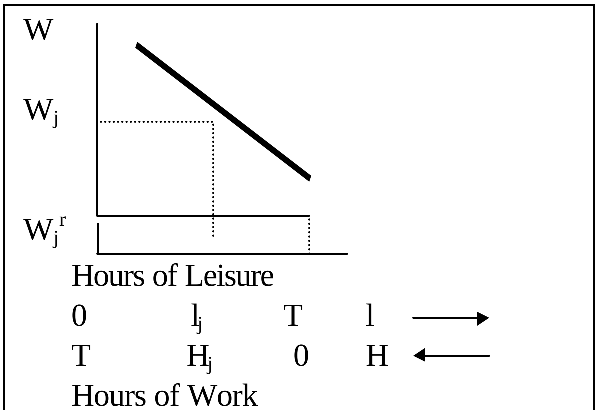

Figure 2-3 illustrates the relationship between the market wage, the reservation wage, and the number of hours worked. The vertical axis represents the wage rate. The horizontal axis represents both the demand for leisure and the supply of labor. Leisure demand is increasing to the right and hours supplied is increasing to the left. L_j is leisure demanded for individual j and H_j is the number of hours worked by individual j. The curve in the graph is a typical downward sloping demand curve for leisure. If the wage is W_j, individual j works H_j hours, and consumes L_j leisure time. However, if the wage rate is W_j^r, then individual j works zero hours and spends all his time in leisure. The reservation wage is the point on the demand curve for leisure at which an individual is willing to supply exactly zero hours of work. The figure does not show the demand curve going beyond this point because there is a limitation on the number of hours available. The reservation wage rate is also referred to as the shadow wage rate evaluated at zero hours of work; it is the valuation of time for individual j at zero hours of work. When hours of work are positive, the shadow wage rate (evaluated at the hours worked) is exactly equal to the market wage rate.

Figure 2-3 also illustrates an important feature of the procedure outlined here. Hours worked will always be positive if $W_j > W_j^r$. Additionally, given that the number of hours worked is constrained to be non-negative, hours worked equals zero if the market wage is less than the reservation wage. Equation 5.1 below summarizes the hours-worked equation.

$$
5.1) \qquad \begin{array}{ll} H_j = Z_j \cdot g + d \cdot W_j + v_j & \text{iff } W_j - W_j^r \geq 0 \\ H_j = 0 & \text{iff } W_j - W_j^r < 0 \end{array}.
$$

Again, H_j is the number of hours that individual j works. Z_j is the set of observed regressors for individual j. W_j is the observed wage rate for individual j, and γ and δ are unknown parameters to be estimated. The error term, v_j, is a normally distributed random error with mean zero and variance σ^2_v, representing unobserved taste preferences. In addition to observing hours for the N_1 working sample, we also observe the binary employment outcome; is an individual employed or not. People work provided that $W_j - W^r_j \geq 0$. The following equations illustrate the observed and unobserved components of the employment decision.

$$
5.2) \qquad \begin{array}{lll} I_j = 1 & \text{(If employed)} & \text{iff } W_j \geq W_j^r \\ I_j = 0 & \text{(If not employed)} & \text{iff } W_j < W_j^r. \end{array}.
$$

Expected Hours Conditional on Working

The regressors in the market wage equation, X_1, represent the variables that are related to the market wage. Similarly X_2 in the reservation wage equation represents the variables that are related to the valuation of time. X_1 and X_2 can be very different sets of regressors. However, from a practical standpoint, with a couple of exceptions, we are unable to determine, a priori, which variables are in one set and not in the other. Moreover, since we are interested in the latent variable W_j-W_j^r, and this is a linear combination of X's and u's (W_j-W_j^r= $X_{j1}B_1$ - $X_{j2}B_2$+ u_{j1} - u_{j2}), we can define $X_{j1}B_1$ - $X_{j2}B_2$ = X_jB, u_{j1} - u_{j2} = u_j, and Var(u_j)= σ^2. Also, let the covariance between v and u be equal to σ_{vu}; cov(v,u) = σ_{vu}. These simplifications allow us to take expectations of both sides of equation 5.1, and derive the simplified result at the bottom of 5.3. Equation 5.3 is the expected number of hours worked given that $I_j = 1$ or that $W_j - W^r_j \geq 0$.

5.3)
$$\begin{aligned}
E(H_j \mid W_j - W_j^r \geq 0) &= Z_j \cdot g + d \cdot W_j + E(v_j \mid W_j - W_j^r \geq 0) \\
&= Z_j \cdot g + d \cdot W_j + E(v_j \mid u_j \geq -X_j B) \\
&= Z_j \cdot g + d \cdot W_j + E(E(v_j \mid u_j) \mid u_j \geq -X_j B)) \\
&= Z_j \cdot g + d \cdot W_j + \frac{s_{vu}}{s^2} \cdot E(u_j \mid u_j \geq -X_j B)) \\
&= Z_j \cdot g + d \cdot W_j + \frac{s_{vu}}{s^2} \cdot \frac{s \cdot f(X_j B / s)}{\Phi(X_j B / s)} \\
&= Z_j \cdot g + d \cdot W_j + \frac{s_{vu}}{s} \cdot l(X_j B / s)
\end{aligned}$$

E represents the expectations operator. Using the equations for the wages and the definitions for the linear combinations of the X's and u's, we can write the equation as in line two of 5.3. The functions ϕ and Φ are, respectively, the density and distribution functions of the standard normal. Applying iterated expectations and the definition for the conditional expectations, we can simplify as in the last line of 5.3. Lambda in the last line of 5.3 is the truncated probability distribution function for the probability of observing the individual in the working sample.[24]

Equations 5.31-5.34 give the definitions of the normal distribution, the marginal distribution, the conditional distribution, and the relationship between the joint normal, the

[24] The density function for the truncated normal distribution of y with mean u, variance σ_y^2, and the truncation occurring at c is: $f(y \mid y < c) = \frac{1}{s_y}(f(\frac{y-u}{s_y}) / \Phi(\frac{c-u}{s_y}))$. See Maddala (1994) p. 5.

marginal and the conditional distributions. First, f(v,u) is the joint normal distribution function for v and u. Then v and u are normally distributed;

5.31) $$\begin{pmatrix} v \\ u \end{pmatrix} \sim N\left(\begin{matrix} 0 \\ 0 \end{matrix}, \begin{bmatrix} s_v^2 & s_{vu} \\ s_{vu} & s^2 \end{bmatrix} \right).$$

The marginal distributions are:

5.32) $$f_v(v) = N\left(0, s_v^2\right)$$ $$f_u(u) = N\left(0, s^2\right).$$

The conditional distributions are:

5.33) $$f\left(v \middle| u\right) = N\left(\frac{s_{vu}}{s^2} \cdot u, s_v^2 (1 - r^2) \right)$$ $$f\left(u \middle| v\right) = N\left(\frac{s_{vu}}{s_v^2} \cdot v, s^2 (1 - r^2) \right),$$

where $r = \frac{s_{vu}}{s_v s}$. Finally,

5.34) $$f(v, u) = f(v|u) f_u(u).$$

Equation 5.35 shows in more detail the transition from line 2 to line 5 in equation 5.3. Specifically, expanding the last term on the right in line 2 of equation 5.3 we get equation 5.35.

$$
\begin{aligned}
E(v_j | u_j \geq -X_j B) &= \int_{-\infty}^{\infty}\int_{-\infty}^{X_j B} v_j f(v_j, u_j | u_j \geq -X_j B) du_j dv_j \\
&= \int_{-\infty}^{\infty}\int_{-\infty}^{X_j B} v_j f(v_j | u_j) f_u(u_j | u_j \geq -X_j B) du_j dv_j \\
\text{5.35)} \qquad &= \frac{\sigma_{vu}}{\sigma^2}\int_{-\infty}^{X_j B} u_j f_u(u_j | u_j \geq -X_j B) du_j \\
&= \frac{\sigma_{vu}}{\sigma^2}\int_{-\infty}^{X_j B} u_j \frac{\sigma\phi(u_j/\sigma)}{\Phi(X_j B/\sigma)} du_j \\
&= \frac{\sigma_{vu}}{\sigma}\cdot\frac{\phi(X_j B/\sigma)}{\Phi(X_j B/\sigma)}.
\end{aligned}
$$

The functions ϕ and Φ are defined as in 5.3. The step from line 3 to line 4 in equation 5.35 uses the definition of the density function for the truncated distribution (see note 24).

Equation 5.3 demonstrates the problem with an OLS regression of H on S and W. If X and Z contain some of the same regressors and σ_{vu} does not equal zero, then δ and γ will be biased. The bias from an OLS regression can be seen by looking at the OLS estimate of γ. Representing equation 5.1 in matrix notation and ignoring wages for the moment, $\gamma\hat{}_{ols}=(Z'Z)^{-1}Z'H - (Z'Z)^{-1}Z'V$. Under normal circumstances the assumption that the regressors and the error are uncorrelated results in Z'V disappearing. The non-randomness of V in the hours worked regression for only the working sample, however, means that Z'V will not disappear. Hence, $\gamma\hat{}_{ols}$ will be biased. In practical terms, this means that there is something different about the working sample, and this difference is likely to be correlated with the observed variables. Finally, equation 5.3 shows how the sample selection problem can be treated as an omitted variable bias problem and solved by including an estimate of lambda.

Expected Wage Conditional on Working

As mentioned previously, one major problem with estimating labor supply at the cross-sectional level is that wages are not observed for people who do not work. This means that estimates of the probability that an individual works cannot use observed wages. One solution is to estimate wages for those individuals who do work, and then use the estimated parameters to predict wages for all individuals. Similar to the hours-worked equation, this procedure is plagued by sample selection problems. People with high unobservables (large positive errors in the wage equation) will have high wages, and this is likely to be correlated with the participation decision. Conversely, people with low unobservables will have low wages and tend not to participate in the labor force. Therefore, estimating wages for the working population, and not taking into account the sample selection or omitted variable bias (OVB) will produce biased estimates of the parameters. Equation 5.4 illustrates the problem. First, from equation 1.0 σ_1^2 and σ_{12} are defined as the variance for the market wage error term and the covariance between u_1 and u_2, respectively. Following the same procedure as in 5.3, equation 5.4 shows the expected wage conditional on working.

5.4)
$$
\begin{aligned}
E(W_j \mid W_j - W_j^r \geq 0) &= X_{j1}B_1 + E(u_{j1} \mid W_j - W_j^r \geq 0) \\
&= X_{j1}B_1 + E(u_{j1} \mid X_j B + u_j \geq 0) \\
&= X_{j1}B_1 + E(u_{j1} \mid u_j \geq -X_j B) \\
&= X_{j1}B_1 + \frac{(s_1^2 - s_{12})}{s} \, l\left(X_j Ba / s\right).
\end{aligned}
$$

Equation 5.4 illustrates the sample selection problem as an OVB problem, where lambda is the omitted variable from the OLS regression. Lambda is defined as in equation 5.3.

Both equations 5.3 and 5.4 illustrate the problem of estimating hours and wages from only a sample of workers. Maddala (1994) suggests that researchers should first do a probit estimation of the zero-one participation decision and then calculate an estimate of λ for each observation using the estimated parameters from the probit. The estimate of λ is then added to the OLS regression of the hours equation, and can also be added to the OLS regression for wages. Maddala (1994 p.222) suggests that this process of iterated estimation will obtain the Maximum Likelihood (ML) estimates of the parameters.

Probit Maximum Likelihood Procedure

This section demonstrates the probit procedure for the estimation of participation in the labor force. In order to facilitate the estimation of participation and the subsequent hours and wages equations we assume that the error terms are distributed normally. This assumption allows us to use the standard normal distribution in the estimation of the participation decision. Using the same notation as in the previous section and the definition of the standard normal, the probability of observing an individual in the working sample is:

5.5)
$$\Pr ob(W_j - W_j^r \geq 0) = \Pr ob(I_j = 1) = \Pr ob(u_j \geq -X_j B) = \Phi(X_j B^*)$$
$$\textit{Where} \quad \Phi(X_j B^*) = \int_{-\infty}^{X_j B/s} \frac{1}{\sqrt{2p}} \exp(\frac{-t^2}{2}) dt, \quad .$$
$$\text{and} \quad B^* = B/s$$

Given equation 5.5, the likelihood function, the log of the likelihood function, and the first derivative of the log of the likelihood function with respect to B* are:[25]

[25] ∂ represents the partial derivative.

$$L = \prod_j [\Phi(X_j B^*)]^{I_j} [1 - \Phi(X_j B^*)]^{1-I_j}$$

5.6) $$LogL = \sum_j I_j Log[\Phi(X_j B^*)] + \sum_j [1 - I_j] Log[1 - \Phi(X_j B^*)] .$$

$$\frac{\partial LogL}{\partial B^*} = S(B^*) = \sum_j \frac{I_j - \Phi(X_j B^*)}{\Phi(X_j B^*)[1 - \Phi(X_j B^*)]} \phi(X_j B^*)$$

The probit estimation chooses the parameters, B*, in order to maximize the likelihood of observing all of the observations. By setting S(B*) equal to zero we can solve for the set of parameters that maximize the probability of observing the sample. The information matrix, I(B*), is the second derivative of the log likelihood function with respect to B*. Since S(B*) is nonlinear in B*, the ML estimates must be obtained by an iterative procedure. Using an initial estimate of B*, say B_0, B_1 can be found by $B_1=B_0+[I(B_0)]^{-1}S(B_0)$. Finally, after converging to an estimate of B*, say B^, an estimate of the variance-covariance matrix can be obtained from I(B^).

Sample Selection Corrected Ordinary Least Squares

From the probit estimation we obtain estimates of B^. This allows us to create an estimate of lambda for each observation. Next λ^ is added as one of the regressors in both the wage and hours regressions. The addition of λ^ for each observation eliminates the OVB associated with the estimation of hours and wages.

This estimation procedure has a number of data requirements that are fairly stringent. For the identification of the parameters in the hours regression with the inclusion of lambda, a sufficient condition is that X contains more regressors than Z. However, leaving out an important variable could possibly produce OVB. A necessary and sufficient condition is that X contains some regressor that is correlated with participation but not correlated with hours. Moreover, if we want an estimate of wages from the analysis, then we need something that is correlated with participation but not correlated with wages. This requirement is equivalent to requiring something correlated with the individual valuation of time but not correlated with the market wage. This dissertation uses the time spent in transportation to work as a variable correlated with the participation decision but not with wages. Local unemployment is used as a variable correlated with the participation decision but not with the hours decision. Finally, experience should affect the market wage, but age, not experience, should affect the desired hours of work, and the reservation wage. Therefore, transportation time to work can be included in the probit but excluded from the wage regression. Local unemployment can be included in the probit but excluded from the hours regression. Age should be included in the probit and hours regression, but excluded from the wage regression. Finally, experience should be included only in the wage regression.

Identification of lambda in the wage regression is insured by leaving age, age squared, contemporaneous fertility, and for 1980 and 1990 an estimate of transportation time to work out of the wage equation. Leaving local unemployment out of the annual hours equation insures identification of lambda in the hours regression.[26]

[26] Transportation time to work is available in sample years 1980 and 1990 for the migration sample of the long form. Transportation time records the total amount of time in minutes that it took the worker to get from home to work. Because this variable is only available for a subsample of the workers an estimate is used for all individuals, see appendix A for the results of the estimation. Age and age squared are exogenous variables in the participation estimation, while experience and experience squared are used in the wage equation. While the age versus

Table 13-5 in appendix A shows the estimation results of an OLS regression of time spent in transportation to work on 300 regressors. There are 287 dummy variables representing metropolitan areas that are not shown in the table. The intercept includes white residents in the District of Columbia. The regression explains about 9% of the variation in transportation time. Interestingly, being female reduces the amount of time spent in transportation t work by about 4 minutes, while being black increases the amount of time by roughly the same amount. Each automobile owned by the household reduces the time spent in getting to work by about half a minute, while the number of trucks the family owns increases the time by half a minute. Finally, being married increases transportation time by almost a minute and a half. The actual values for transportation time cannot be used because they are only available for the working sample.[27] Predicted values for all of the observations are created.

Conclusion

In this chapter, a theoretical model of family fertility and labor supply decisions was presented. The Theoretical model illustrated the difficulty in theoretically predicting the effect of wages on labor supply. It also showed that changes in the wages of one spouse could have different effects on the labor supply of the other spouse depending on the complementarity or substitutability of spousal time spent outside of work. Specifically, if the time spent in leisure and

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experience variable could potentially be useful, they are highly correlated; Experience equals age less time spent in education.

[27] Similar to the problems that we encountered when looking at wages we could have a sample selection problem with using only the people who worked as our sample for transportation time. However, if people use the time spent in transportation of their neighbors and friends or the city as a whole as an indication of the time that it will take them to get to work then the appropriate variable is the average time in each metropolitan area.

the production children is complementary, then the effect of a change in the spouse's wage rate is the same as a change in the own wage rate. Conversely, if, as one might suppose, spouse's time is a substitute for own time in the production of children, then some the effect of an increase in the spouses wage on own labor supply is negative. If the husband's time can be substituted for the wife's time in the production of children, then the demand for the husband's time devoted to children will increase with increases in the wife's wage.

The theoretical effect of the EITC was also explored. The EITC in theory should have a positive impact on fertility. The EITC acts like a subsidy to the cost of having a child and therefore can be considered as a price reduction. A reduction in the price of children, assuming that children are a normal good, results in an unambiguous increase in the desired number of children.

In the empirical section the problems with estimating fertility and labor supply were described. The decisions are simultaneous and require the use of some exogenous variation in order to disentangle the effects of fertility on labor supply. In addition to the simultaneous nature of the decisions there is also a problem with sample selection in the observed wage rate. People who work have an observed wage rate, while those that don't work do not. Thus the observed wage may be capturing the effect of some other variable, the desire to work for example, not measured in the data set. The Heckit procedure is shown to be a solution to the problem of sample selection. Specifically, the Heckit procedure controls for the inherent omitted variable bias in the OLS regression of annual hours of work or the wage rate.

Chapter 3 **Cross-Sectional Estimation of Fertility**

In this chapter, the results of the fertility analysis are presented. The analysis presented here will not only focus on fertility but also on the impact of the EITC on fertility. The principal reason for focusing on the effect of the EITC on fertility it that the EITC is a policy variable that allows policy makers to have some influence over fertility.[28] This chapter starts out with a discussion of previous research on the effects of federal policy variables on fertility. Next, a detailed discussion of the structure of the EITC program and the current literature regarding its effects on labor supply and children are presented. Finally, the results of the estimation procedure are shown.

Chapter 4 **Introduction**

The previous sections showed the theoretical effects economic variables are believed to have on fertility, as well as the estimation methodology employed in the cross-section estimation of fertility and labor supply. In addition to the economic variables discussed previously, a number of articles have shown that policy variables can have an impact on fertility decisions as well. The following results show that demographic, economic, and policy variables can have an impact. Increases in the EITC are shown to increase the probability of observing a birth in a household. This is an important result for the study of the impact of the EITC on the economy. Previous studies of the EITC assume that eligibility for the EITC is endogenous through

[28] The presentation in this section and the concectration on the effects of the EITC are influenced by the fact that the effects of the EITC on fertility were analyzed as an independent study.

adjustments to the number of hours worked. However, none of the studies allow for eligibility to be a choice that the family makes by adjusting the size of the family.

Researchers have shown that federal policy variables have an effect on fertility. Specifically, researchers have shown that the value of the federal dependent exemption is positively associated with fertility choices made by women (Whittington, Alms and Peter (1990), Whittington (1992), Gohman and Ohsfeldt (1994), and Georgellis and Wall (1992)). Zhang, Wuan, and Van Meerbergen (1993) found that the Canadian federal exemption and other federal family policies had a positive and significant effect on Canadian fertility. However, there has been no research on the effect of the EITC on fertility.

Using samples taken from the Census Bureau's PUMS data sets, this research finds that the EITC increases the probability of observing a birth in a household for the years 1980 and 1990. The female wage rate is shown to have a negative impact on fertility suggesting that the substitution effect is dominating the income effect. Income, defined as all other sources of income other than one's own earned income, is shown to have a positive effect on fertility in 1980 and 1990, and an insignificant effect in 1970. Being married and having a spouse who works are found to have the two largest impacts on fertility, with the number of children under the age of five coming in a close third.[29] The positive and significant results for the EITC are shown to be robust across a number of samples and specifications. The EITC elasticity of

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[29] During the 1980's there was an increase in the number of out-of-wedlock births with well over the majority of the births coming from teen-age women. While there is important work to be done analyzing the determinants of teen childbirth, those issues are beyond the scope of this dissertation. For a detailed analysis of the fertility in 1990 see U.S. Bureau of the Census, Current Population Reports, Series p-20, No. 454, *Fertility of American Women*: June 1990, U.S. Government Printing Office, Washington, D.C., 1991.

fertility is shown to range between 0.012 and 0.1 depending on the sample and specification used.

The EITC elasticities, while small, can have large impacts with reasonable changes in the value of the credit. Assuming that families will respond similarly to the $500 child tax credit enacted in 1997 as they do to the EITC, these results imply that the probability of observing a birth in the average household will increase by 10%, adding roughly 400,000 births a year. There are a number of differences between the EITC and the child tax credit. First, the EITC is targeted at the working poor, while the child tax credit applies to all families with incomes less than $110,000. Secondly, the EITC is refundable while the child tax credit is not. Thus, compared to the EITC, the child tax credit increases the eligible population (albeit to a population which may not view $500 as enough of an incentive to increase fertility) and does not allow individuals to receive a refund of the credit.[30]

The results presented in this section suggest that not only are there unintended consequences to the EITC program (increased fertility), but that previous studies of the labor supply effects of the EITC may have ignored an important aspect of the program. Perhaps more importantly, previous studies have used single women without children as a control group for analyzing the effects of the EITC on labor supply. The results presented here suggest that this control group is also affected by the EITC through increased fertility.

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[30] See Chapter 7 for a general equilibrium analysis of the effects of the $500 child tax credit on the population and the economy.

The data used for the study of fertility and labor supply in Chapter 4 are from the long survey of the decennial census, Integrated Public Use Micro-data Sets. Because of the large size of the data sets (over 2 million observations for 1990) and the wide range of demographic and economic variables available, this data set is ideal for studying questions of family fertility choices.

Chapter 5 **Earned Income Tax Credit**

The Earned Income Tax Credit (EITC) has become an important government program combating poverty. Scholz (1994) estimates that 80-86% of eligible households received the credit in 1990. Roughly 10 million households are eligible for the credit, making the EITC one of the largest transfer programs in the U.S. Eligibility for the EITC is dependent on having earned income and dependent children. Many researchers have analyzed the effects of the EITC on labor supply and income. The EITC theoretically has two principal effects on labor supply. First, through increasing income, it tends to reduce labor supply. Second, through different effects depending on household income, the EITC either increases net wages and tends to increase labor supply, or it reduces net wages, and like the income effect, reduces labor supply. Empirical estimates of the effects of the EITC typically show that it reduces hours of work for those who work (Dickert, Houser, and Scholz (1994)), reduces disposable income (Browning (1995)), and increases participation in the labor force (Dickert, Houser, and Scholz (1994), and Eissa and Liebman (1995)). All of the studies of the effects of EITC on either hours worked, or participation are careful to control for possible endogeneity of eligibility through changing labor supply. However, none of the studies control for possible endogeneity through changing family size. EITC eligibility is dependent on children in the household, so changes in family size could change eligibility status.

The EITC was a small program instituted in 1975 designed to alleviate the regressiveness of FICA taxes. The program was targeted at the working poor who had children, and provided a credit, not an exemption, to individuals. In 1986 there was an expansion of the EITC program as an alternative method of combating poverty. The expansion increased the maximum credit amount and the cap on total income.

The credit is refundable, meaning that the credit is refunded to eligible tax filers regardless of their tax liability. Persons who file a tax report, have a dependent child, have some earned income and total income not exceeding $10,000 in 1979 were eligible for the credit. In 1979 the maximum credit was $500. For household incomes between $0 and $5,000, the EITC credit rises ten cents for each additional dollar earned. For earned incomes between $5,000 and $6,000 the credit was $500. Above $6,000 of earned income, the value of the EITC credit falls 12.5 cents for each dollar earned. For households with earned incomes over $10,000, the credit was not available.[31] The 1986 expansion resulted in an increase in the maximum credit and the range over which the credit is phased out. In 1989 the credit was fully phased out at $19,340 with a maximum credit of $910 dollars for income levels between $6500 and $10,250.

[31] See appendix A in Eissa and Liebman (1995) for phase-in and phase-out rates of the EITC from 1975-1996.

Figure 3-1 Benefits of the EITC by Income 1979, and 1989

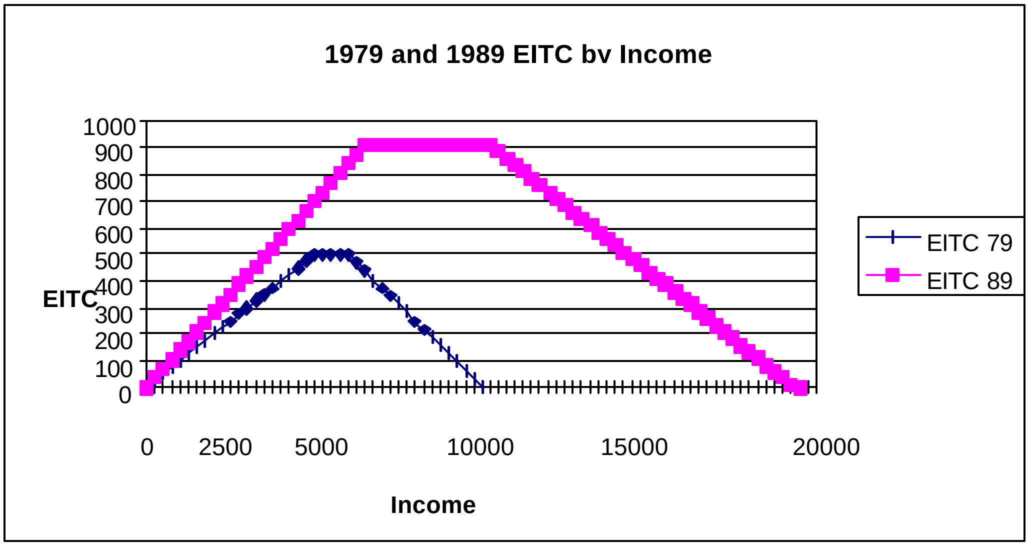


Figure 3-1 shows the nominal dollar value of the 1979 and 1989 credit by income levels. For every dollar increase in the phase-in range up to $5000 the 1979 credit increases by $0.10. In the flat range between $5000 and $6000 the value of the 1979 credit remains constant, and in the phase-out range, over $6000, the 1979 credit is reduced by $0.125 for every dollar earned. The figure shows the fairly large expansion of the EITC program.

The EITC is a refundable credit for individuals having a dependent child in the household. This link to dependent children immediately raises the possibility that families perceive the credit as a subsidy for having children. In addition 99.5% of the recipients receive the transfer in a lump sum, and the transfer is the same regardless of when the child is born in the calendar year, further suggesting that the transfer subsidizes having children.[32]

[32] See Scholz (1994).

In 1979 the maximum EITC transfer was $500. Evaluating along the flat portion of the EITC, this represents between 8.3 and 10% of the beneficiary's income. Total annual child costs including day-care have been estimated to range from $3405 to $7293 in 1982 (see Whittington, Alm, and Peters (1990) table 1 p. 546). Averett, Peters, and Waldman (1992) estimate that in 1986 child day-care costs between $0.77 and $1.70 an hour depending on the type of care. Using the higher estimate, inflating it to 1989 prices by the CPI, and multiplying it by the average number of hours worked by women who worked in 1989, 1551 hours annually, the cost of child care for the average woman in 1989 was $2947. In 1989 the maximum credit was $910 dollars representing 31% of child day-care costs. These figures indicate that the EITC transfer to families with dependent children is a substantial amount of money that can be used to offset the cost of having a child. Given the nature of the program, a transfer of income to parents, and the size of the transfer, it seems reasonable to ask the question: by reducing the cost of having a child does the EITC increase the likelihood of observing a birth in eligible households?

Chapter 6 **Fertility Results**

Table 3-1 shows the mean and standard deviation of a number of variables for the 1970, 1980, and 1990 fertility samples. The mean number of births has declined from 6 births per 100 women in 1970 to 4 births per 100 women in 1990. The mean age of women has increased slightly from 33.8 in 1970 to 34.2 in 1990. This change reflects the changing age composition of the U.S. The aging of the Baby Boomers not only accounts for the increase in the mean age between 1970 and 1990, but also accounts for the slight dip in mean age in 1980.

The tax value of state exemptions (state tax rate multiplied by the exemption dollar value) has been steadily increasing in nominal terms from $14.07 in 1970 to $33.86 in 1990. However, in 1990 dollars the value has fallen from over $40 to $33.86. This represents a decline in the value of state dependent exemptions from those seen in 1970. Importantly, women in the sample have, on average, more education in 1990 than they did in 1970. In 1970 they had slightly less than a high school education, a value of 15 corresponds to an education through 12th grade, while in 1990 they had on average slightly more than a high school education. The table shows a steady decline in the percentage of women who are married. In 1970 66% of the women aged 16-55 were married, while in 1980 and 1990 59% and 56% of the women were married. In addition to the declines in the birth rate for women, there also has been a marked decline in the number of children that women have, on average. In 1970 women had on average 25 children between the ages of 1 and 5 per 100 women, while in 1990 that number was 21. Similarly for children over 4 in 1970 there were 110 per 100 women and in 1990 there were 81 per 100 women.

Table 3-1 Means and Standard Deviations of Dependents and Regressors (1970, 1980, and 1990)

Fertility Samples	1970		1980		1990	
Women Ages (16-55)	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Births (Ratio)	0.06	0.24	0.05	0.22	0.04	0.20
Age	33.83	18.80	32.87	19.24	34.22	19.09
Age Squared	1285.45	1794.62	1210.38	1858.09	1285.60	1907.85
Log of OLS Estimate of Wages	0.36	0.50	1.25	0.38	1.87	0.42
Log of Selection Corrected Wages	0.37	0.52	1.28	0.35	1.91	0.40
Other Hhld Income $1000	7.69	6.79	14.70	14.62	24.40	29.46
Tax Value State Exemption	14.07	17.61	26.73	32.49	33.86	51.31
State Tax Rate	0.03	0.03	0.05	0.04	0.04	0.04
EITC			18.30	103.71	45.06	203.06
Years of Education (15=HS)	13.39	3.21	15.14	3.18	15.67	2.96
Married	0.66	0.49	0.59	0.50	0.56	0.50
Married Quarter 1	0.15	0.37	0.13	0.34		
Married Quarter 2	0.22	0.43	0.20	0.41		
Married Quarter 3	0.21	0.41	0.20	0.40		
Married Quarter 4	0.19	0.40	0.16	0.38		
Husband Labor Participation	0.62	0.50	0.56	0.50	0.53	0.49
No. Children 1< age < 5	0.25	0.49	0.20	0.42	0.21	0.44
No. Children age >= 5	1.10	1.35	0.89	1.14	0.81	1.01
Twins at First Birth	0.01	0.08	0.01	0.07	0.01	0.09
Twins at Second Birth	0.01	0.07	0.00	0.06	0.01	0.07
First 2 children same gender	0.18	0.33	0.14	0.30	0.13	0.29
Two or More Children	0.39	0.45	0.34	0.43	0.32	0.43
Husb. Part. * No. Child 1<age<5	0.21	0.45	0.16	0.38	0.16	0.38
Husb. Part. * No. Child age>=5	0.91	1.26	0.68	1.03	0.59	0.90
Teenager	0.14	0.30	0.13	0.29	0.10	0.25
Hhld. Income <30k 1990, <20k 1980			0.55	0.50	0.47	0.50
Hhld. Income <25k 1990, <15k 1980			0.41	0.49	0.39	0.49

The average value of the EITC in Table 3-1 also shows a marked increase from 1980 to 1990. The average value of the EITC in current dollars increased from $18.30 in 1980 to $45.06 in 1990. In 1990 dollars the EITC in 1980 was $28.07. The increase in real value from 1980 to 1990 represents the effects of the 1986 expansion of the EITC program. The increased subsidy to parents in 1990 from 1980 might lead to an increased effect of the EITC in 1990.

Table 3-2 shows the results from two different Logit specifications of the probability of observing a birth in a household for the years 1970, 1980, and 1990. The Logit function is $P = e^{X\alpha}/(1+e^{X\alpha})$, where P is the probability of observing the outcome, e represents the exponential function and $X\alpha$ are the regressors and the parameters, respectively. The Table presents the results in the form of elasticities and the average fixed effects. The elasticity with respect to X is defined as $(1-P)*X\alpha$, where α is the parameter, P is the probability of observing a birth evaluated at the mean, and X is the regressor. The average fixed effect is the percentage change in the probability with a change from a value of zero to one for the dummy variable evaluated at the mean values of the other regressors; ([P(Dummy=1)-P(Dummy=0)] / P(Dummy=0))*100, where P() is the probability function. The “wage OLS” specification uses the predicted value of the log of wages from an OLS regression of wages. The “wage Heckit” specification uses instead the predicted value of the log of wages from a regression of wages on experience, education, marital status, local unemployment, and occupation and state dummies, using the Heckit correction.

All of the specifications across all of the years suggest that the probability of observing a birth is initially an increasing function of age, but at a decreasing rate. The transition points where age starts having a total negative effect on fertility are at age 43 in 1970, age 50 in 1980, and age 53 in 1990. The transition points are increasing from 1970 to 1990 reflecting the fact that women are having children later in life. All of the specifications suggest that the log of the wage rate (wage OLS and wage Heckit) decreases fertility. Women who have a higher opportunity cost of time spent in the production of children have fewer children. Moreover, the effect of wages on fertility is increasingly important. The elasticities decrease from -0.5 in 1970 to -3.1 in 1990.

Marital status and number of children ages 1 to 4 have a positive impact on fertility across all years and specifications. Being married increases the probability of observing a birth by 148% in 1990. In percentage point terms, the 148% increase in the probability of observing a birth, evaluated at the mean, translates into a 1.1 percentage point increase from 0.74% to 1.8%. In addition to current marital status the Table presents the average fixed effects for the quarter in which the woman was first married for the years 1970 and 1980. The left out persons are those who have never been married. The parameter estimates for each quarter of marriage are statistically different from each other. Despite the tenfold difference in the size of the effect between 1970 and 1980, there is a clear pattern of increased probability of birth for women first married in the second and third quarters of the year.[33] Having two or more children reduces the probability of observing a birth. However, having twins at the first birth has an insignificant effect in 1970 and 1990, and a positive effect on the probability of observing a birth in 1980. Twins at second birth has a distinct negative effect on the probability of observing a birth for all years. Finally, although first two children of the same gender are insignificant in 1970 it raises the probability of observing a birth in 1980 and 1990.

Similar to the effects of marital status on fertility, having a husband participate in the labor force has a significant impact on the birth probability. Husband participation increases the

[33] Quarter of marriage is also correlated with a number of outcome variables including the likelihood of being widowed, and divorced. Women married in the first and fourth quarters are more likely to be widowed and divorced than those married in the second and third quarters. See Tables 9-9 through 9-11 for frequency tables by quarter of marriage.

probability by 83% in 1970 and almost 200% in 1990. Recalling from the previous table that the mean number of husbands participating in the labor force has also been declining it is not surprising that the spouse's participation plays an increasingly important role in the decision to have children. In all of the specifications, except the 1970 wage Heckit specification other household income increases the probability of observing a birth.

Table 3-2 Logit Estimation of the Probability of Birth (full samples for 1970, 1980, and 1990)

Sample Year	1970		1980		1990	
Specification	Wage OLS	Wage Heckit	Wage OLS	Wage Heckit	Wage OLS	Wage Heckit
Elasticities						
Age	9.904	10.224	14.355	15.009	15.798	16.696
Age Squared	-8.724	-8.838	-10.524	-10.862	-11.542	-11.897
Ln Wage OLS	-0.524		-2.646		-2.194	
Ln Wage Heckit		-0.552		-3.573		-3.160
Other Hhld Income	0.028[1]	-0.013[3]	0.165	0.222	0.117	0.149
Tax Value State Exemption	-0.040[3]	-0.030[3]	-0.480	-0.542	-0.012[3]	-0.014[3]
State Tax Rate	-0.255	-0.238	-0.157	-0.197	-0.285	-0.325
EITC			**0.047**	**0.048**	**0.042**	**0.041**
Education	0.423	0.528	1.503	-1.198	1.246	1.718
Average fixed effects for Dummy and Discrete Variables						
Hhld. Income <30k 1990, <20k 1980			36.2	37.4	33.9	34.4
Married	57.6	56.9	202.3	224.9	148.9	147.8
Married Quarter 1	693.4	667.1	69.8	76.0		
Married Quarter 2	771.7	740.0	78.1	85.3		
Married Quarter 3	743.6	714.0	80.0	87.4		
Married Quarter 4	722.4	694.4	73.8	80.6		
Husband Labor Participation	83.2	83.7	133.5	119.4	215.5	199.2
No. Children 1< age < 5	82.6	79.7	86.3	75.2	141.1	129.7
No. Children age >= 5	11.3	10.7	29.4	25.8	37.1	33.3
Twins at First Birth	-7.1[3]	-7.0[3]	36.5	41.3	11.8[2]	10.2[3]
Twins at Second Birth	-10.6[3]	-10.4[3]	-41.0	-43.6	-23.0	-23.0
First 2 children same gender	1.8[3]	1.7[3]	14.2	15.9	7.0	6.6[1]
Two or More Children	-51.7	-50.8	-61.5	-64.7	-59.3	-59.8
Husb. Part. * No. Child 1<age<5	-44.6	-44.1	-38.5	-33.5	-49.1	-45.7
Husb. Part. * No. Child age>=5	-18.4	-18.1	-35.1	-36.5	-37.0	-37.5
Teenager	-33.4	-28.7	10.1	-7.6[1]	55.1	39.1
- 2 Log L						
Intercept and Covariates	132493	132498	151284	150910	162271	156795
Intercept Only	177361	177361	199490	198955	204391	197561

All estimates are significant at the 1% level unless noted otherwise below. 1 Significant at the 5% level. 2 Significant at the 10% level. 3 not significant. Other variables not shown here are dummy variables for immigration status, metro status, racial and ethnic background, and for the 1980 and 1990 years indicators of English speaking capabilities, and school attendance in the previous year. In addition, all of the full specifications included occupational and state dummies. Married in quarter 1-4 are all statistically different form each other in both 1970 and 1980.

For the years 1980 and 1990, when the EITC program was in place, the value of the EITC had a positive and significant effect on fertility across both specifications. Recalling the theoretical model of the demand for births, the positive effect suggests that families perceive the

EITC as a subsidy to the cost of having a child. Using the Heckit specification estimate of the elasticity of the EITC on fertility suggests that a 10% increase in the value of the EITC would result in a 0.48% increase in 1980 and a 0.41% increase in 1990.

In a number of articles the federal value of exemptions has been shown to have a positive and significant effect on the probability of observing a birth. However, Whittington (1993) was unable to find a significant effect of the tax value of state dependent exemptions. The tax value of state dependent exemptions like the EITC, theoretically, acts as a subsidy to the price of having a child. Using a different data set, this research confirms Whittington's results that families do not take into account the state tax value of dependent exemptions when making fertility choices.

Except for the Heckit specification in 1980, education is positively associated with increases in the probability of observing a birth. Educational attainment is likely to be highly suggestive of expected labor market participation. Individuals who are not intending to participate heavily in the market are likely to invest less time in acquiring costly human capital. Educational attainment also plays an important role in the estimation of wages, see appendix A. So, while educational attainment is endogenous, it is necessary to control for it in order to get an unbiased estimate of the effect of wages on fertility. However, interpreting the elasticities for education is problematic. Education appears to be positively correlated with fertility, except for the "Wage Heckit" specification in 1980; however, education could easily be compensating for the effect of education on wages, or picking up the effect of the education of the spouse.

Table 3-2 showed two specifications for the probability of observing a birth. The results across the two specifications are largely the same. However for the variables that we might anticipate are strongly related to labor force participation -wages, income, education- there were differences in the effects these variables had on fertility. This suggests that the use of the Heckit procedure is important in accounting for the sample selection inherent in estimating wages.[34]

For both 1980 and 1990 the specifications included a dummy variable for incomes less than $30,000 in 1990 and $20,000 in 1980. The EITC is a program aimed at the working poor, so an analysis of the effects of the EITC using a sample for all individuals regardless of their income might be simply capturing the effect of being in the lower portion of the income distribution. In order to control for that possibility a dummy variable is used. In both years and specifications the effect of being in the lower region of the income distribution is to increase the probability of observing a birth. In 1980 the probability of observing a birth evaluated at the mean increased by 36-37%, while in 1990 the probability increased by 34%.

[34] See Appendix A for a comparison of the parameter estimates for the OLS and the Sample-Selection-Corrected OLS of the log of wages.

Table 3-3 Logit Estimation of the Probability of Birth for Low-Income Households

Women age 16-55 by Household Income 80 and 90 samples only				
Year	1980		1990	
Household Income less than	$20,000	$15,000	$30,000	$25,000
Elasticities				
Age	13.734	8.148	15.380	13.326
Age Squared	-16.781	-13.533	-18.923	-17.694
Selection Corrected Log Wage	-2.509	-1.570	-2.863	-2.455
Other Hhld Income	0.229	0.179	0.123	0.120
Tax Value State Exemption	-0.270	-0.064[3]	0.021[3]	0.027[3]
State Tax Rate	-0.598	-0.726	-0.366	-0.353
EITC	**0.097**	**0.102**	**0.055**	**0.053**
Education	-0.018	-2.408	1.220	1.015
Average fixed effects for Dummy and Discrete Variables				
Married	202.3	165.5	132.6	122.8
Married Quarter 1	60.1	55.5		
Married Quarter 2	73.2	85.9		
Married Quarter 3	74.1	75.5		
Married Quarter 4	71.1	80.9		
Husband Labor Participation	107.9	98.8	153.7	152.9
No. Children 1< age < 5	64.2	44.3	88.3	83.3
No. Children age >= 5	23.7	15.5	22.7	19.8
Twins at First Birth	30.7[1]	20.1[3]	14.6[3]	20.8[2]
Twins at Second Birth	-38.6	-34.4[2]	-15.4[3]	-5.4[3]
First 2 children same gender	17.9	9.8[2]	3.9[3]	8.0[2]
Two or More Children	-57.8	-45.0	3.9	-46.4
Husb. Part. * No. Child 1<age<5	-37.5	-32.4	-44.2	-43.9
Husb. Part. * No. Child age>=5	-32.2	-24.4	-35.8	-33.4
Teenager	-20.9	-16.6	2.2[3]	-3.2[3]
- 2 Log L				
Intercept and Covariates	82864	55286	67756	54093
Intercept Only	107641	72319	83653	66671

All estimates are significant at the 1% level unless noted otherwise below. 1 Significant at the 5% level. 2 Significant at the 10% level. 3 not significant. Other variables not shown here are dummy variables for immigration status, metro status, racial and ethnic background, and for the 1980 and 1990 years indicators of English speaking capabilities, and school attendance in the previous year. In addition, all of the full specifications included occupational and state dummies. Married in quarter 1-4 are all statistically different from each other.

The dummy variable for incomes less than 30,000 in 1990 and 20,000 in 1980 certainly is accounting for some effect of being in the lower portion of the income distribution. However, all of the other variables are constrained to be the same and so we may still be attributing something to EITC that is merely the effect of being in the lower region of the income distribution. To reduce further the likelihood that EITC is an unintended proxy for having a low income Table 3-3 shows the results of Logit regressions for the years 1980, and 1990 where the sample is only from the lower portion of the income distribution. The two different samples presented in Table 3-3 are for 1980 households with income less than $20,000, and households with incomes less than $15,000. In 1990 the first sample is for households with incomes less than $30,000, and the second sample is for households with incomes less than $25,000. One of the criteria in choosing the cutoff points is that the sample includes all of the possible incomes for EITC eligibility. Thus, all of the samples include the full range of possible incomes for EITC eligibility.

Across both years and the two different samples, the EITC has a positive and significant effect on fertility. Rather than giving smaller impacts, restriction to the low income households *increases* the effect of the EITC on fertility. Reducing the sample resulted in an increase in the elasticity from 0.05 in 1980 with the full sample to 0.10 in the smaller sample. Similarly, the elasticity increased from 0.04 to 0.05 in 1990.

Since the EITC is dependent on having some earned income, it is possible that the EITC has a differential effect for married and single women. Married women, if they drop out of the labor force at the occurrence of a birth, are more likely to have earned income from their spouse than are single women. However, single women may be more likely to both stay in the labor force and to be eligible for the EITC. Table 3-4 shows the results of estimating the fertility equation separately for married and single women for a Logit with the years pooled. The pooled estimation uses 1984 dollars for the EITC, wages, other household income, and the value of state exemptions.

Comparing the different estimations, it appears that the EITC influences single women more than married women. Interestingly, educational attainment seems to have a differential effect for women who are married and women who are single. For single women, higher education levels are associated with lower probabilities of birth. This difference may reflect differences in risk aversion. Single women with more education may be more risk averse and consequently have fewer children. The change in the sign for married women is also interesting. This may reflect the endogenous nature of marital status, and positive assortative mating on education and other variables. Women with more education may be more likely to marry men with more education, and therefore the education variable may be capturing the combined effect of high education levels of both the husband and the wife.

Table 3-4 Logit Estimation of the Probability of Birth Pooled Years by marital status

Pooled Sample of Women 1970, 1980, 1990 Sample	Full	Married	Single
Elasticities			
Age	13.268	14.872	7.324
Age Squared	-10.388	-12.354	-5.454
Wage OLS	-0.027	0.082	0.379
Other Hhld Income	0.064	0.166	-0.193
Tax Value State Exemption	0.007	0.013	0.022
State Tax Rate	-0.017	-0.001	-0.056
Federal Tax Rate	-1.938	2.791	-1.289
Tax Value Federal Exemption	1.436	-3.606	0.859
EITC	**0.024**	**0.012**	**0.014**
Education	0.078	0.359	-1.012
Average fixed effects for Dummy and Discrete Variables			
Married	210.8		
Husband Labor Participation	216.2	65.2	
No. Children 1< age < 5	165.3	42.1	139.4
No. Children age >= 5	35.6	5.9	24.0
Two or More Children	-56.2	-57.6	-34.0
Husb. Part. * No. Child 1<age<5	-54.9	-17.6	
Husb. Part. * No. Child age>=5	-30.8	-7.7	
Teenager	22.2	54.1	29.6
Year 1970	98.4	497.6	15.0
Year 1980	120.7	167.2	15.1

All estimates are significant at the 1% level unless noted otherwise below. 1 Significant at the 5% level. 2 Significant at the 10% level. 3 not significant. Other variables not shown here are dummy variables for immigration status, metro status, racial and ethnic background, and for the 1980 and 1990 years indicators of English speaking capabilities, and school attendance in the previous year. In addition, all of the full specifications included occupational dummies.

