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

Timothy Dowd

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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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this project reach fruition. Opinions expressed here are mine, and do not represent the opinions

of the Health Care Financing Administration.

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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 |

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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

ZfertlagZero-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

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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.

**2**

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.

**2**

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

**3**

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

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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

1. See Ahlburg (1987) for a discussion of competing econometric based models of population and the economy.
2. 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.
3. 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.

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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

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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.

**7**

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

**8**

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, ZN, and quality of children, ZQ. 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

**9**

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, ZN, and noting that the Marshallian demand can be inverted, yields the

equality between the Hicksian and Marshallian demands: hH(P,W,U)=gH(P,W,C(·)), 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, HN and HQ, Lj=T-*lj*-HjN-HjQ,

the effect of a change in the own wage rate or the spouse’s wage rate can be decomposed in

the following manner:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1) | *¶g H jN* | = | *¶hH jN* |  |
| *¶Wi* | *¶Wi* |  |
|  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| + | *¶g H jN* | × *Li* . |  |
| *¶M* |  |
|  |  |  |

*U*

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

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

**10**

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. i¹j) 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, ZQ. 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) | *¶Lj* | = - | *¶hl j* | - | *¶h H jN* |  |
|  |  |  |  |

* *¶h HQj*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| -[ | *¶g l j* | + | *¶g H jN* | + | *¶g HQj* | ]×*L* . |

|  |  |
| --- | --- |
| *¶Wi ¶Wi* | *¶Wi* |
|  | *U* |

*U*

*¶Wi*

|  |  |  |
| --- | --- | --- |
| *¶M ¶M ¶M* | *i* |  |
|  |  |

*U*

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.

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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 ZN and ZQ 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 ZN, then the demand for the husband’s time devoted to ZN

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

1. The EITC is described in more detail in chapter three.

**12**

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 (ZN, ZQ). If the price of

births rises, then in order to observe a birth there must be an increase in the marginal utility

derived from ZN, 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:

1. *¶g B* = *¶h B*

*¶P BB¶P*

* *¶g B B* .

*¶M*

*U*

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

**13**

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.

1. *¶g B* = *¶h B ¶Wj ¶Wj*

* *¶g B*× *Lj* .

*¶M*

*U*

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, Hj, are net substitutes.

Conversely the first term on the right hand side is negative if B and Hj 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.

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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.

1. See Chapter 3 for a more detailed discussion of the EITC program.

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**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

1. See Ruggles and Sobek (1995).
2. 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.

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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

1. 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.

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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.

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

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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.

1. 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

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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,e);
2. Probability of Labor Force Participation (part) = f(X,W,e);

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).

1. 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.
2. For an excellent discussion of empirical results see Pencavel (1986).

**20**

1. If individual works, wage (W) = f(X,e), else wage is not observed;
2. If individual works, annual hours of work (hours) = f(X,W,e), else hours are not observed.

All four of these equations are related to each other through the independent variables and the

error term, e. 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

1. 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.
2. See Maddala (1994) for a detailed explanation of the competing methodologies.

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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

1. 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.

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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

1. 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.
2. 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

1. 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.

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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

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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

1. 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.

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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

1. 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 sy2, and the truncation occurring at c is:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *f* ( *y* |  | | *y* < *c*) = | | 1 | | (*f*( | | *y* - *u* | | ) | F( | | *c* - *u* | | )) . See Maddala (1994) p. 5. |  |
|  | |  |
|  | |  | |  | |  | |  |
|  | |  | |  | | *s y* | |  | | *s y* | | |  | | *s y* | |  |



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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 eX, and e Y, be normal (0,1) error terms. Z is some

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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 e Y, and X

depends on W and an the error term eX; X = 0.75\*W + eX, and Y=0.5\*X + 0.5\*Z + W + e 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.

**28**

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

Plot of Y\*X. Legend: A = 1 obs, B = 2 obs, etc.

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| 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 | | |  | |  | | AADFDIIKTZZZZZZZZZZZZZWWNJEBCBB | | | | | | |  |  | |  |
|  | ‚ | |  | |  | | AACHDMMTTTZZZZZZZZZZZZZPMNICBABAA | | | | | | |  |  | |  |
|  | ‚ | |  | | A | | AA CFLLQZZZZZZZZZZZZZZRWPJHCBA | | | | | | |  |  | |  |
|  | ‚ | |  | |  | | 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 | |  | |  |  |  | |  |
|  | ‚ | |  | | ABAAAEBABAAA | | | | | |  | |  |  |  | |  |
|  | ‚ | |  | | A | |  | | AAA AA | |  | |  |  |  | |  |
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|  | ‚ | |  | |  | |  | | A | |  | |  |  |  | |  |
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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

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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

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

Plot of Y\*X. Legend: A = 1 obs, B = 2 obs, etc.

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| 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 | | |  | | BCAACDFQXQUZZZZZZZTYSLIEDBBAB | | | | | | |  |  | |  |
|  | ‚ | | 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 | |  |  |  | |  |
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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.

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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

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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 |  | | +g\*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, N1 of whom work (N1<N). Individuals know their market wage rate (Wj), but

researchers only observe Wj for the N1 working individuals. All individuals also have a

reservation wage (Wrj). 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

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

form:

*Wj* = *X j*1 *B*1 + *u j*1

|  |  |
| --- | --- |
| 5.0) | . |
| *Wjr* | = *X j* 2 *B*2 + *u j* 2 |

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, X1, 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

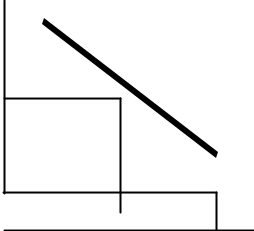
their time. This value, though equal to Wj when hours worked are positive, is not necessarily

equal to Wj when hours worked are zero.

**34**

Figure 2-3 Leisure Demand Schedule

W



Wj

Wjr |

Hours of Leisure

0 lj T l



T Hj 0 H



Hours of Work

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 Hj 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 Wj, individual j

works Hj hours, and consumes *L*j leisure time. However, if the wage rate is Wjr, 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 Wj > Wjr. 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.

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|  |  |  |  |
| --- | --- | --- | --- |
| *H j* | = *Z j* ×*g* + *d* ×*Wj* + *v j* | iff *Wj* | - *Wjr* ³ 0 |
| 5.1) |  |  | . |
| *H j* | = 0 | iff *Wj* | - *Wjr* < 0 |

Again, Hj is the number of hours that individual j works. Zj is the set of observed regressors for

individual j. Wj is the observed wage rate for individual j, and g and d are unknown parameters

to be estimated. The error term, vj, is a normally distributed random error with mean zero and

variance s2v, representing unobserved taste preferences. In addition to observing hours for the

N1 working sample, we also observe the binary employment outcome; is an individual employed

or not. People work provided that Wj -Wrj ³0. The following equations illustrate the observed

and unobserved components of the employment decision.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *I j* | = 1 | (If employed) | iff *W j* | ³ *W jr* |
| 5.2) |  |  |  | . |
| *I j* | = 0 | (If not employed) | iff *W j* | < *W jr* . |

Expected Hours Conditional on Working

The regressors in the market wage equation, X1, represent the variables that are related

to the market wage. Similarly X2 in the reservation wage equation represents the variables that

are related to the valuation of time. X1 and X2 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 Wj-Wjr, and this is a linear combination of X’s and u’s (Wj-Wjr= Xj1B1 -

Xj2B2+ uj1 - uj2), we can define Xj1B1 - Xj2B2 = XjB, uj1 - uj2 = uj, and Var(uj)= s2. Also, let

the covariance between v and u be equal to svu; cov(v,u) = svu. These simplifications allow us

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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 Ij =1 or that Wj-Wrj³0.

|  |  |  |  |
| --- | --- | --- | --- |
| *E* ( *H j* | *Wj* - *Wjr* ³ 0) = *Z j* | ×*g* |  |
|  | = *Z j* | ×*g* |  |
|  | = *Z j* | ×*g* |  |
| 5.3) | = *Z j* | ×*g* |  |
|  |  |  |
|  | = *Z j* | ×*g* |  |
|  | = *Z j* | ×*g* |  |

* *d* ×*Wj*
* *d* ×*Wj*
* *d* ×*Wj*
* *d* ×*Wj*
* *d* ×*Wj*
* *d* ×*Wj*
* *E* (*v j Wj* - *Wjr* ³ 0)
* *E* (*v j u j* ³ - *X j B*)
* *E* ( *E* (*v j u j* ) *u j* ³ - *X j B* ))

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| + | *s vu* | × *E* (*u j* | |  | *u j* ³ - *X j* | | | | *B*)) |  |
|  |  |
|  |  |
|  | *s* 2 |  | *s* ×*f*( *X j B* | | | *s* ) | | | . |  |
| + | *s vu* | × |  |  |
| *s* 2 | F( *X j B* | | |  | ) |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  | *s* | |  |  |  |  |
| + | *s vu* | ×*l*( *X j B s* ) | | | | |  |  |  |  |
| *s* |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |



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 f and F 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

1. The density function for the truncated normal distribution of y with mean u, variance sy2, and

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| the truncation occurring at c is: *f* ( *y* |  | | *y* < *c*) = | | 1 | | (*f*( | | *y* - *u* | | ) | F( | | *c* - *u* | | )) . See Maddala (1994) p. 5. |  |
|  | |  |
|  | |  | |  | |  | |  |
|  | |  | |  | | *s y* | |  | | *s y* | | |  | | *s y* | |  |



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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) | æ*v*ö | æ0 | | , | é*s v*2 | *s vu* | ùö |  |
| ç ÷ | ~ *N* ç | 0 | ê*s* | *s* 2 | ÷. |  |
|  | è*u*ø | ç |  | ú÷ |  |
|  |  | è |  |  | ë *vu* |  | ø |  |
|  |  |  |  |  |  | û |  |

The marginal distributions are:

*f v* (*v*) = *N* (0,*s* 2*v* )

5.32)

*f u* (*u*) = *N* (0,*s* 2 ).

The conditional distributions are:

1. (*v u*) = *N* æç*s vu*2 ×*u*,*s* 2*v* (1- *r*2 )ö÷
   * *s*ø

5.33)

1. (*u v*) = *N* æ*s vu* ×*v*,*s* 2 (1 - *r* 2 )ö,
   * *s* 2*v*÷øè

where *r* = *s vu* . Finally,

*s v s*

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.

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|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | |  | |  | |  | | ¥ | | | | X | | | | B | | | | | |  | |  | |  | |  | |  | |  | |  | |  | |  |  |
| E(v j | u j | | ³ -X j B) = ò-¥ ò-¥j | | | | | | | | | | | | | | v jf (v j , u j | | | | | | | | | | | | | | | | | | | | | | u j ³ -X j B)du jdv j |  |
|  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  |
|  | |  | | = | | ¥ X jB v j f (v j | | | | | | | | | | | | | |  | | u j )f u (u j | | | | | | | | | | | | | |  | | u j ³ -X j B)du jdv j | |  |
|  | |  | |  | |  | |  |
|  |  | |  | | ò- ¥ ò-¥ | | | | | | | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  |
|  | |  | | = | | s | | vu | |  | | X jB | |  | |  | |  | |  | |  | |  | |  | |  | | ³ -X j B)du j | | | | | | | | | |  |
|  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |
| 5.35) | |  | |  | |  | | u jf u (u j | | | | | | | | | | | | | | u j | | | |  |
|  | |  | |  | |  |
|  | |  | |  | | s2 | | | | ò-¥ | | | |  | | sf( u j s ) | | | | | | | | | | | | | | | | | | | | | | | |  |
|  | |  | |  | | svu | | | |  | | X jB | |  | |  |
|  | |  | | = | |  | | | | ò-¥ u j | | | |  | |  | | | | | | | | | | | |  | |  | |  | | du j | | | | | |  |
|  | |  | | s2 | | | | F(X j B | | | | | | | | | | | | | |  | | ) | |  |
|  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | s | | | |  | |  | |  | |  | |  |  |
|  |  | | = | | svu | | | | × | | f(X j B s ) | | | | | | | | | | | | | | | | | |  | |  | |  | |  | |  | |  |  |
|  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | | | . | |  | |  | |  | |  | |  | |  |  |
|  |  | | s | | | | F(X j B | | | | | | | | | | | | ) | | | |  | |  | |  | |  | |  | |  |  |
|  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  |
|  |  | |  | |  | |  | |  | |  | |  | |  | | s | | | | | |  | |  | |  | |  | |  | |  | |  | |  | |  |  |



The functions f and F 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 svu does not equal zero, then d and g will be

biased. The bias from an OLS regression can be seen by looking at the OLS estimate of g.

Representing equation 5.1 in matrix notation and ignoring wages for the moment, g^ols=(Z’Z)-

1Z’H - (Z’Z)-1Z’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, g^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.

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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 s12

and s12 are defined as the variance for the market wage error term and the covariance between

u1 and u2, respectively. Following the same procedure as in 5.3, equation 5.4 shows the

expected wage conditional on working.

*E* (*Wj Wj* - *Wjr* ³ 0) =

=

|  |  |  |
| --- | --- | --- |
| 5.4) | = |  |
|  |  |
|  | = |  |

*X j*1 *B*1

*X j*1 *B*1

*X j*1 *B*1

*X j*1 *B*1

* *E* (*u j*1 *Wj* - *Wjr* ³ 0)
  + *E* (*u j*1 *X j B* + *u j* ³ 0)
  + *E* (*u j*1 *u j* ³ - *X j B* )

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| + | (*s* 12 - *s* 12 ) | *l*(*X j Ba* | *s*). |  |
|  |  |
|  | *s* | |  |  |



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.

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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 l for each

observation using the estimated parameters from the probit. The estimate of l 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:

Pr *ob*(*Wj* - *Wjr* ³ 0) = Pr *ob*( *I j* = 1) = Pr *ob*(*u j* ³ - *X j B* ) = F( *X j B*\*)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | *X j B s*1 | |  | -*t* 2 | |  |  |
| 5.5) | *Where* | F( *X j* | *B*\*) = | ò-¥ |  | exp( |  | )*dt*, | . |  |
|  | 2*p* |  |  |
|  |  |  |  |  | 2 | |  |  |  |
|  | and | *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

1. ¶ represents the partial derivative.

