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Working Paper Series
La Follette School Working Paper No. 2000-003
http://www.lafollette.wisc.edu/publications/workingpapers

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April 3, 2000

1. Introduction

Since the mid-1980s there have been numerous studies concerned with estimating dynamic models of welfare participation. These studies have focused on estimating the determinants of the distribution of spell lengths by parameterizing the AFDC exit rate. Generally, the AFDC exit rate is specified as a function of labor market, policy, and demographic variables. Although results vary, several findings are consistent across studies. Among these findings are that the level of the AFDC guarantee is negatively related to AFDC exit rates, black women have lower exit rates than white women, women with higher education have higher exit rates from AFDC, and women with young children experience lower AFDC exit rates and longer spells.

This paper extends the literature on the dynamics of AFDC participation by using monthly data from the Survey of Income and Program Participation to estimate a structural competing risk model of AFDC spells based on the theory of search. Because transitions from the AFDC program occur due to earnings increases, marriage, and a myriad of other reasons, the standard job search model is modified to allow for search in the marriage market as well as residual transitions from AFDC.

Explicit in this search perspective is the distinction between the random and the behavioral components of AFDC exit. In models of job search, job offers are assumed to arrive at rate l. For each offer that arrives the unemployed worker must make a decision regarding whether of not the offer is to be accepted. Offers are accepted if, and only if, they are in excess of the workers reservation wage. Given the structure of these models the unemployment hazard can be written as $l[1-F(R)]$, where the distribution function F characterizes the distribution of wage offers. The job offer arrival rate can be thought of as the chance component of the unemployment hazard while the decision whether or not to accept the offer can be thought of as the choice, or behavioral, component of the unemployment hazard.

In the context of the search process that individuals engage in while on welfare there are offer arrival rates and reservation income levels for the labor and the marriage markets. The offer arrival rates in the job and marriage markets are the chance components of AFDC exit while the decision to accept job and marriage offers are the behavioral components of AFDC exit. Although structural estimation of AFDC exit rates has potential difficulties and imposes severe restrictions on the data, it has the potential to provide insights that are not available with a reduced form approach. More specifically, the structural approach to estimating the AFDC exit rates allows for identification of the choice and chance components of AFDC exit rates. The identification of the choice and chance components of spell endings makes it possible to assess the extent to which continued participation in the AFDC program is a choice, thus assisting policy makers in designing programs to hasten exit from welfare.

The outline of the remainder of this paper is as follows. In Section 2 the relevant literature on job and marital search is reviewed. Because there is large bodies of literature devoted to these subjects and the focus of this analysis is on structural estimation, emphasis is placed on studies that attempt structural estimation of the parameters of job or marital search or provide direct information on the search behavior of welfare recipients. In Section 3 a theoretical model of search while on AFDC is presented. This model will serve as a basis for the structural estimation that is described in Section 4. The data used in this paper is described in Section 5. In Section 6 estimates of the structural competing risk model of AFDC durations are presented and discussed. In Section 7 the impact of a lifetime limit on welfare benefits is examined. Section 8 concludes this paper.

2. Literature Review

While estimates of the structural parameters of search while on AFDC do not exist, there has been extensive work on estimating structural job search models that differentiate between the choice and chance components of the unemployment hazard (see Devine and Kiefer (1991) for a summary of this literature). Most of this literature makes use of European data so it is not clear whether the results can be generalized to the United States. The general finding among the studies that estimate structural job search models using European data is that job offer arrival rates are low and job offer acceptance probabilities are high. Van den Berg (1990), using data from the Netherlands Socio-Economic Panel, estimates that on average the expected number of offers a week is 0.012 while the probability of accepting an offer is 0.97. Estimates by Narendranathal and Nickel (1988) obtained from the Cohort Study of the Unemployed (United

Kingdom) are somewhat less dramatic. They estimate that, on average, 0.018 offers arrive per day and that the probability of accepting an offer is 0.57.

While there has been much work on the estimation of structural job search models there has been relatively little work on estimating the parameters of marital search. The only study that attempts to estimate anything like an offer arrival rate or reservation product for marital search was conducted by van der Klaauw (1996). Using a dynamic discrete choice framework and data from the Panel Study of Income Dynamics (PSID), van der Klaauw estimates that the yearly probability of a marriage offer is approximately 0.80 through the sample mean. Van der Klaauw's estimates indicate that offer arrival probabilities are negatively correlated with age, education, being nonwhite, and residing in the South. The implication of Van der Klaauw's estimates is that the probability of accepting any given marriage offer is low. For an average 23-year old female the expected probability of accepting a marriage offer would be less than 0.25.

The search parameters of AFDC recipients have not been estimated, but some facts about the search process have emerged. Edin and Lein (1997) interviewed 214 welfare reliant women about their work and welfare histories, their incomes, and their expenditures. These interviews indicate that most women on the AFDC program do have plans to leave welfare for work. Eighty-six percent of the women that were interviewed indicated that they planned to leave welfare for work. Over one-third of the women interviewed who did not plan to leave welfare for work planned to marry. Because most of the welfare reliant women interviewed had some labor market experience, they were able to form realistic expectations about what type of jobs they could get. On the whole, the interviews conducted by Edin and Lein are very supportive of an optimizing model of the decision to leave welfare. The authors write, “Because the cost and benefits associated with leaving welfare for work were constantly on their minds, many of the women we interviewed could do these calculations off the top of their heads, and some were able to show us the backs of envelopes and scrapes of notebook paper on which they had scribbled such calculations in the last few weeks." (Edin and Lein 1997, p. 65)

Edin and Lein's interviews suggest that finding a job is not a problem for most welfare recipients; however, finding a job that provides enough income to make work favorable to welfare is. A prima facia analysis of the evidence presented by Edin and Lein's study suggest that job offer arrival rates are high and job offer acceptance probabilities are low. This, however, might not be true. One potential drawback of the empirical job search literature is that the estimates of the offer arrival rates and acceptance probabilities do not indicate what strategies individuals employ while searching. If, as part of their job search strategies, welfare recipients ignore segments of the labor market where it is easy to obtain employment, but hard to earn enough income to survive off welfare, then job offer arrival rates will not necessarily be high and offer acceptance probabilities will not necessarily be low.

The interviews conducted by Edin and Lein are important in the sense that they provide some support for the assumptions of the search model described in the next section of this paper. The most fundamental of these assumptions are: (1) women on AFDC have a desire to leave the program and, thus, search for jobs and marriage partners; (2) women on AFDC have a realistic assessments of the chances of receiving job and marriage offers; (3) women on AFDC have knowledge of the distribution of incomes associated with job and marriage offers; and (4) women on AFDC behave optimally.

3. A Search Model of AFDC Durations

The intent of this section is to approximately describe the search process which current AFDC recipients employ as a strategy for getting off welfare. Assume individuals search simultaneously in the job and marriage markets. Job and marriage offers arrive at the Poisson rates of l_w and l_m and the log income levels associated with such offers are characterized by the distributions F and G respectively. Transitions off of AFDC for reasons other than employment or marriage arrive at the Poisson rate l_n. When on AFDC an individual receives the benefit b indefinitely. Each period in which a job or marriage offer arrives an AFDC recipient must make a choice about whether to accept the offer or remain on AFDC. Wages over the course of a job spell are assumed to remain constant and transitions back to AFDC from work occur at the Poisson rate d_w. Marriages last forever at the same utility level. When an individual transitions off AFDC for reasons other than work or marriage she is assumed to receive the per-period utility associated with being on AFDC. Transitions back to AFDC from this residual state occur at the Poisson rate of d_n. Thus, a current AFDC recipient will find herself in one of four states in the future; on

AFDC, off AFDC via marriage, off AFDC via employment, or off AFDC for some other reason. I assume that an individual maximizes the expected discounted sum of utility where the per-period utility associated with each of these states is as follows

$$utility(income = y \mid AFDC) = \log(y) + q_u$$

$$utility(income = y \mid marriage) = \log(y) + q_m$$

$$utility(income = y \mid employment) = \log(y) + q_w .$$

This utility function is similar to those employed by Nerendranathal and Nickel (1985) and van den Berg (1990). The q_i $(i = u, m, w)$ parameters in the utility specification above are intended to account for differences in nonpecuniary preferences over the states of work, marriage, and AFDC receipt. At equal levels of income women will not value AFDC receipt, work, and marriage equally. Being on AFDC affords women more leisure, but may be stigmatizing. While AFDC receipt may be stigmatizing, working women experience a loss in leisure and may incur many additional costs.[1] Without loss of generality q_u is normalized to zero. The per-period utility associated with residual AFDC spell endings is assumed to be the same as being on AFDC.

Given the structure outlined above the expected discounted utility of a job, U, solves

$$rU = \log(b) + l_w \int \max\{W(y_w) - U, 0\} dF(y_w) + l_m \int \max\{M(y_m) - U, 0\} dG(y_w)$$

$$+ l_n [N - U] \qquad (1)$$

where $W(y_w)$ is the expected discounted utility of being employed and receiving income y_w, $M(y_m)$ is the expected discounted utility of being married and receiving family income y_m, and N is the expected discounted utility associated with residual AFDC spell endings. Analogously, the expected discounted stream of utility associated with being employed solves

$$rW(y_w) = \log(y_w) + q_w + d_w [U - W(y_w)] \qquad (2)$$

[1] These additional cost may be substantial. Edin and Lein (1997) estimates that single mothers who worked spent an additional $190 a month on child care, clothing, transportation, and healthcare than single mothers on welfare.

while expected discounted stream of utility associated with being married satisfies

$$rM(y_m) = \log(y_m) + q_m \tag{3}$$

The expected value of being off AFDC for reasons other that work and marriage solves

$$rN = \log(b) + d_n[U - N] \tag{4}$$

With some algebra it can be shown that the reservation income levels in the job and marriage markets satisfy the following

$$\log(R_w) = \log(b) - q_w + \frac{l_w(r+d_n)}{(r+d_w)(r+l_n+d_n)} \int_{\log(R_m)}^{\infty} [\log(y_w) - \log(R_w)] dF(\log(y_w))$$

$$+ \frac{l_m(r+d_n)}{r(r+l_n+d_n)} \int_{\log(R_m)}^{\infty} [\log(y_m) - \log(R_m)] dG(\log(y_m)) \tag{5}$$

and

$$\log(R_m) = \log(b) - q_m + \frac{l_w(r+d_n)}{(r+d_w)(r+l_n+d_n)} \int_{\log(R_m)}^{\infty} [\log(y_w) - \log(R_w)] dF(\log(y_w))$$

$$+ \frac{l_m(r+d_n)}{r(r+l_n+d_n)} \int_{\log(R_m)}^{\infty} [\log(y_m) - \log(R_m)] dG(\log(y_m)). \tag{6}$$

respectively.[2] Note that the right hand sides of equations (5) and (6) are the per-period value of continued search in both the job and marriage markets denominated in terms of log income. An interesting feature of this model is that the standard job search model is nested in equation (5). In the absence of a marriage market $(l_m = 0)$ and the residual state $(l_n = 0)$ the reservation wage R_w is the reservation wage associated with the pure job search problem. Given (5) and (6) job (marriage) will be accepted if, and only if, $\log(y_w) > R_w$ $(\log(y_m) > R_m)$.