All of these results indicate that federal policy, in the form of the EITC, has a positive impact on fertility. Increases in EITC are shown to increase fertility. Across a number of specifications and samples the EITC is shown to be robust in its impact on fertility. Moreover, the impact appears to be stronger for single women than married women. Single women who are more likely to be attached to the labor force are also more likely to increase their fertility with increases in the EITC. The implication for studies of the EITC is that not only is eligibility endogenous by adjusting labor supply, but also by adjusting family size. The stronger effect for single women may indicate that the positive effects of EITC found in the labor supply of single women are to some degree the result of increases in fertility for these women.

Chapter 7 **Conclusion**

In chapter 2 it was shown that there are theoretical reasons for thinking that families take economics into account when making fertility decisions. The fertility results presented here show that across a number of different specifications, years, and samples, economic variables not only can play a role in fertility decisions, but also play an important role in those decisions. The female wage reduces the probability of observing a birth by 3.1% for every 1% increase in the log of wages. Considering the large increases in both female labor force participation and wages, it is not surprising that some of the decrease in fertility over the last several decades can be attributed to the increased opportunity cost of staying at home with a baby. Similarly, household income less one's own earned income is shown to have a positive effect on fertility, increasing the probability of observing a birth by 0.2% for every 1% increase in income. Even though we are unable to draw any firm conclusions about the effect of education on fertility, the level of educational attainment clearly plays an important role in the determination of wages, and fertility. Education is associated with increases in the probability of observing a birth for married women, and decreases in the probability of observing a birth for single women.

The effect of the EITC is to increase the probability of observing a birth. The EITC elasticity of birth is estimated to be between 0.012% for married women in all years, and 0.1%

for the full specification in 1980. The variation in elasticities for 1990 is somewhat smaller ranging from 0.04% in the full specification with all women to 0.05% for all women living in households with less than $25,000 of household income including one's own earnings.

The EITC increases the probability of observing a birth for the years 1980 and 1990. The positive and significant effect of the EITC holds up across a variety of specifications and samples. Interestingly, in the pooled estimation of fertility, where EITC is zero for 1970, the results are still significant and positive. These results suggest that further expansions of the EITC will be associated with increases in fertility. Specifically, the 1993 OBRA expansion of the EITC, which expanded the coverage for families with more than one child, should be associated with an increase in births.

To date research on the EITC acknowledges that individuals choose their eligibility status by adjusting their hours of work. However, researchers have assumed that choosing eligibility status by changing family size is not possible. This research shows that EITC has a positive and significant effect on fertility and casts doubt on the assumption of exogeneity in the analysis of the effect of EITC on labor supply. In each of the different specifications the effect of the EITC is found to be positive and significant. These results are important because other researchers use single women without children as a control group. The EITC actually contaminates the control group by inducing some of these women to have children.

In sum, the cross-section results presented here suggest that there are important policy, economic, and non-economic effects on fertility decisions. These effects need to be controlled for in the estimation of labor supply and in projections of population.

Chapter 8 **Cross-Section Estimation of Labor Supply**

In this chapter the results of the empirical estimation of labor supply decisions are presented. First there is a brief introduction to the important issues that are involved in estimating labor supply, as well as a presentation of some of the stylized facts about labor supply. Next the results of the probit estimation of labor force participation for women, married men, and single men are presented, paying particular attention to the effects of children on their parents' labor supply. Then the results from the sample-selection-corrected estimates of annual hours of work are presented as well as the effects of family structure on participation and annual hours of work for married men. Finally, the chapter concludes with a discussion of policy implications and a summary of the results.

Introduction

The previous results show that there can be important economic effects on fertility decisions. However, just as important for the economy are the effects that children have on their parents' labor supply. This chapter explores two determinants of labor supply: those that children have on parents and those of economic variables. The effects of children on their parent's work and those of economic variables on work decisions are analyzed by looking at the participation and the annual hours worked for women, married men, and single men. A Heckit procedure is used to control for sample selection in observed wages and hours worked.

Numerous studies have analyzed the effect of children on female labor supply, typically finding that the presence of children, particularly pre-school children, has a negative impact on the labor supplies of their mothers. Though the theoretical model outlined above also applies to men, few studies have specifically looked at the effect of children on male labor supply. Angrist and Evans (1996) found very little in the way of effects of fertility on married males. In an analysis of time-use data for married men, Carlin and Flood (1997) found significant effects of children on male labor supply in Sweden. This study finds that men are increasingly influenced by the combination of family size and the spouse's labor force participation. When interacted with the wife's labor force participation, fertility is found to decrease hours of work and increase participation for married men, suggesting that mother and father's time are substitutes at the margin but not for primary care of infants. Perhaps more importantly, married men in the 1990 sample reduce their participation by almost 4 percentage points if their wives work and they have two children between the ages of 1 and 5.

The results presented here use the predicted fertility from the full specification in Table 13-6 of appendix A, if the woman is between the age of 16 and 55 (otherwise the predicted fertility is 0) and actual fertility. While the previous chapter had a number of specifications for fertility they were principally formulated to study the effects of the EITC. Consequently, a different specification that does not focus so heavily on the EITC is used for the predicted values of fertility in the labor supply regressions. The married male sample links the predicted fertility of each wife to the husband. Finally, the single male labor supply analysis assumes that the probability of observing a birth is zero; all children including infants are used as independent variables.

Table 8-1 shows the means for labor force participation, annual hours, the log of wages, and a number of other variables for the years 1970, 1980, and 1990. The average participation for women age 16 and older has increased 15 percentage points from 41% in 1970 to 56% in 1990. Similarly, single males have increased their participation in the labor force from 59% to 69%. However, married men have reduced their participation 8 percentage points from 86% in 1970 to 78% in 1990.

Table 8-1 Means for Dependent and Independent variables for Labor Supply

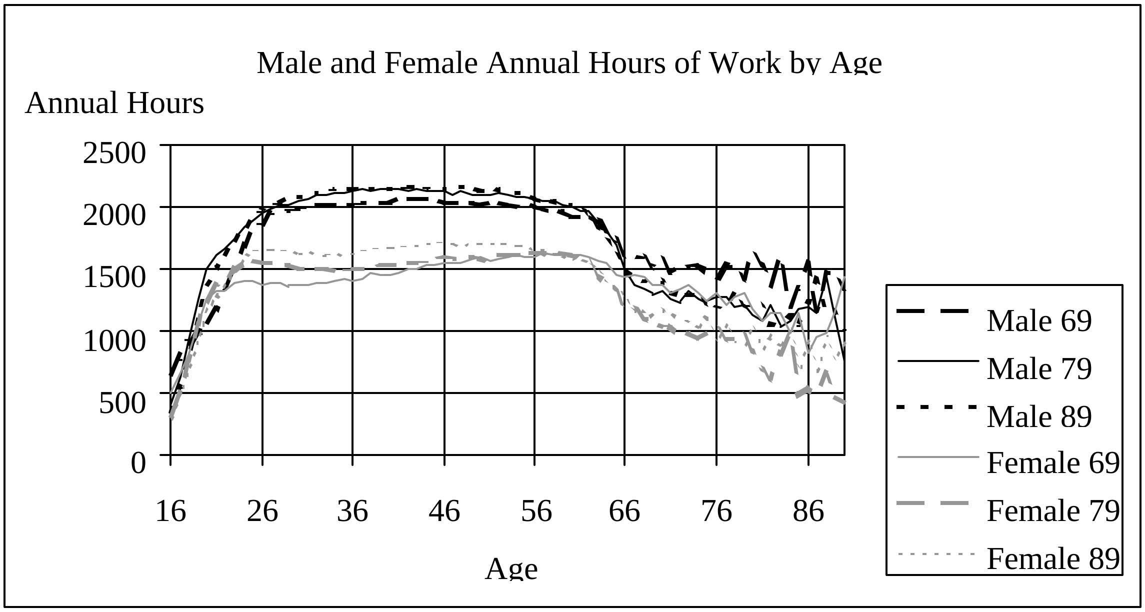
Labor Supply Samples	Female			Married Male			Single Male		
Age 16+	1970	1980	1990	1970	1980	1990	1970	1980	1990
Participation	0.41	0.50	0.56	0.86	0.81	0.78	0.59	0.66	0.69
Annual Hours	1632.1	1423.4	1551.4	2152.2	2085.0	2137.7	1692.4	1512.0	1627.4
Log of Wages (actual)	0.56	1.35	1.96	1.31	1.98	2.48	0.73	1.47	1.98
Age	43.16	42.89	44.65	45.64	46.05	47.73	33.53	31.81	34.16
Age Squared	2216.2	2210.3	2358.3	2320.5	2370.5	2523.0	1527.4	1331.1	1478.0
Other Hhld Income $1000	6.66	13.46	23.02	2.50	7.27	16.80	3.92	7.49	10.58
State Tax Rate	0.03	0.04	0.04	0.03	0.05	0.04	0.03	0.01	0.04
Tax Value State Exemption	13.35	25.50	32.43	14.47	27.35	34.41	13.06	7.06	30.93
EITC		32.04	65.83		7.26	17.30		33.15	75.26
Years of School (15=HS)	12.82	14.63	15.22	13.12	15.14	15.70	12.62	14.61	14.94
Local Unemployment	0.02	0.03	0.03	0.02	0.03	0.03	0.02	0.03	0.03
Estimate Commute time to work		19.76	20.44		23.96	24.05		23.00	23.30
Probability of Birth	0.04	0.03	0.03	0.05	0.05	0.04			
Spouse Part. * Prob. Birth	0.03	0.03	0.02	0.03	0.03	0.03			
Dummy and Discrete Variables									
Married	0.60	0.56	0.54						
Spouse Labor Participation	0.52	0.45	0.42	0.39	0.49	0.58			
Birth	0.05	0.04	0.03	0.07	0.06	0.04			
No. Children 1< age < 5	0.18	0.14	0.15	0.27	0.21	0.22	0.01	0.01	0.02
No. Children age>=5	0.87	0.71	0.65	1.19	0.99	0.88	0.11	0.07	0.09
Spouse Part. * No. Child 1<age<5	0.16	0.11	0.11	0.07	0.09	0.12			
Spouse Part.* No. Child age>=5	0.68	0.51	0.43	0.47	0.53	0.58			
Spouse Part.* Birth	0.04	0.03	0.02	0.01	0.02	0.02			
Two or more Children	0.29	0.25	0.24	0.41	0.37	0.34			
Teenager	0.10	0.09	0.07	0.01	0.00	0.00	0.33	0.27	0.20
Age Twenty	0.21	0.23	0.19	0.17	0.17	0.11	0.29	0.37	0.34
Age 30 - 45	0.24	0.25	0.30	0.32	0.33	0.37	0.12	0.16	0.24
Age 45 - 60	0.23	0.20	0.19	0.30	0.27	0.26	0.11	0.09	0.10
Age Sixty	0.11	0.11	0.12	0.13	0.14	0.15	0.07	0.05	0.05
Age 70+	0.10	0.11	0.13	0.08	0.09	0.11	0.09	0.06	0.07

* For the single male samples the number of children categories are for number of children less than age 5 and greater than or equal to age 5. Spouse participation is a zero-one variable equal to one if you are married and your spouse works otherwise it is equal to 0.

The mean number of hours worked by women in the previous year has declined from 1,632 in 1970 to 1,551 in 1990. There was an even sharper dip in the number of hours worked between 1970 and 1980, from 1,632 to 1,423. This pattern of declining hours worked with a sharper decline in 1980 is the same for both the married men and the single men. The decline in hours-worked in 1980 is principally the result of the large Baby Boomer generation being in the young age groups. Figure 8-1 shows the average number of hours worked by age and gender for the years 1969, 1979, and 1989. The graph indicates that annual hours worked by age are relatively similar for all three years. Men worked almost identical hours in 1979 and 1989, with slightly fewer hours worked in 1969. Women had slightly more variation in the number of hours worked. Women under the age of 60 worked fewer hours in 1969 than in either 1979 or 1989.[35]

[35] See McGrattan and Rogerson (1998) for a more detailed discussion of the changes in hours worked over the last 50 years. See also Katz and Murphy (1992) for an explanation of the changes in wages that may have influenced hours.

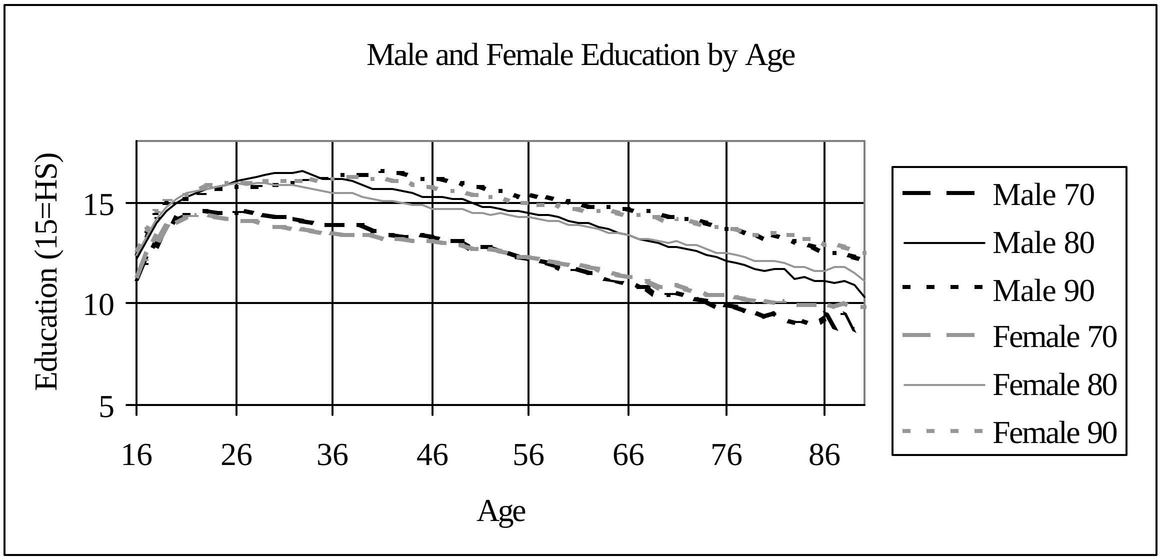
Figure 8-1 Male and Female Annual Hours of Work by Age (1969, 1979, and 1989)



The large reductions in marriage rates over the last several decades are reflected in the percentage of women who are married, which has declined substantially from 60% in 1970 to 54% in 1990. Similarly, there have been substantial declines in the number of births. The crude female birth rate declined from 5% in 1970 to 3% in 1990. Despite the increased number of women in the prime childbearing years in 1980 (the number of twenty-year-olds increased from 21% to 23% of the sample), there is a one-percentage point decline in the crude birth rate from 1970 to 1980.

An important correlated variable for labor supply is the level of education. In 1970 both men and women had less than a high school education on average. However, by 1990 only single men had slightly less than a high school education on average; both married men and women had slightly more than a high school education. Figure 8-2 shows male and female education by age for the years 1970, 1980, and 1990. The graph indicates that education levels have been increasing across the age groups. Indeed, the increases from 1970 to 1980, and to some extent those from 1980 to 1990, are not just the result of an aging educated populace; between 1970 and 1980 education levels increased for all cohorts.

Figure 8-2 Male and Female Education by Age (1970, 1980, 1990), 15 = completion of high school



Probit Estimates of Female Labor Force Participation

Table 8-2 presents the results from probit estimations of the female probability of participating in the labor force for the years 1970, 1980, and 1990. The column headed by a "P" shows the estimates for female participation using the predicted probability of a birth, and the column headed by a "B" shows the results for estimates using the actual birth outcome. Two specifications are presented for each year. The first specification uses the predicted probability of fertility and the second specification uses a 0/1 actual birth outcome variable. An increase in the probability of observing a birth decreases the probability of participating in the labor force. The elasticities are about the same in 1970 and 1980, but dropped significantly in 1990. A 1%

increase in the probability of observing a birth decreased the probability of participating by 0.04% in 1970, while in 1990 it decreased the probability of participating by 0.01%. This reduction in the effect of a birth on participation suggests that changing norms towards mothers of infants and changing institutions have made it easier for women to have an infant and stay in the labor force.[36] However, the interaction between husband's participation and the probability of birth had stronger effects in 1990. A 1% increase in the probability of observing a birth interacted with husband's participation decreased the probability of participating by 0.015% in 1970, and by 0.019% in 1990.

The actual occurrence of a birth, like the probability of birth, also reduces the probability of participating in the labor force. In 1970 a birth was associated with a 55% decline in the probability of participating, while in 1990 it was associated with a 46% decline. A husband's participation in the labor force interacted with the occurrence of a birth also has a negative effect on the wife's probability of participating in the labor force. Given a birth, the effect of the spouse working is to reduce the probability of the wife working by 25% in 1970, 24% in 1980, and 9% in 1990. The trend in the coefficient for the interaction between birth and husband's participation and the probability of birth and the husband's participation are divergent. The reduction in importance of the interaction term between actual birth and the husband's participation compared with the increasingly negative effect of the interaction between the probability of birth and the husband's participation, reflects the changing dependence of families on husbands and wives for both childcare and income. Recall from the

[36] These results are consistent with the results obtained from other studies of fertility and labor supply. See Rosenzweig and Schultz (1985) for a discussion of the life cycle effects of

fertility results that the husband's labor force participation had an increasingly important and positive effect on the probability of observing a birth. The effect of the husband's participation on female labor force participation has a similar upward trend to the husband's participation interacted with the probability of a birth. Thus, a husband's participation in the labor force increases the probability of a birth, and the probability of the wife's participation. However, a husband's participation interacted the actual birth outcome attributes too much of the negative effect to births and not enough to the interaction terms. Thus, controlling for the simultaneity of fertility and participation, results in a better estimate of the effects of births and husbands participation on female labor supply.

The effect of having children between the ages of 1 and 5 and over 5 is to reduce a woman's probability of participating in the labor force. In 1970 having a pre-school child resulted in a 15.4% reduction in the probability of participating. By 1990, having a preschool aged child reduced the probability by 27.2%. The increase in the average fixed effect of having a pre-school child is counter intuitive. However, the addition of a pre-school child is far more disruptive in 1990 than in 1970. This is precisely because women are participating in the labor force more in 1990 than in 1970. This point is borne out in an opposite manner for school-aged children. In 1970 having a school-aged child reduced participation by 4.5%. By 1990, a school-aged child reduced participation, on average, by 1.3%. For women who intend to have a career outside of the home, school aged children are less likely to disrupt their careers than are pre-school children.

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children.

In sum, the effects of children on their mother's participation in the labor force are to reduce the likelihood of participating. Children, defined as infants, 1-5 year olds, and 5-18 year olds, all have a negative effect on their mother's participation. However, these effects have changed over time. The number of women who participate in the labor force has greatly increased since 1970, and consequently not only have employers changed their approach to mothers, but the infrastructures have changed as well. One example of the infrastructure changes that have occurred is that in 1965 only 8% of pre-school children of full-time working mothers were cared for by organized childcare, but by 1991 30% of working mothers were using organized childcare (Rindfuss, Brewster, and Kavee, 1996, p.464). These changes have resulted in changes of the effects of children on their mothers. In 1990 mothers are less likely to drop out of the labor force with the birth of an infant than in 1970. Children under the age of five have a greater negative impact on participation in 1990 than they did in 1970. And finally, women are more likely to participate in the labor force in 1990 than in 1970 if they have children who are of school age. In other words, the variance of the effects of children on their mother's participation over the child's life cycle is greater in 1990 than in 1970.

Finally, increases in the EITC reduce participation. The EITC elasticity of participation was -0.024 in 1980 and -0.09 in 1990. The coefficient on the EITC must be interpreted as the income effect of increases in the EITC. Because the elasticities are small it is possible that in addition to accounting for income, accounting for the substitution effects could very easily make the total effect of the EITC on participation positive. Additionally, it is possible that even after accounting for the substitution effects, the total effect is negative for the secondary worker in the household. Eissa, and Hoynes (1998) find through a difference in differences approach that increases in the EITC enacted in 1993 resulted in a 2-3 percent drop in participation rates for married women with less than 12 years of schooling.

Other household income (all income except one's own earned income) has a negative impact on the participation of women. The elasticity with respect to other household income is declining in an absolute sense from -0.2% in 1970 to -0.17% in 1980 and -0.12% in 1990. This suggests that women are becoming less and less likely to drop out of the labor force as their income from other sources increases. However, increases in their husband's labor force participation are increasingly likely to induce women to participate in the labor force themselves.

Table 8-2 Probit of Probability of Female Labor Force Participation

Female Labor Force	1970		1980		1990	
Participation	P	B	P	B	P	B
Elasticities						
Age	2.512	2.371	1.869	2.732	2.642	2.657
Age Squared	-1.653	-1.402	-1.411	-1.824	-1.904	-1.893
Other Hhld Income	-0.197	-0.233	-0.172	-0.169	-0.122	-0.124
State Tax Rate	0.128	0.132	0.037	0.040	0.049	0.064
Tax Value State Exemption	-0.010[2]	-0.007[3]	0.053	0.061	-0.003[3]	-0.005[3]
EITC			-0.024	-0.025	-0.009	-0.008
Education	0.393	0.372	0.513	0.438	0.588	0.584
Local Unemployment	-0.091[1]	-0.052[3]	-0.065	-0.071	-0.070	-0.075
Estimate Commute time to work			-0.040	-0.038	0.116	0.101
Probability of Birth	-0.042		-0.044		-0.013	
Husb. Part. * Prob. Birth	-0.015		-0.022		-0.019	
Average fixed effects for Dummy and Discrete Variables						
Married	-30.8	-32.8	-33.2	-36.9	-28.9	-30.1
Husb Labor Participation	34.4	27.9	43.4	36.3	49.1	44.6
Birth		-54.9		-51.0		-45.9
No. Children 1< age < 5	-15.4	-25.7	-29.5	-29.9	-27.2	-26.6
No. Children age>=5	-4.5	-3.9	-1.5	-4.0	-1.3	-2.6
Husb. Part. * No. Child 1<age<5	-7.8	-21.7	-10.0	-14.5	-5.1	-9.3
Husb. Part.* No. Child age>=5	0.9[1]	3.9	-1.9	0.2[3]	-3.4	-2.0
Husb. Part.* Birth		-25.0		-23.9		-8.7
Two or more Children	0.8[3]	-8.8	-2.9	2.7	-0.9[3]	1.9
Teenager	-5.6	18.3	32.5	29.1	23.3	21.8
Age Twenty	-7.5	3.9	8.4	7.5	5.8	3.1
Age 45 - 60	-4.7	3.5	2.5[1]	0.1[3]	-0.6[3]	-0.1[3]
Age Sixty	-40.1	-40.1	-26.1	-29.5	-26.3	-26.6
Age 70+	-49.5	-61.1	-14.2	-15.7	-7.2	-9.8
-2 Log L	481064	566846	465316	489212	551380	564332

Other variables not shown here are race, ethnicity, occupation, state of residence, and metropolitan residence dummy variables. Additionally, the 1980 and 1990 samples include dummy variables for not being able to speak English and school enrollment in the previous year. All estimates are significant at the 1% level unless noted otherwise. 1 Significant at the 5% level. 2 Significant at the 10% level. 3 not significant.

Probit Estimates of Male Labor Force Participation

Table 8-3 shows the estimation results for the probit on married male participation. There are two estimations for each year. The first estimation, in columns headed by a “P”, uses the wife’s predicted probability of birth, and the second estimation, in columns headed by a “B”, uses the actual binary birth variable. Similar to the female participation estimates, the married male estimation indicates that participation initially increases with age, but at a decreasing rate. Like the effect for women, other household income has a negative effect on the participation of married men. Unlike the effect for women, the effect of other household income is becoming stronger. The elasticity is twice as large in 1990 as it is in 1970. Similarly, the effect of the wife's participation is also to increase the participation of the husband.

Table 8-3 Probit of Probability of Married Male Labor Force Participation

Married Male Labor Force Participation	1970 P	1970 B	1980 P	1980 B	1990 P	1990 B
Elasticities						
Age	0.453	0.147	0.339	0.759	0.338	0.071[2]
Age Squared	-0.300	-0.178	-0.341	-1.175	-0.390	-0.289
Other Hhld Income	-0.026	-0.025	-0.037	-0.157	-0.050	-0.050
State Tax Rate	0.110	0.094	-0.007[1]	-0.029	0.086	0.084
Tax Value State Exemption	-0.012	-0.008	0.059	0.237	-0.010	-0.009
EITC			-0.002	-0.009	-0.002	-0.001
Education	0.051	0.048	0.124	0.518	0.182	0.186
Local Unemployment	-0.059	-0.065	0.001[3]	0.010[3]	-0.026	-0.025
Estimate Commute time to work			0.034	0.132	0.076	0.077
Probability of Birth	0.034		0.015		0.019	
Wife Part. * Prob. Birth	-0.003		0.004		0.009	
Average fixed effects for Dummy and Discrete Variables						
Wife Labor Participation	5.6	4.8	8.4	42.4	15.7	16.8
Birth		2.4		15.6		4.1
No. Children 1< age < 5	-0.6	1.9	0.6	5.3	1.0	2.3
No. Children age>=5	0.0[3]	0.0[3]	0.4[1]	2.5[1]	1.1	1.4
Wife Part. * No. Child 1<age<5	0.7	-1.4	-3.1	-7.2	-5.7	-4.1
Wife Part.* No. Child age>=5	-0.3	-0.2	-0.9	-4.5	-1.5	-1.8
Wife Part.* Birth		-3.6		-20.4		-4.9
Two or more Children	3.8	2.2	3.1	8.3	3.4	1.5
Teenager	-9.3	-5.0	-4.1	-11.6	-9.8	-13.1
Age Twenty	-9.6	-5.6	-4.3	-13.0	-5.7	-4.7
Age 45 – 60	1.3	1.3	1.3	5.0	2.2	2.2
Age Sixty	-8.7	-7.5	-7.1	-24.2	-11.0	-10.5
Age 70+	-15.3	-14.6	1.2[2]	4.9	-0.8[3]	-0.5[3]
-2 Log L	154212	167822	148854	149788	179300	182366

Other variables not shown here are race, ethnicity, occupation, state of residence, and metropolitan residence dummy variables. Additionally, the 1980 and 1990 samples include dummy variables for not being able to speak English and school enrollment in the previous year. All estimates are significant at the 1% level unless noted otherwise. 1 Significant at the 5% level. 2 Significant at the 10% level. 3 not significant.

An increase in the probability of a birth increases the probability of participation for married men. In 1970 a 1% increase in the probability of birth would increase, on average, the probability of participation by 0.03%, while in 1990 it would have increased the probability of participation by 0.02%. The interaction of the wife's participation with the probability of birth initially decreased participation slightly by 0.003%, but by 1990 it has reversed signs and a 1%

increase in the interaction variable increases participation by 0.009%. However, given that the spouse works, a 1% increase in the probability of birth has roughly the same positive effect in 1990 as it did in 1970. This is because, while the effect of the wife's participation both separately and interacted with the probability of a birth has been increasing from 1970 to 1990, the effect of the probability of a birth has been decreasing. This result is almost exactly opposite to the result seen for women. An increase in the probability of birth decreases female participation, and the interaction with husband's participation also decreases participation. This suggests that parents prefer to have the mother be the primary caretaker of infants, and that there is a reluctance to reduce the father's participation. Mother's time and father's time are not substitutes for one another in the primary care of infants.

The situation is somewhat different for older children. With the exception of the 1970 estimates, husbands increase their participation with increases in the number of pre-school and school aged children. In 1990, an increase in the number of pre-school children from none to one increases the father's participation by 1%. A school aged child similarly increases the father's participation by 1.1% in 1990. With the exception of pre-school children in 1970, increases in the interaction terms between the wife's participation and pre-school and school aged children reduce participation. Unlike the results from the interaction of spouse participation with the probability of birth, the interaction terms for pre-school and school aged children suggest that the mother's and father's time are substitutes in the rearing of pre-school and school aged children. Not surprisingly, these results imply that fathers are poor substitutes for nursing mothers, but can substitute in the care of 5 year olds.

These results are significant. The theoretical model implies that there should be equally important effects for men as there are for women of having children in the household. However, there has been a lack of empirical evidence that men react to current or previous fertility choices. These results show that men react to both current fertility and to the number of children they have. While women have much larger changes due to children, these results indicate that there may be increasing effects of children on male labor supply.

Table 8-4 shows the results of estimating a probit for single men. Age increases participation but at a decreasing rate. Like the estimates for women and married men, other household income and EITC reduces the participation of single men. Single men, like married men, are more likely to participate in the labor force if they have children. An increase from no children 0-5 years old to one child 0-5 years old increases the probability of participating by over 17% in 1970 and by roughly 3% in 1980 and 1990.

Table 8-4 Probit of Probability of Single Male Labor Force Participation

Single Male Labor Force Participation	1970	1980	1990
Elasticities			
Age	1.99	1.12	0.90
Age Squared	-0.91	-0.63	-0.58
Other Hhld Income	-0.04	-0.02	-0.02
State Tax Rate	0.09	0.03	0.07
Tax Value State Exemption	-0.02	-0.02[1]	-0.01[2]
EITC		-0.01	-0.00
Education	0.27	0.24	0.31
Local Unemployment	-0.15	-0.02[1]	-0.06
Estimate Commute time to work		-0.02[3]	0.06
Average fixed effects for Dummy and Discrete Variables			
No. Children age < 5	17.44	2.86	3.10
No. Children age>=5	8.08	2.05[3]	3.42
Teenager	3.69[2]	10.98[1]	6.47
Age Twenty	16.53	6.01	3.54
Age 45 – 60	-26.10	-11.44	-4.67
Age Sixty	-63.07	-35.05	-29.45
Age 70+	-75.73	-18.32	-9.28
-2 Log L	187982	151750	182240

Other variables not shown here are race, ethnicity, occupation, state of residence, and metropolitan residence dummy variables. Additionally, the 1980 and 1990 samples include dummy variables for not being able to speak English and school enrollment in the previous year. All estimates are significant at the 1% level unless noted otherwise. 1 Significant at the 5% level. 2 Significant at the 10% level. 3 not significant.

The probit estimations show that income negatively affects participating, that age initially has a positive impact but at a decreasing rate, that education levels positively affect the participating, and that the EITC negatively impacts participating. The results for the EITC are in contrast to the simulation results of Dickert, Houser, and Scholz (1994). Estimation of the effect of the EITC typically is done using non-linear budget constraints and simulation techniques. Dickert *et al*. use the after-tax and EITC wage rate to determine the effects of the 1993 EITC expansion on labor supply. The analysis presented here does not try to control for the non-linear effects of the EITC. An estimate of income is used to determine the dollar value of the credit.

This methodology implicitly assumes that persons treat the EITC as a lump sum transfer. Ninety nine and a half percent of EITC payments are made in one lump sum at the end of the year, suggesting that the lump sum transfer assumption may be appropriate.[37]

Annual Hours

Table 8-5 shows the means for females, married males, and single males for the working samples in the years 1970, 1980, and 1990. The average age is lower for the working samples than it was for the participation samples. This is because the working samples are not representative of the populations. Hours worked decline from 1970 to 1990 for all of the samples. Recall Figure 8-1 that showed that age-specific average hours actually increased in 1989 from their values in 1970. Thus the decline in hours of work partially reflects the changing age structure of the population. Comparing the means in Table 8-5 with those in Table 8-1 we see that in 1990 the female working sample is slightly younger, 37.5 years of age for the working sample versus 44.7 for all women age 16 and over. The female working population in 1990 is slightly more educated, 15.97 for the working sample versus 15.22 for all women, and the female working population is more likely to be married than the female population as a whole. Finally, the female working population is more likely to be married to a husband who works; 91% husband participation rate in the working sample versus 77% husband participation in the population.[38] In addition, married men are increasingly married to women who work; the

[37] Scholz (1994) argues that because individuals receive the benefit as a lump sum the links between net wages and the EITC are likely to be unclear. Nevertheless, Dickert et al results can be regarded as the total effect while these results are the income effect of increases in the EITC. Given the small elasticity for EITC the total effect could very well be positive.

[38] The table presents the percentage of women who are married and the percentage of women who are married and have a spouse who works relative to the total number of women regardless of marital status. The percent of women who are married and who have a spouse

participation rate for wives was 42% in 1970 and 68% in 1990. These differences in means are also reflected in the parameter estimates from the probit estimation of the probability of working. For women, education and husband labor force participation have a positive effect on participation. Marital status has a negative effect. Similarly, married men in the working sample have more education, are younger, have more children, and are more likely to be married to a woman who works.

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who works relative to the number of women married is 1/(percent married) * (percent married and spouse works relative to total number of women).

Table 8-5 Mean Values of Independent and Dependent Variables for Annual Hours

Means for Annual Hours	Female			Married Male			Single Male		
Estimation	1970	1980	1990	1970	1980	1990	1970	1980	1990
Annual Hours Worked	1632.1	1423.4	1551.4	2152.2	2085.0	2137.7	1692.4	1512.0	1627.4
Age	39.30	35.96	37.50	42.55	42.05	42.80	32.16	28.34	30.62
Age Squared	1755.9	1491.9	1582.9	1976.0	1939.4	1983.0	1271.2	958.5	1092.6
Teenager	0.07	0.10	0.07	0.01	0.00	0.00	0.24	0.24	0.17
Age Twenty	0.25	0.31	0.25	0.19	0.20	0.14	0.34	0.45	0.41
Age 45-59	0.30	0.21	0.22	0.34	0.30	0.29	0.16	0.09	0.10
Age Sixty	0.08	0.06	0.06	0.09	0.09	0.09	0.05	0.03	0.03
Age 70+	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.01
Other Hhld Income $1000	5.85	12.61	22.24	2.21	6.37	15.07	2.98	6.37	8.30
OLS Ln Wage Selection Corrected	0.57	1.39	1.99	1.28	2.00	2.50	0.73	1.52	2.04
State Tax Rate	0.04	0.05	0.04	0.04	0.05	0.04	0.04	0.01	0.04
Tax Value of State Exemption	14.65	27.42	35.70	15.16	28.34	36.19	14.74	7.66	33.51
EITC		13.12	37.35		2.50	9.67		18.98	57.84
Years of Education (15=HS)	13.71	15.49	15.97	13.55	15.63	16.16	13.45	15.37	15.53
Married	0.58	0.56	0.56						
Spouse Labor Participation	0.54	0.51	0.51	0.42	0.55	0.68			
No. Children 1<age<5	0.11	0.13	0.15	0.30	0.25	0.27	0.03	0.01	0.02
No. Children Age >=5	0.87	0.75	0.73	1.33	1.10	1.01	0.16	0.07	0.09
Probability of Birth	0.04	0.04	0.04	0.06	0.06	0.05			
Birth				0.07	0.07	0.05			
Spouse Part.* No. Child 1<age<5	0.09	0.10	0.12	0.08	0.10	0.15			
Spouse Part.* No. Child >5	0.67	0.55	0.52	0.54	0.61	0.69			
Spouse Part.* Probability of Birth	0.03	0.04	0.03	0.03	0.04	0.04			
Spouse Part* Birth				0.01	0.02	0.03			
Two or More Kids	0.28	0.27	0.27	0.47	0.42	0.41			
Estimate of Commute Time		19.42	20.46		23.82	24.07		22.60	23.19
Lambda	0.45	0.36	0.32	0.14	0.14	0.15	0.41	0.28	0.25

Table 8-6, Table 8-7, and Table 8-10 show the coefficient estimates from a sample-selection-corrected OLS estimate of annual hours worked in the previous year for women, married men, and single men. The columns headed by a “P” represent the estimates using the predicted probability of birth, and the columns headed by a “B” represent the estimates of annual hours using the actual birth outcome. Like the probit estimations of participation, female annual hours initially increase as age increases, but at a decreasing rate. Other household income decreases annual hours for all of the samples, with a somewhat larger impact for women and single men than for married men. As in the probit estimations, the EITC has a negative impact on the number of hours worked, however the estimates are not significant for single men. Marital status has a large negative impact on annual hours worked for women, reducing annual hours by 110 to 157 hours a year. Having a husband who works increases the number of hours that women work by almost 200 hours in 1990. Recalling the theoretical discussion in Chapter 2, these results suggest that husband and wife times are complements in the production of leisure.

Table 8-6 Sample-selection-corrected OLS of Annual Hours of Worked by Women

Female Annual Hours Parameter Estimates	1970 P	1970 B	1980 P	1980 B	1990 P	1990 B
Age	35.0	36.4	35.7	37.7	68.0	70.6
Age Squared	-0.4	-0.4	-0.5	-0.5	-0.9	-0.9
Teenager	-119.4	-110.5	147.1	153.7	131.0	140.1
Age Twenty	-0.1[3]	-2.3[3]	156.0	160.7	178.2	195.6
Age 45-59	18.7[1]	21.2	96.2	93.0	111.5	104.7
Age Sixty	-71.9	-82.1	146.9	130.8	135.7	111.6
Age 70+	108.3	94.8	372.2	351.8	455.8	435.0
Other Hhld Income	-12.5	-13.7	-9.2	-9.7	-4.9	-5.4
OLS Log of Wage Selection Corrected	568.0	595.2	1267.1	1223.7	1056.8	968.9
State Tax Rate	325.8[1]	434.7	160.8[3]	202.6[1]	753.3	659.6
Tax Value of State Exemption	0.5[2]	0.5[2]	0.4[1]	0.4[1]	0.1[3]	0.1[3]
EITC			-0.2	-0.2	-0.1	-0.1
Education	-15.0	-14.8	-45.6	-42.3	-37.4	-27.7
Married	-158.8	-174.6	-110.1	-118.4	-157.4	-159.6
Husb. Labor Participation	124.8	146.9	191.5	219.3	197.8	256.3
No. Children 1<age<5	-79.0	-89.1	18.2[3]	3.0[3]	-148.9	-98.7
No. Children Age >=5	-19.8	-20.0	18.8	21.7	3.0	16.8
Probability of Birth	-222.1		-74.6[3]		1804.2	
Birth		-339.2		-293.1		-244.5
Husb. Part.* No. Child 1<age<5	-83.2	-75.1	-231.9	-233.5	-106.4	-171.1
Husb. Part.* No. Child >5	5.1[2]	5.1[2]	-17.3	-25.6	-18.5[3]	-43.7
Husb. Part.* Probability of Birth	214.3		67.5[3]		-1124.1	
Husb. Part* Birth		11.5[3]		-14.4[3]		38.2
Two or More Kids	-21.2	-21.5	-56.1	-65.2	6.1[3]	-30.4
Estimate of Commute Time			-0.4[3]	-0.3[3]	5.2	5.6
Lambda	493.8	580.0	-98.1	-2.3	160.0	339.1
R-Square	0.1243	0.1287	0.2085	0.2142	0.2045	0.2061

Other variables not shown here are race, ethnicity, occupation, state of residence, and metropolitan residence dummy variables. Additionally, the 1980 and 1990 samples include dummy variables for not being able to speak English and school enrollment in the previous year. All estimates are significant at the 1% level unless noted otherwise. 1 Significant at the 5% level. 2 Significant at the 10% level. 3 not significant.

The picture changes when children are introduced. In the female annual hours of work regression the coefficient on the probability of birth has a large swing from a negative impact to a large positive effect. In 1970 a change from zero probability to a probability of one decreases annual hours of work by 222 hours, in 1980 it decreased annual hours of work by 75 hours, and in 1990 it increased annual hours of work by 1,804. At the same time the actual occurrence of a birth has a negative effect on hours of work in all three sample years, although it is slowly becoming less negative. These effects suggests that failing to use a two stage approach to the estimation of female annual hours of work would mislead the researcher into believing that the occurrence of a baby reduces work by a similar amount in 1990 as in 1970. In particular, the interaction between husband's participation and the probability of birth also changes sign from increasing hours in 1970 to decreasing hours in 1990. Given participation of the husband and the average probability of birth, the net effect of a 1% increase in the probability of birth is a slight reduction of 18 minutes worked annually in 1970, and an increase of 27 hours in 1990. Alternatively, in terms of standardized estimates, given that the husband works, a standard deviation increase in the probability of birth increases hours of work by 0.05 standard deviations. Thus, women were negatively influenced by increases in fertility in 1970, but in 1990 increases in fertility actually increase the number of hours worked, but only slightly.

The number of pre-school children in the household reduces female annual hours by 79 in 1970, has a slight positive effect of 18 hours in 1980 (although not significantly different from zero), and reduces hours worked by 149 hours in 1990. The interaction of the husband's participation and the number of pre-school children decreases the number of hours worked by 83 in 1970, 232 in 1980, and 106 in 1990. These results also suggest that mother and father's time are substitutes in the production of pre-school children. School aged children decrease hours worked in 1970 and increase hours worked in 1980 and 1990. The interaction between husband's participation and school-aged children is significant at the ten-percent level and increases hours worked in 1970, decreases hours worked in 1980, and is insignificant in 1990. These results suggest that husband's and wife's time are complements unless there are children in the household. Once children enter the picture, given that the husband works, increases in the number of children in any age group decreases the wife's number of hours worked annually.

Wage rates increase hours worked in all years. The implied uncompensated or Marshallian wage rate elasticity of hours evaluated at the mean number of hours worked and the mean log of wages is 0.68 in 1990, 0.89 in 1980, and 0.35 in 1970. The total income elasticity of hours is -0.02 in 1970, -0.04 in 1980, and -0.04 in 1990.[39] These numbers imply income compensated wage elasticities of 0.37 in 1970, 0.93 in 1980 and 0.72 in 1990. Recalling equations 1 and 2, these results indicate that the net compensated effects are positive and the net income effects are negative as hypothesized.

Finally, the parameter estimate on Lambda, the inverse Mills ratio, is significant in all three years, indicating that controlling for the sample selection problem was necessary. The variables most influenced by the inclusion of Lambda are the several age variables, the wage rate, and education. The results from an OLS regression without correcting for sample selection suggest that the hours profile by age is flatter, except for persons older than sixty; in 1990 the parameter estimate on effect of age is 60 hours per additional year of age, versus sample selection result of 68. They also suggest that education has a more negative impact on hours of work; parameter estimate of –44 hours of work for every additional year of education

[39] The relationship between the uncompensated wage elasticity (E), the income compensated wage elasticity (E*), and the total income elasticity (TIE) is E = E* + TIE. TIE is the product of the income elasticity and the ratio of own earnings to household income.

compared with sample selection result of –37. Thus, the inclusion of Lambda is not only significant, but is important in it's ability to estimate unbiased parameters.

Table 8-7 shows the results from the OLS of annual hours for married men. Like the female hours regression, the parameter estimate on Lambda at the bottom of the table is significant in all three years, indicating that an OLS regression which did not account for the sample selection problem would have resulted in biased estimates.

The table shows the effect of changes in the participation of wives on their husband's hours of work. In 1970, the wife's participation in the labor force increased the husband's hours worked; in 1980 the coefficient for wife's participation was insignificant; but by 1990 wife's participation reduced the husband's annual hours of work. Contrary to the results for women, these results suggest that married men viewed their leisure time with their wives as complementary in 1970; but by 1990, there had been a shift in perceptions and husbands now viewed their leisure time as substitutes for their wife's.

Table 8-7 Sample-selection-corrected OLS of Annual Hours for Married Men

Married Male Annual Hours Parameter Estimates	1970 P	B	1980 P	B	1990 P	B
Age	-5.46	-0.14[3]	44.22	44.87	57.41	55.61
Age Squared	0.01[3]	-0.04[1]	-0.54	-0.54	-0.69	-0.68
Teenager	3.15[3]	17.36[3]	-99.27	-94.19	-354.73	-362.01
Age Twenty	44.44	39.64	36.56	35.98	-1.06[3]	-1.28[3]
Age 45-59	-9.06[1]	-9.50[1]	37.15	37.13	70.07	70.40
Age Sixty	-21.36	-27.64	0.31[3]	0.65[3]	-79.21	-76.77
Age 70+	96.71	90.88	-170.43	-167.40	-240.24	-242.73
Other Hhld Income	-8.70	-9.02	-3.89	-3.86	-1.63	-1.57
OLS Log of Wage Selection Corrected	711.20	726.88	4.30[3]	12.99[3]	-351.90	-366.88
State Tax Rate	295.09[1]	470.58	-58.47[3]	-55.08[3]	-27.34[3]	-116.54[3]
Tax Value of State Exemption	0.54[1]	0.57[1]	-0.36[1]	-0.34[2]	0.09[3]	0.10[3]
EITC			-0.09[1]	-0.09[1]	-0.19	-0.17
Education	-23.90	-24.47	8.85	8.40	27.29	27.96
Wife Labor Participation	92.32	84.00	6.23[3]	-0.26[3]	-50.31	-60.60
No. Children 1<age<5	44.70	49.27	11.97	16.20	7.11[2]	13.25
No. Children Age >=5	3.42	2.10[2]	0.91[3]	-0.09[3]	13.23	11.95
Probability of Birth	-131.85		41.97[3]		268.35	
Birth		44.39		23.25		22.37
Wife Part.* No. Child 1<age<5	-26.45	-39.72	1.29[3]	-5.90[3]	4.16[3]	0.80[3]
Wife Part.* No. Child >5	-3.44[1]	-0.24[3]	-0.39[3]	1.85[3]	-8.19	-6.44
Wife Part.* Probability of Birth	-260.81		-149.00		-99.00[1]	
Wife Part* Birth		-17.44[2]		-19.31[1]		2.35[3]
Two or More Kids	-14.95	-4.48[3]	10.20[1]	12.59	34.01	26.11
Estimate of Commute Time			0.02[3]	0.01[3]	3.17	3.19
Lambda	22.96	50.88	-343.58	-344.83	-258.23	-275.83
R-Square	0.1176	0.1173	0.1550	0.1550	0.1529	0.1528

Other variables not shown here are race, ethnicity, occupation, state of residence, and metropolitan residence dummy variables. Additionally, the 1980 and 1990 samples include dummy variables for not being able to speak English and school enrollment in the previous year. All estimates are significant at the 1% level unless noted otherwise. 1 Significant at the 5% level. 2 Significant at the 10% level. 3 not significant.