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1. = Õ[F( *X j B*\*)] *I j* [1 - F( *X j B*\*)]1-*I j*

*j*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 5.6) | | *LogL* = å*I j Log*[F( *X j B*\*)] + å[1 - *I j* ]*Log*[1 - F( *X j B*\*)] . | | | | | |  |
|  | |  | | *j* | | *j* | |  |
|  | | *¶LogL* | | = *S*(*B*\*) = å | | *I j* - F( *X j B*\*) | |  |
|  |  | |  | |  | | *f*( *X j B*\*) |  |
|  | *¶B* \* | |  | |  | |  |
|  | |  | | *j* | | F( *X j B*\*)[1 - F( *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 B0, B1 can be found by B1=B0+[I(B0)]-1S(B0). 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 l^ is added as one of the regressors in both the

wage and hours regressions. The addition of l^ 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

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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

1. 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

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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

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

1. 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.

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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.

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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

1. 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.

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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

1. 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.

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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.

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

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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

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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.

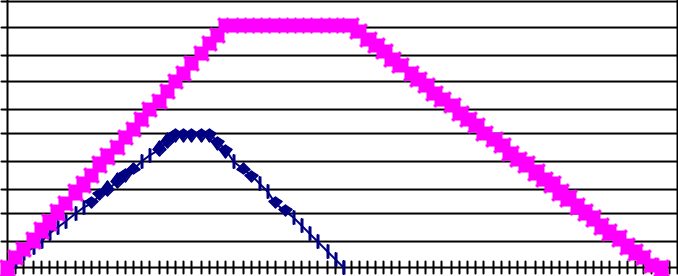
1. See appendix A in Eissa and Liebman (1995) for phase-in and phase-out rates of the EITC from 1975-1996.

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

**1979 and 1989 EITC by Income**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1000 |  |  |  |  |  |
| 900 |  |  |  |  |  |
| 800 |  |  |  |  |  |
| 700 |  |  |  |  |  |
| 600 |  |  |  |  |  |
| 500 |  |  |  |  |  |
| **EITC**400 |  |  |  |  |  |
| 300 |  |  |  |  |  |
| 200 |  |  |  |  |  |
| 100 |  |  |  |  |  |
| 0 |  |  |  |  |  |
| 0 | 2500 | 5000 | 10000 | 15000 | 20000 |
|  |  |  | **Income** |  |  |



 EITC 79

EITC 89

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

1. See Scholz (1994).

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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.

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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.

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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.

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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 =

eXa/(1+eXa), where P is the probability of observing the outcome, e represents the exponential

function and Xa 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)\*Xa, where a 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

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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

1. 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.

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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.

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sample Year | 1970 |  | 1980 |  | 1990 |  |
| Specification | Wage | Wage | Wage | Wage | Wage | Wage |
|  | OLS | Heckit | OLS | Heckit | OLS | 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 | 0.0281 | -0.0133 | 0.165 | 0.222 | 0.117 | 0.149 |
| Tax Value State Exemption | -0.0403 | -0.0303 | -0.480 | -0.542 | -0.0123 | -0.0143 |
| 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 | -7.13 | -7.03 | 36.5 | 41.3 | 11.82 | 10.23 |
| Twins at Second Birth | -10.63 | -10.43 | -41.0 | -43.6 | -23.0 | -23.0 |
| First 2 children same gender | 1.83 | 1.73 | 14.2 | 15.9 | 7.0 | 6.61 |
| 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 | -7.61 | 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

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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.

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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%.

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

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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 | -0.0643 | 0.0213 | 0.0273 |
| 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 | 30.71 | 20.13 | 14.63 | 20.82 |
| Twins at Second Birth | -38.6 | -34.42 | -15.43 | -5.43 |
| First 2 children same gender | 17.9 | 9.82 | 3.93 | 8.02 |
| 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 | 2.23 | -3.23 |
| - 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

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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

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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.

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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

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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%

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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.

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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

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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.

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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.

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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 |  | 19.76 | 20.44 |  | 23.96 | 24.05 |  | 23.00 | 23.30 |  |
|  | work |  |  |  |  |  |  |  |  |  |  |
|  | 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 | 0.52 | 0.45 | 0.42 | 0.39 | 0.49 | 0.58 |  |  |  |  |
|  | Participation |  |  |  |  |  |  |  |  |  |  |
|  | 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 | 0.16 | 0.11 | 0.11 | 0.07 | 0.09 | 0.12 |  |  |  |  |
|  | 1<age<5 |  |  |  |  |  |  |  |  |  |  |
|  | Spouse Part.\* No. Child | 0.68 | 0.51 | 0.43 | 0.47 | 0.53 | 0.58 |  |  |  |  |
|  | age>=5 |  |  |  |  |  |  |  |  |  |  |
|  | 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

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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

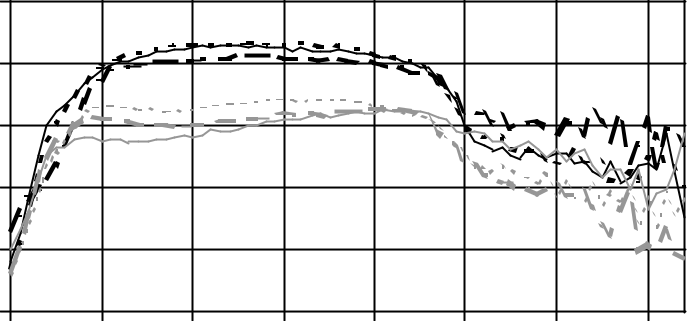
1. See McGrattan and Rogerson (1998) for a more detailed discussion of the changes in hours worked over the last 50 years. See also Katz and Murphy (1992) for an explanation of the changes in wages that may have influenced hours.

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

Male and Female Annual Hours of Work by Age

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Annual Hours |  |  |  |  |  |  |  |
| 2500 |  |  |  |  |  |  |  |
| 2000 |  |  |  |  |  |  |  |
| 1500 |  |  |  |  |  |  |  |
| 1000 |  |  |  |  |  |  |  |
| 500 |  |  |  |  |  |  |  |
| 0 |  |  |  |  |  |  |  |
| 16 | 26 | 36 | 46 | 56 | 66 | 76 | 86 |
|  |  |  |  | Age |  |  |  |



Male 69 Male 79 Male 89 Female 69 Female 79 Female 89

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

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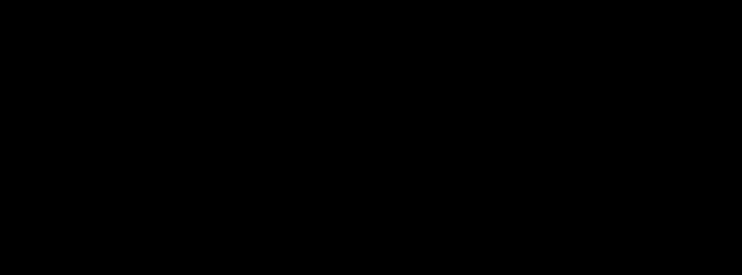
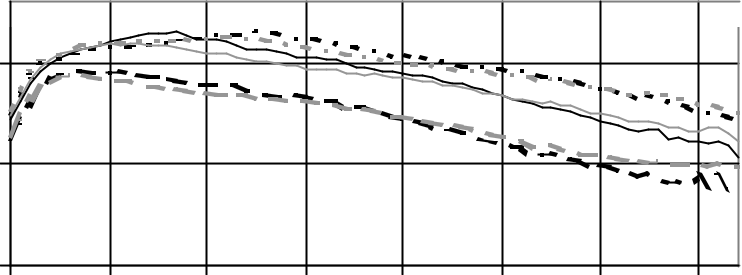
have been increasing across the age groups. Indeed, the increases from 1970 to 1980, and to

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

Male and Female Education by Age



|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| (15=HS) |  |  |  |  |  |  |  | Male 80 |  |
|  | 15 |  |  |  |  |  |  | Male 70 |  |
| Education |  |  |  |  |  |  |  |  |
| 10 |  |  |  |  |  |  | Male 90 |  |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | Female 70 |  |
|  |  |  |  |  |  |  |  |  |
|  | 5 |  |  |  |  |  |  | Female 80 |  |
|  |  |  |  |  |  |  | Female 90 |  |
|  | 16 | 26 | 36 | 46 | 56 | 66 | 76 |  |
|  | 86 |  |
|  |  |  |  |  | Age |  |  |  |  |

**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%

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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

1. 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

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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.

children.

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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

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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.

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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 | -0.0102 | -0.0073 | 0.053 | 0.061 | -0.0033 | -0.0053 |  |
| EITC |  |  | -0.024 | -0.025 | -0.009 | -0.008 |  |
| Education | 0.393 | 0.372 | 0.513 | 0.438 | 0.588 | 0.584 |  |
| Local Unemployment | -0.0911 | -0.0523 | -0.065 | -0.071 | -0.070 | -0.075 |  |
| Estimate Commute time to |  |  | -0.040 | -0.038 | 0.116 | 0.101 |  |
| work |  |  |  |  |  |  |  |
| 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 | -7.8 | -21.7 | -10.0 | -14.5 | -5.1 | -9.3 |  |
| 1<age<5 | 0.91 |  |  | 0.23 |  |  |  |
| Husb. Part.\* No. Child | 3.9 | -1.9 | -3.4 | -2.0 |  |
| age>=5 |  |  |  |  |  |  |  |
| Husb. Part.\* Birth |  | -25.0 |  | -23.9 |  | -8.7 |  |
| Two or more Children | 0.83 | -8.8 | -2.9 | 2.7 | -0.93 | 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 | 2.51 | 0.13 | -0.63 | -0.13 |  |
| 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

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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.

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Married Male Labor Force | 1970 |  | 1980 |  | 1990 |  |
| Participation | P | B | P | B | P | B |
| *Elasticities* |  |  |  |  |  |  |
| Age | 0.453 | 0.147 | 0.339 | 0.759 | 0.338 | 0.0712 |
| 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 | -0.0071 | -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 | 0.0013 | 0.0103 | -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 | 0.03 | 0.03 | 0.41 | 2.51 | 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 | 1.22 | 4.9 | -0.83 | -0.53 |
| -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%

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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.

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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.

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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 | -0.021 | -0.012 |
| EITC |  | -0.01 | -0.00 |
| Education | 0.27 | 0.24 | 0.31 |
| Local Unemployment | -0.15 | -0.021 | -0.06 |
| Estimate Commute time to work |  | -0.023 | 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 | 2.053 | 3.42 |
| Teenager | 3.692 | 10.981 | 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.

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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

1. 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.
2. 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

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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.

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

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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 | 0.57 | 1.39 | 1.99 | 1.28 | 2.00 | 2.50 | 0.73 | 1.52 | 2.04 |
| Corrected |  |  |  |  |  |  |  |  |  |
| 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 | 14.65 | 27.42 | 35.70 | 15.16 | 28.34 | 36.19 | 14.74 | 7.66 | 33.51 |
| Exemption |  |  |  |  |  |  |  |  |  |
| 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 | 0.09 | 0.10 | 0.12 | 0.08 | 0.10 | 0.15 |  |  |  |
| 1<age<5 |  |  |  |  |  |  |  |  |  |
| Spouse Part.\* No. Child >5 | 0.67 | 0.55 | 0.52 | 0.54 | 0.61 | 0.69 |  |  |  |
| Spouse Part.\* Probability | 0.03 | 0.04 | 0.03 | 0.03 | 0.04 | 0.04 |  |  |  |
| of Birth |  |  |  |  |  |  |  |  |  |
| 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

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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.

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Female Annual Hours | 1970 |  | 1980 |  | 1990 |  |  |
| Parameter Estimates | P | B | P | B | P | 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 | -0.13 | -2.33 | 156.0 | 160.7 | 178.2 | 195.6 |  |
| Age 45-59 | 18.71 | 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 | 568.0 | 595.2 | 1267.1 | 1223.7 | 1056.8 | 968.9 |  |
| Corrected | 325.81 |  | 160.83 | 202.61 |  |  |  |
| State Tax Rate | 434.7 | 753.3 | 659.6 |  |
| Tax Value of State Exemption | 0.52 | 0.52 | 0.41 | 0.41 | 0.13 | 0.13 |  |
| 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 | 18.23 | 3.03 | -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 |  | -74.63 |  | 1804.2 |  |  |
| Birth |  | -339.2 |  | -293.1 |  | -244.5 |  |
| Husb. Part.\* No. Child | -83.2 | -75.1 | -231.9 | -233.5 | -106.4 | -171.1 |  |
| 1<age<5 | 5.12 | 5.12 |  |  | -18.53 |  |  |
| Husb. Part.\* No. Child >5 | -17.3 | -25.6 | -43.7 |  |
| Husb. Part.\* Probability of | 214.3 |  | 67.53 |  | -1124.1 |  |  |
| Birth |  | 11.53 |  | -14.43 |  |  |  |
| Husb. Part\* Birth |  |  |  | 38.2 |  |
| Two or More Kids | -21.2 | -21.5 | -56.1 | -65.2 | 6.13 | -30.4 |  |
| Estimate of Commute Time |  |  | -0.43 | -0.33 | 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,

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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

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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

1. 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.

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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.

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Married Male Annual Hours | 1970 |  | 1980 |  | 1990 |  |  |
| Parameter Estimates | P | B | P | B | P | B |  |
| Age | -5.46 | -0.143 | 44.22 | 44.87 | 57.41 | 55.61 |  |
| Age Squared | 0.013 | -0.041 | -0.54 | -0.54 | -0.69 | -0.68 |  |
| Teenager | 3.153 | 17.363 | -99.27 | -94.19 | -354.73 | -362.01 |  |
| Age Twenty | 44.44 | 39.64 | 36.56 | 35.98 | -1.063 | -1.283 |  |
| Age 45-59 | -9.061 | -9.501 | 37.15 | 37.13 | 70.07 | 70.40 |  |
| Age Sixty | -21.36 | -27.64 | 0.313 | 0.653 | -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 | 711.20 | 726.88 | 4.303 | 12.993 | -351.90 | -366.88 |  |
| Corrected | 295.091 |  | -58.473 | -55.083 | -27.343 | -116.543 |  |
| State Tax Rate | 470.58 |  |
| Tax Value of State Exemption | 0.541 | 0.571 | -0.361 | -0.342 | 0.093 | 0.103 |  |
| EITC |  |  | -0.091 | -0.091 | -0.19 | -0.17 |  |
| Education | -23.90 | -24.47 | 8.85 | 8.40 | 27.29 | 27.96 |  |
| Wife Labor Participation | 92.32 | 84.00 | 6.233 | -0.263 | -50.31 | -60.60 |  |
| No. Children 1<age<5 | 44.70 | 49.27 | 11.97 | 16.20 | 7.112 | 13.25 |  |
| No. Children Age >=5 | 3.42 | 2.102 | 0.913 | -0.093 | 13.23 | 11.95 |  |
| Probability of Birth | -131.85 |  | 41.973 |  | 268.35 |  |  |
| Birth |  | 44.39 |  | 23.25 |  | 22.37 |  |
| Wife Part.\* No. Child 1<age<5 | -26.45 | -39.72 | 1.293 | -5.903 | 4.163 | 0.803 |  |
| Wife Part.\* No. Child >5 | -3.441 | -0.243 | -0.393 | 1.853 | -8.19 | -6.44 |  |
| Wife Part.\* Probability of Birth | -260.81 |  | -149.00 |  | -99.001 |  |  |
| Wife Part\* Birth |  | -17.442 |  | -19.311 |  | 2.353 |  |
| Two or More Kids | -14.95 | -4.483 | 10.201 | 12.59 | 34.01 | 26.11 |  |
| Estimate of Commute Time |  |  | 0.023 | 0.013 | 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

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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,

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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.