Having derived the reservation incomes in the job and marriage markets it is now possible to write down the AFDC hazard. The probability of exiting AFDC via employment is the product of the job offer arrival rate and the probability that a given offer is above R_w. Analogously, the probability of leaving

[2] Details are provided in the Appendix B.

AFDC via marriage is the product of the marriage offer arrival rate and the probability that an offer is above R_m. The AFDC hazard is simply the sum of the probability of leaving AFDC via employment, marriage, or other reasons. Thus the AFDC hazard may be written

$$h = l_w[1 - F(\log(R_w)] + l_m[1 - G(\log(R_m)] + l_n \tag{7}$$

The assumption of Poisson arrival rates implies that the distribution of completed AFDC spells will be exponential with mean $1/h$.

At this juncture enough structure has been imposed on the model to write down a likelihood function for completed spells as a function of h. Let t denote the time of a completed AFDC spell and let T denote the time of a right-censored AFDC spell. Suppose that there are n completed AFDC spells and m right censored AFDC spells. Furthermore, suppose that of the n completed spells observed in the data n_w end because of an earnings increase, n_m end because of marriage and n_n end for other reasons. Within the subset of spells that end because of an earnings increase let n_w^c represent the number of spells for which completed employment spells are observed. Likewise, within the subset of spells that end for reasons other than earnings increases and marriage, let n_w^c represent the number of residual spells of non-AFDC receipt that are completed. Letting $h_w = l_w[1 - F(\log(R_w))]$ and $h_w = l_m[1 - G(\log(R_m))]$ the log likelihood function is

$$\begin{aligned} L = & \sum_{i=}^{n_w^c}[\log(h_{wi}) - h_i t_i + \log(d_{wi}) - d_{wi} t_{wi}] + \sum_{i=1}^{n_w - n_w^c}[\log(h_{wi}) - h_i t_i - d_{wi} T_{wi}] \\ & + \sum_{i=1}^{n_m}[\log(h_{mi}) - h_i t_i] + \sum_{i=1}^{n_n^c}[\log(l_{ni} - h_i t_i + \log(d_{ni}) - d_{ni} t_i] \\ & + \sum_{i=1}^{n_n - n_n^c}[\log(d_{ui}) - h_i t_i - d_{ni} T_{ni}] - \sum_{i=1}^{m} h_i T_i \end{aligned} \tag{8}$$

where t_w and t_m $(T_w$ and $T_n)$ denote the length of completed (censored) job and residual spells of non-AFDC receipt. To complete the empirical model l_w, ?$_\mathrm{m}$, l_n, d_w, and d_n will need to be parameterized and strategies for estimating the distribution functions F and G will need to be explored. Before proceeding along these lines there are a few points that need to be made.

First, the reservation income levels derived above are assumed to be stationary even though there are many reasons to believe that they are not. Recent work by Wallace (2000) using data from the SIPP panels of the early 1990s has shown that there is a significant degree of negative duration dependence in AFDC spells. If the underlying reason for the duration dependence in spells data is that work readiness, or perceived work readiness, declines with spell length, then the job offer arrival rate may decline with the length of spells.[3] If job offer arrival rates decline with the length of time spent on AFDC then the reservation income levels will not be stationary. Likewise, the economic environment in which AFDC recipients search for jobs changes over the course of business cycles. Changes in anticipated job offer arrival rates or wages brought about by business cycle fluctuations are another potential source of nonstationary reservation wages. In the sense that the model described above does not allow for nonstationarity it is somewhat unrealistic.

Secondly, it is important to note that job search among AFDC recipients differs from what is normally termed job search. In the standard job search problem an individual without a job is eligible to collect unemployment benefits. A distinguishing feature of the AFDC program is that an individual who is employed is able to collect benefits as long as their earnings are low enough. In some states, during certain times, it has been possible for some women to work 40 hours a week at the minimum wage and still remain eligible for AFDC benefits (Blank, 1997). What I refer to as job search while on AFDC is search for a job with a combination of wage and hours that provides sufficient income for an individual to leave welfare.

4. Estimation

There are two issues that need to be addressed before the structural model of AFDC spells is complete. First, parametric forms for l_w, $?_{\mathrm{m}}$, l_n, d_{w}, and d_n must be specified. Secondly, the estimation of the wage and marriage offer distributions must be discussed.

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[3] See Chapter II for an extensive treatment of this issue.

Parameterizing the AFDC Exit Rate

The job offer arrival rate l_w, the marriage offer arrival rate l_m, the residual AFDC hazard l_n, the rate of transition back to AFDC following earnings related AFDC exits d_w, and the rate of return to AFDC following residual exits d_n are all taken to be exponential functional forms of the exogenous variables X_w, X_m, and X_u. That is

$$l_w = \exp\left(X_w \cdot a_w\right)$$

$$l_m = \exp\left(X_m \cdot a_m\right)$$

$$l_n = \exp\left(X_u \cdot a_u\right)$$

$$d_w = \exp\left(X_w \cdot b_w\right)$$

$$d_n = \exp\left(X_u \cdot b_n\right)$$

The vector X_w should contain variables that affect an individual's potential productivity when employed as well as a measure of labor market tightness. At a minimum X_w will contain a measure of education, age, the state unemployment rate, and an individual's race. The vector X_m should contain dummy variables for race and any information about an individual that would make her a particularly good or bad marriage partner. To the extent that more educated women are more attractive to potential spouses a measure of educational attainment should also be included in X_m. The vector X_n will contain information on an individual that would indicate an individual’s propensity to exit AFDC for some reason other than employment or marriage. Some of these transitions from AFDC will occur because of loss of eligibility due to children aging. Thus, X_n should contain an indicator of whether an individual's youngest child is near 18.

Estimating Offer Distributions

In theory, income data can be incorporated directly into the log likelihood function (7) and the parameters of the income offer distributions can be estimated jointly with a_w, a_m, a_n, b_w, and b_n. Let $j = w, m$. Suppose that log offers are determined by $\log(y_j) = Z_j \cdot p_j + u_j$ where $u_j \sim N(0, s_j^2)$. Then

$\log(y_j) \mid Z_j \sim N(Z_j \cdot p_j, s_j^2)$ and post AFDC incomes from work and marriage are observed if, and only if, $Z_j \cdot p_j + u_j > R_j$. The probability that a log offer is in excess of the reservation level of utility is $1 - \Phi\left[\frac{R_j - Z_j \cdot p_j}{s_j}\right]$ where Φ is the standard normal cdf. Thus, the distribution of $\log(y_j)$ conditional on $\log(y_j)$ being observed can be written as

$$f\left(\log(y_j) \mid \log(y_j) > R_j\right) = \frac{s_j^{-1} \cdot f\left[\frac{\log\left(y_j - Z_j \cdot p_j\right)}{s_j}\right]}{1 - \Phi\left[\frac{R_j - Z_j \cdot p_j}{s_j}\right]}.$$

Given a sequence of accepted offers $\{y_{ji}\}_{i=1}^{n}$ and the sequence of exogenous variables that affect the distribution of wage offers $\{Z_{ji}\}_{i=1}^{n}$ the parameters p_j and s_j can be estimated by the method of maximum likelihood. The log likelihood function is

$$L(p_j, s_j) = -n_j \log(s_j) - \frac{1}{2s_j^2} \sum_{i=1}^{n_j} \left(y_{ji} - Z_{ji} \cdot p_{ji}\right)^2 - \sum_{i=1}^{n} \log\left[\Phi\left(-\frac{1}{s_j}\left(R_{ji} - Z_{ji} \cdot p_j\right)\right)\right] \quad (9)$$

For the sample of individuals who left AFDC because of increased earnings and marriage all of the data required by equation (9) is observed, so equation (9) can be incorporated directly into equation (8).

Unfortunately estimating the parameters of the offer distribution parameters jointly with a_w, a_m, a_n, b_w, and b_n does not work well in practice. Attempts to estimate the offer distribution parameters along with the other parameters of the model did not lead to convergence of the likelihood function. Problems associated with trying to estimate the offer distribution parameters jointly with a_w, a_m, a_n, b_w, and b_n are due, in part, to bad income data. Only 34 of the women in my sample left AFDC via marriage. Thus, the sample contains only 34 observations on $\log(y_m)$. This is not a large enough sample to properly estimate the parameters of the distribution of marriage offers. In addition to the sample being too small, it contains several individuals for whom y_m is zero.

To estimate the parameters of the offer distributions I used a reduced form approach. Assume that whether the income associated with job or marriage offers is observed is determined by the value of index functions $y_j^* = W_j \cdot g_j + e_j$ where $e_j \sim N(0,1)$. If $y_j^* > 0$ then y_j is observed. Likewise, if $y_j^* < 0$, y_j is not observed. Thus, job and marriage offers are observed with probability $\Phi(W_j \cdot g_j)$. Now the problem of estimating the offer distribution parameters is one of sample selectivity bias. To account for the presence of selectivity bias I used Heckman's two step estimation procedure.

In estimating the wage offer distribution parameters I used data from the women who completed spells of AFDC receipt with an earnings increase. The results of this estimation are shown in Table A.2. In estimating the wage offer distribution, a test for the presence of sample selectivity indicated that it was not a problem, thus, the estimates used in the analysis that follows are from the specification without the selectivity regressor.

Because of a lack of data, estimating the distribution of marriage offers using the income of women who left AFDC via marriage was impossible. To estimate the parameters of the marriage offer distributions I used data from the 1990, 1991 and 1992 Survey of Income and Program Participation (SIPP). From the SIPP I identified all single women ages 18 to 50 with children less than 18-years of age present in the household. I followed these single women throughout the sample period and noted when a marriages occurred. When a marriage did occur I recorded the family income during the first month of the marriage. The sample averages of the variables from SIPP data that were used to estimate the distribution of log marriage offers are shown in Table A.3. A probit equation for whether a woman entered into marriage during the sample period was estimated. The results of this probit estimation (contained in Table A.4) were used to form the Mill's ratio, which was included as a regressor in the regression of $\log(y_m)$ and Z_m.

Given prior estimates of the distribution of log wage and marriage offers the likelihood function (equation (8)) can be maximized. Slightly complicating the maximization of the likelihood function is the presence of the reservation wage equations (5) and (6) in the h_w, h_m, and h terms. Because closed form solutions to the reservation wages equations do not exist, the reservation wages for each sample member must be calculated numerically each time the likelihood function is evaluated. Fortunately, numerical solutions of the reservation wages equations can easily be obtained by iterating on a transformation of equations (5) and (6).[4]

5. Data

Implementation of the structural estimation procedure outlined above will require data that indicates the length of time on AFDC, the reason for leaving AFDC as well as a host of demographic, labor market, and program variables. To create such a data set I pooled the 1990, 1991, and 1992 panels of the SIPP with data on state unemployment rates and maximum AFDC benefits. The SIPP is a longitudinal data set published by the United States Census Bureau. Once every four months SIPP participants are asked about their income, earnings, and program participation over the previous four months. The 1990 and 1991 SIPP panels ran for 32 months while the 1992 SIPP panel ran for 40 months. Together the 1990, 1991, and 1992 panels of the SIPP provide monthly information on approximately 170,000 individuals.

