THE PINHAS SAPIR CENTER FOR DEVELOPMENT
TEL AVIV UNIVERSITY

"Retirement Behavior Among Married Couples in the USA and Israel - A study and a comparison"

Chemi Gotlibovski[1], Yoram Weiss[2], Evan David Feinsilver[3]

Discussion Paper No. 10-13

November 2013

The paper can be downloaded from: http://sapir.tau.ac.il

Thanks to The Pinhas Sapir Center for Development at Tel Aviv University for their financial support.

[1] Chemi Gotlibovski - The Academic College of Tel Aviv Jaffa, Tel Aviv Israel.
Email: chemi@post.tau.ac.il.

[2] Yoram Weiss- The Eitan Berglas School of Economics, Tel Aviv University, Ramat Aviv, Israel
Email: weiss@post.tau.ac.il.

[3] Evan David Feinsilver - Email: david@avichai.org.il.

Table of Contents

1. Introduction ………………………………….. 3
2. Background …………………………………. 4
3. Literature Survey ……………………………. 7
4. The Theoretical Model ……………………… 12
5. The Empirical Implementation …………….. 14
6. The Data …………………………………….. 19
7. Results ………………………………………. 22
8. Simulations ………………………………….. 24
   - The effect of education 26
   - The effect of being self-employed vs. a salary 29
   - The effect of health 29
   - The effect of pensions 30
   - The effect of changing life expectancy 32
   - The effect of changing the legal retirement age 34
   - "Goodness of Fit" tests 37
9. Appendices ………………………………….. 42
   - Appendix 1: Graphs of the Simulations 42
   - Appendix 2: Estimated Parameters 58
   - Appendix 3: Tables 68
   - Appendix 4: Calculation of health transition probabilities 74

ABSTRACT

A large body of evidence has accumulated indicating that husbands and wives tend to cluster their retirement decisions. This paper, based upon the Health and Retirement Study, presents a structural dynamic model of the retirement behavior of married couples, that assumes that the retirement decision is reached through a joint maximization of "family utility." Partners maximize a joint utility function, dependent on their observable features, namely – health, work status, age, age difference, salaried/independent status, and pension eligibility. An error term is added to allow for unobservable qualities. Following this, and given the results of the estimation, we simulated the behavior of hypothetical couples, to estimate the isolated effect of particular variables (e.g. the effect of a deterioration in health or lack of a pension on the timing of the retirement decisions). This paper was constructed so as to make it comparable with similar studies on Israel. Our main findings are that such a model is a good description of reality; that couples without a pension continue to work (at least one spouse) until an advanced age far more than couples with a pension; that among the various education levels, the highest percentage of working couples are those who have finished college, more than couples with higher degrees and more than couples who have only finished high school; however each of these groups may work less for different reasons – one out of choice (those with higher degrees have accumulated more funds, and so can retire earlier), and one out of necessity (those with less education have more difficulty finding jobs, and are paid less if they do work). In the US, it seems that the need to fund health care privately curbs the spouse's willingness to retire when the other partner is sick; although husbands do react significantly by reducing their workload. In Israel the responses are stronger, probably due to the fact that the government funds most of the citizen's health costs. We also found that changing the legal retirement age has significant impact on retirement patterns, and should be considered as a major tool by policymakers.

1. INTRODUCTION

A variety of studies have indicated that couples tend to cluster their retirement decisions (Hurd (1990), Gustman & Steinmeier (2000) and others), rather than decide on retirement independently of each other.

There may be several possible reasons for this clustering:

a) Couples usually share a common budget constraint. Thus, for example, couples with limited means may postpone their retirement date, whereas wealthy couples can afford to "purchase" leisure at an earlier age.

b) Each partner usually chooses a partner with tastes similar to his/her own, and therefore, each independently would tend to reach similar decisions regarding the timing of retirement.

c) The preferences of the spouses may be linked to one another. For example, each partner may obtain a higher utility from leisure if their spouse joins them. Thus, even if each partner chooses their own retirement date independently from their spouse, still, they will enjoy their retirement more if the spouse retires as well;

d) Married partners can select their retirement dates to maximize some joint goal. This goal could bring about a positive correlation in the retirement dates (e.g. if both want to enjoy leisure together), or a negative correlation (e.g. if one partner is sick, and the other partner wants to work more to fund the medical treatment).

It is important to differentiate between a correlation in retirement decisions, and an active decision by married partners to coordinate their retirement. Correlation can be a result of similar preferences (point (b) above), or more specifically, similar attitudes regarding how best to spend time, in work or leisure, during one's life or as a result of the fact that each partner enjoys retirement (leisure) more when the other partner is retired as well. The latter case could also lead to an active decision to coordinate retirement. An active decision could also improve the welfare of the family when each spouse faces different financial incentives (point (c)). This is the difference between retirement "happening" at the same time (because the partners have similar attitudes), or the retirement date being chosen at a particular time.
When planning retirement, there are several options. Partners may discuss and jointly decide on the optimal retirement time for each of them (cooperative behavior). Alternatively, the partner that retires first may retire according to her/his best option, while taking into account the expected response of the partner. This behavior is along the lines of the Stackelberg model.
In this paper we adopted the cooperative behavior assumption. Thus, we estimate a structural dynamic model of the retirement decisions of married couples that assumes that the retirement decision is reached through a joint maximization of family utility.

The model is estimated separately for a sample of couples in the USA and in Israel. The USA data comes from the Health and Retirement Study surveys from 1992 – 2008, a biannual survey that addresses a variety of behavioral, health and economic aspects of the elderly population in the United States. The data on Israel comes from a retrospective survey conducted by SHARE in 1995.

The importance of such an estimation lies in the fact that when policymakers decide on the age at which men and women become eligible for social security (in the USA) or on the mandatory retirement age (in Israel), such decisions are based upon calculations of how many years men and women will work to fund the country's benefit system, before retiring and becoming a recipient of these benefits. However, if married couples do not follow the "recommendations" of the government, and instead coordinate their retirement ages between themselves, the pay-as-you-go benefit system may be under-funded (if people retire sooner than expected), or overfunded, if they retire later than expected, which may enable the governments to lower the entitlement age.

2. BACKGROUND

Before reviewing the literature on this subject, some background information on Social Security and pension plans in the United States and Israel will help to understand the circumstances under which couples make their retirement decisions.

USA

Social security regulations and the pension systems

Benefits, for both men and women, are first available at age 62 and are subject to an earnings test prior to the normal retirement age of 65. The level of benefits is determined based upon the person’s income over the years – a higher income leads to higher Social Security payments. Benefits are lower (about 80% for life) if they begin at age 62, and increase to 100% if a person retires at age 65, and are further increased each year if retirement is postponed after age 65, up to age 70. Between 2005 and 2022 the threshold of age 65 is being gradually raised to 67.

Social Security eligibility is usually independent of whether or not a person is entitled to a pension. Social Security also provides dependent benefits. A worker’s spouse is entitled to a benefit of 50% of the worker’s primary insurance amount, once she reaches retirement age, and a surviving spouse (if the partner has died) to 100%. The spouse may also be entitled to Social Security payments based upon her own work history. In such a case, the benefit will be the higher of the two benefits.

Lastly, it should be noted that Social Security benefits are payable even if a person continues to work. However, there is some reduction in the benefits if a person claims the benefits before age 65.

Pensions

A second component of retirement wealth comes from pensions. There are two main types of pensions in the United States – "Defined Benefit" pensions and "Defined Contribution" pensions. The former is a "richer" form of pension, which only the high tier of employees usually have. In a Defined Benefit (DB) plan, the employer commits to pay a retired employee a specified amount, based on salary, years of employment, etc. If the funds accumulated are not sufficient, the employer will have to dip into his profits to fund this commitment (the reverse does not hold – if the DB plan makes a profit, there is no commitment to pay the employee more than the specified amount). Defined Contribution (DC) plans, on the other hand, are more common, but provide less – they provide whatever the employer and employee have put into them, along with interest, etc. In the United States, 50% of the private industry workers and 85% of the state and government employees participate in a pension plan (either DC or DB). Of these, 20% of private industry workers, and 79% of State employees participate in a Defined Benefit plan. In contrast, 41% of private industry and 17% of state employees participated in a Defined Contribution plan (as of 2010.[1] There is some overlap as some employees have both types of pensions). The most prevalent form of pension plan in the private sector is the DC plan, with government employees the situation is somewhat different.
Lastly, an important aspect of the DB plans is that they usually provide incentives to retire at age 62 or 65[2], sometimes even a disincentive to retire after that (negative earnings). With DC plan this is less so, especially because it is dependent on accrued savings, not on a pre-specified employer's commitment. However, after reaching retirement age, employers may stop contributing to these plans, so financial incentives to retire exist in the DC plan as well once an employee reaches retirement age.
Regarding employees without any pension coverage, it is worth noting that in the USA, although large percentages do not have a pension at all, the Social Security system compensates for this significantly, through the Spousal Entitlement Benefit.

[1] From website of the US Bureau of Labor Statistics - http://www.bls.gov/ncs/ebs/sp/ebnr0016.pdf and http://www.bls.gov/opub/perspectives/program_perspectives_vol2_issue3.pdf and http://www.bls.gov/opub/perspectives/program_perspectives_vol2_issue6.pdf

[2] Usually, because an employer wants to ensure some turnover of employees, i.e. getting rid of older employees and hiring new young ones.

Israel

The Pension and social security Systems

In Israel, a person retiring may have two sources of income. The main source is from a pension, in which an employee saves a percentage of their salary times the number of years at work. The minimal legal retiring age to be entitled to a pension is 60 for women and 65 for men (that is, up until 2004. After that the age was raised gradually to 62 for women and 67 for men. As our sample included surveys up to 2005, the ages of 60 and 65, respectively, are almost exclusively the relevant ones.

The calculation of the pension benefit varies from fund to fund, and from workplace to workplace. The old practice (prior to 1995) was usually to save 2% of the salary over the working years, and upon retiring, the employee receives 2% of their salary, times the number of working years. Thus, a person who worked at a place for 30 years, would retire with 60% of their last salary, or possibly of their average salary, depending on the particular pension fund.

Due to the large actuary deficits in those funds, the pension system for new participants was changed to a defined contribution system from around 1995.

An important change was made in the pension system in Israel in 2008, when saving for a pension became mandatory. The mandatory saving began at a low percentage, and is rising gradually to a maximum of 17.5% of the salary (with a cap on the total saving per year).

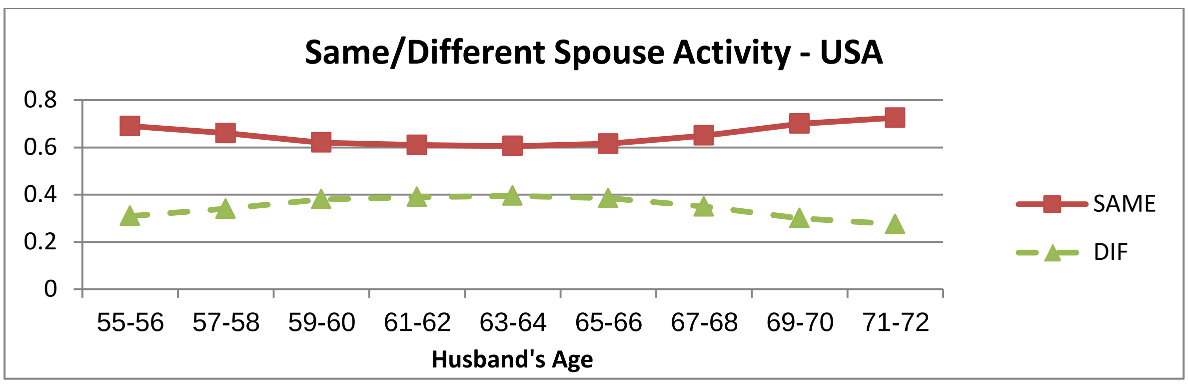
In addition to the pension, an employee is entitled to payments from National Insurance ("*Bituach Leumi*"). This is typically called "Old Age Pension". The basic payments are roughly NIS 1,500 for a single person and NIS 2,250 for a couple and these payments can increase by up to 50% according to the number of years the person worked during her/his life. The entitlement for the payment was, until 2004, from age 65 for men and 60 for women and it was subject to an income test (from 2004 the entitlement age was gradually increased to 67 for men and 62 for women as it for today)

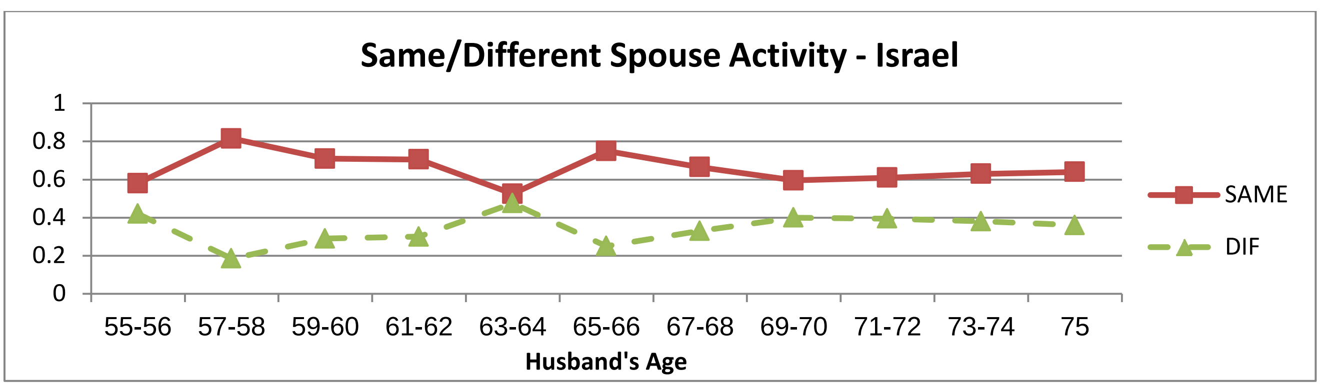
3. LITERATURE SURVEY

Hurd (1990) pointed out that until 1990, it has not been possible to seriously study the retirement decisions of married couples, simply because, particularly for working/retiring women, no large statistical body of information has been available. In order to obtain such information, it is necessary to track a substantial group of married couples, over approximately 20 years (from their mid-fifties to their mid-seventies). It is only in recent decades, with the increase in women's participation in the job market, that such data has become available.[3] He goes on to explore what data is indicative of the assumption that couples coordinate their retirement decisions, without actually running any real analysis; his work is mainly a prodding for future research.

Hurd points out, for example, that although it makes obvious sense that in their younger years both partners work, and that in their later years, both are retired, the fact that during all years over 50% of the couples choose the same activity (working or retiring), is an indication that there is some measure of coordination between them.

The graphs below, taken from the HRS and Israel samples, illustrate this point. They track the percentage of couples who either both work or both retire ("Same") versus couples who make different work decisions.





[3] Hurd notes that in the RHS, which preceded the HRS, and which was conducted from 1969 to 1979, there were just 139 observations of couples who both had a working history.

The Different Dimensions of the Retirement Decision - Previous studies

The retirement decision includes many considerations. Over the years, researchers have deliberated which considerations are of paramount importance, and how to model them. Moore (1988), Lumsdaine et al. (1990, 1992, 1994), and Stock and Wise (1990a, 1990b), have emphasized the importance of including the option value of the pension in the opportunity set. Gustman and Steinmeier (1983, 1984, 1985a, 1986a, 1986b) have emphasized the importance of modeling hours constraints on the main job and the availability of partial retirement only at a lower wage. Rust (1990) and Berkovec and Stern (1991) have developed stochastic dynamic models, which among other things, allows reverse flows ("un-retirement") to be taken into consideration. In this paper, quite a few factors have been taken into account. However, incorporating all features in one model is a formidable task, and is beyond the scope of this paper. Gustman & Steinmeier (2000) were one of the first to extend research done on the retirement causes of individuals to encompass the retirement decisions of married couples using a structural model. Prior studies that have examined the retirement patterns and decisions of individuals using structural models treat the spouse's retirement decision as exogenous. Others have examined the reasons for clustering in the retirement decisions of married couples, using reduced form models, without constructing one overall estimation model for the couples' retirement decisions. Gustman & Steinmeier (2000) model consists of maximizing two symmetric utility functions, one for the husband and one for the wife, that include parameters for each partners age, health, the other spouse's work status, and personal taste for work/leisure

Using the National Longitudinal Survey data from 1968-1989, they develop a model that takes into account both cooperative behavior and non-cooperative bargaining[4], and find that there are several Nash equilibria.

Assuming each spouse knows the leisure preferences of the other spouse, each spouse chooses the labor supply that will maximize her/his own utility, given the labor supply that the other spouse will choose as a result.

Since each spouse's labor supply enters the utility function of the other spouse, there is the possibility of two or more Nash equilibria. Either both spouses choose an action that is advantageous to both of them (i.e. time their retirement by mutual agreement) – and this is one possible solution; or if one timing is advantageous to one spouse and one is advantageous to the other, the spouse that retires first chooses an action that he/she prefers (i.e. this is their dominating strategy), and the other partner has no choice but to make the best decision that he/she can, given

[4] One might ask why they use a non-cooperative bargaining model, as opposed to our model of a joint family utility-maximizing decision. One possibility is that in the past, when the husband was the main bread-earner, he was in more control of the family decisions, leading naturally to a non-cooperative model. Nowadays, with wives having comparable earning-power, a joint family utility function is more appropriate. Becker (1991), Chiappori (1992) and Lundberg and Pollak (1993) debate this issue.

that the other partner has already decided to work/retire; this is another Nash equilibrium. In their words – "In essence, the spouse who retires first can commit the couple to the Nash equilibrium that he/she prefers."

In just about every paper on this topic, restrictions and simplifications are made in order to make the estimation feasible, and to focus on specific aspects of the retirement process. Gustman and Steinmeier, for example, consider any reduction in the workload, from full to part-time work, as a retirement decision. In addition, they ignore what they call "reverse flows", i.e. people who return to work after retiring.

They find that for both women and men, health plays a significant factor in determining retirement age. Their model did not account for the influence of each partner's health state on the other spouse's retirement decision (as our model does), only on the person's own decision[5]. They found that a health problem increases the retirement probability as much as the effect of two years of age. They also examined the variances in retirement decisions (after all other obvious effects are eliminated), which they called "taste". Since there is considerable variance, they conclude that taste plays a very large role in retirement decisions, roughly five times the effect of the age term. Their estimates indicate that the husband's retirement decision has little effect on the retirement decision of the wife, but the wife's retirement has a notable effect on the retirement decision of the husband –wives who retire later, correspond to husbands who retire later. They suggest a rationale that a husband prefers not to find himself at home, a housekeeper, while his wife continues to work; whereas the wife is often used to juggling housekeeping and work, and thus is less affected by the husband's retirement decision. (The authors note that although they find the parameters of the husband's retirement effect on the wife to be insignificant, and the wife's retirement effect on the husband to be significant, still, this model is far from comprehensive enough to draw firm conclusions, and these results should be related to as indicative only [6].)

In contrast to the structural model of Gustman and Steinmeier (2000), Coile (2004) employs a reduced-form model, using the Health and Retirement Study. Coile regresses a group of age, wealth and spouse variables on each spouse's decision to retire. Her findings show (similar to Gustman and Steinmeier) that the husband's retirement decision has little effect on the wife, but the wife's retirement decision strongly affects the husband's retirement decision. Her interpretation of this is that (a) women are strongly influenced by their own economic variables in making retirement decisions, and are not merely following their husbands, and (b) that there is

[5] Although one might argue that a sick spouse's decision to retire indirectly influences the healthy spouse's retirement decision, through leisure complementarities or through financial considerations.

[6] Gustman and Steinmeier note that they may not be sampling a representative sample of the population, because by analyzing the behavior of married couples where both have to make a retirement decision, they have pre-selected those couples where the wife has previously chosen to engage in a meaningful career, from which she can then retire.

asymmetric complementarity between the husband's leisure and the wife's leisure: The wife's enjoyment of leisure does not strongly depend on the husband being retired as well, whereas the husband's enjoyment of leisure depends much more on the wife being retired as well.
Jimenez-Martin, Labeaga and Matinez-Granado (1999) examined the retirement behavior of older European couples, using data for 12 countries from the European Community Household Panel (ECHP).

As we have done in this paper, they too use a joint household utility function. They also use the same four work-states we use – both working, husband only working, wife only, and both retired. Using a multinomial logit model to analyze transitions from one state to another, given health and other parameters, the authors find that the huge jump in retirement probability (from close to 0% to 50% when the husband is 65 and the wife is 60) indicates that financial incentives generated by the Social Security system influences the joint retirement decision: couples postpone retirement until they are eligible for a pension.

While there is the obvious result that poor health increases the probability of retiring, there is an asymmetric effect between husbands and wives. While poor health of any member increases their own probability of retiring, poor health of the husband also increases the probability of both partners retiring. However, the effect of the wife's health on the probability of joint retirement is almost negligible. This may be due to an underlying financial consideration – the family must decide whether the wife should continue working, and employ hired help to assist the sick husband, or whether they are better off if the wife retires. Because the wife's salary is usually relatively low, the economically efficient allocation is for the wife to retire. The opposite assertion holds when the husband is the one who is sick.

Lastly, one of their interesting findings is that although cross-spouse health effects are mainly insignificant, there is an exception: when the husband is out of the labor force due to health reasons and the wife is employed, the wife's exit rate is reduced by 24% relative to when the husband is in good health. This is found in situations where the husband has a low level of benefits, indicating that the wife's work income becomes fundamental for sustaining the household. Comparing this with point (b), we can conclude that a wife will retire sooner when a husband is in poor health, provided this is financially viable.

Just to illustrate the wide range of issues that need to be taken into consideration, Johnson, Davidoff and Perese (2002) consider the effects of health insurance on the retirement decision. In the United States, roughly two thirds of the working population have health insurance through their employers. As after age 65 all citizens in the USA are eligible for Medicare health insurance, Johnson's paper analyzes the behavior of people who retire before the age of 65, and whether people who might have retired, for various reasons, before age 65, postpone their retirement until they become eligible for Medicare.

Using a probit model, measuring the impact of an increase in the insurance premium cost on labor force participation, the authors find that insurance costs significantly reduce retirement rates for full-time wage and salary workers aged 51 to 61.

Last, but not least, is a paper by Casanova (2010) which is quite similar to this one. The author presents a structural, dynamic model of saving and retirement decisions, using HRS data from 1992 - 2008. Casanova models both full-time and part-time work of each spouse, and the consumption and savings decisions explicitly. One main difference between Casanova's paper and this one, is that health, in her paper is modeled as an unexpected financial shock, whereas in our model, health is built into the utility function explicitly, and therefore can be used as an explicit reason to continue or discontinue work, irrespective of the accompanying health costs.[7] Casanova notes, insightfully, that because married spouses constitute a form of mutual insurance to one another, a model that does not consider the presence of a working wife may overestimate the risk facing the man. Another point: Due to the Social Security Spousal Benefit, a model where the participation status of the wife is not considered, may underestimate the men's incentive to retire (i.e. the man may retire not only because he wants to, but because it will enable his wife to collect her Spousal Benefit).

The author finds that leisure complementarities account for up to 8 percent of observed joint retirements (within one year of each other), and the Social Security Spousal benefit account for another 13 percent[8]. Thus, incentives (financial and others) for joint retirement play a crucial role in determining couple's choices.

In our model, in contrast to Casanova, we did not explicitly account for leisure complementarities in the utility function, nor did we construct variables taking the couple's financial assets into account. On the other hand, this paper does model the couple's health situation explicitly.

While this is a paper in economics, it is worth bearing in mind that there are a wide range of issues, not all economic, that come into play with life-changing decisions such as retirement. For example, a large body of papers (many by sociologists) analyze the relevance of job involvement, job satisfaction, organizational commitment, and career identification to retirement decisions.

I mention these papers to underline the complexity and multi-disciplinarian characteristics of the retirement decisions of individuals. This complexity is further compounded by trying to analyze the joint husband-wife aspects of retirement.

[7] One difference from this type of modeling is that if a person has medical insurance, in Casanova's model this will not be translated into a financial shock, and therefore will not be consequential to participation decisions, whereas in our model, it would constitute a change in health status, which directly affects the utility function, and therefore the participation decision as well.

[8] This is done by running a simulation in which the leisure complementarity parameter is set to zero, and comparing the joint retirement rates to those in a simulation where it is estimated freely. Same for the Social Security Spousal benefit.

4. THEORETICAL MODEL

This paper follows the model of collective labor supply, as developed by Chiappori (1988, 1992), in which the basis for analysis is the joint labor supply decisions by members of a household (in our case, a two-member household). We veer from the model presented by Chiappori in that we estimate a single utility function for the couple, which is maximized in such a way that maximum utility is produced over the lifetime of the couple by their choices in each period. The utility function is linear, and includes state-space variables (e.g. each spouse's education, age, pension, etc.) which are multiplied by parameters (to be estimated).

Consider a couple that maximize a joint family utility function. (Note that while we discuss the "husband's" and "wife's" choices, it should be clarified that all decisions are made by the household as a single unit). In any period, the couple jointly determine their work status (to retire or not), given their current work and health status, given their future expectations, and given the constraint that retirement is irreversible. There are four possible states for the couple's work/retirement status: Both working, only husband works, only wife works, both are retired. The states are denoted by R_{it} . Let us also assume there is a state-space variable for the couple's health - H_t . Health evolves exogenously and independently for each spouse, according to a Markovian process, in which the transition probabilities from one health state to another depend on various factors (e.g. the age and schooling of each spouse). For simplicity, we assume that health cannot improve, and that once a person is in bad health, they remain in that state.