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Married Male Labor Force | | 1970 |  | 1980 |  | 1990 |  |
| Participation Probability | | Labor | Hours | Labor | Hours | Labor | Hours |
| And Annual Hours | | Force |  | Force |  | Force |  |
| 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

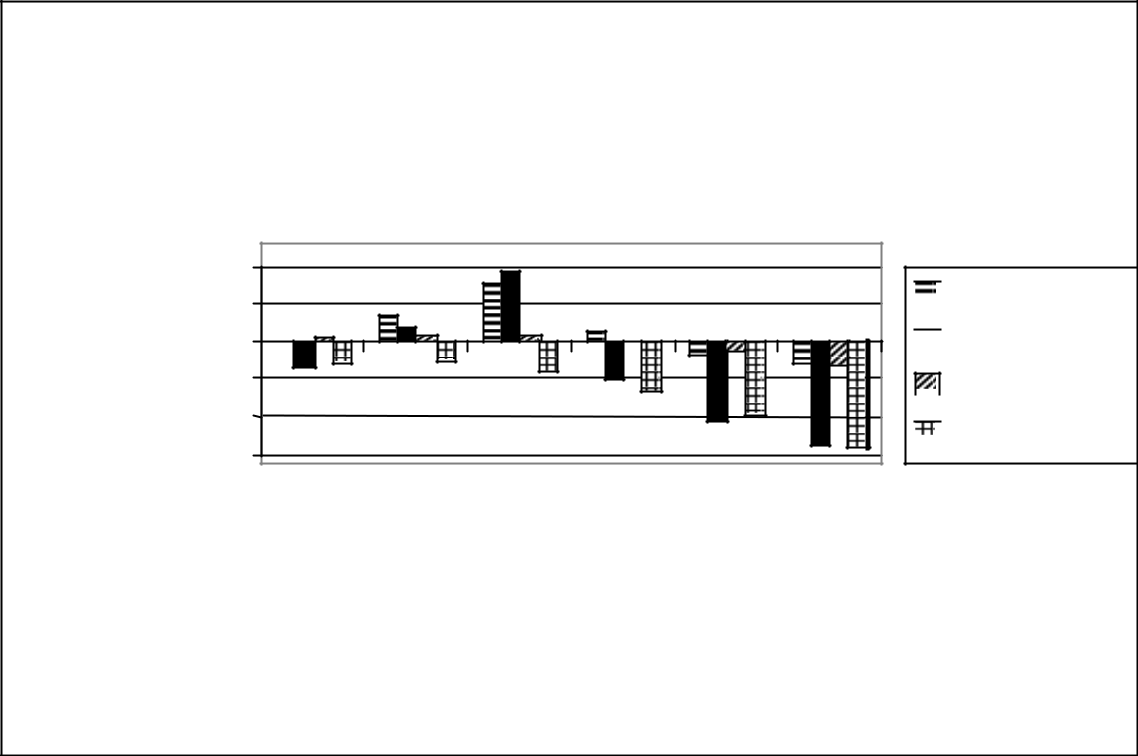
husbands in 1990 react differently to the presence of children in the family than they did in 1970.

Husbands with wives working in the labor force have increased their participation as the number

of children increases.

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Figure 8-1 Predicted Probability of Husbands Participation



**Probability of Husband’s Participation**

(Percentage Point Difference from No Children Family Type given the Spouse's labor attachment; probability without children

less probability for family type with children)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | 4 |  |  |  |  |  |  |
| **Percentage** | 2 |  |  |  |  |  |  |
| **Point** | 0 |  |  |  |  |  |  |
| - 2 |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| **Differences** - 4 | |  |  |  |  |  |  |
|  | - 6 |  |  |  |  |  |  |
|  | 1970 | 1980 | 1990 | 1970 | 1980 | 1990 |  |

 1 Child < 5

 2 Children < 5

 1 Child > 5

 2 Children > 5

Spouse works Spouse does not work

**Year and**

**Labor Force Attachment of Spouse**

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 -

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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,

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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.

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Single Male Annual Hours | 1970 | 1980 | 1990 |  |
| Parameter Estimates |  |  |  |  |
|  |  |  |  |  |
| 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 | -4.733 | 228.55 | 54.19 |  |
| Age Sixty | -14.013 | 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 | 1183.49 | 2342.69 | 1109.68 |  |
| Corrected | 156.143 | 2521.313 |  |  |
| State Tax Rate | 1107.63 |  |
| Tax Value of State Exemption | 0.981 | -2.942 | 0.013 |  |
| EITC |  | -0.033 | 0.013 |  |
| Education | -41.37 | -78.87 | -27.24 |  |
| No. Children age<5 | 32.75 | 17.203 | 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.

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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 | -0.0053 | 0.0033 |
| 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

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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

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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.

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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.

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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

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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

1. 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.
2. Previous versions of LIFT use exogenous participation rates.

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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

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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

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

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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.

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**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

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

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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) | [*WA*] = [*AO*][*OI* ][*WI* ] |
|  | 3C13C22C 44 C1 |

**W**ages 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.

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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 aoj 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,

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

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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) | | [*HIAG*]= *PIPH* ·[*HI*] | |
|  | 3*x* 4 | | 3*x* 4 |

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

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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

1. 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.

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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

1. 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.
2. See Bachu (1993), and Bachu (1991) for recent discussions of birth expectations.

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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)];

}}}}

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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

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

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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) | | [*F* \*]= *f* ([*A*]+ *b*1 ×ln( [*WA*]) + *b*2 ×[*HI* ]+ [*KID*]×*B*3 + [*Z* ]× *B*4 ) . | | | | |
|  | 3*x*1 | | 3 *x*1 | 3*x*1 | 3*x*1 | 3 *x* 33*x*13*x*10 10*x*1 |

*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.

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

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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

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

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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

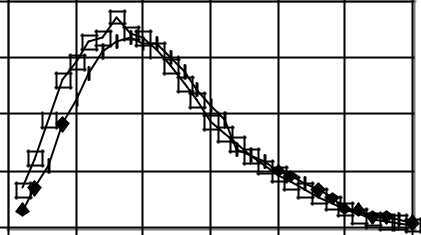
problems in the cross-section estimates by doing a time-series analysis.

**121**

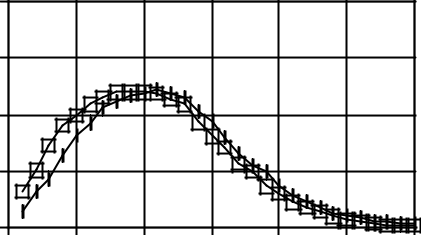
Figure 9-1 IPUMS Sample and NCHS Female Fertility by Age (1969, 1979, and 1989)

1969 Fertility Rates

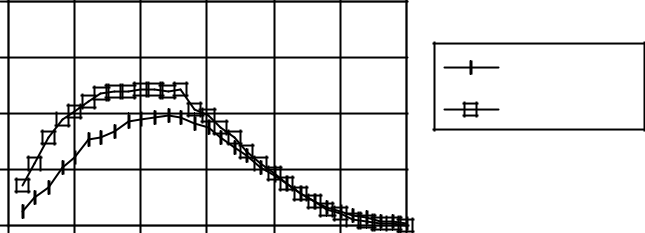
|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 0.2 |  |  |  |  |  |  |  |
| Fertility | 0.15 |  |  |  |  |  |  |  |
| Rate | 0.1 |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  | 0.05 |  |  |  |  |  |  |  |
|  | 0 |  |  |  |  |  |  |  |
|  | 15 | 20 | 25 | 30 | 35 | 40 | 45 |  |
|  |  |  |  | Age |  |  |  |  |



|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | 1979 Fertility Rates | | |  |  |
| 0.2 |  |  |  |  |  |  |
| 0.15 |  |  |  |  |  |  |
| 0.1 |  |  |  |  |  |  |
| 0.05 |  |  |  |  |  |  |
| 0 |  |  |  |  |  |  |
| 15 | 20 | 25 | 30 | 35 | 40 | 45 |
|  |  |  | Age |  |  |  |



|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | 1989 Fertility Rates | | | |  |  |
|  | 0.2 |  |  |  |  |  |  |  |
|  | 0.15 |  |  |  |  |  | IPUMS |  |
| Fertility |  |  |  |  |  |  |  |
| 0.1 |  |  |  |  |  | NCHS |  |
| Rate |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  | 0.05 |  |  |  |  |  |  |  |
|  | 0 |  |  |  |  |  |  |  |
|  | 15 | 20 | 25 | 30 | 35 | 40 | 45 |  |
|  |  |  |  | Age |  |  |  |  |



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,

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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

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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:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | *ASFR* | | + B2 · log | *FSTAR* | | · Frwage + B4 | · Unem .51 |  |
| *6.3)* | log |  | = B1 |  | + B3 |  |
|  |  |  |
|  |  | 1 - *ASFR* | |  | 1 - *FSTAR* | |  |  |  |

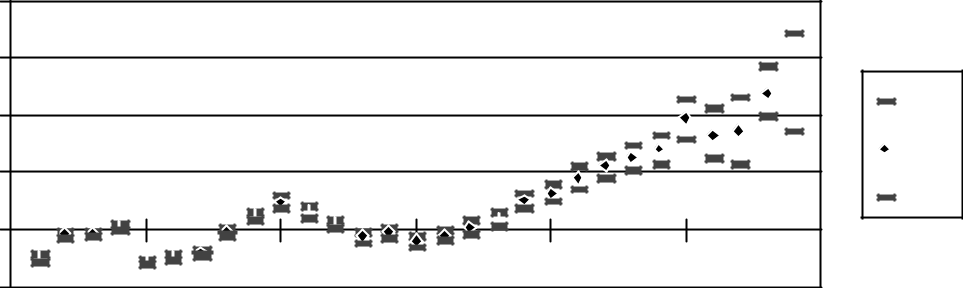
Figure 9-2 shows the estimated intercept parameter for each ASFR between the age of

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Intercept |  |  |  |  |
| Parameter Value |  |  |  |  |  |  |  |
| 20 |  |  |  |  |  |  |  |
| 15 |  |  |  |  |  |  |  |
| 10 |  |  |  |  |  | B+s |  |
|  |  |  |  |  | B |  |
| 5 |  |  |  |  |  |  |
|  |  |  |  |  | B-s |  |
|  |  |  |  |  |  |  |
| 0 |  |  |  |  |  |  |  |
| -5 |  |  |  |  |  |  |  |
| 15 | 20 | 25 | 30 | 35 | 40 | 45 |  |
|  |  |  | Age |  |  |  |  |



zero until the late thirties where they become increasingly positive.

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Figure 9-3 shows the parameter estimates for B2, the parameter on the transformed F\*

variable. Given the construction of the dependent and the independent variable, B2 should be

1.0 if F\* exactly replicates the ASFR. Until the middle thirties B2 seems to be roughly clustered

around 1.0. However, after age 35 B2 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

Parameter on Log(Fstar/(1-Fstar))

|  |
| --- |
| Parameter |

4

3

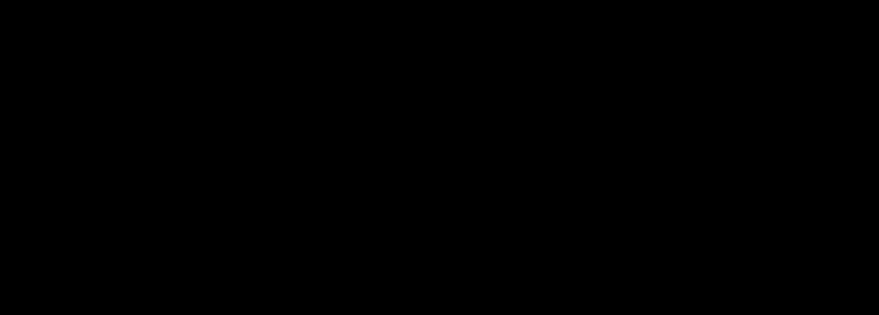
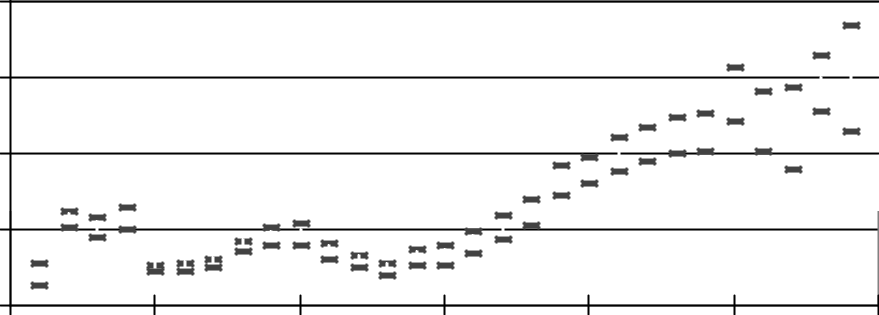
2

1

0

15 20

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 25 | 30 | 35 | 40 | 45 |
|  | Age |  |  |  |



 B+s

B

 B-s

Figure 9-4 shows the parameter B3 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 B3 may very well be zeroing

out only the negative effect from the cross-section. However, for women between the ages of

