INTERNATIONAL ECONOMIC REVIEW
Vol. 47, No. 1, February 2006

JOB SEARCH AND ASSET ACCUMULATION UNDER BORROWING CONSTRAINTS*

BY SÍLVIO RENDON [1]

Centro de Investigación Económica - Instituto Tecnológico Autónomo de México (ITAM), Mexico

This article examines the relationship between wealth accumulation and job search dynamics. It proposes a model in which risk-averse individuals search for jobs, save, and borrow to smooth their consumption. One motivation for accumulating wealth is to finance voluntary quits in order to search for better jobs. Using data on men from the National Longitudinal Survey (1979 cohort), I estimate the individual's dynamic decision problem. The results show that borrowing constraints are tight and reinforce the influence of wealth on job acceptance decisions, namely that more initial wealth and access to larger amounts of credit increase wages and unemployment duration.

1. INTRODUCTION

This article studies the relationship between asset accumulation and imperfect capital markets, and job search and employment dynamics. I develop and estimate a model of job search and savings that replicates observed trends in assets, employment transitions, and wages. I find that asset holdings are related to job search outcomes because they allow wealthier individuals to be more selective and to wait for jobs that offer higher wages. For example, increasing initial asset holdings by $5,000 raises accepted quarterly wages by $800 in the first quarter after high school graduation. It also extends average unemployment duration by over two quarters. I also find evidence of tight borrowing constraints; agents can borrow only 14% of the present value of their risk-free income. Simulation results based on the estimated model show that relaxing borrowing constraints has an important effect on labor market outcomes. Increasing an individual's access to credit to half of the present value of his risk-free income causes his wages in

* Manuscript received November 2002; revised September 2004.

[1] This article is a revision of part of my Ph.D. dissertation submitted to New York University, 1997. I thank Chris Flinn, Ken Wolpin, and Wilbert van der Klaauw for their encouragement and advice. W. Baumol, R. Bénabou, A. Caplin, D. Gale, M. Gertler, B. Jovanovic, R. Kinnunen, Y. Nyarko, F. Peracchi, S. Pratap, N. Quella, G. Rabault, G. Topa, A. Velasco, C. Wilson, and E. Wolff as well as the editor, Petra Todd, and two anonymous referees provided helpful comments and suggestions. I also thank participants of seminars at NYU, U. of Western Ontario, European Institute Florence, U. Carlos III, U. Pompeu Fabra, ITAM, Florida International U., U. of Copenhagen. I gratefully acknowledge financial support of the Spanish Ministry of Science and Technology (Grant SEC 2001-0674) and the Mexican Association of Culture. The usual disclaimer applies. Please address correspondence to: Sílvio Rendon, Department of Economics and Centro de Investigación Económica - Instituto Tecnológico Autónomo de México (ITAM), Av. Camino Sta Teresa #930, Mexico D.F. 10700, Mexico. Phone: +52 55 5628 4000. Fax: +52 55 5628 4058. E-mail: *srendon@itam.mx*.

the first quarter after graduation to rise by $750 and to remain higher for several periods afterward.

In the model presented in this article, agents decide in each time period on a level of consumption and a job acceptance policy, given their asset holdings and subject to a borrowing constraint parameterized as a fraction of what can be paid back with certainty. Additionally, employed agents experience wage growth while working for the same employer. This model has the following implications: (i) reservation wages are increasing in assets; (ii) during unemployment spells agents decumulate assets and gradually reduce their wage aspirations; (iii) during employment spells agents save to hedge against future periods of unemployment; and (iv) increases in assets during employment spells act as a source of quits to unemployment. Thus, saving decisions are closely related to changes in the observed patterns of labor market variables, namely quits to unemployment to search for better paid jobs, increasing hazard rates during unemployment, and lower accepted wages the longer an unemployment spell.