State space

The state space in period *t* consists of variables that are observed both by the couple and by the econometrician, and variables that are observed only by the couple, and not by the econometrician.

Let the husband be indicated by subscript *m*, and the wife by subscript *f*.

The observable variables are:

- H_t - Couple's current health status
- R_t - Couple's current work/retirement status
- Age_{it} - Spouses' age $(i = m,f)$
- Edu_i - Spouses' education $(i = m,f)$
- D_{1i} - Whether spouses are over or under early retirement age (and therefore eligible for Social Security). $(i = m,f)$
- D_{2i} - Whether spouses are self-employed or receives a salary.

- D_{3i} - Whether spouses are entitled to a pension.
- D_{4i} – Whether spouse is over or under legal retirement age.

This last dummy - D_{4i} – is added because a couple's entitlement to certain benefits changes at legal retirement aid (for example they are entitled to Medicare coverage, to Social Security, and to pension payments, if they have a pension).

Therefore, a couple's state space at time *t* can be denoted by:

$z_t = (H_t, R_t, Age_{it}, Edu_i, D_{1i}, D_{2i}, D_{3i}, D_{4i},)$

The unobserved state variable is denoted by $\varepsilon_{jt,}$ which is that couple's particular preferences, given their observable state variables. ε_{jt} affects the utility derived from current variables. Because the econometrician cannot observe $\varepsilon_{jt,}$ it is assumed to come from a random distribution.
Putting these two things together, we assume a couple's utility function to be as follows:

$U_t = U(z_t) + \varepsilon_{jt} =$

$$= \alpha_1 * H_t, + \alpha_2 * R_t, + \alpha_3 * Age_{it} + \alpha_4 * Edu_{it} + \alpha_5 * D_{1i} + \alpha_6 * D_{2i} + \alpha_7 * D_{3i} + \alpha_8 * D_{4i} + \varepsilon_{jt}$$

Once their state space is observed, the spouses can decide whether one or both should retire. This choice is made by calculating their expected future health, and taking into consideration any change in state variables in the next period (for example whether one or more spouses reach legal retirement age, or any other change in financial or other entitlement).
In our model we further refined the health indicators to include a "moderately sick" parameter, which we assumed would not affect the current utility flow but would affect the probability of becoming seriously sick, which may affect the current work/retirement decision. Thus, a couple need not be "hit over the head" with a serious illness for one or both spouses. They would have some form of warning that health issues may pose a problem in the near future, which would in turn affect their estimation of future developments.
Based on previous research, we expect that age, health and financial considerations take an important part in the timing of retirement. However, by estimating the model we will be able to take this a few steps further: We will be able to assess the relative importance of each of these factors, as well as examine how husbands respond to a wife's illness, and vice versa; whether having a pension makes a difference – and if so – to what extent; and whether changing the legal retirement age changes the behavior of both spouses, or perhaps of only one. It is expected, theoretically, that increasing the legal retirement age will cause people to retire later – but how much later? And what proportion of men and women will respond to this change? It is these finer results that we can derive from the estimation of the empirical model.

5. THE EMPIRICAL IMPLEMENTATION

In recent decades, advances in computational capacity have made it possible to estimate a stochastic dynamic discrete choice model of behavior. Unlike earlier static lifetime models, dynamic models account for the sequential nature of the retirement process, in which individuals adjust their behavior as events unfold. The dynamics lay mainly in the fact that any current decision depends on future expectations (the Emax function, described below).

This choice is determined using the value function associated with each state:

$V_t(R_t, H_t, z_t)$ = Value (work status, health, other personal variables)

Where R_t is the work status in the current period, H_t is the current health situation, and z_t denotes the state-space attributes of the husband and wife, such as schooling and age.

The health state of the couple, H_t, develops as follows: There are three health states for each person – Health, Moderately Sick, and seriously sick. Thus, for the couple, there are nine health states (3x3). We assume that being healthy and being seriously sick affect the work/retirement decision directly (i.e. they affect the current or future utility flow). Being moderately sick does not appear directly in the utility function, but it may have an influence (expected to be positive) on the probability of becoming seriously sick, so it may affect the current retirement decision due to the change in the future expectations.
An error term is added to each of the work/retirement options to account for unobserved characteristics and preferences. Therefore, we write:

$V_t(R_t, H_t, z_t) + \varepsilon_{jt}$

with the term ε_{jt} drawn from a random distribution.

Following Bellman (1957), we define $V_t(R_t, H_t, z_t)$ recursively as:

V(continuing work or retiring) = (Value of work and health today) + (value of future)

formally:

$$V_t(R_t, H_t, z_t) = U_t\,(R_t, H_t, z_t) + \Sigma_{J(Ht)}\, \Pi_{ij}\,(t) * \delta * E\{\text{Max}_{K(Rt)}\,[V_{t+1}(R_{t+1}, H_{t+1}, z_t)\,]\} + \varepsilon_{jt}$$

- δ is the subjective discount factor;
- The sum (Σ) over the group $J(H_t)$ is over the various future health states, at the probabilities denoted by Π_{ij} (t). If both spouses are healthy, all future health options are possible. Since health is assumed to be an absorbing state, if both spouses are moderately sick, for example, then there are only four possible future states (both moderately sick, husband moderately sick and wife seriously sick, wife moderately

sick and husband seriously sick, and both seriously sick). If both are seriously sick, then there is only one possible future state.

- $K(R_t)$ denotes the set of feasible work choices at time t, given R_t. For example, if both spouses are working, then there are four possible states for the next period (both working, only husband works, only wife works, both do not work). However if the husband is retired, than there are only two work options for the next period – either husband remains retired and the wife works, or both are retired. The couples will choose the option which give them the maximum discounted utility, conditional on a given future health state.
- The function $U_t(R_t, H_t, z_t)$ describes the utility from being in a particular state, at period *t*. An important aspect of this function is that it changes when a person approaches official retirement age, due to contractual or institutional changes such as social security benefits or pension programs that become payable at this age.

When deciding for the last period[9] T, i.e. at the end of period T-1, the value function is zero for all states after T (meaning that when the person looks at the last period, and decides whether to work or retire, they do not take into account any future periods, only the last period). So, for the last period, this equation will be reduced to

$$V_T(R_T, H_T, z_t) = U_T(R_T, H_T, z_t) + \varepsilon_{jt}$$

This is the key to solving the Bellman equation. At the last period, the person simply chooses the work/retirement choice with the highest value

$$V_T = \max_{\text{work options at T}} U(R_T) + \varepsilon_{jt}$$

Moving back one period to T-1, they choose the maximum between retiring today or postponing the decision to next period

$$\text{Max}\,[\max_{\text{work options at T-1}} U(R_{T-1}), E(V_T)]$$

Or, in words – the maximum between choosing to retire today, and the expected value from waiting for the next period. In this way, the multi-period problem is reduced to a series of two-period problems.

Because the error term comes from a distribution, calculating the value of future options becomes an integration over the quadruple error distribution (it is quadruple if all options are indeed feasible; as we have noted above, possibly only part of the options are feasible, in which case there would be fewer integrations):

---

[9] In our data: for USA - when the husband is 71-72 years old. For Israel - when the husband is 75 years of old. The different in T between the countries is due to the differences in the samples.

$$\int\int\int\int \max (V_1, V_2, V_3, V_4)\, d\varepsilon_1 d\varepsilon_2 d\varepsilon_3 d\varepsilon_4$$

This is notated as the Emax function:

$$\text{Emax}(V_1, V_2, V_3, V_4) = \iiiint \max (V_1, V_2, V_3, V_4)\, d\varepsilon_1 d\varepsilon_2 d\varepsilon_3 d\varepsilon_4$$

A full notation, with all arguments and subscripts, would be:

$$\text{Emax}(V_1(t+1), V_2(t+1), V_3(t+1), V_4(t+1)) \mid S(t) =$$

$$\int_{\varepsilon_{1t}}\int_{\varepsilon_{2t}}\int_{\varepsilon_{3t}}\int_{\varepsilon_{4t}} \text{Max}(V_1(t), V_2(t), V_3(t), V_4(t)) \mid S(t) \times f(\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}, \varepsilon_{4t})\, d\varepsilon_1 d\varepsilon_2 d\varepsilon_3 d\varepsilon_4$$

Where:

- $V_i(t)$ = the value of choice i at time t.
- S(t) - the state space at period t, which dictates the options available to choose from at time t+1.
- $f(\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}, \varepsilon_{4t})$ – the joint distribution function of $\varepsilon_{it.}$

This model is a typical example of structural estimation of a dynamic discrete choice model of behavior. The problem is one of sequential discrete choice optimization, constrained by resource limitations (in our case – constrained by health as well) and imperfect information about future events. Surveys by Eckstein and Wolpin (1989a) and by Rust (1992) provide a good introduction to this type of problem.

A major obstacle to the application of this approach is computational. It is not so unusual to perform high-dimensional integration to calculate the choice probabilities needed for estimation; this exists in static discrete choice models as well. However, in the dynamic setting, the integration must be performed for each state space, i.e. for each "branch" of the "work/retirement/health evolution tree" in each period.

In the case at hand, the Emax operator entails a multiple integration of four dimensions (the four work states of the couple), and that function must be calculated for each element of the state space (each health and work state).

The model predicts that the proportion of couples who choose a particular work status (for example "Both Work") at time t would be

Pr(Choosing "Both Work") = Pr [

(V("Both Work") + Emax (V(future states for "Both Work")) + ε_{2t} >
V("Husband only works") + Emax (V(future states for "Husband only works") ,

(V("Both Work") + Emax (V(future states for "Both Work")) + ε_{2t} >
V("Wife only works") + Emax (V(future states for "Wife only works") ,

(V("Both Work") + Emax (V(future states for "Both Work")) + ε_{2t} >
V("Both retired") + Emax (V(future states for "Both retired"[10])]

A comparison of these predicted probabilities (over time) to the corresponding observed choices, forms the basis for the estimation of the parameters of the reward function.
The likelihood function for the sample is the product of the probabilities of the choices made in each period by each couple. Then the parameters in the utility functions are numerically adjusted so as to maximize the likelihood of couples choosing the work choice paths they actually did.

$L = \Pi_{n,t} \Pr(R_{it})$

n = 1,2…N (over the sample couples)

t = 1,2…T (over the periods)

R_{it} = the couple's particular work/retirement choice in period *t*

so that:

$\ln (L) = \Sigma_{n,t} \Pr(R_{it})$

and the computer numerically adjusts the parameters to maximize this likelihood figure.

<u>Rust's Solution method – using Extreme Value Distribution</u>

Computational simplifications for handling large choice sets or large state spaces, while still enjoying a closed form solution, have involved finding convenient forms for the reward functions and error distributions. Miller (1984), Pakes (1986) and Rust (1987) are the leading examples of this approach. The approach developed by Rust has been widely adopted in the economics literature.
Rust makes the following assumptions:

(i) The reward functions are additively separable in the unobservables, with each unobservable associated with a mutually exclusive choice (i.e. the reward function has the form $V_i(t)$ = U(work status, health, age, etc.) + ε_{it})

(ii) The error terms are time (serially) independent and independent between the different alternatives;

[10] Note that for the state of "Both Retired" there is only one possible future state – to remain "both retired"; so Pr(Both Retired) = 100%. For all other states there is more than one future branch. For example from "Only Husband Works" the next period state could either be the same, or "Both Retired". And so forth.

(iii) The unobservables (error terms) are distributed as multivariate extreme value distributions, i.e. $\exp(-\exp(-\varepsilon_i))$.

Rust (1987) showed that under the above assumptions, we gain two significant benefits, one of them being that we avoid entirely the need for integration. The Emax function specified above has a closed-form solution of:

$$\text{Emax}\ (V_1(t), V_2(t), V_3(t), V_4(t)) \mid S(t) = \gamma + \tau \ln \{ \Sigma_i \exp(V_i(t)) / \tau \}$$

Where:

- γ = Euler's constant
- the sum on the far right runs over the value functions for the various options a person faces.

The second benefit is that the choice probabilities are multinomial logit, i.e.,

$$\Pr(\text{choosing option } i) \mid S(t) = \exp(V_i(t)) / \Sigma \exp(V_i(t))$$

Taking future health state probabilities into account

The first stage in implementing the model outlined above was to calculate the probabilities of moving from one health state to another (from "Healthy" to "Moderately sick" or to "Seriously sick"), for men and women separately.
We assume that those probabilities depend on the age and the education level (represents by a dummy) of the spouse.
Specifically, for each country and for each gender we estimated two hazard equations:

(1) For those who were healthy in their first observation– the transition to become moderately or seriously sick.
(2) For those who were moderately sick in their first observation or become moderately sick after that– the transition to become seriously sick.

The first equation was estimated by a multinomial logit and the second by a logit.

The Utility Function

Due to the nature of the Israel's sample, we don't have retrospective data on the salary of the spouses neither on their consumption[11]. Thus, the utility function consists of the state variables that observed every period. Specifically, the utility function includes: age, schooling and health, with dummies for each level of schooling and health, age, dummies for whether the husband is more than four years older than the wife, same age as the wife, a dummy for the square of the age

[11] We do have retrospective data on the retirement date (If occurs) and the health condition of the spouses.

difference, and dummies for whether the husband has more or less schooling than his wife, is over or above legal retirement age, has a pension, and whether she/he is salaried or self-employed.

Other assumptions

In the empirical model we made several simplifications and restrictions. First, no cases of divorce or remarriage were included or expected by the spouses. Second, both health condition and retirement were considered as irreversible: if a person retired, she/he was "forced" to stay retired and if a person was moderately or seriously sick, she/he “could not” revert to a better health status after that. We also assume that the expected probability of death before period T is zero, so each death that occurs to a spouse before period T, were totally unexpected from both couples point of view.

6. THE DATA

USA

Using the HRS surveys from 1992 through 2008 (nine surveys), we gathered 1841 married couples for whom either husband or wife worked (or both) in the first survey they were interviewed. All couples were surveyed from the time the husband was at age 55 or 56 on. For all couples, we also have information on whether they received a salary (worked for others) or were self-employed, and whether they were entitled to a pension. Statistics on work/retirement and health are in Table US1, statistics on education are in Table US2 and US3, pension statistics are in Table US4, and data on health transitions is in Table US5.

The health category of "Seriously sick" were defined as either cancer, a stroke, or heart problems.

We sorted the sample into five education categories: Some high school, finished high school, some college, finished college and MA or PHD.

The main observation, as one can see from the statistics in Table US2, is that there is a clear tendency of couples to marry partners with same or similar education levels, hence a higher probability along the diagonal.[12]

[12] Note: The SHARE data for Israel took advantage of retrospective questions regarding the work status and health of the participating couples, which covered, whenever possible, the entire history of the spouses where the husband’s age was 55 to 75. The original reason for limiting the observations to those in which the husband's age is from 55 to 75 is that until age 55, most couples have not yet retired and after age 75, most are retired. With the HRS, we had two difficulties: First, the HRS surveys are conducted every two years, so we had data on couples for every other year and second, if a man was 55 in 1992, he was 71 in 2008 (or at most – 56 in 1992 and 72 in 2008). Thus, we could not run the entire gamut of ages 55 through 75, as in the SHARE data.

<u>ISRAEL</u>

It is important to remember that in Israel the panel is from a retrospective survey, i.e. a sample group of couples were asked about their current status, and about their work and health history. Let us take, for example, a couple where the husband is aged 63. He can provide his history from age 55 up to 63, but not beyond, where as if a 75-year old man were asked, he could provide a complete track record from age 55 to 75. Thus, unlike the USA sample, we do not begin at age 55 with a group of couples, and proceed from there into the future, but rather there are starts and jumps as couples “disappear”, as it were, from the sample. This can be noted by comparing the population in each age level in Table US1 and Table IL1.
The data for the Israel sample appears in Tables IL1 to IL5.
Apart from the difference in how the panel was constructed, on the whole, the tendency for similar education levels to marry one another is the same in the USA and Israel. Pension eligibility in the USA is about 60% for men and 50% for women, whereas in Israel 45% of both sexes are eligible.

<u>Comparing Retirement Behavior in the USA and Israel</u>
Regarding the influence of education, the results for the Israeli sample (see Graphs US-IL-A, US-IL-B in Appendix 2) are different from the same graphs for the USA in several important ways. First, there are different legal retirement ages for men in each country– 62 in the USA and 65 in Israel. Regarding women, at the time of the survey, the offical minimum retirement age for women in Israel was 60 and the maximum 65, meaning that they could retire at 60, but could also decide to continue to work until age 65.
Another difference is that in Israel husbands tend to retire later than their wives, for all ages and education levels (the opposite of the situation in the USA). This difference in retirement rates goes from a 15% gap when the husband is aged 60, to a peak of 36% when the husband just passes the legal retirement age, at 66-67. The fact that there is a difference of 15% to begin with appears to be the Israeli baseline, because when the husband is at age 60, both he and his wife (the wife being on average 4 years younger) are far from their retirement age The increase in this gap of about 20% (from 15% to 36%) can be attributed to the optional retirement of wives at age 65 or to the conditions in the labor market (including the tendency to hire older people).
Because the maximum difference in employment levels occurs, for all education levels, when the husband is 66-67 and his wife is on average 62-63 years old, this increase in the gap is clearly because the wife has already reached the minimum retirement age, so a portion of them have retired, whereas a high percent of the husbands at age 66-67 are a year or two past legal retirement age, and still working. At age 65 (legal retirement age for men) only 50% have retired, and another 20% retire until age 67. There seems to be some reluctance amongst the Israeli husbands to retire exactly at 65. This might also indicate that the motivation to retire together with the wife is less prominent in Israel, at least relative to the USA.

"Unretirement"

The work culture in the United States is somewhat different than in other countries. In the United States it is quite common for individuals to retire, and then change their mind and go back to work (see Maestas (2009), Gustman & Steinmeier (1981 and 1984), Ruhm (1990) and Burtless and Moffitt (1985)).[13]

In order to simplify the data and make it comparable to the studies on Israel, we assumed that each person's first retirement decision is also his/her permanent decision (This means that retirement percentages are biased upwards).

13 Maestas (2009), for example, finds that nearly 50% of retirees in the USA follow a non-traditional path of retirement, that involves either partial retirement, or retirement followed by a return to work.

7. RESULTS

In this section, we present the parameters and their standard errors that were estimated for USA and for Israel and compare the results for those countries.
However, because the model is highly non-linear, the estimated parameters cannot easily be interpreted as is. Therefore, in order to isolate the effect of the various factors, we simulated the retirement decisions of different synthetic couples, where we changed only one attribute of each spouse (or one attribute of one of the spouses) between the simulations.
All the simulations start when the husband is aged 55 (or 56).

We isolated the following effects on the retirement decision:

- The effect of education. The effect of the partners own health problem on their retirement and on their spouse's retirement. For example: to what extent did a spouse retire earlier when they or their partner became sick.
- The effect of being eligible to pension benefits.
- The effect of being self-employed compared to being a hired worker.

In addition, taking advantage of the simulation tool, we explored two more factors:

- How a change in life expectancy affects the couple's retirement
- How a change in the legal retirement age affects the couple's retirement.

Because de facto the population's overall life expectancy is increasing, these simulation results are an important tool in predicting a country's employment/retirement situation several years into the future. Likewise, the simulation of changes in legal retirement ages can serve as a "prediction tool" for policy-makers when trying to assess the influence of this tool on the balances in the pension plans.

MAIN RESULTS

The estimated parameters and their standard errors are presented in Appendix 2.

USA

Overall, the parameters estimated for the USA had a much higher T-value than their counterparts for Israel. This is probably due to the fact that the Israeli sample was much smaller than the US sample. As we have already noted, the actual values of the estimated parameters provide no concrete information as is, however their sign (plus or minus) and T-value are indicative of their validity as predictors of retirement decisions.
For the US, all of the "family" characteristics we included in the model – the couple's joint work and health status – had a high T-value. The parameters for the work status – i.e. whether both are working, or only one spouse – were negative, meaning that when one or more spouses are

working, they tend to try and continue working (and avoiding retirement, hence the negative value for the "value" of retirement). Putting it differently, "work exerts inertia".
When both partners are healthy, this gives a positive parameter, so good health is a reason to retire (sooner rather than later) – while the couple's health is still in good condition, they want to enjoy their retirement years. However if one partner is sick, this also gives higher value to the couple's joint retirement value, presumably because the healthy partner will thus be freer to care for the sick spouse.
Education: The more the husband or wire are educated, the higher the value of retirement.
Age increases the value of retirement, i.e. as each year goes by, the husband will be more inclined to retire. This makes simple sense. The effect of age is mitigated by the legal retirement age, which provides negative parameters if only one spouse is working, i.e. if only the husband or only the wife are working, age has a decreased effect on the value of the husband's retirement. Interestingly enough, for the wife this effect is the opposite – Age has a <u>negative</u> effect on the value of retirement (for all work situations), meaning that as the wife ages, she wants to retire less and less. This can easily be understood, for the husband, he has worked all his life, intensively, and prefers to rest from that in his later years. The wife, on the other hand, finds that work provides her with an activity, interest, social interaction, and other added benefits, as well as possibly a feeling of well-being that improves her overall physical and mental health. Being over legal retirement age has a mixed effect; but if only one spouse is working, either husband or wife, this threshold has a positive effect on the wife's inclination to retire.
In our model we checked the effect of other variables on the retirement decision – whether the husband was more educated than the wife, a large age difference, and other factors, but overall, these came out with a low T-value, so their effect cannot be said to be significant, for this sample.
The effect of being self-employed vs. receiving a salary was largely with low T-values, with one exception: If the wife receives a salary, and is over legal retirement age, and both spouses are working, then retirement has a higher value. However if only one spouse is working, retirement has a lower value for the couple. This could mean that if both are working, they have relatively little quality time together, and would prefer to have more thru retirement. But if only one spouse is working, a better balance is kept between being occupied separately and quality time together.
Lastly, being eligible for a pension has a consistently negative effect on retirement, i.e. not having a pension is a significant factor in postponing the couple's retirement. This was corroborated by the pension simulations.

<u>ISRAEL</u>

As noted above, the bulk of the estimated parameters for Israel came out with low T-values, with the exception of the effect of the wife's age. However, these results notwithstanding, the simulations provided a clearer look at the expected retirement behavior of Israeli couples.

8. SIMULATIONS

Because of the non-linear nature of the model, and since for any couple many factors are simultaneously at work (for example, whether the spouse retired, each spouse's health, their respective age, and so on), the actual value of the estimated parameters tell us very little about the influence of the underlying factors. Therefore, the model's results are analyzed by conducting simulations on synthetic couples, for whom we create a particular profile. For example, in order to assess the influence of education on the retirement decision, we compare the simulated retirement decisions of synthetic couples who have the same attributes except for their education level. Comparing the retirement decision of those couples can reveal the influence of the education on the retirement decision.
We conducted the following simulations, for both USA and Israel:

A. Changing education levels.
B. Changing health status - Husband is sick and wife healthy, and vice versa.
C. Entitlement to pensions - One or both spouses are not eligible for a pension.
D. One spouse is (or was) self-employed and the other receives a salary.
E. Changing the life-expectancies.

In the baseline synthetic couple we use for the simulations both spouses are healthy throughout their lifetime, the husband 3 years older than his wife (in USA) and 4 years older (in Israel. Both gaps are close to the average gap in the USA and Israel, respectively).
In all of the simulations, we calculated only an “unconditional” simulations that began when the husband was at age 55.
The term "unconditional simulations" means that we calculate the simulations using the predicted retirement decision from the model as the initial condition for all the periods (except for the first period in which we assume that both couple didn't retire). As there is no retirement decision in the data for the synthetic couples, we used the model predictions as initial conditions.
The simulation plotted what developed from age 55 of the husband on.

Main Simulation Results

The main conclusions from the simulations that follow are as follows:

- Education: With respect to education levels, couples with the lowest education levels seem to have the most difficulty finding employment at an advanced age, and therefore retire earlier than others. Conversely, those with a college education retire latest (on average). This result holds for both USA and Israel.
- Health: Regarding retirement when one or more spouse have a serious health problem, overall, men retire earlier when their wives are sick more than wives do when their husband’s are sick. Men retire up to 25% in Israel to accommodate a sick wife, vs. up to

10% in the USA. However, care should be taken when comparing the USA and Israel results; more on this below.

- Entitlement to a pension: This was found to have a strong influence on the couple's retirement – when no partner was entitled to a pension, , lack of a pension caused one partner to continue to work into much later years, relative to couples who were entitled to a pension.
- Increasing Life Expectancy: Changes in life expectancy do not have a drastic effect on retirement patterns. However, it is an added factor that should be taken into account. At retirement age, in the USA an increased life expectancy of four years postponed the retirement date for about 5% of both husbands and wives, v.s. 1.5% in Israel.

Comparing the Results for USA and Israel

Before we present the results and the comparison between USA and Israel in a more detailed fashion, it is important to emphasize that we conducted totally separate estimations (i.e., we estimated a different set of parameters, although using the same model) for the USA and Israel, with the hope that it would be interesting to compare the two results. However, upon taking a closer look at the differing circumstances in Israel and the USA, it becomes apparent that such a comparison might be problematic for several reasons:

- Due to the different legal retirement ages in the USA (62 for both genders) and in Israel 65 and 60 (for men and women, respectively).
- Different cultural attitudes, as well as different employment climates are at play.
- Retirement for salaried workers in Israel at the legal retirement age is usually mandatory. Employers tend use the legal option to force employees to retire at the legal retirement age. In the USA, however, the meaning of "legal retirement age" is only an entitlement to Social Security, not the age at which employees must retire.