Pre-school or school-aged children increase the number of hours that fathers work. This is a fairly standard result in the male labor supply literature. The difference that this study explores is how changes in the participation of wives have influenced husband's participation and hours. Thus, as with the female annual-hours-of-work results, the married men regression includes as regressors the interaction of the wife's labor force participation and the number of children in the household.

The interaction between the wife's participation and pre-school children reduced the husband's annual hours of work in 1970, but was insignificant in influencing hours for married men in both 1980 and 1990. Similarly, school aged children interacted with the wife's participation reduced the husband's hours of work in 1970, had no effect in 1980, and again reduced them in 1990. The probability of birth also switched roles in its impact on hours. In 1970 the probability of birth reduced hours of work, in 1980 it was insignificant, and in 1990 actually increased hours worked. Finally, the interaction between the probability of birth and the wife's participation consistently reduced the husband's hours worked in all years, although by only 99 hours in 1990 compared with over 260 hours in 1970.

The reduction in hours caused by the interaction between the wife's participation and the probability of birth indicates that mother's time and father's time are substitutes for marginal hours in the production of infants and school aged children. However, the interaction between the wife's participation and the number of pre-school children had a negative effect in 1970 and insignificant effects in 1980 and 1990. Thus, the mother's and father's time are treated as substitutes for marginal husband hours when there are infants and school-aged children in the household. These results are similar to those for women, with the important distinction that if the wife does not work, then the husband increases his hours of work with increases in the number of children. On the other hand, if the husband does not work the results for women are mixed, with the wife decreasing hours of work if there are preschool aged children and in 1980 and 1990 increasing them if there are school aged children.

Effects of Family Structure on Married Male Participation and Hours

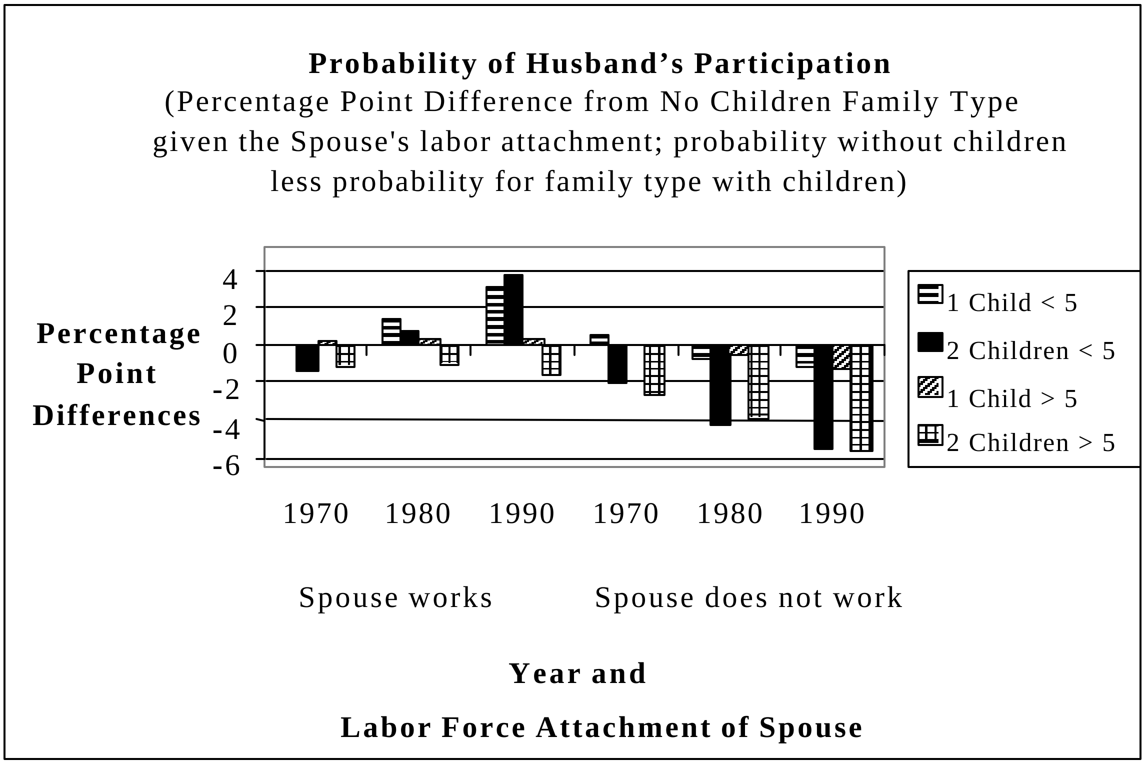
The results shown in Table 8-7 and Table 8-3 show the partial effects for changes in the number of children and the wife's participation on the number of hours of work and the decision to participate in the labor force. Table 8-9 shows the predicted probability of participation and hours for men with different family structures. This table shows the total effects of changing the family structure. The participation of married men whose spouses work changes very little between 1970 and 1980. However, by 1990 the probability of participation for married men changes substantially in the presence of different numbers and ages of children. Participation drops over 3 percentage points when one pre-school child is added to the household, from 92% with no children to 89%. Participation drops by almost 4 percentage points when two pre-school children are added. This same pattern of small changes in 1970 and large changes in 1990 repeats itself with predicted number of hours worked. In 1990, for married men with a spouse who works, there is a 56 hour increase from a family without children to a family with two pre-school children. Thus in 1990, the addition of two pre-school aged children reduces the probability of the father participating in the labor force, but if the father works, increases the number of hours he works. Similar, but opposite results hold for men whose spouses do not work. In 1970 participation varies by a maximum of 2.7 percentage points, while in 1990 it varies by a maximum of 5.7 percentage points. However, hours worked for men whose spouses do not participate in the labor force vary more in 1970 than in 1990.

Table 8-9 Predicted Participation and Annual Hours by Family Structure

Married Male Labor Force Participation Probability And Annual Hours	1970 Labor Force	Hours	1980 Labor Force	Hours	1990 Labor Force	Hours
Sample Average Age	46	43	46	42	48	43
Percent of Spouses Working	39%	42%	49%	55%	58%	68%
Married and Spouse works						
No Children	97.5	2168	95.7	2062	91.9	2081
1 Child under 5	97.5	2186	94.3	2076	88.8	2092
2 Children under 5	98.8	2190	94.9	2099	88.2	2137
1 Child over 5	97.3	2168	95.4	2063	91.6	2086
2 Children over 5	98.6	2153	96.7	2074	93.5	2125
Married Spouse does not Work						
No Children	94.1	2092	88.5	2066	82.1	2136
1 Child under 5	93.5	2136	89.2	2078	83.2	2143
2 Children under 5	96.1	2166	92.7	2100	87.7	2184
1 Child over 5	94.1	2095	89.0	2067	83.3	2149
2 Children over 5	96.8	2084	92.4	2078	87.8	2197

The figure below illustrates the effects of changes in family types and labor force status of wives on the predicted probability the husband participates in the labor force. The figure presents the effects graphically by showing the percentage point differences from predicted participation for husbands without children. Positive values indicate that the childless husband has a greater probability of participating in the labor force. The figure clearly illustrates that husbands in 1990 react differently to the presence of children in the family than they did in 1970. Husbands with wives working in the labor force have increased their participation as the number of children increases.

Figure 8-1 Predicted Probability of Husbands Participation



In sum, a married man in 1990 is less likely to participate in the labor force if he is married to a spouse who works and they have children. However, if a married man works and there are children in the house he will work more hours regardless of the wife's participation status. Married men are beginning to take up some of the responsibilities of child rearing, but only by opting out of the labor force. These results are encouraging for the application of the theoretical model to male labor supply. Previous work has been unable to find any negative effects of children on labor supply, whether looking at participation or at hours worked.

Table 8-7 also shows the effect of changes in the wage rate. Increases in the predicted log of wages increase hours for married men in 1970, have no effect in 1980 and decrease hours in 1990. The implied wage elasticities of hours are 0.33 in 1970, 0.002 in 1980, and -

0.165 in 1990. The total income elasticities are -0.031 in 1970. -0.029 in 1980, and -0.02 in 1990. The implied compensated elasticities are 0.361 in 1970, 0.031 in 1980 and -0.145 in 1990.

The implied elasticities for other household income are -0.0089 in 1970, -0.0118 in 1980, and -0.0115 in 1990. The elasticities, while small, are increasing in absolute value from 1970. Therefore, it appears that there is a decreased reliance on the husband's income and an increased reliance on other household income including the wife's earned income.

The results from the analysis of hours and participation have contradictory implications for the net substitutability of time between the father and mother. The participation analysis suggested that mother's and father's time were not substitutable in rearing infants, but the hours results indicate that mother's and father's time are substitutes. The participation results capture the complementarity or substitutability for primary care of the infant, while the hours results capture differences for the marginal time of the parents in the care of infants. Therefore, it appears that parents believe that the mother's and father's time are substitutes at the margin, but that in the primary care of infants the mother's time is not substitutable with the father's. Mom and Dad are equally capable of changing diapers, but Dad is unable to provide the same care to infants as mom.

Table 8-10 shows the results from the sample-selection-corrected OLS estimate of annual hours of work for single men. The effects of children on single men are interesting in that they differ from both those of the married men and those of women. Single men, like married men, increase their hours of work if there are pre-school children in the household. However, unlike the married men, single men decrease their hours of work if there are school aged children in the household. The wage elasticity of hours of work in 1990 is 1.389. The total income elasticity of hours of work is -0.0085 in 1990. These elasticities suggest that the compensated wage elasticity of hours is 1.3984 for single men in 1990. Lambda, the inverse Mills ratio, is positive and significant in all three years indicating that the parameters from an uncorrected OLS would have been biased. Finally, as noted previously, the effect of the EITC changes sign between 1980 and 1990, but is insignificant in both years.

Table 8-10 Sample-selection-corrected OLS of Annual Hours

Single Male Annual Hours Parameter Estimates	1970	1980	1990
Age	36.53	-11.10	46.17
Age Squared	-0.48	-0.22	-0.69
Teenager	99.76	215.29	60.33
Age Twenty	130.79	159.99	157.14
Age 45-59	-4.73[3]	228.55	54.19
Age Sixty	-14.01[3]	586.76	249.12
Age 70+	352.04	1265.84	730.31
Other Hhld Income	-6.79	-3.88	-2.72
OLS Log of Wage Selection Corrected	1183.49	2342.69	1109.68
State Tax Rate	156.14[3]	2521.31[3]	1107.63
Tax Value of State Exemption	0.98[1]	-2.94[2]	0.01[3]
EITC		-0.03[3]	0.01[3]
Education	-41.37	-78.87	-27.24
No. Children age<5	32.75	17.20[3]	31.54
No. Children Age >=5	-12.24	-142.01	-28.48
Estimate of Commute Time		-2.78	3.94
Lambda	734.33	263.21	78.55
R-Square	0.2784	0.3472	0.3283

Other variables not shown here are race, ethnicity, occupation, state of residence, and metropolitan residence dummy variables. Additionally, the 1980 and 1990 samples include dummy variables for not being able to speak English and school enrollment in the previous year. All estimates are significant at the 1% level unless noted otherwise. 1 Significant at the 5% level. 2 Significant at the 10% level. 3 not significant.

Table 8-11 below shows the implied EITC elasticities of hours of work for women, married men and single men evaluated at the sample mean, and the mean credit amount for those who were eligible to receive the credit. The table indicates that for women and married men the EITC has a negative effect on hours of work. These results must be interpreted as the income effects associated with the EITC. Substitution effects have not been explicitly modeled. It is interesting to note that all of the elasticities are of the same magnitude as those from the non-linear virtual income literature used in exploring the effects of the EITC on hours of work. Dickert, Houser, and Scholz (1995) report comparable estimates ranging from 0.00 to -1.56 for single men, from 0.00 to -3.17 for married men, and from -0.57 to -4.33 for all females (Table 2 p. 11). Eissa, and Hoynes (1998) also find negative effects of the EITC expansion in 1993 on the hours of work for both men and women.

Table 8-11 EITC Elasticity of Hours for 1980, and 1990

EITC Elasticity of Hours	1980	1990
Female	-0.038	-0.033
Married Male	-0.011	-0.039
Single Male	-0.005[3]	0.003[3]

[3] not significant.

The results from the hours estimation have many coefficients that change sign and significance. This suggests that the relationships being captured in the annual hour's equations are not very stable. One might expect that with the large changes in female participation, married male labor supply would also go through changes that are hard to identify in any given year. The advantage to looking at a number of cross-sectional estimates is that we are able to get a sense of the changes taking place in how people make decisions. The disadvantage is that we cannot determine if the changes are transient or permanent. The results presented here indicate that participation decisions, while changing, are not unstable, but that the decisions regarding hours of work are more difficult to estimate. These results suggest that when trying to model the labor supply of the U.S. population, a combination of cross-section and time-series estimation techniques would likely prove useful.

Policy Implications

There are two major policy implications of the results presented in this and the previous chapter. The first is with respect to effects of the EITC on fertility. This research indicates that the effect of the EITC is to increase fertility. Moreover, fertility is negatively associated with participation for men and women. A variety of studies have shown that the effect of the EITC is to reduce labor supply and may in fact reduce disposable income for the eligible groups [Browning (1995)]. Additionally, the elasticities are larger in absolute value for women than for men. Therefore, through both the effects on fertility and on participation, increases in the EITC may differentially influence the gender mix of the labor force, decreasing both male and female participation but that of females more than males.

The effect of the EITC on fertility may seem small; the elasticity from a pooled sample for married women is 0.012. However, these small elasticities can have large impacts. Using the smallest elasticity estimated and assuming that the recently enacted $500 child tax credit would have a similar effect on fertility as the EITC, we find that the fertility rate would increase by 10%. A 10% increase in the fertility rate for women in their childbearing ages is a significant increase in the number of children born in any given year. Assuming that roughly 4 million children are born every year, the $500 dollar tax credit will result in almost 400,000 more infants born every year. This increase in the number of infants will have two significant impacts on the economy. First the newborns will forever increase the population path for the economy. Second, the newborns will have impacts on the labor supply of their parents.

The second major policy implication is in the treatment of parental leave time. The results presented here highlight that fathers are increasingly opting to stay out of the labor force in order to be the primary provider of care to children. However, if the father works, regardless of the wife's labor force status he will tend to increase hours of work with increases in the number of children, other than infants, in the household. These increases in the number of hours worked by men are completely opposite to the results seen for female hours of work. Women, therefore, shoulder more of the burden of childcare in two-worker households. They are more likely to reduce their hours of work to meet the needs of their children. Women are observed to be more flexible with the time spent at work than men are. Increased pressure on employers to provide leave benefits equally to men and women may result in a balancing of the effects of children on hours. Carlin and Flood (1997) argue that a variety of government-instituted policies, including ten days off for the father at childbirth, have resulted in more flexibility in their hours of work. The results presented here indicate that men are changing their roles with regard to child care, but that those roles are changing slowly.

Conclusion

The results from the labor supply analysis suggest that higher wages raise the number of hours worked for women and single men, while they produce lower hours for married men.

Household income not including own earnings has a negative impact on hours of work and participation. A husband's participation in the labor force has a positive effect on the wife's hours of work and participation. At the same time, the wife's participation has a positive effect on the husband's probability of participating in the labor force, but for those men who do work it has a negative effect on hours worked. The EITC has a negative impact on participation and hours for women and married men. The results from the hours estimation are consistent with results in the literature on EITC. If viewed as income effects the participation results with regard to EITC are also consistent with the EITC literature.

Perhaps more interesting than the effects of wages, income, and the EITC are the effects of children on labor supply for married men. Carlin and Flood (1997) find that there are significant reductions in the hours worked by Swedish men when children are present in the household. However, previous research on male labor supply in the U.S. has found no negative effects of children on men's labor supply. The results presented here indicate that there have been significant changes in the way that men make decisions about labor supply. Men are starting to play a primary role in child care by reducing participation.

Chapter 9 **Modeling Issues and Estimation**

In this chapter the major issues involved in modeling fertility and participation are presented. First, there is a brief introduction to population forecasting. Because the cross-section results may systematically miss important trends and relationships between economic variables over time, the next section discusses the mechanics of modeling fertility and labor force, with special attention to the combination of the cross-section results with a time-series analysis. Next, a discussion of how the cross-section and time-series results are linked with the LIFT model is presented. Finally, the last sections present the results of the time-series estimation of age-specific fertility rates and participation rates.

Introduction to Population and Labor Force Projections

Typically, population projections are made using the cohort-component method for the middle of the year (July 1st). Multiplying age-specific fertility rates (ASFR) by the number of women in each age group creates the number of newborns in the forecast period. Distributing the total fertility rate among the different age groups creates the ASFRs. Each year the previous year's population is aged one year; ignoring immigration, population age 35 at time t is equal to population age 34 at time (t-1) multiplied by the survival rate for 34 year olds.

Immigrants add a slight complication and need to be dealt with differently than the resident population. Immigration is accounted for by exogenously assuming the net number of immigrants for each age group and adding them to the number of people in each age group. Immigrants enter the country throughout the year and are assumed to have birthdays distributed throughout the year. Consequently, half of the 34-year-old immigrants in year t will actually be 35 by July 1st. In addition immigrants enter the country throughout the year, and are obviously alive when they enter the country, resulting in an effective survival rate for 34 year old immigrants of 0.5 + 0.5(actual survival rate 34 year olds). The leading 0.5 accounts for the immigrants entering the country alive, and the 0.5 multiplication factor for the survival rate accounts for the immigrants arriving in the country evenly throughout the year.[40]

The labor force is calculated by applying age-specific participation rates to the relevant age group, thereby creating a pool of laborers. Demographers rarely endogenously determine the fertility rates, and economists forecasting the economy rarely endogenously determine the participation rates.[41]

This section outlines the methods used to endogenously determine the fertility and participation rates. Briefly, cross-section estimates of the decision to have a child or to participate in the labor force are incorporated into the model using economic results from LIFT. A predicted value of the dependent variable (age-specific fertility or participation rates) is created based on the cross-section equations. The predicted value of the dependent variable (F* or P*) and a number of other variables are then used as independent variables in time-series regressions of the actual age-specific fertility rate or participation rate. From the cross-section results F* and P* depend on the number of children in the household, the spouse's

[40] Interestingly, life expectancy at birth does not represent the life expectancy of any one person. Rather, life expectancy calculations are means for representing the current survival rates of all age groups in one year. Life expectancy is calculated by instantaneously aging 100,000 persons through the currently prevailing survival rates. Thus, if survival rates are changing over time, life expectancy does not represent the expected life of anyone.

[41] Previous versions of LIFT use exogenous participation rates.

participation in the labor force, the wage rate, household income, and a number of other variables. Time-series regressions are necessary to capture changes over time that are not well represented in the cross-section work and also any systematic errors that result in lower or higher estimated values than those that actually occurred. The next section describes the process used to incorporate the cross-section estimates into a cohort component method of forecasting population.

Modeling Fertility and Labor Force

Objective

The objective of modeling fertility and labor supply is to create an endogenous model allowing the economy to influence the size and age distribution of the population and of the labor force. The cross-sectional estimates of fertility and labor supply show that economic variables can play an important role in determining fertility and labor supply. Fertility decisions today can influence labor supply today and in the future. Similarly economic variables, the wage rate, total income, and the unemployment rate, can have an important impact on the size of the labor force.

Fertility decisions today obviously influence the size of the labor force in the future. Increases in the number of children today will increase the number of potential laborers in 20 years. Perhaps equally important to changes in the size of the population is the effect that children have on the labor supply of their parents. Increased fertility today, resulting in more children, may increase or decrease the size of the labor force depending on the decisions households make about childcare. These changes in the labor force are likely to be skewed towards younger women and away from men and older people, changing the distribution of the labor force by age and gender.

Interestingly, while Denton and Spencer (1988) find large changes in the economy resulting from endogenizing population, they only find these results several decades after shocks to fertility decisions. The major mechanism through which increased fertility had an impact in their economic model was through changes in the size of the labor force with the entry of the young workers into working ages. This work differs from theirs by estimating the effects of fertility on current labor supply and allowing for those impacts to affect the model.

Using the economic effects discussed in chapters 3 and 4 requires that the demographic model be incorporated into an economic model of the U.S.. The driver model used here is the LIFT model of the INFORUM project at the University of Maryland.[42] LIFT produces a number of economic variables including average wage by industry, hours of work, employment by industry, and personal income which can be used to link LIFT to the demographic and labor force model.

Fertility

The population forecasts depend on forecasts of the ASFRs. The modeling framework employed here uses the cross-section fertility results combined with other explanatory variables from the LIFT model to obtain estimates of fertility rates in the forecast periods. These age-specific fertility equations will then be incorporated into the Demographic Projections Model (DPM) using the cohort component method of forecasting population. This section briefly

[42] See McCarthy (1991) for a detailed discussion of the LIFT model and its properties.

outlines the issues involved in creating ASFRs and illustrates some of the techniques for dealing with these issues.

Chapter 3 explores the effects of economic variables on fertility decisions. The cross-section work found that the wage rate and household income have elasticities of -3.5% and 0.1% respectively (see Chapter 3). In addition to the economic variables, there are a number of other variables that are important determinants of fertility. Age and marital status are probably the most important determinants of fertility. A 1% change in the age of the average woman from 34.2 to 34.6 years of age results in an almost 5% decline in the probability of observing a birth. Similarly a 1% increase in the age of the average woman from 20 to 20.2 years of age results in a 2.2% increase in the probability of observing a birth. However, holding everything else constant, increasing the age of a woman from 20 to 34 reduces the probability of observing a birth by over 18%. Age does not affect fertility in a linear manner and peaks at about age 26. Similarly, for the average woman, becoming married increases the probability of having a child by 162%. Thus, fertility rates will move depending on the value of these other variables.

From the cross-section estimates, the fertility rate for 25 year-old women depends on a constant, the average wage for 25 year-old women, the average income, the average number of children, the average marriage rate, the average labor force participation rate for husbands, the average education level, and other variables. In order to forecast the age-specific fertility rate, age-specific values of the independent variables need to be created.

Linking to LIFT

Among a host of other variables, LIFT produces the average wage rate by industry, personal income, and the number of unemployed persons. These are the primary variables used to link the demographic model to LIFT. However, these industry and aggregate variables need to be translated into age and gender specific variables. In order to get these age specific variables it is necessary to obtain some information about the age distribution of occupations, industries, wages, and income from the 1970, 1980, and 1990 IPUMS data sets.[43] In other words, what does the distribution of occupations look like for 25-year-old men? Because, age-specific fertility and participation depend on the distribution of occupations, wages, and income, a distribution of these variables must be forecasted. The forecasted distribution will come from the 1990 IPUMS.

Age Distribution Issues

The age distributions of a number of economic and non-economic variables need to be created from the 1970, 1980, and 1990 IPUMS data sets. The 1970 and 1980 IPUMS provide important information about the changes in the age distributions of wages and income.

A crucial variable for understanding fertility is the female wage rate. LIFT does not produce female and male wages by age. Therefore, we need to translate LIFT's wages by industry to wages by age and gender. The primary link used in this model is the distribution of occupations. An estimate of the age distribution of occupations is created from the three IPUMS cross-sections, and then translated into wages by age. The following example illustrates

[43] See Appendix C for the age distribution of household income and wages by gender, and marital status.

how we can translate LIFT output of wages by industry into wages by age. Suppose that we had three age groups (young, middle, and old), two occupations (professional, and blue collar), and four industries (durable, non-durable, service, and government). Then we could calculate the age distribution of wages from the industry distribution of wages by the following formula.

6.0) $$\underset{3X1}{[WA]} = \underset{3X2}{[AO]}\underset{2X4}{[OI]}\underset{4X1}{[WI]}$$

Wages by **A**ge (WA) represents wages by the three age groups. **A**ge by **O**ccupation (AO) is a 3x2 matrix of the wage in each age and occupation relative to the average wage in each occupation, weighted by the ratio of individuals in age j and occupation k relative to people in age group j; $ao_{j\,k}$=[(wage $_{j\,k}$)/(wage $_{k}$)]*[(No. people $_{j\,k}$)/(No. people $_{j}$)], where *j* is an index over age groups and *k* is an index over occupation groups. **O**ccupation by **I**ndustry (OI) is a 2x4 matrix of the wage in each occupation and industry relative to the average wage in the industry, weighted by the ratio of individuals in occupation *k* and industry *l* relative to people in occupation group *k*; $oi_{k\,l}$ =[(wage $_{k\,l}$)/(wage $_{l}$)]*[(No. people $_{k\,l}$)/(No. people $_{k}$)], where *k* is an index over occupations and *l* is an index over industries. Finally, **W**age by **I**ndustry (WI) is a 4x1 matrix of the average wage in each industry. Pre-multiplying WI by OI transforms the average wage in industries into the average wage by occupation. Pre-multiplying by AO transforms the average wage by occupation into the average wage by age, resulting in WA. This example can be generalized to each gender and to the 51 LIFT industries, 22 occupations, and 110 ages. Thus LIFT wages by industry are transformed into wages by age and gender.

An additional complication to predicting the wage distribution by age is that we do not observe wages for all individuals. Individuals who do not work do not have an observed wage. It is likely that there is some correlation between the decision to work and the wage rate. The wage rate for married men who are seventy years of age or more is substantially higher than for the other age groups (see appendix C). Men who can command a much higher wage rate in their elderly years are, possibly, more likely to work than those who cannot, creating a sample selection problem for the observed wage rate. Therefore, we must use a sample-selection-corrected estimate of the wage rate to help us determine the applicable hourly wage rate for each age group.[44] The easiest way to translate actual wages by industry into sample-selection-corrected wages by age is to use the actual values for matrices WI, and OI, but use the predicted wage from chapter 4 relative to the average actual wage in matrix AO. This will result in deflating the actual wage so that it is applicable for all individuals regardless of employment status. This modification results in an equation of the following form for $ao_{j\,k}$: $ao_{j\,k}=[(wagehat_{j\,k})/(wage_{k})]*[(No.\ people_{j\,k})/(No.\ people_{j})]$, where wagehat represents the predicted value from the sample-selection-corrected wage estimation, and *j* and *k* are indices as described above.

A further complication with using the age distribution for occupations and industries from the Census data is that there are individuals who are not allocated to a particular industry or occupation. In order to solve this problem, a non-existent industry 52 is created. Similarly,

[44] See chapter 4 for a detailed discussion of the issues involved in estimating wages and labor supply.

individuals without a specified occupation are assigned to occupation 22. The wage for industry 52 is assumed to be the average in the economy. Finally, there is not an exact correspondence between LIFT and IPUMS industry detail. Several sectors, specifically those for state, local and federal government, are not available in the same detail in the IPUMS as in LIFT. Therefore, the bridge matrix transforms wages by industry that result from LIFT into the 43 industries used in DPM. The total number of employees in each industry is used as a weight in the calculation of aggregate wages.

AGE DISTRIBUTION FOR INCOME

LIFT calculates total personal income (PI) in the economy. Dividing PI by the number of households results in personal income per household (PIPH). From the IPUMS data sets a matrix of household income to average household income for each age, gender and marital situation can be created (HI). Multiplying PIPH by HI will result in a matrix of household income by age, gender, and marital status (HIAG).

6.1) $$\underset{3x4}{[HIAG]} = PIPH \bullet \underset{3x4}{[HI]}$$

AGE DISTRIBUTION FOR OCCUPATIONS

Occupational choice not only influences the wage that women face but also is an important variable determining fertility and labor force attachment. An estimate of the age distribution of occupations must be created from the IPUMS 1990 sample in order to estimate fertility. The estimate will calculate the percentage of women in each age and occupational group relative to the total number of women in each age group; these are the weights for the AO matrix above.

AGE DISTRIBUTION OF MARITAL STATUS

Marital status is probably the single most important determinant of fertility. Consequently a matrix of the age distribution of marital status, MA is created. For the three age group example, MA would be a 3x1 vector of the percent of women in each of the three different ages that are married. Marital behavior in the U.S. has changed dramatically over the last several decades; in 1970 66% of women between the ages of 16 and 55 were married, but by 1990 only 56% of the women were married. Nevertheless, the work presented here assumes that the marital distribution is held fixed in the forecast years at the 1990 levels.[45]

The participation of husbands in the labor force is also an important determining factor for fertility. Husband participation increases the likelihood of having a child. Unlike the dramatic increases in female participation rates, male participation rates have moved very slowly. Fortunately, simultaneously forecasting labor force participation rates and fertility is one of the main thrusts of this work and can be used to obtain estimates of the participation rates of husbands. In order to forecast the participation rate of husbands, the average age of husbands

[45] While there have been dramatic changes in the marital tendencies of the U.S. population, there is also some evidence that marriage rates are stabilizing. The demographic model built and demonstrated in this dissertation provides a framework for further study of interesting demographic issues. So, while an in depth study of the marriage behavior is beyond the scope of this dissertation, it is not beyond the scope or framework of this model.

given the wife's age is calculated first. Then the participation rate for husbands is calculated as the participation rate for men who are of the corresponding average age.[46]

AGE DISTRIBUTION OF OLDER CHILDREN

Today's fertility choices have a real impact on fertility choices in the future. The presence of an older child increases the probability of having another child. However, once there are two or more children in the household the impact of the older children on fertility is diminished. Parents usually start to have children with some desired total number of children in mind.[47] Consequently, the age-specific fertility equations must keep track of the number of children already in households and distribute them to women by their age. The average number of children in the household is calculated by retaining lagged values of the fertility rates. In other words we will need a matrix of the average number of older children that women have for each age group. This matrix will have to be calculated dynamically as ASFRs adjust to changes in the economy. In this way fertility today will depend on fertility yesterday, and we can control for the total number of children that women have over their childbearing life-cycle.

Keeping track of the number of older children in the household is accomplished by adding up the conditional fertility rates of women over their childbearing years. Consider forecasting the fertility rate for a forty-year-old woman. The fertility rate depends upon, among other variables, the number of children between the age of 1 and 5 (NCHLT5), the number of

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[46] This simplification ignores the fact that married men have a different participation profile than single men. However, for many ages the majority of the men are married and therefore the average of the married and the single is closer to that of the married men. This simplification is necessary because the model calculates the average participation rate of men regardless of marital status.

[47] See Bachu (1993), and Bachu (1991) for recent discussions of birth expectations.

children over the age of 5 (NCHGT5), and whether or not there are 2 or more children already in the household (2KIDS). The NCHLT5 can be calculated by adding up the appropriate age-specific fertility rates for the last 4 years; NCHLT5 = Fert39(t-1)+Fert38(t-2)+Fert37(t-3)+Fert36(t-4). Similarly, the NCHGT5 can be calculated by adding up the fertility rates from 5 years ago through 18 years ago; NCHGT5= Fert35(t-5)+... +Fert22(t-18).

The percentage of 40-year-old women with two or more children is somewhat more complicated. The percentage of women with two or more children is the sum of conditional probabilities over the years during which the woman can have a child. Simply stated, the percentage of women with two or more children is equal to the probability that a woman has a second child given that she has a first, plus the probability that a woman has a third child given that she has two other children, and so on. The following C code illustrates the method of calculating the percentage of women who have two or more children.

```
for(age=16;age<=73;age++){          // 73=55+18, used for labor force participation
    if(age<19) edad = age;             // Don't add up fertility in years before born.
    else edad = 19;
     for(i=1;i<edad;i++) {
          j = i+1;
          for(k=j;k<edad;k++) {
                    for(m=k+1;m<edad;m++) {
                        TWOKID[age] = TWOKID[age]+ (1-TWOKID[age])*
                        fertlag[edad-i][age-(edad-i)]*fertlag[edad-k][age-(edad-k)]+
                        (1-TWOKID[age])*
                        fertlag[edad-i][age-(edad-i)]*fertlag[(edad-k)][age-(edad-k)]*
                        fertlag[(edad-m)][age-(edad-m)];
                        }}}}
```

TWOKID is the percentage of women who have two or three children in their household, and fertlag[k][j] is fertility for age j and time period k.[48]

This process of including past fertility results maintains the internal consistency of the model for predicting fertility, and creates a link from previous fertility to current fertility and labor force participation.

AGE DISTRIBUTION OF EDUCATION

The age distribution of education plays an important role in the fertility decision. The age distribution of education is obtained from the 1970, 1980, and 1990 IPUMs. Between 1970 and 1990 the age-specific education levels have gone up for all ages and genders. This is likely to be the case in the forecast period. Consequently, for those age-gender-specific education levels that increased between 1980 and 1990, half of that rate of increase was applied to years through 1999, a quarter of that increase through 2009, an eighth of the increase is applied to the years through 2019, and finally a sixteenth of the increase is applied to the years after 2020. Similarly, the age-specific percent enrolled in school increased between 1980 and 1990 for all age groups and genders. The forecast applies half of the yearly increases between 1980 and 1990 to the years 1991 through 2000. Between 2001 and 2010 a quarter of the increases between 1980 and 1990 are applied to the school enrollment. Finally, an eighth of the increase and a sixteenth of the increase is applied to the years 2011 to 2020 and 2021 to 2050. The

[48] This process of summing the conditional fertilities does not allow children to die. This is a simplification, but unlikely to change the results significantly.

forecast of education and school enrollment is characterized by increasing education levels but at a decreasing rate.[49]

CROSS-SECTIONAL VARIABLES ROLLED INTO THE INTERCEPT

A number of variables in the cross-section estimates are not used in the simulation model. These variables are rolled into the intercept value by multiplying the estimated parameter and the average value of the variable. Specifically, race, ethnic, and state dummies, state tax rates and state dependent exemptions, the EITC, metropolitan status, and dummies for English speaking and immigration status are all rolled into the intercept.

Fertility Equations

For illustration purposes, simplifying the age structure from 110 ages to 3 and applying the methods outlined above results in the following age-specific fertility equations:

6.2) $$\underset{3x1}{[F^*]} = f(\underset{3x1}{[A]} + b_1 \cdot \ln(\underset{3x1}{[WA]}) + b_2 \cdot \underset{3x1}{[HI]} + \underset{3x3}{[KID]} \cdot \underset{3x1}{B_3} + \underset{3x10}{[Z]} \cdot \underset{10x1}{B_4}).$$

f() represents the Logit probability function applied to the cells of the 3x1 matrix; *f()*=Exp()/(1+Exp()). A is a matrix of constants. Fertility by age (F*) is a vector of predicted fertility rates using the results of the cross-section estimation. WA and HI are defined as above and are in 1989 dollars. KID is 3x3 matrix of the average number of children less than five, older than five, and two or more children that women in each age group have. Z is a matrix of many of the other regressors that have age distributions.

[49] The educational attainment levels are exogenously determined. An interesting area of further study and analysis is to consider endogenizing educational attainment.

Time-series Analysis of Fertility Equations

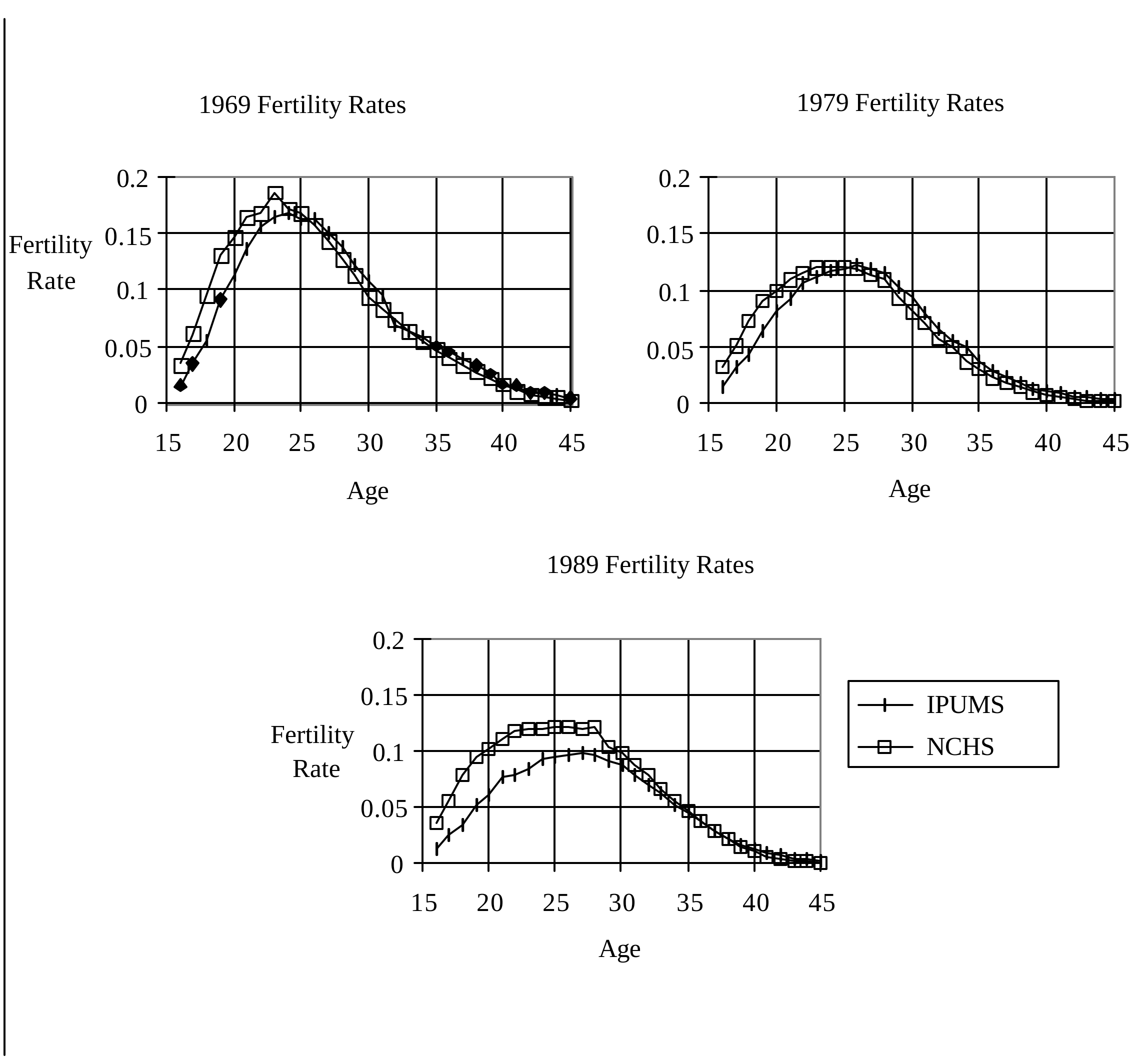
The results of the cross-section analysis are captured in F*. However, while capturing many of the effects of differences in socio-economic variables, F* may not capture the effects of changes in cross-section and other variables over time. By using F* as an independent variable in a time-series analysis of age-specific fertility, systematic shifts in individuals responses to changes in other variables can be captured and included in the model. Moreover, the cross-section work captured the mean effect across a broad range of variables and ages. The time-series regression for each age group will try to capture the mean effect on that specific age group, thereby eliminating large errors associated with age groups who have characteristics that drastically diverge from those of the mean.

In addition to the issues raised above, the cross-section estimates are made from one data set while the actual time-series data are from another. The cross-section estimates are from the 1970, 1980, and 1990 decennial long-form samples. Actual fertility rates are calculated using the number of births by each age from the National Center for Health Statistics (NCHS).[50] Age-specific fertility rates are the number of births for each age mother divided by the population of females in each age. One consequence of using two different data sets for the creation of fertility equations is that the sample may not reproduce actual total fertility. Figure 9-1 shows the mean fertility by age from NCHS and IPUMS for the years 1969, 1979, and 1989. In the Figure, solid data points represent the IPUMS data sets whereas unfilled data points represent the NCHS data. In 1969 and 1979 the IPUMS estimates are relatively close

[50] See U.S. Department of Health, Education, and Welfare, *Vital Statistics of the United States*, for the years 1950-1993.

but generally below the actual fertility rates. However, in 1989 the IPUMS estimates are well below the actual fertility rates. Brownrigg and de la Puente (1992) find that there is a correlation between observing a young child and the Census undercount. De la Puente (1995) documents that the census undercount was the result of irregular, ad hoc, or unnoticed housing units. These housing units tended to be among the poor. Thus the 1990 undercount may have contributed to the under-estimate of fertility. These results suggest that it is important to correct for systematic problems in the cross-section estimates by doing a time-series analysis.

Figure 9-1 IPUMS Sample and NCHS Female Fertility by Age (1969, 1979, and 1989)



In order to do a time-series analysis, the independent variable F* needs to be created for history. The historical values of F* are created by running a historical simulation. The parameter values used in creating F* are from the 1970, 1980, and 1990 estimation discussed in Chapter 3. The parameter values for the intervening years are linearly interpolated, as are the values of variables like the occupational distribution by age. The estimates were made using current dollars. F* is calculated using 1990 dollars. In order to use the 1970 and 1980 results, the parameters for the wage rate and the value of other household income for 1970 and 1980 are multiplied by the ratio of average household income in 1970 and 1980 divided by average household income in 1990. This effectively puts the parameter values into 1990 dollars instead of 1970 or 1980 dollars.

Once a set of historical F*s are created they can be used as independent variables in the times-series regressions of ASFRs. The history of fertility rates used in the model is from 1950 to 1994. However, because F* is calculated using the number of children in the household which in turn is calculated using historical fertility rates, the first year that can be used to estimate the time-series regression is 1968 (1950+18=1968). For years prior to 1969 the value of parameters and age distribution variables are assumed to be like those from the 1970 IPUMS.

Figure 9-1 showed the mean female fertility rate by individual age for women between the age of 16 and 45 for the years 1969, 1979, and 1989. Mean fertility peaked for these women between the age of 24 and 27 at about 17% in 1969, 12% in 1979, and 10% in 1989. After age 28 the fertility rate slowly declines to zero. While technically not part of the Baby Boomers (1946-1964), the children born in 1969 were part of a cohort of children with mothers who had higher fertility rates than have occurred since.

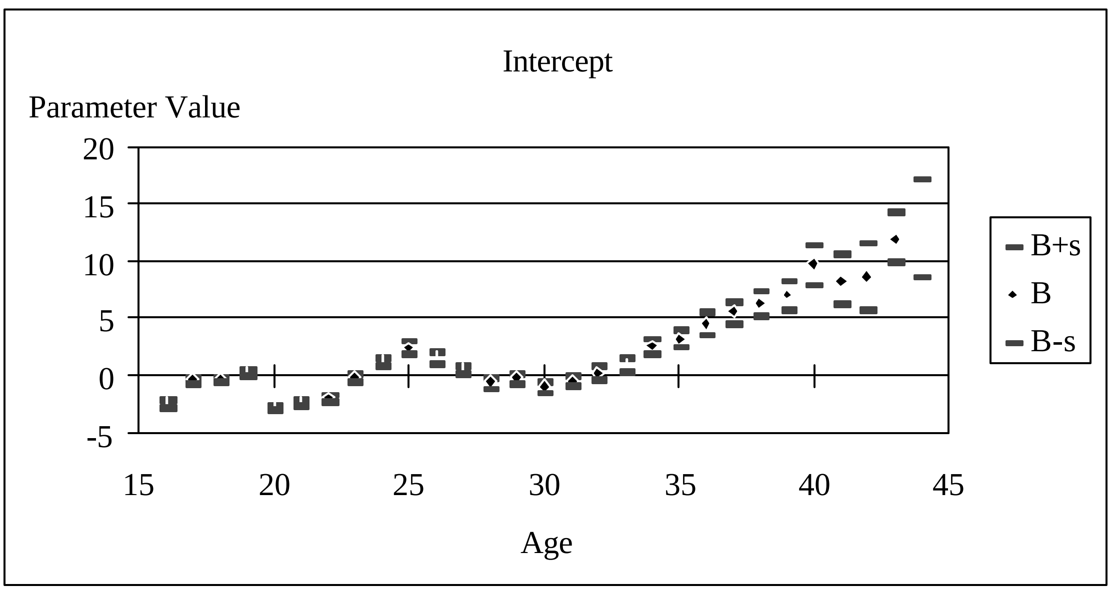
Figure 9-2 through Figure 9-6 show the results of the time-series Logit regressions from 1969 to 1993. The dependent variables are the natural log of the ASFRs, or probabilities of having a birth, divided by one minus the probability; log(P/(1-P)). The Logit formulation effectively bounds predicted values of fertility rates between zero and one. Since F* is a probability and, ideally, should be identical to the ASFRs, a similar transformation is done to

F*; log(F*/(1-F*)). Other variables included in the regression are the female wage rate relative to the wage of 39 year old males (Frwage), and the unemployment rate relative to total population (Unem). The estimation equation is:

6.3) $$\log\frac{ASFR}{1-ASFR} = B_1 + B_2 \bullet \log\frac{FSTAR}{1-FSTAR} + B_3 \bullet \text{Frwage} + B_4 \bullet \text{Unem}\,.$$ [51]

Figure 9-2 shows the estimated intercept parameter for each ASFR between the age of 16 and 44. The figure also shows the parameter plus one standard deviation and the parameter less one standard deviation. The estimated parameters tend to cluster around

Figure 9-2 Logit Estimation of Intercept Parameters for Fertility Rates 1969-1993



zero until the late thirties where they become increasingly positive.

Figure 9-3 shows the parameter estimates for B_2, the parameter on the transformed F* variable. Given the construction of the dependent and the independent variable, B_2 should be 1.0 if F* exactly replicates the ASFR. Until the middle thirties B_2 seems to be roughly clustered around 1.0. However, after age 35 B_2 becomes progressively larger than 1.0. This suggests that F* is predicting lower fertility for these older age groups.