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

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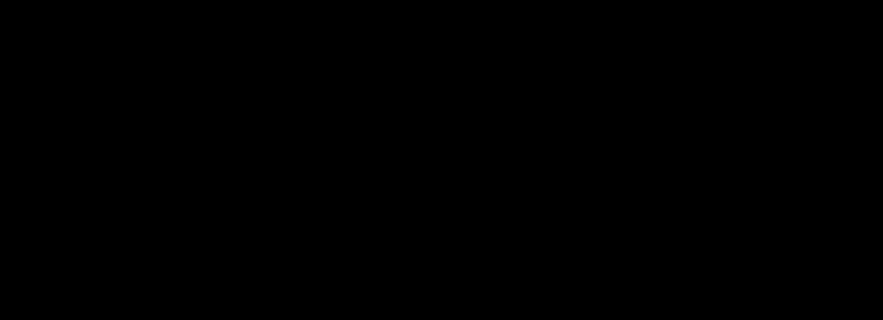
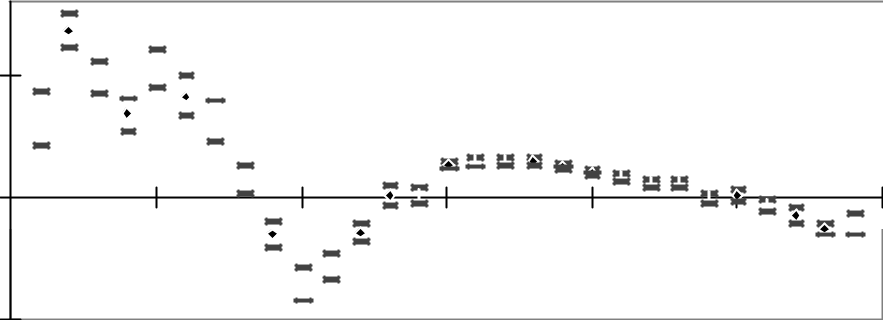
24 and 28 and older than 40 there is a distinctly negative impact of wages on fertility. Therefore,

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

|  |
| --- |
| Parameter Value |

Parameter on Female Relative Wage



5

0

-5

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 15 | 20 | 25 | 30 | 35 | 40 |
|  |  |  | Age |  |  |

 B+s

 B

 B-s

45

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

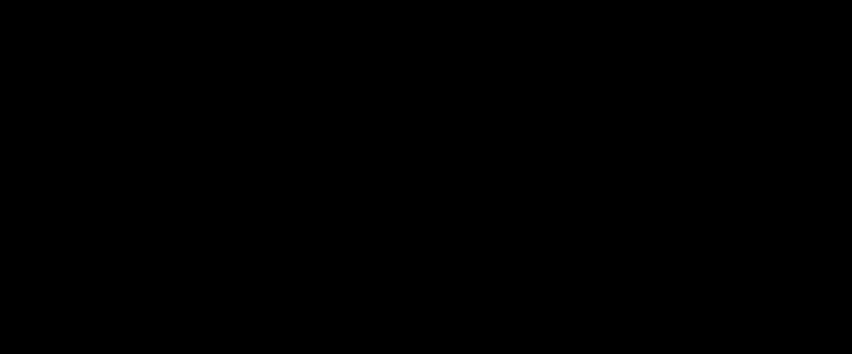
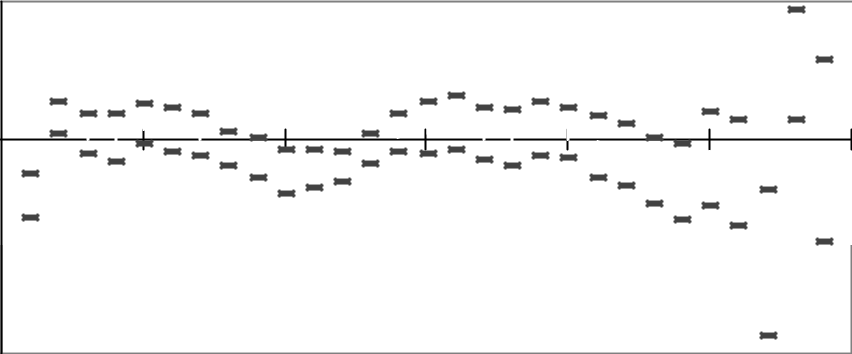
graph showed two standard deviations about the parameter all but a few of the confidence

intervals would include zero.

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

Parameter on Unemployment



|  |
| --- |
| Parameter Value |

10

5

0

-5

-10

-15

-20

15

20

|  |  |  |
| --- | --- | --- |
| 25 | 30 | 35 |
|  | Age |  |

40

 B+s

B

 B-s

45

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

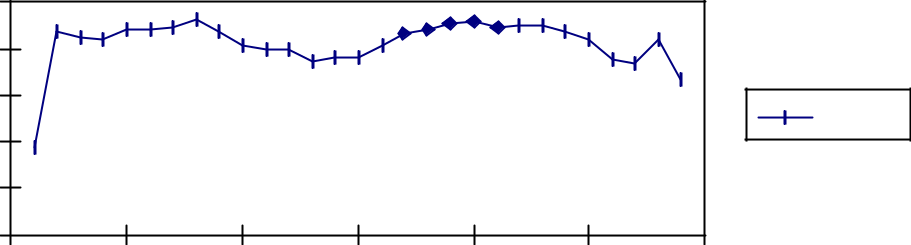
fertility of 16 year old women.

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

Adjusted R-Square

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| RBSQ |  |  |  |  |  |  |  |
| 1 |  |  |  |  |  |  |  |
| 0.8 |  |  |  |  |  |  |  |
| 0.6 |  |  |  |  |  | RBSQ |  |
| 0.4 |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| 0.2 |  |  |  |  |  |  |  |
| 0 |  |  |  |  |  |  |  |
| 15 | 20 | 25 | 30 | 35 | 40 | 45 |  |
|  |  |  | Age |  |  |  |  |



**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.

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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 | ASPR | = B1 · log | PSTAR | + B2 · ZFrwage + B3 · ZUnem + B4 · ZSevsix + |  |
|  |  |  |
| 1 - ASPR | 1 - PSTAR |  |
|  |  |  |  |
|  |  | B5 · ZFertlag | |  |  |

1. 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.

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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

1. 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.

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

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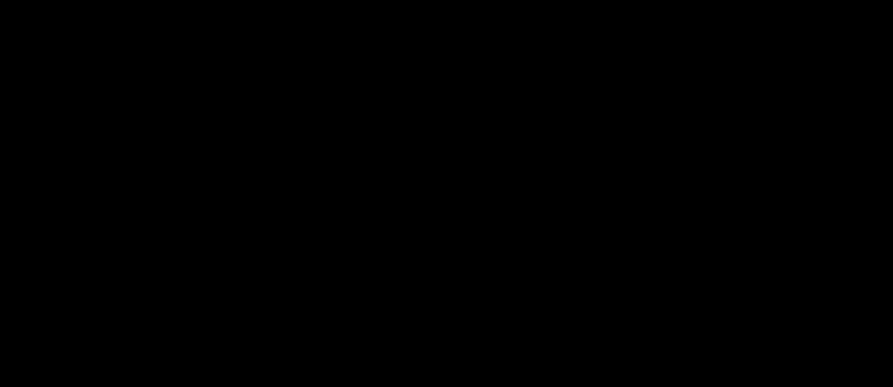
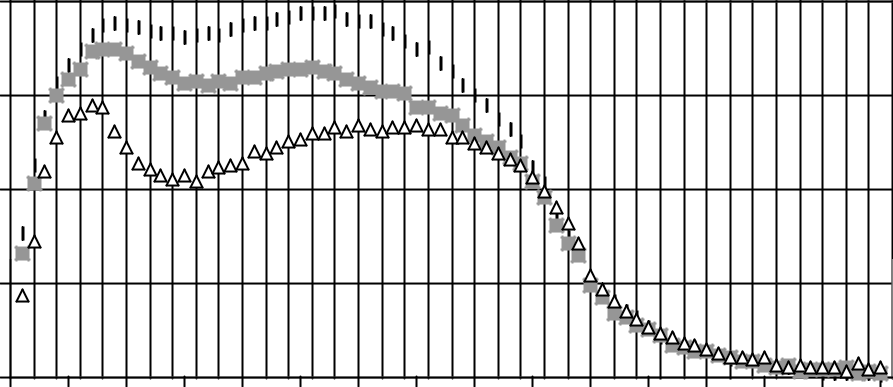
(see Figure 9-1)-- suggesting that the presence of toddlers in the home may be the cause of the

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

0.8



0.6

0.4

0.2

0

1989

 1979

 1969

15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90

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

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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

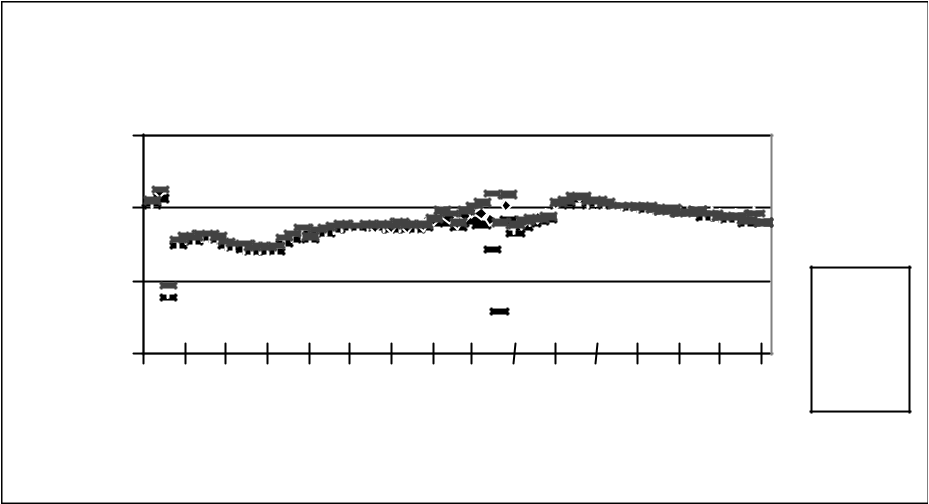
women has increased from 45.3% in 1990 to 49.6% in 1996 supports this cohort argument.55

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 B1 is clustered around 1.0.

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



Parameter on Log(P\*/(1-P\*))

|  |  |  |
| --- | --- | --- |
| Par 1.5 | |  |
| am | 1 |  |
| ete |  |
|  |  |
| r |  |  |
| Va 0.5 | |  |
| lue | 0 |  |
|  |  |

15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90

 B-s

B

 B+s

Age

Figure 9-9 shows the parameter estimates for B2, the parameter on the zero mean

female relative wage rate. It appears that over the life cycle women are initially positively

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

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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

Parameter on Female Relative Wage

|  |
| --- |
| Parameter Value |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 12 | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | | | | | | |  |
|  | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | | | | | | |  |
| 9 | |  | |  | | | | | | | | | | | | | | | | | | |  | | | | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | | | | | | |  |
|  | |  | | | | | | | | | | | | | | | | | | | | | |  | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | | | | | | |  |
|  | |  | | | | |  | | | | |  |  |  | | | | |  | |  | | | | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | |  | | | | |  |
| 6 |  | |  | |  | |  | | |  | |  |  | | | | |  | |  | | | |  | | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | |  | |  | | | B+s |  |
| 3 | |  | |  | |  | | | | |  | | | | | |  | | | |  |  | | |  | | |  |  |  | |  | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | |  | |  | B | |  |
|  | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | |  | |  | | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | |  | | | | | B-s |  |
|  | |  | | | |  | | | | | | | | | | |  | | | | | | | | |  | | | |  | |  | |  |  |  |  |  |  |  |  |  | | | | |  | |  | | | | | |  | | | |  | | |  | | |  | |  | |  | | |  |
| 0 | |  | |  | | | |  | | | | | | | | | | |  | | | | | | | | |  | | | |  | | | | | | | | | | | |  |  |  |  | |  | |  |  |  |  |  | |  |  |  | |  |  | |  |  | |  | |  | | | | |  |
| -3 | |  | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | | | | | | |  |
|  | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | | | | | | |  |
|  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  |

15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90

Age

Figure 9-10 shows the parameter estimate for B3 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.

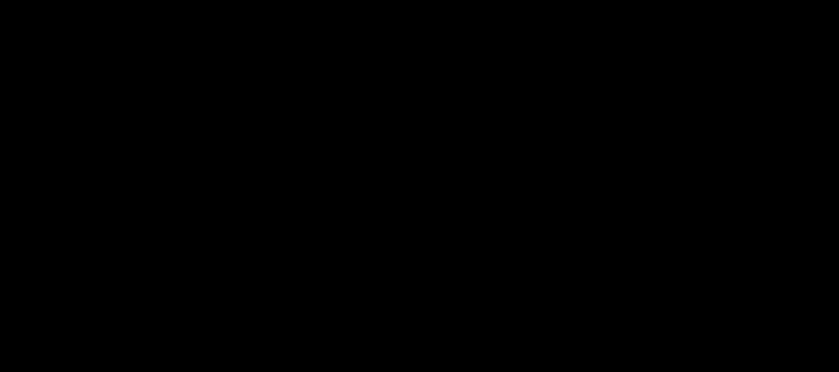
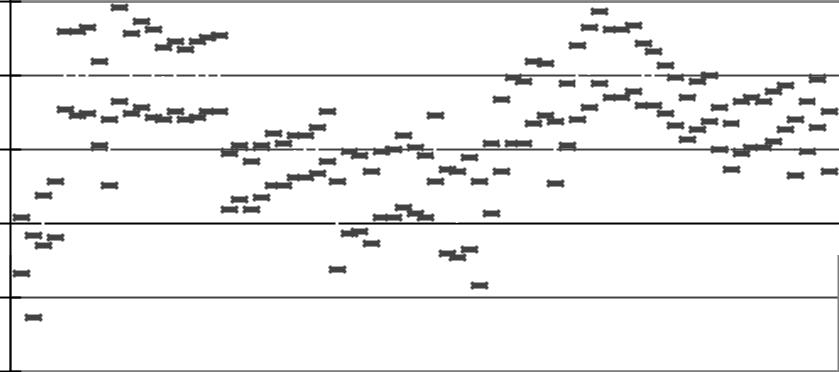
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Figure 9-10 Logit of Female Participation 1969-1996 Parameter on Unemployment

Parameter on Unemployment

|  |
| --- |
| Parameter Value |

12



8

4

0

* 4
* 8

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 |
|  |  |  |  |  |  |  | Age | |  |  |  |  |  |  |  |

 B+s

B

 B-s

Figure 9-11 shows the parameter estimate for B4, the parameter on the dummy prior to

1976. The parameters pick up the break in the time-series. The series have lower values prior

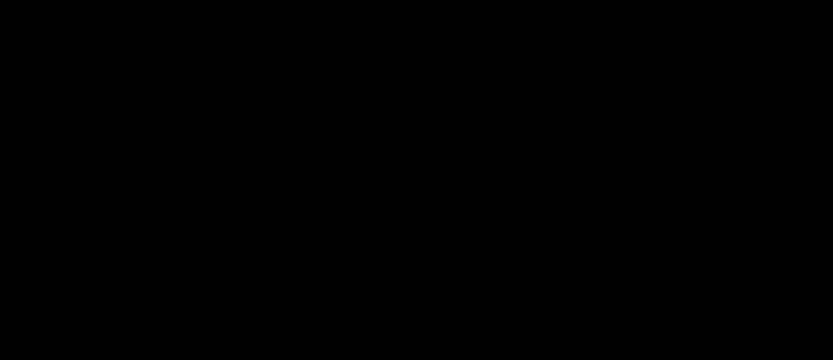
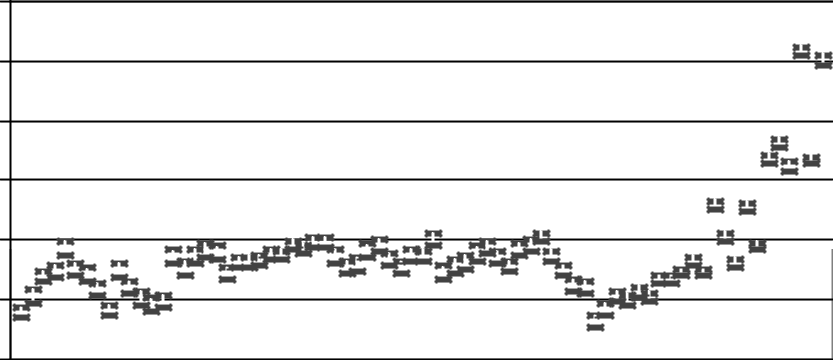
to 1976, which is picked up by a negative value for B4.