Indeed, all of the simulations point to the fact that in the USA, relative to Israel, more couples retire before legal retirement age and at legal retirement age (62 for men and 60 for women). The entire issue of retiring is approached more casually – partial retirement is a more readily available option in the USA, thus enabling a more gradual retirement process.
Of course, this is not to say that any comparison is not possible. Differences in education levels follow a similar pattern, and there are other similarities. However, it is important to bear in mind that any comparison should be approached with some degree of caution.

The detailed simulation results were as follows:

I. THE INFLUENCE OF EDUCATION ON THE RETIREMENT DECISION

USA

We simulated for both countries couples where both partners have varying levels of education: (1) incomplete high school; (2) finished high school; (3) some college; (4) finished college and (5) MA/PHD.

Graph US-0 (Appendix 2) shows for the USA sample a comparison of the probabilities that both spouses didn't retire ("both work") divided according to education levels. The graph shows that those who completed college (a Bachelor's degree) retired latest. Couples with less education and those with an MA or PHD, retire earlier. This is probably due to the fact that those with a higher education are more wealthy, or have more comfortable job conditions and/or benefits, and thus are able to retire earlier. Whereas the less-educated have difficulties finding a job at an advanced age, and therefore also tend to (or perhaps more precisely - forced to) retire earlier. But this cannot explain entirely why those who complete college are those who retire latest.

In this regard, one could consider that there may be two opposing forces at work – a better job will create more wealth, which will induce earlier retirement. On the other hand, a better job is also a more interesting job and usully demands less physical effort which will cause a later retirement. However, this is conjecture, and not formally included in this research.

The trend of work patterns amongst education levels was found to be robust to changes to health, life expectancy and changing the legal retirement age that we made in the different simulations. Giving numbers to this trend in the years just before early retirement age (59-61), there are 8-9% more couples who both work and have finished college than MA+PHD couples and "Finished High School" couples (After legal retirement age - 65, the differences diminish).

Another angle of viewing the data is to focus only on the husband or the wife and compare the probability that the husband (or wife) works, per various levels of education. See Graph US-1 and US-2 in Appendix 2, and Table A below. This is the combined probability that either both husband and wife are working, or the husband alone.

The highest participation level occurs when the husband (and wife) has finished college. Another, slightly lower (local) maximum, occurs when both have finished high school. The minimum occurs, as expected, when the couple have not finished high school, as this impacts significantly on their job opportunities.

Looking at the "inter-education-level" trends in this table, by tracking the changes between various education levels (each "difference" column is the difference between the two adjacent columns), we can see as follows:

Table A – Probability that Husband Works- USA

Husband's Age	Some HS	Diff.	Finished HS	Diff.	Some College	Diff.	Finished College	Diff.	MA + PHD
55-56	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00
57-58	0.89	0.03	0.92	-0.01	0.91	0.04	0.95	-0.02	0.93
59-60	0.74	0.06	0.80	-0.02	0.78	0.09	0.87	-0.05	0.82
61-62	0.55	0.09	0.64	-0.03	0.61	0.13	0.73	-0.06	0.67
63-64	0.32	0.10	0.42	-0.04	0.38	0.14	0.52	-0.07	0.45
65-66	0.18	0.08	0.26	-0.02	0.24	0.13	0.36	-0.06	0.30
67-68	0.10	0.06	0.16	-0.02	0.14	0.10	0.25	-0.06	0.19
69-70	0.05	0.05	0.10	-0.01	0.09	0.08	0.16	-0.04	0.12
71-72	0.03	0.03	0.06	-0.01	0.05	0.05	0.10	-0.02	0.08

Perhaps the first thing to notice about these statistics is that by the time the husband has reached legal retirement (62), roughly a third have already retired (excluding those who have not finished high school). This suggests that independently of the effect of education, either they have the means to retire early (each year of early retirement is quite costly, in financial terms) or some other special reason (e.g. – the extent to which husbands would retire earlier in order to spend retirement time with their wives).

The most marked change is between couples who have "some college" education and those who have finished college. The second-biggest jump is between "some high school" and "finished high school". It is worth noting that these differences in retirement rates begin right at the start of the survey, when the husband is aged 55-56, indicating that these patterns are not simply a difference in decisions at the legal retirement age, but rather a more intrinsic trend, connected to a couple's preferences and opportunity set.

With the women's results, it is evident that if the wife has finished high school (or any higher education), her work probabilities are on a plateau (i.e. not "education-sensitive"), and vary only minimally between education levels.

Last note: For all education levels and for all ages of the husband in the USA, there was a consistently higher probability that the wife didn't retire than the men (see Graph US-3). This could be attributed to the fact that the wives are 3 years younger than the husbands.

Table B - Probability that Wife Works - USA

Husband's Age	**Some HS**	Diff.	**Finished HS**	Diff.	**Some College**	Diff.	**Finished College**	Diff.	**MA + PHD**
55-56	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00
57-58	0.93	0.03	0.96	-0.01	0.95	0.00	0.96	-0.01	0.94
59-60	0.82	0.07	0.89	-0.02	0.88	0.01	0.89	-0.03	0.86
61-62	0.68	0.11	0.79	-0.02	0.77	0.01	0.77	-0.04	0.74
63-64	0.49	0.15	0.64	-0.03	0.61	0.00	0.61	-0.04	0.57
65-66	0.32	0.16	0.47	-0.03	0.45	-0.01	0.44	-0.04	0.40
67-68	0.20	0.14	0.34	-0.02	0.32	-0.01	0.31	-0.03	0.28
69-70	0.13	0.12	0.24	-0.02	0.22	-0.02	0.21	-0.02	0.19
71-72	0.08	0.09	0.16	-0.01	0.15	-0.02	0.13	-0.01	0.12

Israel

In Israel the simulation shows a pattern similar to that in the USA, with the husband's highest employment rates among those who finished college (and not those with higher degrees). However, from about age 68, those with higher degrees (MA & PHD) have higher employment rates than any other education level. Indeed, this makes sense, because higher degrees are considered by many to provide not only skills, but the ability to learn and adapt to new environments and techonologies. Thus those with advanced degrees are the most employable class.
At the other end of education levels, "some high school" and "finished high school" lag behind higher education levels by a alrger gap than for the USA.
With women, the situation is different. Those with an MA or PHD have a far higher employement rate, at any age, than any other education level. The second-highest employment level (somewhat surprisingly) goes to those with "some college education". It is important to remember that the sample size for the Israel group, especially for particular education levels, are quite small, so apart from noting these statistics, we are not venturing an explanation at this point.

II. SELF-EMPLOYED VS. SALARIED WORKERS

Unlike the situation in USA, in Israel many salaried employees faced mandatory retirement at the legal age of 65 (mainly in the public sector), whereas self-employed people can choose their retirement. In order to further explore the fact that men in Israel delay their retirement beyond the legal retirement age, and whether they retire out of choice or because they are forced to, we compared this simulation to one where the husbands are self-employed (and the wife on a salary). We found (see graphs US-4 and IL-4 in Appendix 2) that indeed, when the husband was self-employed, he postponed his retirement significantly. We found differences of up to 30% in the work/retired probaiblities, with the maximum occuring when the husband was at age 69-70. Thus, we can conclude that a significant factor in the reitrement decision in Israel is that retirement is mandatory, and that if the retirement decision was left up to the employees to decide, it would probably occur after the legal retirement age of 65.
At the husband's legal retirement age, looking at those who have finished high school, about 50% of the women are still working, even though they are past their minimum legal retirement age . This goes down to 30% two years later, which fits in with the additional 20% of men who retire between the age of 65 and 67. This may be considered a coordination of retirement between husbands and wives, but the opposite can be argued as well – both retire because they are able to do so, and not necessarily due to some motivation to coordinate retirement with each other. But the fact remains that a significant percentage do choose to retire together at this stage.

III. THE INFLUENCE OF HEALTH ON THE COUPLES' RETIREMENT DECISION

In this section we conduct the following simulations: (1) Husband sick and wife healthy; (2) Wife sick and husband healthy and (3) both sick. All vs. the baseline when both are healthy. All for couples where both partners finished high school, receive a salary and are entitled to a pension.

USA

Graph US-6 and US-7 shows the influence of the health condition of one spouse on her/his spouse retirement. The simulation shows that women (and men) hardly change their work probabilities when their husbands are sick (up to 1%). On the other hand, their husbands are more inclined to retire (relative to healthy couples) when their wives are sick. While the percentage of men that retire earlier varies with age, it reaches about 10% at legal retirement age of 62.

In the USA, although husbands will retire earlier if their wives are sick, there is no further drop in the work percentages (i.e. no pushing the retirement even earlier) if the husband himself becomes sick. He basically has two "tracks" or "modes" – If his wife is healthy (and he is either healthy or not) that is one “mode”, and if his wife is sick (again, whether the husband is healthy or sick) is another “mode”. The wife, on the other hand, has three “tracks” – if both are healthy she works the most, she will retire earlier if she is sick, and even earlier if both she and her husband are sick.

Israel

In Israel the patterns are markedly different than in the USA.
Graph IL-6 shows the husband’s behavior, and that he will retire significantly earlier if he is sick, relative to when he is healthy. If his wife becomes sick, he will retire even earlier.
The wives (see Graph IL-7) retire a bit earlier if they are sick, and there is no significant difference if their husband’s become sick as well.
A strange anomaly occurs in the Israel data, that when both partners are sick. In this situation, the probability of retirement for each of husband and wife is higher than when only one partner is sick. In other words, if the husband is healthy, when his wife is sick, this will reduce his work probability; but if he is sick as well, this will increase his work probability. The same applies to the wife (see graphs IL-6, IL-7).
Graph IL8 shows the influence of the health condition of one spouse on her/his spouse
The graph shows that husbands whose wives are seriously sick have, on average, 25% higher chance to retire, peaking when they are 66-67, just past legal retirement age. In other words, the double motivation of legal retirement age plus the fact that the wife is seriously sick makes a big difference for families in Israel, and the family’s decision is quite often in favor of the husband’s retirement.
When the husbands become seriously sick, the family decision is more frequently in favor of the wife’s retirement, but to a lesser degree, up to 9.5%.
The maximum drop occurs when the husband is aged 66-67, so the wives are 62-63. This again may indicate that opposing forces are at work – on the one hand, the wife wants to retire earlier, to care for her husband, but needs to work more, in order to fund the required medical care. Thus the result may be a compromise between these two opposing forces.

IV. COMPARING COUPLES WITH AND WITHOUT PENSIONS

In this section we examined the work patterns of husbands and wives, in situations where one or both of them are not entitled to a pension.
The couples' attributes are: husband and wife both healthy, both finished high school. We conduct the following simulations: (1) only husband has pension; (2) only wife has pension; (3) both do not have pension and (4) both have pension.
In the USA, when the husband is not entitled to a pension, both the husband and wife bear the brunt of dealing with the situation. The husband has up to 28% higher probability of working, clear into his 70s, whereas the wife has a higher chance of working of up to 20%, relative to when

both have a pension (see graphs US-9 and US-10). If the wife is the one who does not have a pension, the husband does not change his work/retirement decision significantly, but the wife does, and has a higher probability of working of up to 37%, into her mid-sixties (see graphs US-11 and US-12). This may indicate that it is important for the wife to have her own source of income, and not be entirely dependent on her husband's income.

In Israel (see Graphs IL-9 thru IL-12) the patterns are somewhat different. When the husband does not have a pension, he works significantly less than where he is entitled (the opposite of the behavior in the USA). In our simulation, the difference grew to 30% when the husband was aged 67. Working less when the husband does not have a pension may indicate that such a husband is generally "less employable". He has probably worked in low-level jobs during his entire life (which is why he does not have a pension upon retirement) and now, in his advanced years, has even more difficulty finding a job so he is "forced" to retire. As a result, his wife tends to work more, in order to compensate. She will work with up to a 35%-40% higher probability, peaking when the husband is aged 66-71 (and the wife aged is 62-67). This higher probability continues into their later years, and even when the husband is aged 75 (wife is about 71) the wife has a 17% higher probability to be working than if both have a pension.

When the Israeli wife does not have a pension, there are smaller differences in work/retirement decisions. Husbands will work up to 10% more, and wives will work 7% less.

It is important to note that traditionally in Israel the husband is more often the main breadwinner. Thus, if the wife is not entitled to a pension, this has less influence on their retirement decisions relative to the USA, where the work division appears to be more egalitarian across the sexes.

We also did a simulation where both partners do not have a pension (See Graphs US-13 - US-14 and IL-13- IL-14).

In the USA, the results indicate an augmented form of the results we previously found when only the husband does not have a pension. When both partners do not have a pension, the couples decided that the husband should work more (up to 36% more, peaking when the husband is aged 65-66), and that the wife work even more – up to 44% more, peaking when the husband was 69, which is when the wife is 66. A strong and clear pattern of both partners pitching in to deal with the difficult financial situation.

The pattern that emerged for Israel was also similar to the situation where only the husband does not have a pension - the husband had a lower probability of working (peaking at 16-18% at ages 66-68) and the wife worked more (12-13% at the same ages). Here we see a pattern of "mutual insurance" between the husband and wife – the husband has more difficulty finding a job, but the wife steps in and works more.

V. SIMULATING CHANGES IN LIFE EXPECTANCY

Changes in life expectancy is a well-known phenomenon in the western world over the last decades. These changes could alter the optimal work and retirement path of the spouses.
In order to assess the potential influence of the increase in life expectancy, we conducted simulations on the entire original sample, in which we artificially changed the couple's expected life-span, and compared the results to one another. The results are present in Graphs US-15, US-16, IL-15, IL-16.

Because it is computationally difficult to increase the life horizon in our model (this requires a massive computation), we instead decreased it for both spouses (by 4 and 5 year is USA and Israel, respectively) and deduced from the changes that were found what would happen if both spouses face a longer life-span (the original results). Technically, we did this change by decreasing the Emax span.
In the USA, we artificially changed the husband’s expected life-span from 75 to 72 and the wife's life-span by 3 years to 69.
In Israel, we decreased the life expectancy of the husband from 75 to 70 and the wife's life-span by 3 years to 68.

The table below shows the differences in the retirement probability of the husband and the wife over their lifetime, as a result of the shorter life expectancy.

Husband's Age	USA Difference Husband Works	USA Difference Wife Works	ISRAEL Difference Husband Works	ISRAEL Difference Wife Works
55	0.000	0.000	0	0
56	0.016	0.013	0.001	0.001
57	0.014	0.013	0.002	0.002
58	0.016	0.015	0.003	0.003
59	0.028	0.029	0.003	0.004
60	0.030	0.033	0.004	0.005
61	0.042	0.051	0.005	0.006
62	0.046	0.057	0.006	0.007
63	0.062	0.079	0.008	0.008
64	0.065	0.086	0.011	0.010
65	0.073	0.102	0.016	0.013
66	0.073	0.114	0.024	0.017
67	0.078	0.132	0.030	0.019
68	0.078	0.145	0.035	0.020
69	0.084	0.162	0.040	0.023
70	0.085	0.165		
71	0.131	0.219		

For the USA, we see that although the life expectancy is still far above the legal retirement age of 62, it brought about a significant change in the couples' retirement decisions - an increase of about 5% for both husband and wife's propensity to retire prior to legal retirement age (62/60), and this increases to 10% and beyond as the husband's age increases.

In Israel, the table shows that the decrease in the life expectancy hardly brings about any change in retirement probabilities, for both men and women – up to about 1% prior to the husband's legal retirement age, and a 2-3% increase thereafter. Again, those moderate changes are assumed to be a result of the mandatory retirement age in Israel.

We can summarize by saying that the life expectancy has a moderate influence in the USA, and minimal in Israel, even though in Israel this change moved the expected "death date" much closer to the legal retirement age.

But perhaps the real surprise lies hidden in a different piece of information. In Israel, when the husband is at age 69 – the probability that he is still working is 27% and 23%, for life expectancies of 75 and 70, respectively. This means that even with only one year of life expectancy, a full 23% of the men still work! For the wives, the numbers are similar, with 23% and 21% of the women working, respectively, for the two life expectancies.

This result for the women is not too surprising because they are on average four years younger than their husbands, so their age, on average, one year before the end of the life horizon (according to the mode) is only 65. Also, the number of 21% could represent wives which are younger than their husband by more than 4 years, so when their husband was at age 69, they didn't reach the mandatory retirement age.

In the USA, the numbers are different. Towards their later years, almost all men retire (at age 70, 13% of the men work if the life expectancy is 75, and 5% if it is lowered to 72). There seems to be a much more embracing attitude towards retirement in general.

VI . POLICY MEASURE – THE INFLUENCE OF POSTPONING THE LEGAL RETIREMENT AGE ON THE RETIREMENT DECISION

In this section we will try to assess the potential influence of a recently worldwide policy – increasing the legal retirement age. Although this policy was recently implemented in many countries including Israel, mainly due to the increase in the life expectancy in recent decades, not all facets of its influence on the actual timing of retirement are yet clear.

In order to explore the influence of the legal retirement age, we conducted several simulations in which we changed this age. For this simulation we took the entire sample as is, without any separation into education levels or health levels – and examined the change in the couple's retirement timing, reacting each time to a different legal retirement age.

For the USA couples we postponed the retirement age four years for both husband and wife – from 62 for men and 60 for women, to 66 for men and 64 for women.

In Israel, the legal retirement age was changed from 65 for men and 60 for women to 67 for men and 64 for women, which is the current situation for males according to the law passed in 2004. For women, the minimum, retirement age by the same law is 62, but they can retire until age 67, (dependent on their own decision.).

As can be seen from the table below, the response pattern of the retirement timing in Israel is similar to the response pattern in USA, but larger.

Comparing Reactions to changes in Legal Retirement Age
USA vs. Israel[14]

	USA	USA	Israel	Israel
Husband's age	Difference Husband Works	Difference Wife works	Difference Husband Works	Difference Wife works
55	0.000	0.000	0.000	0.000
56	0.030	0.015	0.012	0.018
57	0.034	0.020	0.023	0.033
58	0.040	0.025	0.034	0.048
59	0.076	0.049	0.045	0.063
60	0.087	0.057	0.058	0.078
61	0.139	0.091	0.073	0.095
62	0.151	0.097	0.094	0.116
63	0.214	0.133	0.121	0.139
64	0.214	0.130	0.161	0.173
65	0.222	0.146	0.225	0.213
66	0.196	0.138	0.340	0.255
67	0.142	0.131	0.363	0.266
68	0.126	0.111	0.278	0.236
69	0.091	0.105	0.221	0.205
70	0.082	0.086	0.177	0.176
71	0.053	0.076	0.148	0.153
72	0.058	0.063	0.125	0.129
73			0.103	0.107
74			0.084	0.082
75			0.068	0.058

[14] In the table, the husband's and the wife's new legal retirement age is highlighted. Note that for the wives, the simulated new legal retirement age – 64 (for both countries) occurs when the age of the husband is (on average) 67 in USA and 68 in Israel.

The simulation shows that in the US, up to 22% more of the couples decided that the husband should postponed their retirement (in Israel, up to 36%), with a sharp peak when the husband is at age 65 (in Israel at age 67) (See Graphs US-19, US-20, IL-19 and IL-20). The influence on the women was that about 10-20% of them postponed their retirement between the husband's age of 61-73, which is for women ages 57-69, peaking when the husband is aged 66-68, and the women aged 62-64. This is in line with the overall picture of couples responding to this incentive when both husband and wife are in their mid-sixties, before old age sets in with its myriad difficulties. Whereas in Israel, one can see a clearer connection between the legal retirement age and the actual retirement age, in the USA the reaction is more blurred, both in the original model and in the simulation. A possible explanation for the difference response of men to the legal retirement age in these countries could be the different status of the "legal retirement age" as explained before.

<u>Comparing Retirement Behavior in the USA and Israel</u>

In addition to the effect of the legal retirement age, a direct comparison between retirement patterns in the US and Israel shows that there is an additional difference at play. We return for a moment to a simulation of a synthetic couple, which was done in the education-related simulations. We simulated the retirement behavior of a couple who finished college, are both healthy, have a pension, and are on a salary, and compared the patterns in the US and Israel. Graphs US- IL-A and US-IL-B show this comparison, and higlight the fact that the main source of the different retirement patterns in USA and Israel is the retirement pattern of the husbands, whereas the wives behave alike.

The gap in the work probabilities for men between the USA and Israel goes from 18% when the husband is aged 60 (before legal retirement age in the USA) to a 48% difference when the husband is aged 65, the legal retirement age in Israel. This pattern persists from age 55 on, so there seems to be an underlying factor apart from the different legal retirement age. It could be the lower average salaries in Israel which would cause lower pension savings over a lifetime; or other factors. Graph US-IL-B shows the difference in work probabilities between women in the USA and Israel, according to the husband's age.

Although, on average, in Israel the wives are about 4 years younger than their spouses, and in the USA just over 3 years younger, this single year of age difference does not preclude us from seeing clearly that women's work patterns in the USA and Israel are very similar, whereas that of the men are markedly different.

To summarize, we can deduce from these simulations that in both the USA and Israel, men and women respond significantly to changes in the legal retirement age. We see that from a perspective of government policy, postponing the legal retirement age will induce couples to work into their later years, being particularly responsive to this change when they are in their mid-sixties.

In Israel men’s behavior is especially tied up with the legal retirement age. The simulation shows that for a high percentage of the couples, their work/retirement decision is dependent upon the legal retirement age, which seems in line with the fact that the legal retirement age in Israel is also the mandatory retirement age.

In the USA, postponing the legal retirement age could influence on the actual retirement age via two channels:

1. Changing the Social security entitlement age can affect the incentives to retire at each age.
2. Postponing the retirement age may create a “norm” of the maximum working age, even if this age is not mandatory, thus inducing the population to work more or less years.

VII. “GOODNESS OF FIT”

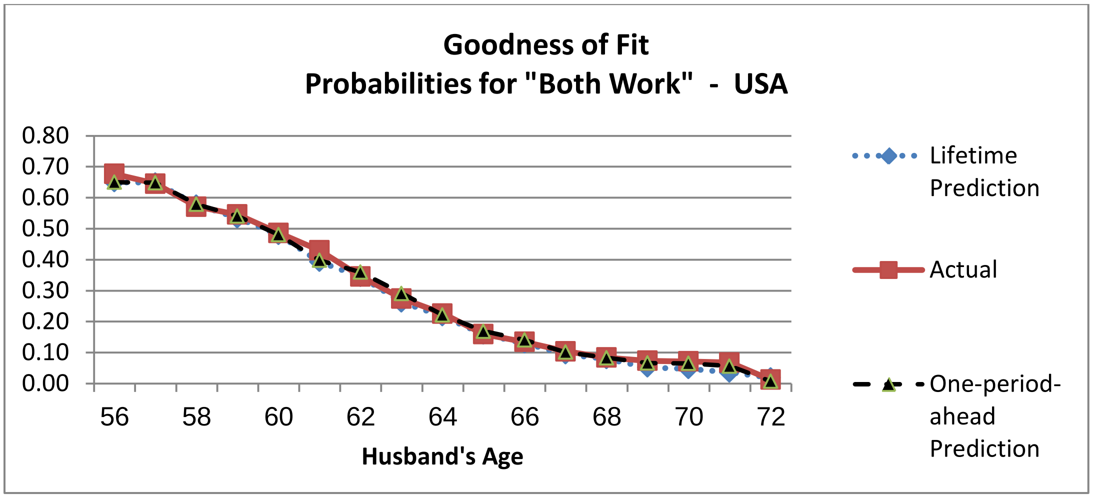
In order to assess the model's “goodness of fit”, i.e. the extent to which results coincide with data, we calculated the predictions of the model on the original samples in two ways: conditional and unconditional, and compared them with the actual samples behavior.

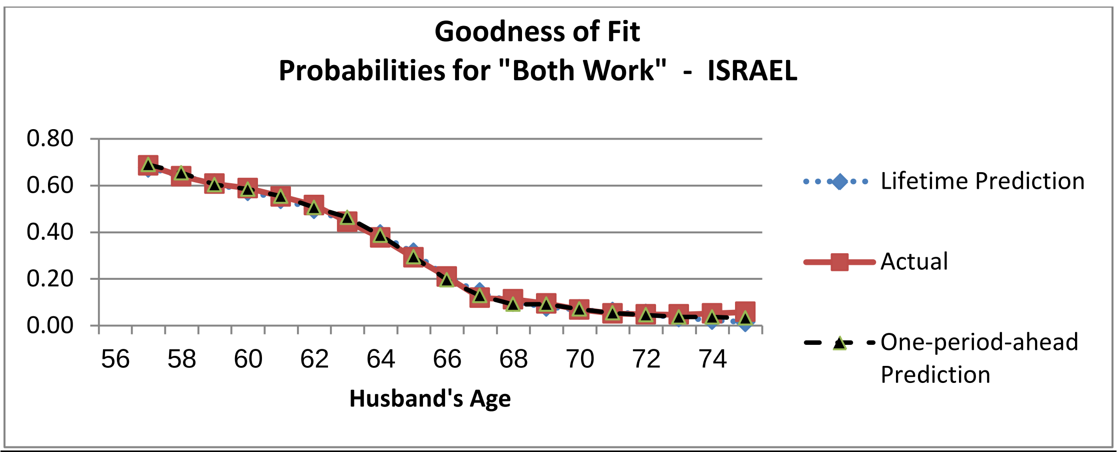
1. Conditional predictions (“One Period Ahead Prediction”)

The conditional predictions were calculated by running a one-period-ahead prediction, using the actual data on retirement as an initial condition in each period. For each period, starting when the husband was aged 55, we predict the retirement decision of the next period using the estimated parameters (and the current retirement status of the spouses), and compared the predictions with the actual data.