Figure 9-3 Logit Estimation of F* Parameters for Fertility Rates 1969-1993

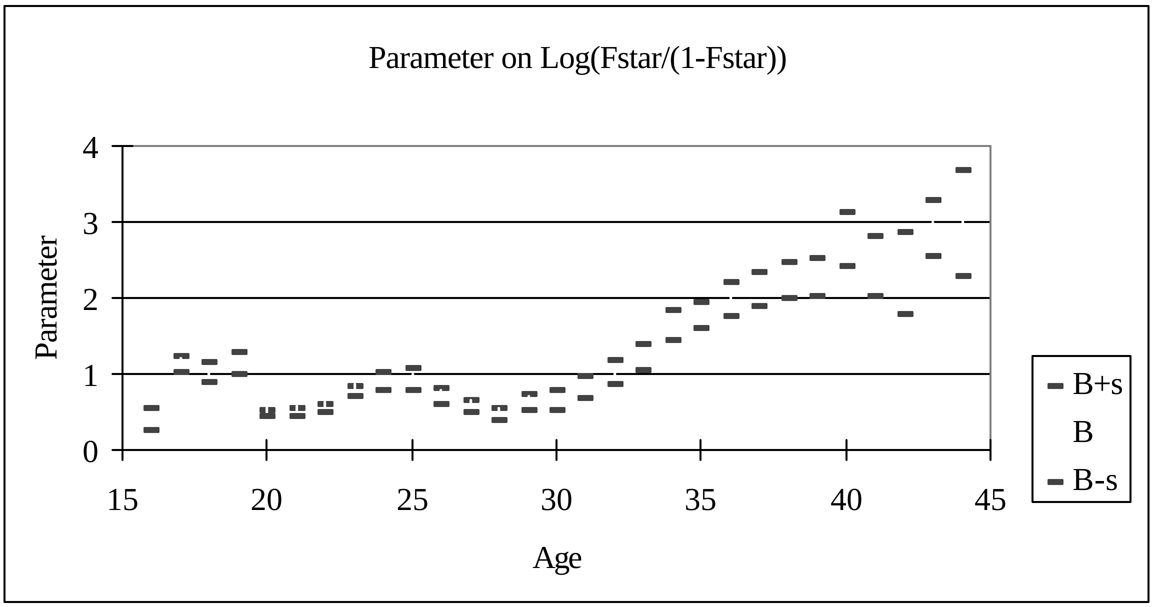


Figure 9-4 shows the parameter B_3 on the female wage relative to the male wage of 39-year-olds. The figure suggests that increases in the relative wages for women under the age of 24 will increase fertility. However, F* calculated from the cross-section results includes a negative effect of wages on fertility. Thus, the estimated parameter B_3 may very well be zeroing out only the negative effect from the cross-section. However, for women between the ages of

[51] Table 13-25 in appendix D shows the results from an alternative specification. Appendix D compares two specifications.

24 and 28 and older than 40 there is a distinctly negative impact of wages on fertility. Therefore, the cross-section analysis did not fully take into account the negative effect of wages.

Figure 9-4 Logit Estimation of Female Relative Wage Parameters for Fertility Rates 1969-1993

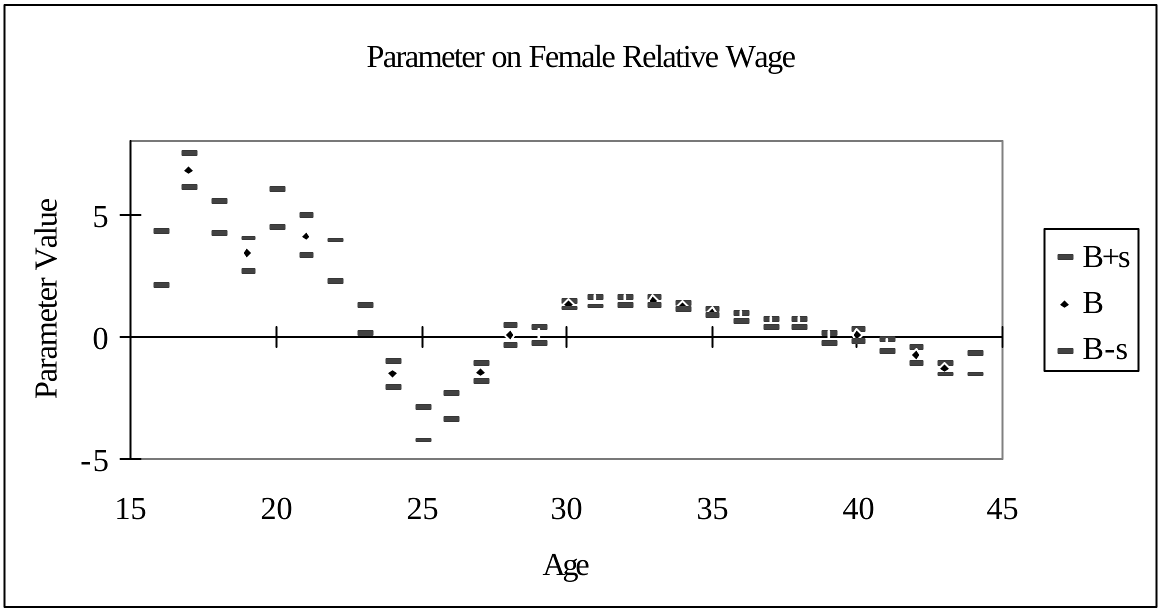
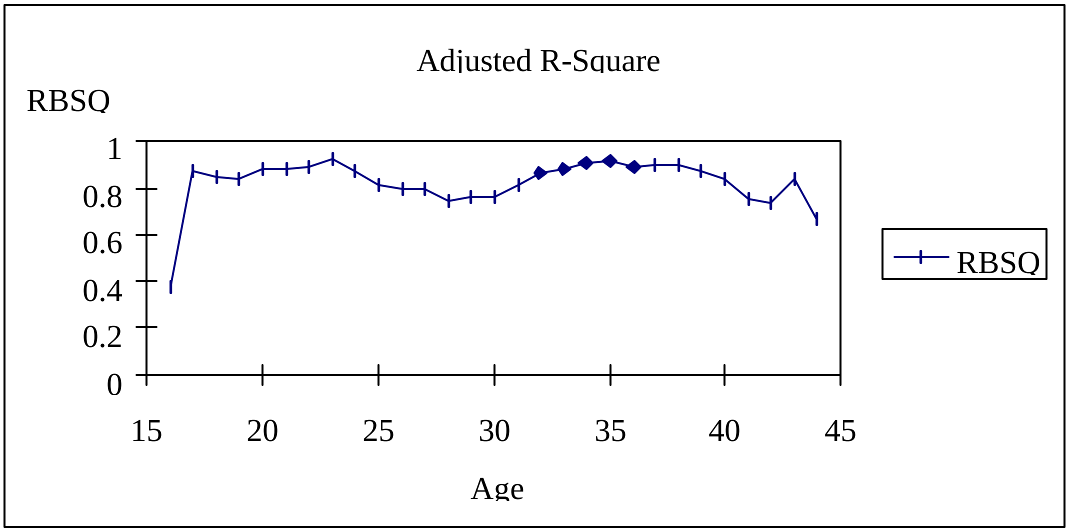


Figure 9-5 shows the parameter estimates for changes in the unemployment rate. The graph strongly suggests that the unemployment rate has essentially zero impact on fertility. If the graph showed two standard deviations about the parameter all but a few of the confidence intervals would include zero.

Figure 9-5 Logit Estimation of Unemployment Parameters for Fertility Rates 1969-1993

Figure 9-6 shows the adjusted R-squares for each regression. The regressions are overall explaining most of the variation in ASFRs. The one exception is that of 16-year-old women, explaining only 38% of the variation in teen motherhood. Figure 9-3 showed the parameter estimates for the constructed cross-section variable, F*, the estimated parameter for 16 year olds was well below our expected value of 1 suggesting that F* over estimated the fertility of 16 year old women.

Figure 9-6 Logit Estimation Adjusted R-Squares for Fertility Rates 1969-1993



Labor Force Participation

The objective of modeling labor force participation is to determine endogenously the size of the labor force. The current version of LIFT uses exogenous participation rates to calculate the size of the labor force. Like modeling fertility, the endogenization of labor supply will rely on the use of age-specific equations for the participation rate and the number of hours worked. The result of the equations will be a set of predicted participation rates and annual hours worked for each age. The predicted values combined with the population in each age bracket create the total labor force.

The participation equations are calculated in a similar manner to that used for calculating ASFRs. First create P*, age-specific participation rates (ASPR) based on the results from the cross-section estimates. Then use P* as an independent variable for estimating participation by age over time.

P* for women is simply the predicted value from the cross-sectional estimation.

However, for men P* is a weighted combination of the predicted values for single and married men, where the weights are the percentage of men single and married. Men are treated differently than women because fertility can be attached to married men in the cross-section but not to single men.

Time-series Results

Figure 9-8 through Figure 9-14 show the results of the time-series Logit estimation for women for the years 1969 to 1996. The dependent variables are the Logit transformation of the participation rate; log(ASPR/(1-ASPR)).[52] The equation used to estimate female labor force participation is:

6.4)

$$\log \frac{ASPR}{1-ASPR} = B_1 \bullet \log \frac{PSTAR}{1-PSTAR} + B_2 \bullet ZFrwage + B_3 \bullet ZUnem + B_4 \bullet ZSevsix + B_5 \bullet ZFertlag$$

[52] Published data on age-specific participation rates is difficult to obtain for more than a few recent years. Consequently the gender-age-specific participation rates for the years between the decennial censuses are made by moving the values obtained from the IPUMS with the movements in aggregate gender-age groups. Time-series values of the ASPRs are constructed from the 1970, 1980, and 1990 IPUMs, and the United States Statistical Abstract for the years 1969-1996. ASPRs are created by calculating the participation rate for all ages from the ten year decennial censuses, and then moving the individual age participation rates in the intervening years with published participation rates for men and women in age groups 16-19, 20-24, 25-34, 35-44, 45-54, 55-65, and 65 plus. Thus the participation rate for 28 year old men in 1985 is mlabfrc28{1985} = mlabfrc28{1990}* (prtm2534{1985}/prtm2534{1990}), where mlabfrc is the male labor force, prtm2534 is the participation rate for men between the ages of 25 and 34, and the braces indicate the year. This formulation moves the detailed participation rates from the decennial censuses with the changes in the published participation rates for the intervening years.

By construction there is not an intercept.[53] P* is the cross-sectional estimate created by using the parameter estimates from the 1990 PUMS. The leading Z in the name of the other variables indicates that the variables have a zero mean. ZFrwage is the female wage relative to the male wage for 39-year-olds less the average Frwage between 1969 and 1996. ZUnem is the unemployment rate relative to the population less the mean unemployment rate over the estimation period. The dependent data prior to 1976 comes from a different data source, consequently there is a noticeable break in the time-series between 1975 and 1976. In order to account for the changing data source, a zero-one dummy variable with a value of one before 1976 and zero after 1976 is included. Thus, Zsevsix is a zeroed dummy variable with values of 0.75 before 1976 and negative 0.25 after 1975.[54] Zfertlag is fertility from last year for women one year younger minus the average of lagged fertility over the estimation period. For women older than 45 Zfertlag is deleted from the regression.

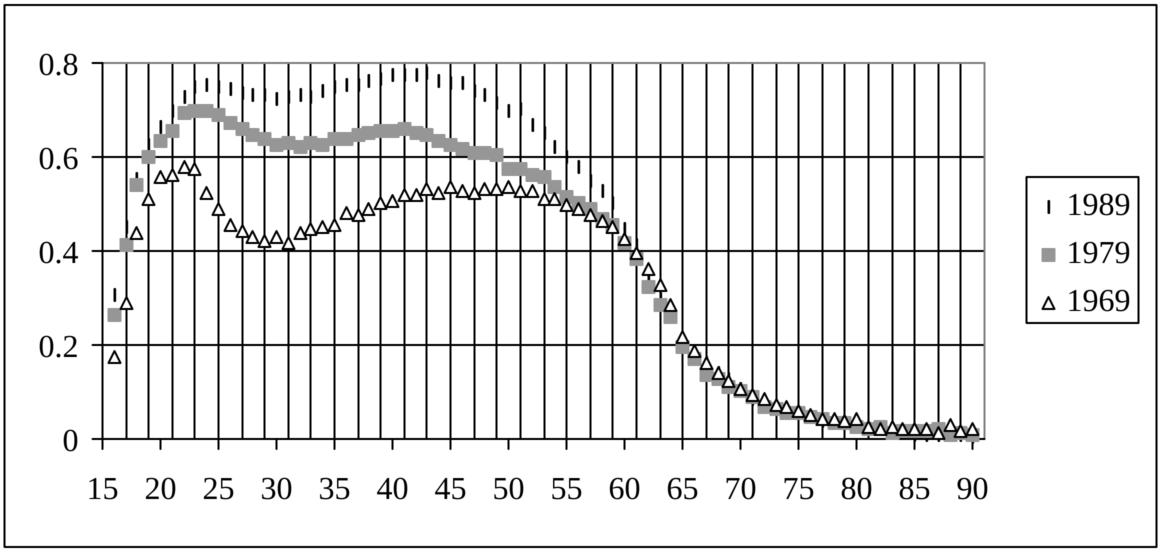
Figure 9-7 shows the mean female labor force participation rates for women age 16-91 for the years 1969, 1979, and 1989. Over that time frame, the mean participation rate was roughly 70% for women between 23 and 46. There is a slight dip in participation for women in their late twenties and early thirties --generally high fertility years occur just before these years

[53] The intercept is left out of the regression for a number of reasons. First, the constructed cross-section estimate of participation uses only the 1990 parameters. A linear interpolation of the parameters from 1970 to 1980 to 1990 like that used for fertility was performed and resulted in very poor fits. The interpolation introduced severe trends in the constructed time-series that were undesirable. Therefore only the 1990 parameters were used. This resulted in a set of time-series variables, P*, that moved like the actual but only around the 1990 participation rate. Consequently, for age groups that experienced very little movement in their participation the P* variable acted like a constant variable. This necessitated that the intercept be left out for those regressions. In order to maintain consistency across the equations, the intercept was excluded from all of the participation regressions.

[54] See U.S. Bureau of the Census, *Statistical Abstract of the United States: 1997* (117th edition) Washington, DC 1997, p. 394.

(see Figure 9-1)-- suggesting that the presence of toddlers in the home may be the cause of the dip. By age 65, only 20% of the women are working, most women are retired. The figure shows the large changes that have happened in the workplace between 1969 and 1989.

Figure 9-7 Mean Female Labor Force Participation by Age



In 1969, no single age group has an average participation greater than 60%. However, by 1979 every single age group from 19 years of age to 49 years of age has average participation rates greater than 60%. Moreover, by 1989 every single age group from 22 years of age to 50 years of age has an average participation rate greater than 70%.

There are two things that stand out about Figure 9-7. First, in 1969 there is a very pronounced decline in the participation rate in the late twenties and early thirties. This decline is far slighter in 1979 and 1989. Secondly, by age 60 the participation rates in 1969, 1979, and 1989 merge. There are a number of possible explanations for the merging of the participation rates. The fact that these women all seem to have the same participation rates may suggest that they all faced similar economic situations, i.e. same wages, and income. However, the radical changes in participation witnessed over the last several decades was principally built on the shoulders of women who in 1989 are in their forties. Thus, the merging of participation rates in 1989 may only reflect the fact that the cohorts with increased participation have not reached their sixties yet, and once they do reach their sixties, there quite likely may be a divergence in participation rates. More recent data showing that the participation rate for 55 to 64 year old women has increased from 45.3% in 1990 to 49.6% in 1996 supports this cohort argument.[55]

Figure 9-8 shows the parameter on the estimated participation rate from the cross-section. Given the construction of the estimation equation, the parameter on P* should be 1. With the exception of a few outliers B_1 is clustered around 1.0.

Figure 9-8 Logit of Female Participation 1969-1996 Parameter on P*/(1-P*)

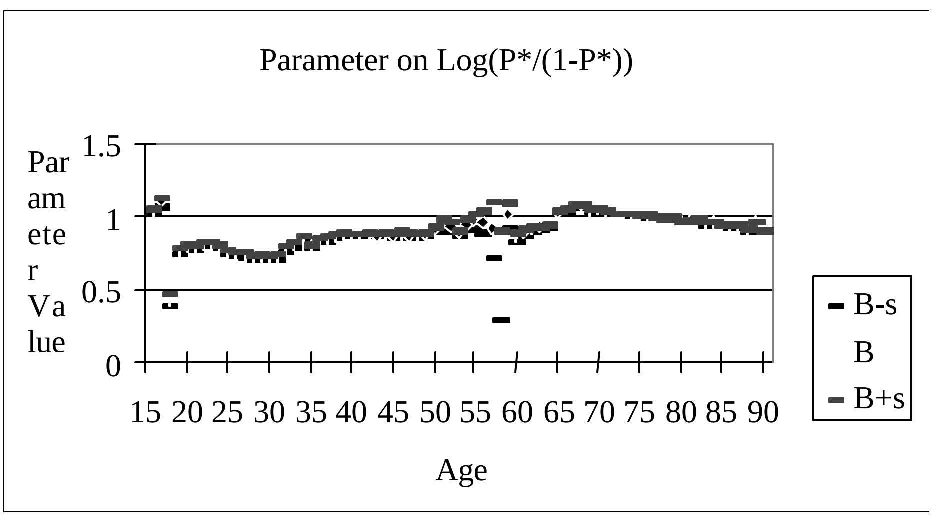


Figure 9-9 shows the parameter estimates for B_2, the parameter on the zero mean female relative wage rate. It appears that over the life cycle women are initially positively

[55] See U.S. Bureau of the Census, *Statistical Abstract of the United States: 1997* (117th edition.) Washington, DC, 1997, p. 397.

influenced by increases in the female wage rate. But, as they age they are less likely to be influenced by changes in the female wage rate.

Figure 9-9 Logit of Female Participation 1969-1996 Parameter on Female Relative Wage

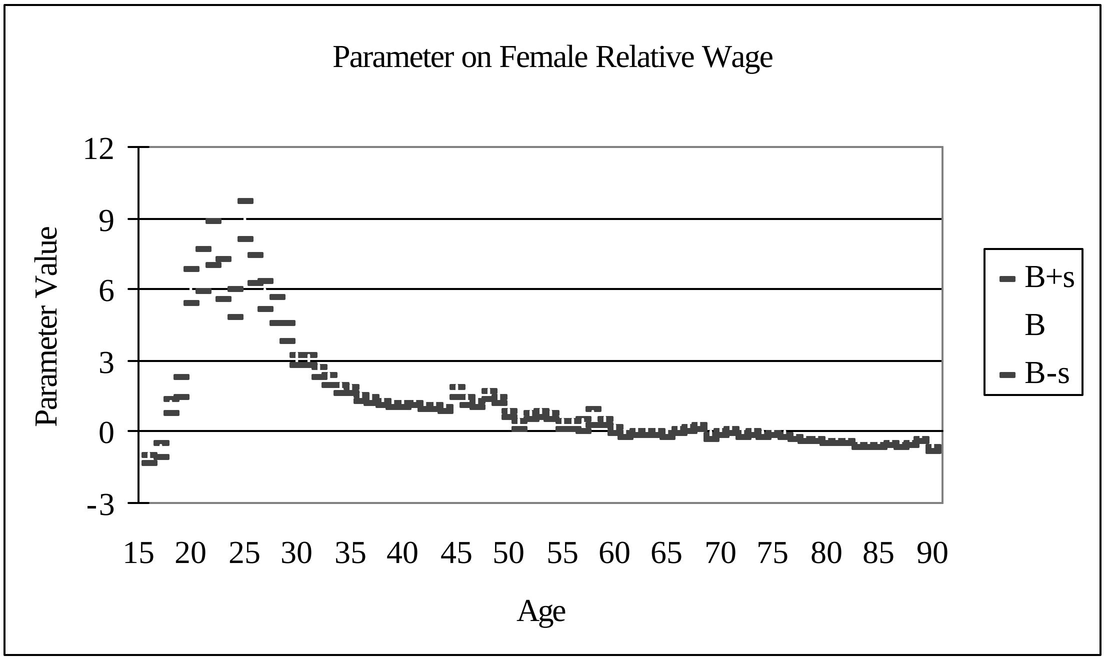


Figure 9-10 shows the parameter estimate for B_3 the parameter on the zero mean unemployment variable. Before analyzing the figure and the parameters it is useful to note that the cross-section estimate of the effect of unemployment on participation was negative. Hence, the apparent effect from the figure that as unemployment increases women will tend to enter the labor force, may actually be wrong. The figure does suggest that P* attributed too much of a negative effect of unemployment for women younger than 35 and older than 58. The negative effect from the cross-section may very well be correct for women between the ages of 35 and 57.

Figure 9-10 Logit of Female Participation 1969-1996 Parameter on Unemployment

Figure 9-11 shows the parameter estimate for B_4, the parameter on the dummy prior to 1976. The parameters pick up the break in the time-series. The series have lower values prior to 1976, which is picked up by a negative value for B_4.

Figure 9-11 Logit of Female Participation 1969-1996 Parameter on 1976 Dummy

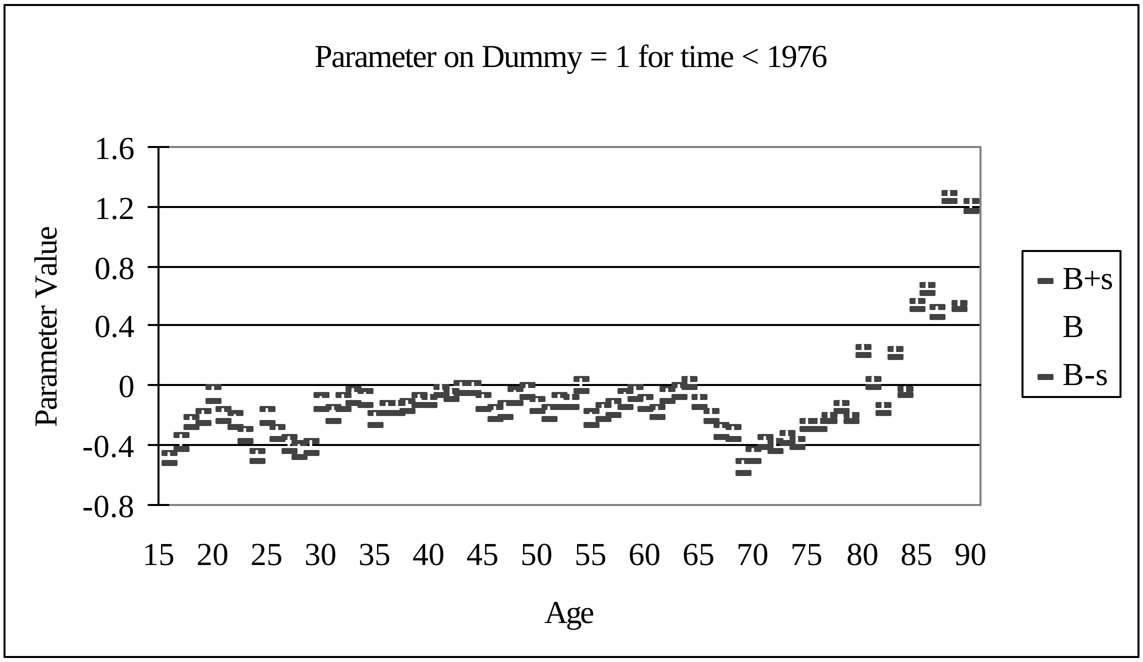


Figure 9-12 Logit of Female Participation 1969-1996 Parameter on Lagged Fertility

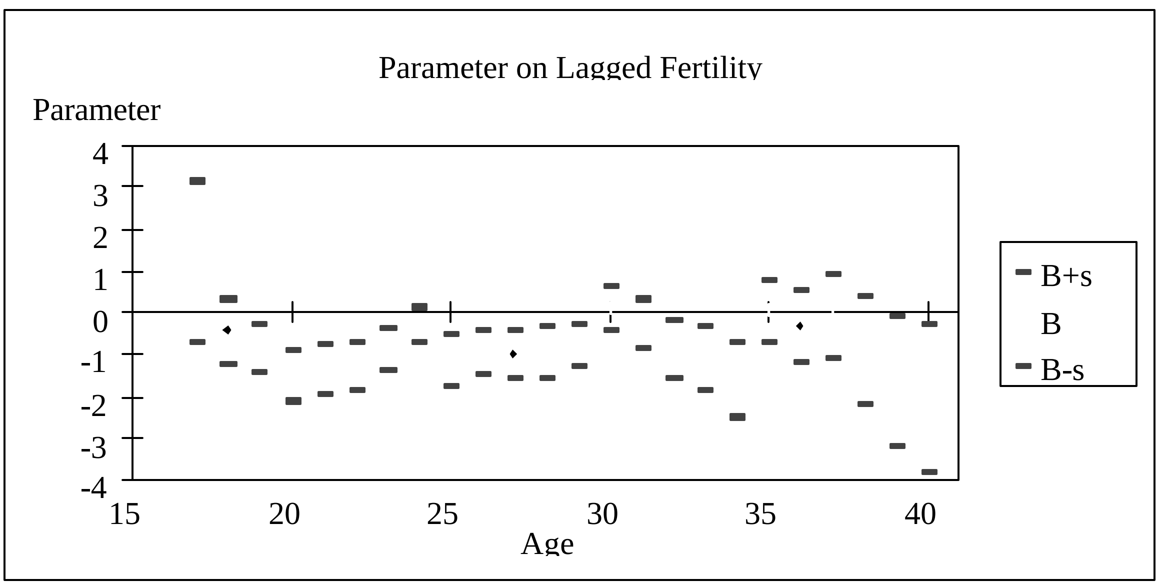
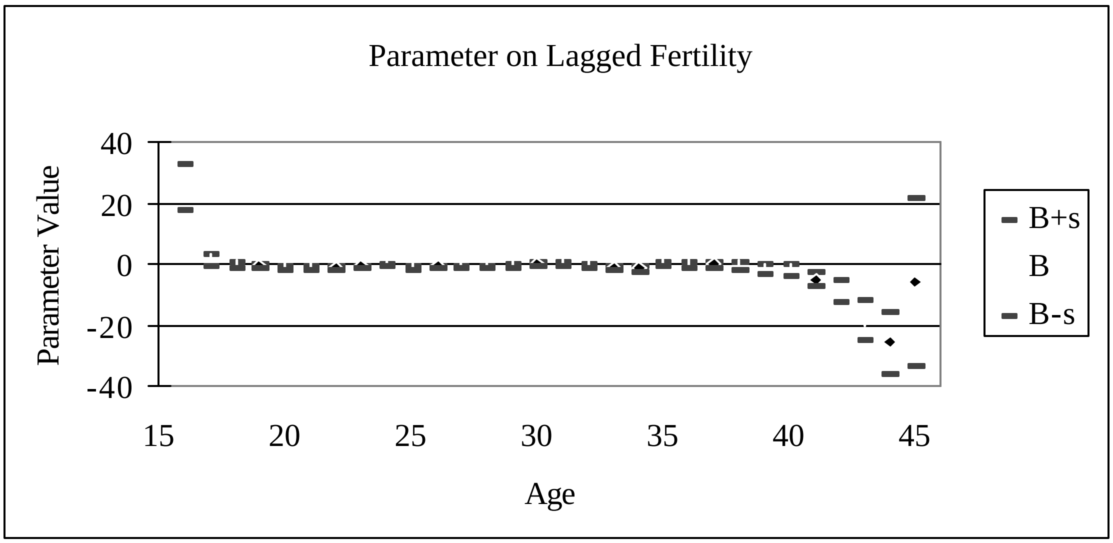


Figure 9-12 and Figure 9-13 show the parameter estimate for B_5, the parameter on lagged fertility. The first figure eliminates 16, and 40-45 year olds. The second figure shows all of the parameter estimates for women age 16-45. Figure 9-12 shows that the effect of increased fertility in the previous year is to decrease the participation rate for women in the current year. Figure 9-13 includes the parameter estimates for women 16, and 40-45. The parameter on 16-year-olds is substantially different from those on the other age groups. The high positive value suggests that 15 year olds who have children will increase their participation in the next year. The same result applies to 17 year olds however, to a much smaller degree.

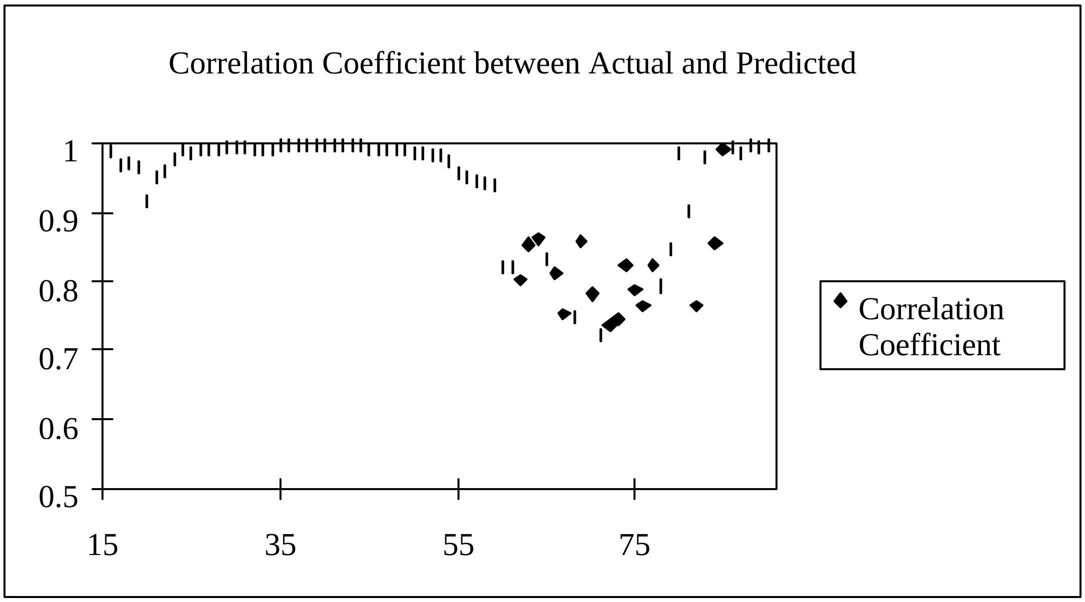
Figure 9-13 Logit of Female Participation 1969-1996 Parameter on Lagged Fertility



Finally, Figure 9-14 shows the correlation coefficient between the actual dependent variable and the predicted dependent variable using the estimated parameter values from the regression.[56]

In contrast to the changes seen in the female participation rates, male participation rates have remained relatively steady. The participation rate for married men between the ages of 35 and 44 was 98.1 in 1970, 97.1 in 1980, 96.7 in 1990, and 95.4 in 1996. The 2.7 percentage point drop in participation from 1970 to 1996 is very small when compared with the 29-percentage point increase in participation of married women in the same age bracket. Similar to the drop for married men, single men also have been

Figure 9-14 Logit of Female Participation 1969-1996 Correlation Coefficient



slowly reducing their participation in the labor force. Between 1970 and 1996 single men between the ages of 35 and 44 have reduced their participation by 4.1 percentage points from 86.1. Men have very slowly reduced their participation over the last several decades.

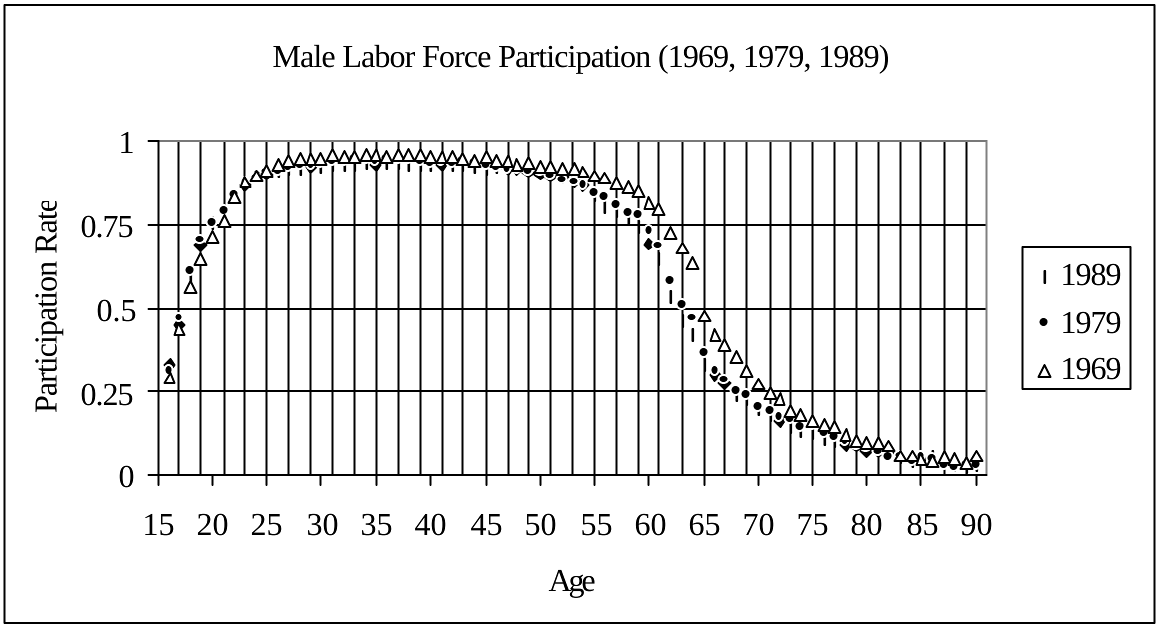
Figure 9-15 shows the mean male labor force participation by individual age for the years 1969, 1979, and 1989. Between age 22 and age 55, male participation is fairly flat and

---

[56] The correlation coefficient between two random variables X and Y is:
$\rho(X,Y) = \frac{Cov(X,Y)}{\sigma_x \sigma_y}$. Cov(.) is the covariance and σ is the standard deviation. The correlation coefficient is bounded between -1 and 1.

relatively high above 80%. However, after age 55 it starts to drop of in all three years. Between age 60 and 65 there is a precipitous drop in participation. In 1969, the single largest drop, 15.8 percentage points, occurs between age 64 and 65. However, in both 1979 and 1989 the single largest drop in participation occurs between age 61 and 62, with 10.7 and 11.3 percentage point drops respectively. Overall the reductions in participation between age 60 and 65 are similar; in 1969 the reduction in participation was 33.5 percentage points, in 1979 it was 36.8, and in 1989 it was 35.9. Thus it appears that men are reducing their participation at earlier ages and over a greater range of ages. Anderson et al (1997) find that at least a quarter of the reduction in participation for men between the age of 60 and 65 is the result of changes in the pensions and social security plans during the 1970's and 1980's. These drastic reductions in the rate at which men are participating in the labor force make it crucial that participation is modeled for each year's age group.

Figure 9-15 Mean Male Labor Force Participation by Age (1969, 1979, and 1989)



Like the time-series regression for women, the Logit formulation of ASPRs are regressed on P*, the male relative wage rate, the unemployment rate, and a dummy variable capturing the break in the time-series between 1975 and 1976. Also like the female participation regressions, the estimation equation does not include an intercept and the constructed cross-section variable, P*, uses only the 1990 parameters (see footnote 53). The estimation equation is:

6.5) $$\log\frac{ASPR}{1-ASPR} = B_1 \bullet \log\frac{PSTAR}{1-PSTAR} + B_2 \bullet ZMrwage + B_3 \bullet ZUnem + B_4 \bullet ZSevsix.$$

Where ASPR, P*, Zunem, and Zsevsix, are all defined as in the female participation regression. Zmrwage is the male wage relative to the wage for 39-year-old females less the mean of the male relative wage over the estimation period. As in the all of the previous formulations the coefficient on the log of P* over one minus the P* should be 1.0. A priori, B_2 and B_3 could be either positive or negative. B_4 captures the effect of breaks in the time-series of participation rates and thus is expected to be both positive and negative depending on whether the data prior to 1976 has higher or lower estimates of the participation rates.

Figure 9-16 through Figure 9-20 present the results from the time-series regression for male ASPRs for the years 1969-1996. Figure 9-16 shows the parameter estimate for B_1, the parameter on the transformed P*. A priori, we expect B_1 to have a value of one. A value of one would indicate that the cross-section estimates are very close to the actual ASPRs. A value greater than or less than one suggests that P* is underestimating or overestimating the ASPR respectively. The figure shows that for all but a few of the age groups, B_1 is very close to one. The parameters for men between the ages of 60 and 70 (typical retirement years) are unusual. The parameters for these men vary from almost 2.5 to almost zero. This large variance in parameters for these age groups suggest that in some instances, prior to age 63, P* is underestimating participation and in others, after age 63, it is overestimating participation. The cross-section estimates forced a smooth reduction in participation as a result of age, where, as seen in Figure 9-15, there actually appears to be a drastic drop in participation for men. Thus, one possible cause for the wildly varying values of B_1 is this smooth transition enforced in the cross-section estimation.

Figure 9-16 Logit of Male Participation Rates 1969-1996 Parameter on P*

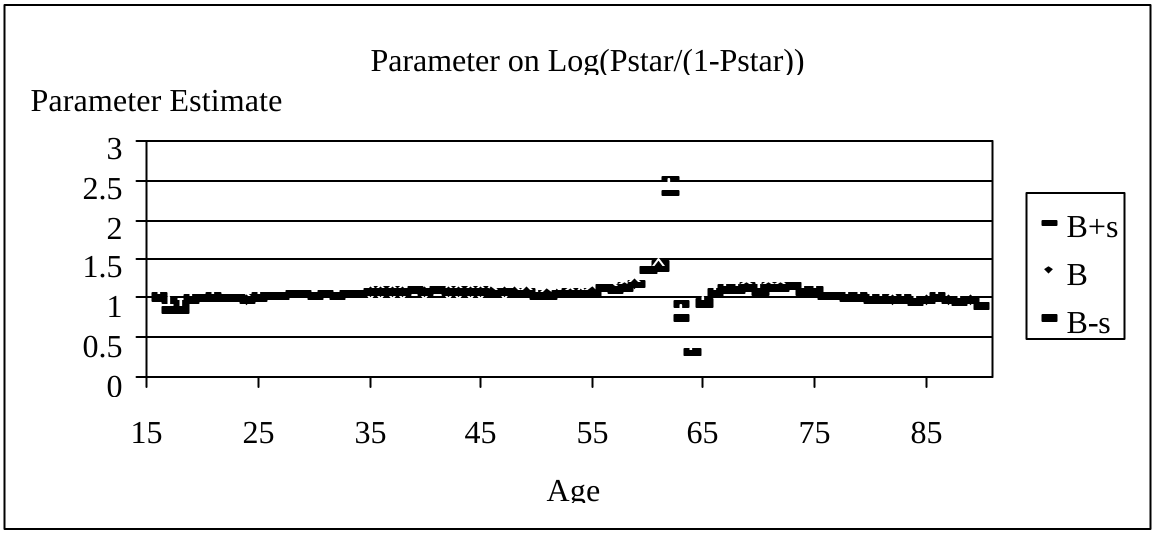


Figure 9-17 shows the parameter B_2, the zero mean male relative wage variable. The male wage is relative to the female wage for 39-year-olds. For men between 20 and 65 years of age B_2, is positive; increases in male relative wage increase the probability of participating in the labor force. For men older than 65 B_2, is on the whole negative, suggesting that increases in the relative wage decrease participation.

Figure 9-17 Logit of Male Participation 1969-1996 Parameter on Male Relative Wage

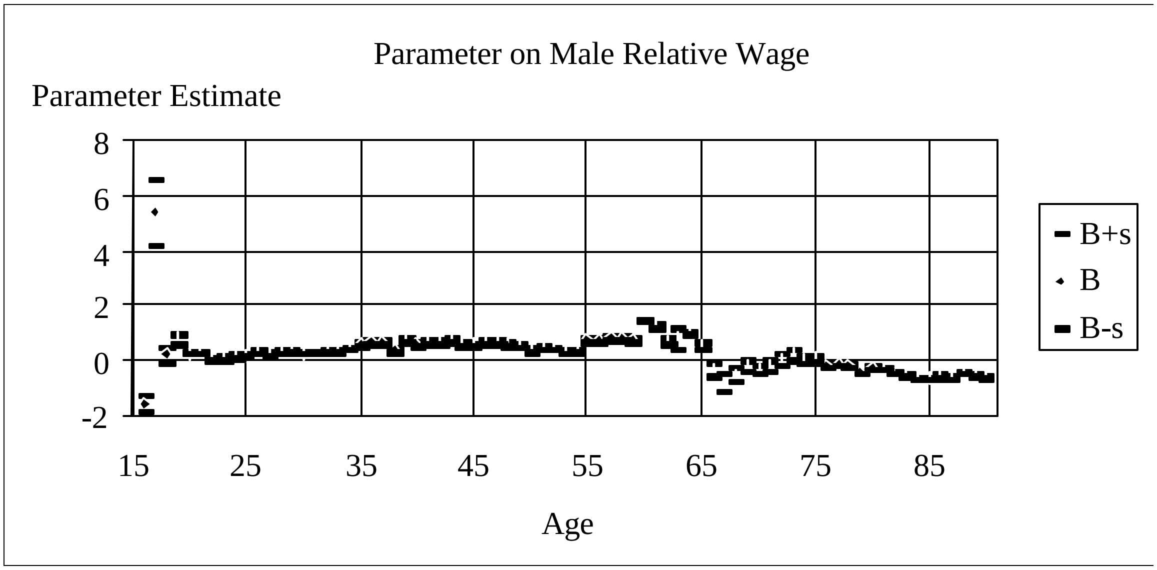


Figure 9-18 Logit of Male Participation 1969-1996 Parameter on Unemployment

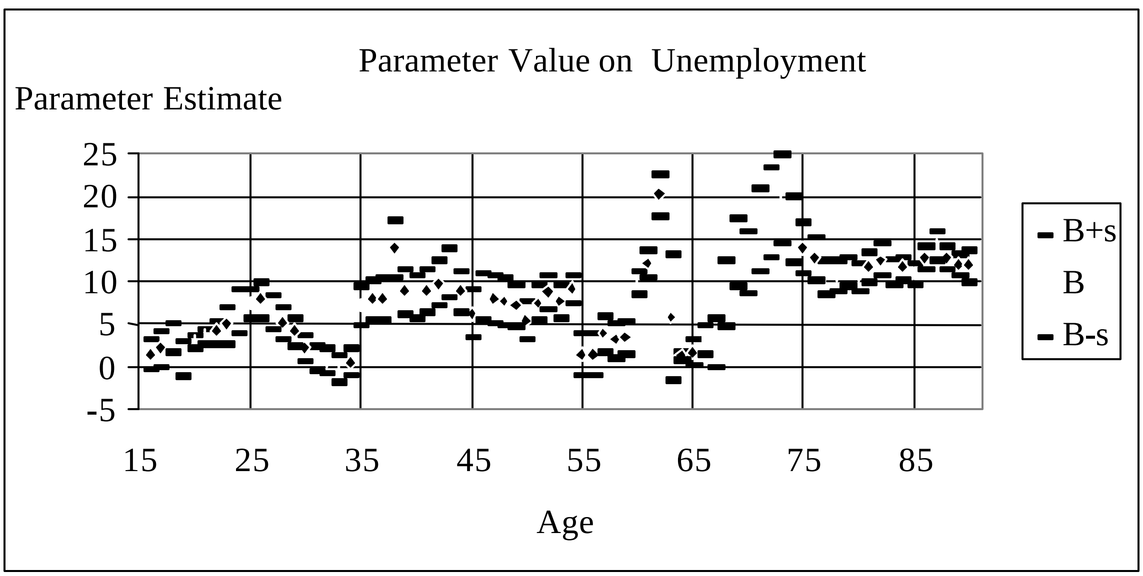
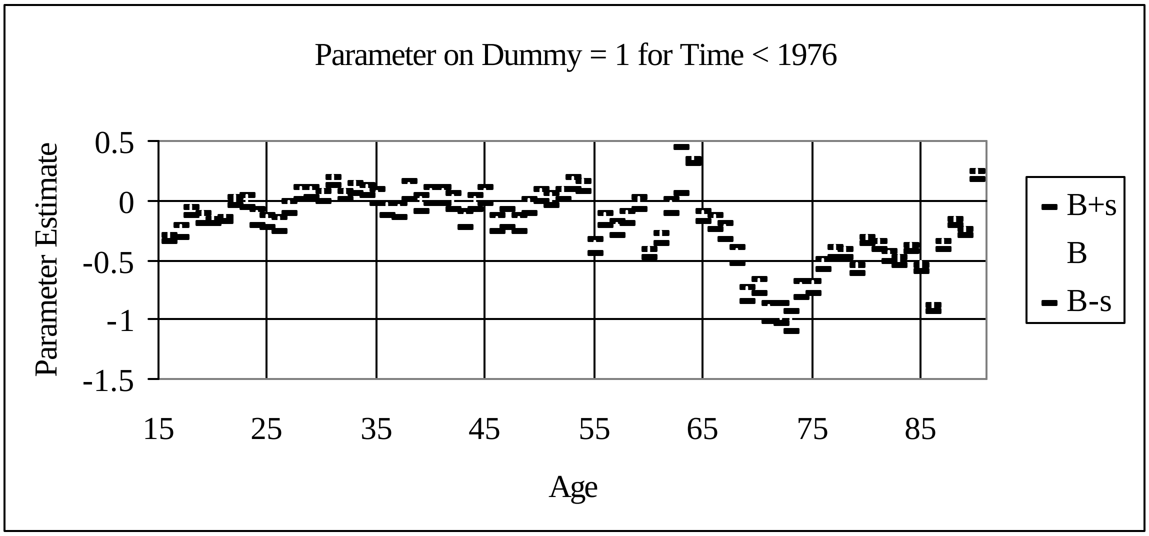


Figure 9-18 graphs the parameter results for B_3, the parameter on the Zero mean unemployment rate. As with the female participation equations it is difficult to asses the total effect of unemployment on participation without actually running a simulation because the variable P* is negatively related to unemployment. Thus, the positive B_3's could merely be eliminating the effect of the negative unemployment from the cross-section, or compensating in some fashion. The one or two negative or zero values are unambiguously suggesting an overall negative relationship between the unemployment rate and the participation rate. Men in their early thirties and near retirement ages (60-65) decrease participation with higher unemployment rates.