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

Parameter on Dummy = 1 for time < 1976

|  |  |  |
| --- | --- | --- |
|  | 1.6 |  |
| Value | 1.2 |  |
| 0.8 |  |
| Parameter |  |
| 0.4 |  |
|  |  |
|  | 0 |  |
|  | -0.4 |  |
|  | -0.8 |  |



15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90

Age

 B+s

B

 B-s

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | Parameter on Lagged Fertility | | |  |  |
| Parameter |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |
| 1 |  |  |  |  | B+s |  |
| 0 |  |  |  |  | B |  |
| -1 |  |  |  |  | B-s |  |
| -2 |  |  |  |  |  |  |
| -3 |  |  |  |  |  |  |
| -4 | 20 | 25 | 30 | 35 | 40 |  |
| 15 |  |
|  |  |  | Age |  |  |  |

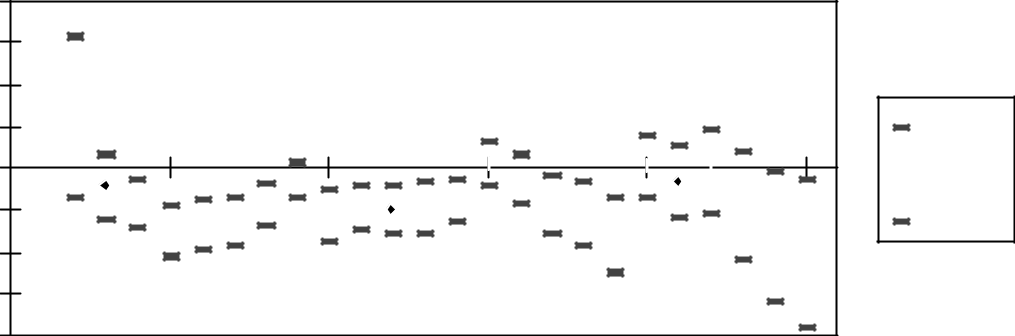


Figure 9-12 and Figure 9-13 show the parameter estimate for B5, the parameter on

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

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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

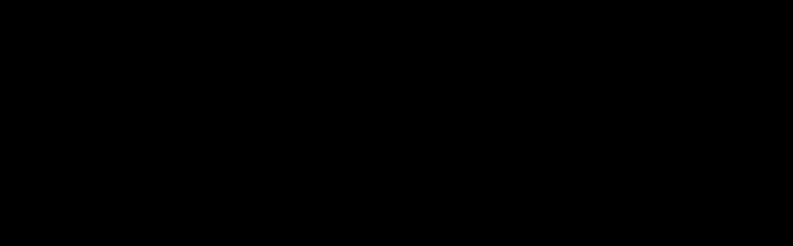
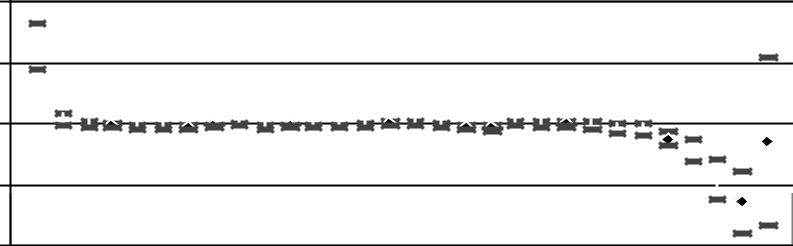
high positive value suggests that 15 year olds who have children will increase their participation

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

Parameter on Lagged Fertility

|  |  |  |
| --- | --- | --- |
| Value | 40 |  |
| 20 |  |
|  |  |
| Parameter | 0 |  |
| -20 |  |
| -40 |  |
|  |  |



|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 15 | 20 | 25 | 30 | 35 | 40 | 45 |
|  |  |  | Age |  |  |  |

 B+s

B

 B-s

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

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and 44 was 98.1 in 1970, 97.1 in 1980, 96.7 in 1990, and 95.4 in 1996. The 2.7 percentage

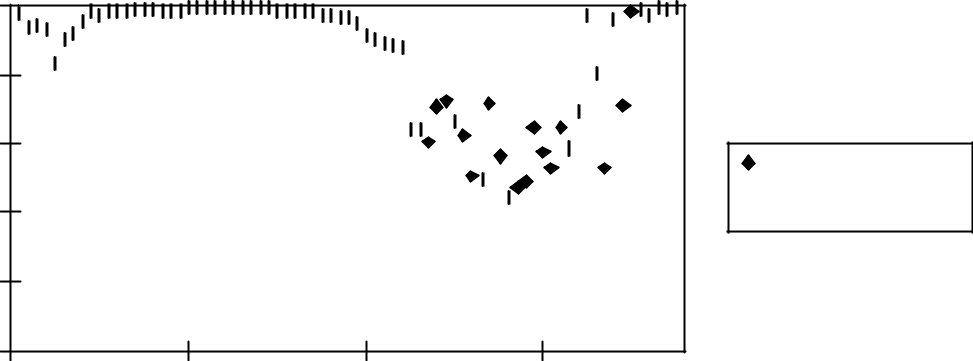
point drop in participation from 1970 to 1996 is very small when compared with the 29-

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | Correlation Coefficient between Actual and Predicted | | |  |
| 1 |  | |  |  |  |
| 0.9 |  | |  |  |  |
| 0.8 |  | |  | Correlation |  |
|  |  | |  |  |
| 0.7 |  | |  | Coefficient |  |
|  | |  |  |  |
| 0.6 |  | |  |  |  |
| 0.5 |  | |  |  |  |
| 15 | 35 | | 55 | 75 |  |



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

1. The correlation coefficient between two random variables X and Y is:

r( X, Y) = Cov(X,Y) . Cov(.) is the covariance and s is the standard deviation. The sxsy

correlation coefficient is bounded between -1 and 1.

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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

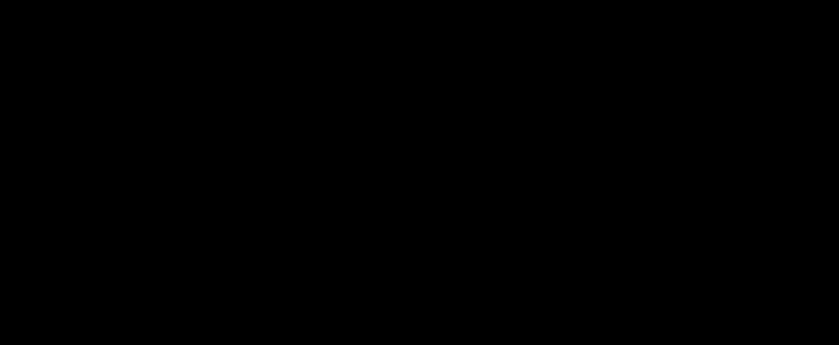
for each year’s age group.

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

Male Labor Force Participation (1969, 1979, 1989)

|  |  |  |
| --- | --- | --- |
|  | 1 |  |
| Rate | 0.75 |  |
|  |  |
| Participation | 0.5 |  |
| 0.25 |  |
|  | 0 |  |



1989

 1979

 1969

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 |
|  |  |  |  |  |  |  | Age | |  |  |  |  |  |  |  |

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:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | ASPR | | · log | PSTAR | | · ZMrwage + B3 · ZUnem + B4 · ZSevsix. |  |
| 6.5)log |  | = B1 |  | + B2 |  |
|  |  |  |
|  | 1 - ASPR | |  | 1 - PSTAR | |  |  |

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, B2

and B3 could be either positive or negative. B4 captures the effect of breaks in the time-series of

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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 B1, the

parameter on the transformed P\*. A priori, we expect B1 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, B1 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 B1 is this smooth transition enforced in the

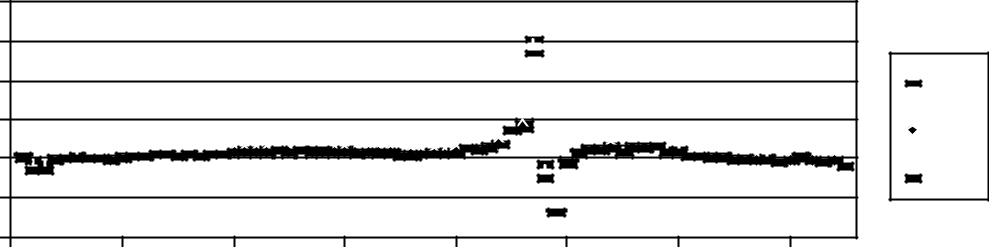
cross-section estimation.

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

Parameter on Log(Pstar/(1-Pstar))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter Estimate | |  |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |  |
| 2.5 |  |  |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  | B+s |  |
| 1.5 |  |  |  |  |  |  | B |  |
| 1 |  |  |  |  |  |  | B-s |  |
| 0.5 |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| 0 |  |  |  |  |  |  |  |  |
| 15 | 25 | 35 | 45 | 55 | 65 | 75 | 85 |  |
|  |  |  |  | Age |  |  |  |  |
| Figure 9-17 shows the parameter B2, 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

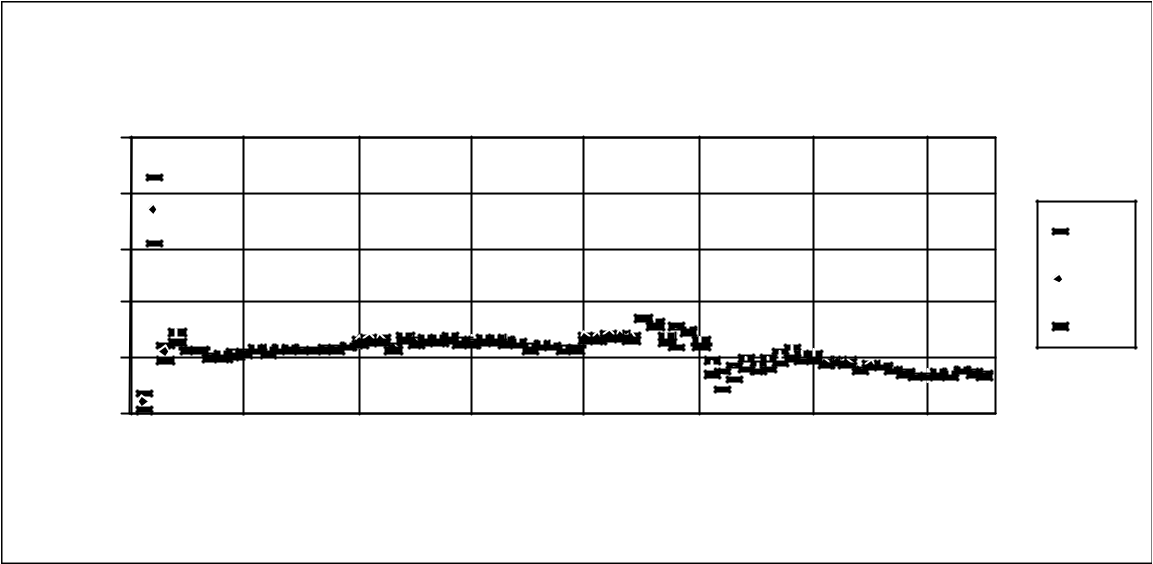
of age B2, is positive; increases in male relative wage increase the probability of participating in

the labor force. For men older than 65 B2, is on the whole negative, suggesting that increases in

the relative wage decrease participation.

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



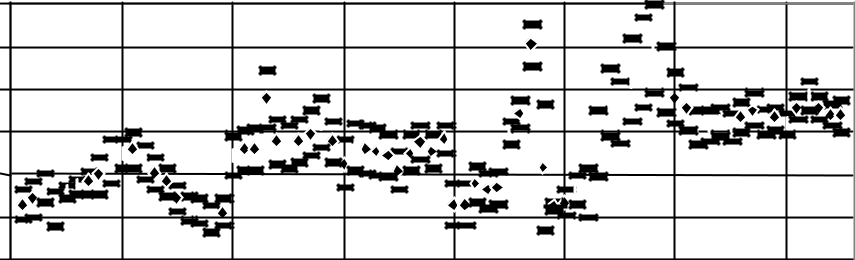
|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Parameter on Male Relative Wage | | | | |  |  |
| Parameter Estimate | |  |  |  |  |  |  |  |
| 8 |  |  |  |  |  |  |  |  |
| 6 |  |  |  |  |  |  | B+s |  |
| 4 |  |  |  |  |  |  |  |
|  |  |  |  |  |  | B |  |
| 2 |  |  |  |  |  |  |  |
|  |  |  |  |  |  | B-s |  |
| 0 |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| -2 |  |  |  |  |  |  |  |  |
| 15 | 25 | 35 | 45 | 55 | 65 | 75 | 85 |  |
|  |  |  |  | Age |  |  |  |  |

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

Parameter Value on Unemployment

Parameter Estimate

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 25 |  |  |  |  |  |  |  |
| 20 |  |  |  |  |  |  |  |
| 15 |  |  |  |  |  |  |  |
| 10 |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |
| 0 |  |  |  |  |  |  |  |
| -5 |  |  |  |  |  |  |  |
| 15 | 25 | 35 | 45 | 55 | 65 | 75 | 85 |
|  |  |  |  | Age |  |  |  |



 B+s

B

 B-s

Figure 9-18 graphs the parameter results for B3, the parameter on the Zero mean

unemployment rate. As with the female participation equations it is difficult to asses the total

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effect of unemployment on participation without actually running a simulation because the

variable P\* is negatively related to unemployment. Thus, the positive B3’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 B4, the parameter for the dummy

variable prior to 1976. The dummy captures the effect of the breaks in the time-series of actual

data. B4 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.