2. Unconditional Predictions (“Lifetime Prediction”)

The unconditional predictions were calculated by using the predicted retirement decision from the model as the initial condition for all the periods, except from the first period in which we use the actual retirement status of the couple.





Additional graphs of these forecasts, for the USA and Israel, are in Appendix 2 (Graphs US-17, US-18 and IL-17 and IL-18).

Generally, it is clear from the graphs that the model for both countries fits the data very well, even when using the unconditional simulation, which means that we need to predict the entire path of lifetime work/retirement, without using any actual retirement decision.

Summary

The hypothesis standing behind this work – that for a married couple, retirement decisions can best be modeled as a decision arrived at by the family unit as a whole, and timed, for each spouse, so as to maximize joint (family) utility – appears to be corroborated by the results presented here. Some of the attempts made to verify this model's validity are shown here – such as the "Goodness of fit" tests. Other tests for its validity can be seen in Feinsilver (2011).

As we delve into a closer examination of the behavior in Israel and the US, differences in the respective economic and cultural environments, as well as the differences in legal retirement ages between the two countries, make themselves evident as couples in each country respond differently to simulated circumstances.

However, on the whole, several points are clear, for both countries: First, that in the higher education levels ("finished college" and up), couples have more flexibility in deciding when to retire. They also probably have improved financial circumstances, both in terms of current salary and in terms of accumulated savings, which also contributes towards enabling them to retire at a time that is optimal to them. This "optimal" time may be at a later age, due to working in a more interesting job, or earlier, due to a better financial situation. We found that couples where both spouses finished college, retired latest, compared to all other education levels.

Couples do make allowances for their spouses health situation, however the behavior is mixed – some spouses work the same, or even more – in order to fund the increased health care expenses; and others work less, presumably in order to care themselves for their sick spouses.

Being entitled (or not) to a pension makes a significant difference in retirement behavior. Couples who are not entitled to a pension arrange things so that one or both spouses work in their later years, to compensate for the lack of a pension income.

Lastly, we found that couples respond strongly to changes in the legal retirement age, so that government policy-makers should consider delaying the legal retirement age as an effective way of decreasing pension liabilities or underfunding.

References:

Burtless, G. and Moffitt, R. The Joint Choice of Retirement Age and Post-retirement Hours of Work, *Journal of Labor Economics,* 1985 vol. 3, No. 2

M. Casanova (2010), Happy Together: A Structural Model of Couples' Joint Retirement Choices, UCLA Economics Dept.

Chiappori, Pierre-Andre, Rational Household Labor Supply. *Econometrica, Vol 56, No. 1 (Jan. 1988)*

Chiappori, Pierre-Andre, Collective Labor Supply and Welfare. *Journal of Political Economy, Vol 100, No. 3 (June 1992)*

Coile, C. (2004) Retirement Incentives and Couples' Retirement Decisions. *Topics in Economic Analysis and Policy 4,* 1-28

Eckstein, Zvi ahd Wolpin, Kenneth I., The Specification and Estimation of Dynamic Stochastic Discrete Choice Models: A Survey, *The Journal of Human Resources,* Vol. 24, No. 4 (Autumn 1989)

Feinsilver, Evan David, The Retirement Decisions of Married Couples in the United States, MA thesis, Tel Aviv University, September 2011.

Hurd, Michael D. The Joint Retirement Decision of Husbands and Wives - Chap. 8 from *Issues in the Economics of Aging*, by D. Wise, University of Chicago Press.

A. Gustman & T. Steinmeier (2000) Retirement in dual-career families: A Structural model. *Journal of Labor Economics, 18*, 503-545

A. Gustman & T. Steinmeier, Social Security and Retirement Dynamics. *University of Michigan Retirement Research Center, July 2006*

Gustman, A and Steinmeier, T., Partial Retirement and the Analysis of Retirement Behavior, *NBER Working Paper No. 763*, September 1981

Maestas, Nicole, Expectations and realizations of Work After Retirement, *Journal of Human Resources, Vol 45 No. 3, 2010*.

S. Jimenez-Martin, J. Labeaga, M. Martinez-Granado, Health Status and Retirement Decisions for Older European Couples, *Universidad Carlos III de Madrid, Working Paper 99-82, Economic Series 30, October 1999*

R. Johnson, A Davidoff, K Perese (2003) Health Insurance Costs and Early Retirement Decisions, *Industrial & Labor Relations Review, Vol 56, No. 4*

Ruhm, C., Bridge jobs and Partial Retirement, *Journal of Labor Economics,* 1990 vol. 8, No. 4

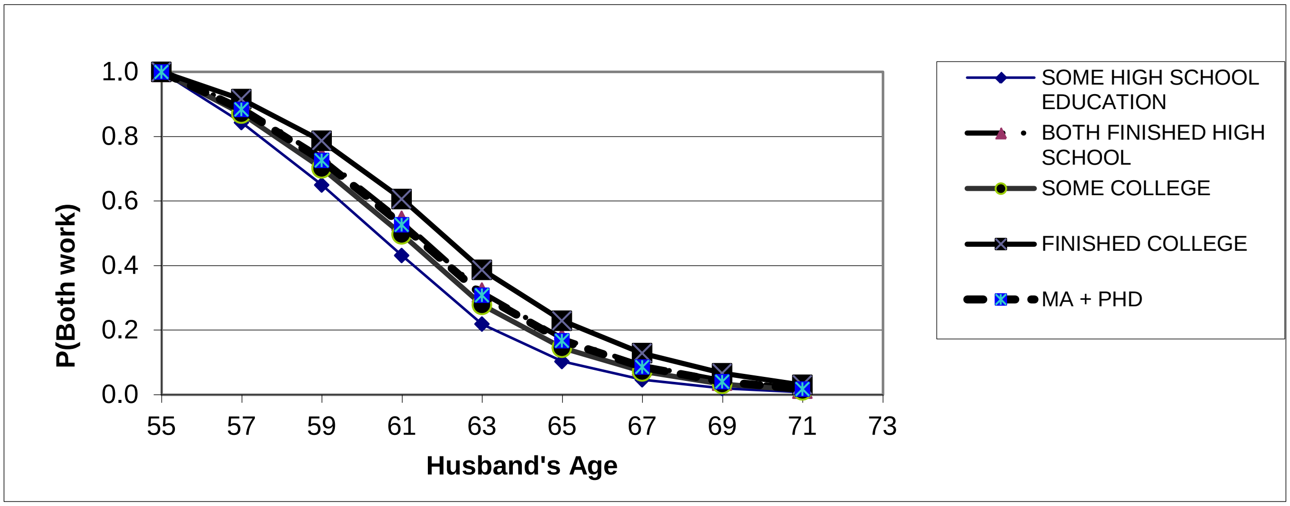
Rust, John, A Dynamic Programming Model of Retirement Behavior, NBER working paper No. 2470, December 1987.

Rust, John, Optimal replacement of GMC Bus Engines: An Empirical Model of Harold Zurcher, *Econometrica*, Vol 55, No. 5 (September 1987)

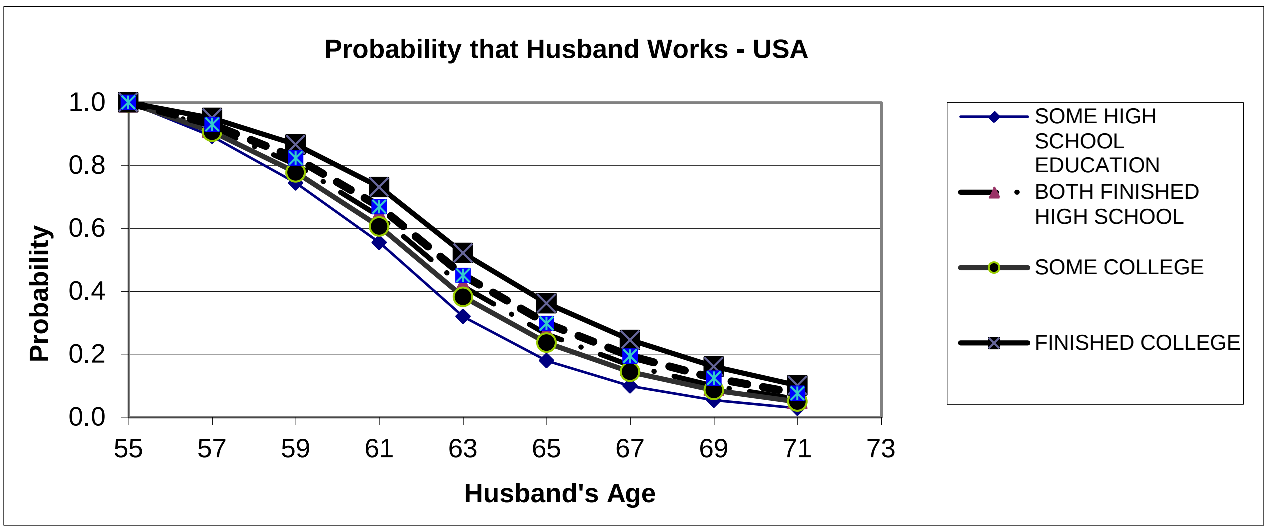
Appendix 1: Graphs of the Simulations

Graph US - 0

Influence of Education on Probability that Both Spouses Work[15] - USA



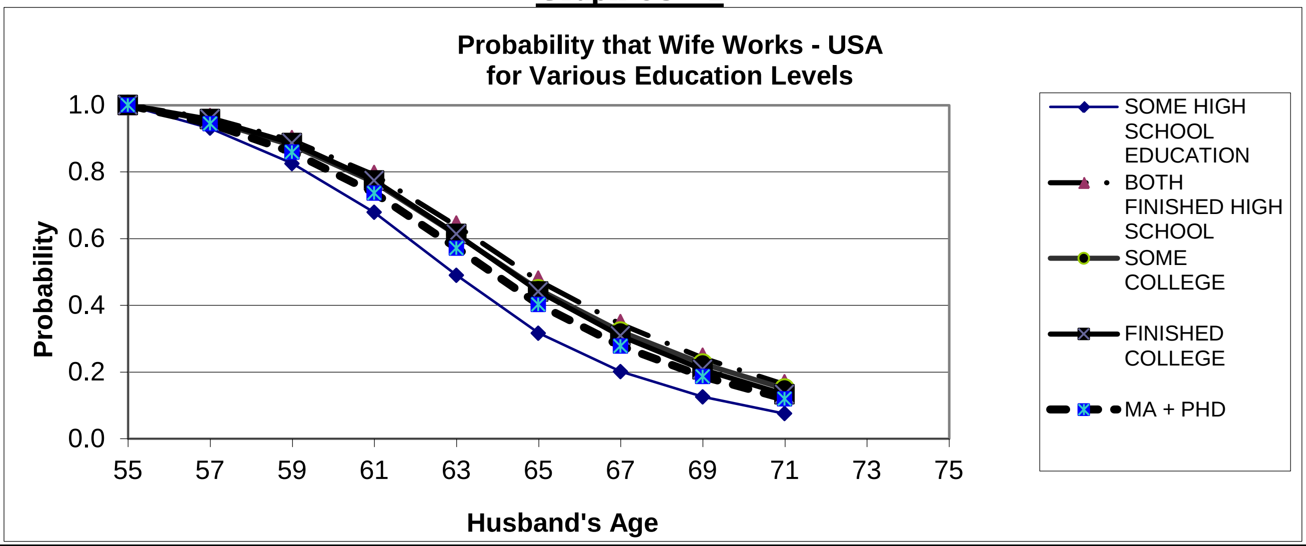
Graph US – 1



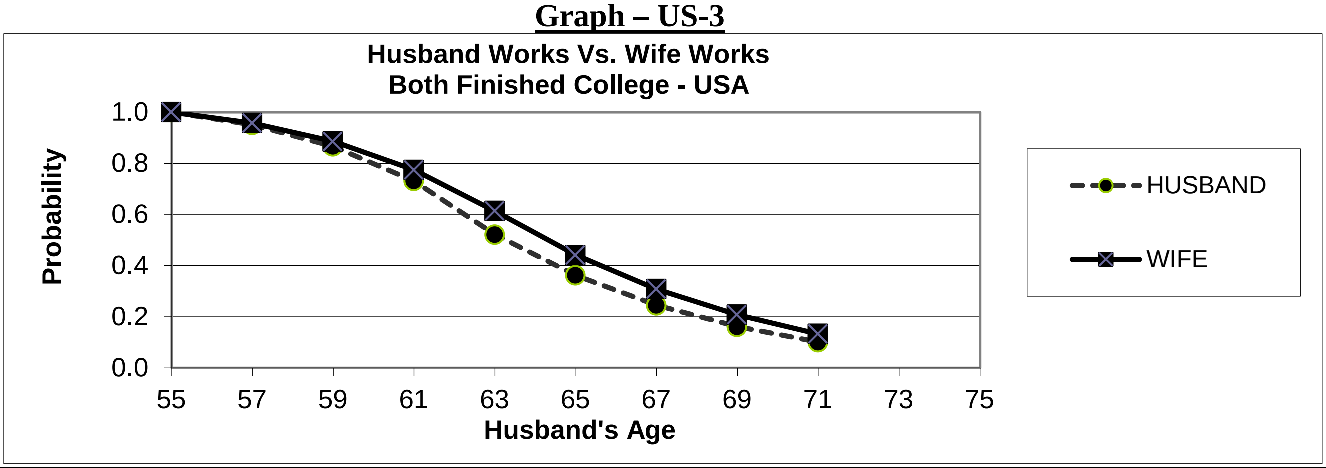
---

[15] Note: The simulations provided four probabilities, for each age level of the husband: The probabilities that - Both work, Only husband works, Only wife works, and Both retired. These add up to 100%. From these we could calculate the probability that the husband works – it is the probability that "Both work" plus the probability that "Only husband works".