From the SIPP panels, I recorded the length of first observed spells of continuous AFDC receipt. In order for a spell of AFDC receipt to be included in the sample the individual must have been an unmarried female between 18 and 50 years of age with a child younger than 18 present in the household during each month of the spell. Spells that ended for one or two months for no discernible reason and were followed by another spell of AFDC receipt were coded as continuous spells. There were also a number of instances in which the AFDC status of individuals over a four-month period could not be precisely determined because an interview was missed. In these instances the spell was coded as continuous if the respondent reported receiving AFDC upon rejoining the sample. If more than one interview was missed an ongoing spell of AFDC receipt was coded as right censored. All left censored spells were dropped from the sample. In order to clarify the meaning of the race variable I eliminated all respondents who did not report being either black or white from the sample.

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[4] Equations (2.5) and (2.6) must be transformed so that they are contraction maps. A contraction map is a function that maps onto itself and has the special property of converging to a unique fixed point when iterated upon, beginning with any initial value.

Coding the data in the manner described above produces 947 spells of AFDC receipt. Table 1 shows the Kaplan-Meier estimates of the survival function. The estimated median spell length is 16.5 months. While it is estimated that 43 percent of AFDC spells will end in less than one year, an estimated 43 percent of AFDC spells last more that two years. The longest completed spells observed in the SIPP data are 32 months. An estimated 40 percent of the spells will last at least 32 months. It is significant that the Kaplan-Meier estimates of the survivor function presented in Table 1 differ from those presented in Fitzgerald (1995). Using the 1984 and 1985 panels of the SIPP, Fitzgerald estimates a median spell length of 11-12 months. In Fitzgerald's data an estimated 52 percent of AFDC spells will end within one year. The probability of observing a spell that lasts at least 25 months is 0.30.

There are potentially two reasons for the differences between the estimates of the survival function presented in Table 1 and Fitzgerald's estimates of the survival function. First, there are differences in the way that the data is coded. Fitzgerald considered spells of general assistance recipiency as well as AFDC recipiency. Additionally, Fitzgerald only coded over one month gaps of AFDC recipiency while I coded over one, two, and, in some cases, four month gaps.[5] The second potential reason for the differences in spell durations between Fitzgerald's data and the data used in this study is the dramatic increase in AFDC caseloads. AFDC caseload growth was relatively flat during the 1980s. Beginning in late 1989 AFDC caseloads began to rise rapidly. Between the fourth quarter of 1989 and the first quarter of 1994 AFDC caseloads grew 33 percent (Blank, 1997). If this rapid growth in AFDC caseloads was in part the result of recipients being slow to leave AFDC then we would expect to observe longer spell lengths in the early 1990s than in the mid 1980s.

For the purposes of the analysis that follows, there are three ways that a spell of AFDC receipt can end. First, a spell can end because of an increase in earned income. Secondly, a spell can end because of marriage. Thirdly, a spell can end because of some reason other than an earnings increase or marriage. An AFDC spell was coded as ending because an increase in earnings if during either of the first two months off

[5] Four-month gaps in AFDC recipiency were coded over if they corresponded with an interview period, the interview was missed, and the respondent reported being on AFDC during the first month covered by the subsequent interview.

of AFDC a respondent's earnings exceeded her earnings during the last month on AFDC by more than 50 dollars or if her earnings during the first month off AFDC exceeded 700 dollars. Spells in which the respondent was married in the first two months following her last reported month of AFDC receipt were coded as ending because of marriage. In the few cases where spell endings corresponded with marriage and earnings increases, spells where coded as ending in marriage.

Panel (a) of Table 2 shows the reasons for spell endings in the SIPP data. Fifty-seven percent of first observed spells of AFDC receipt are right censored. Twenty-three percent of the recorded AFDC spells end with an increase in earnings. Approximately 4 percent of the spells end in marriage. I was unable to find ending reasons for the remaining 16 percent of the spells.[6] How do these numbers compare with those found by other researchers? Panel (b) of Table 2 shows the same tabulations for Fitzgerald's data from the 1984 and 1985 SIPP panels. Fitzgerald's data exhibit a lower percentage of censored spells. This is not surprising considering that his spells durations are much shorter. The percent of spell endings attributable to changes in earned income are very similar across the two data sets. Fitzgerald's data indicate a higher percentage of spells that end in marriage and a higher percentage of spells where the reason for spell endings cannot be determined. These differences are largely due to small differences in how the data were coded.[7] The only other study using data from the SIPP was conducted by Blank and Rugles (1996). Using SIPP data from the late 1980s they attribute forty-two percent of spell endings to increases in earned income. In my data 46 percent of spell endings are attributable to earnings increases. Blank and Ruggles code spell endings due to a change in family composition but do not report the figures for spell endings due to marriage alone, thus it is impossible to make further comparisons.

From the subsample of individuals whose spells ended due to an increase in earnings or for reasons undetermined, I recorded the length of continuous spells of non-AFDC receipt. The distribution of spells of non-AFDC receipt for respondents whose AFDC spells ended with an increase in earned income are shown in panel (a) of Table 3, while the distribution of spells of non-AFDC receipt for respondents

[6] There was an increases in unearned family income associated with seven percent of the spells that were coded as havin residual spell endings.

[7] Fitzgerald coded a spell as ending with an increase in earnings if the respondents earnings during the first 6 months off AFDC exceeded their earnings while on AFDC by more than 50 dollars.

whose AFDC spells ended for undetermined reasons are shown in panel (b) of Table 3. The most striking feature of these tables is the relatively skewed distribution of the completed spells and the high proportion of censored spells. These characteristics of the distribution of spells of non-AFDC receipt are partly due to how the data is coded. In order for a spell of non-AFDC receipt to be observed an individual must first complete a spell of AFDC receipt. For many women in the sample completing a spell of AFDC receipt takes a large portion of a SIPP panel. Because AFDC spells tend to be long, there are not very many long completed spells of non-AFDC receipt.

The means of the variables used in this analysis of AFDC durations are shown in Table 4. Variable values were taken from the first month a respondent reported being on AFDC unless otherwise indicated. All monetary variables were converted to 1992 dollars using the GDP deflator. Most of the variables in Table 4 are self-explanatory, however, there are some variables that require additional comment.

UNEMPLOYED is a binary variable which indicates whether a respondent reported being unemployed during the first month she was on AFDC. EMPLOYED indicates whether a respondent was employed during the first month that she reported being on AFDC. The UNEMPLOYMENT RATE is the monthly unemployment rate from the state and month in which the respondent first reported being on AFDC. The MAXIMUM BENEFIT is the maximum AFDC benefit in the state and year in which the respondent first reported receiving AFDC benefits. ENDING INCOME is the post AFDC family income of respondents whose spells ended due to an increase in earnings. Analogously, ENDING FAMILY INCOME is the post AFDC family income of respondents whose spells ended with a marriage.

6. Results

The parameter estimates of the empirical search model described above are presented in Table 5. The estimates seem reasonable. High school graduates have the highest job offer arrival rates, followed by individuals with some college. One possible explanation for the lower job offer arrival rates of individuals with some college is that these individuals may have a more tightly defined set of skills and, thus, may receive fewer offers. Blacks receive a significantly lower number of job offers per month than whites. The presence of children under 5-years of age significantly reduces the job offer arrival rate. An individual's labor force status during the first month of her AFDC spell also has a substantial effect on the expected number of job offers she receive. Labor force status at the beginning of a spell may be a good proxy for search intensity or previous labor market experience. Employed persons have the highest job offer arrival rates. Unemployed persons have higher job offer arrival rates than labor force non-participants, though not significantly so. The effect of the state unemployment rate is of the predicted sign, but not significant. The lack of significance of the state unemployment rate is consistent with some of the earlier work concerned with estimating AFDC durations (Blank 1989 and Fitzgerald 1992). This finding has led some researchers to speculate that the state unemployment rate is too aggregate to be used as a measure of labor market tightness (Fitzgerald 1995, Harris 1993, Hoynes 1996, and Sanders 1992). Studies that use county, or local labor market, unemployment rates generally find that these measures of labor market tightness have significant negative effects on AFDC exit (Hoynes 1996).

One assumption of the model is that the arrival of job offers is a stationary process. This assumption is violated if the job offer arrival rate changes with age, as appears to be the case. Women in the 18- to 24-year old age group have slightly lower job offer arrival rates then women in the 25- to 34-year old age group, though not significantly so. The effect of being in the 35- to 50-year old age is group is large, negative, and significant at the 5 percent level. One interpretation of the age parameter estimates that is consistent with the stationary offer arrival rate assumption is that they represent birth cohort effects and not true age effects. Another interpretation of the age effects consistent with the stationary arrival rate assumption is that age is correlated with some unobservable characteristics. For instance, women with less labor market experience and long histories of AFDC receipt may be over-represented in the sample of older women.

The first thing to notice about the estimates of the marriage offer arrival rate is the magnitude of the intercept term. It is nearly double the intercept term in the job offer arrival rate equation, indicating that search in the marriage market is not a very large component of the exit rate from AFDC. There is some evidence that marriage offer arrival rates decrease with age as the coefficient on the 35 to 50 age group large, negative, and significant at the 10 percent level. The only other significant effect in the marriage offer arrival rate equation is the effect of race. Blacks have much lower marriage offer arrival rates than their white counterparts. Estimates of marriage offer arrival rates increase with the level of education.

It interesting that the most important factor in determining the residual AFDC exit rate comes from having a respondent's youngest child being 16 or 17 years old. Unlike the job offer arrival rate equation and the marriage offer arrival rate equation there is not a clear pattern in the coefficients of the residual AFDC exit rate equation. The fact that there is no clear pattern in the coefficients and the largest effect in this equation comes from the OLD KID variable suggest that some of these residual AFDC exits are random while others are the result of loss of eligibility due to children aging. Welfare recipients are aware that they will lose the benefits when they no longer have dependents younger than 18. This knowledge regarding the loss of benefits due to children aging introduces yet another source of nonstationarity into the model. It is important to note that the finite horizon on benefits is unlikely to affect the estimates of the search model parameters very much. The reason that the finite horizon on benefit receipt is unlikely to affect the estimates is that the sample used in this analysis is very young. Almost half of the women in the sample are ages 18 to 24 and less than 2 percent of the sample falls into the category of having their youngest child in the 16 to 17 year old age group. The prospect of losing benefits is far enough in the future for the great majority of women in the sample that it is not likely to influence their behavior over the course of the sample period.

The last sets of coefficient estimates in Table 5 are for the equations that determine the rates of transition back to AFDC following exits from the AFDC program. There are not very many significant coefficients in these equations. Because spells of AFDC receipt are relatively long, spells of non-AFDC receipt are not observed until a spell of AFDC receipt is completed, and the SIPP panels are relatively short, there may not be a sufficient number of completed spells of non-AFDC receipt with which to estimate these equations with a high degree of precision. While there are not very many significant effects in the equations that determine transition back to AFDC, most of the estimated coefficients have the expected sign. The presence of young children increases the rate of transition back to AFDC from an earnings related AFDC exit while individuals who were in the labor force (either employed or unemployed) during their first period in which they where observed being on AFDC have lower rates of transition back to AFDC following a earnings related AFDC exit. Blacks have lower rates of transition back to AFDC following earnings related exits, but higher rates of transition back to AFDC following residual AFDC exits.