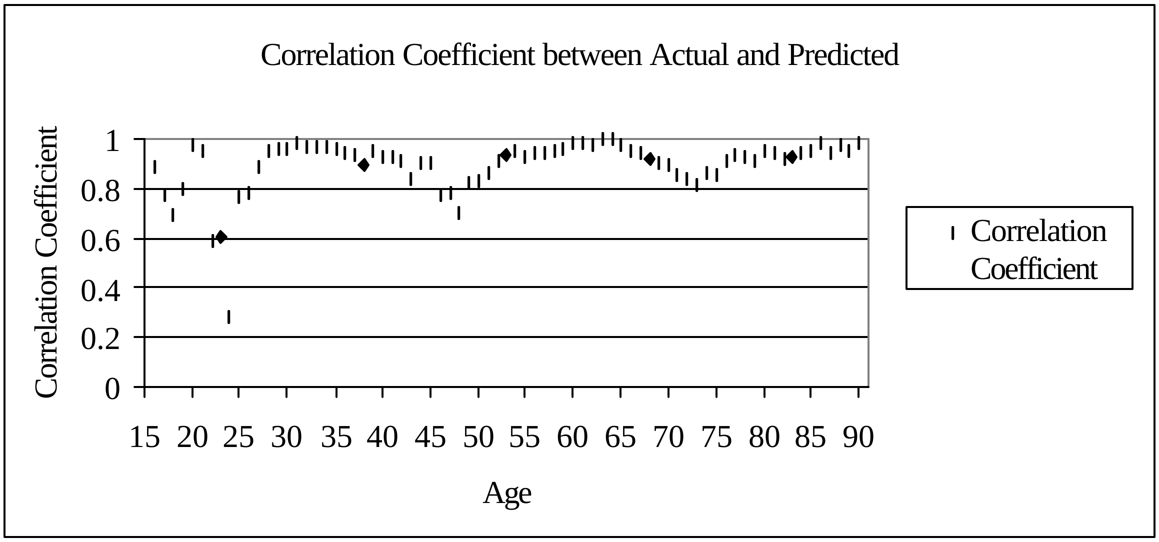
Figure 9-19 shows the parameter estimates for B_4, the parameter for the dummy variable prior to 1976. The dummy captures the effect of the breaks in the time-series of actual data. B_4 is estimated to be both positive and negative, depending on whether the data prior to 1976 is higher or lower than the data that occurs after 1976.

Figure 9-19 Logit of Male Participation 1969-1996 Parameter on 1976 Dummy



Finally, Figure 9-20 shows the correlation coefficients for the male ASPR regressions. Like the female ASPR regressions, the male regressions are specified without an intercept, necessitating an alternative to R-Square for testing the fit of the equations. The correlation coefficient describes the correlation between the actual values and the predicted ones. A high positive correlation suggests that when the actual variable is above its mean, the predicted variable is also above its mean. The figure shows that most of the predicted values have a high degree of positive correlation with the actual. The one exception is the predicted value for 24-year-old males, where the correlation is quite low.

Figure 9-20 Logit Estimation of Male Age-specific Participation Rates 1969-1996 Dependent is LogP/(1-P)



Annual Hours of Work

In addition to forecasting the participation rates for men and women, DPM forecasts age-specific annual-hours of work for men and women. The annual hours of work variable is constructed using only the cross-section equation, and then it is scaled by a constant to match the 1990 annual hours of work. Table 9-1 Annualshows the distribution of the scalars for men and women. For men, the mean value of the scalar is 1.03, while for women the mean value is 1.1. For both men and women the median is slightly less than the mean. The standard deviation is slightly greater for women than it is for men. In sum, the scalar is overall close to one, but closer to one for men than for women.

Table 9-1 Annual Hours Scalar Distributions for Men and Women

Male Hours Scalar			
N	*Mean*	*Std Dev*	
75	1.032067	0.227843	
Quantiles		99%	2.037
100% Max	2.037	95%	1.659
75% Q3	1.034	90%	1.129
50% Med	0.992	10%	0.852
25% Q1	0.97	5%	0.841
0% Min	0.56	1%	0.56
Female Hours Scalar			
N	*Mean*	*Std Dev*	
75	1.101093	0.296327	
Quantiles		99%	2.862
100% Max	2.862	95%	1.7
75% Q3	1.108	90%	1.196
50% Med	1.051	10%	0.92
25% Q1	1.008	5%	0.909
0% Min	0.488	1%	0.488

Major Linkages with LIFT

The major avenues through which the demographic model is linked to LIFT are the population and participation rates that come out of the demographic model, as well as from LIFT wages, unemployment, and income.[57] Because these different variables from LIFT can have different and complex effects on the demographic model, this section investigates the effects of a 1% increase in (a) wages, in (b) the number of unemployed persons, and in (c) personal income for the years 1993-2050. Each increase is done individually and separately from the others. The results are the gross elasticities of wages, unemployment, and personal

[57] In the forecast period the marginal effect of wages (above age-specific average wages for 1989) on fertility is reduced, by 25% between 1990 and 1994, 35% between 1995 and 1999, 45% between 2000 and 2004, 55% between 2005 and 2009, 60% between 2010 and 2014, and 65% therafter. In addition, the marginal effects of income above the 1989 age-specific mean on participation is reduced by 50% between 1990 and 1999, 65% between 2000 and 2009, and 80% therafter. These reductions in the marginal effects account for the fact that the cross-section parameter are decreasing in absolute value between 1970 and

income with respect to the endogenous variables (fertility, and male and female labor force participation).

Table 9-2 shows these elasticities for the years 1997, 2020, and 2050. The table indicates that for the Total Fertility Rate (TFR), a 1% increase in wages decreases fertility in 2050 by almost 5%. There are similar, though smaller, elasticities for an increase in the number of unemployed. A 1% increase in personal income tends to increase fertility but only slightly in 1997. In 1997 TFR is up by 0.5%, in 2020 the TFR is up 0.9%, and in 2050 the TFR is up 1.2%. For the most part the increases seem to be compounded over the years. That is, the elasticities are larger in 2050 than they are in 1997. This is the result of decreased fertility in previous years reducing not only current fertility but also influencing the participation of husbands and women, and through the number of children already in the household impacting fertility. The elasticities for both male and female participation are somewhat smaller than those for fertility. A 1% increase in wages seems to have very little effect on the participation of men until 2050 when it reduces participation by -0.6%. Similar reductions in male participation occur with increases in the number of unemployed, and personal income. For women the results are somewhat more complicated. Increases in wages and the number of unemployed actually increase the female participation rates in 1997, and 2020. But by 2050 those increases have given way to decreases on the order of 0.2%. This is the result of the combined effects of decreased fertility in the early years increasing participation in the early years. At the same time, male participation decreases by 0.6% and 0.5%. The significant decrease in male participation

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1990. Not reducing the marginal effects would result in driving participation and fertility to unacceptably low levels of predicted fertility and participation.

in 2050 reduces female participation by more than the direct effect of increases in wages and unemployment.

Table 9-2 Model Elasticities 1993-2050

Model Elasticities From 1% increase 1993 - 2050			
Year	1997	2020	2050
Total Fertility Rate Elasticity with respect to			
Wages	-4.1	-3.9	-4.7
Unemployed	-3.0	-3.4	-4.3
Personal Income	0.5	0.9	1.2
Males 20-65 Labor Force Participation Rate Elasticity with respect to			
Wages	0.0	0.0	-0.6
Unemployed	-0.1	0.0	-0.5
Personal Income	-0.2	-0.1	-0.5
Females 20-65 Labor Force Participation Rate Elasticity with respect to			
Wages	0.2	0.2	-0.2
Unemployed	0.0	0.2	-0.2
Personal Income	-0.1	0.1	-0.3

In sum, the major linkages in the model seem to work in predictable ways, although once all of the equations are turned on, the results are somewhat different than the direct effects might suggest. The model has a number of interesting properties with respect to economic variables. Increases in wages and unemployment reduce the fertility rate, thereby reducing the potential future labor force. These changes in fertility rates have important effects on female participation today; decreases in fertility increase female participation. Increases in income actually have a negative impact on fertility through their indirect effects on male participation. All of these effects show that the model is sensitive to changes in the economy. Moreover, the results suggest that the effects of changes in policy variables may be far from immediately transparent.

Conclusion

This chapter presented an overall methodology employed to combine cross-section estimates into a time-series estimation of fertility and labor force participation. The major linkages with the LIFT model are through transforming industrial wages into wages by age, transforming personal income into age-specific household income, and the unemployment rate. The cross-section predicted variables, the F-star and P-star variables, all have reasonable signs and magnitudes in the time-series estimations. The level of correlation between the predicted variables from the time-series analysis all suggest that a large portion of the variation in the dependent variables is being explained by the independent regressors. Finally, the major economic linkages with LIFT all have reasonable model characteristics; fertility decreases with increases in the wage rate, decreases with increases in the number of unemployed persons, and increases with increases in personal income.

Chapter 10 SSA Projections: an analysis of the demographic and economic assumptions

In this chapter, the DPM model uses the Social Security Administration (SSA) economic projections as the economic drivers of the DPM model. Then the chapter compares the resulting fertility and labor force participation forecasts from DPM with those of the SSA. The chapter is organized in the following manner. First it will present the three SSA projections paying particular attention to the variables that are expected to have an impact on the model. Second it will present the results for endogenizing fertility alone. Third, both SSA economic and fertility projections are used to create DPM forecasts of participation. Finally, both fertility and participation are endogenized using only the economic projections from the SSA to drive the model.

Introduction

The previous chapters have shown how economic variables can influence individual decisions that households make about fertility and labor supply. This chapter uses the model developed in chapter 5 to analyze the Social Security Administration projections. Specifically, a Low cost projection, an Intermediate projection, and a High cost projection, are taken from the 1997 Annual Report of the Board of Trustees of the Federal Old-Age and Survivors Insurance and Disability Insurance Trust funds. The first and third scenarios are meant to provide a best case and worst case upper and lower bound on the outcome for the SSA trust funds. The three projections include forecasts of age-specific fertility rates, participation rates, growth in wages, growth in the economy (GDP), and the unemployment rate. The demographic and economic forecasts are then used to drive the Demographic Projections Model (DPM). The results can then be compared with the SSA forecasts.

The purpose of this dissertation is to show how the economy affects demographic variables and how those demographic variables can then feedback to have important impacts on the economy. The SSA projections are essentially straight-line projections for each variable of interest. In other words, each variable is analyzed separately without recognizing that the economy is a system. The purpose of this chapter is to isolate the problem of unconnected forecasting and to show how simultaneously forecasting the economy and the population is an important exercise. Thus, a priori, the expectation from this chapter is that holding everything else constant and only allowing one variable to change results in different profiles of fertility and participation than if all of the variables are allowed to interact.[58]

Three sets of DPM simulations are presented here: one set presents the results of endogenizing fertility using the other variables projected by the SSA; a second set presents the results of endogenizing participation rates using the other variables projected by the SSA; and a third set of simulations is presented in which both fertility and participation are endogenized. Thus for each SSA projection, Low, Intermediate, and High, there are three DPM projections

[58] The SSA makes long term projections about a number of variables, fertility, labor force participation, interest rates, GDP growth, and the inflation rate. The purpose of their projections is to determine reasonable forecasts for the OASDI trust funds. In order to cover a large variance in the forecast of the trust funds, the SSA provides forecasts of these economic and demographic variables consistent with Low, Intermediate, and High costs for the trust funds. Thus, the alternative forecasts do not necessarily take into account the relationships between these variables, merely the effect that they have on the trust fund. See Monaco and Phelps (1998) for a discussion of macroeconomic feedback effects.

(fertility endogenized, participation endogenized, and both fertility and participation endogenized).

The results of the three sets of DPM simulations show that when using the economic assumptions found in the High cost (Low cost) alternative the endogenized variable has a considerably different profile. In the SSA High scenario, fertility is lower than in the Intermediate case. However, when fertility is endogenized using the High cost scenario economic variables the resulting fertility is higher than in the Intermediate case. Thus the economics of family decisions about fertility tend to move the High or Low scenario closer to the Intermediate scenario. The economics of fertility (and to a lesser extent, labor supply) implemented in the DPM model tend to push the economy back toward a middle scenario. Therefore, this work verifies that the SSA bounds are indeed upper and lower boundaries on the set of possible outcomes. The Intermediate scenario is a possibly a decent base case. However, because the proper linkages are not included in the SSA projections for the trust funds, the alternative projections do not provide a meaningful basis for policy analysis. Rather the SSA projections provide a warning signal about the health of the trust funds. The next section presents the SSA projections in more detail.

Board of Trustees of OASDI Projections

The Board of Trustees for the Old-Age, survivors, and Disability Insurance (OASDI) trust funds is required to submit annual reports to the U.S. Congress on the financial status of the trust funds. In doing so the Board takes into account changes in the economy and demographics of the U.S. to reasonably forecast the solvency of the trust fund over the next 75 years. The Board of Trustees for OASDI (1997) find that by the second decade of the next century the assets of the OASDI Trust funds will grow to $2.74 trillion. However, within 7 years of accumulating $2.74 trillion, they project that the trust funds will become insolvent; revenues will only cover 75% of the annual expenditures.

In order to make these trust fund projections, the Board of Trustees' report must take into account the future of the economy (wages, income, prices, etc.), the population size, and the population distribution. A simple example of these issues is that if the economy grows faster, the outlook for the trust funds is better. Similarly, if there is an increase in the number of working age people, the trust funds receive additional revenue from the additional workers, resulting in a better outlook for the trust funds.

Table 10-1 shows the projections of a number of variables from the 1997 report of the Board of Trustees of the OASDI. The Table shows the unemployment rate (Unem), the total fertility rate (TFR), the average participation rate for men and women between the ages of 20 and 64 (prtm20 and prtf20), and three indexes for the real wage, real GDP and the CPI. The participation rates are the sum of age-cohort-specific participation rates divided by the number of cohorts. The unitary weighting of the cohort participation rates eliminates differences in the participation rate for 20-64 year olds due to changes in the distribution of the population.

Table 10-1 Board of Trustees of the OASDI Trust funds 1997 Assumptions[59]

Year	SSA Alt.	Unem Rate	Average Annual % Change Real Wage	Real GDP	CPI	Total Fertility Rate	Participation Rates Men 20-64	Women 20-64
1996	Low	5.4	0.7	2.5	2.9	2024	0.84	0.69
	Int.	5.4	0.7	2.5	2.9	2013	0.84	0.69
	High	5.4	0.7	2.5	2.9	2001	0.84	0.69
2000	Low	5.1	1.4	2.7	2.5	2052	0.85	0.71
	Int.	5.8	0.8	2.0	3.4	1996	0.85	0.70
	High	6.6	-0.1	1.1	6.0	1940	0.84	0.70
2010	Low	5.0	1.4	2.3	2.5	2120	0.84	0.71
	Int.	6.0	0.9	1.8	3.5	1951	0.84	0.71
	High	7.0	0.4	1.3	4.5	1780	0.83	0.71
2020	Low	5.0	1.4	1.8	2.5	2193	0.84	0.72
	Int.	6.0	0.9	1.3	3.5	1905	0.84	0.71
	High	7.0	0.4	0.7	4.5	1616	0.83	0.70
2050	Low	5.0	1.4	2.1	2.5	2200	0.84	0.73
	Int.	6.0	0.9	1.3	3.5	1900	0.83	0.71
	High	7.0	0.4	0.4	4.5	1600	0.83	0.69

Table 10-1 shows the SSA projections for the years 1996, 2000, 2010, 2020, and 2050. In each year the Low cost projection (alternative I), the Intermediate projection (alternative II), and the High cost projection (alternative III), are shown. The Board of Trustees regards the Intermediate estimates "as their 'best estimates.'"[60] The High and Low cost estimates provide reasonable bounds for both pessimistic and optimistic projections. Thus in 2050 the Board of Trustees project the unemployment rate to be 6%, the real wage will have increased 57% over its value in 1996, GDP will have increased 111%, and the CPI will have

[59] The economic variables are created from Board of Trustees OASDI (1997) Table III.B.1, p. 179. The total fertility rates are from Felicite Bell (1997). The labor force participation rates used in the Board of Trustees Report are from an unpublished mimeo of participation rates from Rob Baldwin in the Office of the Actuary, Social Security Administration, Room 700, Altmeyer Building, Baltimore, MD 21235.

increased 635%. The Total Fertility Rate (TFR) is projected to decline from its current value to 1.9 children per woman. Finally, participation rates are expected to decline slightly for men and increase slightly for women. The Low cost estimates show lower unemployment rates, faster GDP and wage growth, slower growth in prices, higher labor force participation, and a higher TFR. Conversely, the High cost estimates project higher unemployment, slower real wage and GDP growth, higher inflation, lower participation and fertility.

DPM Analysis of SSA Projections

As shown in the previous chapter, DPM uses real wages, real income, and the unemployment rate as the primary links to the economy. The DPM simulations presented here use the SSA projections of these variables as the drivers of the model. Wages in all 52 sectors are made to move with the movements in the average wage movements from the SSA projections. In order to obtain unemployment relative to the population, the unemployment rate is multiplied by SSA estimates of the labor force and divided by SSA estimates of the population. Personal income is assumed to grow at the same rate as the growth in GDP. The fertility simulations use the participation rates from the SSA projections for each alternative. The participation simulations use the SSA fertility rates for each alternative.

If the policy objective is to reduce the probability of an insolvent trust fund it might be very useful to have boundaries of the possible set of outcomes. However, if the best estimates are used to produce forward-thinking policies, and the best estimates fail to include the natural relationships between the variables of interest and the policy variable, the policy implementation

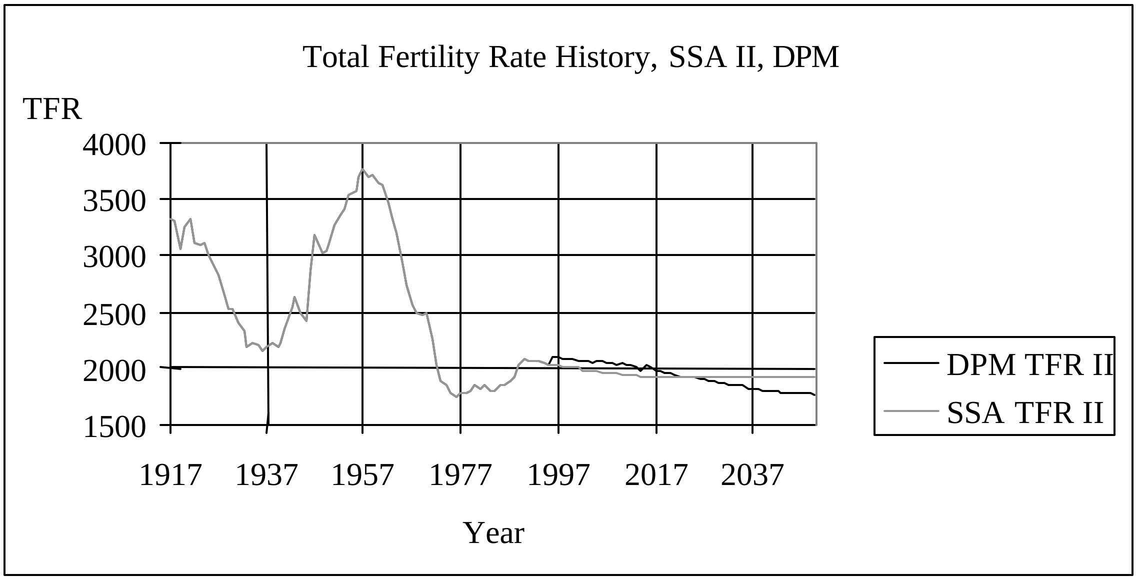
[60] Board of Trustees of OASDI (1997), p. 11.

is just as likely to go wrong as it is to go right. In addition to forecasting each variable separately, the SSA projections of the key demographic and economic variables all reach their “ultimate values” between 10 and 25 years into the future. In 2010 the unemployment rate reaches its ultimate value of 5%, 6%, and 7% in the Low, Intermediate, and High cost scenarios respectively. Similarly, growth in the CPI and the real wage reach their ultimate values in 2010, and the total fertility rate reaches its ultimate values in 2021. Once they reach their ultimate values there is not only a lack of an inter-relationship between them and other important variables, but also a complete lack of movement in the variable. While forecasting a single variable and holding it constant may provide reasonable bounds, it does not provide useful information to the policy maker about possible policy changes.

Endogenizing Fertility

Figure 10-1 shows the history of the total fertility rate, TFR, from 1917 to 1995 and two projections of TFR from 1995 to 2050. The two projections are the SSA Intermediate, or best estimate, of the TFR and the DPM simulated projection using the SSA Intermediate economic projections as a driver of the model.

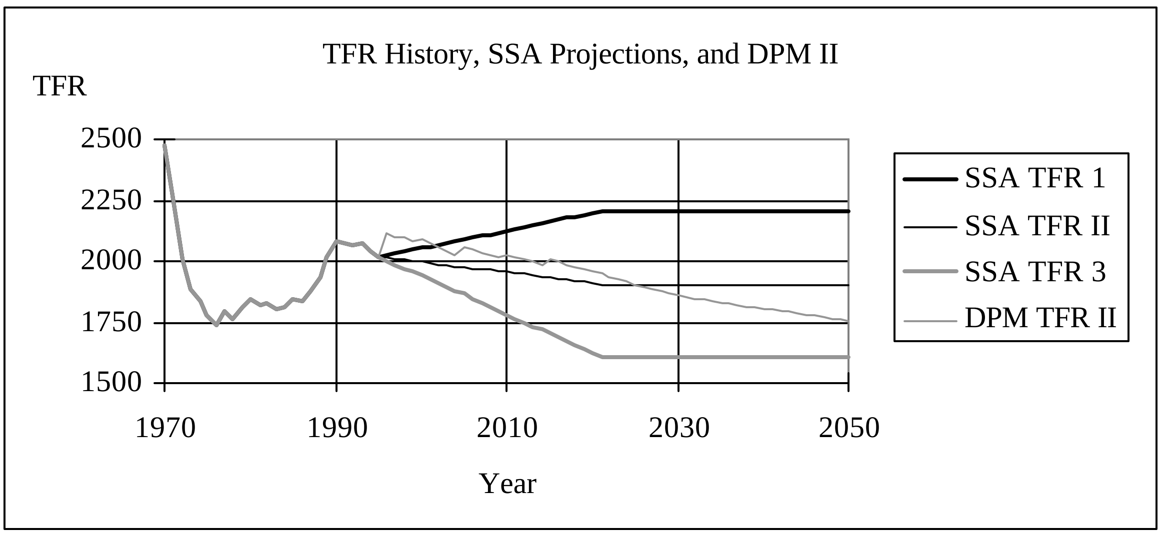
Figure 10-1 Total Fertility Rate History and Intermediate Assumptions 1917-2050



There are a number of interesting things about the figure. First, between 1917 and roughly 1970 the lowest TFR, 2.15, occurred in 1936. After 1970, however, the TFR dropped to 1.7 children per woman in the childbearing ages, and has remained below any level seen prior to that time. Second, both forecasts have a slight downward trend from the level seen in the 1990's, continuing the low TFR relative to the historical TFR. Finally, the DPM forecast starts out at a slightly higher level than the SSA forecast, but ends up at a lower level. The SSA forecast reaches its ultimate level in the year 2021 and remains flat at that level throughout the rest of the forecast. The DPM forecast, however, continues the downward trend. The DPM forecast in the year 2050 is roughly equivalent to the low level that was reached in 1976. The reason for the continued decline in TFR between 2020 and 2050 is that the real wage index (see Table 10-1) continues to grow from 1.2 to 1.57. A primary avenue of economic effects on fertility is through the wage rate. Another avenue of economic effects is from male labor force participation. Male labor force participation of 20-64 year olds is declining slightly from 84% in 2020 to 83% in 2050, see Table 10-1 Intermediate alternative.

The Intermediate DPM forecast continues its downward trend past the 2021 SSA level. Consequently, one concern is that the DPM Intermediate projection actually goes outside of the SSA bounds. Figure 10-2 shows the three SSA alternative estimates and the DPM Intermediate forecast. Except for the initial couple of years the SSA bounds also bound the DPM Intermediate forecast.

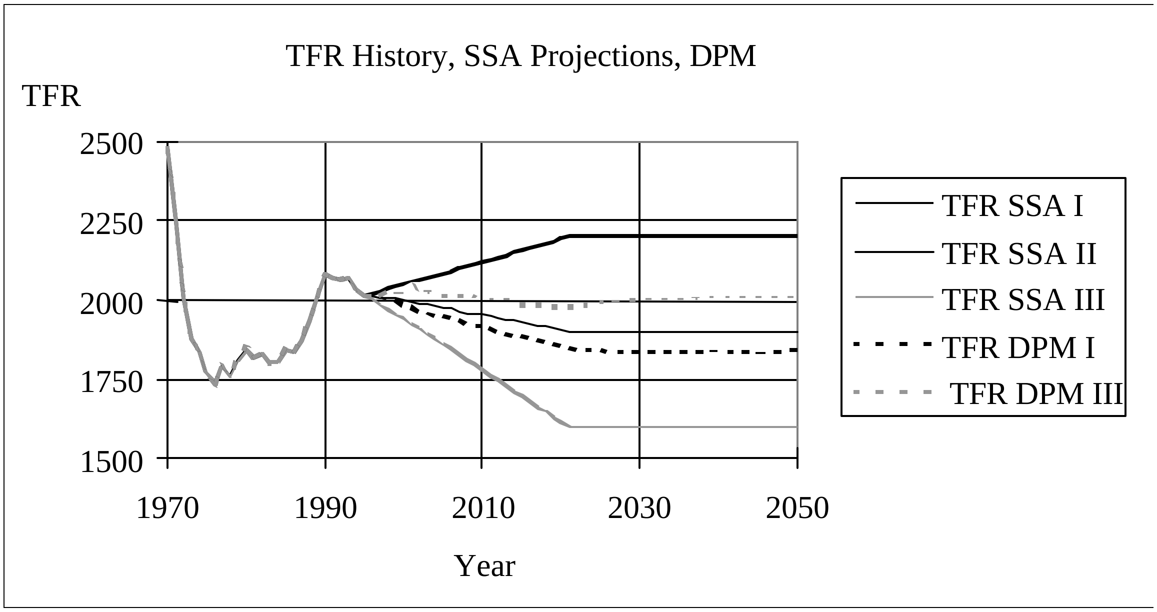
Figure 10-2 Total Fertility Rates for SSA Alternatives and DPM II



Finally, just as the DPM Intermediate forecast might go outside the SSA bounds, DPM alternatives I and II might go outside of the SSA bounds. In order to see the level of variance in the same graph, Figure 10-3 shows the DPM alternatives I, II, and III and the three SSA alternatives, where the DPM alternatives have been adjusted so that DPM II is the same as SSA II. Thus DPM I has had the same constant term adjustment in order to make DPM II the same as SSA II. There are two interesting features of the figure. First, both of the DPM alternatives made using the SSA estimates of economic variables fall inside of the SSA boundaries. Second, using the SSA Low cost economic data results in lower fertility than the Intermediate, and using the SSA High cost economic data results in higher fertility. Thus while SSA I assumes a high level of fertility, the projected economy under the Low cost scenario results in a low level of fertility, and vice versa. This is precisely because the Low cost scenario has a higher real wage. The boundaries chosen by SSA are indeed overly optimistic and overly pessimistic boundaries.

The Board of Trustees Report analyses the sensitivity of the actuarial balances with respect to fertility assumptions. They argue that for every 0.1 increase in the TFR the long-range actuarial balances will increase by about 0.12 percent of taxable payroll [Board of Trustees, Federal Old-Age and Survivors Insurance Trust funds (1997) p.135]. Thus, the increase in TFR as a result of using the economic assumptions from the High cost (Low cost) scenario is to increase (decrease) the actuarial balance by half a percent. This analysis verifies the use of SSA alternatives I and III as extreme outside limits on the set of possible outcomes.

Figure 10-3 Total Fertility Rates for SSA Alternatives and DPM I and III



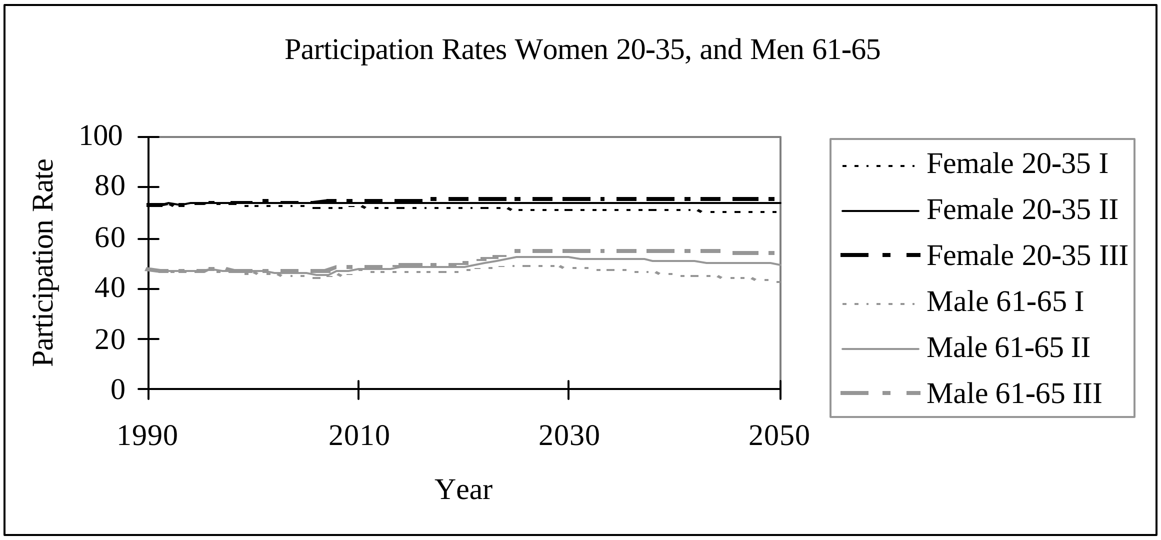
Endogenizing Labor Force Participation

The second set of simulations uses the SSA economic estimates for the three alternatives and the SSA fertility rates. Interestingly, there is very little movement in the SSA assumptions about participation rates. The participation rates for men and women do not move very much with the different alternatives. Table 10-1 showed the SSA estimates for the participation rates of men and women between the ages of 20 and 64. In the year 2050 there is a 1-percentage point difference between the Low cost scenario and the Intermediate scenario for men. Women also had slight differences in the participation rate with the Low cost scenario, with, for example, 2 percentage points more participation in the Low cost alternative and two percentage points less in the High cost alternative.

The important aspect of the SSA estimates of participation is that they are not moving very much. The DPM results using the SSA economic estimates have even smaller differences than the SSA estimates. In point of fact, the three different DPM scenarios have very similar participation profiles. There are two exceptions. The participation profiles for men between the age of 61 and 65 and women between the ages of 20 and 35 have distinctly different participation profiles depending on which alternative is used. Figure 10-4 shows the labor force participation rates for men age 61-65 and women age 20-35 for the three different DPM alternatives. The darker lines are the participation rates for women and the shaded lines are for the men. For both the men and women alternative I is represented as the small dotted line, alternative II is represented by the thin solid line, and alternative III is represented by the heavy broken line. Alternative I, the Low cost scenario, have lower participation for both of these groups of people. Similarly, alternative III has higher participation for both of these groups of people.

Even if there is very little difference between the participation profiles, this pattern of lower participation in the Low cost scenario and higher participation in the High cost scenario is true for all of the participation rates, men age 16-90 and women age 16-90. The SSA estimates have participation rates actually going in the other direction for the different scenarios; the Low cost alternative has higher participation. Like the fertility analysis, the participation analysis suggests that the economics will tend to pull the results back to the Intermediate solution.

Figure 10-4 Labor Force Participation Rates for Women 20-35 Years Old, and Men 61-65 Years Old



Endogenizing both Fertility and Labor Force Participation

The final set of simulations endogenized both the fertility and participation decisions. This simulation allows participation to play a role in the decision that individuals make about fertility and vice versa. The lesson learned in the previous sections suggests that by allowing for more simultaneous behavior the results should show less variation and tend toward the Intermediate results. Indeed this is exactly what happens, although to a more limited extent than expected. The total fertility rate does not change from the results in the first set of simulations, and for the most part, participation rates remained the same as in the second set of simulations. The major difference occurred for participation of 20-35 year old women. By endogenizing fertility, the variation in participation rates of women between the age of 20 and 35 (typically years associated with high fertility rates (see **Figure 9-1**)) is reduced. The participation rates for these women are essentially identical.

Conclusion

This chapter has shown that there are important relationships between economic variables and the fertility and participation rates. Changes in the economy can influence the population by increasing or decreasing fertility. The SSA estimates are shown to have reasonable bounds on the set of outcomes. However, they also fail to allow reasonable interactions between the variables. From a policy perspective, any attempt to change the future outcome of the OASDI Trust funds will rely on changing some policy variable like tax rates or retirement ages. However, how the economy and individuals will react to these changes can only be analyzed in a fully endogenous system. Thus, if these policies are implemented without fully understanding the relationships between the variables, the policy may fail.

Chapter 11 **Policy Simulations and Evaluations**

In this chapter the DPM model is combined with the LIFT model in order to evaluate two policies: (1) changing the Social Security retirement age, and (2) the introduction of the Child Tax Credit enacted in 1997.

The chapter is organized in the following manner. First the Base results from combining the DPM and LIFT models are presented. Second, the effects of changing the age of full eligibility for Old Age and Survivors Insurance (OASI) from age 67 in 2025 to age 67 in 2014 are investigated. Results from a simulation where the federal surplus is allowed to increase and one where the federal surplus relative to GNP is held at the Base levels are presented. Third, the effects of the $500 Child Tax Credit passed in August of 1997 are shown to increase the fertility rate and the population. Like the analysis for the retirement section, a simulation where the surplus is allowed to grow is compared with a simulation where the surplus is held at the Base level. An alternative assumption about the effect of the $500 Child Tax Credit on fertility is also presented.

Introduction and Base Forecast

The previous chapter compared simulation results from DPM with the SSA estimates of population and the economy. The compatibility of the SSA economic estimates with their demographic estimates was analyzed. Thus the results were, of necessity, partial equilibrium, in the sense that the economy was not allowed to adjust. The SSA forecasts were found to provide sufficient bounds over the possible outcomes for the economy. However, the economics of the forecasts suggested that key demographic variables might actually move in the opposite directions from those assumed by the SSA, suggesting that the SSA economic and demographic forecasts are not compatible. In this section, two policies and their impact on the economy and the population are analyzed. This chapter generalizes the previous chapter by providing general equilibrium results.

Both policy analyses start from the Base forecast and iterate between the LIFT model and the DPM model until the two converge. In practice the models converge between two and four iterations. Table 11-1 shows historical and Base forecast population levels and the determinants of population. The forecast uses the life expectancy or age-specific survival rates and immigration assumptions from the Census Bureau middle series, see Day (1996). The table shows some interesting patterns in the history and the forecast. First the population growth rate continues its downward trend from 1.7 in 1960 to 0.3 in the forecast. The main determinants of the decrease in population growth rate are an assumed constant level of immigration at 8.8 million persons every decade, a decreasing fertility rate, and only slightly increasing survival rates. The assumed immigration level of 8.8 million persons every decade is the same as the number of immigrants in the decade ending in 1910. In the decade ending in 1910, unlike the decade ending in 2000, 53% of the increase in the population is associated with immigration. In the Base projection the population is 362 million in 2050, with 8.8 million immigrants in the decade ending in 2050. In contrast to immigration at the turn of the century, immigration makes up 77% of the increase in population. This is primarily because fertility is down substantially in 2050 compared to the turn of the 20th century.

The increases in life expectancies witnessed over the last century continue in the forecast from a life expectancy of 72 years for men and 79 years for women in 1990, to 80 for men and 85 for women in 2050. The increasing life expectancy combined with a decreasing total fertility rate, from just over 2 children per woman to 1.9 children per woman in 2050, means that the population is increasingly dominated by the elderly. Immigrants also increasingly dominate the population

The Base population projections are within the bounds of both the SSA and the Census Bureau population projections. The intermediate SSA projections, Bell (1997), also predict a population of 362 million persons in 2050.[61] The Census Bureau projections, Day (1996), predict 394 million persons in 2050, and have high and low projections of 282 million and 519 million persons.

[61] The Social Security Area projections include civilian residents in Puerto Rico, the Virgin Islands, Guam, American Samoa, Palau, the Northern Mariana Islands, the armed forces and their dependents overseas, Federal civilian employees and their dependents overseas, and other citizens overseas. Thus their population area is larger than those of either the Census Bureau projections or DPM, which predict the resident population. The SSA also adjusts for the Census undercount, and has a slightly higher level of immigration than either the Census projections or DPM. The Census and DPM projections have slightly greater reductions in mortality than the SSA intermediate projections; in 2050 SSA life expectancy at birth for men is 77.5 and for women 82.9. Consequently, while the Base DPM projection results in the same population in 2050 as the SSA intermediate projections, the paths of the projections are different.

Table 11-1 Population History and Base Projections[62]

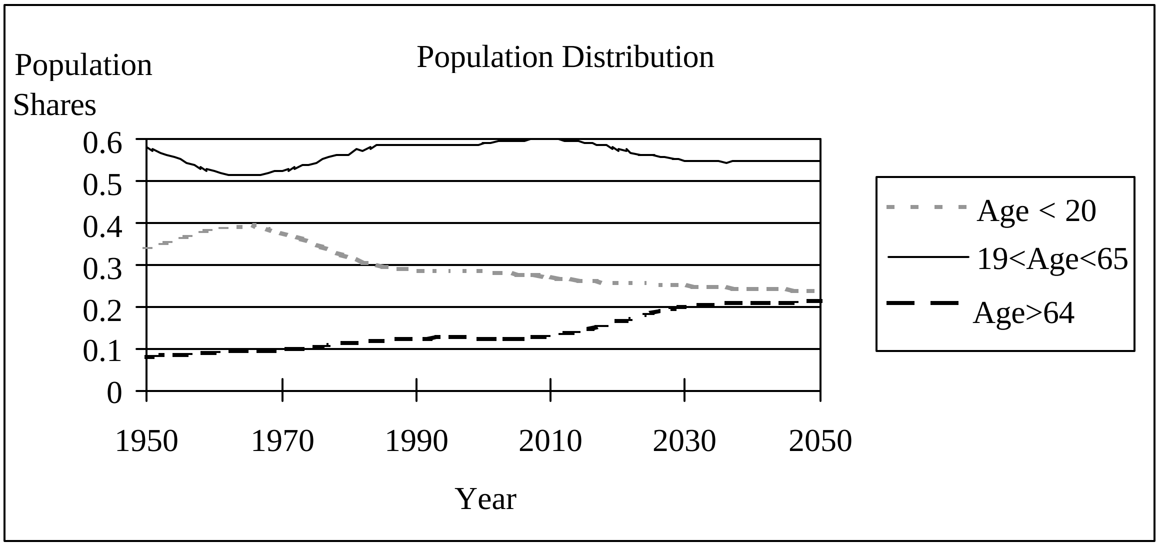
Year	Population Millions	Annual Growth	Total Fertility Rate	Life Expectancy Male	Life Expectancy Female	Immigration Decade Sum	Immigration % Pop. Increase
1850	23.2					1.71	
1860	31.4	3.0				2.6	31.7
1870	38.6	2.0				2.32	32.2
1880	50.2	2.6				2.81	24.2
1890	62.5	2.2				5.25	42.7
1900	75.8	1.9		46.3	48.3	3.69	27.7
1910	92.4	2.0		48.4	51.8	8.80	53.0
1920	106.5	1.4	3263	53.6	54.6	5.74	40.7
1930	123.1	1.5	2533	58.1	61.6	4.11	24.7
1940	132.1	0.7	2229	60.8	65.2	0.53	5.9
1950	152.3	1.4	3090	65.6	71.1	1.04	5.1
1960	180.7	1.7	3650	66.6	73.1	2.52	8.9
1970	205.1	1.3	2480	67.1	74.8	3.32	13.6
1980	227.7	1.0	1840	70.0	77.4	4.49	21.1
1990	249.9	0.9	2081	71.8	78.8	7.34	33.1
2000	275.0	1.0	2046	73.0	79.8	9.86	39.3
2010	296.9	0.8	2006	74.1	80.7	8.80	40.2
2020	318.0	0.7	1975	75.4	81.6	8.80	41.6
2030	336.4	0.6	1955	76.7	82.5	8.80	48.0
2040	350.6	0.4	1923	78.2	83.5	8.80	61.7
2050	362.1	0.3	1883	79.8	84.7	8.80	77.0

The effects increased survival rates and decreased fertility have on the age distribution of the population can be seen in Figure 11-1. The figure clearly shows that the elderly will increasingly dominate the population. The percentage of the population age 65 and older increases from under 10% in 1950 to just over 20% in 2050. Meanwhile the percentage of the population under the age of 20 declines from its peak of nearly 40% in the late 1960's to 24% in 2050. Finally, the percentage of the population between the age of 20 and 64 (those typically

[62] The historical portion of the table is taken from Dowd, Monaco, and Janoska (1998). Total Fertility is the fertility that is prevalent at that date in time for women and so does not represent the fertility that any one-age cohort would be expected to have. The decade sum for

associated with strong labor force attachment) reaches a peak of 60% in 2010 and then slowly declines and stabilizes to roughly 54% in 2030.

Figure 11-1 Percentage of Population: less than 20, between 20 and 64, and 65 and older



As one might suppose, these projections of the changes in the population have important impacts on the economy. Dowd, Monaco, and Janoska (1998) show that the changes in the age distribution, absent the population increases, have important impacts on the distribution of output, jobs, and the productivity of the economy.

The alternative policy simulations that are investigated in this chapter show the changes in the population and the economy that result from implementing two different policies that have their primary effect on either the fertility rate or labor force participation rates. The chapter therefore concentrates on showing deviations in economic and population variables from their

immigration is in millions and the percent of the population increase represents the increase in population attributable to immigration.

Base values. Nevertheless, a brief description of the Base economic forecast is useful.[63] The are a number of important features of the Base economic forecast. First, the federal government increases personal taxes and FICA taxes and holds spending in real terms constant, so that there is an increasing surplus. Second unemployment rates are roughly consistent with the SSA middle series estimates of 6%. GDP starts out growing slowly at 0.8% over the period from 1996 to 2000 and ends by growing at 1.2% between 2030 and 2050. Hourly compensation consistently grows faster than prices, leading to higher levels of real wages.

[63] See appendix B for detailed tables of the Base economic and demographic forecast.

Table 11-2 Base Economic Forecast Summary Table

Growth Rates %	1996-2000	2000-2010	2010-2015	2015-2020	2020-2030	2030-2040	2040-2050
Potential GNP	1.4	1.7	1.6	1.4	1.3	1.3	1.3
Gross Domestic Product	0.8	1.7	1.5	1.3	1.3	1.2	1.2
Components							
Personal consumption	0.3	1.1	1.3	1.1	1.3	1.3	1.3
Fixed investment	2.1	3.3	2.4	2.3	2.3	2.0	2.0
Exports	2.5	3.4	2.4	1.7	1.0	0.8	0.7
Imports	1.7	2.5	1.9	1.4	1.5	1.6	1.7
Federal government	0.0	0.0	0.0	0.0	0.0	0.0	0.0
State & local gov.	1.5	1.2	0.6	0.7	0.7	0.6	0.5
Price Level and Inflation Indicators							
GNP deflator	2.3	3.0	3.0	3.2	3.1	3.0	3.0
PCE deflator	2.8	3.4	3.3	3.5	3.3	3.1	3.0
Avg Hourly compensation	3.4	3.7	3.9	4.0	3.9	3.8	3.8
Private Labor Productivity	0.9	1.1	1.0	1.1	1.0	1.0	1.0
M2	3.8	4.2	4.4	4.2	4.1	4.0	4.0
Real disposable income	-0.1	1.3	1.4	1.1	1.3	1.3	1.3
Federal surplus	0.0	7.4	6.2	6.5	4.5	2.6	3.7
Employment Indicators							
Total jobs	0.1	0.8	0.5	0.3	0.4	0.3	0.2
Labor force	0.3	0.8	0.5	0.3	0.3	0.3	0.3
Actual Levels	2000	2010	2015	2020	2030	2040	2050
Unemployment rate, %	5.2	6.1	5.9	6.0	5.8	5.9	6.0
Three month T-bills, %	4.4	5.6	5.7	5.8	5.8	5.9	5.9
Exchange rate US$/Foreign	1.0	1.0	1.1	1.1	1.1	1.2	1.2
Savings rate, pct	2.9	4.3	4.4	4.4	4.5	4.5	4.0
Ratio Surplus to GNP	0.9	1.2	1.3	1.4	1.4	1.2	1.2
Population, total (in millions)	275.0	296.9	307.6	318.0	336.4	350.6	362.0
Total Fertility Rate	2046.3	2006.4	1997.2	1975.1	1954.6	1923.3	1883.3
Working Age Population (16-85)	203.5	222.9	232.3	241.0	255.1	263.6	270.3
Civilian Labor Force (millions)	135.5	146.7	150.2	152.5	157.7	162.5	166.7
Labor Force Participation Rates							
Teenagers, 16-19	48.4	47.6	47.7	47.5	47.5	47.2	46.9
Men, 20-64	86.3	84.6	84.0	83.6	84.5	84.2	83.5
Women, 20-64	70.7	69.6	69.3	69.4	70.5	70.3	69.8
Men, 65-84	17.7	20.3	21.3	21.8	22.1	20.4	20.8
Women, 65-84	8.6	10.5	11.4	11.8	12.6	11.4	11.9

Retirement Eligibility Simulations

The Base forecast implements the legislated increases in the full eligibility retirement ages from age 65 in 2002 to age 66 in 2008 and from age 66 in 2019 to age 67 in 2025. These changes are implemented in the following manner. First the population of 65-year-old eligible Old Age and Survivors Insurance (OASI) recipients is decreased by 1/6 each year between 2002 and 2008. Similarly, the population of eligible 66-year-olds is decreased by 1/6 each year between 2019 and 2025. Second, the calculated participation rates of 66-year-olds in 2008 are assumed to be like the participation rates of 65-year-olds, and the participation of 65-year-olds is assumed to be like those of 64 year olds. In other words participation rates are calculated for 65 year olds and then the participation rates for 66 year olds are set to be what the participation would be for 65 year olds absent the legislated increases. A similar procedure is implemented in 2025 so that the participation rates of 67-year-olds in 2025 are assumed to be like those of 65 year olds in the absence of the legislated changes in eligibility. In the transition years, the participation rates are moved by 1/6 towards the final age participation; the participation of 66 year olds in 2002 is the participation of 66 year olds, participation of 66 year olds in 2003 is equal to 5/6 the participation of 66 year olds and 1/6 the participation of 65 year olds, and so on. Thus the equations for the participation rates of these age groups are becoming the equations of younger ages, leading to increasing participation for these age groups. Table 11-2 shows that the participation rates for women 65-84 years old increases from 8.6% in 2000 to 11.9% in 2050. Similarly, the participation rates for men 65-84 years old increases from 17.7% in 2000 to 20.8% in 2050.