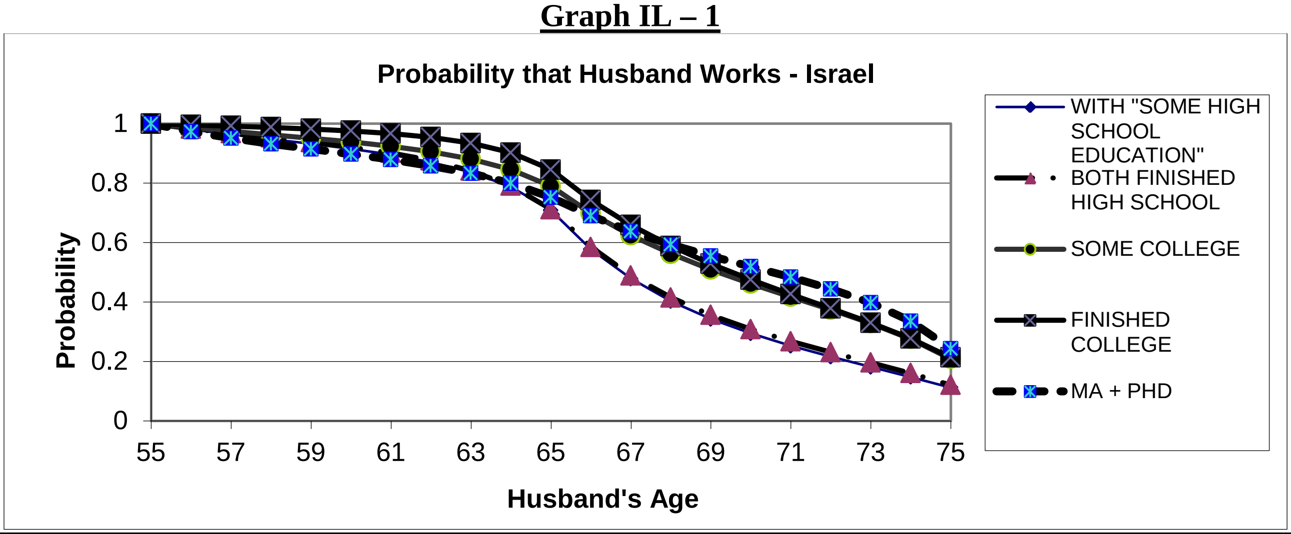
Graph US – 2



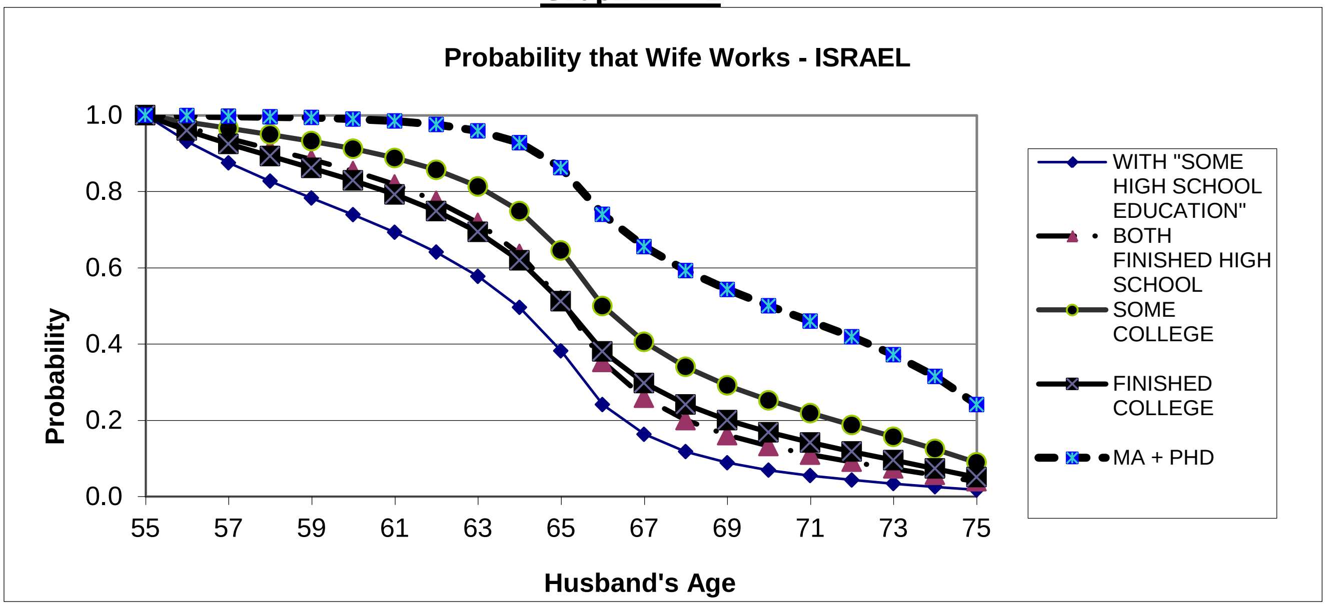
Graph – US-3



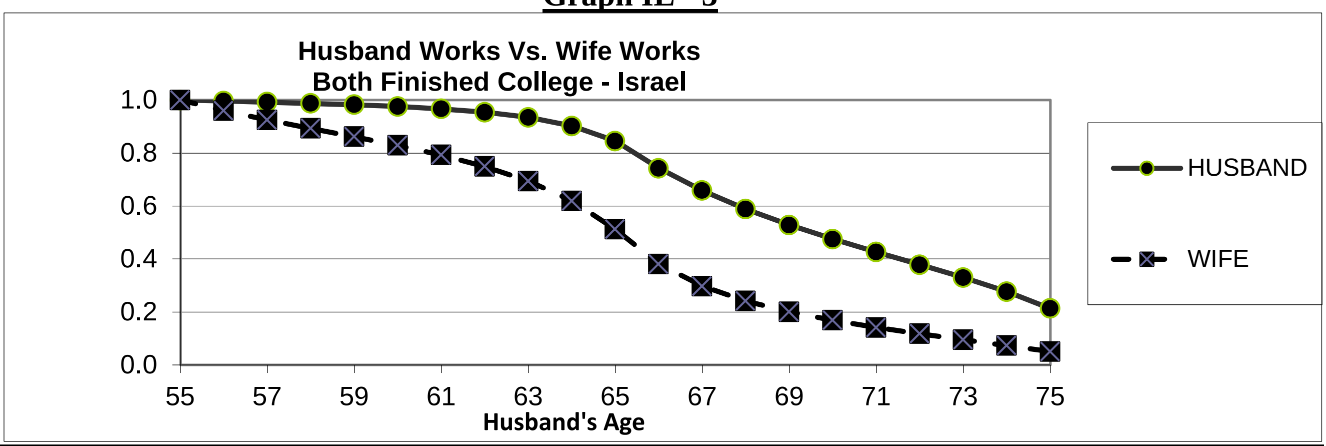
Graph IL – 1



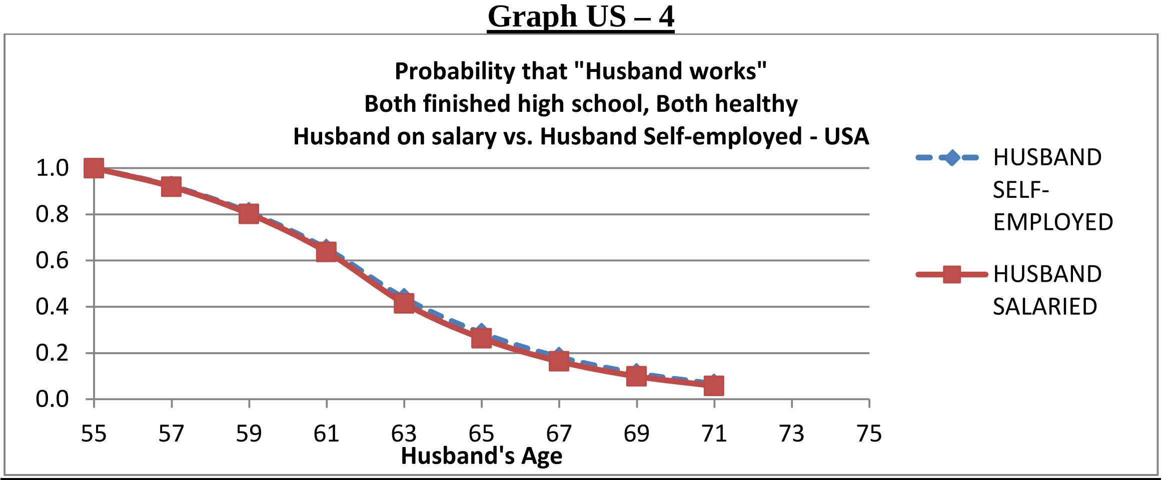
Graph IL – 2



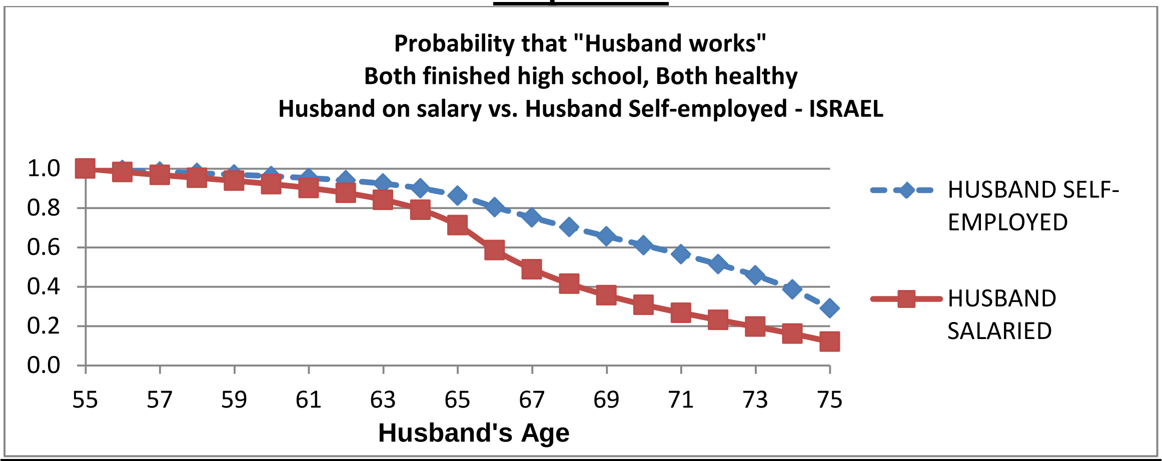
Graph IL - 3



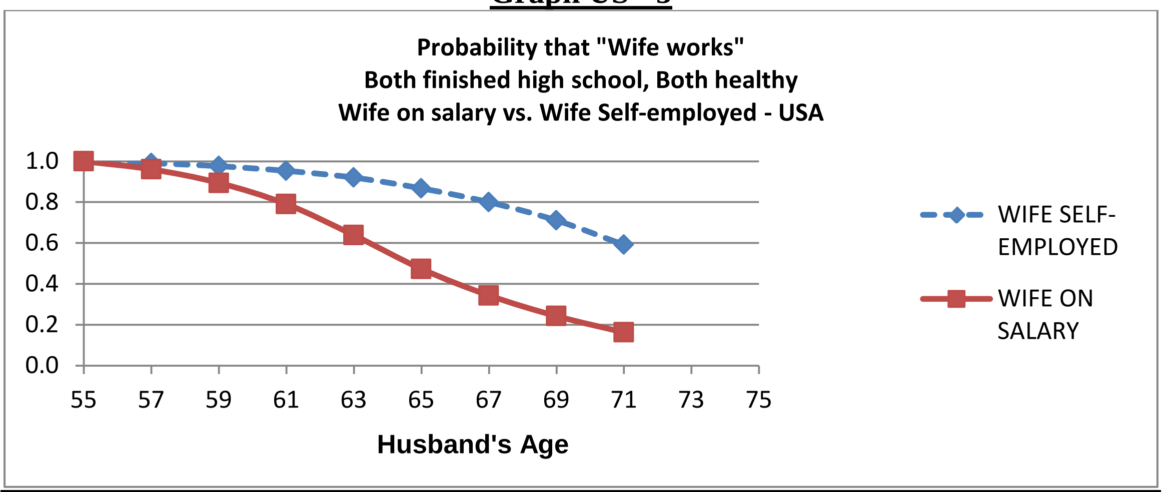
Graph US – 4



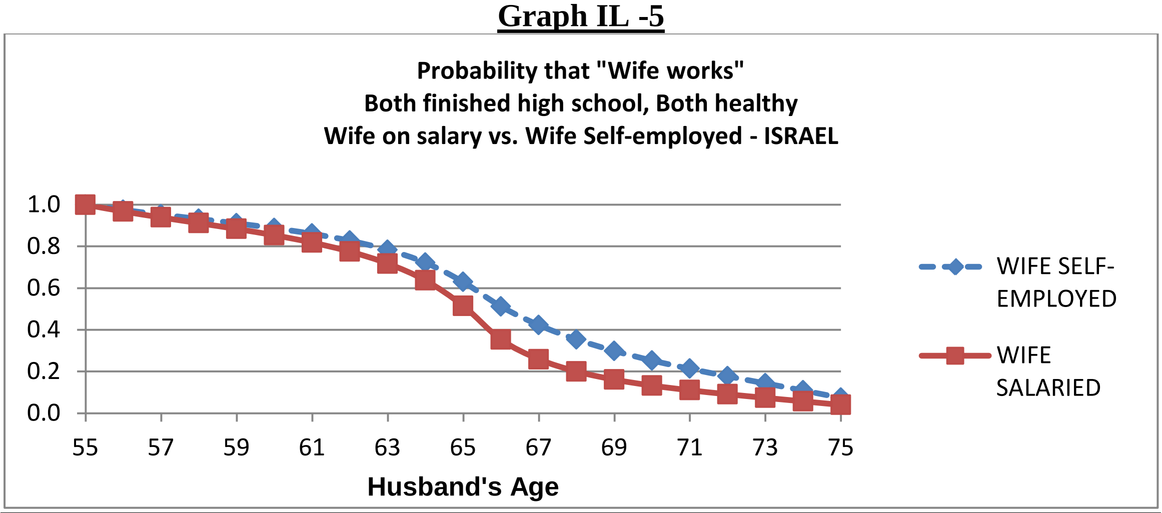
Graph IL - 4



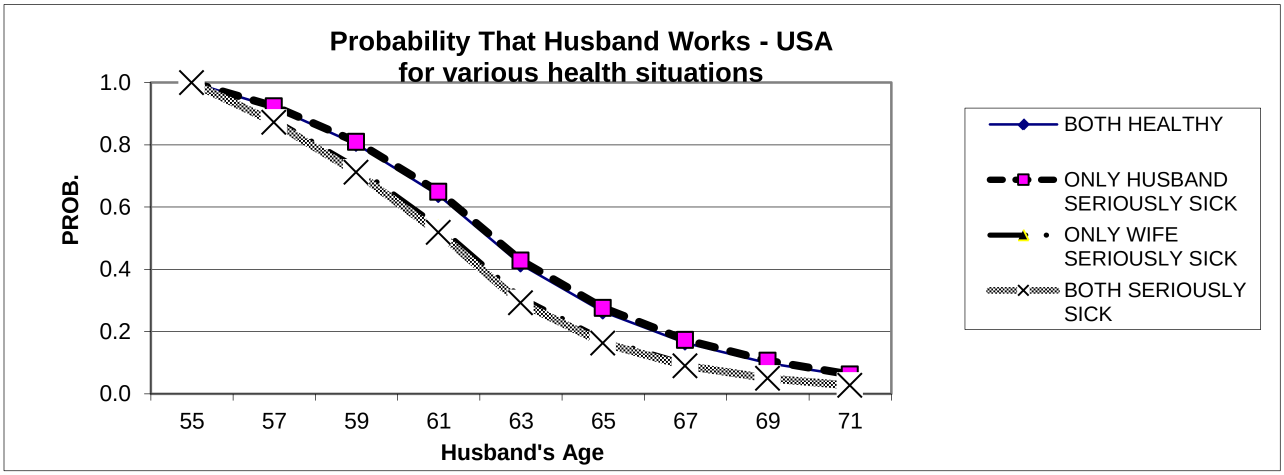
Graph US - 5



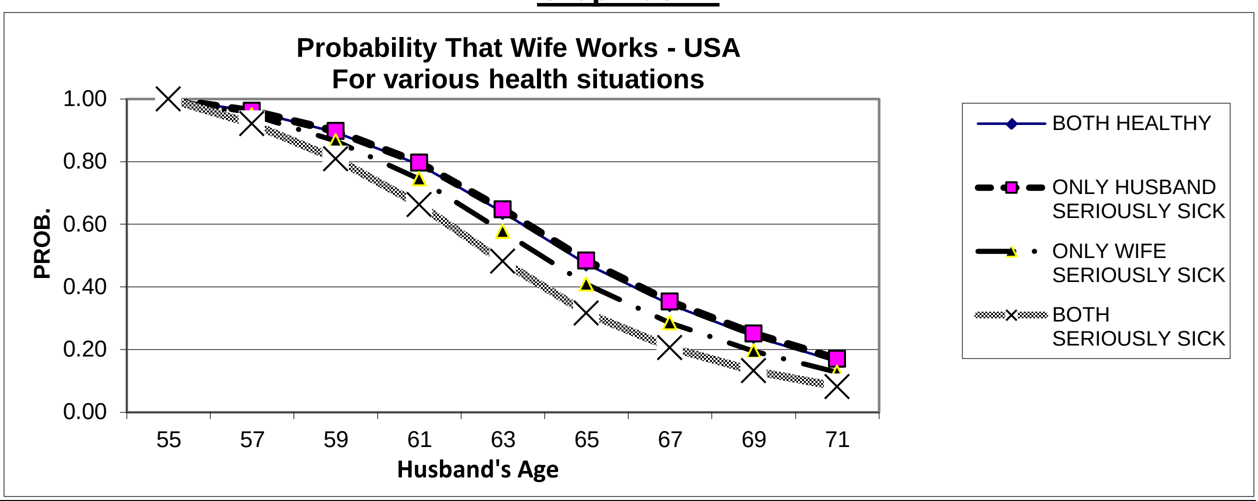
Graph IL -5



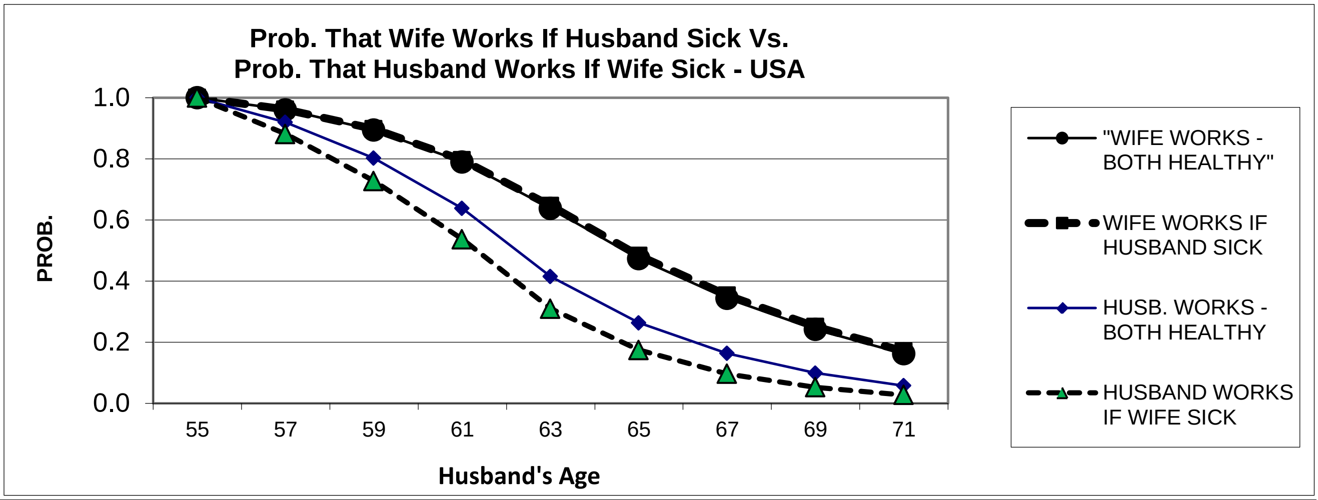
Graph US – 6



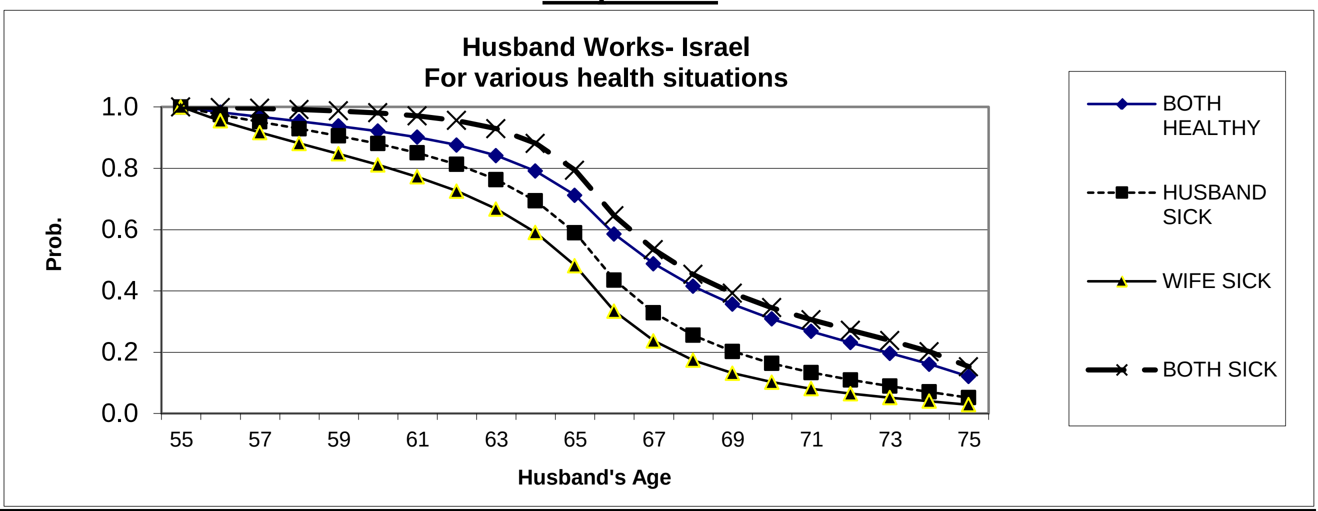
Graph US - 7



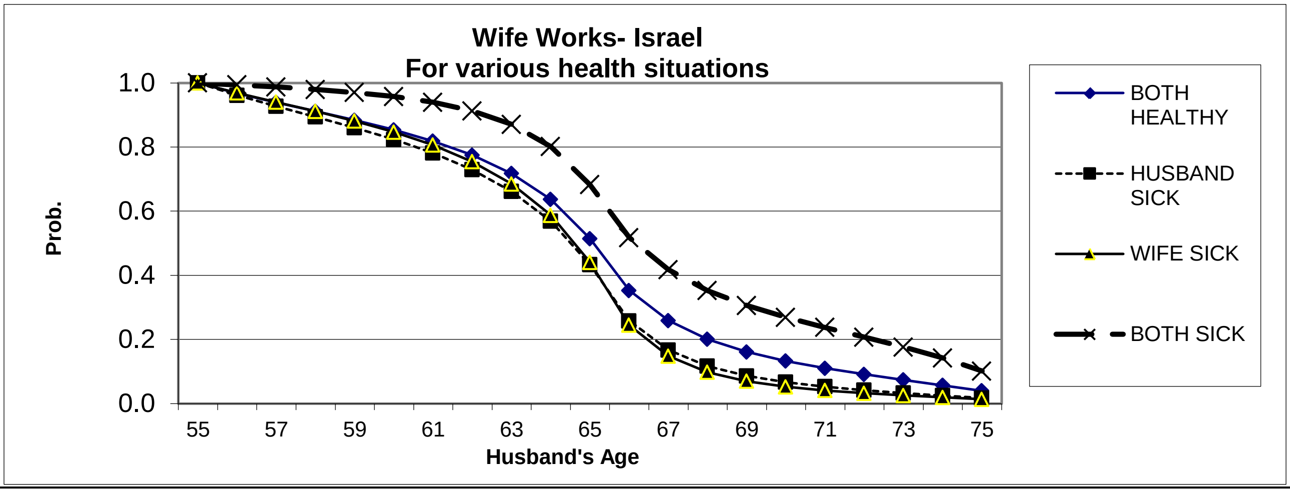
Graph US - 8



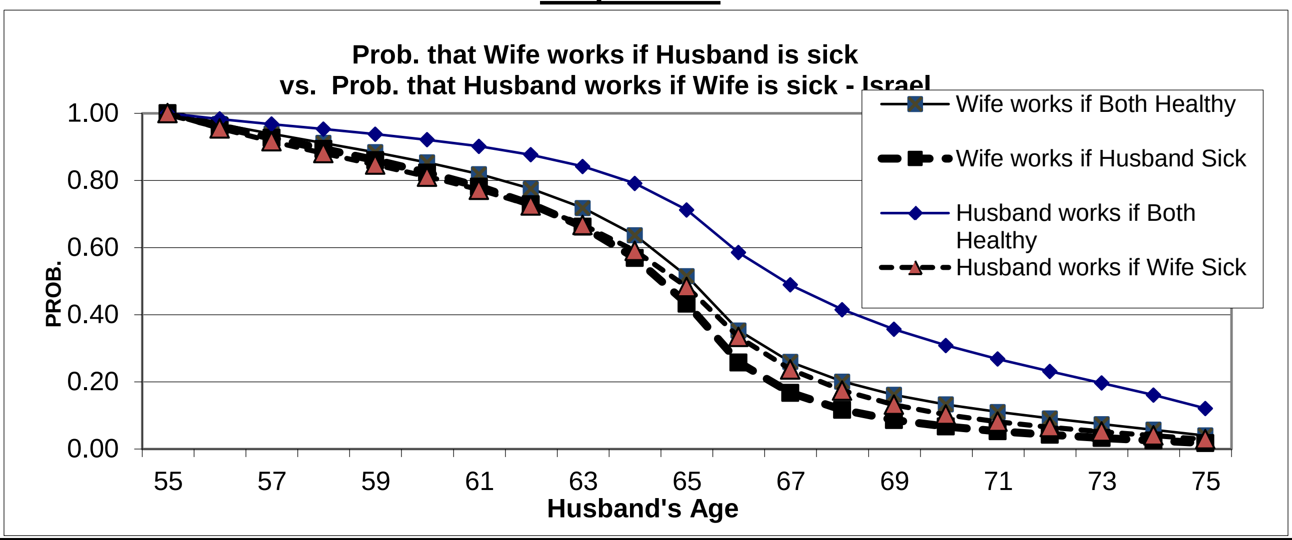
Graph IL - 6



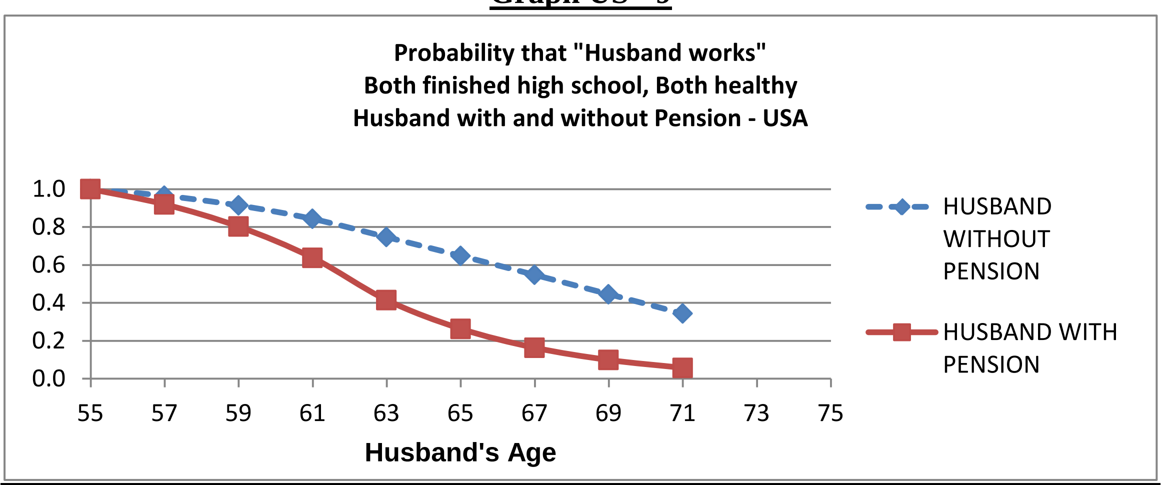
Graph IL - 7



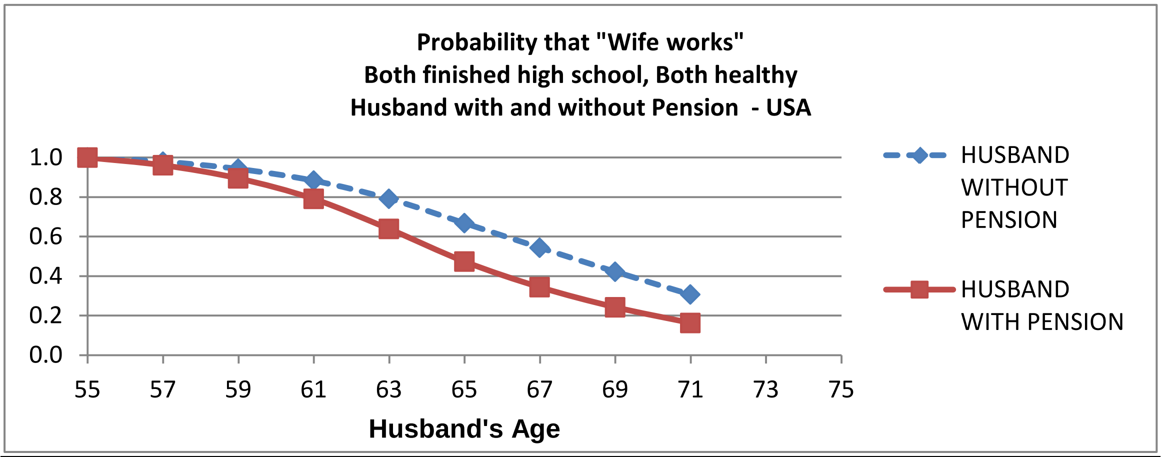
Graph IL – 8



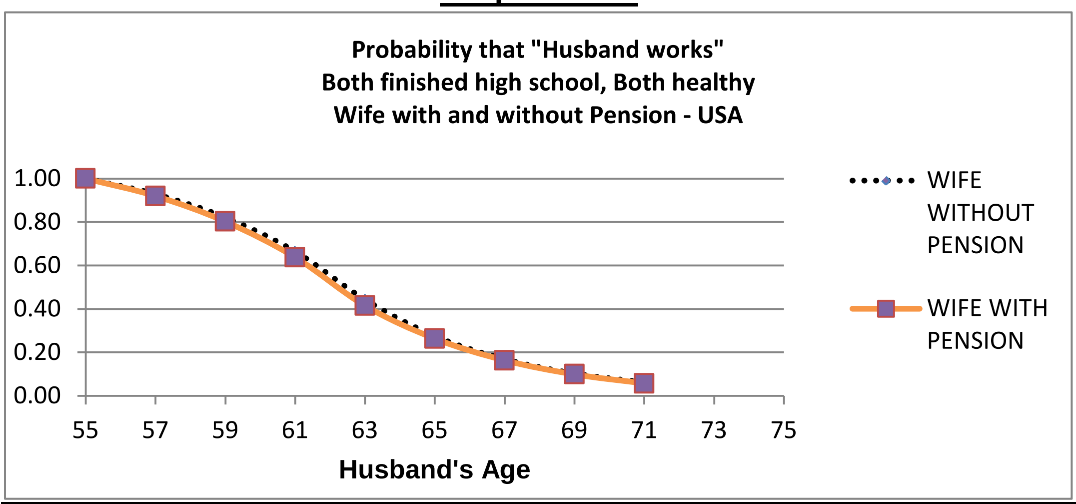
Graph US - 9



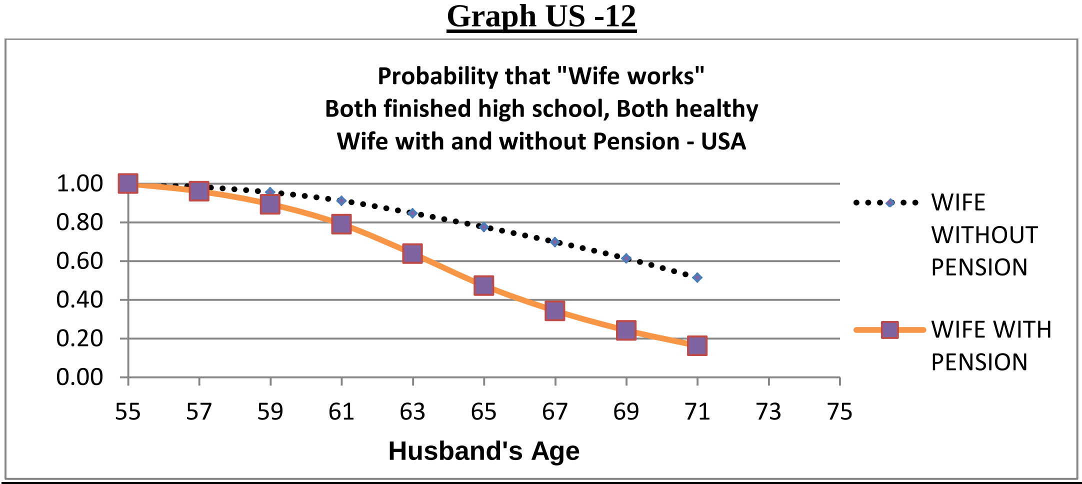
Graph US - 10



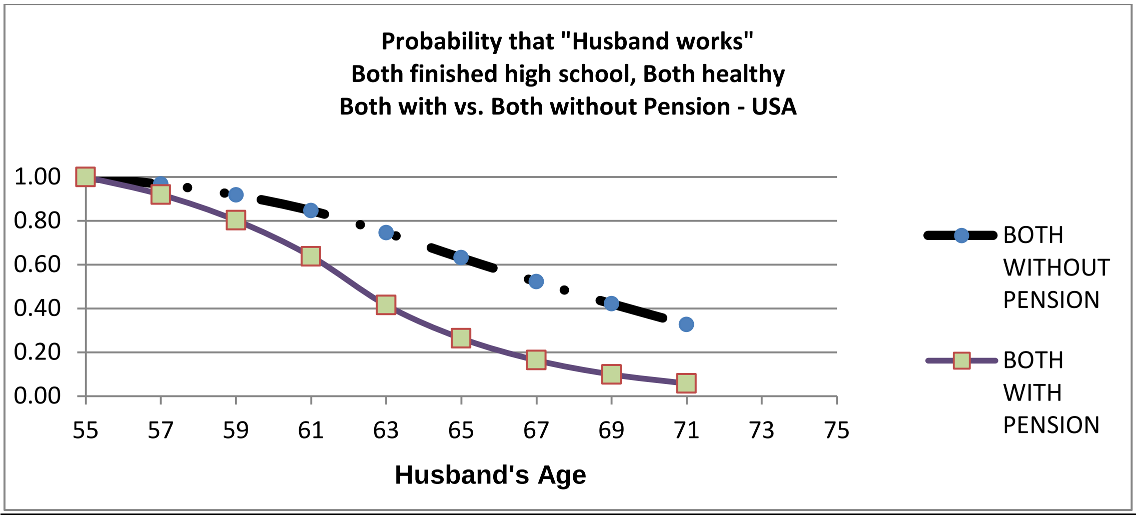
Graph US - 11



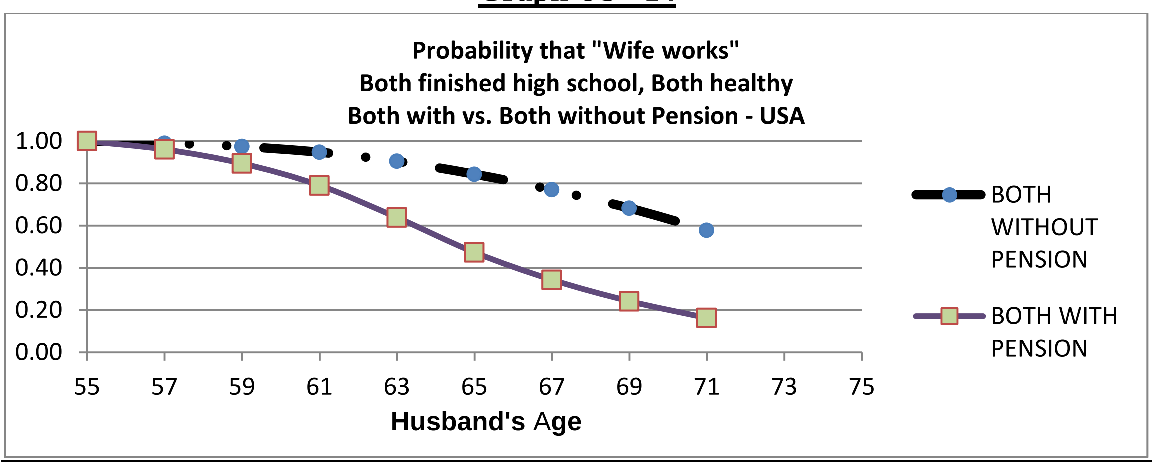
Graph US -12



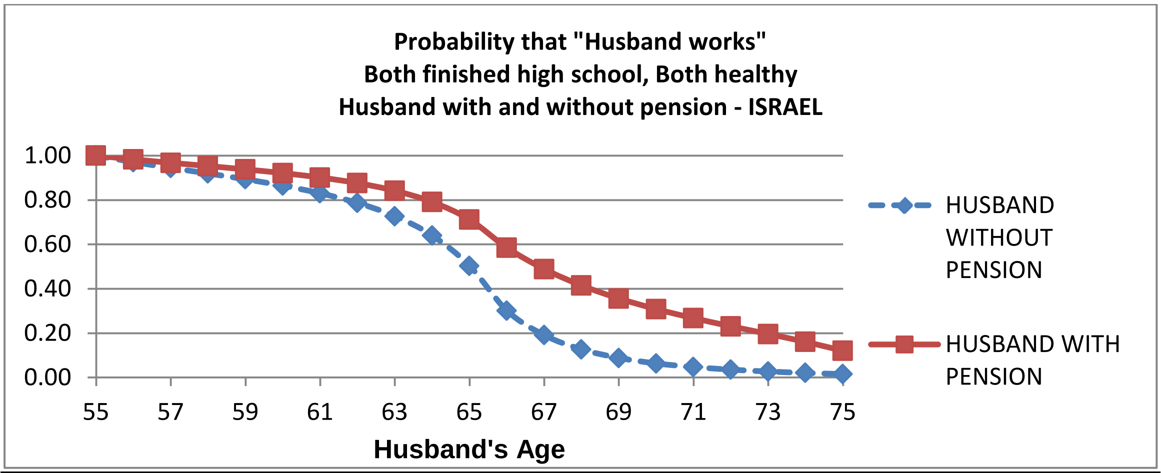
Graph US - 13



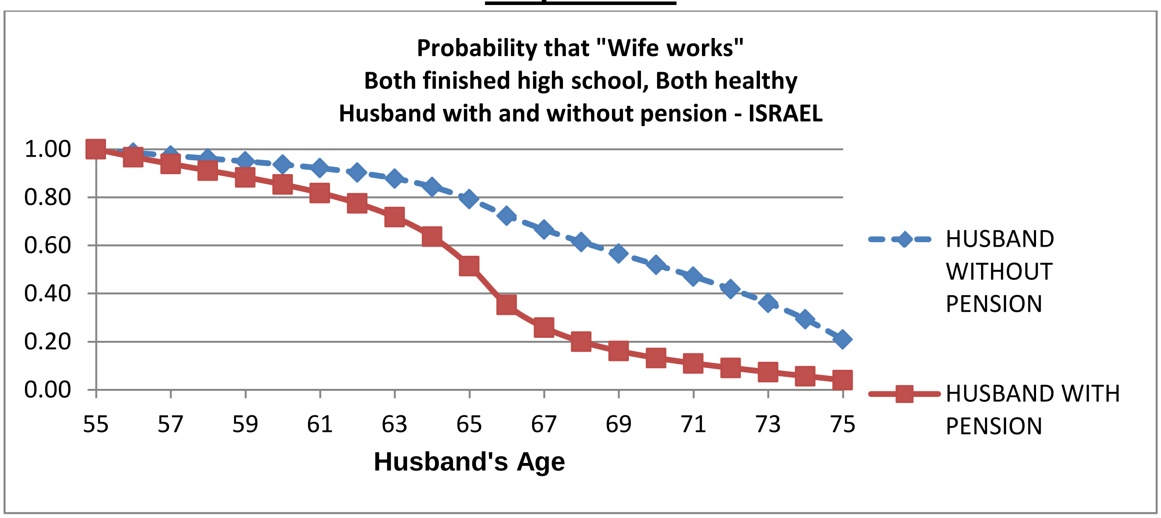
Graph US - 14



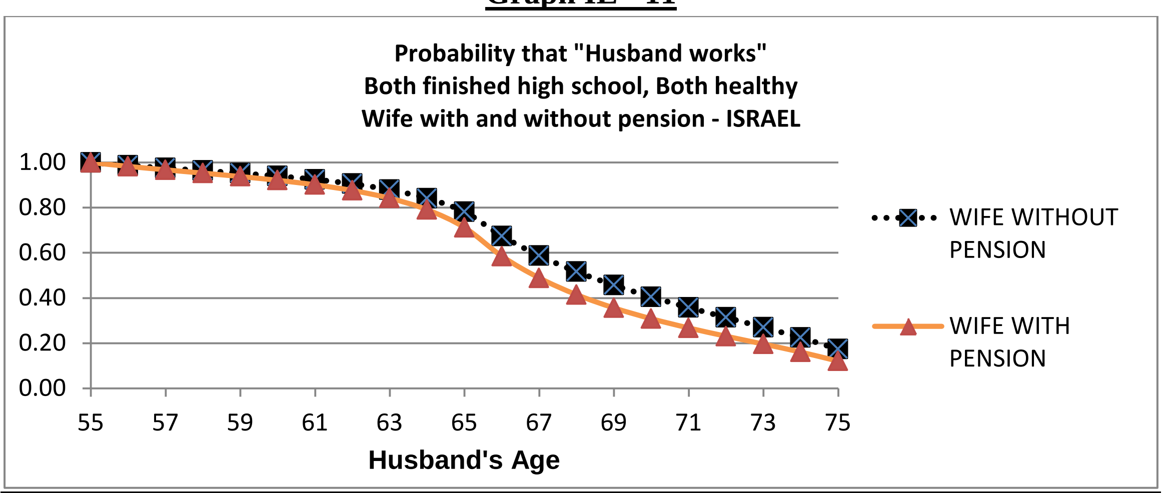
Graph IL - 9



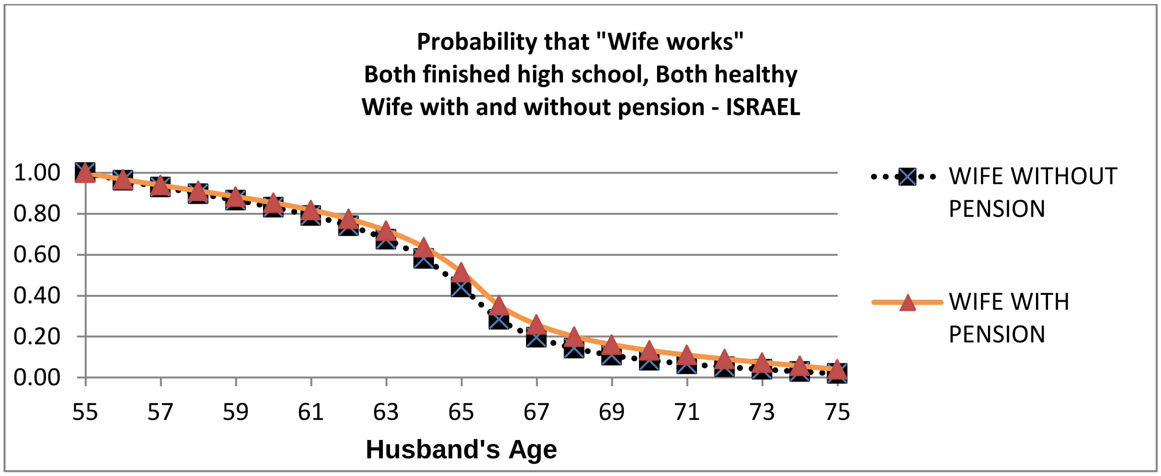
Graph IL - 10



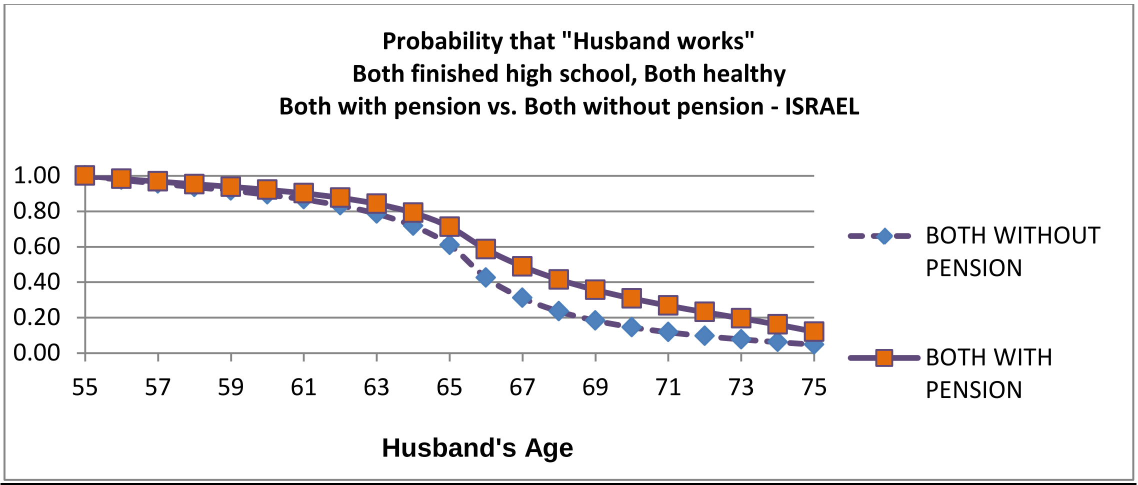
Graph IL - 11



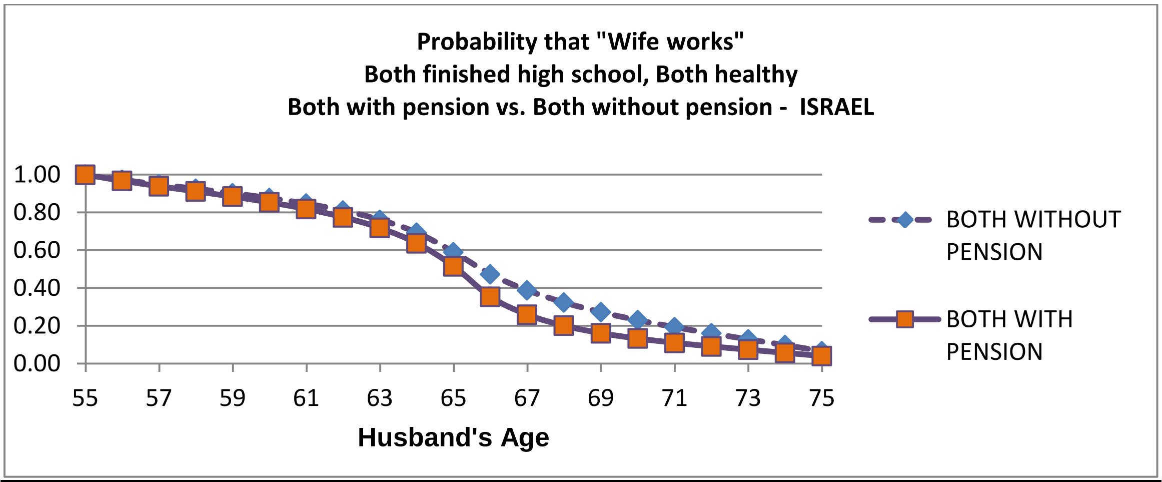
Graph IL - 12



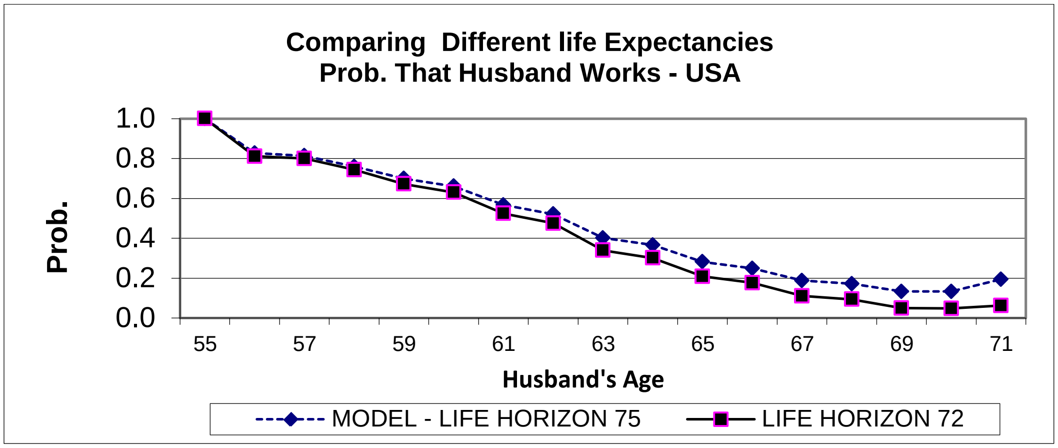
Graph IL - 13



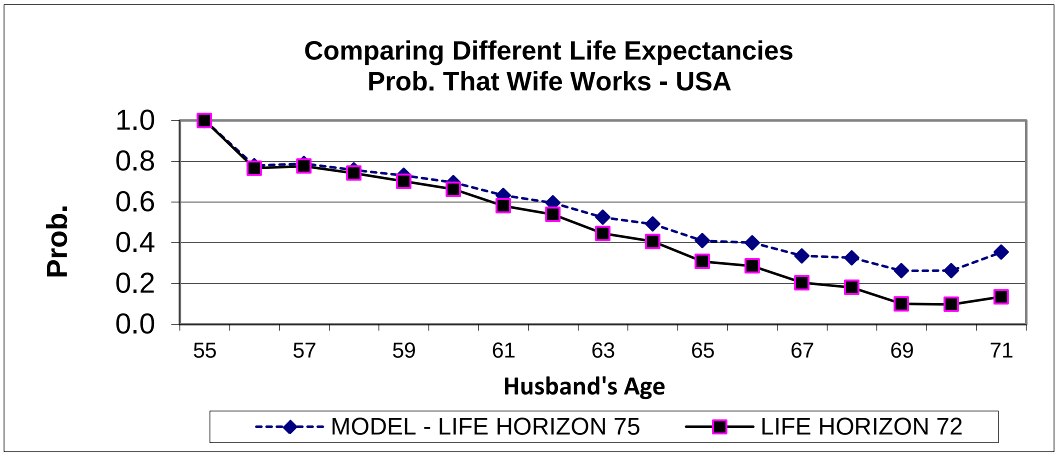
Graph IL- 14



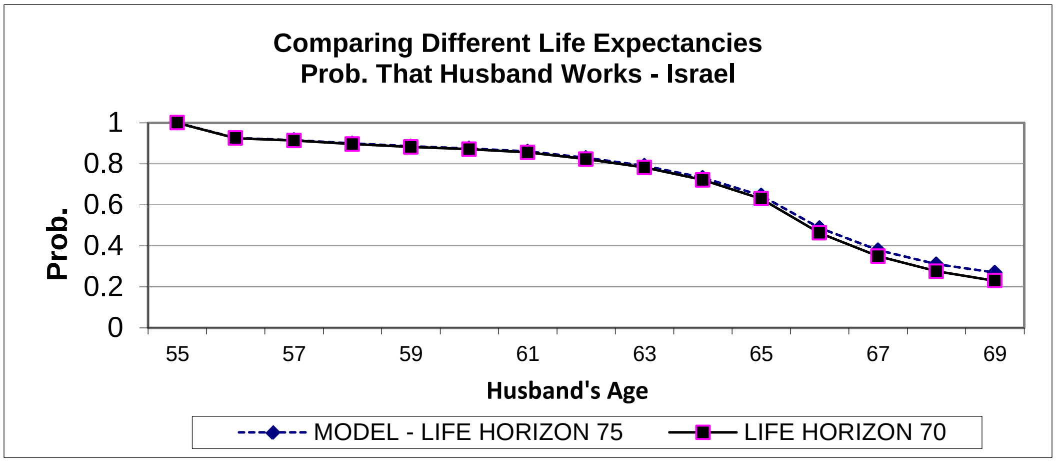
Graph US - 15



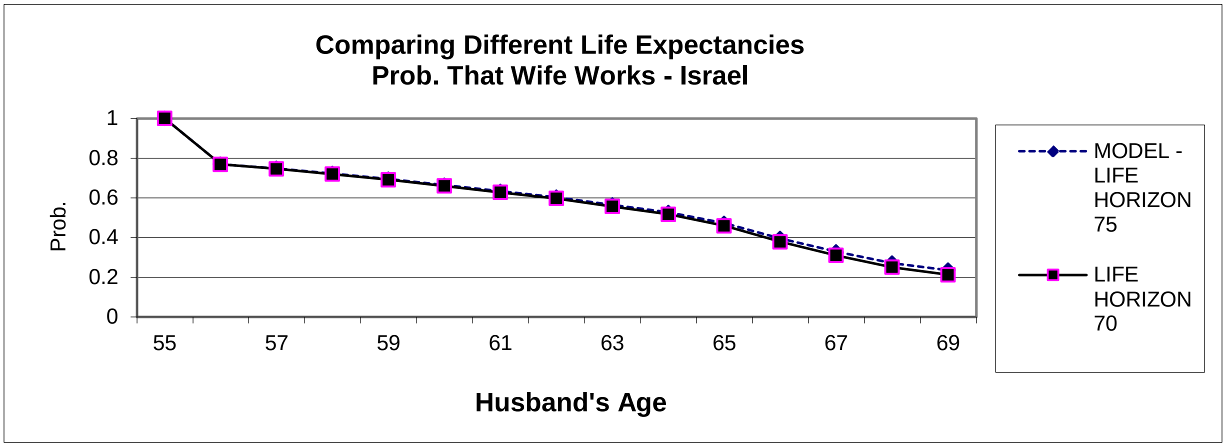
Graph US - 16



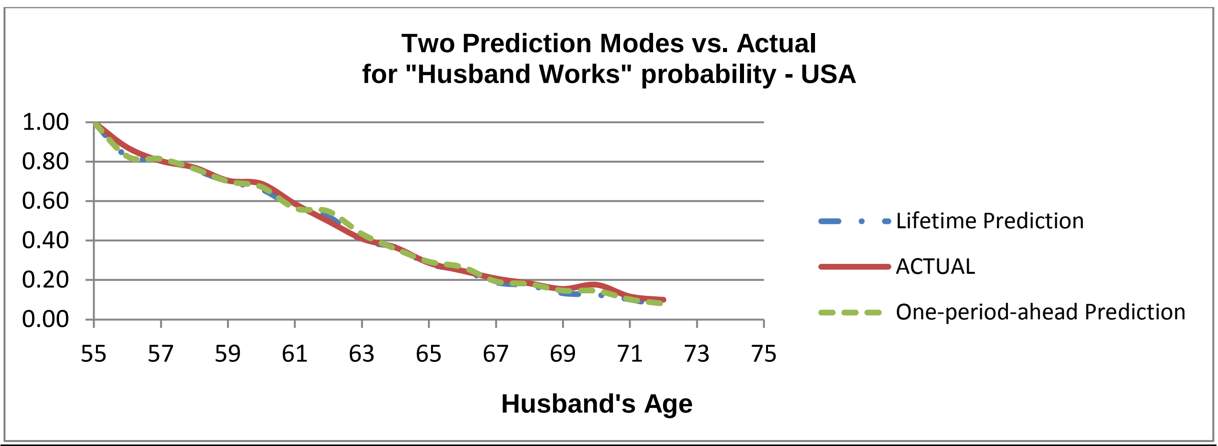
Graph IL - 15



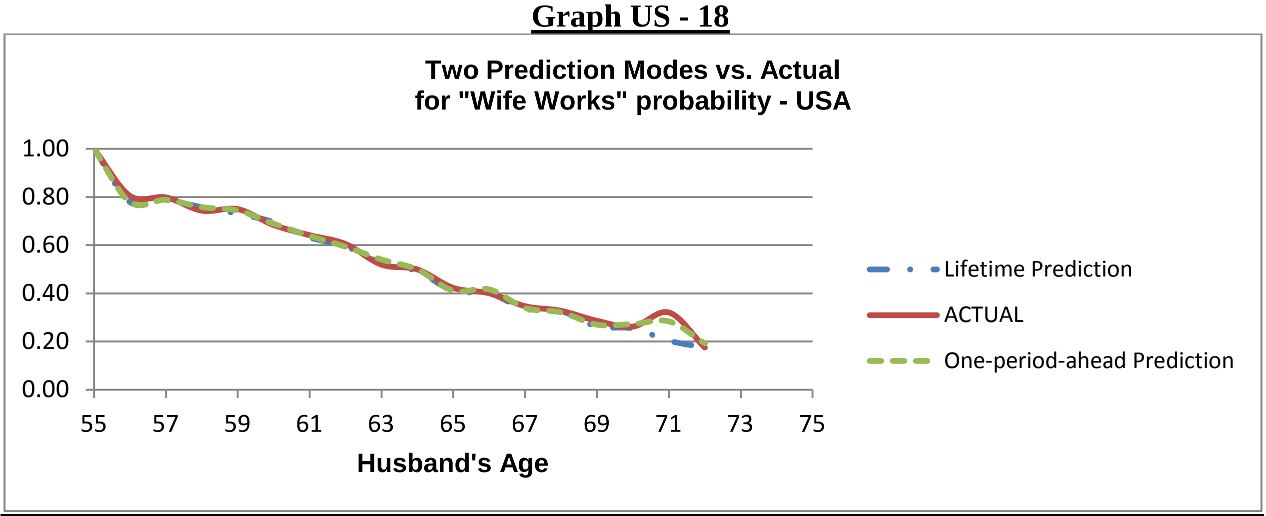
Graph IL - 16



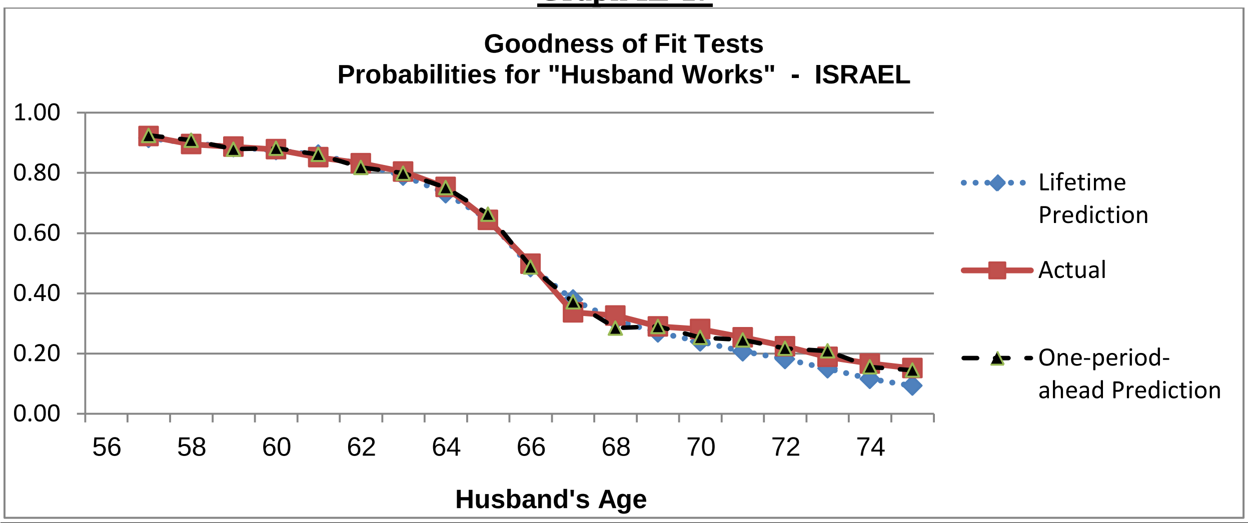
Graph US - 17



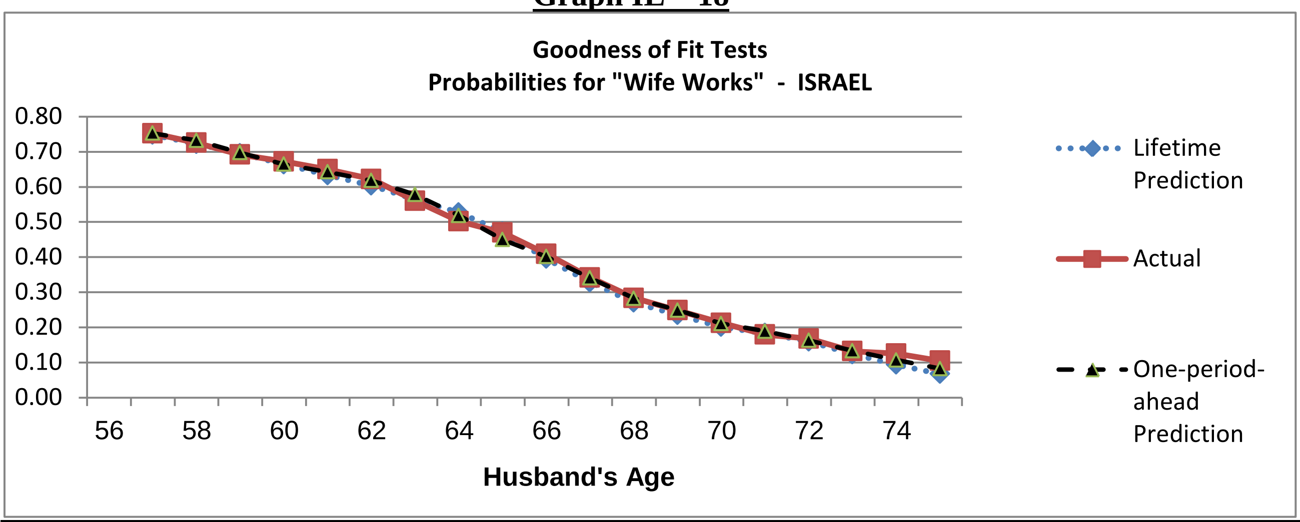
Graph US - 18



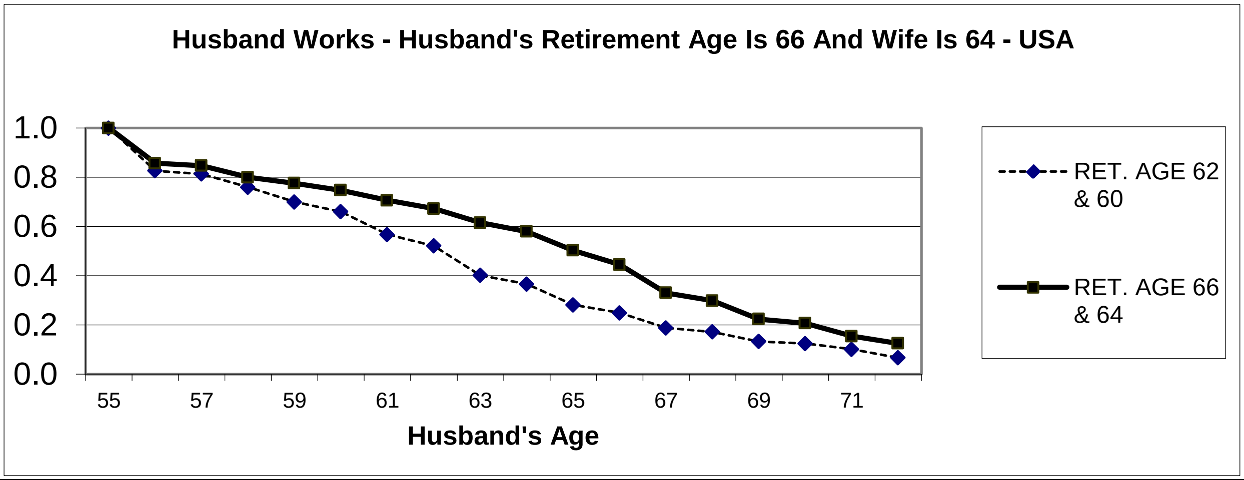
Graph IL-17



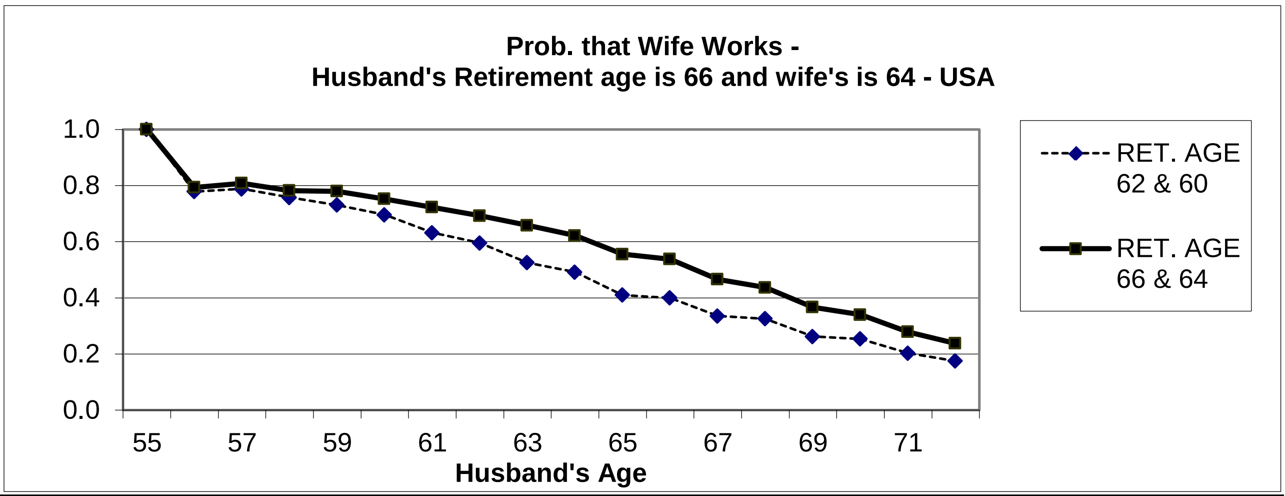
Graph IL – 18



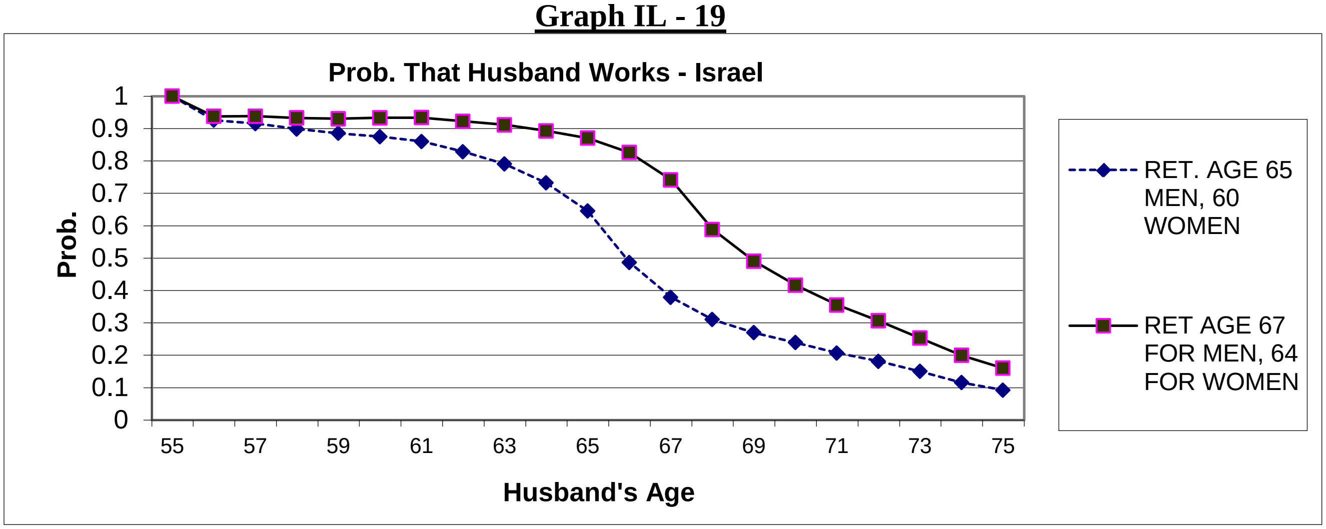
Graph US - 19



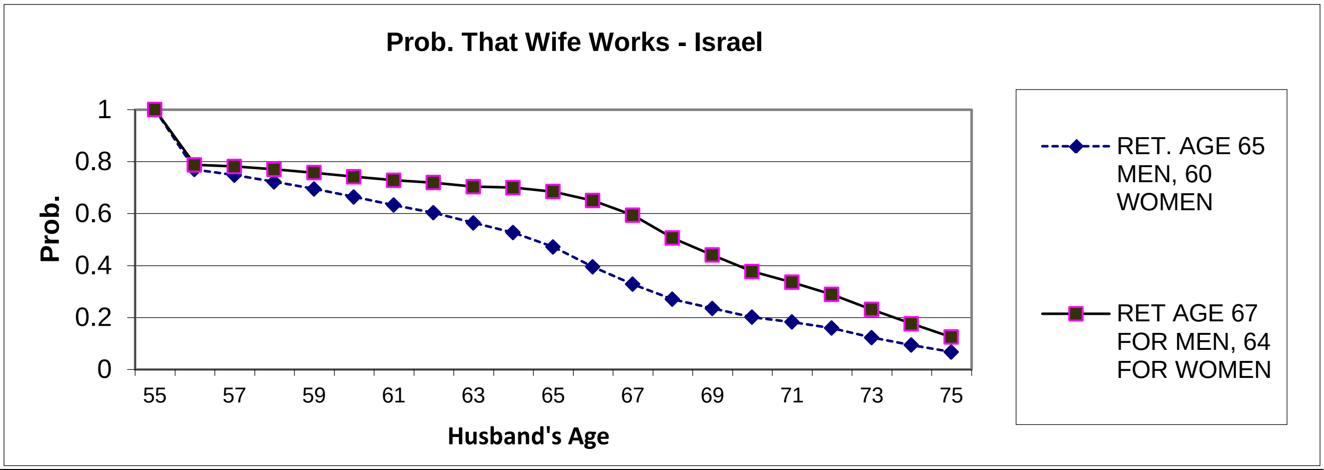
Graph US - 20



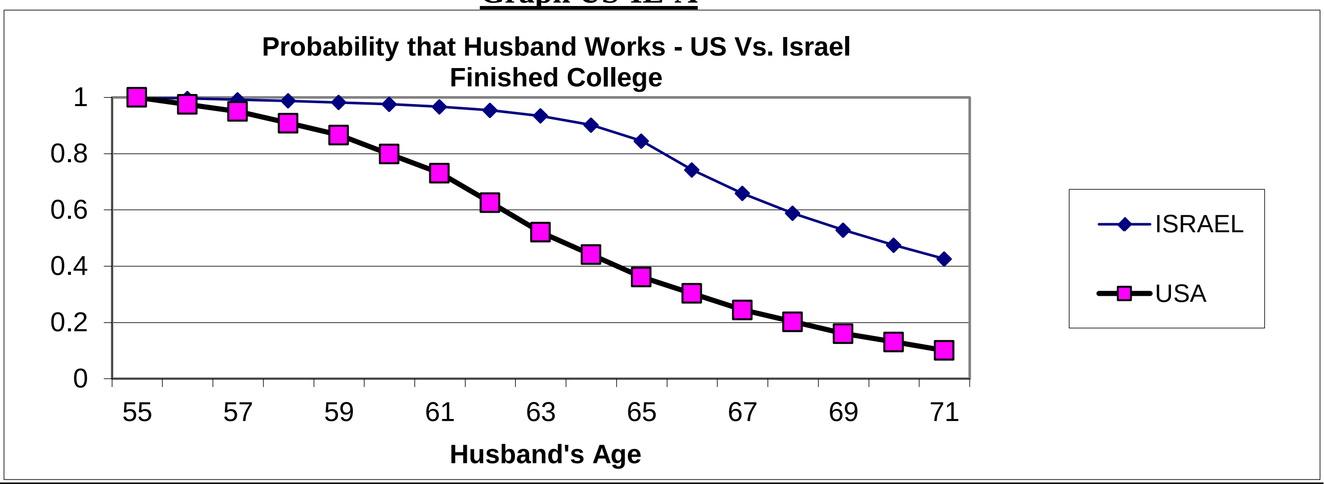
Graph IL - 19



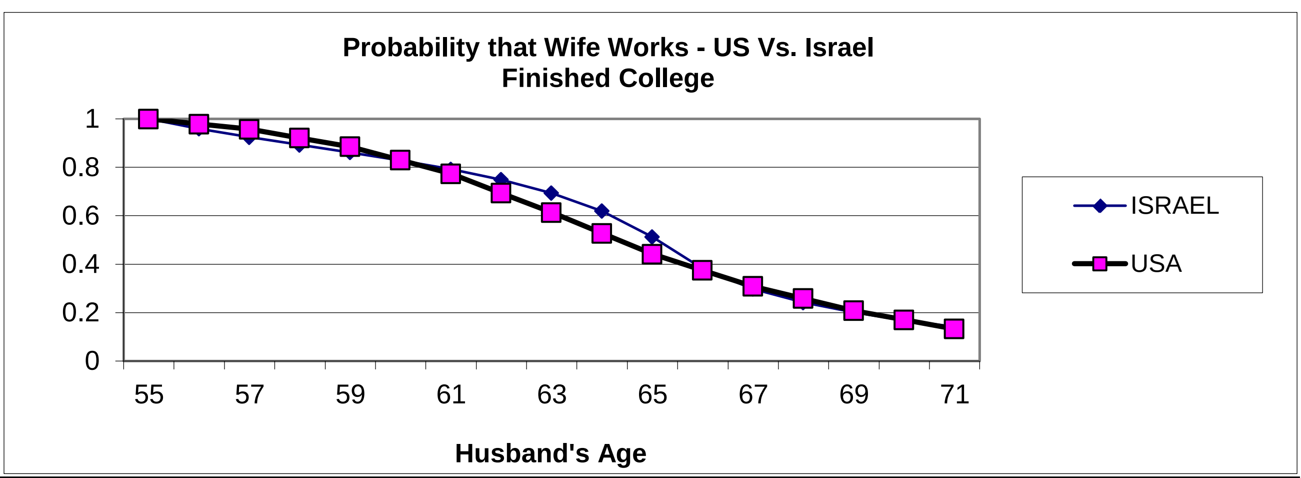
Graph 1L - 20



Graph US-IL-A



Graph US-IL-B



Appendix 2: Estimated Parameters

USA

Var. No.	VALUE	SE	T-value	NAME	Meaning	
1	-1.12303	0.008	-147	CONS(1)		**Work status 1 = Both Working**
2	-2.92239	0.038	-76.3	CONS(2)	Different Constants for Work Status 1 - 3 (relative to Work Status # 4, which is "Both Retired")	**Work status 2 - Only Husband working**
						Work status 3 = Only Wife working
3	-2.11001	0.006	-378	CONS(3)		**Work Status 4 = Both not working**
4	0.27374	0.016	17.59	ALFA0(1,1)		Both working, Both healthy
5	0.306879	0.027	11.37	ALFA0(1,2)		Both working, Husb. Healthy, wife sick
6	0.105612	0.014	7.604	ALFA0(1,3)		Both work, Wife healthy, husb. Sick
7	0.087124	0.041	2.116	ALFA0(2,1)		Only husb. Works, both healthy
8	0.101262	0.016	6.476	ALFA0(2,2)		Only husb works, husb. Healthy, wife sick
9	-0.05442	0.021	-2.62	ALFA0(2,3)		Only husb. Works, wife healthy, husb. Sick
10	0.125482	0.036	3.471	ALFA0(3,1)		Only wife works, both healthy
11	0.144222	0.032	4.45	ALFA0(3,2)	Constants for each (Work, Health) combination, relative to (Both retired, Both sick)	Only wife works, husb. Healthy, wife sick
12	0.083557	0.012	6.75	ALFA0(3,3)		Only wife works, Only wife healthy, husb. Sick

USA – Cont.

13	0.05205	0.012	4.421	ALFA1H(1,1)	Husband Education, age, etc. Dummy parameters for each of the HUSBAND's Education group, for each work status 1-3 (relative to (Less than High School, Both retired)	Husb. HS, both work