Although most of the coefficients have the expected sign there are also a few puzzling results. Most notably, the rate of transition back to AFDC following an earnings related AFDC exit is increasing in education. This result suggests that there is less job stability among more educated former welfare recipients that is contrary to intuition and previous research (Edin and Harris 1998). To examine the possibility that these results are attributable to the restrictions imposed by the model I estimated reduced form versions of these transition rate equations. The results were virtually identical to those reported in Table 4 suggesting that the finding of greater job instability among more educated former welfare recipients is not due to the structural model. Another possible explanation for this finding is problems associated with the sample design relative to this analysis. Because individuals with higher levels of education have a higher likelihood of exiting AFDC via an earnings increase, they are at greater risk of completing a spell of non-AFDC receipt brought about by an increase in earnings over the course of a SIPP panel. If educated former welfare recipients are disproportionately represented in subsample of individuals with completed spells of non-AFDC, then the effect of the education variables on the rate of transition from non-AFDC receipt following an increase in earnings to AFDC receipt may be biased upward.

One additional point of interest regarding the residual AFDC exit rate and the rates of transition back to AFDC following earnings related and residual exits from the AFDC program is whether these transition probabilities are truly exogenous. To test the assumption that the residual AFDC exit rate and the rats of transition back to AFDC are exogenous I included the log of the maximum AFDC guarantee for a four-person family as an additional variable in these equations. In all of the equations this variable had the expected sign and was significant. This result suggests that there is some degree of choice in residual AFDC exits as well as transitions back to AFDC from work and the residual state.

The sample averages of the estimates of the search model parameters are shown in Table 6. On average, sample members expect 0.04 job offers per month. Another way of interpreting this number is that the expected waiting time for a job offer is about 25 months. An average of 68 percent of all job offers are found be acceptable, thus choice does play a role in continued participation in the AFDC program. The estimates presented in Table 5 highlight the fact that marriage is not a very important avenue for leaving welfare. Although the mean of the marriage offer acceptance probability is over 83 percent, on average sample members expect to wait about 16 years before receiving a marriage offer. The average of the AFDC hazard is .044 indicating that the average duration of a welfare spell is 22.7 months. The estimates of the transition rates from non-AFDC receipt to AFDC receipt indicate that there is considerable churning in the AFDC population.

The estimates presented in Table 4 can be used to speculate about the effectiveness of cutting benefit levels as a way of reducing the duration of AFDC spells. One of the implications of the model developed in this paper is that there are diminishing returns to reducing benefit levels. As benefit levels are reduced the importance of the behavioral component of exit from AFDC declines with respect to the random components of AFDC exit. Because of these diminishing returns there is a limit to the effectiveness of policies aimed at reducing welfare spell lengths by altering the incentives of welfare recipients. The effectiveness of policies that alter the incentives of welfare recipients is dependent on the relative contributions of behavioral versus random components in determining AFDC exit.

Table 7 presents the sample elasticities of the job offer acceptance probabilities, the expected accepted income levels, and the AFDC exit rate with respect to the maximum AFDC guarantee. So that the responsiveness of the behavior of AFDC recipients to changing benefits can be fully assessed, the sample elasticities in Table 7 are evaluated at the average real benefit level, the highest real benefit level, and the lowest real benefit level.[8] A one percent increase in average benefit levels decreases the probability of accepting a job offer by 0.61 percent while increasing the expected accepted wage by 0.37 percent. The elasticity of the AFDC exit rate with respect to benefit levels is -0.33. This estimated elasticity is consistent with the estimates reported for black women by Fitzgerald (1995) using a less restrictive model.[9]

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[8] The highest real benefit level was recorded in California during 1990. In 1990 California provided a maximum AFDC benefit of $824. The minimum real benefit level was recorded in Mississippi during 1993. In 1993 Mississippi provided a maximum AFDC benefit of $144.

[9] Fitzgerald (1995) estimated reduced form duration models where the exit rate was assumed to have the simple logit form.

Fitzgerald's estimate of the elasticity of the AFDC hazard for whites was much lower than the results reported in Table 7.

The results presented Table 7 indicate that the returns to policies aimed at reducing the duration of welfare spells by altering incentives may diminish rapidly. The benefit elasticity of the job offer acceptance probability evaluated at the highest real maximum AFDC guarantee in the sample is 10 times higher than the elasticity evaluated at the lowest real maximum AFDC guarantee. This difference in the benefit elasticities of the job offer acceptance probability translates into a considerable differential in the benefit elasticities of the AFDC exit rate. A one percent increase in the maximum AFDC guarantee in the highest benefit state would reduce the AFDC exit rate by 0.57 percent while a one percent increase in the maximum AFDC guarantee would decrease the AFDC exit rate in the lowest benefit state by only 0.09 percent.

Testing the Search Model

I have estimated a very stylized model of AFDC durations. The natural question to ask is whether or not this model fits the data. Fortunately there are several implications of the model that can be tested. As mentioned above the search model described in this paper has very specific implications for the distribution of the log of accepted job and marriage offers. Let $j = i, m.$ Above I assume that $\log(y_j) = Z_j \cdot p_j + u_j$ where $u_j \sim N(0, s_j^2)$. This assumption implies that $\log(w_j) \mid Z_j \sim N(Z_j \cdot p_j, s_j^2)$ and the post AFDC income of individuals who exited AFDC via an earnings increase or marriage are observed if, and only if, $Z_j \cdot p_j + u_j > \log(R_j)$. Thus, y_j conditional on y_j being observed has a truncated normal distribution with

$$E\left(\log(y_j) \mid \log(y_j) > R_j\right) = Z_j \cdot p_j + \frac{s_j \cdot f\left[\dfrac{\log(y_j) - Z_j \cdot p_j}{s_j}\right]}{1 - \Phi\left[\dfrac{\log(R_j) - Z_j \cdot p_j}{s_j}\right]}$$

where f and Φ are the standard normal pdf and cdf. The above expressions provide a convenient test of whether or not the log of post AFDC spell earnings for women who left the AFDC program via earnings increases and marriage could have been generated by a model characterized by the parameters $\hat{a}_w, \hat{a}_m, \hat{a}_n, \hat{b}_w, \hat{b}_n, \hat{q}_w, \hat{q}_{m,} \hat{p}_w, \hat{p}_m, \hat{s}_w$, and $\hat{s}_m$. A test of whether the model fits the data can be obtained by comparing the sample averages of expected accepted log wage and log marriage offers with the sample averages of observed log wage and log marriage offers. Under the null hypothesis that the search model with parameters generated the data $\hat{a}_w, \hat{a}_m, \hat{a}_n, \hat{b}_w, \hat{b}_n, \hat{q}_w, \hat{q}_{m,} \hat{p}_w, \hat{p}_m$, $\hat{s}_w$, and $\hat{s}_m$ these means should be equal. The sample mean of the expected accepted log wage offer is 7.12, while the actual mean from Table 4 is 6.82 with a standard deviation of 0.65. The sample mean of the expected accepted log marriage offer is 7.39, while the actual mean is 6.91 with a standard deviation of 1.63. Although the expected accepted log income levels are substantially higher than the mean income levels, the hypothesis that the post AFDC income data was generated by the search model cannot be rejected.

Another rough test of how well the data fits the model comes from examining the fraction of accepted offers below the imputed reservation income levels. If the fraction of accepted offers below the imputed reservation income levels is high then the model does not fit the data well. Forty-nine of the 223 individuals whose spells ended due to an increase in earned income had accepted wages below their imputed reservation wages. The results for the sample of individuals who married were slightly more favorable. Four out of 34 of the women whose spells ended because of an increase in earnings had accepted marriage offers below their imputed reservation wages.

There is some indication from the comparison of the expected accepted offers to accepted offers that the estimates presented in Table 5 over-predict reservation wages. One possible explanation for this apparent over-prediction of the reservation wages is the presence of unobserved heterogeneity in the q_w and q_m parameters. It is probably true that not all women have equal nonpecuniary preferences over the states of welfare recipiency, work, and marriage. Some women undoubtedly really dislike being on welfare despite the increase in leisure that not having to work affords them. These women may accept offers below the reservation levels of income that are implied by the model. Fifteen of the women whose spells ended because of an increase in earned income accepted wage offers below the maximum AFDC benefit.

Another explanation for the relatively high reservation wages implied by the results presented in parameter estimates in Table 5, is the choice of the discount rate. The results presented in Tables 5 and 6 are based on $r = 0.05$. This rate might be too low for a sample of welfare recipients.[10] To examine the sensitivity of the results presented in Tables 5 and 6 to the choice of r, I re-estimated the model with r set to 0.10 and 0.20. Table 8 shows the sample averages of the estimates of the offer arrival rates, the offer acceptance probabilities, expected accepted log offers, the residual AFDC exit rate, the AFDC exit rate, and the median spell length for the search model re-estimated with r set equal to 0.10 and 0.20. The main difference between the results presented in Table 6 and the results shown in Table 8 is in the estimates of the arrival rates and acceptance probabilities. While the estimated arrival rates reported in Table 8 are lower than those in Table 6, the estimated acceptance probabilities are higher. Because these effects offset each other, and estimates of the residual AFDC exit rate do not change, there is no change in the sample average of the AFDC hazard. Expected accepted incomes are lower when the model is estimated assuming higher discount rates. In this sense, the estimates in Table 8 are more consistent with the data.

Yet another potential explanation for the problem is the presence of unreported income. This problem may be quite severe for low-income families. Edin and Harris (1998) report the average expenditures of women that leave welfare for work exceed their earnings at their main job by over $400 per month. Given the potential for underreporting of income among low-income families in survey data it is possible that the estimates presented in Table 5 are fairly accurate and the income levels recorded at the completion of AFDC spells are erroneous. There is some indirect evidence that this might be the case. Edin and Lein (1997) ask welfare reliant women living in Chicago, San Antonio, Boston, and Charleston what they felt they would need to earn to leave welfare via employment. Seventy percent of the women gave hourly wages between $8 and $10 dollars an hour. Assuming a 30-hour workweek this translates to monthly reservation wages of between $960 and $1200 a month. The average imputed reservation wage

[10] There is substantial evidence that poor people discount heavily. Indeed there are several industries built around poor people having high discount rates. Examples of such industries include rent to own furniture stores that charge exorbitant finance fees and check cashing stores that offer "payday loans." A payday loan is a short-term loan against an anticipated paycheck. The monthly interest rate on these loans is usually upwards of 40 percent.

for the sample used in this analysis was $689 a month. Because a large fraction of the Edin and Lein's sample comes from two large cities with a high cost of living the reservation wages that they report are probably biased upward.

While the assumed presence of unreported income does make the results of the search model more believable, it does causes other potential problems. I used data on post AFDC spell earnings from the sample of former AFDC recipients who exited AFDC via an earnings increase to estimate the conditional mean and the variance of the offer distributions. If the estimates of the parameters of the offer distributions are biased, then estimates of the job offer arrival rates, the marriage offer arrival rates, residual AFDC exit rates, and the transition rates from non-AFDC receipt may also be biased. Because bias in the estimates of the wage offer distributions may be a problem, it is worth investigating how sensitive the estimates are to misspecification of the offer distribution parameters.