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

Parameter on Dummy = 1 for Time < 1976

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Estimate | | 0.5 | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  | | | | | | |  |
| 0 | | | |  | | |  |  | |  | |  | |  | |  |  |  |  | |  | |  |  | |  |  |  |  | |  | |  | | | | | | | | | | |  | | | | | | | | | | |  | | | | | | | | |  | | | | | |  | | |  | | | | | | | | | | |  | | | |  | | B+s | | | | |  |
| Parameter | | -0.5 | |  | |  |  | | |  | |  | |  | |  |  | |  | |  | |  |  | |  |  | |  | |  |  | | |  | | |  | |  | |  | |  | | | |  | | |  | |  | |  | | |  | | | |  | | | | |  |  | |  | |  |  | | | | |  | | | | | | | | | |  | |  | | | B | |  |
|  | -1 | |  | | | | | |  | | | |  | | | | | | |  | | | | |  | | | | |  | | | |  | | |  | |  | |  | |  | |  | | | | | | | | | | | | | | | | | | | | | | | |  | |  | | | |  | | | | | | | | | | | |  | |  | |  | | | B-s |  |
|  | |  | | | | | |  | | | |  | | | | | | |  | | | | |  | | | | |  | | | | |  | |  | |  | |  | |  | | | | | | | | | | | | | | | | | | | | | | | | | |  | | | | | | | | | | | | | | | | | |  | |  | | | | |  |
|  | |  | | | | | |  | | | |  | | | | | | |  | | | | |  | | | | |  | | | | | | | | | | |  | |  | | | | | | | | | | | | | | | | | | | | | | | | | |  | | | | | | | | | | | | | | | | | |  | | | | | | |  |
|  | | -1.5 | |  | | | | | |  | | | |  | | | | | | |  | | | | |  | | | | |  | | | | | | | | | | | | |  | | | | | | | | | | | | | | | | | | | | | | | | | |  | | | | | | | | | | | | | | | | | |  | | | | | | |  |
|  | |  | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  |
|  | 15 | | | | 25 | | | | | | 35 | | | | 45 | | | | | | | 55 | | | 65 | | | | | 75 | | | | | | | | | | | | | | | |  |  | |  |  | |  | |  | |  |  | |  |  |  | |  | |  | 85 | | | | | | | |  |  |  |  | |  |  |  |  |  | |  |  |  | |  | |  |  | |  |  |
| Age | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  |

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-

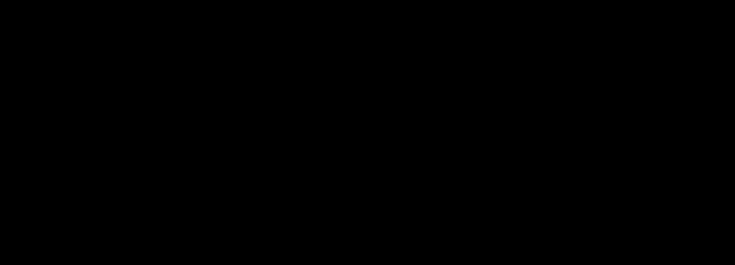
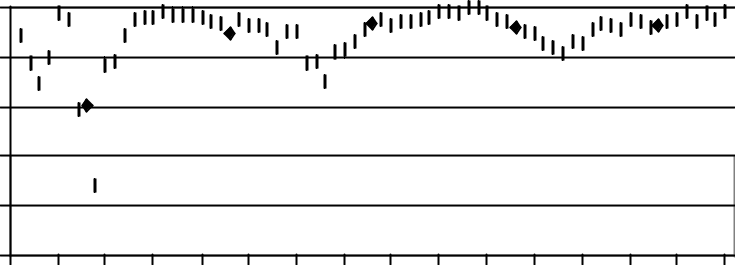
year-old males, where the correlation is quite low.

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

Correlation Coefficient between Actual and Predicted

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Coefficient | 1 |  |  |  |  |  |  |  |  |  |  |  |  |
| 0.8 |  |  |  |  |  |  |  |  |  |  |  |  |
| 0.6 |  |  |  |  |  |  |  |  |  |  |  |  |
| Correlation | 0.4 |  |  |  |  |  |  |  |  |  |  |  |  |
| 0.2 |  |  |  |  |  |  |  |  |  |  |  |  |
| 0 |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 15 | 20 25 | 30 | 35 40 | 45 | 50 55 | 60 | 65 | 70 | 75 | 80 85 | 90 |  |
|  |  |  |  |  |  | Age |  |  |  |  |  |  |  |



Correlation Coefficient

**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.

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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

1. 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

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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

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

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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.

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**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.

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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

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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

1. 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.

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(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

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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.

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Table 10-1 Board of Trustees of the OASDI Trust funds 1997 Assumptions59

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | SSA | | Unem | | Average Annual % Change | | |  | | Total | | Participation Rates | |
| Year | Alt. | | Rate | | Real Wage | | Real GDP | CPI | | Fertility | | Men | | Women |
|  |  | |  | |  | |  |  | | Rate | | 20-64 | | 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

1. The economic variables are created from Board of Trustees OASDI (1997) Table III.B.1, p.
   1. 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.

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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

1. Board of Trustees of OASDI (1997), p. 11.

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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.

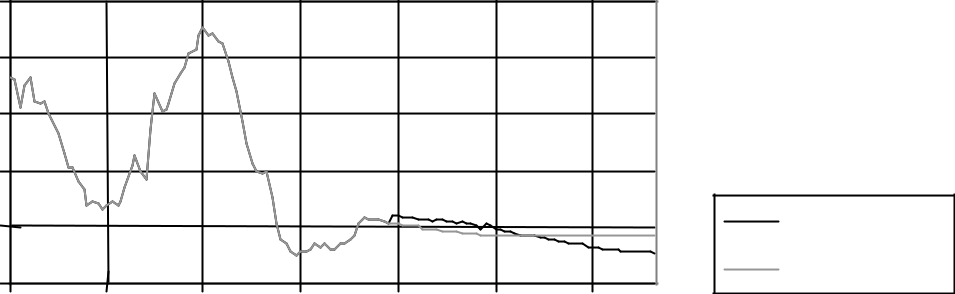
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Figure 10-1 Total Fertility Rate History and Intermediate Assumptions 1917-2050

Total Fertility Rate History, SSA II, DPM

TFR

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 4000 |  |  |  |  |  |  |  |
| 3500 |  |  |  |  |  |  |  |
| 3000 |  |  |  |  |  |  |  |
| 2500 |  |  |  |  |  |  |  |
| 2000 |  |  |  |  |  | DPM TFR II |  |
| 1500 |  |  |  |  |  | SSA TFR II |  |
|  |  |  |  |  |  |  |
| 1917 | 1937 | 1957 | 1977 | 1997 | 2017 | 2037 |  |
|  |  |  | Year |  |  |  |  |



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

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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

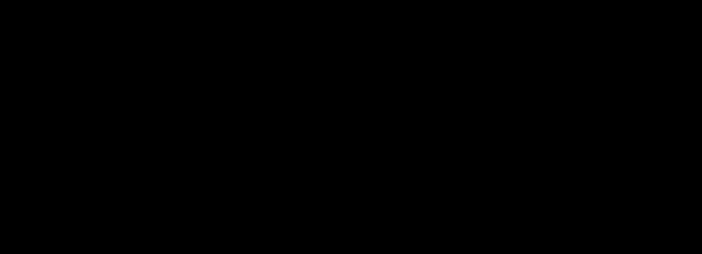
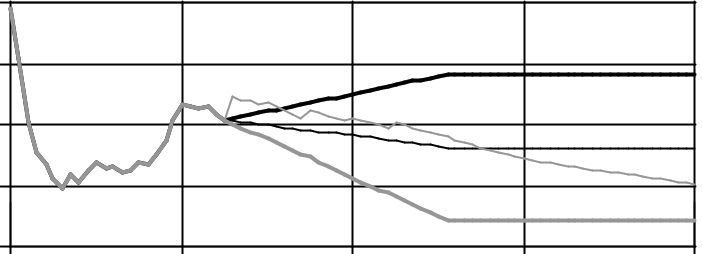
Intermediate forecast. Except for the initial couple of years the SSA bounds also bound the

DPM Intermediate forecast.

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

TFR History, SSA Projections, and DPM II

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| TFR |  |  |  |  |
| 2500 |  |  |  |  |
| 2250 |  |  |  |  |
| 2000 |  |  |  |  |
| 1750 |  |  |  |  |
| 1500 |  |  |  |  |
| 1970 | 1990 | 2010 | 2030 | 2050 |
|  |  | Year |  |  |



SSA TFR 1

SSA TFR II

SSA TFR 3

DPM TFR 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

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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

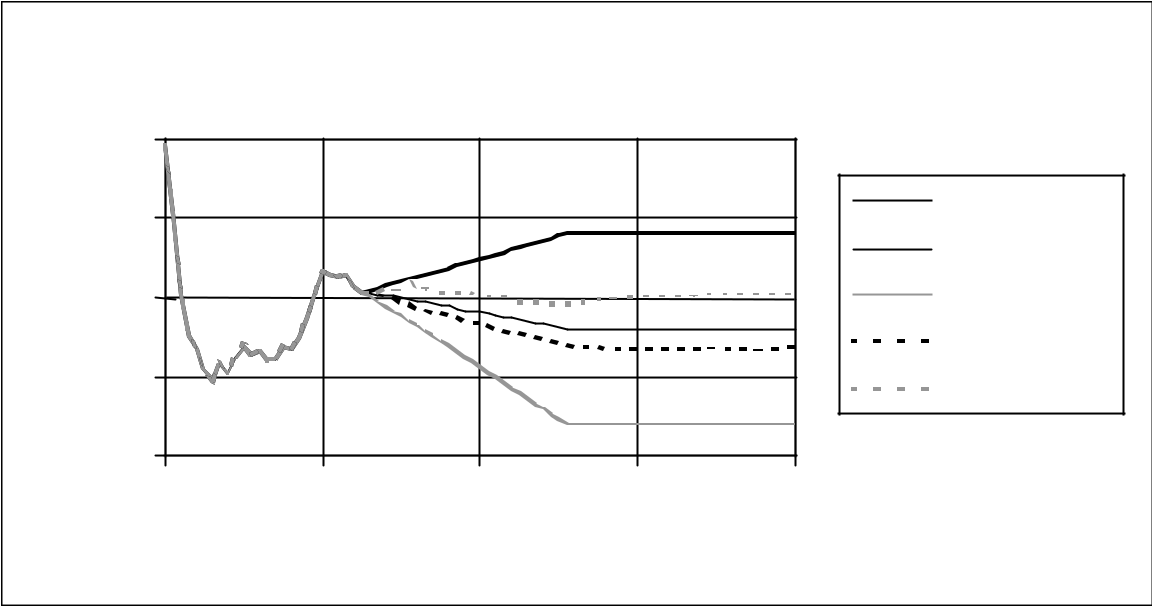
TFR as a result of using the economic assumptions from the High cost (Low cost) scenario is to

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.

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



TFR History, SSA Projections, DPM

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| TFR |  |  |  |  |  |
| 2500 |  |  |  |  |  |
| 2250 |  |  |  | TFR SSA I |  |
|  |  |  | TFR SSA II |  |
|  |  |  |  |  |
| 2000 |  |  |  | TFR SSA III |  |
| 1750 |  |  |  | TFR DPM I |  |
|  |  |  | TFR DPM III |  |
|  |  |  |  |  |
| 1500 |  |  |  |  |  |
| 1970 | 1990 | 2010 | 2030 | 2050 |  |
|  |  | Year |  |  |  |

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

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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

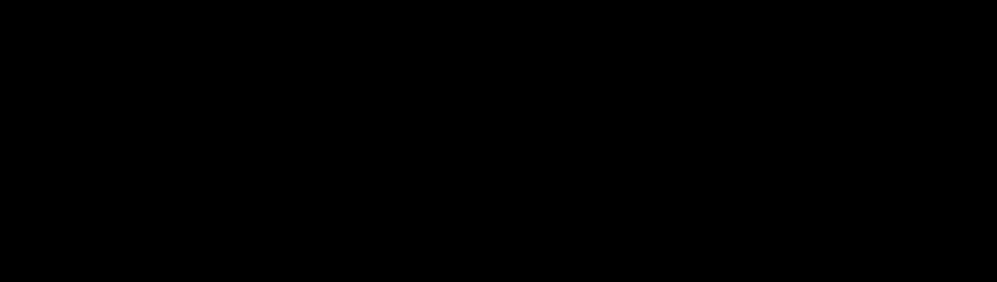
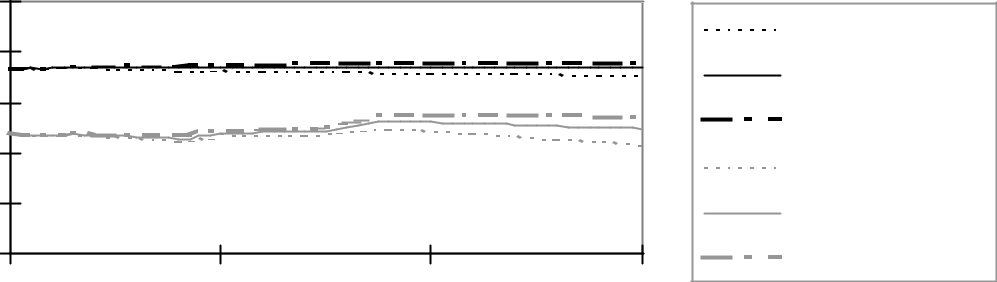
cost alternative has higher participation. Like the fertility analysis, the participation analysis

suggests that the economics will tend to pull the results back to the Intermediate solution.

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | |  | | Participation Rates Women 20-35, and Men 61-65 | | |  |
| Rate | 100 | |  | |  | Female 20-35 I |  |
| 80 | |  | |  |  |
|  | |  | Female 20-35 II |  |
|  | |  | |  |  |
| Participation | 60 | |  | |  |  |
|  | |  | Female 20-35 III |  |
| 40 | |  | |  |  |
|  | |  | Male 61-65 I |  |
|  | |  | |  |  |
| 20 | |  | |  | Male 61-65 II |  |
|  | 0 | |  | |  | Male 61-65 III |  |
|  | 1990 | | 2010 | | 2030 | 2050 |  |
|  |  | |  | | Year |  |  |



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.