14	0.182372	0.018	10.08	ALFA1H(1,2)		Husb. HS, Only husb. Works
15	0.118743	0.019	6.171	ALFA1H(1,3)		Husb. HS, Only wife works
16	0.021452	0.015	1.438	ALFA1H(2,1)		Husb. Some college, both work
17	0.193025	0.028	6.857	ALFA1H(2,2)		Husb. Some college, only husb. Works
18	0.110618	0.031	3.594	ALFA1H(2,3)		Husb. Some college, Only wife works
19	0.083858	0.022	3.809	ALFA1H(3,1)		Husb. BA, both work
20	0.21372	0.015	14.24	ALFA1H(3,2)		Husb. BA, only husb. Works
21	0.0514	0.026	1.986	ALFA1H(3,3)		Husb BA, only wife works
22	0.038227	0.019	2.004	ALFA1H(4,1)		Husb. MA+, both work
23	0.310784	0.02	15.57	ALFA1H(4,2)		Husb. MA+, only husb. Works
24	0.099877	0.017	5.722	ALFA1H(4,3)		Husb. MA+, only wife works
25	0.033744	2E-04	162.6	ALFA2H(1)	Dummy parameters for HUSBAND's age, for each work status 1-3 (relative to "Both retired")	Parameter for husb. age, both work
26	0.047041	6E-04	77.99	ALFA2H(2)		Parameter for husb. age, Only husb. Works
27	0.060658	3E-04	230	ALFA2H(3)		Parameter for husb. age, Only wife works
28	0.005645	4E-04	12.88	ALFA3H(1)	Parameters for interaction between Husband's age & being over the legal retirement age (62), for each work status 1-3	
29	-0.00654	6E-04	-10.9	ALFA3H(2)		
30	-0.00433	3E-04	-14.8	ALFA3H(3)		

USA – Cont.

31	0.149004	0.012	12.73	ALFA1W(1,1)	Wife Education, age, etc.
32	-0.0329	0.023	-1.44	ALFA1W(1,2)	
33	0.058792	0.019	3.137	ALFA1W(1,3)	
34	0.124257	0.012	10.37	ALFA1W(2,1)	
35	-0.03696	0.026	-1.43	ALFA1W(2,2)	
36	0.065398	0.018	3.692	ALFA1W(2,3)	
37	0.196033	0.035	5.681	ALFA1W(3,1)	
38	0.028049	0.021	1.357	ALFA1W(3,2)	
39	0.026505	0.037	0.709	ALFA1W(3,3)	
40	0.140576	0.014	10.14	ALFA1W(4,1)	Dummy parameters for each of the WIFE's Education group, for each work status 1-3 (relative to (Less than High School, Both retired)
41	-0.06507	0.022	-2.93	ALFA1W(4,2)	
42	0.007742	0.027	0.291	ALFA1W(4,3)	
43	-0.01388	4E-04	-34.8	ALFA2W(1)	
44	-0.00182	5E-04	-3.64	ALFA2W(2)	
45	-0.02885	4E-04	-81.3	ALFA2W(3)	Parameters for WIFE's age, for work status 1-3
46	-0.00449	3E-04	-14.5	ALFA3W(1)	
47	0.004052	4E-04	9.909	ALFA3W(2)	
48	0.004308	2E-	21.62	ALFA3W(3)	Parameter for interaction between wife's age & wife's legal retirement age (60)

04

USA – Cont.

Misc. variables

49	-0.00102	0.018	-0.06	ALFA4(1)	
50	-0.01827	0.032	-0.57	ALFA4(2)	Parameters for "Husband more educated than wife", for each work status 1-3
51	-0.00846	0.029	-0.29	ALFA4(3)	
52	-0.0708	0.012	-6.14	ALFA5(1)	
53	0.052374	0.025	2.12	ALFA5(2)	Parameters for "Husband less educated than wife", for each work status 1-3
54	0.013288	0.012	1.1	ALFA5(3)	
55	-0.0429	0.009	-4.68	ALFA6(1)	
56	0.023893	0.02	1.212	ALFA6(2)	Parameters for "Husband more than 4 years older than wife", for each work status 1-3
57	-0.02116	0.018	-1.16	ALFA6(3)	
58	0.04526	0.049	0.917	ALFA7(1)	
59	-0.02297	0.041	-0.57	ALFA7(2)	
60	-0.00096	0.037	-0.03	ALFA7(3)	Parameters for "Wife same age as husband", for work status 1-3
61	0.000392	2E-04	1.823	ALFA8(1)	
62	-0.00019	6E-04	-0.34	ALFA8(2)	
63	-0.00033	1E-04	-2.26	ALFA8(3)	Parameter for "Age Difference Squared", for work status 1-3
64	-0.01196	0.051	-0.23	ALFA9(1)	Parameter for effect of HUSBAND being SELF-EMPLOYED, per Husband's age x being over legal retirement age, for each work status 1-3
65	-0.00087	0.039	-0.02	ALFA9(2)	
66	-0.00059	0.022	-0.03	ALFA9(3)	
67	-0.01279	6E-04	-20	ALFA9A(1)	
68	-0.00059	4E-04	-1.62	ALFA9A(2)	Parameter for effect of HUSBAND being on a SALARY, per Husband's age x being over legal retirement age, for each work status 1-3