To examine the sensitivity of the estimates in Tables 6 and 8 to a small misspecification of the mean of the log wage offer distribution, I increased the mean of the log wage offer distribution by 0.10 and re-estimated the model. This might seem like a very small shift in the log wage offer distribution but it corresponds to about a 10 percent shift in the mean of the offer distribution. The results from the re-estimated model indicate that the estimates of job offer arrival rates, marriage offer arrival rates, and residual AFDC exit rates are not changed by a minor misspecification of the mean of the log wage offer distribution. Although the mean of the wage offer distribution is changed in the re-estimated model, the offer acceptance probabilities remain the same. This insensitivity of the offer acceptance probabilities is due to increases in the mean of the offer distribution being exactly offset by increases in the estimates of q_w. Because estimates of the offer arrival rates and acceptance probabilities do not change when the mean of the wage offer distribution is changed the estimates for the AFDC exit rate do not change. Thus, the model is fairly insensitive to potential misspecification of the wage offer distribution.

A final check of how well the model fits the data comes from comparing the survival function from the structural model to the Kaplan-Meier estimates of the survival function. Figure 1 plots the sample mean of the survival function implied by the parameter estimates presented in Table 5 and the Kaplan-

Meier estimate of the survival function from Table 1. Examination of Figure 1 reveals that between month 4 and 9 the sample mean of the survival function from the search model is above the 95 percent confidence interval of the Kaplan-Meier estimate. After month 26 the sample mean of the survival function from the search model is below the 95 percent confidence interval of the Kaplan-Meier estimate. These results suggest that the search model underestimates the AFDC exit rate during the early part of a spell and overestimates the AFDC exit rate during the later months of a spell.

The structural search model estimated above does not fit the data perfectly. There is some indication that the model over-predicts reservation wages for some individuals. As explained above this over-prediction of the reservation wages could be explained by unobserved heterogeneity in the q_w and q_m parameters or the presence of unreported income. The structural search model also under-predicts the AFDC exit rate during the early part of a spell and over-predicts the AFDC exit rates later in a spell. These over and under-predictions of the AFDC exit could be explained by unobserved heterogeneity or duration dependence in the job offer arrival rate. Although the structural search model does not fit the data perfectly, it fits as good as most structural search models (see Devine and Kiefer (1991) for a summary of these studies).

7. The Effects of a Life Time Limit on Benefit Receipt

In late 1996 President Clinton signed the Personal Responsibility and Work Opportunity Reconciliation Act. This law replaced the current AFDC program with Temporary Assistance to Needy Families (TANF) block grants. In order to receive TANF block grants states must limit lifetime receipt of TANF benefits to 60 months and require TANF recipients to work within 2 years of receipt. Duncan et al. (1997) provide estimates of the number of families affected by a lifetime limit on welfare benefit receipt of 5 years. Duncan et al. estimate that some two million families (40 percent of the current caseload) will be affected by the five-year time limits on welfare receipt. The important thing to note about the estimates presented in Duncan et al. is that they assume there is no behavioral response to the imposition of a time limit. One of the main benefits to structural estimation is that it provides for policy simulations that take into account the full set of behavioral responses by economic agents. Perhaps the best application of the model developed and estimated in this paper is to analyze the effect of time limits. In this section I modify the search model developed in Section 3 to incorporate nonstationarity resulting from a lifetime limit on benefit receipt. I then use this modified model along with the parameter estimates presented in Table 5 to consider the likelihood that the average sample member will reach the time limit.

Let T represent the length of the time limit and let t represent accumulated time on welfare. Then the value of being on welfare given $t < T$ periods of accumulated welfare receipt solves the following first order differential equation

$$rU(t) = b + l_w \int_{-\infty}^{\infty} \max\{W(y_w \mid t) - U(t), 0\} dF(\log(y_w)) + l_m \int_{-\infty}^{\infty} \max\{M(y_m) - U(t), 0\} dG(\log(y_m))$$

$$+ l_n [N(t) - U(t)] + U'(t) \tag{11}$$

where $W(y_w \mid t)$ is the expected discounted utility of being employed and receiving income y_w, $M(y_m)$ is the expected discounted utility of being married and receiving family income y_m, and $N(t)$ is the expected discounted utility associated with residual AFDC spell endings. Analogously, the expected discounted stream of utility associated with being employed solves

$$rW(y_m \mid t) = \log(y_m) + q_w + d_w [U(t) - W(y_w \mid t)] \tag{12}$$

while expected discounted stream of utility associated with being married satisfies

$$rM(y_m) = \log(y_m) + q_m . \tag{13}$$

The expected value of being off AFDC for reasons other that work and marriage solves

$$rN(a) = \log(b) + d_n [U(t) - N(t)] . \tag{14}$$

After T periods of accumulated welfare receipt the welfare benefit is assumed be one so that $U(T)$ solves

$$rU(T) = l_w \int_{-\infty}^{\infty} \max\{W(y_w, T) - U(T), 0\} dF(\log(y_w))$$

$$+ l_m \int_{-\infty}^{\infty} \max\{M(y_m) - U(T), 0\} dG(\log(y_m)) + l_n [N(T) - U(T)] . \tag{15}$$

By virtue of equations (1.12) through (1.15) the reservation wages satisfy the following

$$\frac{d\left(\log(R_j(t)\right)}{da} = r\left(\frac{r + l_n + d_n}{r + d_n}\right)\left[\log(b) - q_j - \log\left(R_j(t)\right)\right]$$

$$+ \frac{l_w r}{(r + d_w)} \int_{\log\left(R_m(t)\right)}^{\infty} \left[\log(y_w) - \log\left(R_w(t)\right)\right] dF\left(\log(y_w)\right)$$

$$+ l_m \int_{\log\left(R_m(t)\right)}^{\infty} \left[\log(y_m) - \log\left(R_m(t)\right)\right] dG\left(\log(y_m)\right) \quad for \;\; j = i, m. \qquad (16)$$

These differential equations along with the boundary conditions

$$\log\left(R_j(T)\right) = \left(\frac{l_n}{r + l_n + d_n}\right)\left[\log(b) - q_j\right]$$

$$+ \frac{l_w(r + d_n)}{\left(r + l_n + d_n\right)} \int_{\log\left(R_w(T)\right)} \left[\log(y_w) - \log\left(R_w(T)\right)\right] dF\left(\log(y_w)\right)$$

$$+ \frac{l_m(r + d_n)}{\left(r + l_n + d_n\right)} \int_{\log\left(R_n(T)\right)} \left[\log(y_m) - \log\left(R_m(T)\right)\right] dF\left(\log(y_n)\right) \quad for \;\; j = w, m \qquad (17)$$

can be used to solve for the time paths of the reservation wages.[11]

Although closed form solutions for $R_w(t)$ and $R_m(t)$ do not exist, some characteristics of the time paths can be discerned. First, $R_w(t)$ and $R_m(t)$ are decreasing in t. Another way of thinking about this result is that welfare recipients get less choosy about job and marriage offers as they get closer to reaching the time limit. Another interesting feature of the time paths of $R_w(t)$ and $R_m(t)$ is that for any fixed t

$$\lim_{T \to \infty} R_j(t) = R_j^*$$

where R_w^* and R_m^* are the reservation income levels in the absence of time limits. Put differently, very long time limits will not affect the behavior of welfare recipients in the early states of recipiency. Although very long time limits may not affect the behavior of welfare recipients who have not accumulated very

[11] See Appendix C for details on the derivation of equations (11), (16), and (17).

much time on welfare, the imposition of shorter time limits may immediately reduce the reservation levels of income. This immediate reduction in reservation income levels following the imposition of relatively short time limits occurs because short time limits will have an immediate effect on the expected present value of being on welfare.

Figure 2 plots the time paths of the log reservation wage, job offer acceptance probabilities, and the welfare hazard for the average sample member evaluated at the parameter estimates presented in Table 5 for a 60-month time limit. For comparative purposes, the equivalent functions in the absence of time limits are also plotted (dashed lines). Examination of Figure 2 reveals that the effects of a 60-month time limit can be large. In panel (a) of Figure 2 the log reservation wage decreases by more than 50 percent between the first month on welfare and the sixtieth cumulative month on welfare. The effect of the declining reservation wages on the behavioral component of the welfare hazard can be seen in panel (b) of Figure 2. The job offer acceptance probability increases by 25 percent between the first and sixtieth months of cumulative welfare receipt. Interestingly, most of the increase in the job offer acceptance probability takes place between the first and 45th months of cumulative welfare receipt. At 45 months, the job offer acceptance probability is nearly one. The net result of the increasing job and marriage offer acceptance probabilities can be seen in panel (c) of Figure 2. Between months 1 and 45 the welfare hazard increases by nearly 20 percent. Because acceptance probabilities achieve a near maximum at 45 months the welfare hazard remains virtually unchanged between months 45 and 60.

The search model implies that there are significant behavioral changes made in response to a 5-year life time limit of welfare benefit receipt. Given the large predicted effects of time limiting welfare benefit receipt on behavior a natural question to ask is what is the likelihood of reaching the time limit. When examining the likely effects of welfare reform it is important to note that time limits are not the only characteristic of welfare programs to have changed. The 1996 welfare reform legislation also mandated work requirements and the "get tough" talk associated with welfare reform may have made welfare programs more stigmatizing.[12] Furthermore, many states have implemented and expanded programs which

[12] Estimates of the effect of early welfare reform efforts on aggregate AFDC caseloads presented in Blank (1997b) and Levine and Whitmore (1997) show that aggregate AFDC caseload began to decline

provide job training and job search assistance. For these reasons, it is also interesting to consider other ways in which welfare reform may change the parameters of the search model. For instance, work requirements in conjunction with time limits, may increase search intensity. To the extent that employment during the first period of welfare receipt is a proxy for search intensity, it is useful to condition the job offer arrival rate on employment when considering the likely effects of welfare reform. Additionally, work requirements and increased stigma associated with welfare reform will have the effect of reducing the nonpecuniary disutility of work relative to welfare recipiency. Reducing the nonpecuniary disutility of work can be accomplished by setting the parameter q_w to zero.

Column 1 of Table 9 shows the likelihood that the average recipient will reach the 5-year time limit in one continuous spell of 5 years, or in multiple spells over the course of a 10 year period, with and without the behavioral adjustments. In column 2 of Table 9 the same simulations are shown with the job offer arrival rate conditioned on employment and q_w set to zero. The results presented in Table 9 indicate that allowing for a behavioral adjustment to time limiting welfare benefit levels when assessing the likelihood that individuals reach the time is important. When allowing behavior to change in response to a time limit regime the likelihood that the average sample member hits the time limit in one spell decreases by 20 percent. The likelihood that the average sample member hits the time limits in multiple spells over a 10- year period drops by nearly 10 percent when allowing for a behavioral response to the policy change.

The results shown in column 2 of Table 9 are more striking. When conditioning the job offer arrival rate on employment and setting $q_w = 0$ the likelihood that the average sample member hits the time limit without any modification to her behavior drops considerably. Allowing for a behavioral adjustment under this scenario further reduces the likelihood of hitting the time limit by 40 percent. When the chances of reaching the time limit in multiple spells are examined, the results are just as striking. Without any change in search behavior the likelihood of reaching the 5-year time limit in 10 years, conditioning on

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prior to the approval of welfare reform measures for implementation. This is consistent with the hypothesis that talk of welfare reform influences the behavior of welfare recipients.

employment and $q_w = 0$, drops to 0.16. Allowing for a change in behavior in response the time limit decreases this probability to 0.11.