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**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.

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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

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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.

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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.

1. 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.

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Table 11-1 Population History and Base Projections62

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Population | |  | | Total | | Life Expectancy | | | Immigration | |
| Year | Millions | | Annual | | Fertility | | Male | | Female | Decade | | % Pop. |
|  |  | | Growth | | Rate | |  | |  | Sum | | 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

1. 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

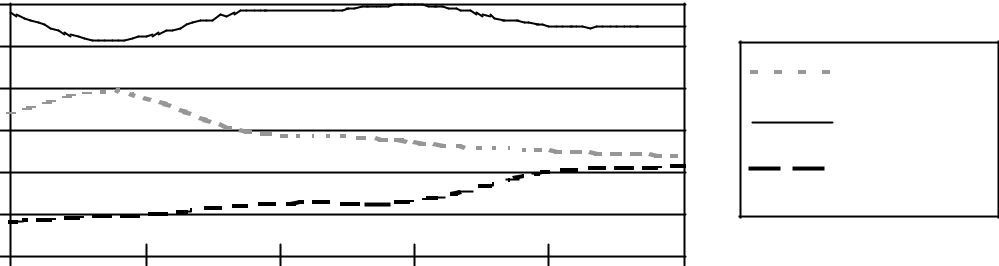
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associated with strong labor force attachment) reaches a peak of 60% in 2010 and then slowly

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Population |  | Population Distribution | | |  |  |
| Shares |  |  |  |  |  |  |
| 0.6 |  |  |  |  |  |  |
| 0.5 |  |  |  |  | Age < 20 |  |
| 0.4 |  |  |  |  |  |
|  |  |  |  | 19<Age<65 |  |
| 0.3 |  |  |  |  |  |
|  |  |  |  |  |  |
| 0.2 |  |  |  |  | Age>64 |  |
| 0.1 |  |  |  |  |  |  |
| 0 |  |  |  |  |  |  |
| 1950 | 1970 | 1990 | 2010 | 2030 | 2050 |  |



Year

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.

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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.

1. See appendix B for detailed tables of the Base economic and demographic forecast.

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Table 11-2 Base Economic Forecast Summary Table

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Growth Rates % | 1996- | 2000- | 2010- | 2015- | 2020- | 2030- | 2040- |
|  | 2000 | 2010 | 2015 | 2020 | 2030 | 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

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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

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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

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

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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.

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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

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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.

1. 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.

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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

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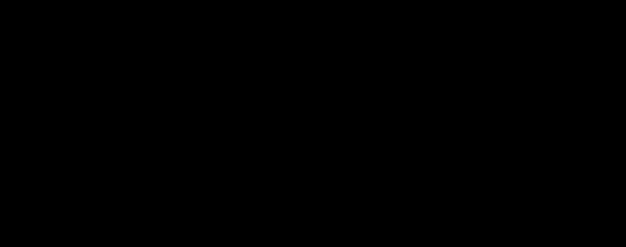
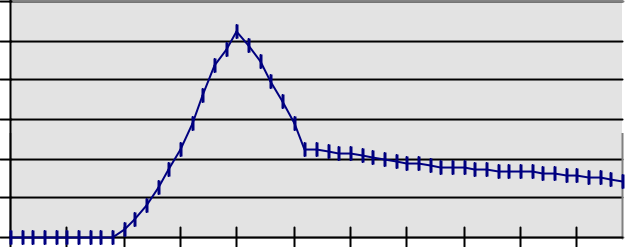
base forecast. The increase in age of eligibility has its most significant impact in 2016 where the

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 RET6766

|  |  |
| --- | --- |
| Change in | Difference in Solvency Ratios: |
| Solvency Ratio | Retirment Alternative less Base |
| 1.2 |  |
| 1.0 |  |
| 0.8 |  |
| 0.6 |  |
| 0.4 |  |
| 0.2 |  |



0.0

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1996 | 2001 | 2006 | 2011 | 2016 | 2021 | 2026 | 2031 | 2036 | 2041 | 2046 |
|  |  |  |  |  | Year | |  |  |  |  |

 Solvency Ratio

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.

1. 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.

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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.

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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-

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

simulation.

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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 |

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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.

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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 |

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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 |

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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

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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.

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

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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

1. 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.
2. 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.

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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

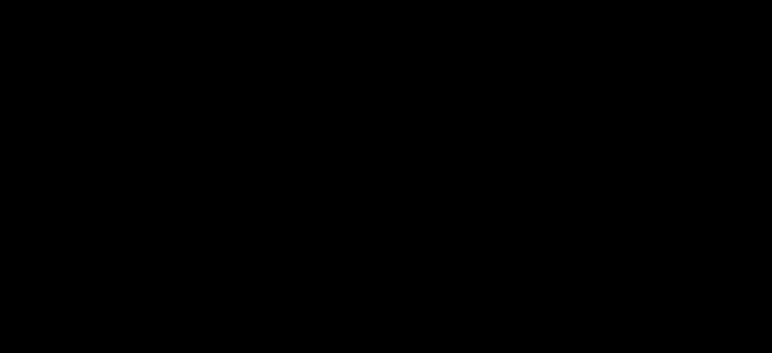
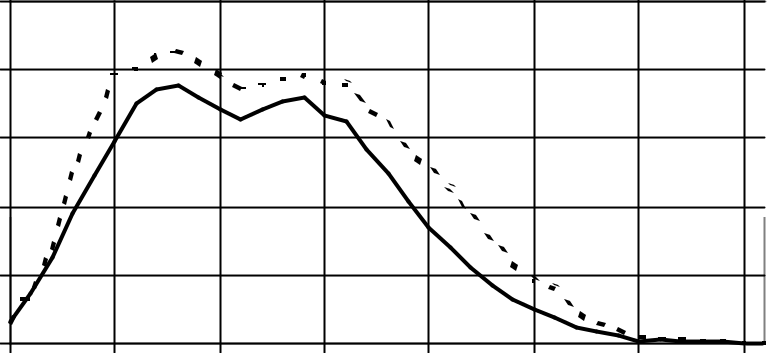
the early 20’s where the age-specific fertility rates climb above 12%.

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

Age Specific Fertility Rates in 2050

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 0.15 |  |  |  |  |  |  |  |  |
| Rate | 0.12 |  |  |  |  |  |  |  |  |
| 0.09 |  |  |  |  |  |  |  |  |
| Fertility | 0.06 |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  | 0.03 |  |  |  |  |  |  |  |  |
|  | 0 |  |  |  |  |  |  |  |  |
|  | 14 | 19 | 24 | 29 | 34 | 39 | 44 | 49 |  |
|  |  |  |  |  | Age |  |  |  |  |



Base

Alt

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

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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.

1. See Bell (1997) and Day (1996).

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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.

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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.

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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,

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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.

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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

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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

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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

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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%.

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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.

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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

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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.

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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

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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

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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

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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

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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.

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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.

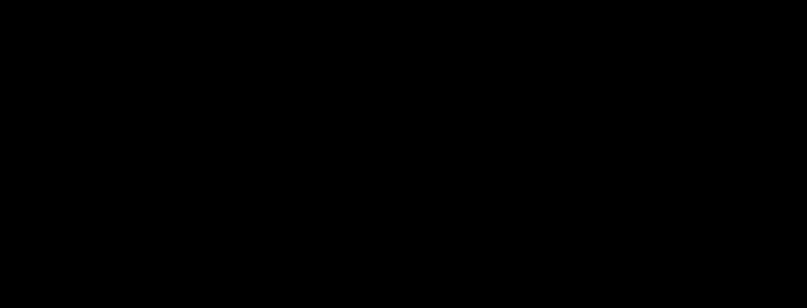
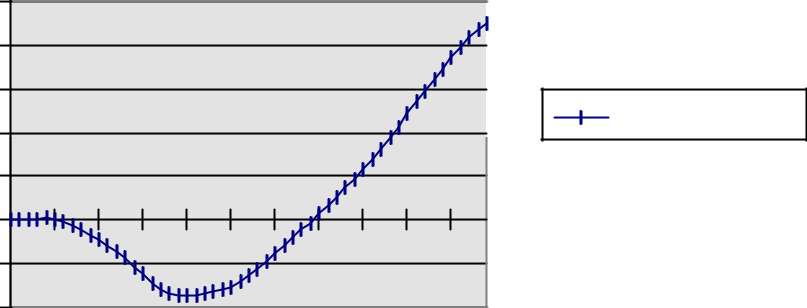
Figure 11-4 Change in Solvency Ratio Child Credit

Differences in Solvency Ratios:

Solvency Ratio

Child Credit less Base

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0.5 |  |  |  |  |  |  |  |  |  |  |  |
| 0.4 |  |  |  |  |  |  |  |  |  |  |  |
| 0.3 |  |  |  |  |  |  |  |  |  | Solvency Ratio |  |
| 0.2 |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
| 0.1 |  |  |  |  |  |  |  |  |  |  |  |
| 0.0 |  |  |  |  |  |  |  |  |  |  |  |
| -0.1 |  |  |  |  |  |  |  |  |  |  |  |
| -0.2 |  |  |  |  |  |  |  |  |  |  |  |
| 1996 | 2001 | 2006 | 2011 | 2016 | 2021 | 2026 | 2031 | 2036 | 2041 | 2046 |  |
|  |  |  |  |  | Year | |  |  |  |  |  |



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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

1. 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.

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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.

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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

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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.

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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.

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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.

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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

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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.

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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

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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

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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

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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.

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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.

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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 | -0.012 | -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 | 0.023 | -0.013 | 0.04 | -0.03 | 0.021 |  |
| Husb. Labor | -0.11 | -0.10 | -0.06 | -0.08 | -0.03 | -0.06 |  |
| Participation | -0.031 |  |  |  |  |  |  |
| No. Children 1<age<5 | -0.05 | -0.17 | -0.13 | -0.12 | -0.09 |  |
| No. Children age>=5 | -0.013 | -0.01 | -0.04 | -0.03 | -0.04 | -0.04 |  |
| Husb. Part.\* No. Child | -0.013 | -0.023 | 0.11 | 0.11 | 0.10 | 0.10 |  |
| 1<age<5 |  |  |  |  |  |  |  |
| Husb. Part.\* No. Child | -0.04 | -0.04 | -0.01 | -0.02 | -0.02 | -0.02 |  |
| age>=5 |  |  |  |  | -0.602 |  |  |
| Local Unemployment | 11.98 | 6.09 | -1.97 | -1.55 | -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.

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

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Married Male Log of | 1970 | |  | 1980 | |  | 1990 | |  |  |
| Wages |  | |  |  | |  |  | |  |  |
|  | 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 | -0.0141 | | -0.0073 | -0.0093 -0.0161 | | | 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 | -0.091 | | -0.112 | -0.135 | | -0.143 | -0.161 | | -0.214 |  |
| Participation |  | |  |  | |  |  | |  |  |
| No. Children 1<age<5 | | -0.027 -0.022 | | | -0.034 -0.035 | | | -0.038 -0.033 | |  |
| No. Children age>=5 | 0.0033 | | - | -0.0043 -0.0033 | | | -0.0043 | | -0.015 |  |
|  |  | | 0.00033 |  | |  |  | |  |  |
| Husb. Part.\* No. Child | 0.046 | | 0.038 | 0.029 | | 0.034 | 0.045 | | 0.024 |  |
| 1<age<5 | -0.0013 | | 0.0041 | 0.0033 | | 0.0033 | 0.0053 | |  |  |
| Husb. Part.\* No. Child | 0.020 |  |
| age>=5 |  | |  |  | |  |  | |  |  |
| Two or more Children | 0.043 | | 0.033 | 0.056 | | 0.056 | 0.050 | | 0.080 |  |
| Local Unemployment | 7.934 | | 7.487 | -0.7841 -0.6821 | | | -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.

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Single Male Log | 1970 | |  | | 1980 | |  | | 1990 | |  |  |
| of Wages |  | |  | |  | |  | |  | |  |  |
|  | Heckit | | OLS | | Heckit | | OLS | | Heckit | | OLS |  |
| Experience | 0.031 | | 0.043 | | 0.030 | | 0.033 | | 0.035 | | 0.037 |  |
| Experience | -0.0003 | | -0.0004 | | -0.0003 | | -0.0004 | | -0.0005 | | -0.0005 |  |
| Squared |  | |  | |  | |  | |  | |  |  |
| Teenager | | -0.152 | | -0.242 | | -0.120 | | -0.096 | | -0.124 -0.098 | |  |
| Age Twenty | 0.0243 | | 0.071 | | -0.0113 | | 0.0033 | | 0.0083 | | 0.0143 |  |
| 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 | 0.058 | | 0.096 | | -0.0063 | | 0.0003 | | 0.0193 | | 0.0232 |  |
| 1<age<5 |  | |  | |  | |  | |  | |  |  |
| No. Children | 0.032 | | 0.056 | | 0.071 | | 0.076 | | 0.055 | | 0.054 |  |
| age>=5 |  | |  | | -0.6573 | | -0.5913 | |  | |  |  |
| Local | 18.784 | | 17.340 | | -1.842 | | -1.773 |  |
| Unemployment |  | |  | |  | |  | | 0.0661 | |  |  |
| Lambda | -0.561 | |  | | -0.137 | |  | |  |  |
| 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.

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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 |  | 21.854 |
| Minutes |  |  |
|  | Parameter | Standard |
| Variable | Estimate | 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 | 0.130 | 0.018 |
| Hhld. |  |  |
| 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.

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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 | 0.000 | 0.013 |
| Hhld |  |  |
| 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. |  |

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|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Chapter 17 Estimate of Probability of Birth | | | | | | | | | |  | |  | |  | |  | |  |  |
|  |  | | | | | | | |  |  | |  | | | |  | | |  |
| 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 | | Full | | | Simple | | Simple | | Full | | Simple Simple | | | Full |
|  |  | |  | | w/ State | |  | |  |  | | w/ State | |  | |  | | w/ |  |
|  |  | |  | | Dum | |  | |  |  | | Dum | |  | |  | | State |  |
|  |  | |  | |  | |  | |  |  | |  | |  | |  | | Dum |  |
|  | *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 0.0281 | | | | | 0.0033 | | 0.0083 | | 0.060 | | 0.064 | | 0.065 | 0.074 |
|  | | Tax Value State | | 0.004 | | -0.070 | | - | | | - | | -0.269 | | -0.172 | | 0.0033 -0.0083 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 | |  | |  | | -7.13 | | |  | |  | | 36.8 | |  | |  | 12.72 |
|  | Twins at Second | |  | |  | | -10.63 | | |  | |  | | -39.7 | |  | |  | -21.9 |
|  | First 2 children | |  | |  | | 1.83 | | |  | |  | | 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.