69	0.000014	5E-04	0.028	ALFA9A(3)	

70	0.003202	0.018	0.178	ALFA10(1)	
71	-0.00304	0.016	-0.18	ALFA10(2)	Parameter for effect of WIFE being SELF-EMPLOYED per Wife's age x
72	-0.00408	0.027	-0.15	ALFA10(3)	Being over legal retirement age, for each work status 1-3
73	0.003128	4E-04	6.985	ALFA10A(1)	
74	-0.00171	5E-04	-3.42	ALFA10A(2)	Parameter for effect of WIFE being on a SALARY, per wife's age x
75	-0.0026	5E-04	-4.92	ALFA10A(3)	being over legal retirement age, for each work status 1-3
				USA – Cont.	
76	-0.00776	4E-04	-18.4	ALFA11(1)	
77	-0.00636	4E-04	-15.3	ALFA11(2)	Parameters for interaction between Husband's legal retirement age x
78	-0.00149	3E-04	-4.58	ALFA11(3)	whether eligible for PENSION x husband's age
79	-0.00298	2E-04	-14.4	ALFA12(1)	
80	-0.00293	5E-04	-5.65	ALFA12(2)	Parameters for interaction between Wife's legal retirement age x
81	-0.00692	3E-04	-21.7	ALFA12(3)	whether eligible for PENSION x Wife's age

ISRAEL Parameters

Var. No.	VALUE	SE	T-value	NAME	Meaning	
1	-6.72817	0.07	-96.4	CONS(1)		**Work status 1 = Both Working**
2	-3.1807	0.135	-23.6	CONS(2)	Different Constants for Work Status 1 - 3 (relative to Work Status # 4, which is "Both Retired")	**Work status 2 - Only Husband working**
						Work status 3 = Only Wife working
3	-3.21848	0.157	-20.5	CONS(3)		**Work Status 4 = Both not working**
4	-0.02677	0.125	-0.21	ALFA0(1,1)		Both working, Both healthy
5	-0.15377	0.185	-0.83	ALFA0(1,2)		Both working, Husb. Healthy, wife sick
6	-0.18995	0.137	-1.39	ALFA0(1,3)		Both work, Wife healthy, husb. Sick
7	0.241882	0.113	2.146	ALFA0(2,1)		Only husb. Works, both healthy
8	0.127943	0.153	0.835	ALFA0(2,2)		Only husb works, husb. Healthy, wife sick
9	0.032855	0.123	0.268	ALFA0(2,3)		Only husb. Works, wife healthy, husb. Sick
10	0.410135	0.217	1.887	ALFA0(3,1)	Constants for each (Work, Health) combination, relative to (Both retired, Both sick)	Only wife works, both healthy
11	0.313188	0.252	1.245	ALFA0(3,2)		Only wife works, husb. Healthy, wife sick
12	0.314184	0.23	1.366	ALFA0(3,3)		Only wife works, Only wife healthy, husb. Sick

Israel – Cont.

Husband

Education, age, etc.

13	-0.15836	0.096	-1.65	ALFA1H(1,1)	Dummy parameters for each of the HUSBAND's Education group, for each work status 1-3 (relative to (Less than High School, Both retired)	Husb. HS, both work
14	-0.10808	0.121	-0.9	ALFA1H(1,2)		Husb. HS, Only husb. Works
15	-0.25881	0.122	-2.12	ALFA1H(1,3)		Husb. HS, Only wife works
16	-0.15936	0.138	-1.16	ALFA1H(2,1)		Husb. Some college, both work
17	-0.0768	0.197	-0.39	ALFA1H(2,2)		Husb. Some college, only husb. Works
18	-0.36513	0.219	-1.67	ALFA1H(2,3)		Husb. Some college, Only wife works
19	-0.19719	0.178	-1.11	ALFA1H(3,1)		Husb. BA, both work
20	0.06473	0.244	0.265	ALFA1H(3,2)		Husb. BA, only husb. Works
21	-0.3871	0.249	-1.55	ALFA1H(3,3)		Husb BA, only wife works
22	-0.16257	0.244	-0.67	ALFA1H(4,1)		Husb. MA+, both work
23	0.128917	0.322	0.401	ALFA1H(4,2)		Husb. MA+, only husb. Works
24	-0.41018	0.308	-1.33	ALFA1H(4,3)		Husb. MA+, only wife works
25	0.060744	0.012	5.264	ALFA2H(1)	Dummy parameters for HUSBAND's age, for each work status 1-3 (relative to "Both retired")	Parameter for husb. age, both work
26	0.015769	0.007	2.235	ALFA2H(2)		Parameter for husb. age, Only husb. Works
27	0.00797	0.008	0.998	ALFA2H(3)		Parameter for husb. age, Only wife works
28	-0.00838	0.043	-0.2	ALFA3H(1)	Parameters for interaction between Husband's age & being over the legal retirement age (62), for each work status 1-3	
29	-0.00508	0.029	-0.18	ALFA3H(2)		
30	-0.00604	0.004	-1.41	ALFA3H(3)		

Israel – Cont.