That the effect of allowing behavioral response to time limits is higher when conditioning the job offer arrival rate on employment is not surprising. Conditioning on employment dramatically increases the value of the job offer arrival rate. When the job offer arrival rate increases reservation income levels will increase. Increases in reservation income levels, holding the parameters of the offer distributions fixed, will decrease offer acceptance probabilities, thus increasing the importance of choice in determining whether an individual remains on welfare. Since time limits will eventually push offer acceptance probabilities close to one, increases in the degree of choice in the welfare hazard maximizes the potential for behavioral adjustments.

8. Conclusion

This paper has been concerned with estimating a structural, competing risk model of AFDC durations based on the theory of search. This structural estimation procedure provides for decomposition between the choice and change components of AFDC exit. The estimates presented in this paper indicate that both choice and chance play an important role in continued participation in the AFDC program. In particular, the average monthly probability of receiving a job offer is about 0.04 while the average probability of accepting a job offer is 0.68. The estimates of the search model parameters indicate that marriage is not a very important component in determining the AFDC exit rate. Although marriage offer acceptance probabilities are high, marriage offer arrival rates are extremely low. The sample average of the expected waiting time until a marriage offer is received is over 20 years. One of the main implications of the search model is that there is a substantial degree of diminishing returns to policies aimed at reducing the time spent on welfare. In the states with high benefit levels, reducing welfare benefits will have a large effect on the AFDC exit rate, while in states with very low benefit levels reducing benefits will have virtually no effect on the AFDC exit rate.

This paper also considers the effects of time limiting benefits on the exit rate from welfare. Time limiting welfare benefits introduces nonstationarity into the search process in the form of increased job and marriage offer acceptance probabilities as the proximity to the time limit decreases. Simulations conducted using the parameter estimates generated by the stationary search model suggest the degree of behavioral modification in the face of time limits may be substantial. Allowing for changing search behavior brought about by time limits reduces the likelihood that the average recipient will hit the a 5-year time limit in 10 years from 0.44 to 0.40. When conditioning the job offer arrival rate on employment to account for increased search intensity and the effect of work requirements the importance of allowing for a behavioral changes increases considerably. Without the behavioral adjustment, the probability that the average recipient hits a 5-year time limit in 10 years is 0.16. Allowing for changes in behavior due to time limits reduces this probability to 0.11.

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Table 1
Distribution of First Observed AFDC Spells

Time	Number Completed	Cumulative Percentage	Number Censored	Cumulative Percentage	Survivor Function
0-3	100	24	63	12	0.89
4-6	146	60	106	32	0.72
7-9	46	71	66	44	0.65
10-12	52	84	57	54	0.57
13-15	26	90	32	60	0.52
16-18	18	94	39	68	0.48
19-21	12	97	40	75	0.45
22-24	7	99	45	84	0.43
25-27	1	99	20	87	0.42
28-32	3	100	43	95	0.40
33-39	0	_	25	100	_

Estimated Median Spell Length: 16.5 months

Table 2
Ending Reasons for First Observed Spells of AFDC Receipt

(a) Sample Analyzed in this Chapter

	Number	Percent
Censored	537	56.7
Change in Earned Income	223	23.5
Change in Marital Status	34	3.6
Unable to Determine Reason	153	16.2

(b) Sample Analyzed by Fitzgerald (1995)

	Number	Percent
Censored	269	50.5
Change in Earned Income	120	22.5
Change in Marital Status	28	5.3
Unable to Determine Reason	116	21.7

Table 3
Distribution of Spells of non-AFDC Receipt by Reason for Spell Ending

(a) Spells Ending with an Increase in Earned Income

Time	Number Completed	Cumulative Percentage	Number Censored	Cumulative Percentage	Survivor Function
0-3	30	46	14	9	0.86
4-6	17	73	36	31	0.77
7-9	6	81	20	44	0.74
10-12	4	89	21	57	0.70
13-15	4	95	12	65	0.66
16-18	1	97	19	77	0.65
19-21	2	100	14	86	0.63
22-39	0	_	23	100	_

(b) Spells Ending for Undetermined Reasons

Time	Number Completed	Cumulative Percentage	Number Censored	Cumulative Percentage	Survivor Function
0-3	10	21	16	8	0.93
4-6	20	64	21	35	0.80
7-9	10	85	22	56	0.68
10-12	6	98	9	64	0.60
13-15	0	98	5	69	0.60
16-18	0	98	11	79	0.60
19-21	0	98	10	87	0.60
22-39	1	100	12	100	0.60

Table 4
Sample Means and Standard Deviations

Variable	Mean
MEDIAN SPELL LENGTH	16.50
HIGH SCHOOL DROPOUT	0.34
	(0.47)
HIGH SCHOOL GRADUATE	0.47
	(0.50)
SOME COLLEGE	0.19
	(0.39)
AGE GROUP 1(=1 if 18<=AGE<=24)	0.46
	(0.50)
AGE GROUP 2 (=1 if 25<=AGE<=34)	0.36
	(0.48)
AGE GROUP 3 (=1 if 35<=AGE<=50)	0.19
	(0.39)
BLACK	0.34
	(0.47)
YOUNG KIDS (=1 if respondent has children with age<=5)	0.73
	(0.44)
OLD KIDS (=1 if respondent's youngest child is 16 or 17)	0.02
	(0.13)
ENDING INCOME (the log of post AFDC income of respondents whose spells ended because of an increase in earnings)	6.82
	(0.65)
ENDING FAMILY INCOME (the log of post AFDC income of respondents whose spells ended with a marriage)	6.91
	(1.63)
MAXIMUM BENEFIT (the log of maximum AFDC benefit)	5.86
	(4.80)
EMPLOYED (=1 if in employed)	0.22
	(0.41)
UNEMPLOYED (=1 if unemployed)	0.14
	(0.35)
UNEMPLOYMENT RATE (state monthly unemployment rate)	6.81
	(1.49)
Number of Observations	947

Table 5

Estimates of the Search Model Parameters ($r = .05$, T-Ratios in parentheses)

Variable	l_w	l_m	l_n	d_w	d_n	q_w	q_n
INTERCEPT	-2.958** (6.16)	-5.307** (6.92)	-4.447** (25.33)	-3.475** (4.10)	-3.160** (10.41)	-0.291 (0.43)	0.392 (0.19)
HIGH SCHOOL GRADUATE	0.514** (2.75)	0.450 (1.00)	0.039 (0.22)	0.476 (1.37)	-0.093 (0.30)	__	__
SOME COLLEGE	0.277 (1.19)	0.748 (1.38)	-0.358 (1.37)	0.669* (1.71)	-0.436 (0.86)	__	__
AGE GROUP 2 (=1 if 25<=AGE<=34)	0.052 (0.28)	-0.577 (1.39)	0.311 (1.65)	-0.296 (0.92)	-0.377 (1.17)	__	__
AGE GROUP 3 (=1 if 35<=AGE<=50)	-0.515* (1.95)	-1.123* (1.77)	0.325 (1.44)	-0.336 (0.75)	-0.526 (1.27)	__	__
BLACK	-0.294* (1.92)	-0.949** (2.07)	0.107 (0.64)	-0.072 (0.27)	0.378 (1.27)	__	__
YOUNG KIDS (=1 if respondent has children with age<=5)	-0.697** (3.51)	__	__	0.081 (0.24)	__	__	__
UNEMPLOYED (=1 if unemployed)	0.460** (2.09)	__	__	-0.149 (0.40)	__	__	__
EMPLOYED (=1 if employed)	1.308** (7.49)	__	__	-0.536* (1.93)	__	__	__
UNEMPLOYMENT RATE (state monthly unemployment rate)	-0.077 (1.46)	__	__	-0.016 (0.17)	__	__	__
OLD KIDS (=1 if respondent's oldest child is 16 or 17)	__	__	1.485** (4.02)	__	-10.89 (0.07)	__	__

Table 6

Sample Means of Search Model Probabilities and Expectations (r=0.05)

Variable	Sample Mean
Job Offer Arrival Rate (l_w)	0.039
Job Offer Acceptance Probability $[1-F(\log(R_w))]$	0.680
Expected Accepted Log Wage Offer	7.100
Marriage Offer Arrival Rate (l_m)	0.004
Marriage Offer Acceptance Probability $[1-G(\log(R_m))]$	0.832
Expected Accepted Log Marriage Offer	7.366
Residual AFDC Exit Rate l_n	0.015
AFDC Exit Rate (h)	0.044
Rate of Return to AFDC Following an Earnings Related Exit (d_n)	0.032
Rate of Return to AFDC Following a Residual Exit (d_n)	0.035

Table 7
Sample Means of AFDC Benefit Elasticities by Benefit Level (r=0.05)

Elasticity	Sample Mean
Average Real Benefit Level	
Job Offer Acceptance Probability $[1-F(\log(R_w))]$	-0.605
Expected Accepted log Wage Offer $E(\log(y_w) \mid y_w) > R_w)$	0.368
Marriage Offer Acceptance Probability $[1-G(\log(R_m))]$	-0.177
Expected Accepted Log Marriage Offer $E(\log(y_m) \mid y_m) > R_m)$	0.278
AFDC Exit Rate (h)	-0.330
Highest Real Benefit Level	
Job Offer Acceptance Probability $[1-F(\log(R_w))]$	-1.873
Expected Accepted log Wage Offer $E(\log(y_w) \mid y_w > R_w)$	0.658
Marriage Offer Acceptance Probability $[1-G(\log(R_m))]$	-0.406
Expected Accepted Log Marriage Offer $E(\log(y_m) \mid y_m > R_m)$	0.472
AFDC Exit Rate (h)	-0.572
Lowest Real Benefit Level	
Job Offer Acceptance Probability $[1-F(\log(R_w))]$	-0.129
Expected Accepted log Wage Offer $E(\log(y_w) \mid y_w > R_w)$	0.128
Marriage Offer Acceptance Probability $[1-G(\log(R_m))]$	-0.073
Expected Accepted log Marriage Offer $E(\log(y_m) \mid y_m > R_m)$	0.149
AFDC Exit Rate (h)	-0.088

Table 8
Sample Means of Search Model Probabilities and Expectations (r=0.10 and r=0.20)

	Sample Mean	
Variable	$r = 0.10$	$r = 0.20$
Job Offer Arrival Rate (l_w)	0.036	0.035
Job Offer Acceptance Probability $[1 - F(\log(R_w))]$	0.707	0.725
Expected Accepted Log Wage Offer $E(\log(y_w) \mid y_w > R_w)$	7.075	7.059
Marriage Offer Arrival Rate (l_m)	0.004	0.003
Marriage Offer Acceptance Probability $[1 - G(\log(R_m))]$	0.931	0.991
Expected Accepted Log Marriage Offer $E(\log(y_m) \mid y_m > R_m)$	7.169	7.028
Residual AFDC Exit Rate (l_n)	0.015	0.015
AFDC Exit Rate (h)	0.044	0.044
Rate of Return to AFDC Following an Earnings Related Exit (d_w)	0.032	0.032
Rate of Return to AFDC Following a Residual Exit (d_n)	0.035	0.035

Table 9
Probability of Hitting a 5-year Limit on Benefit Receipt

	Average Recipient	Average Recipient (EMPLOYED=1, $q_w = 0$)
One Continuous Spell (No Change in Behavior)	0.099	0.019
One Continuous Spell (With Change in Behavior)	0.078	0.011
Multiple Spells in a 10-Year Period (No Change in Behavior)	0.443	0.160
Multiple Spells in a 10-Year Period (With Change in Behavior)	0.401	0.111