This research investigates the effect of moving the full eligibility status of the OASI programs from age 66 in 2014 to age 67 in 2014 and thereafter (RET67 alternative). In essence the increases in eligibility age in the Base are moved 11 years earlier. This makes the transition period a continuous transition from 65 years of age for full eligibility in 2002 to 67 years of age in 2014. The increases in the age for full eligibility were initially implemented in order to help the solvency of the OASDI trust funds. The SSA predicts that the trust funds will become insolvent sometime during the decade ending in 2030.[64] The SSA does not assume that participation will increase as a result of the increased age at which individuals become eligible. The research presented here implicitly assumes that the individuals will increase their participation so that 67-year-olds in 2014 will look like 65 year olds in the absence of a change. These are the two extreme points on the possible set of outcomes; one can imagine an infinite set of outcomes for the participation rates of those approaching their retirement years. The difficulty with implementing this is that there has never been an increase in the eligibility age and therefore there is no empirical evidence on the reactions of individuals. Nevertheless, assuming no change in the participation rates yet reducing the cost of the program is untenable.

Table 11-3 shows effects of the change in the eligibility age on the economy. The table shows the increase in participation of men and women 65-84 years of age. The largest increase occurs in 2015 with a 2.3 percentage point increase in the participation of male and female 65-84 year olds. The effect on participation rates of moving the increase in eligibility age to the year 2014 is gone by the year 2030. However, it does not disappear from the economy. While the increase in participation rates peaked in 2015, the increase in the level of the economy does not peak until 2050 when GDP is 0.7% larger than in the Base. This increase in the size of the

[64] See Board of Trustees, Federal Old Age and Survivors Insurance and Disability Insurance Trust Funds (1997).

economy lags well behind the increase in potential GNP which peaks in 2015 at 0.7% larger than the Base. Because potential GNP grows faster than actual GDP, the unemployment rate is initially higher than the Base but eventually is lower than the Base. Another important result is that the price level of consumer goods, the PCE deflator, is 1.3% higher in the alternative and that average hourly compensation is up less than the increases in prices, resulting in a decrease in real wages.

The impetus for increasing the eligibility age is to improve the outlook of the social insurance trust funds. The move to 2014 has a whopping effect. The federal surplus increases by 27.2 percent in 2015 and by 23% in 2050. There are important feedback results of the increase in the federal surplus. First, the increase in the federal surplus puts downward pressure on interest rates. The three-month T-bill is reduced by 10 basis points in the years 2010 through 2030. The reductions in the interest rate and the increases in inflation put upward pressure on the exchange rate, up 4.3% in 2050. The increases in the exchange rate (reductions in the value of the U.S. dollar) make U.S. products more competitive, resulting in increases in exports; exports are up 2.6% in 2050.

Other interesting results are that the increase in the unemployment rate and the decrease in the real value of wages negatively affect the participation rates of teenagers.

Table 11-3 Macro-economic Summary for Retirement Age 67 in 2014 Simulation RET67

percentage deviations from Base	2010	2015	2020	2030	2040	2050
Potential GNP	0.0	0.3	0.7	0.3	0.3	0.4
Gross Domestic Product	-0.1	0.0	0.6	0.4	0.5	0.7
Components						
Personal consumption	-0.2	-0.4	0.0	-0.4	-0.5	-0.6
Fixed investment	0.0	0.2	0.6	-0.1	-0.1	-0.1
Exports	0.1	0.4	1.3	1.9	2.2	2.6
Imports	-0.3	-0.6	-0.8	-1.5	-1.8	-2.3
Price Level and Inflation Indicators						
PCE deflator	0.1	0.2	0.4	0.6	1.0	1.3
Avg Hourly compensation	0.0	0.1	0.1	0.3	0.8	0.9
Private Labor Productivity	0.0	0.1	0.1	0.2	0.2	0.3
Exchange rate scalar	0.3	1.0	1.9	2.6	3.5	4.3
Real disposable income	-0.4	-0.7	-0.2	-0.3	-0.3	-0.4
Federal surplus, bil $	11.9	27.2	20.1	11.7	18.9	22.8
Total jobs, mil	0.0	0.2	0.6	0.2	0.2	0.3
Labor force, mil	0.2	0.8	0.9	0.0	0.0	0.0
Deviations From Base						
Ratio Surplus to GNP	0.1	0.4	0.3	0.2	0.2	0.2
Three month T-bills, %	-0.1	-0.1	-0.1	0.1	0.1	0.0
Savings rate, pct	-0.1	-0.3	-0.1	0.1	0.2	0.2
Total Fertility Rate	-0.2	-0.3	-0.1	0.1	0.1	0.2
Unemployment rate, %	0.2	0.5	0.2	-0.1	-0.2	-0.2
Civilian Labor Force						
Teenagers 16-19	-0.3	-0.9	-0.4	0.1	0.2	0.2
Men, 20-64	0.1	0.3	0.4	0.0	0.0	0.1
Women, 20-64	0.1	0.3	0.3	0.0	0.0	0.0
Men, 65-84	2.5	10.7	8.8	-0.1	0.0	0.0
Women, 65-84	5.2	20.3	18.2	0.4	-0.1	-0.1
Labor Force Participation Rates						
Teenagers, 16-19	-0.1	-0.4	-0.2	0.1	0.1	0.1
Men, 20-64	0.1	0.2	0.3	0.0	0.0	0.1
Women, 20-64	0.1	0.2	0.2	0.0	0.1	0.0
Men, 65-84	0.5	2.3	1.9	0.0	0.0	0.0
Women, 65-84	0.6	2.3	2.1	0.1	0.0	0.0

Table 11-4 shows the percentage deviations from Base values of the federal government receipts and expenditures. Receipts are initially down by 0.2 and 0.1 percent in 2010 and 2015, but then are up in 2020 and 2030 by 0.5%. At the same time that receipts are down, total expenditures are down by more than the reduction in receipts, resulting in an increase in the surplus.[65] While transfer payments to Old Age Beneficiaries is down 7%, the lion's share of the reductions is in net interest paid, down 50% in 2020. These positive effects come at a cost. The increased unemployment results in increases in the number of recipients of unemployment insurance; benefits are up by 14.3% in 2015.

[65] The base forecast projects the government becoming a net creditor by 2030. This is the result of fixed federal spending and increasing taxes. Thus, the sign reversal in net interest payments reflects the changing position of the federal government from a net debtor to a net creditor. While this is unrealistic, we are interested in shock from base results.

Table 11-4 Government Expenditures and Receipts, Retirement Age 67 in 2014 Simulation RET67

percentage deviations from Base	2010	2015	2020	2030	2040	2050
RECEIPTS	-0.2	-0.1	0.5	0.5	1.0	1.2
Personal tax and non-tax receipts	-0.3	-0.5	0.2	0.3	0.7	1.0
Corporate profits tax	-0.1	-0.5	-0.2	0.3	0.7	1.1
Indirect business tax and nontax	-0.1	0.2	0.8	0.7	1.1	1.4
Contributions for social insurance	-0.1	0.2	0.8	0.6	1.2	1.4
EXPENDITURES	-0.9	-1.8	-0.8	-0.2	0.1	0.2
Purchases of Goods and Services	0.0	0.2	0.3	0.5	0.9	1.1
National defense	0.0	0.2	0.3	0.5	1.0	1.2
Compensation of employees	0.0	0.1	0.1	0.3	0.8	0.9
Other	0.1	0.3	0.5	0.7	1.2	1.5
Nondefense	0.0	0.1	0.2	0.4	0.9	1.1
Compensation of employees	0.0	0.1	0.1	0.3	0.7	0.9
Other	0.0	0.1	0.2	0.5	1.0	1.2
Transfer Payments	-1.4	-2.6	-0.5	0.5	0.9	1.2
To persons	-1.4	-2.6	-0.5	0.5	0.9	1.2
Old age benefits	-3.6	-7.0	-2.1	0.6	1.0	1.3
Hospital & medical	-0.1	0.1	0.6	0.6	1.0	1.4
Unemployment	5.6	14.3	6.6	-2.9	-3.5	-4.1
Retirement: Fed civ & RR	0.0	0.2	0.4	0.6	1.0	1.3
Vet life insur,workmen comp.	0.1	0.2	0.3	0.6	1.0	1.3
Military retirement	0.0	0.0	0.0	0.0	0.0	0.0
Veterans benefits	0.0	0.0	0.0	0.0	0.0	0.0
Food stamps	1.3	3.2	1.8	-0.8	-0.5	-0.4
Other	0.1	0.2	0.4	0.6	1.0	1.3
To foreigners	0.0	0.0	0.5	0.5	1.0	1.2
Grants-in-Aid to S&L Govt	0.0	0.1	0.2	0.2	0.4	0.6
Net Interest Paid	-2.4	-11.8	-49.3	39.6	23.8	22.0
Surplus or Deficit (-), NIPA	11.9	27.2	20.1	11.7	18.9	22.8
Social insurance funds	4.1	9.8	6.5	3.4	4.3	4.2
Other funds	0.2	0.9	-0.3	0.0	-0.2	-1.3
Debt of Federal Government	-1.3	-9.4	-40.7	43.6	24.2	22.6
Fed Spending, % of GDP	-0.8	-1.9	-1.4	-0.8	-1.0	-1.1
Fed Receipts, % of GDP	-0.1	-0.2	-0.2	-0.1	-0.1	-0.1

Figure 11-2 shows the effect of changing the retirement age on the solvency ratio. The solvency ratio is defined as the ratio of the fund to annual expenditures. Thus, increasing the retirement age affects both the annual expenditures and value of the fund. The figure shows the absolute value of the difference between the solvency ratio in the retirement alternative and the base forecast. The increase in age of eligibility has its most significant impact in 2016 where the solvency ratio is increased by 1. In other words, in 2016 there is an increase in the size of the fund relative to the amount paid out.

Figure 11-2 Change in Solvency Ratio under RET67[66]

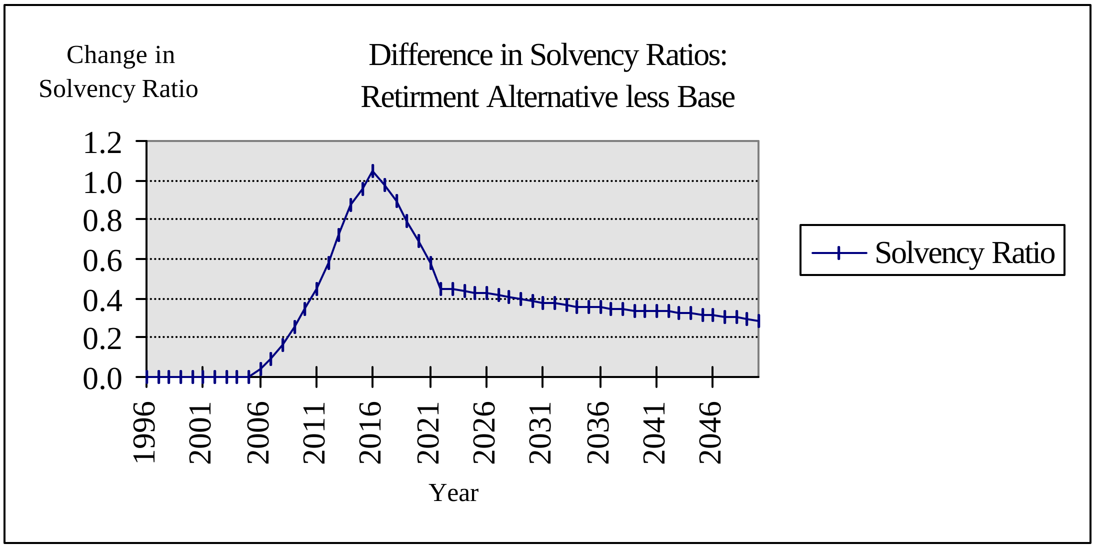


Table 11-5 shows the percentage deviations in output for aggregate industries. The sectors with the largest increases in output are mining, and non-durables and durables manufacturing. Mining output is up 1.6% in 2050 and manufacturing is up 1.8% in 2050. Since these three sectors are associated with high levels of exports it is not surprising that with the higher levels of exports, under the alternative retirement age that we see these sectors growing the fastest.

[66] The value of the OASDI trust funds is calculated assuming administrative costs are a constant 1% of benefits, and that net interest payments are distributed by the ratio of OASDI trust funds to total trust funds. See Dowd and Monaco (1995) for a more detailed description of the calculation.

Table 11-5 Output by Aggregate Industry Retirement Age 67 in 2014 Simulation RET67

Percentage Deviations from Base	2010	2015	2020	2030	2040	2050
Total Output	-0.1	0.1	0.7	0.6	0.7	0.9
Agriculture,forestry,fishery	-0.1	-0.1	0.3	0.3	0.3	0.4
Mining	-0.1	0.1	1.1	1.1	1.3	1.6
Construction	-0.1	0.1	0.7	0.1	0.2	0.3
Nondurables manufacturing	-0.1	0.1	1.0	1.1	1.4	1.8
Durables manufacturing	0.0	0.4	1.5	1.4	1.6	1.9
Transportation	-0.1	0.0	0.7	0.5	0.6	0.7
Utilities	-0.1	0.0	0.5	0.4	0.5	0.6
Trade	-0.2	-0.1	0.4	0.1	0.1	0.1
Finance, insurance, real estate	-0.2	-0.2	0.3	0.0	0.0	0.1
Services, nonmedical	-0.2	-0.1	0.4	0.1	0.1	0.1
Medical Services	-0.1	-0.2	0.2	0.2	0.6	1.1
Miscellaneous	0.2	0.4	0.2	-0.1	-0.1	0.0

These changes in the distribution of output have an impact on the distribution of jobs in the economy. Table 11-6 shows the percentage deviations from the Base levels of jobs by aggregate industries. As expected, mining and the two manufacturing sectors have the largest increases in jobs.

Table 11-6 Jobs by Aggregate Industry Retirement Age 67 in 2014 Simulation RET67

percentage deviations from Base	2010	2015	2020	2030	2040	2050
Civilian jobs	0.0	0.2	0.6	0.2	0.2	0.3
Private sector jobs	0.0	0.3	0.8	0.2	0.2	0.3
Agriculture, forestry, fishery	0.0	0.2	0.5	0.3	0.3	0.4
Mining	0.0	0.3	1.2	1.0	1.2	1.5
Construction	0.1	0.4	0.8	0.0	0.1	0.2
Nondurables manufacturing	0.0	0.2	0.9	1.0	1.1	1.4
Durables manufacturing	0.1	0.6	1.5	1.4	1.7	2.1
Transportation	0.0	0.3	1.0	0.5	0.6	0.7
Utilities	-0.1	0.1	0.5	0.4	0.5	0.8
Trade	-0.1	0.1	0.6	-0.2	-0.3	-0.3
Finance, insurance, real estate	-0.1	0.0	0.6	0.1	0.1	0.2
Services, nonmedical	0.0	0.4	0.8	0.0	0.0	0.0
Medical services	0.0	0.3	0.5	0.1	0.6	1.1

The previous simulation assumes that the policy makers are unconcerned with the consequences on the federal surplus. An alternative assumption is that the policy makers want to hold the surplus constant at the Base levels (RETCON). The next set of Tables show the results of implementing a Surplus neutral policy holding the surplus at the Base levels by decreasing the overall personal tax rate. Table 11-7 shows the results of this simulation on the macro-economy. The Ratio of the Surplus to GNP is set so that there is no change from the Base - values of 0.0 and -0.1. The reduction in the surplus results in no difference in the interest rates from the Base. This results in very little change in the exchange rate; in fact there is a slight decline in 2050, compared to the 4.3% increase in the RET67 simulation. Potential GNP is roughly the same as in the RET67 alternative until about 2020, at which point the surplus neutral alternative looks like the Base. Real disposable income under the RETCON simulation is up by 0.1% in 2050 compared to a 0.4% decline in the RET67 simulation. The slight increase in disposable income results in a somewhat smaller labor force; the civilian labor force of men 20-

64 is up 0.4% in the RET67 simulation compared with a 0.3% increase in the RETCON simulation.

Table 11-7 Macro-economic Summary for Surplus-Neutral Retirement Age 67 in 2014 Simulation RETCON

Percentage Deviations from Base	2010	2015	2020	2030	2040	2050
Potential GNP, bil 77$	0.0	0.3	0.6	0.1	0.0	0.0
Gross Domestic Product, bil 77$	0.0	0.1	0.4	0.1	0.1	0.0
Components of GDP						
Personal consumption	-0.1	0.1	0.4	0.0	0.0	0.1
Fixed investment	0.1	0.2	0.4	-0.1	-0.1	-0.1
Exports	0.1	0.1	0.3	0.4	0.2	-0.1
Imports	-0.1	0.0	0.1	-0.3	-0.1	0.2
Price Level and Inflation Indicators						
PCE deflator (77=100)	0.0	0.1	0.0	0.0	0.0	0.0
Avg Hourly compensation	0.0	0.0	0.0	0.1	0.1	0.0
Private Labor Productivity	0.0	0.0	0.0	0.0	0.0	0.0
Exchange rate scalar	0.2	0.3	0.5	0.5	0.2	-0.3
Real disposable income	-0.1	-0.1	0.2	0.0	0.1	0.1
Federal surplus, bil $	2.2	4.0	2.2	-2.2	-8.2	-12.3
Employment Indicators						
Total jobs, mil	0.1	0.4	0.6	0.0	0.0	0.0
Labor force, mil	0.2	0.8	0.9	0.0	0.0	0.0
Deviations from Base Values						
Three month T-bills, %	0.0	0.0	0.0	0.0	0.0	0.0
Savings rate, pct	0.0	-0.1	-0.1	0.0	0.0	0.0
Ratio Surplus to GNP	0.0	0.0	0.0	0.0	-0.1	-0.1
Total Fertility Rate	-3.1	-6.9	-1.7	2.1	1.0	2.9
Unemployment rate, %	0.1	0.4	0.2	0.0	0.0	0.0
Civilian Labor Force						
Teenagers, 16-19	0.0	-0.1	0.0	0.0	0.0	0.0
Men, 20-64	0.1	0.2	0.3	0.0	0.0	0.0
Women, 20-64	0.1	0.2	0.2	0.0	0.0	0.0
Men, 65-84	0.1	0.4	0.4	0.0	0.0	0.0
Women, 65-84	0.1	0.5	0.5	0.0	0.0	0.0
Labor Force Participation Rates						
Teenagers, 16-19	-0.1	-0.4	-0.2	0.1	0.1	0.1
Men, 20-64	0.1	0.2	0.3	0.0	0.0	0.1
Women, 20-64	0.1	0.2	0.2	0.0	0.1	0.0
Men, 65-84	0.5	2.3	1.9	0.0	0.0	0.0
Women, 65-84	0.6	2.3	2.1	0.1	0.0	0.0

The effects on government expenditures and receipts are shown in Table 11-8. Total receipts are down compared to both the Base and the RET67 alternative. While total receipts are lower in the RETCON, expenditures are very similar to the RET67 alternative. The one important exception is that net interest paid is much flatter in the RETCON alternative than in RET67. In RET67 there are substantial decreases in the net interest paid by the federal government in the early years of the forecast. Alternatively, the flat interest rate in RETCON results in little change in the level of net interest paid. Finally, and perhaps most importantly, the reduced number of recipients for the OAS insurance results in increases in the trust funds. In either scenario, the trust funds are up by roughly 5% in 2050.

Table 11-8 Government Expenditures and Receipts Retirement Age 67 in 2014 Surplus Neutral Simulation

	2010	2015	2020	2030	2040	2050
RECEIPTS	-0.7	-1.3	-0.4	-0.1	-0.3	-0.3
Personal tax and non-tax receipts	-1.9	-4.0	-1.9	-0.6	-1.2	-1.1
Corporate profits tax	0.0	-0.4	-0.4	-0.1	-0.1	-0.1
Indirect business tax and nontax	0.0	0.3	0.6	0.1	0.1	0.1
Contributions for social insurance	0.0	0.2	0.5	0.1	0.1	0.0
EXPENDITURES	-0.8	-1.7	-0.6	0.0	0.1	0.2
Purchases of Goods and Services	0.0	0.0	0.0	0.1	0.1	0.0
National defense	0.0	0.0	0.0	0.1	0.1	0.0
Compensation of employees	0.0	0.0	0.0	0.0	0.1	0.0
Other	0.0	0.1	0.1	0.1	0.1	0.0
Nondefense	0.0	0.0	0.0	0.1	0.1	0.0
Compensation of employees	0.0	0.0	0.0	0.0	0.1	0.0
Other	0.0	0.0	0.0	0.1	0.0	0.0
Transfer Payments	-1.4	-2.8	-0.8	0.0	0.0	0.0
To persons	-1.5	-2.8	-0.8	0.1	0.0	0.0
Old age benefits	-3.6	-7.1	-2.5	0.1	0.0	0.0
Hospital & medical	0.0	0.2	0.4	0.1	0.1	0.0
Unemployment	3.4	10.3	6.8	-0.3	-0.5	0.5
Retirement: Fed civ & RR	0.0	0.1	0.0	0.1	0.0	0.0
Vet life insur,workmen comp.	0.0	0.1	0.0	0.1	0.0	0.0
Military retirement	0.0	0.0	0.0	0.0	0.0	0.0
Veterans benefits	0.0	0.0	0.0	0.0	0.0	0.0
Food stamps	1.0	2.9	2.3	-0.1	0.1	0.2
Other	0.0	0.1	0.0	0.1	0.0	0.0
To foreigners	0.0	0.0	0.2	-0.1	-0.1	-0.2
Grants-in-Aid to S&L Govt	0.0	0.0	0.0	0.0	0.0	0.0
Net Interest Paid	-1.0	-2.4	-8.7	3.1	-1.8	-5.3
Interest paid	-0.9	-2.1	-6.3	3.7	-2.0	-5.5
To persons & business	-0.9	-2.1	-6.3	3.7	-2.0	-5.5
To foreigners	-0.9	-2.1	-6.3	3.7	-2.0	-5.5
Interest received	-0.1	-0.1	0.0	0.3	0.4	0.6
Subsidies less Current Surplus	0.0	0.1	0.0	0.0	0.0	0.1
Surplus or Deficit (-), NIPA	2.2	4.0	2.2	-2.2	-8.2	-12.3
Social insurance funds	5.1	11.9	7.7	4.0	4.8	5.7
Other funds	6.6	15.9	10.4	6.5	8.9	11.1
Debt of Federal Government	-0.7	-1.9	-6.8	3.0	-2.5	-6.0
Fed Spending, % of GDP	-0.8	-1.8	-1.0	-0.1	0.0	0.2
Fed Receipts, % of GDP	-0.7	-1.5	-0.8	-0.2	-0.4	-0.4

As we would expect, the very small changes in the economy in the RETCON simulation combined with the flat exchange rate result in very little change in the distribution of output or jobs. Table 11-9 and Table 11-10 show the percentage deviations from the Base values for output and jobs, respectively. In contrast to the RET67 alternative, there is very little change in Total output or its components. Similarly, the lack of changes in the distribution of output result in very small changes in the distribution of jobs.

Table 11-9 Output by Aggregate Industry Retirement Age 67 in 2014 Surplus Neutral Simulation

percentage deviations from Base	2010	2015	2020	2030	2040	2050
Total Output	0.0	0.2	0.5	0.1	0.1	0.0
Agriculture,forestry,fishery	0.0	0.0	0.2	0.1	0.1	0.0
Mining	0.0	0.2	0.5	0.2	0.2	-0.1
Construction	0.1	0.2	0.4	-0.1	0.0	-0.1
Nondurables manufacturing	0.0	0.2	0.5	0.2	0.2	-0.1
Durables manufacturing	0.1	0.3	0.6	0.2	0.1	-0.1
Transportation	0.0	0.1	0.5	0.1	0.1	0.0
Utilities	0.0	0.1	0.4	0.1	0.1	0.0
Trade	0.0	0.1	0.5	0.0	0.0	0.0
Finance, insurance, real estate	0.0	0.1	0.4	0.0	0.1	0.0
Services, nonmedical	0.0	0.2	0.5	0.1	0.1	0.0
Medical Services	0.0	0.0	0.2	-0.2	0.0	0.0
Miscellaneous	0.0	0.0	0.0	-0.2	-0.3	-0.2

Table 11-10 Jobs by Aggregate Industry Retirement Age 67 in 2014 Surplus Neutral Simulation

Percentage Deviations from Base	2010	2015	2020	2030	2040	2050
Civilian jobs	0.1	0.4	0.6	0.0	0.0	0.0
Private sector jobs	0.1	0.5	0.8	0.0	0.0	0.0
Agriculture, forestry, fishery	0.1	0.3	0.4	0.1	0.1	0.0
Mining	0.1	0.3	0.6	0.2	0.1	-0.1
Construction	0.2	0.4	0.6	-0.1	-0.1	-0.1
Nondurables manufacturing	0.0	0.2	0.5	0.2	0.1	0.0
Durables manufacturing	0.1	0.4	0.7	0.3	0.1	-0.1
Transportation	0.1	0.5	0.8	0.1	0.1	0.0
Utilities	0.0	0.2	0.4	0.1	0.1	0.0
Trade	0.1	0.5	0.8	0.0	0.0	0.1
Finance, insurance, real estate	0.1	0.3	0.6	0.1	0.1	0.1
Services, nonmedical	0.1	0.6	0.9	0.0	0.0	0.0
Medical services	0.1	0.4	0.6	-0.2	0.0	0.0
Civilian Government	0.0	0.0	-0.1	0.0	0.0	0.0

In sum, the effect of moving forward the age 67 retirement eligibility date to 2014 is to increase the level of growth in the economy, and to either reduce interest rates or tax rates. The effect on the distribution of jobs is dependent on whether or not the policy is surplus/deficit neutral. If the policy is surplus-neutral it will raise disposable income by reducing taxes. If it is not surplus-neutral it will reduce interest rates, and increase exports. Finally, there are important gains made in the solvency of the Social Insurance Trust Funds. In both RET67 simulation and the RETCON simulation the Social Insurance Trust Funds are better off with an eligibility age of 67 in 2014. Specifically, the trust fund solvency rates are increased by one year's worth of expenditures in 2016.

$500 Child Tax Credit

The previous section explored the effects of a policy change aimed at labor force participation of persons in their 60’s. This section will explore the effect of a policy that has its first impact on fertility. In August 1997, the U.S. Congress passed H.R. 2014, "Revenue Reconciliation Act of 1997"[67]. The tax revision had an important family tax relief section. The tax relief is aimed at families with children and provides a non-refundable tax credit in the amount of $500 for each child under the age of 13 in 1997, and under the age of 18 for 1998 and after. The credit is available to all taxpayers with a dependent child who are married filing jointly and have income less than $110,000. Alternatively, if they are single they must have a dependent child and income less than $75,000. Chapter 3 claimed that the $500 Child Tax Credit using the smallest estimated elasticity for EITC, those from the pooled estimates, would result in a 10% increase in fertility if parents reacted to the Child Tax Credit in a similar manner. This section explores the effects of the $500 Child Tax Credit using DPM in a general equilibrium model. The model uses the parameter estimates from the 1990 full estimate of the effect of the Earned Income Tax Credit on fertility Table 9-6; elasticity of 0.027 compared with 0.014.

As previously shown in chapter 3, the Earned Income Tax Credit (EITC) has a positive effect on the probability of observing a birth. Briefly, the EITC is a refundable credit to working parents. Because the credit is only available for persons with a child (this was the law until 1993) the credit acts like a subsidy to the cost of having a child. Similarly, as a prerequisite to receive the $500 child credit is that a child must be present in the home. This analysis explores the effects of the $500 Child Tax Credit (CTC) on fertility and the economy.

[67] See U.S. Congress, 105-1, H.R. 2014, August 1997.

The analysis starts from the assumption that the effects of the CTC on fertility will be similar to those of the EITC. The EITC and the CTC both require the presence of a child, and taxpayers must file a tax return in order to receive either credit. The EITC is refundable and targeted at the working poor, while the CTC is non-refundable and available to almost all taxpayers with children - in 1990 90% of all children were living in households that had incomes below the (1997 $) income cutoff.[68] Thus, while the EITC and the CTC have differences, they are alike in one important feature, they both make a direct link between the number of dependents and the value of the credit. It is important to illuminate the differences. Compared to the EITC, the CTC has a larger and wealthier eligible population, the CTC is a smaller dollar value than the maximum amount of the EITC, and finally the CTC is non-refundable. These differences suggest that the effect of the CTC will be different from that of the EITC. Nevertheless, the CTC acts as a subsidy to the cost of having a child, and therefore, should increase fertility.[69]

In order to implement the policy in DPM, first the value of the credit, $500, was reduced by 10% to reflect the fact that 10% of the children are not eligible. Second, the value of the credit is deflated to 1989 dollars; the estimation and model equations are all in 1989 dollars. Third, the value of the credit is multiplied by the parameter estimate for EITC, 0.000622. The

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[68] The income cutoff levels were deflated to 1990 dollars, and then a gross comparison of the total number of children in the IPUMS 1990 sample compared with those below the income cutoff was used to calculate the 90% child eligibility.

[69] It is worthwhile noting that while the CTC should have an impact on fertility from a theoretical perspective, it may very well not. Recall the analysis of the value of state tax exemptions in chapter 3, the value of state tax exemptions should have a positive effect on fertility, which showed that there was no effect. Additionally, the EITC transfers a considerable sum of money in percentage terms to the beneficiaries. The effect that the CTC will have on wealthier persons is debatable.

resulting value is added into the Logit equation to come up with the new fertility rate. Fourth, the increase in income associated with the credit could have an impact on participation decisions. Therefore, the average number of children multiplied by the value of the credit in thousands of dollars and the parameter on income for participation is added to the participation equation; the equation for women is (number of children)*($347.66)/1000)*(-0.00664). Finally, the model is run with the policy having an impact on fertility starting in 1998, and participation starting in 1997. Since the CTC was passed in August of 1997 and there is a 9-month gestation period, fertility for 1997 is unaffected. Fertility for 1998 however, can be affected starting around July. Therefore, for 1998 the effect is half of the effect that would be seen if the CTC were passed in March of 1997. Finally, in order to reduce government receipts, the value of the credit relative to personal income is used to reduce the amount of personal taxes paid.

Figure 11-3 shows the resulting age specific fertility rates in the CTC simulation compared to the Base. Under both the Base and the CTC simulations the fertility rates in 2050 have similar appearances. They both have a double peak, one occurring in the early 20's and the other occurring in the late 20's. The increase resulting from the CTC is most noticeable in the early 20's where the age-specific fertility rates climb above 12%.

Figure 11-3 Age Specific Fertility Rates in 2050 for the Base and the $500 Child Credit Forecast

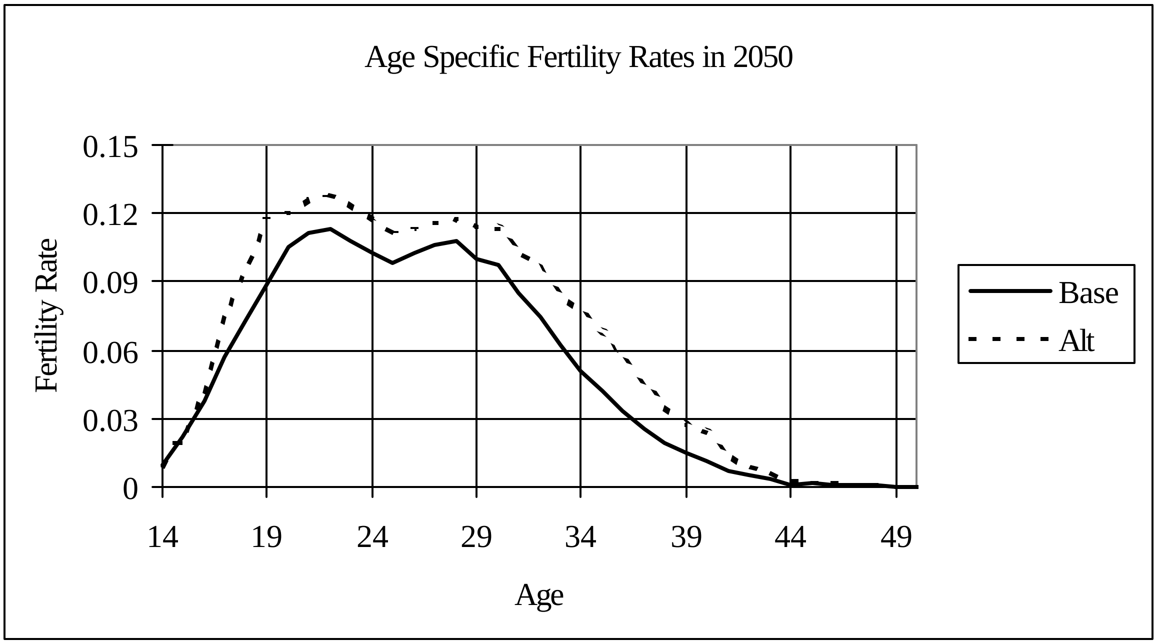


Table 11-11 shows a summary of the population that results from the general equilibrium simulation of the CTC. As can be seen in Figure 11-3 above, the Total Fertility Rate (TFR) increases substantially. At the turn of the century the TFR increase due to the CTC is 22%. The increase slowly increases over the forecast period until 2050 where the TFR is 23% greater as a result of the CTC. These increases are well above the prediction in chapter 3 of a 10% increase in fertility. This is primarily because the prediction in chapter 3 used a parameter estimate with half of the elasticity of those used in the DPM model. Nevertheless, the 23% increase in fertility in 2050 is very large. The difference between the SSA low cost TFR and the intermediate TFR is 16%, while the difference between the low cost and the high cost is 32%. The Census Bureau projections for TFR assume an intermediate level of 2245 with a low and high projection 15% different from the intermediate.[70] While these projections are not really comparable to the general equilibrium results obtained with DPM from the CTC, they do provide some information about the variability in fertility projections.

The increases in fertility have predictable effects on the population. Population is up 0.8% in 2000, and 23% in 2050. The increases are initially only in the younger population but then as the population ages, they filter into the older age groups until in 2050 the number of 50-64 year olds is up by 3.1%. The effect of the CTC becomes exponential in 2015 as the number of women in their childbearing ages increases. This compounding of the effects results in an increase of 58% in the population of 0-4 year olds in 2050. Thus there are large changes in the age distribution of the population. One immediate impact this has is that the percentage of the population in their working age years, aged 16-85, increases by 15.4% in 2050. The increase is obviously centered more on the younger workers.

[70] See Bell (1997) and Day (1996).

Table 11-11 Population and Labor Force Summary for $500 Child Tax Credit Simulation (CTC)

Percentage Deviations from Base Values	2000	2010	2015	2020	2030	2040	2050
Total Fertility Rate	21.9	21.9	22.1	22.6	22.8	22.6	23.1
Population, total (in millions)	0.8	3.6	4.9	6.5	10.6	15.6	21.4
0-4 years	10.6	21.8	21.8	26.4	39.4	47.9	57.8
5-14 years	0.0	16.5	21.9	21.2	29.1	40.9	48.8
15-19 years	0.0	0.0	10.1	22.0	20.6	31.5	41.9
20-29 years	0.0	0.0	0.0	4.8	20.4	22.0	33.3
30-39 years	0.0	0.0	0.0	0.0	4.6	19.5	21.0
40-49 years	0.0	0.0	0.0	0.0	0.0	4.5	19.0
50-64 years	0.0	0.0	0.0	0.0	0.0	0.0	3.1
65-74 years	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75-84 years	0.0	0.0	0.0	0.0	0.0	0.0	0.0
85-100 years	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Working Age (16-85)	0.0	0.0	0.5	2.3	5.5	9.6	15.4
Civilian Labor Force (millions)	-0.5	-0.7	-0.3	1.5	5.6	10.9	18.1
Teenagers 16-19	-0.5	-0.6	5.1	22.3	19.0	29.1	38.9
Men, 20-64	0.1	0.1	0.3	1.4	6.3	11.7	19.3
Women, 20-64	-1.2	-1.7	-1.6	-0.7	4.1	9.3	16.8
Men, 65-84	-0.7	-0.4	-0.5	-0.6	-0.6	-0.2	-0.8
Women, 65-84	-0.5	-0.4	-0.7	-0.2	-0.5	-0.5	-0.5
Deviations from Base Values							
Labor Force Participation Rates							
Teenagers, 16-19	-0.2	-0.3	-0.9	0.0	-0.5	-0.6	-0.9
Men, 20-64	0.1	0.1	0.3	0.2	0.3	0.6	0.8
Women, 20-64	-0.9	-1.1	-1.1	-1.2	-1.0	-0.7	-0.3
Men, 65-84	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2
Women, 65-84	0.0	0.0	-0.1	0.0	-0.1	-0.1	-0.1

The table also shows how changes in fertility and the economy have an impact on labor force participation. Participation of teenagers tends to be down. The participation of men between the age of 20 and 64 tends to be up, while that of women in the same age group tends to be down. One can surmise that the women are reducing their participation as a result of the increased demands on their time at home, while the men are increasing their participation as a result of the increases in the number of children, see Table 4-8.

These large effects on the population have important impacts on the economy. The initial decrease in the labor force participation of women should result in a lower unemployment rate. The increase in the number of children should also effect not only the mothers labor force participation but also increase spending by governments for schools and goods associated with children. Table 11-12 shows a summary table of macro-economic effects of the CTC and the population changes associated with it. As expected the unemployment rate is initially flat before it declines in 2015 and 2020. State and local government spending is up by 18% in 2050. Since most education spending is concentrated at the state and local level it is natural that we see these increases in spending.

The population changes also have important impacts on other economic indicators. In the early years potential GNP initially declines with the reductions in the labor force but by 2015 it begins an impressive increase from a 1% increase over the Base to a 19% increase over the Base in 2050. These increases in potential GNP are the result of increases in the labor force from a slight decline of 0.3% in 2015 to an 18% increase in 2050. GDP, like potential GNP, has a 1% increase over the Base in 2015 and a 17.5% increase over the Base in 2050. The large increases in the population are also reflected in increases in personal consumption. Personal consumption is up by almost 1% in 2015 and by over 12% in 2050. Thus the CTC results in an increase in the population which initially lowers potential GNP through reductions in the labor force and then, as the new workers become working age, increases potential GNP and actual GDP.

One of the reasons that personal consumption does not increase as dramatically as GDP is that the federal government is siphoning off a fantastically large surplus. The federal surplus, although initially lower, increases 265% over the Base in 2050! There are two reasons for the enormous increases in the federal surplus. First the larger population and its larger labor force results in ever increasing tax revenues while federal government spending increases more slowly. Second, the increases in the federal surpluses reduce interest rates and consequently the net interest payments on outstanding debt. Interest rates are down -1.1 percentage points in 2050. Thus the federal government is taking a more substantial portion of the increased activity in the economy, resulting in disposable income and personal consumption increasing more slowly than the economy.

The large reductions of interest rates also have a negative impact on the value of the dollar and a positive impact on the exchange rate, with their consequent effects on exports and imports. As the U.S. interest rate declines, the dollar becomes less attractive to foreigners. As the dollar becomes less attractive to foreigners, the exchange rate measured as the U.S. dollar to foreign currency increases. The lower value of the dollar increases the competitiveness of U.S. products overseas and leads to increased exports. Conversely, as the U.S. dollar becomes less valuable, foreign goods become more expensive and there is a consequent reduction in imports. Thus the large federal surplus acts to siphon activity away from consumer expenditure and towards exports.

Another interesting implication of the CTC simulation is that in 2050 the real value of hourly compensation is down by 1.7%, combined with a 2.08% increase in the PCE deflator, results in a 0.38% decline in average hourly compensation. This is the result of an increase in the size of the labor force and its consequent increase in the unemployment rate of 1 percentage point in 2050. The increased availability of labor in 2050 allows employers to pay less than they had to with a smaller labor pool in the Base.

Table 11-12 Macro-economic Summary for $500 Child Tax Credit Simulation

Percentage Deviations from Base	2000	2010	2015	2020	2030	2040	2050
Potential GNP	-0.05	0.06	0.95	2.80	6.36	11.74	18.93
Gross Domestic Product	-0.06	-0.04	1.00	2.75	5.85	10.86	17.48
Components							
Personal consumption	0.08	0.25	0.86	2.39	4.97	8.42	12.44
Fixed investment	-0.51	-1.90	-0.69	0.58	2.08	4.89	8.02
Exports	0.00	0.46	1.09	2.28	5.37	11.25	20.92
Imports	0.01	-0.65	-0.63	-0.48	-1.27	-3.14	-6.73
State & local gov.	0.00	0.11	2.28	5.26	8.49	13.42	18.02
Price Level and Inflation Indicators							
PCE deflator	-0.08	0.37	0.53	0.44	0.74	1.24	2.08
Avg Hourly compensation	0.10	0.13	0.13	-0.19	-0.29	-0.45	-0.38
Exchange rate -US$/Foreign Currency	0.0	-0.2	1.1	2.1	2.8	7.6	16.2
Private Labor Productivity	0.07	0.06	0.13	0.02	0.01	0.23	0.74
Labor force, mil	-0.52	-0.70	-0.30	1.49	5.63	10.90	18.05
Real disposable income	0.06	-0.01	0.69	2.05	4.08	6.98	10.28
Federal surplus	-4.99	-6.27	9.68	30.64	67.20	154.23	264.64
Deviations from Base Values							
Unemployment Rate	0.0	0.1	-0.3	-0.5	0.1	0.3	0.9
Three month T-bills, %	0.0	-0.1	-0.3	-0.3	-0.5	-0.8	-1.1
Savings rate, pct	0.0	-0.1	0.0	-0.2	-0.6	-1.0	-1.4
Ratio Surplus to GNP	0.0	-0.1	0.1	0.4	0.8	1.6	2.5
Deviations from Base Growth Rates							
	96-00	00-10	10-15	15-20	20-30	30-40	40-50
Potential GNP	0.0	0.0	0.2	0.4	0.3	0.5	0.6
GDP	0.0	0.0	0.2	0.3	0.3	0.5	0.6
M2 Growth Rate	0.0	0.0	0.1	0.4	0.3	0.5	0.6
PCE deflator (1977 = 100)	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Private Labor Productivity	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Total Jobs (millions)	-0.1	0.0	0.2	0.4	0.3	0.5	0.6
Labor Force (millions)	-0.1	0.0	0.1	0.4	0.4	0.5	0.6

The CTC simulation changes the age distribution of the population. Dowd, Monaco, and Janoska (1998) show that the aging of the baby boomers and its consequent change in the age distribution of the population has important impacts on the industrial composition of the economy. They show that the economy will have lower productivity and be more concentrated in the service sectors than if there were no aging. The CTC simulation presents a different type of problem to the economy than the one analyzed by Dowd, Monaco, and Janoska (1998). Specifically, the age distribution of the population is now weighted considerably more towards the young than in the Base. Like the analysis of Dowd et al the next set of tables explores the changes in industrial composition as a result of the changes to the population age distribution from the CTC.

Table 11-13 shows percentage deviations from the Base forecast for aggregate personal consumption expenditure (PCE) sectors. Total PCE increases by 12.4% over the Base. Many of the aggregate sectors have similar increases in expenditure as the total. However, four sectors standout as having substantially different increases in personal expenditure. Motor vehicles, housing, and transportation all have smaller increases than the average, with 1.4%, 2.1%, and 3.9%, respective differences from total PCE in 2050. Medical services, on the other hand, have an impressive 29% increase over the Base in 2050. These differences are the result of changing age distributions, and relative prices. For motor vehicles, the very young have a positive impact on spending relative to adults, while older children and adults under the age of 30 have a smaller impact on spending relative to adults. Thus, aggregate PCE motor vehicle spending actually experiences faster growth than total PCE until 2040. Both housing and transportation have lower spending relative to the average because children and young adults spend less on these items than older adults do. Conversely, children spend relatively more on medical services than adults do (126% of spending by adults) and as a result medical services experiences a dramatic increase in PCE. Because of the change in the age distribution of the population the CTC simulation concentrates more of the spending in the medical services and less of it in motor vehicles, housing, and transportation.

Table 11-13 Personal Consumption Expenditures $500 Child Tax Credit (CTC) Simulation

Percentage Deviation from Base	2000	2010	2015	2020	2030	2040	2050
Personal Consumption Expenditure	0.1	0.3	0.9	2.4	5.0	8.4	12.4
Durable Goods	0.5	-0.1	0.5	2.3	4.9	8.2	12.0
Motor Vehicles and Parts	1.0	0.4	1.5	3.0	5.4	8.2	11.0
Non-Durable Goods	0.2	0.6	1.2	2.5	5.0	8.5	12.5
Food and Alcohol	0.1	0.5	1.1	2.2	4.7	8.2	12.9
Clothing	0.3	0.6	1.0	2.7	5.5	9.0	12.9
Services	-0.1	0.1	0.8	2.3	4.9	8.4	12.6
Housing & Household operation	-0.2	-0.1	0.1	1.1	3.2	6.3	10.3
Transportation	-0.6	-1.3	-0.9	0.3	2.4	5.1	8.5
Medical Services	0.3	3.3	5.5	8.4	13.7	20.6	29.0

The changes in PCE in the Table above illustrate how the changing age distribution affects personal consumption by aggregate sectors. These changes in PCE combined with changes in the economy --increased exports and lowered imports-- will also impact the distribution of output by aggregate sector. Like the RET67 simulation the decreased value of the dollar impacts the industries that are export sensitive. Mining and both durable and non-durable manufacturing have all increased by substantially more than the economy. Mining and non-durable manufacturing are up 25% over the Base, and durable manufacturing has increased by 23% over the Base. These increases in high productivity sectors counterbalance the large increases in the low productivity medical-services industry, which is up 28% over the Base. Finally, the smallest increase in activity occurs in the finance, insurance, and real estate sectors where the larger young population tends to spend less of their money. The combination of the changes in PCE and the economy as a whole result in a very different mix of industrial output than the one that occurred in the Base. These different combinations lead to a different overall productivity level which, in turn, influences the overall economy. Thus, analyzing population changes without taking into account the industrial composition could result in misunderstanding some of the important relationships in the economy.