The asset data used in this analysis come from the National Longitudinal Survey (youth cohort). As seen in Table 1, white male high school graduates who did not attend college on average accumulate assets after leaving school. From year 3 to year 9 after graduation, they increase asset holdings from $6,000 to $13,300. During the same period the percentage of agents with asset holdings over $10,000 increases from 20% to 43%, whereas the fraction of the unemployed or part-time workers decreases from 18% to 9%. Average quarterly wages increase from $3,400 to $4,500. Notably, after graduation, asset accumulation and employment increase concurrently. Table 2 shows the relationship between saving behavior and employment transitions. Becoming or staying unemployed is associated with asset decumulation, whereas becoming or staying employed, whether or not with the same employer, is associated with an increase in asset holdings. Those who remain unemployed between two calendar quarters run down their assets by $1,600, whereas those who stay with the same employer increase their assets by $1,500 per quarter. These comovements, although not surprising, are systematic and informative about the credibility of the asset data.

In standard job search models, if individuals are wealth maximizers in a world with perfect capital markets, then the processes of asset accumulation and job search are unconnected.[2] However, if agents are not able to borrow freely, then they must self-finance the out-of-pocket cost of search and their search time horizon is limited by the size of their financial resources (Mortensen, 1986). Most existing econometric studies of the job search process are based on the assumption of either an infinite search horizon with perfect capital markets or an exogenously given search horizon (Kiefer and Neumann, 1979; Flinn and Heckman, 1982a, 1982b; Wolpin, 1987, 1992; Meyer, 1990).

Danforth (1979), using a model of utility-maximizing job search, analyzed in detail the role of asset endowments on an individual's optimal job search strategy.

[2] See the models surveyed by Lippman and McCall (1976) and Mortensen (1986).

TABLE 1

ASSETS, UNEMPLOYMENT, AND WAGES BY YEARS AFTER GRADUATION. WHITE MALE HIGH SCHOOL GRADUATES BETWEEN 1978 AND 1993

Variable	Year 3	Year 6	Year 9
Average assets	6023	9278	13,329
Percentage of individuals with			
Assets ≤ 0	6.25	12.32	10.00
$0 <$ Assets $\leq 10{,}000$	75.00	57.25	47.14
$10{,}000 <$ Assets $\leq 20{,}000$	9.38	18.12	17.14
$20{,}000 <$ Assets $\leq 30{,}000$	6.25	3.62	10.71
Assets $> 30{,}000$	3.13	8.70	15.00
Percentage of unemployed	18.34	10.94	8.83
Average quarterly wage	3363	4114	4552

NOTE: The amounts are given in 1985 dollars. An individual is unemployed if he works less than 20 hours in a week.

TABLE 2

AVERAGE QUARTERLY SAVING ACCORDING TO EMPLOYMENT TRANSITIONS

Employment Status t	$t+\Delta$			
	Unemployment	Same Employment	New Employment	Total
Unemployment	−1597	0	1,005	123
	(41)		(80)	(121)
Employment	−6095	1542	332	773
	(67)	(685)	(151)	(903)
Total	−4387	1542	565	696
	(108)	(685)	(231)	(1024)

NOTES: The number on top is saving, defined as the average quarterly variation of assets between periods when asset holdings are observed. Below in parentheses is the number of individuals involved in the transition. The employment status in the first period t is described in the first column. The employment status in the next period when assets are observed, $t+\Delta$, is reported in the first row.

In his setup, only the unemployed look for a job and receive wage offers from a nondegenerate distribution; the employed do not search and do not become unemployed and there is no decision about search intensity. A result of this analysis is that reservation wages are increasing in wealth, so that “the rich get richer.” Since Danforth’s seminal paper, several utility-maximizing job search models have been proposed, mostly to assess the role of unemployment insurance in job search and consumption behavior and of job search in business cycles.[3] Recently, there

[3] See Flemming (1978), Hansen and Imrohoroglu (1992), Andolfatto (1996), Blundell et al. (1997), Costain (1997), Hopenhayn and Nicolini (1997), Rendon (1997), Acemoglu and Shimer (1999), Marimon and Zilibotti (1999), Gomes et al. (2001), Lentz (2001), Bertola (2002), Browning et al. (2002), Pissarides (2002), and Joseph and Weitzenblum (2003).

have been several empirical studies that adopted Danforth's basic framework.[4] Stancanelli (1999) and Bloemen and Stancanelli (2001) using Dutch data find that more wealth increases reservation wages and diminishes transitions from unemployment to employment. Similarly, Algan et al. (2002) use French data to show that more wealth decreases unemployment duration and increases the probability of quits to unemployment. Along similar lines, Lentz and Tranæs (2001) propose a model that links asset holdings to job search by the choice of search intensity, showing that assets have a theoretically ambiguous effect on search intensity. Using Danish data, they find that search intensity exhibits positive duration dependence over the unemployment spell, which suggests that wealth has a negative effect on job search.