Figure 1

Sample Mean of the Survival Function vs. Kaplan-Meier Estimate of the Survival Function (dashed lines represent 95 percent confidence intervals)

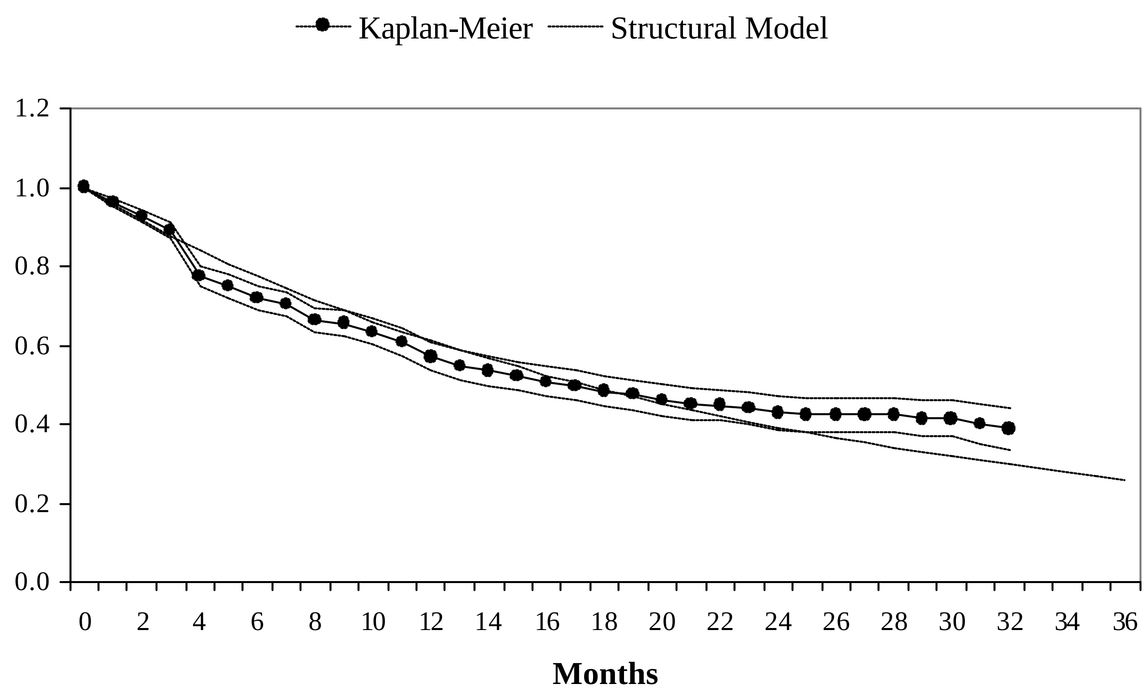
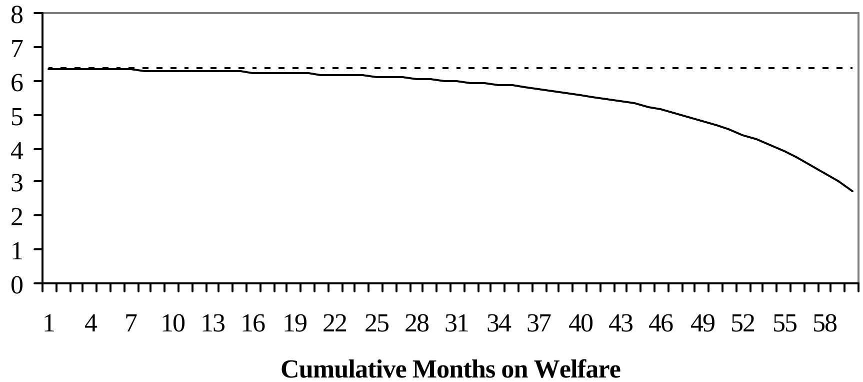


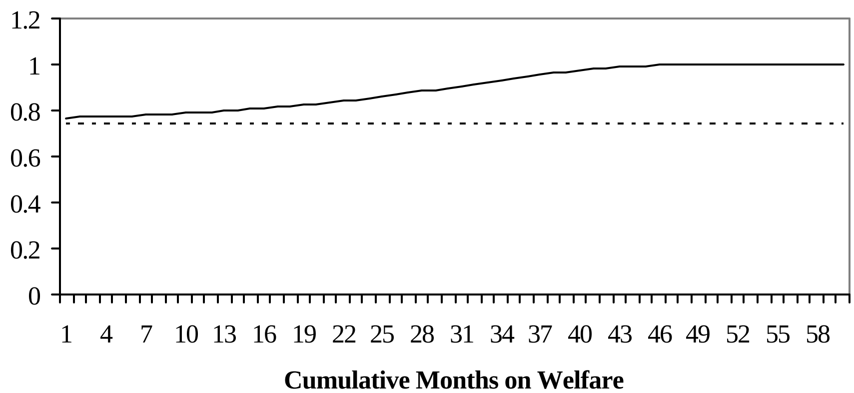
Figure 2

Time Path of Search Model Probabilities and Expectations
(60-Month Time Limit)

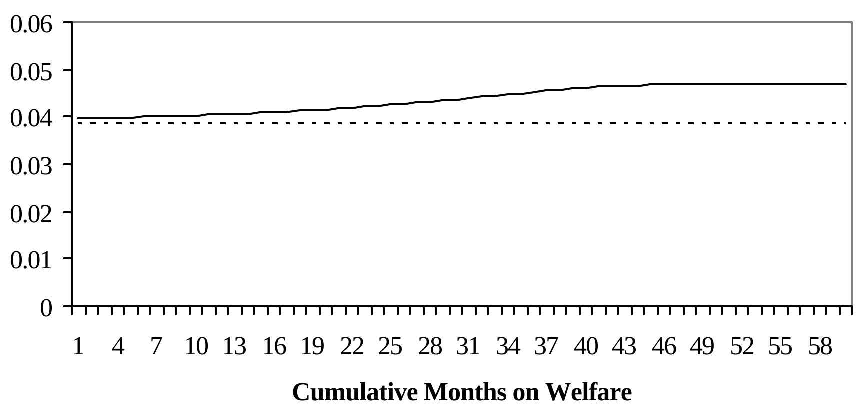
(a) Time Path of Reservation Wage Levels



(b) Time Path of Job Offer Acceptance Probability



(c) Time Path of Welfare Hazard



Appendix A

Tables Describing the Estimation of the Distribution of log Job and Marriage Offers

Table A.1

Probit Estimates of the Probability of Observing Ending Income (T-ratios in parentheses)

Explanatory Variables	Coefficient Estimates
INTERCEPT	0.889
	(1.30)
HIGH SCHOOL GRADUATE	0.294**
	(2.76)
SOME COLLEGE	0.240*
	(1.76)
AGE GROUP 2 (=1 if 25<=AGE<=34)	0.110
	(0.96)
AGE GROUP 3 (=1 if 35<=AGE<=50)	-0.046
	(0.30)
BLACK	-0.031
	(0.31)
YOUNG KIDS (=1 if respondent has children with age<=5)	-0.351**
	(2.84)
OLD KIDS (=1 if respondent’s youngest child is 16 or 17)	-0.237
	(0.66)
UNEMPLOYED (=1 if unemployed)	0.201
	(1.48)
EMPLOYED (=1 if employed)	0.695**
	(6.34)
UNEMPLOYMENT RATE (state monthly unemployment rate)	-0.517
	(1.61)
MAXIMUM BENEFIT (maximum AFDC benefit for a 4 person family)	0.238**
	(2.23)
Number of Observations	947
Log Likelihood Function	2,070

** Significant at the 5 percent level

* Significant at the 10 percent level

Table A.2
Estimates of the Distribution of log Job Offers (T-Ratios in parentheses)

	Coefficient Estimates	
Explanatory Variables	Specification 1	Specification 2
INTERCEPT	6.486** (64.12)	6.345** (25.65)
HIGH SCHOOL GRADUATE	0.152 (1.53)	0.174* (1.65)
SOME COLLEGE	0.405** (3.39)	0.426** (3.43)
AGE GROUP 2 (=1 if 25<=AGE<=34)	0.190** (2.07)	0.212** (2.15)
AGE GROUP 3 (=1 if 35<=AGE<=50)	0.561** (5.01)	0.574** (5.04)
BLACK	-0.091 (1.07)	-0.089 (1.04)
MILL'S RATIO	—	0.093 (0.62)
Estimated Variance	0.364	0.360
R^2	0.155	0.157
Number of Observations	947	947

** Significant at the 5 percent level
* Significant at the 10 percent level

Table A.3
Means and Standard Deviations (Data Used in Estimating Marriage Offer Distribution)

Variable	Mean
MARRIED	0.17
	(0.37)
HIGH SCHOOL DROPOUT	0.25
	(0.43)
HIGH SCHOOL GRADUATE	0.44
	(0.50)
SOME COLLEGE	0.31
	(0.47)
AGE GROUP 1(=1 if 18<=AGE<=24)	0.18
	(0.38)
AGE GROUP 2 (=1 if 25<=AGE<=34)	0.41
	(0.49)
AGE GROUP 3 (=1 if 35<=AGE<=50)	0.40
	(0.49)
BLACK	0.33
	(0.47)
YOUNG KIDS (=1 if respondent has children with age<=5)	0.51
	(0.50)
OLD KIDS (=1 if respondent's youngest child is 16 or 17)	0.06
	(0.49)
FAMILY EARNINGS (the log of post AFDC earnings of respondents whose spells ended because of an increase in earnings)	7.71
	(1.23)
MAXIMUM BENEFIT (the log of maximum AFDC benefit for a family of 4)	6.11
	(0.45)
EMPLOYED (=1 if in employed)	0.60
	(0.49)
UNEMPLOYED (=1 if unemployed)	0.08
	(0.27)
UNEMPLOYMENT RATE (state monthly unemployment rate)	6.30
	(1.38)
Number of Observations	5,512

Table A.4

Probit Estimates of the Probability of Entry into Marriage (T-ratios in parentheses)

Explanatory Variables	Coefficient Estimates
INTERCEPT	0.626**
	(1.98)
HIGH SCHOOL GRADUATE	0.231**
	(4.03)
SOME COLLEGE	0.419
	(0.67)
AGE GROUP 2 (=1 if 25<=AGE<=34)	-0.153
	(1.55)
AGE GROUP 3 (=1 if 35<=AGE<=50)	-0.333**
	(4.26)
BLACK	-0.643**
	(12.52)
YOUNG KIDS	
(=1 if respondent has children with age<=5)	0.145**
	(2.76)
OLD KIDS	
(=1 if respondent's youngest child is 16 or 17)	-0.237**
	(2.21)
UNEMPLOYED	
(=1 if unemployed)	-0.134
	(1.50)
EMPLOYED	
(=1 if employed)	0.052
	(1.04)
UNEMPLOYMENT RATE	
(state monthly unemployment rate)	0.140**
	(8.98)
MAXIMUM BENEFIT	
(maximum AFDC benefit for a 4 person family)	0.406**
	(8.75)
Number of Observations	5,512
Log Likelihood Function	9,910

** Significant at the 5 percent level
 * Significant at the 10 percent level

Table A.5
Estimates of the Distribution of log Marriage Offers (T-Ratios in parentheses)