Table 11-14 Output by Aggregate Industries $500 Child Tax Credit

Percentage Deviations from Base	2000	2010	2015	2020	2030	2040	2050
Total Output	-0.1	0.0	1.0	2.8	6.0	11.4	18.8
Agriculture,forestry,fishery	0.1	0.3	0.9	1.9	3.9	7.4	12.5
Mining	0.0	0.2	1.5	3.7	7.8	14.7	24.5
Construction	-0.5	-1.9	-0.7	1.3	3.7	8.2	13.7
Nondurables manufacturing	0.1	0.4	1.5	3.4	7.5	14.6	25.4
Durables manufacturing	0.0	0.1	1.4	3.1	6.9	13.5	22.7
Transportation	-0.2	-0.6	0.2	1.8	4.5	9.2	15.6
Utilities	-0.2	-0.2	0.6	2.3	5.5	10.6	17.6
Trade	0.0	-0.1	0.7	2.3	5.2	9.6	15.0
Finance, insurance, real est.	-0.5	-1.3	-0.8	0.7	3.2	7.1	12.2
Services, nonmedical	0.0	-0.2	0.5	2.0	4.5	8.4	13.6
Medical Services	0.4	3.3	5.4	8.2	13.3	20.0	28.3
Miscellaneous	0.1	0.6	3.0	6.1	10.1	16.4	22.7

The changes seen in output by aggregate industry have predictable impacts on employment by aggregate industry. The percentage deviations from the Base employment levels are shown in Table 11-15. As in the output table, the distribution of jobs is tilted toward mining, manufacturing, and medical services. All private sector jobs have increased by 15.8%, but those of mining, manufacturing, and medical services all experience increases in excess of 24%.

Similar to the changes in PCE, the age distribution has important impacts on the distribution of government spending. The effect of the changing age distribution can be seen by looking at the increases in jobs in the government sectors relative to the private sector. While private sector jobs are up 15.8% over the Base, total civilian jobs went up by 16.9%; private sector jobs increased less than total jobs, reflecting the fact that civilian government employment is increasing. As the number of children gets ever larger relative to the Base, the number of persons employed by state and local government increases substantially. In 2050, employment by state and local government for education purposes increases by 33% over the Base.

Table 11-15 Jobs by Aggregate Industry and Government $500 Child Tax Credit Simulation

Percentage Deviations from Base	2000	2010	2015	2020	2030	2040	2050
Civilian jobs	-0.4	-0.8	0.0	2.1	5.5	10.5	16.9
Private sector jobs	-0.5	-1.0	-0.5	1.3	4.6	9.4	15.8
Agriculture, forestry, fishery	-0.1	-0.5	-0.1	0.9	3.2	6.8	12.3
Mining	-0.1	0.3	1.5	3.8	8.4	15.8	26.4
Construction	-0.6	-1.7	-0.7	1.0	4.0	8.6	14.5
Nondurables manufacturing	0.1	0.6	1.4	3.4	7.5	14.1	23.8
Durables manufacturing	0.1	0.5	1.6	3.5	7.9	15.3	25.9
Transportation	-1.0	-2.3	-2.0	-0.1	2.7	7.5	14.5
Utilities	0.0	0.3	1.3	3.2	7.5	14.7	24.9
Trade	-0.5	-1.8	-1.5	0.3	3.3	7.6	12.9
Finance, insurance, real est.	-1.2	-2.8	-2.6	-0.8	2.1	6.5	12.6
Services, nonmedical	-0.7	-1.5	-1.3	0.1	2.9	6.8	12.4
Medical services	0.0	2.3	4.1	6.8	12.4	19.9	29.4
Civilian Government	0.0	0.1	2.6	6.1	10.0	16.3	22.4
Federal defense	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Federal non-defense	0.0	0.0	0.0	0.0	0.0	0.0	0.0
State & local education	0.0	0.0	4.0	9.8	15.0	24.1	32.5
State & local health	0.0	2.3	4.3	7.0	11.4	16.6	22.6
State & local other	0.0	0.0	1.2	2.7	6.5	11.3	16.8
Federal govt enterprises	0.0	0.0	0.0	0.0	0.0	0.0	0.0
State & local govt enterprise	0.0	0.0	0.0	0.0	0.0	0.0	0.0

The CTC simulation suggests that the $500 child tax credit will increase the population and the growth of the economy. After the first several years of implementation the credit will result in increases in the federal surplus. Policy makers could decide to pay down the debt and thereby keep the increasing surplus, or they could decide to do any one of a number of things with the surplus including holding the surplus at the Base level. The surplus was shown to have an impact on interest rates and the distribution of output and jobs in the economy. This next section explores the impact of the $500 Child Tax Credit on the population and the economy but with the surplus relative to GNP held at the Base levels.

In the CTC simulation many of the outcomes were the result of the increasing surplus relative to the Base. Because the surplus-neutral CTC simulation (CTCCON) eliminates the effect of the large surplus, it shows more clearly the effects of the changing population on the economy. Table 11-16 shows a summary of the outcomes in the CTCCON simulation. In the CTC simulation the ratio of the surplus to GNP in 2050 was 2.5% larger than in the Base. By construction, the CTCCON simulation holds the ratio of the surplus to GNP at the Base levels. This means that there is an absolute increase in the surplus, 19.3% larger in 2050, but relative to GNP the surplus is essentially the same as in the Base.

Table 11-16 Macro-economic Summary for $500 Child Tax Credit Surplus Neutral (CTCCON) Simulation

	2000	2010	2015	2020	2030	2040	2050
Potential GNP	-0.1	0.1	1.0	2.8	6.1	11.0	17.3
GDP	-0.1	0.0	1.2	3.0	5.8	10.4	15.8
Components, bil 77$							
Personal consumption	0.0	0.1	1.0	3.0	6.4	11.3	17.3
Fixed investment	-0.5	-1.9	-0.4	0.6	2.1	4.9	8.0
Exports	0.0	0.7	1.4	2.2	3.5	5.9	9.0
Imports	-0.1	-0.9	-0.6	0.1	1.0	2.2	3.3
State & local gov.	0.0	0.1	2.3	5.3	8.5	13.4	17.9
Price Level and Inflation Indicators							
PCE deflator (77=100)	-0.1	0.4	0.6	0.4	0.5	0.1	-0.8
Avg Hourly compensation	0.1	0.2	0.1	-0.1	-0.1	-0.5	-1.3
Exchange rate scalar	-0.1	1.5	2.4	2.5	4.8	7.6	11.2
Private Labor Productivity	0.1	0.1	0.1	-0.1	-0.3	-0.6	-0.7
Labor force, mil	-0.5	-0.7	-0.3	1.5	5.6	10.9	18.1
Real disposable income	0.0	-0.1	1.0	2.9	5.9	10.4	15.5
Federal Surplus, bil $	-0.5	-0.3	0.9	3.3	7.8	13.6	19.3
Deviations from Base Values							
Unemployment Rate	-0.1	0.1	-0.5	-0.8	-0.1	0.1	0.8
Three Month T-bills, %	-0.1	-0.1	-0.1	-0.1	-0.3	-0.5	-0.7
Savings rate, pct	0.0	-0.1	0.1	0.0	-0.3	-0.7	-1.3
Ratio of Surplus to GNP	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Deviations from Base Growth Rates							
	96-00	00-10	10-15	15-20	20-30	30-40	40-50
Potential GNP	0.0	0.0	0.2	0.4	0.3	0.5	0.6
GDP	0.0	0.0	0.2	0.3	0.3	0.4	0.5
M2 Growth Rate	0.0	0.0	0.1	0.4	0.3	0.4	0.5
PCE deflator (1977=100)	0.0	0.1	0.0	0.0	0.0	0.0	-0.1
Private Labor Productivity	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Jobs (millions)	-0.1	0.0	0.2	0.4	0.3	0.5	0.5
Labor Force (millions)	-0.1	0.0	0.1	0.4	0.4	0.5	0.6

When holding the surplus to GNP ratio constant, the changes in the economy cause very slight changes in population, with no changes prior to 2040 and only 0.5% increase in fertility in 2050. Relative to CTC, the CTCCON simulation presents results using the converged population from the CTC simulation. One immediate impact of a lower surplus in the CTCCON simulation compared to the CTC simulation is that interest rates are slightly higher in the surplus neutral simulation. In 2050, the three-month T-bill is 0.7 percentage points lower compared with 1.1 percentage points in the CTC simulation. This increase in interest rates slows the economy slightly, potential GNP and GDP are lower than in CTC, and it increases the value of the U.S. dollar. The increased value of the dollar results in only a 9% increase in exports compared to a 21% increase. The increased value of the dollar also increases imports, which are actually 3% greater in CTCCON than in the Base.

Reducing personal income taxes creates the reduction in the surplus. The reductions in personal income taxes result in increases in disposable income. Disposable income in the CTC simulation was up 10% while in the CTCCON simulation it is up 15.5%. At the same time that there is an increase in disposable income there is an increase in the population and the labor force. In 2050 the labor force is 18% larger than in the Base. Therefore disposable income per worker has actually declined, although by less than if the government did not implement a surplus neutral policy.

The decreased activity in the export sectors results in a reduction in private labor productivity. The CTCCON simulation has a decrease in productivity in 2050 of 0.7% compared to the CTC increase of 0.7%. The reduction in productivity is the result of increased activity, relative to the Base, in sectors with lower productivity. Table 11-17 through Table 11-19 show the effect of increased population and the distribution of that population on the level and distribution of PCE, output, and jobs.

Table 11-17 shows that total PCE spending increases by 17%. Because the federal government is no longer siphoning off a portion of the economic activity as it did in the CTC simulation, the level of PCE spending is higher. Like the PCE spending in the CTC simulation, housing and transportation are well below the percentage of the economy that they were in the Base. Medical services continue to see increased economic activity because of the increased number of children. However, unlike the CTC simulation, those sectors that are sensitive to income experience much better outcomes in the CTCCON scenario. Specifically, motor vehicles, which experienced less activity as a percentage of the increase in activity in the CTC simulation, now experiences above-average increases in activity. Similarly, although less pronounced than motor vehicles, durable goods now have an above-average increase in PCE spending.

Table 11-17 Personal Consumption Expenditures $500 Child Tax Credit Surplus Neutral (CTCCON) Simulation

Percentage Deviation from Base	2000	2010	2015	2020	2030	2040	2050
Personal Consumption Expenditure	0.0	0.1	1.0	3.0	6.4	11.3	17.3
Durable Goods	0.4	-0.2	0.8	3.2	7.1	12.7	19.2
Motor Vehicles and Parts	0.8	0.2	2.1	4.5	8.7	14.7	21.4
Non-Durable Goods	0.2	0.5	1.3	3.0	6.3	11.1	17.2
Food and Alcohol	0.0	0.4	1.2	2.6	5.6	10.2	16.3
Clothing	0.2	0.4	1.1	3.4	7.2	12.7	19.0
Services	-0.2	0.0	0.9	2.9	6.2	10.9	16.6
Housing & Household operation	-0.3	-0.2	0.2	1.5	4.0	7.9	13.0
Transportation	-0.7	-1.4	-0.7	1.0	3.8	8.0	13.4
Medical Services	0.2	3.3	5.6	8.8	14.0	20.4	27.1

As in the CTC simulation, these changes in the distribution of PCE spending influence the distribution of output among industries. Table 11-18 shows the percentage deviations from Base levels of output for aggregate industries. The lower level of economic activity in the CTCCON simulation, GDP increases by 16%, compared with the CTC simulation, GDP increased by 17.5%, is reflected in the level of output by industries table. The industry that takes the biggest hit is durables manufacturing. In the CTC simulation the durables manufacturing was up 23% over the Base while in the CTCCON simulation it is up only 16%, the economy average. Finance, insurance and real estate are still low relative to the economy's average, although they do somewhat better in the CTCCON simulation. Finally, as in the CTC simulation and the PCE table, medical services continue to do well with the increased number of children.

Table 11-18 Output by Aggregate Industries $500 Child Tax Credit Surplus Neutral Simulation

Percentage deviations from Base	2000	2010	2015	2020	2030	2040	2050
Total Output	-0.1	0.0	1.3	3.0	5.9	10.6	16.3
Agriculture,forestry,fishery	0.1	0.3	1.0	2.1	4.1	7.4	11.8
Mining	-0.1	0.3	1.9	3.9	7.2	12.6	19.3
Construction	-0.5	-1.8	-0.4	1.4	3.6	7.9	12.7
Nondurables manufacturing	0.1	0.5	1.8	3.6	6.9	12.2	19.4
Durables manufacturing	-0.1	0.3	1.8	3.2	5.8	10.3	15.9
Transportation	-0.3	-0.6	0.5	2.1	4.6	8.8	14.1
Utilities	-0.2	-0.2	0.8	2.6	5.7	10.5	16.6
Trade	-0.1	-0.2	0.9	2.7	5.8	10.5	16.1
Finance, insurance, real estate	-0.5	-1.3	-0.6	1.2	3.9	8.2	13.7
Services, nonmedical	-0.1	-0.2	0.7	2.4	5.1	9.4	14.8
Medical Services	0.3	3.3	5.5	8.7	13.7	20.0	26.6
Miscellaneous	0.2	0.7	2.9	5.6	9.0	14.4	19.6

The changes in output by industry have an impact on the distribution of employment. Table 11-19 shows the percentage deviation from the Base level of employment by aggregate industry. As with the CTC simulation the distribution of jobs becomes skewed toward state and local government, with state and local education employing 33% more people in 2050. The distribution of jobs changes slightly from that of the CTC simulation with fewer jobs going to the high export sectors.

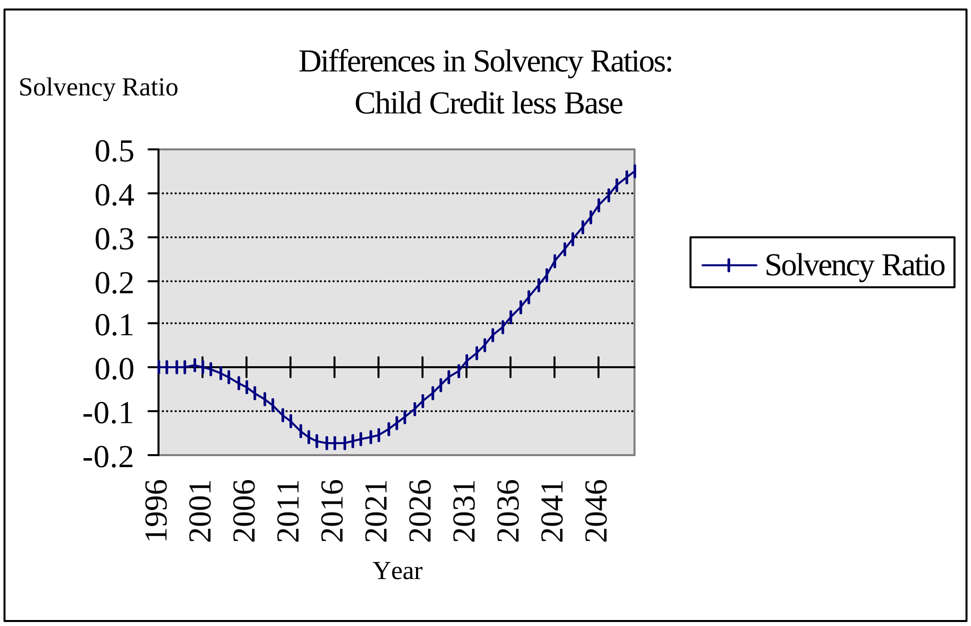
Table 11-19 Jobs by Aggregate Industry and Government $500 Child Tax Credit Simulation Surplus Neutral

Percentage deviations from Base	2000	2010	2015	2020	2030	2040	2050
Civilian jobs	-0.4	-0.8	0.2	2.3	5.8	10.8	17.1
Private sector jobs	-0.5	-1.0	-0.3	1.6	4.9	9.7	16.0
Agriculture, forestry, fishery	-0.2	-0.4	0.0	1.1	3.2	6.6	11.6
Mining	-0.1	0.4	1.9	3.9	7.8	13.8	21.4
Construction	-0.6	-1.6	-0.5	1.0	3.7	8.0	13.4
Nondurables manufacturing	0.1	0.7	1.6	3.6	7.1	12.3	19.3
Durables manufacturing	0.1	0.6	1.9	3.5	6.6	11.6	18.1
Transportation	-1.0	-2.3	-1.8	0.2	2.8	7.2	13.0
Utilities	-0.1	0.3	1.5	3.4	7.6	14.2	23.2
Trade	-0.6	-1.9	-1.3	0.8	4.3	9.6	16.3
Finance, insurance, real estate	-1.2	-2.9	-2.4	-0.3	2.7	7.4	13.6
Services, nonmedical	-0.7	-1.5	-1.2	0.4	3.5	7.7	13.7
Medical services	-0.1	2.3	4.2	7.2	12.7	19.5	27.1
Civilian govt.	0.0	0.2	2.6	6.1	10.0	16.2	22.3
Federal defense	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Federal non-defense	0.0	0.0	0.0	0.0	0.0	0.0	0.0
State & local education	0.0	0.0	4.0	9.8	15.0	24.1	32.5
State & local health	0.0	2.3	4.4	7.1	11.2	15.6	19.7
State & local other	0.0	0.0	1.2	2.7	6.5	11.3	16.8
Federal govt enterprises	0.0	0.0	0.0	0.0	0.0	0.0	0.0

The CTC and CTCCON simulations point out that not only is it important to know the size of the population, but it is also important to know the age distribution of the population. Population distribution changes the composition of the labor force, and the distribution of PCE spending. In addition to the changes in population it is important to realize that assumptions about changes in the surplus can have an impact on the economy through changing composition of demand and output, resulting in changes in the productivity of the economy.

The CTC and CTCCON simulations started from the premise that the $500 dollars would be treated in a similar manner to the EITC. This resulted in a population in 2050 that was 21% larger and increasingly dominated by the young. In addition to the impacts on the composition of output, the increased population also resulted in a ballooning federal surplus. Just as the Baby Boomers (those born between 1946 and 1964) reach their retirement years, the wave of children from the increased tax credit for children starts to enter the labor force. This timing mitigates some of the problems that the social insurance trust funds are bound to face. Figure 11-4 shows the change in the solvency ratio between the CTC alternative and the base. Initially, the increased fertility and decreased participation reduce the solvency ratio. However, later in the forecast when the younger population reaches working age the solvency ratio is positively influenced.

Figure 11-4 Change in Solvency Ratio Child Credit



An alternative scenario is that women treat the increase in income from the child tax credit as income. In other words, instead of using the EITC parameter for the effect of the Child Tax Credit, the income parameter is used. This scenario results in essentially no change in the population. The EITC parameter used for the CTC simulations was 0.000622. The income parameter is 0.0000045. The EITC parameter is 138 times larger than the income parameter, so it should come as no surprise that the simulation using the income parameter results in essentially no change in the population. The parameter on EITC takes into account the link between benefits and children. The income parameter, on the other hand, merely treats the Child Tax Credit as income, ignoring the link between the benefit and children.

The population increase of 21% in 2050 translates into 78 million more people than in the Base. There are two aspects of the credit that must be taken into account when evaluating the simulations on population. First, the credit is modeled as a $500 increase in constant dollars for all time. This means that the credit will not disappear as the economy and price levels grow.[71] Second, the credit not only affects the current population but also increases the fertility of the CTC children as they age into their childbearing years. The geometric increase in population results in ever-increasing numbers. So while in the first full year of implementation of the simulation the total number of babies born only increased by 828,000, by 2050 the number

[71] H.R. 2014 does not index the $500 credit. Thus, in practical terms, the law allows the credit to disappear over time, unless Congress updates the value of the credit. Additionally, real incomes are increasing in the forecast period, so that the $500 held constant in real terms, nevertheless, will be declining as a percentage of real personal income. The parameter on the EITC from the cross-section estimate is associated with dollar amounts, not shares of income. This dissertation assumes that the effect of the CTC using the EITC parameter is constant relative to dollars. Alternatively, one could interpret the EITC parameter as associated with shares of income. If that assumption were used these effects would be smaller.

of babies increased by 2,541,000. Thus the Child Tax Credit put the population on a different trajectory resulting in 78 million more persons.

Clearly, the increase in population depends on the assumption made about how women will react to the credit. The next set of simulation tables explores the impact on population and the economy of assuming that the real parameter for the Child Tax Credit is half of the EITC parameter used in the previous CTC simulations (CTCHALF).

Table 11-20 summarizes the changes in population that result from the CTCHALF simulation. The TFR rate in the year 2000 is 10% greater than in the Base, this compares with a 22% increase in the CTC simulation. The increase in fertility is close to half of the increase that occurred in the CTC simulation. In 2050 the difference between the TFR's becomes greater; TFR in the CTCHALF simulation is 8% higher than the Base, while in the CTC simulation it is 23% greater. The 8% increase in fertility results in an 8% increase in total population. Similarly, the increase in fertility results in an increase in the working age population of 6%, compared with the CTC simulation increase of 15%. Interestingly, while the CTC forecasted labor force participation for women between the age of 20 and 64 down relative to the Base in all years, the CTCHALF simulation predicts that their participation will actually be slightly up in 2050. Thus, although the working age population is only up by 6%, the civilian labor force is up by 8%. In sum, the population results appear to be less than half of the increases seen in the CTC simulation and the distribution of the labor force is skewed less towards 20-64 year old males.

Table 11-20 Population and Labor Force Summary for $500 Child Tax Credit Simulation CTCHALF

Percentage Deviations from Base	2000	2010	2015	2020	2030	2040	2050
Total Fertility Rate	9.9	9.8	9.5	9.5	9.3	8.6	8.1
Population, total (in millions)	0.2	1.5	2.1	2.7	4.4	6.3	8.4
0-4 years	2.6	9.9	9.4	10.5	16.0	18.4	20.8
5-14 years	0.0	6.5	10.0	9.4	11.7	16.4	18.4
15-19 years	0.0	0.0	2.5	10.1	8.9	12.8	16.7
20-29 years	0.0	0.0	0.0	1.2	9.4	9.1	13.5
30-39 years	0.0	0.0	0.0	0.0	1.1	8.9	8.7
40-49 years	0.0	0.0	0.0	0.0	0.0	1.1	8.7
50-64 years	0.0	0.0	0.0	0.0	0.0	0.0	0.8
65-74 years	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75-84 years	0.0	0.0	0.0	0.0	0.0	0.0	0.0
85-100 years	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Working Age (16-85)	0.0	0.0	0.0	0.9	2.3	4.0	6.3
Civilian Labor Force (millions)	-0.2	-0.3	-0.4	0.4	2.5	4.9	7.9
Teenagers 16-19	-0.5	-0.3	-0.8	9.7	8.9	12.5	17.1
Men, 20-64	0.0	0.0	0.0	0.4	2.7	5.2	8.3
Women, 20-64	-0.5	-0.8	-0.8	-0.5	1.8	4.2	7.4
Men, 65-84	-0.1	-0.3	0.2	-0.1	0.1	0.6	0.7
Women, 65-84	-0.3	0.0	-0.3	0.2	0.3	0.4	0.9
Deviations from Base Labor Force Participation Rates							
Teenagers, 16-19	-0.2	-0.2	-0.7	-0.2	0.0	0.0	0.2
Men, 20-64	0.0	0.0	0.0	0.1	0.2	0.5	0.7
Women, 20-64	-0.4	-0.5	-0.5	-0.6	-0.4	-0.1	0.2
Men, 65-84	0.0	-0.1	0.0	0.0	0.0	0.1	0.1
Women, 65-84	0.0	0.0	0.0	0.0	0.0	0.1	0.1

The effects on the economy, shown in Table 11-21, are predictable. In 2050 potential GNP is up 8.2% over the Base, while GDP lags slightly behind. Real disposable income is initially down before it eventually increases. The decline and eventual increase in disposable income pushes personal consumption initially down and then back up. The increase in disposable income in 2050 of 4% is well below the increase in the labor force. Income per worker is down relative to the Base. Average hourly compensation is essentially flat, while the PCE deflator is increasing, resulting in a decline in real hourly wages. The decline in real wages of 1.4% in 2050 is less than the 1.7% decline real wages in the CTC simulation. The increased decline in wages in the CTC simulation contributed to the higher fertility rates; fertility is negatively effected by wages.

Similar to the CTC simulation, the population increase results in a 121% increase in the federal surplus, and a 1.2 percentage point increase in the surplus relative to the Base. The increased surplus pushes interest rates down 0.5 percentage points in 2050. The decrease in interest rates has two effects, one it reduces the net interest payments made on federal outstanding debt, and two it decreases the value of the dollar. The first effect increases the surplus even more through standard debt dynamics, and the second effect pushes up the exchange rate. The decreased value of the dollar makes U.S. goods more competitive overseas and foreign goods less competitive in the U.S.. The result is that exports are higher and imports are lower, leading to an industrial distribution of activity that is skewed towards the export sectors. The change in the distribution of activity across industrial sectors results in an increase in labor productivity.

Table 11-21 Macro-economic Summary for $500 Child Tax Credit Simulation CTCHALF

Percentage Deviations from Base	2000	2010	2015	2020	2030	2040	2050
Potential GNP	0.0	0.0	0.3	1.2	2.9	5.2	8.2
Gross Domestic Product	0.0	-0.2	0.0	1.3	2.8	5.0	7.8
Components							
Personal consumption	0.0	-0.1	-0.5	0.4	1.8	3.3	4.9
Fixed investment	0.2	-1.0	-0.8	0.4	0.9	2.1	3.3
Exports	0.0	0.2	0.7	2.0	3.6	6.2	10.2
Imports	0.1	-0.5	-1.2	-1.2	-1.5	-2.5	-4.4
State & local gov.	0.0	0.0	0.8	2.4	3.6	5.5	7.0
Price Level and Inflation Indicators							
PCE deflator	0.0	0.2	0.4	0.5	0.7	0.9	1.4
Avg Hourly compensation	0.0	0.1	0.2	0.1	0.0	-0.1	0.0
Private Labor Productivity	0.0	0.1	0.2	0.2	0.1	0.2	0.5
Exchange rate scalar	-0.1	0.6	1.7	2.7	4.8	8.6	14.7
Labor force, mil	-0.2	-0.3	-0.4	0.4	2.5	4.9	7.9
Real disposable income	0.1	-0.4	-0.8	0.3	1.6	2.8	4.1
Federal surplus	-3.4	6.8	25.3	27.4	34.8	73.8	121.4
Deviations From Base							
Unemployment rate, %	-0.1	0.2	0.1	-0.3	0.0	0.1	0.5
Three month T-bills, %	0.0	-0.1	-0.2	-0.2	-0.2	-0.4	-0.5
Savings rate, pct	0.1	-0.2	-0.2	0.0	-0.2	-0.4	-0.6
Ratio Surplus to GNP	0.0	0.1	0.3	0.4	0.5	0.8	1.2
Deviations from Base Growth Rates							
	96-00	00-10	10-15	15-20	20-30	30-40	40-50
Potential GNP	0.0	0.0	0.1	0.2	0.2	0.2	0.3
GDP	0.0	0.0	0.0	0.3	0.1	0.2	0.3
M2	0.0	0.0	0.0	0.2	0.2	0.2	0.3
PCE deflator	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Private Labor Productivity	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Jobs	0.0	0.0	0.0	0.3	0.2	0.2	0.3
Labor Force	-0.1	0.0	0.0	0.2	0.2	0.2	0.3

Like the CTC simulation, the increased export activity pushes activity into sectors that are more exportable. Table 11-22 shows the percentage deviations from the Base level of output for aggregate industrial sectors. The distribution is skewed toward mining, manufacturing, and medical services. Both the mining and manufacturing benefit from the increased export activity, while the medical sector benefits from children.

Table 11-22 Output by Aggregate Industry $500 Child Tax Credit Simulation Half EITC Parameter

percentage deviations from Base	2000	2010	2015	2020	2030	2040	2050
Total Output	0.0	-0.2	0.0	1.4	3.0	5.4	8.5
Agriculture,forestry,fishery	0.1	0.0	0.1	0.9	1.8	3.3	5.4
Mining	0.0	-0.1	0.3	2.1	4.1	7.1	11.2
Construction	0.2	-1.0	-0.9	0.8	1.8	3.7	6.1
Nondurables manufacturing	0.1	0.0	0.3	2.0	3.9	7.0	11.6
Durables manufacturing	0.1	-0.1	0.4	2.2	3.9	6.9	10.9
Transportation	0.0	-0.5	-0.5	0.9	2.3	4.4	7.1
Utilities	0.0	-0.3	-0.2	1.0	2.6	4.8	7.7
Trade	0.1	-0.3	-0.4	0.8	2.3	4.2	6.5
Finance, insurance, real estate	-0.1	-0.8	-1.0	0.1	1.4	3.1	5.3
Services, nonmedical	0.1	-0.3	-0.4	0.7	2.0	3.7	5.9
Medical Services	0.1	1.2	1.8	3.3	5.9	8.6	11.8
Miscellaneous	-0.1	0.4	1.4	3.0	4.3	6.8	9.0

The distribution effects seen in output influence the distribution of employment. Table 11-23 shows the percentage deviations from Base levels of employment for the CTCHALF simulation. As expected, the industries that experience strong growth are the ones to have increased employment. Similar to the CTC simulation, the CTCHALF simulation forecasts increases in the number of persons employed by state and local governments. As a result of the increase in the population, the increased employment is concentrated in the education sector. State and local education employment is up 12.5% over the Base. Thus not only does the change in population effect the composition of output it also influences the degree to which resources are devoted to the government sector.

Table 11-23 Jobs by Aggregate Industry and Government $500 Child Tax Credit Simulation CTCHALF

Percentage Deviations from Base	2000	2010	2015	2020	2030	2040	2050
Civilian jobs	-0.1	-0.5	-0.5	0.8	2.5	4.7	7.4
Private sector jobs	-0.1	-0.6	-0.8	0.4	2.2	4.3	7.1
Agriculture, forestry, fishery	-0.1	-0.3	-0.3	0.4	1.5	3.1	5.5
Mining	0.0	-0.1	0.3	2.1	4.3	7.5	12.0
Construction	0.2	-0.8	-0.7	0.6	1.8	3.9	6.4
Nondurables manufacturing	0.1	0.1	0.3	1.8	3.9	6.7	10.8
Durables manufacturing	0.1	0.1	0.5	2.3	4.4	7.7	12.3
Transportation	-0.6	-1.2	-1.5	0.0	1.6	3.8	6.9
Utilities	0.0	0.0	0.2	1.4	3.5	6.6	10.8
Trade	-0.1	-1.0	-1.5	-0.4	1.3	3.3	5.7
Finance, insurance, real estate	-0.5	-1.4	-1.9	-0.6	1.0	3.1	5.8
Services, nonmedical	-0.2	-0.8	-1.2	-0.3	1.3	3.2	5.7
Medical services	0.0	0.8	1.3	2.7	5.5	8.7	12.6
Civilian Government	0.0	0.1	1.0	2.8	4.3	6.6	8.7
Federal defense	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Federal non-defense	0.0	0.0	0.0	0.0	0.0	0.0	0.0
State & local education	0.0	0.0	1.4	4.5	6.4	9.8	12.5
State & local health	-0.1	0.9	1.7	3.1	5.3	7.5	9.8
State & local other	0.0	0.0	0.6	1.1	2.7	4.6	6.7
Federal govt enterprises	0.0	0.0	0.0	0.0	0.0	0.0	0.0
State & local govt enterprises	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Conclusion

The $500 Child Tax Credit implemented by Congress in 1997 as a form of family tax relief has important incentive effects for fertility. The credit requires having a dependent child in the house, and thus, is as a subsidy to the cost of having a child. The analysis presented here suggests that the Child Tax Credit could have an impact on population anywhere from zero to a 21% increase by 2050. The economy that results from the larger population is one of decreased real income and wages, increased federal surplus, decreased interest rates, and higher unemployment. The distribution of activity in the economy is skewed toward those sectors that are used heavily by the young, and away from those that are less attractive to the young. If the surplus is allowed to grow, the economy is more export driven than otherwise. Finally, the labor force is more dominated by males between the ages of 20 and 64. Female participation is reduced slightly, as is teenager participation.

The CTCHALF simulation showed that over time the effects of the $500 dollar increase were less than half of the increase in the CTC simulation. This suggests that the use of a general equilibrium model that allows wages, income, participation, labor demand, and fertility to be endogenously determined is essential to informed policy making.

The retirement eligibility simulations showed that policies aimed at increasing the trust fund surpluses could be successful. The federal surplus increased 23% in 2050 over the Base levels. Equally important, the simulation showed that how policy makers deal with increases in the surplus influences the distribution of output. Interestingly, the increases in participation rates that were assumed to happen to men and women in their 60's resulted in decreases in the participation of teenagers. The increased labor force results in an increase in the unemployment rate. Teenagers are typically the marginal worker and more likely to be unemployed than older workers so it is not surprising that they would reduce their participation when there is an increase in unemployment.

Chapter 12 **Conclusion**

The purpose of this dissertation is to provide an empirically estimated general equilibrium model of the economy, labor supply, and population. Linking a population and labor supply model (DPM) to a macro-economic model with industry detail (LIFT) creates the general equilibrium model. Most demographic and economic models use simple assumptions about either the economy or the population. Often economic forecasts are made with demographic variables exogenously inserted into the model. Similarly, population forecasts are typically made without taking into account future changes in the economy. This dissertation makes the link between the economy and the population explicit, and endogenous.

In order to model the population and labor supply, empirical estimates from decennial cross-sections were made. The estimates included an analysis of the effects of economic variables such as wages, and income on fertility. The female wage rate was shown to have significant negative impacts on the probability of observing a birth. In 1990 a 1% increase in the log of wages decreased the probability of observing a birth by 3.1%. Household income minus one's own earnings was shown to have a positive effect on the probability of observing a birth. These results suggest that economic variables can play an important role in determining the overall fertility rate.

The fertility analysis also controlled for the number of children already in the household, the marital status of the woman, and, if married, the labor force attachment of the husband. The results presented on fertility suggested that one of the biggest single determinants of the probability of observing a birth is the marital status of the woman. A woman who is married is 148% more likely to have a child than a woman who is not, everything else being equal. In addition, the labor force attachment of the husband had a significant impact in 1990. Being married to a husband that works increased the likelihood of observing a birth by almost 200% in 1990.

In addition to the economic and demographic variables, this dissertation focuses on the impact of the EITC on fertility. The EITC acts like a subsidy to the cost of having a child, and in theory should increase the probability of having a child. The empirical analysis suggested that the EITC elasticity of fertility was between 0.01% and 0.1%. While these elasticities are rather small, large changes in the value of the credit can have large changes in fertility outcomes. Perhaps equally important, the effect of the EITC on fertility calls into question previous research on the effects of the EITC on labor supply.

Because fertility and labor supply are intertwined (high fertility is usually associated with lower female labor force attachment) the cross-section analysis also included a detailed analysis of the determinants of labor force participation and annual hours worked. The results indicated that household income had a negative effect on participation and annual hours of work for both men and women. In addition, children were shown to have a negative impact on the participation of married men with spouses who worked.

In order to account for systematic errors over time, a time-series analysis of age-specific fertility and participation rates using the cross section results was performed. The predicted fertility rate or participation rates from the cross-section were not only found to be important in explaining the movement of the dependent variables, but were also of the correct size and magnitude.

The Demographic Projections Model (DPM) was compared to the Social Security Administration (SSA) projections for fertility and participation. The SSA projections were found to provide believable bounds on the set of possible outcomes. However, the SSA High and Low cost projections have incompatible projections of the economy and population. In contrast to the DPM model, which predicted that fertility rates would increase with high unemployment and lower wages, the SSA projected that fertility rates would be lower. Conversely, when the economy was doing well and the SSA projected high fertility, DPM predicted lower fertility. Thus, the direction of the changes in the economy and the population are quite different from the set of outcomes that the SSA predicts for their trust funds.

In the final chapter, two policy simulations and the base population and economy were illustrated and described. When combined with the LIFT model the DPM model converged in 3 iterations and created a Base forecast of slowing fertility and population growth. With slowing fertility the population becomes increasingly dominated by the elderly and immigrants. The elderly are predicted to make up over 20% of the population in 2050. The economy resulting from these populations is one of slowing GDP growth and increasing real wages.

The two policy simulations present the results of shocking the economy with a later retirement age in 2014 and with the $500 Child Tax Credit that was enacted in 1997. The first set of simulations resulted in a much-improved federal surplus; the increased participation and lower eligible population both increase revenues and reduce transfer payment expenditures. The improvement in the bottom line for the federal government has an impact on the exchange rate and on the composition of output through exports and imports.

The second set of simulations show that if women react to the $500 Child Tax Credit in a similar manner to the EITC, the total fertility rate could increase by as much as 23%. The sustained increase in the fertility rate over the next 50 years results in a population with 78 million more people concentrated principally in the younger age groups. This type of a change has a dramatic impact on the economy. GDP is 18% greater than in the Base, and the federal surplus is 265% greater than in the Base. The large change in the distribution of the population results in changes in the composition of industrial activity. Output in the medical services (medical services are demanded by the young and elderly more than middle age adults) is 28% greater than in the base. Similarly, education expenditures by state and local governments increase dramatically.

The general approach of this dissertation is to analyze the determinants of individual decisions on fertility and labor supply. Once equations for fertility and labor supply were created they were incorporated into a simulation model. The simulation model was combined with the LIFT economic model of the U.S. economy. This approach allowed for an analysis of the effects of the $500 Child Tax Credit on both the population and the economy. In the absence of a demographic model, the family tax relief credit would appear to have very little effect on the economy. But by including a demographic analysis of the effects of the credit along with the economic analysis the potential for very large impacts is more evident. Thus, this dissertation fulfilled its mission of providing an empirical link between the economy and population.

There are a number of areas where further research and testing are desirable. First, the DPM model does not model either schooling or educational attainment. Educational attainment levels are simply set exogenously in the forecast. The model could be improved by estimating education decisions of individuals and linking those decisions to the LIFT model and occupations. Second, the model uses exogenous survival rates from the Census Bureau. Survival rates could depend on the standard of living, occupation and industrial composition of the economy, and other variables. Endogenizing survival rates would allow the economy to have an influence on the overall life expectancy. One can surmise that increased expenditure on medical services might lead to decreased mortality rates. Third, the relationship between LIFT employment demand and DPM labor supply could be improved so that there is an actual market. This would require a better understanding of occupation choice at the individual level and occupational demand at the industrial level.

Chapter 13 **Appendices**

Chapter 14 **Appendix A: Cross Section Estimates of Wages, Income, Transportation and Fertility**

Chapter 15 OLS of the log of wages

Table 13-1 Sample Selection Corrected and OLS Estimates of the Female Log of Wages

Female Log of Wages	1970		1980		1990	
Specification	Heckit	OLS	Heckit	OLS	Heckit	OLS
Experience	0.02	0.03	0.02	0.02	0.02	0.02
Experience Squared	0.00	0.00	0.00	0.00	0.00	0.00
Teenager	-0.22	-0.29	-0.15	-0.12	-0.20	-0.19
Age Twenty	0.12	0.11	-0.02	-0.01[2]	-0.06	-0.06
Age 45-59	-0.11	-0.11	-0.09	-0.11	-0.12	-0.13
Age Sixty	-0.11	-0.16	-0.15	-0.13	-0.23	-0.19
Age 70+	-0.39	-0.48	-0.29	-0.26	-0.36	-0.30
Education	0.04	0.04	0.05	0.05	0.06	0.06
Married	0.07	0.02[3]	-0.01[3]	0.04	-0.03	0.02[1]
Husb. Labor Participation	-0.11	-0.10	-0.06	-0.08	-0.03	-0.06
No. Children 1<age<5	-0.03[1]	-0.05	-0.17	-0.13	-0.12	-0.09
No. Children age>=5	-0.01[3]	-0.01	-0.04	-0.03	-0.04	-0.04
Husb. Part.* No. Child 1<age<5	-0.01[3]	-0.02[3]	0.11	0.11	0.10	0.10
Husb. Part.* No. Child age>=5	-0.04	-0.04	-0.01	-0.02	-0.02	-0.02
Local Unemployment	11.98	6.09	-1.97	-1.55	-0.60[2]	-0.91
Lambda	-0.21		0.17		0.171	
R-Square	0.144	0.144	0.092	0.089	0.139	0.138

Other variables not shown here are race, ethnicity, occupation, state of residence, and metropolitan residence dummy variables. Additionally, the 1980 and 1990 samples include dummy variables for not being able to speak English and school enrollment in the previous year. All estimates are significant at the 1% level unless noted otherwise. 1 Significant at the 5% level. 2 Significant at the 10% level. 3 not significant.

Table 13-2 Sample Selection Corrected and OLS Estimates of the Married Male Log of Wages

Married Male Log of Wages	1970		1980		1990	
	Heckit	OLS	Heckit	OLS	Heckit	OLS
Experience	0.025	0.025	0.028	0.027	0.029	0.032
Experience Squared	-0.0004	-0.0004	-0.0004	-0.0004	-0.0005	-0.0005
Teenager	-0.297	-0.182	-0.297	-0.286	-0.290	-0.277
Age Twenty	-0.051	-0.036	-0.053	-0.053	-0.074	-0.081
Age 45-59	-0.014[1]	-0.007[3]	-0.009[3]	-0.016[1]	0.048	0.037
Age Sixty	-0.069	-0.057	-0.103	-0.098	-0.120	-0.120
Age 70+	-0.389	-0.383	-0.332	-0.305	-0.349	-0.368
Education	0.043	0.042	0.046	0.047	0.053	0.054
Husb. Labor Participation	-0.091	-0.112	-0.135	-0.143	-0.161	-0.214
No. Children 1<age<5	-0.027	-0.022	-0.034	-0.035	-0.038	-0.033
No. Children age>=5	0.003[3]	-0.0003[3]	-0.004[3]	-0.003[3]	-0.004[3]	-0.015
Husb. Part.* No. Child 1<age<5	0.046	0.038	0.029	0.034	0.045	0.024
Husb. Part.* No. Child age>=5	-0.001[3]	0.004[1]	0.003[3]	0.003[3]	0.005[3]	0.020
Two or more Children	0.043	0.033	0.056	0.056	0.050	0.080
Local Unemployment	7.934	7.487	-0.784[1]	-0.682[1]	-1.827	-1.829
Lambda	-0.078		0.088		0.118	
R-Square	0.215	0.215	0.144	0.140	0.151	0.150

Other variables not shown here are race, ethnicity, occupation, state of residence, and metropolitan residence dummy variables. Additionally, the 1980 and 1990 samples include dummy variables for not being able to speak English and school enrollment in the previous year. All estimates are significant at the 1% level unless noted otherwise. 1 Significant at the 5% level. 2 Significant at the 10% level. 3 not significant.

Table 13-3 Sample Selection Corrected and OLS Estimates of the Single Male Log of Wages

Single Male Log of Wages	1970		1980		1990	
	Heckit	OLS	Heckit	OLS	Heckit	OLS
Experience	0.031	0.043	0.030	0.033	0.035	0.037
Experience Squared	-0.0003	-0.0004	-0.0003	-0.0004	-0.0005	-0.0005
Teenager	-0.152	-0.242	-0.120	-0.096	-0.124	-0.098
Age Twenty	0.024[3]	0.071	-0.011[3]	0.003[3]	0.008[3]	0.014[3]
Age 45-59	-0.192	-0.249	-0.123	-0.146	-0.077	-0.088
Age Sixty	-0.219	-0.450	-0.236	-0.282	-0.239	-0.235
Age 70+	-0.427	-0.845	-0.454	-0.534	-0.384	-0.407
Education	0.054	0.065	0.058	0.061	0.060	0.060
No. Children 1<age<5	0.058	0.096	-0.006[3]	0.000[3]	0.019[3]	0.023[2]
No. Children age>=5	0.032	0.056	0.071	0.076	0.055	0.054
Local Unemployment	18.784	17.340	-0.657[3]	-0.591[3]	-1.842	-1.773
Lambda	-0.561		-0.137		0.066[1]	
R-Square	0.221	0.220	0.144	0.139	0.179	0.173

Other variables not shown here are race, ethnicity, occupation, state of residence, and metropolitan residence dummy variables. Additionally, the 1980 and 1990 samples include dummy variables for not being able to speak English and school enrollment in the previous year. All estimates are significant at the 1% level unless noted otherwise. 1 Significant at the 5% level. 2 Significant at the 10% level. 3 not significant.

Chapter 16 Estimate of transportation time to work

Table 13-4 OLS Estimate of the Transportation Time to Work in 1980

Transportation Time to Work 1980		
R-square		0.086
Dependent Mean in Minutes		21.854
Variable	Parameter Estimate	Standard Error
Intercept	27.889	0.230
Age	0.032	0.002
Female	-3.961	0.053
Married	1.394	0.059
No. Autos	-0.515	0.034
No. Trucks	0.525	0.047
Number of Persons in Hhld.	0.130	0.018
Black	4.003	0.095
American Indian	1.873	0.369
Chinese	1.759	0.414
Japanese	-0.633	0.431
Rest of Asia	0.714	0.270
Race Other	-0.259	0.523
Hispanic Ethnicity	0.233	0.130

Other Variables not shown here are dummy variables for Standard Metropolitan Statistical Areas.

Table 13-5 OLS Estimate of the Transportation Time to Work in 1990

Transportation Time to Work 1990		
R-square		0.0585
Dep Mean in Minutes		22.3576
		Parameter
Variable	Estimate	Error
Intercept	19.322	0.223
Age	0.004	0.001
Female	-3.282	0.034
Married	1.396	0.038
No. of Vehicles	0.042	0.017
Number of Persons in Hhld	0.000	0.013
Black	2.217	0.065
American Indian	0.570	0.208
Chinese	1.756	0.209
Japanese	0.153	0.283
Rest of Asia	0.438	0.132
Race Other	0.272	0.126
Hispanic Ethnicity	-0.358	0.092

Other Variables not shown here are dummy variables for Metropolitan Areas.