31	0.217081	0.089	2.432	ALFA1W(1,1)	
32	0.066624	0.113	0.59	ALFA1W(1,2)	
33	0.277983	0.124	2.24	ALFA1W(1,3)	
34	0.333265	0.151	2.205	ALFA1W(2,1)	
35	0.10651	0.183	0.583	ALFA1W(2,2)	Wife Education, age, etc.
36	0.511503	0.207	2.474	ALFA1W(2,3)	
37	0.323846	0.167	1.934	ALFA1W(3,1)	
38	-0.0033	0.228	-0.01	ALFA1W(3,2)	
39	0.336904	0.236	1.429	ALFA1W(3,3)	
40	0.436014	0.247	1.766	ALFA1W(4,1)	Dummy parameters for each of the WIFE's Education group, for each work status 1-3 (relative to (Less than High School, Both retired)
41	-0.27524	0.426	-0.65	ALFA1W(4,2)	
42	0.736964	0.299	2.461	ALFA1W(4,3)	
43	0.060501	0.013	4.541	ALFA2W(1)	
44	0.040074	0.005	7.616	ALFA2W(2)	Parameters for WIFE's age, for work status 1-3
45	0.044329	0.005	9.809	ALFA2W(3)	
46	-0.07234	0.003	-28.3	ALFA3W(1)	
47	0.002606	0.002	1.086	ALFA3W(2)	Parameter for interaction between wife's age & wife's legal retirement age (60)
48	-0.03216	0.005	-6.69	ALFA3W(3)	

Israel – Cont.

49	0.125133	0.1	1.255	ALFA4(1)	
50	-0.04291	0.127	-0.34	ALFA4(2)	Parameters for "Husband more educated than wife", for each work status 1-3
51	0.146519	0.125	1.175	ALFA4(3)	
52	-0.17532	0.1	-1.75	ALFA5(1)	
53	-0.02721	0.126	-0.22	ALFA5(2)	Parameters for "Husband less educated than wife", for each work status 1-3
54	-0.29075	0.136	-2.13	ALFA5(3)	
55	0.015486	0.067	0.233	ALFA6(1)	
56	0.00954	0.069	0.139	ALFA6(2)	Parameters for "Husband more than 4 years older than wife", for each work status 1-3
57	-0.00573	0.092	-0.06	ALFA6(3)	
58	-0.20719	0.102	-2.03	ALFA7(1)	
59	-0.31356	0.085	-3.67	ALFA7(2)	Parameters for "Wife same age as husband", for work status 1-3
60	-0.24154	0.129	-1.87	ALFA7(3)	
61	0.003945	0.001	2.938	ALFA8(1)	
62	0.002819	0.001	2.67	ALFA8(2)	Parameter for "Age Difference Squared", for work status 1-3
63	0.003326	0.001	3.098	ALFA8(3)	
64	-0.01641	0.043	-0.39	ALFA9(1)	
65	-0.01228	0.029	-0.42	ALFA9(2)	Parameter for effect of HUSBAND being SELF-EMPLOYED, per Husband's age x being over legal retirement age, for each work status 1-3
66	-0.00301	0.003	-0.86	ALFA9(3)	
67	-0.01404	0.042	-0.33	ALFA9A(1)	
68	-0.00944	0.029	-0.33	ALFA9A(2)	Parameter for effect of HUSBAND being on a SALARY, per Husband's age x being over legal retirement age, for each work status 1-3
69	-0.00432	0.004	-1.01	ALFA9A(3)	
70	0.067795	0.003	24.49	ALFA10(1)	Parameter for effect of WIFE being SELF-EMPLOYED per Wife's age x Being over
71	-0.00059	0.001	-0.53	ALFA10(2)	

Misc. variables

72	0.028401	0.005	5.98	ALFA10(3)	legal retirement age, for each work status 1-3
73	0.071121	0.003	24.1	ALFA10A(1)	Parameter for effect of WIFE being on a SALARY, per wife's age x being over legal retirement age, for each work status 1-3
74	-0.00094	0.002	-0.46	ALFA10A(2)	
75	0.026663	0.007	3.942	ALFA10A(3)	

Israel – Cont.

76	0.002554	0.002	1.188	ALFA11(1)	Parameters for interaction between Husband's legal retirement age x whether eligible for pension x husband's age
77	0.001975	0.002	1.045	ALFA11(2)	
78	-0.01169	0.013	-0.88	ALFA11(3)	
79	0.000586	0.002	0.292	ALFA12(1)	Parameters for interaction between Wife's legal retirement age x whether eligible for pension x Wife's age
80	-0.0016	0.002	-0.94	ALFA12(2)	
81	0.002577	0.002	1.046	ALFA12(3)	

Appendix 3: Tables

Table US-1

Husb. age	No. of Obs.	Avg. Wife's age	Fraction Husband retired	Fraction Wife retired	Fraction both retired	Fraction both working	No. both retired	No. both working	No of Husb. Retired	No of Wife Retired	No. of husband seriously sick	No. of wife seriously sick	Frac. Of Husband seriously sick	Frac. Of Wife seriously sick
55	975	51.9	0.11	0.17	0.00	0.72	0	705	107	163	162	141	0.17	0.14
56	999	52.8	0.15	0.19	0.00	0.66	0	664	148	187	171	165	0.17	0.17
57	903	53.9	0.20	0.20	0.04	0.65	39	583	177	182	196	161	0.22	0.18
58	872	54.7	0.23	0.26	0.06	0.57	50	498	200	224	211	164	0.24	0.19
59	795	55.9	0.30	0.25	0.09	0.55	73	434	235	199	208	161	0.26	0.20
60	755	56.6	0.31	0.32	0.11	0.49	86	367	235	239	193	172	0.26	0.23
61	714	58.0	0.41	0.36	0.20	0.43	144	307	295	256	219	165	0.31	0.23
62	625	58.5	0.50	0.40	0.24	0.35	152	216	314	247	209	173	0.33	0.28
63	576	59.6	0.59	0.48	0.35	0.27	199	158	340	277	201	143	0.35	0.25
64	545	60.5	0.63	0.50	0.36	0.23	197	123	346	273	200	162	0.37	0.30
65	509	61.7	0.71	0.58	0.45	0.16	229	81	363	294	201	145	0.39	0.28
66	490	62.3	0.75	0.60	0.49	0.13	239	66	369	294	208	152	0.42	0.31
67	404	63.2	0.79	0.65	0.55	0.10	222	42	320	264	179	128	0.44	0.32
68	333	64.4	0.82	0.67	0.57	0.08	191	28	272	224	156	110	0.47	0.33
69	245	65.2	0.84	0.71	0.63	0.07	155	18	207	175	111	86	0.45	0.35
70	210	66.3	0.82	0.74	0.63	0.07	133	15	173	155	105	70	0.50	0.33
71	103	67.0	0.88	0.68	0.63	0.07	65	7	91	70	53	36	0.51	0.35
72	80	68.4	0.90	0.83	0.74	0.01	59	1	72	66	43	22	0.54	0.28

Table US2 – Education Levels – Numbers

Husband / Wife --->	Less than HS	High School	Some College	Finished College	MA + PHD	Husband Totals:
Less than High School	156	97	38	3	5	299
Finished High School	73	309	138	17	20	557
Some College	31	154	134	34	39	392
Finished College	5	64	96	66	42	273
MA + PHD	2	42	67	85	124	320
Wife Totals:	267	666	473	205	230	1841

Table US3 – Education Levels /Percentages

Husband / Wife --->	Less than HS	High School	Some College	Finished College	MA + PHD	Husband Totals:
Less than High School	**0.08**	**0.05**	**0.02**	**0.00**	**0.00**	0.16
Finished High School	**0.04**	**0.17**	**0.07**	**0.01**	**0.01**	0.30
Some College	**0.02**	**0.08**	**0.07**	**0.02**	**0.02**	0.21
Finished College	**0.00**	**0.03**	**0.05**	**0.04**	**0.02**	0.15
MA + PHD	**0.00**	**0.02**	**0.04**	**0.05**	**0.07**	0.17
Wife Totals:	0.15	0.36	0.26	0.11	0.12	1.00

Table US4 - Whether Husband/Wife are Eligible for a Pension

Husband / Wife --->	Eligible	Not Eligible	Husband Totals:
Eligible	680	439	1119
Not Eligible	228	494	722
	908	933	1841

Husband / Wife --->	Eligible	Not Eligible	Husband Totals:
Eligible	0.37	0.24	0.61
Not Eligible	0.12	0.27	0.39
Wife's Totals:	0.49	0.51	1.00

Table US5 – Health Transitions

Probabilities of transition from one health state to another, per Husband's age

	No of Husb. That became sick	% of Husbands that became Seriously Sick	No of wives that became sick	% of Wives that became Seriously Sick
55	18	0.02	10	0.01
56	16	0.02	6	0.01
57	10	0.01	6	0.01
58	7	0.01	5	0.01
59	10	0.01	9	0.01
60	14	0.02	6	0.01
61	12	0.02	2	0.00
62	6	0.01	1	0.00
63	6	0.01	4	0.01
64	6	0.01	2	0.00
65	4	0.01	1	0.00
66	3	0.01	0	0.00
67	1	0.00	1	0.00
68	2	0.01	2	0.01
69	0	0.00	0	0.00
70	0	0.00	0	0.00
71	0	0.00	0	0.00
72	0	0.00	0	0.00

Table IL1

Husb. age	No. of Obs.	Avg. Wife's age	Frac. Both working	Fract. Husb. Only works (wife retired)	Fract. Wife only works (Husb. Retired)	Frac. Both retired	No. both working	No. Husb. Only works	No. wife only works	No. both retired	No. of husband seriously sick	No. of wife seriously sick	Frac. Of Husband seriously sick	Frac. Of Wife seriously sick
55	15	51.5	0.53	0.33	0.13	0.00	8	5	2	0	0	0	0.00	0.00
56	32	53.1	0.63	0.19	0.19	0.00	20	6	6	0	6	2	0.19	0.06
57	72	55.0	0.76	0.14	0.04	0.06	55	10	3	4	18	3	0.25	0.04
58	68	55.1	0.81	0.07	0.12	0.00	55	5	8	0	20	4	0.29	0.06
59	110	56.1	0.68	0.09	0.20	0.03	75	10	22	3	18	5	0.16	0.05
60	114	56.8	0.69	0.14	0.15	0.02	79	16	17	2	23	5	0.20	0.04
61	105	58.4	0.72	0.23	0.03	0.02	76	24	3	2	36	8	0.34	0.08
62	96	57.7	0.63	0.15	0.19	0.04	60	14	18	4	31	0	0.32	0.00
63	99	59.4	0.35	0.48	0.12	0.04	35	48	12	4	26	9	0.26	0.09
64	90	59.3	0.46	0.26	0.09	0.20	41	23	8	18	25	10	0.28	0.11
65	165	61.7	0.55	0.27	0.04	0.14	91	44	7	23	27	28	0.16	0.17
66	156	61.4	0.78	0.19	0.00	0.03	121	30	0	5	10	23	0.06	0.15
67	195	63.9	0.58	0.04	0.27	0.11	113	7	53	22	45	21	0.23	0.11
68	252	63.5	0.47	0.18	0.17	0.17	119	46	43	44	48	120	0.19	0.48
69	345	65.5	0.49	0.20	0.14	0.17	169	69	48	59	105	66	0.30	0.19
70	192	65.3	0.36	0.38	0.08	0.17	70	73	16	33	31	25	0.16	0.13
71	153	68.9	0.36	0.29	0.14	0.22	55	44	21	33	29	0	0.19	0.00
72	342	65.7	0.37	0.25	0.11	0.27	127	85	38	92	96	44	0.28	0.13
73	190	69.2	0.41	0.27	0.06	0.27	77	51	11	51	40	33	0.21	0.17
74	200	69.5	0.22	0.25	0.18	0.36	44	50	35	71	45	20	0.23	0.10
75	252	68.8	0.29	0.21	0.15	0.35	72	53	39	88	129	76	0.51	0.30

Table IL2 & IL3 – Education Levels/Percentages

Husband / Wife --->	Less than HS	High School	Some College	Finished College	MA + PHD	Totals:
Less than High School	69	40	11	3	0	123
Finished High School	26	62	17	13	5	123
Some College	10	27	10	9	2	58
Finished College	4	13	10	14	7	48
MA + PHD	1	5	6	8	18	38
Totals:	110	147	54	47	32	390

Husband / Wife --->	Less than HS	High School	Some College	Finished College	MA + PHD	Husband Totals:
Less than High School	**0.18**	**0.10**	**0.03**	**0.01**	**0.00**	0.32
Finished High School	**0.07**	**0.16**	**0.04**	**0.03**	**0.01**	0.32
Some College	**0.03**	**0.07**	**0.03**	**0.02**	**0.01**	0.15
Finished College	**0.01**	**0.03**	**0.03**	**0.04**	**0.02**	0.12
MA + PHD	**0.00**	**0.01**	**0.02**	**0.02**	**0.05**	0.10
Wife Totals:	0.28	0.38	0.14	0.12	0.08	1.00

Table IL4 – Whether Husband and/or Wife are Entitled to a Pension

Husband / Wife --->	Eligible	Not Eligible	Husband Totals:
Eligible(==1)	150	27	177
Not Eligible(==0)	31	182	213
	181	209	390

Husband / Wife --->	Eligible	Not Eligible	Husband Totals:
Eligible	0.38	0.07	0.45
Not Eligible	0.08	0.47	0.55
Wife's Totals:	0.46	0.54	

Table IL5 – Health Transitions

Probabilities of transition from one health state to another, per Husband's age

Husband's age	Total No.of couples	Husband Healthy	Husband became Seriously Sick	% of Husbands who became sick		Wife healthy	No. of Wives who became sick	% of Wives who became sick
55	15	15				15		
56	32	26	0	0.00		30	0	0.00
57	72	54	0	0.00		69	0	0.00
58	68	48	0	0.00		64	0	0.00
59	110	92	3	0.06		105	3	0.03
60	114	91	2	0.02		109	1	0.01
61	105	69	2	0.02		97	2	0.02
62	96	65	2	0.03		96	0	0.00
63	99	73	1	0.02		90	0	0.00
64	90	65	1	0.01		80	0	0.00
65	165	138	3	0.05		137	1	0.01
66	156	146	1	0.01		133	1	0.01
67	195	150	4	0.03		174	1	0.01
68	252	204	4	0.03		132	4	0.03
69	345	240	4	0.02		279	2	0.01
70	192	161	2	0.01		167	3	0.02
71	153	124	2	0.01		153	0	0.00
72	342	246	10	0.08		298	2	0.01
73	190	150	4	0.02		157	2	0.01
74	200	155	5	0.03		180	0	0.00
75	252	123	4	0.03		176	3	0.02

Appendix 4: Calculation of Health Transition Probabilities

For those who were healthy at their first observation, the probability to move from being healthy to moderately or to seriously sick is given by:

$$\Pr(D_{it} = k) = \frac{\exp(A_{kit})}{1 + \exp(\sum_{j=1}^{5} \alpha_j Ed_{jit} + \alpha_6 Age_{it}) + \exp(\sum_{j=1}^{5} \beta_j Ed_{jit} + \beta_6 Age_{it})}$$

Where:

k=1 if the spouse stays healthy in the next observation[16].
k=2 if the spouse becomes moderately sick in the next observation.
k=3 if the spouse becomes seriously sick in the next observation.

$A_{1it} = 1$, for k=1.

$A_{1it} = \alpha_j Ed_{jit} + \alpha_6 Age_{it}$, for k=2.

$A_{1it} = \beta_j Ed_{jit} + \beta_6 Age_{it}$, for k=3

Ed_{jit} - a dummy variable that equals 1 if the education of the spouse belongs to category j, 0 otherwise (the education was partitioned to 5 levels).

Age_{it} - the age of the spouse.

For those who were moderately sick at their first observation or became moderately sick after that, the probability to move from being moderately sick to being seriously sick is given by:

$$\Pr(D_{it} = k) = \frac{\exp(A_{kit})}{1 + \exp(\sum_{j=1}^{5} \gamma_j Ed_{jit} + \gamma_6 Age_{it})}$$

Where:

k=1 if the spouse stays moderately sick in the next observation.
k=2 if the spouse becomes seriously sick in the next observation.

$A_{1it} = 1$, for k=1.

$A_{1it} = \gamma_j Ed_{jit} + \gamma_6 Age_{it}$, for k=2.

[16] The observations for USA are every other year. The observations for Israel are in every year.

It is important to note that in order to get from the multinomial /logit results that represents the hazard rates, we keep (for this estimation) for every spouse the all observations in which her/his health status did not change and only the first observation after the change (if occurs).

Appendix 4a – Results of Regressions for Health Transition Probabilities

A. Regression of Transition from Healthy to Moderately Sick and to Seriously Sick – Husbands - USA

1) Regression from Healthy to Moderately Sick

Explaining Factor	Coef.	Std. Err.	Z	P>|z|	[95% conf. interval]	
Age	-0.0197931	0.0183392	-1.08	0.28	-0.0557373	0.016151
Finished HS	-0.0563095	0.1888087	-0.3	0.766	-0.4263677	0.3137488
Some College	-0.0738911	0.2040778	-0.36	0.717	-0.4738762	0.326094
Finished College	-0.2856925	0.2226976	-1.28	0.2	-0.7221717	0.1507868
MA + PHD	-0.3393855	0.2058384	-1.65	0.099	-0.7428214	0.0640505
Constant	-0.3121016	1.119111	-0.28	0.78	-2.505519	1.881316

2) Regression from Healthy to Seriously Sick

Explaining Factor	Coef.	Std. Err.	Z	P>|z|	[95% conf. interval]	
Age	0.0619317	0.0255954	2.42	0.016	0.0117657	0.1120978
Finished HS	0.3010604	0.3361176	0.9	0.37	-0.357718	0.9598388
Some College	0.4070603	0.35318	1.15	0.249	-0.2851598	1.09928
Finished College	0.3000751	0.3713929	0.81	0.419	-0.4278416	1.027992
MA + PHD	0.3250318	0.3461483	0.94	0.348	-0.3534065	1.00347
Constant	-6.698687	1.599018	-4.19	0	-9.832705	-3.564669

3) Regression from Moderately Sick to Seriously Sick

Explaining factor	Coef.	Std. Err.	Z	P>|z|	[95% conf. interval]	
Age	0.0974352	0.0116646	8.35	0	0.07457	0.1202974
Finished HS	0.0323711	0.1422334	0.23	0.82	-0.2464	0.3111434
Some College	0.1625433	0.1559055	1.04	0.297	-0.143	0.4681126
Finished College	0.1165517	0.1787969	0.65	0.514	-0.2339	0.4669871
MA + PHD	0.2721474	0.1613849	1.69	0.092	-0.0442	0.5884559
Constant	-8.122143	0.7473056	-10.87	0	-9.5868	-6.657451

B. Regression of Transition from Healthy to Moderately Sick and to Seriously Sick – Wives – USA

1) Transition from Healthy to Moderately Sick

Explaining factor	Coef.	Std. Err.	Z	P>|z|	[95% conf. interval]	
Wife's age	0.026053	0.0093919	2.77	0.006	0.0076452	0.0444609
Wife finished HS	0.1505652	0.1950811	0.77	0.44	-0.2317867	0.5329171
Some college	-0.0719013	0.2086464	-0.34	0.73	-0.4808407	0.3370381
Wife finished college	0.0114795	0.2326311	0.05	0.961	-0.444469	0.467428
Wife - MA + PHD	0.1318072	0.2252121	0.59	0.558	-0.3096004	0.5732148
Constant	-3.133807	0.5529059	-5.67	0	-4.217483	-2.050132

2) Transition from Healthy to Seriously Sick

Explaining factor	Coef.	Std. Err.	Z	P>|z|	[95% conf. interval]	
Wife's age	0.0402248	0.0229916	1.75	0.08	-0.0048378	0.0852875
Wife finished HS	-0.2350237	0.4870091	-0.48	0.629	-1.189544	0.7194965
Some college	0.0665833	0.4906652	0.14	0.892	-0.8951028	1.028269
Wife finished college	0.3140177	0.5249824	0.6	0.55	-0.7149289	1.342964
Wife - MA + PHD	0.2687998	0.524776	0.51	0.608	-0.7597423	1.297342
Constant	-5.829912	1.365949	-4.27	0	-8.507122	-3.152702

3) Transition from Moderately Sick to Seriously Sick

Explaining factor	Coef.	Std. Err.	Z	P>|z|	[95% conf. interval]	
Wife's age	0.0166701	0.0132475	1.26	0.208	-0.0092944	0.0426347
Wife finished HS	-0.044432	0.2068153	-0.21	0.83	-0.4497825	0.3609184
Some college	-0.2237346	0.2287791	-0.98	0.328	-0.6721333	0.2246642
Wife finished college	-0.9089379	0.3790989	-2.4	0.017	-1.651958	-0.1659176
Wife - MA + PHD	-0.5701696	0.3143263	-1.81	0.07	-1.186238	0.0458986
Constant	-3.928639	0.8084898	-4.86	0	-5.51325	-2.344028

For both men and women, these results indicate that only age is a statistically significant factor in the probability to become sick, or to move from status of “moderately sick” to “seriously sick”.

C. Regression of Transition from Healthy to Moderately Sick and to Seriously Sick – Husbands - ISRAEL

1) Regression from Healthy to Moderately Sick

Explaining Factor	Coef.	Std. Err.	Z	P>|z|	[95% conf.	interval]
Finished HS	0.4114451	0.2448532	1.68	0.093	-0.0684583	0.8913486
Some College	0.7259332	0.2829343	2.57	0.01	0.171392	1.280474
Finished College	0.463889	0.2862398	1.62	0.105	-0.0971307	1.024909
MA + PHD	0.0755596	0.3191583	0.24	0.813	-0.5499792	0.7010985
Age	0.0520225	0.0132283	3.93	0	0.0260954	0.0779495
Constant	-6.470523	0.8688984	-7.45	0	-8.173533	-4.767514

2) Regression from Healthy to Seriously Sick

Explaining Factor	Coef.	Std. Err.	Z	P>|z|	[95% conf.	interval]
Finished HS	0.3809823	0.4228673	0.9	0.368	-0.4478224	1.209787
Some College	0.9482299	0.4441283	2.14	0.033	0.0777544	1.818705
Finished College	0.7439357	0.442668	1.68	0.093	-0.1236776	1.611549
MA + PHD	0.7223755	0.4383232	1.65	0.099	-0.1367222	1.581473
Age	0.0365011	0.0222238	1.64	0.101	-0.0070568	0.0800591
Constant	-6.609138	1.444197	-4.58	0	-9.439712	-3.778563

3) Regression from Moderately Sick to Seriously Sick

Explaining factor	Coef.	Std. Err.	Z	P>|z|	[95% conf. interval]	
Finished HS	0.0950917	0.345204	0.28	0.783	-0.5814956	0.7716791
Some College	0.2576684	0.3847963	0.67	0.503	-0.4965185	1.011855
Finished College	-0.0305989	0.3967652	-0.08	0.939	-0.8082444	0.7470465
MA + PHD	0.7135503	0.4351701	1.64	0.101	-0.1393673	1.566468
Age	0.0527359	0.0175758	3	0.003	0.018288	0.0871838
Constant	-7.260231	1.205397	-6.02	0	-9.622767	-4.897696

D. Regression of Transition from Healthy to Moderately Sick and to Seriously Sick – Wives – ISRAEL

1) Transition from Healthy to Moderately Sick

Explaining factor	Coef.	Std. Err.	Z	P>|z|	[95% conf. interval]	
Wife finished HS	-0.0608116	0.1868412	-0.33	0.745	-0.4270136	0.3053905
Some college	0.0056162	0.2382449	0.02	0.981	-0.4613352	0.4725675
Wife finished college	0.5861282	0.2677208	2.19	0.029	0.061405	1.110851
Wife - MA + PHD	-0.0150493	0.3225091	-0.05	0.963	-0.6471554	0.6170569
Wife's Age	0.0685994	0.0107911	6.36	0	0.0474491	0.0897496
Constant	-6.795739	0.6450468	-10.54	0	-8.060007	-5.53147

2) Transition from Healthy to Seriously Sick

Explaining factor	Coef.	Std. Err.	Z	P>|z|	[95% conf. interval]	
Wife finished HS	-0.5933245	0.542279	-1.09	0.274	-1.656172	0.4695229
Some college	0.0336301	0.5917289	0.06	0.955	-1.126137	1.193397
Wife finished college	-0.6938568	1.05005	-0.66	0.509	-2.751917	1.364203
Wife - MA + PHD	-0.7134335	1.047289	-0.68	0.496	-2.766082	1.339215
Wife's Age	0.0312387	0.0301855	1.03	0.301	-0.0279237	0.0904012
Constant	-6.467574	1.746192	-3.7	0	-9.890049	-3.0451

3) Transition from Moderately Sick to Seriously Sick

Explaining factor	Coef.	Std. Err.	Z	P>|z|	[95% conf. interval]	
Wife finished HS	-0.8657572	0.4773848	-1.81	0.07	-1.801414	0.0698997
Some college	-0.9895108	0.6289308	-1.57	0.116	-2.222192	0.2431708
Wife finished college	-1.337746	0.7499485	-1.78	0.074	-2.807618	0.1321263
Wife - MA + PHD	-0.1465704	0.7557887	-0.19	0.846	-1.627889	1.334748
Wife's Age	0.0373717	0.026437	1.41	0.157	-0.0144439	0.0891873
Constant	-6.354721	1.663009	-3.82	0	-9.614159	-3.095283

In Israel the results are similar, however the education level is in some cases closer to being a determinant factor in the health transition, for both men and women.