	Coefficient Estimates	
Explanatory Variables	Specification 1	Specification 2
INTERCEPT	7.144**	6.660**
	(63.83)	(24.22)
HIGH SCHOOL GRADUATE	0.253**	0.302**
	(2.08)	(2.58)
SOME COLLEGE	0.508**	0.629**
	(4.35)	(4.75)
AGE GROUP 2 (=1 if 25<=AGE<=34)	0.297**	0.256**
	(2.87)	(2.31)
AGE GROUP 3 (=1 if 35<=AGE<=50)	0.468**	0.355**
	(4.21)	(2.82)
BLACK	-0.080	-0.242*
	(0.77)	(1.80)
MILL’S RATIO	__	0.360*
		(1.93)
Estimated Variance	1.428	1.519
R^2	0.058	0.157
Number of Observations	5,512	5,512

** Significant at the 5 percent level
* Significant at the 10 percent level

Appendix B

Derivation of the Reservation Wage Equations

The purpose of this appendix is to show how the reservation wage equations (5) and (6) were derived. The first step to deriving the reservation wage equations involves calculation the value of $l_u\left[N-U\right]$. Note that

$$(r+l_u+d_n)\left[N-U\right]=-l_w\int_{-\infty}^{\infty}\max\{W(y_w)-U,0\}dF\left(\log(y_w)\right)$$

$$-\ l_w\int_{-\infty}^{\infty}\max\{W(y_w)-U,0\}dF\left(\log(y_w)\right).$$

Simplifying and collecting terms

$$l_u\left[N-U\right]=-\frac{l_n l_w}{\left(r+l_u+d_n\right)}\int_{-\infty}^{\infty}\max\{W(y_w)-U,0\}dF\left(\log(y_m)\right)$$

$$-\frac{l_n l_w}{(r+l_u+d_n)}\int_{-\infty}^{\infty}\max\{M(y_w)-U,0\}dG\left(\log(y_m)\right)\ . \qquad \text{(B.1)}$$

Substitution of equation (B.1) into equation (1) yields the following

$$rU=\log(b)+\frac{l_w(r+l_n)}{(r+l_n+d_n)}\int_{-\infty}^{\infty}\max\{W(y_w)-U,0\}dF\left(\log(y_w)\right)$$

$$+\frac{l_m(r+l_n)}{(r+l_n+d_n)}\int_{-\infty}^{\infty}\max\{M(y_m)-U,0\}dG\left(\log(y_m)\right). \qquad \text{(B.2)}$$

Subtracting equation (B.2) from equation (2) gives the surplus value of employment. This surplus value equation is given by

$$r\left[W(x)-U\right]=\log(y_m)-\log(b)+q_w$$

$$-\frac{l_w(r+d_n)}{(r+l_n+d_n)}\int_{-\infty}^{\infty}\max\{W(y_m)-U,0\}dF\left(\log(y_w)\right)$$

$$-\frac{l_m(r+d_n)}{(r+l_n+d_n)}\int_{-\infty}^{\infty}\max\{M(y_m)-U,0\}dG(\log(y_m)). \quad \text{(B.3)}$$

The value of x that makes an individual indifferent between accepting a job that provides per-period utility $\log(x)+q_w$ and remaining on AFDC is the reservation wage in the job market. This reservation product can be found by setting equation (B.3) equal to zero. Setting equation (B.3) equal to zero implies that

$$\log(R_w)=\log(b)-q_w+\frac{l_w(r+l_n)}{(r+l_n+d_n)}\int_{-\infty}^{\infty}\max\{W(y_w)-U,0\}dF(\log(y_w))$$

$$+\frac{l_m(r+l_n)}{(r+l_n+d_n)}\int_{-\infty}^{\infty}\max\{M(y_m)-U,0\}dF(\log(y_m)). \quad \text{(B.4)}$$

The next step in deriving the surplus value of a marriage that provides per-period utility $\log(y_m)+q_m$. This surplus value can be found by subtraction equation (B.2) from equation (2)

$$r(M(x)-U)=\log(y_m)-\log(b)+q_m$$

$$-\frac{l_w(r+d_n)}{(r+l_u+d_n)}\int_{-\infty}^{\infty}\max\{W(y_m)-U,0\}dF(\log(y_w))$$

$$-\frac{l_m(r+d_n)}{(r+l_u+d_n)}\int_{-\infty}^{\infty}\max\{M(y_m)-U,0\}dG(\log(y_m)). \quad \text{(B.5)}$$

The value of y_m that makes an individual indifferent between entering into a marriage that provides per-period utility $\log(x)+q_m$ and remaining on AFDC is the reservation wage in the product in the marriage market. This reservation product can be found by setting equation (B.5) equal to zero. Setting (B.5) equal to zero implies that

$$\log(R_w)=\log(b)-q_m+\frac{l_w(r+l_u)}{(r+l_u+d_n)}\int_{-\infty}^{\infty}\max\{W(y_w)-U,0\}dF(\log(y_w))$$

$$+\frac{l_m(r+l_u)}{(r+l_u+d_n)}\int_{-\infty}^{\infty}\max\{M(y_m)-U,0\}dF(\log(y_m)) \quad \text{(B.6)}$$

Noting that $\left[M(y_m)-U\right]=\frac{1}{r}\left[\log(y_m)-\log(R_m)\right]$ and $\left[W(y_w)-U\right]=\frac{1}{(r+d_w)}\left[\log(y_w)-\log(R_w)\right]$

equations (B.4) and (B.6) become the reservation wage equations (5) and (6)

$$\log(R_w)=\log(b)-q_w+\frac{l_w(r+d_n)}{(r+d_w)(r+l_n+d_n)}\int_{\log(R_m)}^{\infty}\left[\log(y_w)-\log(R_w)\right]dF\left(\log(y_w)\right)$$

$$+\frac{l_m(r+d_n)}{r(r+l_n+d_n)}\int_{\log(R_m)}^{\infty}\left[\log(y_m)-\log(R_m)\right]dG\left(\log(y_m)\right) \quad (5)$$

$$\log(R_m)=\log(b)-q_m+\frac{l_w(r+d_n)}{(r+d_w)(r+l_n+d_n)}\int_{\log(R_m)}^{\infty}\left[\log(y_w)-\log(R_w)\right]dF\left(\log(y_w)\right)$$

$$+\frac{l_m(r+d_n)}{r(r+l_n+d_n)}\int_{\log(R_m)}^{\infty}\left[\log(y_m)-\log(R_m)\right]dG\left(\log(y_m)\right). \quad (6)$$

Appendix C

Derivation of the Time Path of the Reservation Wage Equations

This appendix shows how the differential equations that define the reservation wages in the job and marriage markets in the presence of a lifetime limit on AFDC benefit receipt are derived (equations (11) and (16) in the text).

Following van den Berg (1990), the value of being on welfare conditional on t periods of cumulative welfare receipt is given by

$$U(t)=\int_t^{\infty}\left\{\int_t^{t} b(s)e^{-r(s-t)}ds + l_w e^{-r(t-t)}\int_{-\infty}^{\infty}\max\{W(y_w\mid t),U(t)\}dF(\log(y_w)) + e^{-r(t-t)}\right.$$

$$\left. + l_m e^{-r(t-t)}\int_{-\infty}^{\infty}\max\{M(y_m),U(t)\}dG(\log(y_m)) + l_u e^{-r(t-t)}N(t)\right\}he^{-h(t-t)}dt \qquad \text{(C.7)}$$

where $b(s)$ is the benefit in period s, $W(y_w \mid t)$ is the value of being employed at a job providing per-period wage of y_w given t periods of cumulative welfare receipt, and $r, M(y_m), N, F, G, l_w, l_m, l_u$, and h are defined as in the text.[c1] Note that by using Liebnitz's Rule the derivative of $U(t)$ can be written

$$U'(t)=\int_t^{\infty}\left\{\int_t^{t} b(s)e^{-r(s-t)}ds + l_w e^{-r(t-t)}\int_{-\infty}^{\infty}\max\{W(y_w\mid t),U(t)\}dF(\log(y_w)) + e^{-r(t-t)}\right.$$

$$\left. + l_m e^{-r(t-t)}\int_{-\infty}^{\infty}\max\{M(y_m),U(t)\}dG(\log(y_m)) + l_n e^{-r(t-t)}N(t)\right\}\left[\frac{d}{dt}\left(he^{-h(t-t}\right)\right]dt$$

$$+\int_t^{\infty}\left[he^{-h(t-t)}\right]\frac{d}{dt}\left\{\int_t^{t} b(s)e^{-r(s-t)}ds + l_w e^{-r(t-t)}\int_{-\infty}^{\infty}\max\{W(y_w\mid t),U(t)\}dF(\log(y_w))\right.$$

$$\left. + e^{-r(t-t)} + l_m e^{-r(t-t)}\int_{-\infty}^{\infty}\max\{M(y_m),U(t)\}dG(\log(y_m)) + l_n e^{-r(t-t)}N(t)\right\}dt$$

[c1] Note that in this application $b(s)=0$ for $s>T$.

$$- l_w \int_{-\infty}^{\infty} \max\{W(y_w \mid t), U(t)\} dF(\log(y_w)) - l_w \int_{-\infty}^{\infty} \max\{M(y_m), U(t)\} dG(\log(y_m))$$

$$- l_n N(t) \text{ .}^{c2} \tag{C.2}$$

The first two lines of equation (C.2) simplify to $hU(t)$. Using Liebnitz's Rule for a second time, lines 3 and 4 of equation (C.2) simplify to $rU(t) - b$. With some additional algebra equation (C.2) simplifies to equation (11)

$$rU(t) = b + l_w \int_{-\infty}^{\infty} \max\{W(y_w \mid t) - U(t), 0\} dF(\log(y_w)) + l_m \int_{-\infty}^{\infty} \max\{M(y_m) - U(t), 0\} dG(\log(y_m))$$

$$+ l_n [N(t) - U(t)] + U'(t) \text{ .} \tag{1.11}$$

To find the time paths of the reservation wages note that $R_w(t) = rU(t) - q_w$, $R_m(t) = rU(t) - q_m$,

$$W(y_w \mid t) = \frac{[\log(y_w) + q_w - rU(t)]}{r + d_w} \text{ ,} \tag{C.3}$$

$$M(y_m) = \frac{1}{r}[\log(y_m) + q_m] \text{,} \tag{C.4}$$

and,

$$N(t) = \frac{[\log(b) - rU(t)]}{r + d_n} \text{ .} \tag{C.5}$$

Substituting (C.3), (C.4), and (C.5) into (11) and collecting terms yields equation (16).

[c2] **Liebnitz's Rule:** Let $f(x,t)$ be continuous with respect to x for every value of t, with a continuous derivative $df(x,t)\, df(x,t)/dt$ with respect to x and t in the rectangle $a \le x \le b$, $\underline{t} \le t \le \bar{t}$ of the $x - t$ plane. Let the functions $A(t)$ and $B(t)$ have continuous derivatives. If $V(t) = \int_{a(t)}^{b(t)} f(x,t)dx$, then

$$V'(t) = f(B(t),t)B'(t) - f(A(t),t)A'(t) + \int_{A(t)}^{B(t)} \left(\frac{df(x,t)}{dt}\right) dx.$$