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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 |

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Chapter 19 Household Income Estimates

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

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Estimate of Household | 1990 |  | 1980 |  | 1970\* |  |
| Income |  |  |  |  |  |  |
| R-square | 0.3953 |  | 0.4513 |  | 0.4521 |  |
| Observations | 864248 |  | 716110 |  | 554575 |  |
| Dep Mean | 37.76053 |  | 20.24584 |  | 9828.490 |  |
|  |  |  |  |  | 3 |  |
|  | Paramet |  | Paramet |  | Paramet |  |
| Variable | Estimate | Error | Estimate | Error | 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. | -5.198 | 0.126 | -3.084 | 0.062 |  |  |
| Yr. |  |  |  |  |  |  |
| Worked in Previous | 7.278 | 0.084 | 5.322 | 0.048 | 2796.5 | 26.6 |
| Year |  |  |  |  |  |  |
| 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 |

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|  |  |  |  |
| --- | --- | --- | --- |
| 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 |  | -476.8 | 26.4 |
| Machine |  |  |  |
| 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 |  | Table of marital status by quarter of first marriage 1980 | | | |  |
| Percent |  |  |  |  |  |  |
| Row Pct |  |  |  |  |  |  |
| **Col Pct** | Never Married | Quarter 1 | Quarter 2 | Quarter 3 | Quarter 4 | Total |
| Married | 0 | 64305 | 103063 | 102821 | 83164 | 353353 |
| Spouse | 0 | 10.42 | 16.69 | 16.65 | 13.47 | 57.23 |
| Present | 0 | 18.2 | 29.17 | 29.1 | 23.54 |  |
|  | 0 | **80.41** | **82.15** | **83.08** | **82.08** |  |
| Married | 0 | 1085 | 1340 | 1174 | 1122 | 4721 |
| Spouse | 0 | 0.18 | 0.22 | 0.19 | 0.18 | 0.76 |
| Absent | 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 | 186890 | 0 | 0 | 0 | 0 | 186890 |
| Married | 30.27 | 0 | 0 | 0 | 0 | 30.27 |
|  | 100 | 0 | 0 | 0 | 0 |  |

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

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Table 13-10 Quarter of Marriage by Birth Status 1980

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

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

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

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Chapter 21 Frequency Table for Gender of Children

Table 13-12 Gender of Children by Birth Status 1980

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

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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. | 3288.9 | 3893.2 | 4224. | 4537.5 | 5181.5 | 5873.5 | 6691.2 |
|  | 0 |  |  | 5 |  |  |  |  |
| Gross Domestic Product,bil | 3206. | 3304.7 | 3912.6 | 4226. | 4519.9 | 5155.0 | 5829.8 | 6595.6 |
| 77$ | 6 |  |  | 8 |  |  |  |  |
| Components, bil 77$ |  |  |  |  |  |  |  |  |
| Personal consumption | 2198. | 2221.9 | 2490.7 | 2664. | 2815.4 | 3199.2 | 3632.5 | 4156.3 |
|  | 4 |  |  | 0 |  |  |  |  |
| Fixed investment | 600.2 | 652.2 | 907.4 | 1023. | 1145.8 | 1435.3 | 1754.5 | 2134.3 |
|  |  |  |  | 7 |  |  |  |  |
| 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. | 5027.8 | 7644.2 | 9521. | 11737. 17617. | | 26247. | 39234. |
|  | 6 |  |  | 7 | 9 | 1 | 0 | 1 |
| Monetary Base, StL. (bil $) | 504.2 | 630.7 | 1101.2 | 1448. | 1879.8 | 3093.3 | 4982.3 | 7938.5 |
|  |  |  |  | 7 |  |  |  |  |
| 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 | 399.4 | 481.8 | 774.7 | 893.9 | 963.4 | 1062.7 | 1165.5 | 1268.3 |
| exp |  |  |  |  |  |  |  |  |
| Average effective relative prices | |  |  |  |  |  |  |  |
| Exports, US/foreign | 96.4 | 98.9 | 97.8 | 97.3 | 95.9 | 95.2 | 95.6 | 96.9 |
| (1977=100) |  |  |  |  |  |  |  |  |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Imports, foreign/US | 91.6 | 88.4 | 87.7 | 87.7 | 88.6 | 89.2 | 88.8 | 87.6 |
| (1977=100) |  |  |  |  |  |  |  |  |
| Exchange rate scaler | 1.0 | 1.0 | 1.0 | 1.1 | 1.1 | 1.1 | 1.2 | 1.2 |
| Real disposable income | 1721. | 1715.9 | 1949.2 | 2089. | 2209.1 | 2512.3 | 2856.2 | 3261.3 |
|  | 1 |  |  | 4 |  |  |  |  |
| Savings rate, pct | 4.6 | 2.9 | 4.3 | 4.4 | 4.4 | 4.5 | 4.5 | 4.0 |
| Federal surplus, bil $ | - | 81.8 | 171.9 | 233.8 | 324.2 | 510.8 | 660.2 | 955.7 |
|  | 107.1 |  |  |  |  |  |  |  |
| Relative to GNP | -1.4 | 0.9 | 1.2 | 1.3 | 1.4 | 1.4 | 1.2 | 1.2 |
| Factor Payments |  |  |  |  |  |  |  |  |
| Labor compensation | 4463. | 5106.6 | 8166.3 | 10287 12833. 19713. | | | 29546. | 44024. |
|  | 1 |  |  | .1 | 0 | 7 | 3 | 2 |
| Net interest | 435.0 | 524.0 | 974.8 | 1277. | 1667.5 | 2761.4 | 4417.8 | 6972.8 |
|  |  |  |  | 0 |  |  |  |  |
| Corporate profits | 652.9 | 751.8 | 1152.6 | 1436. | 1817.9 | 2976.4 | 4890.9 | 8000.6 |
|  |  |  |  | 0 |  |  |  |  |
| 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. | 1795.7 | 2834.7 | 4409.6 | 6832.5 |
|  |  |  |  | 2 |  |  |  |  |

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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 | 10.9 | 10.6 | 11.3 | 11.5 | 11.7 | 11.8 | 11.8 | 11.8 |  |
|  |  | manufacturing |  |  |  |  |  |  |  |  |  |
|  |  | 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 | 7.6 | 7.8 | 8.7 | 8.9 | 9 | 9.2 | 9.5 | 9.9 |  |
|  |  | Estate |  |  |  |  |  |  |  |  |  |
|  |  | 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 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |  |
|  |  | enterprises |  |  |  |  |  |  |  |  |  |
|  |  | 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 | 1856.9 | 1859.4 | 1849.7 | 1853 | 1859.4 | 1866.6 | 1867.7 | 1868.6 |  |
|  |  | employee |  |  |  |  |  |  |  |  |  |
|  |  | LABOR PRODUCTIVITY - | |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  | private |  |  |  |  |  |  |  |  |  |
|  |  | (GNP-GOVT COE) / Prvt | 14.2 | 14.7 | 16.3 | 17.2 | 18.1 | 20 | 22.1 | 24.5 |  |

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Table 13-15 Employment and Population Base Demographic Results

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Employment and |  |  |  |  |  |  |  |  |
| Population |  |  |  |  |  |  |  |  |
|  | 1996 | 2000 | 2010 | 2015 | 2020 | 2030 | 2040 | 2050 |
| Population, total (in | 265.6 | 275 | 296.9 | 307.6 | 318 | 336.4 | 350.6 | 362 |
| millions) |  |  |  |  |  |  |  |  |
| 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, | 133.9 | 135.5 | 146.7 | 150.2 | 152.5 | 157.7 | 162.5 | 166.7 |
| millions |  |  |  |  |  |  |  |  |
| 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 |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |

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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 | | 11.6 | 11.5 | 10.6 | 10.7 | 10.8 | 11.6 | 12.1 | 12.8 |
| services | |  |  |  |  |  |  |  |  |
| 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 | | 9.7 | 9.7 | 9.9 | 10 | 10 | 9.9 | 10.5 | 11.3 |
| product | |  |  |  |  |  |  |  |  |
| 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 | | 27.9 | 21.9 | 22.3 | 22.6 | 22.9 | 24 | 25.2 | 26.9 |
| product | |  |  |  |  |  |  |  |  |
| 11 | Petroleum & related | 24.8 | 21.5 | 23.2 | 23.5 | 23.5 | 23.8 | 25 | 26.8 |
| ind. | |  |  |  |  |  |  |  |  |
| 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 | | 14.1 | 12 | 12.5 | 12.5 | 12.5 | 12.5 | 13.1 | 14 |
| products, | |  |  |  |  |  |  |  |  |
| 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 | | 21.5 | 19.2 | 19.8 | 20 | 19.9 | 20.1 | 21.1 | 22.6 |
| motor | |  |  |  |  |  |  |  |  |
| 20 | Machinery, excpt | 18.2 | 18.2 | 18.8 | 19.1 | 19.2 | 19.7 | 20.7 | 22.2 |
| electrical | |  |  |  |  |  |  |  |  |
| 21 Electrical machinery | | 15.4 | 16.4 | 16 | 16.1 | 16 | 16 | 17.2 | 18.6 |
| 22 | Motor vehicles and | 21.6 | 17 | 17.8 | 17.7 | 17.4 | 16.9 | 17.4 | 18.5 |
| equip. | |  |  |  |  |  |  |  |  |
| 23 | Instruments and related | 29.5 | 24.9 | 24.8 | 25 | 25.4 | 27 | 28.1 | 29.7 |
| 24 Misc. manufacturing | | 13.3 | 13.2 | 13.4 | 13.5 | 13.6 | 13.8 | 14.7 | 15.9 |
| ind. | |  |  |  |  |  |  |  |  |
| 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 | 12.8 | 13.8 | 14.5 | 14.6 | 14.5 | 14.2 | 15.1 | 16.3 |
| trans. | |  |  |  |  |  |  |  |  |
| 28 Communications | | 26.5 | 19.7 | 21.2 | 21.4 | 21.6 | 22.2 | 23.3 | 25 |

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|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 30 | Electric, gas, and | 20.8 | 20.1 | 20.6 | 20.8 | 21 | 21.9 | 23 | 24.6 |
| sanitary | |  |  |  |  |  |  |  |  |
| 31 | Wholesale and retail | 12.7 | 12.2 | 11.7 | 11.6 | 11.5 | 11.3 | 11.4 | 11.6 |
| trade | |  |  |  |  |  |  |  |  |
| 32 Financial & insurance | | 24.7 | 20.3 | 19.7 | 20 | 20.2 | 21.5 | 22.6 | 24.1 |
| serv. | |  |  |  |  |  |  |  |  |
| 33 | Real estate & | 10.5 | 11.4 | 12 | 12.2 | 12.4 | 13.1 | 13.8 | 14.7 |
| combinations | |  |  |  |  |  |  |  |  |
| 34 | Personal, repair, & | 11.1 | 10.6 | 10.4 | 10.5 | 10.6 | 11.1 | 11.6 | 12.5 |
| hotels | |  |  |  |  |  |  |  |  |
| 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 | | 19 | 17.5 | 17.9 | 18.1 | 18.4 | 19.9 | 20.9 | 22.4 |
| pictures | |  |  |  |  |  |  |  |  |
| 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 |

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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 | 643.6 | 661.9 | 778.9 | 829.1 | 877.2 | 988.2 | 1113.5 | 1262.2 |
| estate |  |  |  |  |  |  |  |  |
| 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 |

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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, | 3.4 | 3.2 | 3 | 2.9 | 2.8 | 2.6 | 2.4 | 2.3 |
| fisheries |  |  |  |  |  |  |  |  |
| 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 | 7.8 | 7.5 | 7.2 | 7.1 | 6.8 | 6.4 | 5.9 | 5.5 |
| manufacturing |  |  |  |  |  |  |  |  |
| 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 | 7.6 | 7.8 | 8.7 | 8.9 | 9 | 9.2 | 9.5 | 9.9 |
| estate |  |  |  |  |  |  |  |  |
| 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 | 34.5 | 29.6 | 38.5 | 45.1 | 53.2 | 74.7 | 99.3 | 133 |
| services |  |  |  |  |  |  |  |  |
| 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 |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Finance, insurance, real | 296.1 | 293.9 | 457.5 | 559.3 | 684.8 | 1046.1 | 1554.7 | 2335.6 |
| estate |  |  |  |  |  |  |  |  |
| 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 | 447.7 | 515.3 | 825.7 | 1006.5 | 1222.1 | 1809.7 | 2734.2 | 4112.8 |
| admin. |  |  |  |  |  |  |  |  |
| Government enterprises | 66.7 | 76 | 109.3 | 130.7 | 155.1 | 219.3 | 328 | 493 |

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Chapter 23 Real Hourly Wages and Salaries by LIFT Industries for Alternative Simulations

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 | -0.2 | -0.5 | -0.6 | -0.2 | -0.2 | -0.4 |
| products | |  |  |  |  |  |  |
| 13 | Leather and leather products | -0.2 | -0.8 | -0.7 | -0.1 | 0.0 | -0.1 |
| 14 | Lumber & wood products,ex | 0.2 | 0.8 | 0.5 | -0.4 | -0.3 | -0.6 |
| furn | |  |  |  |  |  |  |
| 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 |

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|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | 0.3 | -0.5 | -0.2 | -0.5 | -0.9 | -1.2 | -1.4 |
| products | |  |  |  |  |  |  |  |
| 13 | Leather and leather products | 0.4 | -0.4 | 0.0 | 0.3 | -0.6 | -1.0 | -1.6 |
| 14 | Lumber & wood products,ex | -0.6 | -0.3 | -0.8 | -2.2 | -0.6 | 0.2 | 1.9 |
| furn | |  |  |  |  |  |  |  |
| 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 |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |

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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 | 0.2 | -0.2 | -0.2 | -0.3 | -0.9 | -1.5 | -2.1 |
| products | |  |  |  |  |  |  |  |
| 13 | Leather and leather products | 0.3 | -0.2 | -0.3 | 0.0 | -0.8 | -1.4 | -2.1 |
| 14 | Lumber & wood products,ex | -0.3 | 0.0 | 0.0 | -0.8 | -0.6 | -0.1 | 0.3 |
| furn | |  |  |  |  |  |  |  |
| 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 |

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 |

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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.

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

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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(fert0.25/1-fert0.25) = 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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