Table 13-6 Logit Estimation of the Probability of Birth (Log(p/1-p)=XB, where p=Prob(birh=1))

Sample Year	1970			1980			1990		
Specification	Simple	Simple w/ State Dum	Full	Simple	Simple w/ State Dum	Full	Simple	Simple w/ State Dum	Full
Elasticities									
Age	10.036	10.063	9.904	13.714	13.750	14.22	15.19	15.255	15.59
Age Squared	-8.774	-8.775	-8.724	-	-10.410	-	-	-	-
Wage OLS	-0.035	-0.037	-0.524	-0.695	-0.745	-3.037	-0.459	-0.585	-
Other Hhld Income	-0.138	-0.100	0.028[1]	0.003[3]	0.008[3]	0.060	0.064	0.065	0.074
Tax Value State	0.004	-0.070	-	-	-0.269	-0.172	0.003[3]	-0.008[3]	0.010
State Tax Rate	-0.102	-0.330	-0.255	-	-0.109	-0.106	-0.029	-0.215	-
EITC				0.042	0.037	0.027	0.037	0.036	0.027
Education	-0.343	-0.286	0.423	0.147	0.200	1.358	0.286	0.413	1.332
Average fixed effects for Dummy and Discrete Variables									
Married	715.9	737.2	57.6	715.9	878.2	219.9	469.7	484.6	160.9
Married Quarter 1			693.4			69.7			
Married Quarter 2			771.7			76.9			
Married Quarter 3			743.6			78.5			
Married Quarter 4			722.4			72.8			
Husband Labor			83.2			117.8			194.4
No. Children 1<	10.8	7.1	82.6	10.8	3.8	75.0	12.9	11.2	130.8
No. Children age	-13.6	-13.9	11.3	-13.6	-27.5	25.5	-26.8	-27.4	34.4
Twins at First Birth			-7.1[3]			36.8			12.7[2]
Twins at Second			-10.6[3]			-39.7			-21.9
First 2 children			1.8[3]			14.2			7.0
Two or More			-51.7			-60.7			-58.8
Husb. Part. * No. Child			-44.6			-34.8			-47.1
Husb. Part. * No. Child			-18.4			-35.1			-37.1
Teenager			-33.4			9.8			52.7
- 2 Log L									
Intercept and	138850	138332	13249	15967	158860	15253	16911	16872	1630
Intercept Only			17736			19949			2043

All estimates are significant at the 1% level unless noted otherwise below. 1 Significant at the 5% level. 2 Significant at the 10% level. 3 not significant. Other variables not shown here are dummy variables for immigration status, metro status, racial and ethnicity background, and for the 1980 and 1990 years indicators of English speaking capabilities, and school attendance in the previous year. In addition, all of the full specifications included occupational and state dummies. Married in quarter 1-4 are all statistically different form each other in both 1970 and 1980. EITC is created for all women regardless of number of children in household.

Chapter 18 Summary of Predicted Transportation and Local Unemployment

Table 13-7 Summary Statistics for Predicted Variables

Variable	N	Mean	Std Dev	Minimum	Maximum
TRANHAT	2014364	21.21	5.17	8.70	44.09
LUNEMP	2347518	0.03	0.01	0.01	0.08

Table 13-8 Estimate of Household Income for 1970, 1980, and 1990

Estimate of Household Income	1990		1980		1970*	
R-square	0.3953		0.4513		0.4521	
Observations	864248		716110		554575	
Dep Mean	37.76053		20.24584		9828.490 3	
Variable	Paramet Estimate	Error	Paramet Estimate	Error	Paramet Estimate	Error
Intercept	-33.348	0.421	-12.311	0.200	-1771.5	111.8
Experience	0.311	0.008	0.307	0.003	128.8	1.8
Experience Squared	-0.007	0.000	-0.004	0.000	-1.6	0.0
Black	-2.263	0.108	-1.277	0.048	-694.3	29.8
American Indian	-2.630	0.340	-1.475	0.180	-281.4	149.4
Chinese	-1.133	0.416	-0.696	0.239	-543.0	182.1
Japanese	2.623	0.524	1.578	0.250	383.4	157.7
Rest of Asia	-3.003	0.289	-1.922	0.165	-772.6	179.4
Race Other	-0.498	0.234	-0.258	0.273	-873.7	242.8
Hispanic Ethnicityity	-2.592	0.174	-1.699	0.075	-440.2	45.2
Born in the US	0.023	0.252	-0.196	0.138	59.5	76.3
No English	4.734	0.435	2.059	0.214		
Education	2.003	0.012	0.811	0.005	302.2	3.0
No of Children	-1.861	0.069	-1.103	0.033	-544.2	14.7
No of Children <5	-2.363	0.069	-2.358	0.031	-1207.2	15.4
Married	2.147	0.298	-0.581	0.151	-1187.7	62.9
Female	-2.433	0.085	-0.895	0.043	-1411.0	32.4
Immigrant Status	0.698	0.265	0.292	0.142	435.0	77.1
Enrolled in School Prev. Yr.	-5.198	0.126	-3.084	0.062		
Worked in Previous Year	7.278	0.084	5.322	0.048	2796.5	26.6
Metro Status	6.777	0.074	2.658	0.035	1104.2	19.7
Farm	-0.607	0.155	-0.605	0.077	-212.6	45.3
No. Autos			4.329	0.020		
No. Trucks			1.378	0.028		
No. Vehicles	6.862	0.034				
Number of Families	4.447	0.108	1.624	0.055	-1610.3	34.9
No. of Couples	6.921	0.310	4.315	0.156	2317.9	64.4
No. Person Records	3.024	0.061	1.955	0.030	898.0	13.6

Telephone Availability			630.4	24.5
No. of Televisions			1348.1	17.0
Television with UHF			448.9	17.1
Battery Powered Radios			528.9	19.2
Clothes Washing Machine			-476.8	26.4
Clothes Dryer			1018.2	19.1
Dishwasher			3131.6	22.4
Freezer			294.6	18.9

Other variables not shown here are state and occupation dummies. * The 1970 dependent is in actual dollars while the 1990 and 1980 estimates are in thousands of dollars.

Chapter 20 Quarter of Marriage Frequency Tables

Table 13-9 Quarter of Marriage by Current Marital Status

Frequency Percent Row Pct **Col Pct**	Table of marital status by quarter of first marriage 1980 Never Married	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Married Spouse Present	0	64305	103063	102821	83164	353353
	0	10.42	16.69	16.65	13.47	57.23
	0	18.2	29.17	29.1	23.54	
	0	**80.41**	**82.15**	**83.08**	**82.08**	
Married Spouse Absent	0	1085	1340	1174	1122	4721
	0	0.18	0.22	0.19	0.18	0.76
	0	22.98	28.38	24.87	23.77	
	0	**1.36**	**1.07**	**0.95**	**1.11**	
Separated	0	3448	4718	4502	3925	16593
	0	0.56	0.76	0.73	0.64	2.69
	0	20.78	28.43	27.13	23.65	
	0	**4.31**	**3.76**	**3.64**	**3.87**	
Divorced	0	8782	13019	12232	10386	44419
	0	1.42	2.11	1.98	1.68	7.19
	0	19.77	29.31	27.54	23.38	
	0	**10.98**	**10.38**	**9.88**	**10.25**	
Widowed	0	2354	3315	3038	2725	11432
	0	0.38	0.54	0.49	0.44	1.85
	0	20.59	29	26.57	23.84	
	0	**2.94**	**2.64**	**2.45**	**2.69**	
Never Married	186890	0	0	0	0	186890
	30.27	0	0	0	0	30.27
	100	0	0	0	0	

	100	0	0	0	0	
Total	186890	79974	125455	123767	101322	617408
	30.27	12.95	20.32	20.05	16.41	100

Table 13-10 Quarter of Marriage by Birth Status 1980

Frequency Percent Row Pct **Col Pct**	Table of Observed Birth by Quarter of First Marriage 1980 Never Married	 Quarter 1	 Quarter 2	 Quarter 3	 Quarter 4	 Total
No Birth	193276 30.57 32.27 97.89	75587 11.96 12.62 93.56	118228 18.7 19.74 93.33	116181 18.38 19.4 92.95	95614 15.12 15.97 93.46	598886 94.73
Birth	4165 0.66 12.50 2.11	5203 0.82 15.62 **6.44**	8447 1.34 25.36 **6.67**	8806 1.39 26.43 **7.05**	6692 1.06 20.09 **6.54**	33313 5.27
Total	197441 31.23	80790 12.78	126675 20.04	124987 19.77	102306 16.18	632199 100

Table 13-11 Quarter of Marriage by Number of Times Married 1980

Frequency Percent Row Pct **Col Pct**	Table of Marriage number by quarter of first marriage 1980 Never Married	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
N/A	187948 30.59 100 100	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	187948 30.59
Married Once	0 0 0 0	66058 10.75 18.23 **83.42**	105488 17.17 29.1 **84.84**	105512 17.17 29.11 **85.98**	85396 13.9 23.56 **85.13**	362454 58.98
Married Twice or More	0 0 0 0	13128 2.14 20.48 **16.58**	18846 3.07 29.41 **15.16**	17199 2.8 26.84 **14.02**	14917 2.43 23.28 **14.87**	64090 10.43
Total	187948 30.59	79186 12.89	124334 20.23	122711 19.97	100313 16.32	614492 100

Table 13-12 Gender of Children by Birth Status 1980

Frequency Percent **Row Pct** Col Pct	First Two Children Same Gender by Observed Birth No Birth	 Birth	 Total
First Two Children not Same Gender	120142 56.57 **96.34** 59.02	4559 2.15 **3.66** 51.57	124701 58.71
First two Children Same Gender	83410 39.27 **95.12** 40.98	4282 2.02 **4.88** 48.43	87692 41.29
Total	203552 95.84	8841 26.54	212393 100.00

Chapter 22 **Appendix B: LIFT Base Tables**

Table 13-13 Base LIFT Macroeconomic Summary

	1996	2000	2010	2015	2020	2030	2040	2050
Potential GNP, bil 77$	3104.0	3288.9	3893.2	4224.5	4537.5	5181.5	5873.5	6691.2
Gross Domestic Product,bil 77$	3206.6	3304.7	3912.6	4226.8	4519.9	5155.0	5829.8	6595.6
Components, bil 77$								
Personal consumption	2198.4	2221.9	2490.7	2664.0	2815.4	3199.2	3632.5	4156.3
Fixed investment	600.2	652.2	907.4	1023.7	1145.8	1435.3	1754.5	2134.3
Exports	493.5	546.0	769.2	868.7	943.5	1041.5	1133.8	1215.8
Imports	624.8	669.0	856.6	941.8	1011.3	1178.2	1376.4	1624.7
Federal government	184.8	184.8	184.8	184.8	184.8	184.8	184.8	184.8
State & local gov.	330.9	352.0	397.7	410.5	424.3	453.8	480.6	506.4
Price Level and Inflation Indicators								
GNP deflator (77=100)	246.9	270.9	367.4	427.6	501.3	686.0	930.2	1256.6
PCE deflator (77=100)	324.7	363.6	513.2	606.2	721.7	1007.3	1378.3	1862.2
Avg Hourly compensation	275.0	315.1	455.5	552.2	672.9	992.8	1457.7	2138.5
Private Labor Productivity	141.8	146.7	163.2	171.8	181.2	200.2	221.4	245.4
GNP Gap, % of potential	103.3	100.5	100.5	100.1	99.6	99.5	99.3	98.6
Employment Indicators								
Total jobs, mil	133.7	134.0	144.8	148.8	151.0	156.4	160.8	164.9
Labor force, mil	133.9	135.5	146.7	150.2	152.5	157.7	162.5	166.7
Unemployment rate, %	4.7	5.2	6.1	5.9	6.0	5.8	5.9	6.0
Financial Indicators								
M2 (bil $)	4314.6	5027.8	7644.2	9521.7	11737.9	17617.1	26247.0	39234.1
Monetary Base, StL. (bil $)	504.2	630.7	1101.2	1448.7	1879.8	3093.3	4982.3	7938.5
Three month T-bills, %	6.0	4.4	5.6	5.7	5.8	5.8	5.9	5.9
10-year note rate, %	6.9	5.4	6.5	6.7	6.8	7.0	7.2	7.4
Foreign Indicators								
U.S./Foreign Price levels	1.7	1.7	1.8	1.9	1.9	2.1	2.2	2.3
U.S. – foreign real int. rate	0.0	-0.7	-0.1	-0.1	-0.1	0.0	0.1	0.1
Avg foreign demand for US exp	399.4	481.8	774.7	893.9	963.4	1062.7	1165.5	1268.3
Average effective relative prices								
Exports, US/foreign (1977=100)	96.4	98.9	97.8	97.3	95.9	95.2	95.6	96.9

Imports, foreign/US (1977=100)	91.6	88.4	87.7	87.7	88.6	89.2	88.8	87.6
Exchange rate scaler	1.0	1.0	1.0	1.1	1.1	1.1	1.2	1.2
Real disposable income	1721.1	1715.9	1949.2	2089.4	2209.1	2512.3	2856.2	3261.3
Savings rate, pct	4.6	2.9	4.3	4.4	4.4	4.5	4.5	4.0
Federal surplus, bil $	-107.1	81.8	171.9	233.8	324.2	510.8	660.2	955.7
Relative to GNP	-1.4	0.9	1.2	1.3	1.4	1.4	1.2	1.2
Factor Payments								
Labor compensation	4463.1	5106.6	8166.3	10287.1	12833.0	19713.7	29546.3	44024.2
Net interest	435.0	524.0	974.8	1277.0	1667.5	2761.4	4417.8	6972.8
Corporate profits	652.9	751.8	1152.6	1436.0	1817.9	2976.4	4890.9	8000.6
Proprietor income	511.9	536.5	708.3	840.0	1029.9	1693.2	2842.5	4804.0
Depreciation	535.1	615.0	1092.7	1405.2	1795.7	2834.7	4409.6	6832.5

Table 13-14 Base LIFT Employment and Population

	1996	2000	2010	2015	2020	2030	2040	2050
Unemployment rate	4.7	5.2	6.1	5.9	6	5.8	5.9	6
Unemployed (millions)	6.3	7.1	8.9	8.9	9.1	9.1	9.7	10
Civilian jobs (millions)	133.7	134	144.8	148.8	151	156.4	160.8	164.9
Private	112.8	112	120.5	124	125.6	130	133.6	137
Agric,Mining,Structures	11.1	11.1	12.1	12.4	12.7	13.4	14.1	14.9
Durable goods manufacturing	10.9	10.6	11.3	11.5	11.7	11.8	11.8	11.8
Non-durable goods mfg	7.5	7.2	6.9	6.8	6.6	6.1	5.7	5.4
Transp,Communic,Utilities	6.9	6.6	6.7	6.7	6.6	6.5	6.4	6.3
Trade	29.8	29.3	31.2	32.3	32.8	34.2	35.5	36.9
Finance,Insurance,Real Estate	7.6	7.8	8.7	8.9	9	9.2	9.5	9.9
Health	10.6	10.5	10.8	10.9	10.6	10.7	10.5	9.8
Other services (w educ)	27.1	27.6	31.5	33.2	34.4	36.9	39	41
Domestic servants	1.3	1.3	1.3	1.2	1.2	1.2	1.1	1.1
Civilian gov't.	20.9	22	24.3	24.8	25.3	26.4	27.2	27.9
Federal defense	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Federal non-defense	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
State & local education	9.7	10.6	12.4	12.6	12.9	13.5	14	14.4
State & local health	1.7	1.7	1.6	1.6	1.6	1.5	1.4	1.2
State & local other	5.4	5.5	6	6.3	6.5	7	7.4	7.7
Federal govt enterprises	1	1.1	1.1	1.1	1.2	1.3	1.3	1.4
State & local govt enterprises	1	1	1	1	1	1	1	1
Multiple job holders	6	5.6	7.1	7.4	7.5	7.8	8	8.2
Military jobs	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Annual hours worked Private sector (billions)	206.9	205.8	220.6	227.4	231.3	240.4	247.5	254
Avg annual hrs per employee	1856.9	1859.4	1849.7	1853	1859.4	1866.6	1867.7	1868.6
LABOR PRODUCTIVITY - private (GNP-GOVT COE) / Prvt	14.2	14.7	16.3	17.2	18.1	20	22.1	24.5

hrs

Table 13-15 Employment and Population Base Demographic Results

Employment and Population	1996	2000	2010	2015	2020	2030	2040	2050
Population, total (in millions)	265.6	275	296.9	307.6	318	336.4	350.6	362
0-4 years	19.6	19.5	19.7	20.2	20.6	20.7	21	21.1
5-14 years	38.5	39.5	39.7	39.9	40.9	42.3	42.6	43.1
15-19 years	18.3	19.3	20.7	20.5	20.3	21.3	21.7	21.9
20-29 years	37.1	37	40.5	42	42.6	42.5	44.4	45
30-39 years	43.8	41.5	38.5	39.9	41.9	44.1	43.9	45.9
40-49 years	39.2	42.3	41.3	38.6	38.5	41.9	44	44
50-64 years	35.2	41.3	57.2	61.4	60.6	55.9	59.4	63.7
65-74 years	18.8	18.1	20.9	25.9	31.2	36.6	32.9	34.8
75-84 years	11.4	12.3	12.7	12.9	15.1	23.1	27.6	25.5
85-100 years	3.7	4.2	5.6	6.1	6.3	8	13	17.1
Total Fertility Rate	2053.5	2046.3	2006.4	1997.2	1975.1	1954.6	1923.3	1883.3
Households	99.3	101.7	110	116.6	123.8	136.8	143.7	150.2
% head aged 25-35	20.2	20.4	21.7	22	21.9	22	22.5	22.7
% with 2 earners	0.5	0.5	0.5	0.6	0.6	0.5	0.5	0.5
Population Age (16-85)	195.5	203.5	222.9	232.3	241	255.1	263.6	270.3
Teenagers 16-19	14.2	15.3	16.3	16.2	16	16.7	17.1	17.2
Men, 20-64	74.1	77.5	85.1	87.3	88.2	88.8	92.5	96
Women, 20-64	78	81.3	89.1	91.2	92	92.1	95.7	99
Men, 65-84	12.4	12.6	14.4	17	20.6	26.8	27.5	28.1
Women, 65-84	16.7	16.7	17.9	20.5	24.3	30.8	30.7	30
Civilian Labor Force, millions	133.9	135.5	146.7	150.2	152.5	157.7	162.5	166.7
Teenagers 16-19	7.8	7.4	7.8	7.7	7.6	7.9	8.1	8.1
Men, 20-64	65.8	66.9	72	73.3	73.8	75	77.9	80.1
Women, 20-64	56.5	57.5	62	63.2	63.8	64.9	67.3	69.1
Men, 65-84	2.2	2.2	2.9	3.6	4.5	5.9	5.6	5.9
Women, 65-84	1.6	1.4	1.9	2.3	2.9	3.9	3.5	3.6
Labor Force Participation Rates								
Teenagers, 16-19	54.9	48.4	47.6	47.7	47.5	47.5	47.2	46.9
Men, 20-64	88.8	86.3	84.6	84	83.6	84.5	84.2	83.5
Women, 20-64	72.5	70.7	69.6	69.3	69.4	70.5	70.3	69.8

Men, 65-84	18	17.7	20.3	21.3	21.8	22.1	20.4	20.8
Women, 65-84	9.5	8.6	10.5	11.4	11.8	12.6	11.4	11.9

Table 13-16 Real Wages and Salaries and Proprietor Income per Hour, 94 $ per hour

	1996	2000	2010	2015	2020	2030	2040	2050
All Private Industries	14	13.9	14.7	15.1	15.3	15.7	16.5	17.6
1 Farm & agricultural services	11.6	11.5	10.6	10.7	10.8	11.6	12.1	12.8
2 Crude petrol. & nat. gas	25.3	20.8	19.7	19.6	19.6	20.1	20.8	22.2
3 Mining	20.8	20.6	22.9	23.2	23.5	24.2	25.4	27.3
4 Contract construction	15.4	16.3	16.9	16.8	16.6	16	17.2	18.8
5 Food & tobacco	14.5	14.1	14.8	15	15.1	15.3	16.1	17.4
6 Textile mill products	10.7	10.8	11.1	11.2	11.2	11.3	12	12.9
7 Apparel and related product	9.7	9.7	9.9	10	10	9.9	10.5	11.3
8 Paper and allied products	17.2	16.8	17.5	17.7	17.8	18.3	19.2	20.7
9 Printing and publishing	16.9	16	15.8	15.9	15.9	16.1	17.1	18.4
10 Chemical & allied product	27.9	21.9	22.3	22.6	22.9	24	25.2	26.9
11 Petroleum & related ind.	24.8	21.5	23.2	23.5	23.5	23.8	25	26.8
12 Rubber & misc plastic	15.3	15	15.4	15.5	15.5	15.5	16.4	17.7
13 Leather and leather	9.2	10.8	11	11.1	11.1	11.3	11.9	12.9
14 Lumber & wood products,	14.1	12	12.5	12.5	12.5	12.5	13.1	14
15 Furniture and fixtures	11.9	11.9	12.1	12.3	12.3	12.5	13.1	14.1
16 Stone, clay, & glass	14.6	14.3	14.9	15.1	15.1	15.2	16	17.2
17 Primary metal industries	16	15.1	16.7	16.9	16.7	16.2	17.1	18.5
18 Metal products	14.8	15.7	16.5	16.7	16.7	16.7	17.6	19.1
19 Trans eq + ord ex motor	21.5	19.2	19.8	20	19.9	20.1	21.1	22.6
20 Machinery, excpt electrical	18.2	18.2	18.8	19.1	19.2	19.7	20.7	22.2
21 Electrical machinery	15.4	16.4	16	16.1	16	16	17.2	18.6
22 Motor vehicles and equip.	21.6	17	17.8	17.7	17.4	16.9	17.4	18.5
23 Instruments and related	29.5	24.9	24.8	25	25.4	27	28.1	29.7
24 Misc. manufacturing ind.	13.3	13.2	13.4	13.5	13.6	13.8	14.7	15.9
25 Railroads	20.3	19	20.1	20.2	20.2	20.8	21.8	23.3
26 Air transportation	26.6	19.3	21	21.2	21.3	21.2	22.5	24.4
27 Trucking and other trans.	12.8	13.8	14.5	14.6	14.5	14.2	15.1	16.3
28 Communications	26.5	19.7	21.2	21.4	21.6	22.2	23.3	25

30 Electric, gas, and sanitary	20.8	20.1	20.6	20.8	21	21.9	23	24.6
31 Wholesale and retail trade	12.7	12.2	11.7	11.6	11.5	11.3	11.4	11.6
32 Financial & insurance serv.	24.7	20.3	19.7	20	20.2	21.5	22.6	24.1
33 Real estate & combinations	10.5	11.4	12	12.2	12.4	13.1	13.8	14.7
34 Personal, repair, & hotels	11.1	10.6	10.4	10.5	10.6	11.1	11.6	12.5
35 Business services	21.7	21.7	20.7	20.9	21	22.2	23.1	24.4
36 Auto repair	12.4	13.2	13.5	13.7	13.9	14.5	15.4	16.5
37 Recreation, motion pictures	19	17.5	17.9	18.1	18.4	19.9	20.9	22.4
38 Educational services	10.8	11.4	11.1	11.3	11.2	11.2	12.1	13.2
51 Health services	21.3	24.8	31.8	35.9	39.7	45.8	55.6	70.1

Table 13-17 Output by Aggregate Industry (billions of 1977$)

	1996	2000	2010	2015	2020	2030	2040	2050
Total Output	5782.2	6024.9	7381.6	8031.6	8636.3	9931.2	11309	12869
Agriculture,forestry,fishery	189.4	192.3	213.7	224.5	235.1	256.4	277.7	300.6
Mining	82.2	82.2	93	103	111.9	129	146.3	164.3
Construction	202.3	207.4	240.7	256.1	269.5	301.3	333.5	368.1
Nondurables manufacturing	935.4	969.7	1165.3	1256.8	1338.8	1497.2	1655.2	1819.9
Durables manufacturing	1063.7	1118.4	1508.6	1702.4	1889.1	2273.9	2682.9	3145.4
Transportation	228.8	241.2	307.1	337	363.2	418.4	477.5	545.1
Utilities	353.1	368.8	444.4	477.6	507.8	572.7	641.8	721.1
Trade	842.5	882.3	1091.9	1197.7	1293	1510.7	1755.3	2047.2
Finance, insurance, real estate	643.6	661.9	778.9	829.1	877.2	988.2	1113.5	1262.2
Services, nonmedical	714.8	751.2	931.7	1014.3	1089	1260.8	1450.4	1675.2
Medical Services	209.6	216.7	248.5	269.9	290.6	335.1	374.9	405.2
Miscellaneous	316.5	333	357.9	363.2	371.1	387.4	400	414.9

Table 13-18 Jobs by Aggregate Industry (millions)

	1996	2000	2010	2015	2020	2030	2040	2050
Civilian jobs	133.7	134	144.8	148.8	151	156.4	160.8	164.9
Private sector jobs	112.8	112	120.5	124	125.6	130	133.6	137
Agriculture, forestry, fisheries	3.4	3.2	3	2.9	2.8	2.6	2.4	2.3
Mining	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7
Construction	7.1	7.3	8.4	8.9	9.2	10.1	11	11.9
Nondurables manufacturing	7.8	7.5	7.2	7.1	6.8	6.4	5.9	5.5
Durables manufacturing	11.2	10.9	11.6	11.8	11.9	11.9	11.9	11.9
Transportation	4.4	4.4	4.7	4.8	4.9	4.9	5	5.1
Utilities	2.5	2.3	2	1.9	1.7	1.5	1.4	1.3
Trade	29.8	29.3	31.2	32.3	32.8	34.2	35.5	36.9
Finance, insurance, real estate	7.6	7.8	8.7	8.9	9	9.2	9.5	9.9
Services, nonmedical	28.4	28.9	32.8	34.5	35.6	38	40.1	42.1
Medical services	10	10	10.3	10.4	10.2	10.3	10.1	9.5
Civilian Government	20.9	22	24.3	24.8	25.3	26.4	27.2	27.9

Table 13-19 Wage and Salary Income by Aggregate Industry (Billions of $)

	1996	2000	2010	2015	2020	2030	2040	2050
All Industries	3674.9	4072.6	6467.2	8043.4	9835.5	14580	21600	31963
Farm & agricultural services	34.5	29.6	38.5	45.1	53.2	74.7	99.3	133
Mining	27.6	27.5	40.9	50.8	62.3	92.5	135.7	201.9
Contract construction	172.2	206.2	342.7	429.8	526.7	774.3	1232.4	1964.5
Nondurable manufacturing	259	266.9	377.2	441.4	508.7	669.4	892.6	1202.9
Durable manufacturing	416.1	436.2	674.9	818.5	982.8	1392.5	2006.6	2914.2
Transportation	124.8	130.4	208.1	253.1	300.7	414.9	606.6	898.6
Utilities	106.3	103.8	134.1	149.4	166.9	212.5	273.1	360.2
Wholesale and retail trade	592.4	656.8	1018.4	1275.7	1570.1	2380	3599.7	5467

Finance, insurance, real estate	296.1	293.9	457.5	559.3	684.8	1046.1	1554.7	2335.6
Services, non-medical	660.1	736	1176.6	1498	1879.9	2978.3	4546.5	6910.6
Health services	321.2	440.1	851.3	1139.3	1439.6	2137.1	3048.4	4184.1
Government	664.6	745.2	1147.1	1383.4	1659.8	2407.9	3604.5	5390.2
Federal general administ.	150.2	153.9	212.2	246.2	282.6	378.9	542.2	784.5
State & local general admin.	447.7	515.3	825.7	1006.5	1222.1	1809.7	2734.2	4112.8
Government enterprises	66.7	76	109.3	130.7	155.1	219.3	328	493

Table 13-20 Real Wages and Salaries and Proprietor Income per Hour, 94 $ per hour, Retirement Age 67 in 2014 Simulation RET67

Percentage Deviations from Base	2010	2015	2020	2030	2040	2050
All Private Industries	0.0	0.1	0.1	-0.2	0.0	-0.2
1 Farm & agricultural services	0.4	1.6	1.7	-0.3	-0.2	-0.4
2 Crude petrol. & nat. gas	0.5	2.4	1.9	-0.7	-0.6	-1.1
3 Mining	0.5	2.2	1.8	-0.7	-0.6	-1.2
4 Contract construction	-0.2	-1.1	-1.5	-0.5	-0.4	-0.7
5 Food & tobacco	0.2	0.8	0.5	-0.5	-0.4	-0.8
6 Textile mill products	-0.1	-0.2	-0.3	-0.3	-0.2	-0.4
7 Apparel and related products	-0.4	-1.3	-1.1	-0.1	0.1	-0.1
8 Paper and allied products	0.2	0.9	0.7	-0.4	-0.4	-0.7
9 Printing and publishing	-0.2	-0.8	-0.7	-0.1	-0.1	-0.2
10 Chemical and allied products	0.3	1.3	1.3	-0.3	-0.3	-0.5
11 Petroleum and related industri	0.4	2.0	1.6	-0.6	-0.6	-1.1
12 Rubber & misc plastic products	-0.2	-0.5	-0.6	-0.2	-0.2	-0.4
13 Leather and leather products	-0.2	-0.8	-0.7	-0.1	0.0	-0.1
14 Lumber & wood products,ex furn	0.2	0.8	0.5	-0.4	-0.3	-0.6
15 Furniture and fixtures	-0.2	-0.5	-0.4	-0.1	0.0	-0.2
16 Stone, clay, & glass products	0.0	0.4	0.2	-0.4	-0.3	-0.7
17 Primary metal industries	0.0	0.6	0.2	-0.6	-0.5	-1.1
18 Metal products	-0.1	0.0	-0.2	-0.4	-0.3	-0.7
19 Trans eq + ord ex motor veh	0.2	0.8	0.5	-0.4	-0.4	-0.7
20 Machinery, except electrical	0.1	0.6	0.5	-0.3	-0.3	-0.6
21 Electrical machinery	-0.2	-1.4	-1.6	-0.2	-0.2	-0.2
22 Motor vehicles and equipment	0.2	1.0	0.7	-0.5	-0.4	-0.9
23 Instruments and related prod.	0.7	2.2	1.8	-0.4	-0.4	-0.6
24 Misc. manufacturing ind.	0.0	-0.4	-0.6	-0.3	-0.3	-0.4
25 Railroads	0.8	2.8	2.2	-0.8	-0.8	-1.2
26 Air transportation	0.3	1.3	0.6	-0.7	-0.7	-1.2
27 Trucking and other transport	-0.2	-0.5	-0.7	-0.4	-0.3	-0.7
28 Communications	0.6	2.3	1.6	-0.8	-0.8	-1.3
30 Electric, gas, and sanitary	0.4	1.6	1.3	-0.5	-0.5	-0.8
31 Wholesale and retail trade	-0.1	-0.1	0.2	0.1	0.3	0.3
32 Financial & insurance services	0.2	0.7	0.9	-0.1	-0.1	-0.1

33 Real estate & combinations off	0.3	1.2	1.2	-0.3	-0.3	-0.5
34 Personal, repair, & hotels	0.2	0.4	0.4	-0.2	-0.2	-0.3
35 Business services	0.1	0.3	0.6	0.0	0.0	0.0
36 Auto repair	0.3	1.1	0.9	-0.4	-0.3	-0.6
37 Recreation, motion pictures	-0.2	-0.2	0.7	0.1	0.3	0.3
38 Educational services	-0.8	-2.9	-2.5	0.2	0.3	0.3
51 Health services	0.0	-0.2	-0.3	-0.6	-1.0	-1.4

Table 13-21 Real Wages and Salaries and Proprietor Income per Hour, 94 $ per hour $500 Child Tax Credit Simulation (CTC)

Percentage Deviations from Base	2000	2010	2015	2020	2030	2040	2050
All Private Industries	-0.1	-0.4	-0.5	-0.8	-1.1	-1.7	-2.4
1 Farm & agricultural services	-0.9	-1.6	-3.1	-4.5	-4.4	-5.2	-5.9
2 Crude petrol. & nat. gas	-1.7	-1.1	-2.7	-5.3	-3.4	-3.7	-3.3
3 Mining	-1.9	-0.8	-2.2	-4.9	-2.6	-2.8	-2.4
4 Contract construction	0.8	0.8	1.6	1.7	2.1	1.9	1.7
5 Food & tobacco	-0.6	-0.5	-1.1	-2.4	-1.8	-2.3	-2.6
6 Textile mill products	0.0	-0.4	-0.4	-0.9	-1.4	-2.2	-3.2
7 Apparel and related products	0.7	-0.2	0.6	0.8	-0.8	-1.9	-3.3
8 Paper and allied products	-0.7	-0.9	-1.6	-2.9	-2.5	-3.1	-3.5
9 Printing and publishing	0.5	-0.4	-0.1	-0.1	-1.4	-2.4	-3.7
10 Chemical and allied products	-0.9	-1.4	-2.6	-4.0	-3.8	-4.5	-5.1
11 Petroleum and related industri	-1.7	-0.9	-2.1	-4.6	-2.6	-2.9	-2.6
12 Rubber & misc plastic products	0.3	-0.5	-0.3	-0.6	-1.5	-2.4	-3.5
13 Leather and leather products	0.5	-0.4	-0.1	-0.1	-1.3	-2.3	-3.6
14 Lumber & wood prod.,ex furn.	-0.6	-0.4	-0.7	-1.7	-0.4	0.0	0.8
15 Furniture and fixtures	0.2	-0.6	-0.3	-0.6	-1.7	-2.7	-4.0
16 Stone, clay, & glass products	-0.4	-0.5	-0.8	-1.9	-1.6	-2.3	-2.8
17 Primary metal industries	-1.0	0.1	0.1	-1.8	-0.1	-0.4	-0.3
18 Metal products	-0.1	-0.2	-0.1	-1.0	-0.8	-1.5	-2.1
19 Trans eq + ord ex motor veh	-0.5	-0.9	-1.6	-2.8	-2.6	-3.3	-3.8
20 Machinery, except electrical	-0.5	-0.9	-1.5	-2.5	-2.5	-3.2	-3.9
21 Electrical machinery	1.3	-0.2	0.1	1.0	-0.7	-1.8	-3.1
22 Motor vehicles and equipment	-1.0	-1.0	-1.7	-3.6	-2.8	-3.6	-4.0
23 Instruments and related prod.	-1.0	-2.0	-4.2	-5.7	-5.1	-6.0	-6.4
24 Misc. manufacturing ind.	0.5	-0.2	-0.5	-0.5	-1.0	-1.8	-2.6
25 Railroads	-1.9	-1.4	-3.5	-6.0	-3.8	-4.0	-3.7
26 Air transportation	-0.9	0.2	-0.7	-2.5	-0.5	-0.6	-0.2
27 Trucking and other transport	0.2	0.5	1.0	0.4	0.6	0.1	-0.5
28 Communications	-1.6	-0.9	-2.7	-5.1	-2.8	-3.1	-2.5
30 Electric, gas, and sanitary	-1.0	-1.2	-2.5	-4.2	-3.3	-3.9	-4.2
31 Wholesale and retail trade	-0.1	-0.6	-0.5	-0.6	-0.8	-0.3	0.5
32 Financial & insurance services	-0.4	-1.6	-2.5	-3.1	-4.1	-5.1	-6.3

33 Real estate & combinations off	-0.8	-1.1	-2.3	-3.5	-3.4	-4.2	-4.9
34 Personal, repair, & hotels	-0.2	-0.8	-1.5	-1.9	-2.5	-3.4	-4.3
35 Business services	-0.2	-1.5	-2.1	-2.4	-3.8	-4.9	-6.3
36 Auto repair	-0.7	-0.7	-1.6	-2.8	-2.3	-2.7	-3.1
37 Recreation, motion pictures	-0.1	-1.5	-0.8	-1.0	-3.2	-3.9	-5.7
38 Educational services	2.0	0.5	2.1	3.9	0.9	-0.5	-2.6
51 Health services	0.1	-0.5	-0.7	-0.8	-1.1	-1.8	-2.8

Table 13-22 Real Wages and Salaries and Proprietor Income per Hour, 94 $ per hour $500 Child Tax Credit Simulation Surplus Neutral

Percentage Deviations from Base	2000	2010	2015	2020	2030	2040	2050
All Private Industries	-0.1	-0.4	-0.5	-0.7	-0.7	-0.8	-0.9
1 Farm & agricultural services	-0.9	-1.6	-3.3	-4.6	-4.2	-4.4	-4.1
2 Crude petrol. & nat. gas	-1.6	-1.1	-3.0	-6.3	-3.8	-3.7	-2.1
3 Mining	-1.7	-0.8	-2.5	-5.9	-3.2	-3.0	-1.3
4 Contract construction	0.8	0.8	1.4	1.4	2.0	2.2	2.9
5 Food & tobacco	-0.6	-0.5	-1.3	-2.9	-1.8	-1.7	-0.9
6 Textile mill products	0.0	-0.5	-0.3	-0.9	-1.0	-1.2	-1.3
7 Apparel and related products	0.6	-0.3	0.7	1.2	0.0	-0.5	-1.3
8 Paper and allied products	-0.7	-0.9	-1.7	-3.3	-2.4	-2.4	-1.7
9 Printing and publishing	0.5	-0.5	-0.1	0.2	-0.7	-1.1	-1.6
10 Chemical and allied products	-0.9	-1.5	-2.7	-4.2	-3.6	-3.7	-3.3
11 Petroleum and related industri	-1.6	-0.9	-2.3	-5.5	-3.1	-2.9	-1.4
12 Rubber & misc plastic products	0.3	-0.5	-0.2	-0.5	-0.9	-1.2	-1.4
13 Leather and leather products	0.4	-0.4	0.0	0.3	-0.6	-1.0	-1.6
14 Lumber & wood products,ex furn	-0.6	-0.3	-0.8	-2.2	-0.6	0.2	1.9
15 Furniture and fixtures	0.2	-0.6	-0.2	-0.4	-1.1	-1.5	-2.0
16 Stone, clay, & glass products	-0.4	-0.5	-0.9	-2.3	-1.5	-1.6	-1.1
17 Primary metal industries	-0.8	0.1	0.0	-2.6	-0.6	-0.5	0.6
18 Metal products	-0.1	-0.2	-0.2	-1.3	-0.7	-0.8	-0.4
20 Machinery, except electrical	-0.4	-0.9	-1.6	-2.8	-2.3	-2.4	-2.0
21 Electrical machinery	1.2	-0.2	0.0	1.4	0.2	-0.1	-0.4
22 Motor vehicles and equipment	-0.9	-1.0	-1.8	-4.3	-3.0	-3.3	-2.5
23 Instruments and related prod.	-1.0	-2.1	-4.5	-6.1	-5.0	-5.1	-4.3
24 Misc. manufacturing ind.	0.5	-0.2	-0.6	-0.4	-0.6	-0.7	-0.5
25 Railroads	-1.7	-1.4	-3.9	-7.1	-4.2	-3.8	-1.9
26 Air transportation	-0.8	0.2	-1.1	-3.4	-1.0	-0.7	1.0
27 Trucking and other transport	0.2	0.5	1.0	0.1	0.8	0.7	1.0

28 Communications	-1.4	-0.9	-3.1	-6.3	-3.4	-3.1	-1.0
30 Electric, gas, and sanitary	-1.0	-1.2	-2.7	-4.8	-3.4	-3.3	-2.3
31 Wholesale and retail trade	-0.1	-0.6	-0.4	-0.3	-0.2	0.7	1.7
32 Financial & insurance services	-0.4	-1.6	-2.5	-2.9	-3.4	-3.7	-4.1
33 Real estate & combinations off	-0.8	-1.1	-2.4	-3.6	-3.2	-3.3	-3.0
34 Personal, repair, & hotels	-0.2	-0.8	-1.6	-1.8	-2.1	-2.3	-2.3
35 Business services	-0.2	-1.5	-2.1	-2.0	-3.0	-3.4	-4.2
36 Auto repair	-0.7	-0.7	-1.7	-3.1	-2.2	-2.2	-1.6
37 Recreation, motion pictures	-0.2	-1.5	-0.3	-0.3	-2.1	-2.2	-3.6
38 Educational services	1.8	0.4	2.4	5.0	2.3	1.7	0.0
51 Health services	0.1	-0.5	-0.8	-0.8	-0.8	-0.4	0.6

Table 13-23 Real Wages, Salaries and Proprietor Income per Hour, 94 $ per hour $500 Child Tax Credit Simulation Half EITC parameter

Percentage Deviations from Base	2000	2010	2015	2020	2030	2040	2050
All Private Industries	0.0	-0.1	-0.2	-0.5	-0.7	-0.9	-1.2
1 Farm & agricultural services	-0.4	-0.6	-1.2	-2.3	-2.1	-1.9	-1.9
2 Crude petrol. & nat. gas	-0.9	-0.2	-0.2	-2.6	-2.0	-1.4	-1.1
3 Mining	-1.0	-0.1	0.1	-2.3	-1.7	-1.2	-0.8
4 Contract construction	0.3	0.5	1.0	0.9	0.4	-0.1	-0.4
5 Food & tobacco	-0.3	-0.1	0.0	-1.2	-1.2	-1.2	-1.3
6 Textile mill products	0.1	-0.1	-0.1	-0.4	-1.0	-1.3	-1.9
7 Apparel and related products	0.4	-0.1	0.0	0.4	-0.6	-1.4	-2.3
8 Paper and allied products	-0.4	-0.2	-0.3	-1.5	-1.5	-1.4	-1.6
9 Printing and publishing	0.3	-0.2	-0.3	-0.1	-0.9	-1.5	-2.2
10 Chemical and allied products	-0.4	-0.6	-0.9	-2.0	-1.9	-1.8	-1.9
11 Petroleum and related industri	-0.9	-0.1	0.0	-2.2	-1.7	-1.2	-0.9
12 Rubber & misc plastic products	0.2	-0.2	-0.2	-0.3	-0.9	-1.5	-2.1
13 Leather and leather products	0.3	-0.2	-0.3	0.0	-0.8	-1.4	-2.1
14 Lumber & wood products,ex furn	-0.3	0.0	0.0	-0.8	-0.6	-0.1	0.3
15 Furniture and fixtures	0.2	-0.3	-0.3	-0.3	-1.0	-1.5	-2.2
16 Stone, clay, & glass products	-0.2	-0.1	0.0	-0.9	-1.1	-1.3	-1.5
17 Primary metal industries	-0.4	0.3	1.0	-0.7	-0.8	-0.7	-0.8
18 Metal products	-0.1	0.1	0.3	-0.5	-0.8	-1.1	-1.5
19 Trans eq + ord ex motor veh	-0.3	-0.3	-0.3	-1.4	-1.5	-1.6	-1.8
20 Machinery, except electrical	-0.2	-0.3	-0.4	-1.3	-1.4	-1.5	-1.8
21 Electrical machinery	0.5	-0.1	-0.4	0.3	-0.5	-1.4	-2.1
22 Motor vehicles and equipment	-0.4	-0.2	-0.1	-1.6	-1.8	-1.8	-1.9
23 Instruments and related prod.	-0.7	-0.8	-1.5	-3.0	-2.4	-2.2	-2.0
24 Misc. manufacturing ind.	0.1	0.0	-0.2	-0.4	-0.7	-1.2	-1.6
25 Railroads	-1.0	-0.3	-0.6	-3.1	-2.1	-1.5	-1.0
26 Air transportation	-0.6	0.4	0.7	-1.3	-0.8	-0.6	-0.4
27 Trucking and other transport	0.2	0.4	0.8	0.2	-0.3	-0.6	-1.1
28 Communications	-0.9	-0.1	-0.1	-2.6	-1.8	-1.3	-0.8
30 Electric, gas, and sanitary	-0.6	-0.4	-0.6	-2.2	-1.8	-1.6	-1.6
31 Wholesale and retail trade	0.1	-0.3	-0.4	-0.3	-0.4	-0.1	0.3
32 Financial & insurance services	-0.1	-0.8	-1.3	-1.6	-1.8	-2.0	-2.4
33 Real estate & combinations off	-0.4	-0.4	-0.9	-1.8	-1.7	-1.6	-1.8
34 Personal, repair, & hotels	-0.1	-0.3	-0.8	-1.1	-1.3	-1.5	-1.9
35 Business services	-0.1	-0.8	-1.3	-1.3	-1.7	-2.0	-2.5
36 Auto repair	-0.3	-0.2	-0.4	-1.4	-1.3	-1.2	-1.2
37 Recreation, motion pictures	0.2	-1.0	-1.4	-0.3	-1.3	-1.5	-2.3

38 Educational services	1.0	0.0	0.1	1.9	0.3	-1.1	-2.4
51 Health services	0.1	-0.2	-0.4	-0.6	-0.9	-1.2	-1.8

Chapter 24 **Appendix C: Wage distribution by Age from 1990 PUMS**

Table 13-24 Age distribution of mean hourly wage rate and mean household income by gender and marital status

	Male		Female	
Age	Single	Married	Single	Married
Mean Hourly Wage				
teen	5.83	6.89	5.39	5.22
20	9.05	11.03	8.14	8.63
30-45	13.93	16.73	12.27	10.96
45-60	16.50	20.44	12.25	11.14
60	16.78	22.92	11.92	10.94
70+	27.81	32.22	13.50	16.10
*Mean Household Income ($1000)**				
teen	45.50	22.42	44.51	23.24
20-30	45.17	33.97	39.52	36.21
30-45	39.54	49.09	31.65	51.50
45-60	38.25	57.92	30.16	55.78
60	28.60	42.29	23.19	38.54
70+	23.89	31.50	20.12	30.42

* Mean household income for single teens reflects the income of parents.

Chapter 25 **Appendix D: Time Series Fertility Specification**

Chapter 26

Table 13-25 Time Series Regression results for two specifications for Fertility of 27-year Olds

	Intercept	Ln(f*/1-f*)	frwage	unem	RBSQ
Parameter (1)	0.51	0.58	-1.41	-2.44	
T-Stat	1.32	6.94	3.58	1.79	0.80
Elasticity (3)		0.73	-0.05	-0.01	
Parameter (2)	0.88	0.70	-0.77	-1.26	
T-Stat	8.40	7.08	3.70	1.73	0.80
Elasticity (3)		0.79	-0.06	-0.01	

(1) Regression specification is Ln(fert/1-fert) = a + b*Ln(f*/1-f*) + c*frwage + d*unem. (2) Regression specification is is Ln($fert^{0.25}$/1-$fert^{0.25}$) = a + b*Ln($f^{*0.25}$/1-$f^{*0.25}$) + c*frwage + d*unem. (3) Elasticity is the elasticity of the fertility rate with respect to the independent variable.

Table 13-25 shows the results of two different specifications for the time-series regression of fertility of 27 year olds. The first specification is the same as the one reported in chapter 5. The second specification adjusts the dependent and the f* variable by taking the fourth root. The possible advantage of taking the fourth root is that the equation is centered about 0.5. The table shows that there is no difference in the adjusted R-Square, and little difference in the elasticity of fertility with respect to the independent variables.

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