The model proposed in this article generalizes Danforth's canonical model to allow for on-the-job search, wage growth, retirement, and a parametric borrowing limit that is estimated. Incorporating these additional features into the model generates realistic employment transitions and trajectories and distributions of assets and wages over the life cycle.

To estimate the behavioral parameters of the model I apply the method surveyed by Rust (1988) and Eckstein and Wolpin (1989). Using the numerical solution of the dynamic programming problem as an input, I construct probability statements for observed assets, wages, and employment transitions and integrate them into a maximum-likelihood estimation procedure. Accounting for differences in initial assets and assuming specific utility, wage offer distribution, and wage growth functions, I recover the parameters of the search model and use them to evaluate two regime changes: a displacement of the initial asset distribution and a relaxation of the borrowing constraint.

The remainder of the article is organized as follows. Section 2 describes the model and highlights its main implications for asset accumulation and employment dynamics. Section 3 discusses the selection of the sample and presents descriptive statistics. Section 4 describes the estimation procedure. Section 5 presents the results of the estimation, and Section 6 discusses regime changes based on the estimated parameters of the model. Section 7 summarizes the main conclusions of the article.

2. THE MODEL

Consider an individual with a period-by-period utility function $U(\cdot)$ over consumption who seeks to maximize expected lifetime utility without bequests. This agent lives for T_F quarters and works for T quarters, after which he retires and lives off his savings. Throughout his working lifetime he can be unemployed, in which case with probability λ^e he receives one wage offer x drawn from the known wage offer distribution $F(\cdot)$, $x \in [\underline{w}, \bar{w}]$, $0 < \underline{w} < \bar{w} < \infty$, or he can be employed and be laid off with probability θ and receive a wage offer with probability λ^e,

[4] Notable empirical studies on consumption during unemployment, though not on job search, were done by Hamermesh (1982) and Dynarski and Sheffrin (1987), who study consumption patterns during unemployment spells.

drawn from the same distribution $F(\cdot)$. While unemployed, he becomes employed if he receives and accepts a wage offer; otherwise he remains unemployed. While employed, he can experience the following transitions:

- If he is not laid off and receives a job offer, he can accept it and switch to a new job, reject it and stay in the current job, or reject it to quit his current job and become unemployed.
- If he is not laid off and does not receive a job offer, he has to decide between staying in the same job or quitting to unemployment.
- If he is laid off and receives an offer, he can accept it and switch to a new job, or reject it to become unemployed.
- If he is laid off and does not receive an offer, his only option is to become unemployed.

During his working life the agent receives transfers b when unemployed, which include nonlabor income, like family transfers, plus unemployment compensation net of out-of-pocket search costs.[5] When employed, the agent experiences wage growth due to specific human capital accumulation. His current wage $w(\omega, k_t)$ depends on the initial wage draw ω and the number of periods he has been working for the same employer k_t. Specific human capital evolves deterministically until reaching an upper bound: $k_{t+1} = \min(k_t + 1, \bar{k})$.

In each period, given his employment state and his current assets A_t, the agent determines his level of consumption C_t^u and C_t^e or, equivalently, his desired level of assets for the next period A_{t+1}^u and A_{t+1}^e. Initial assets A_0 are inherited, so they are not the product of an earlier accumulation of assets. The rate of return r is the same for saving and borrowing and is constant. The subjective discount factor is $\beta \in (0, 1)$. There is no restriction for transferring resources across periods through saving; assets, however, cannot be lower than a time-dependent level B_t. Under free capital markets the individual can borrow as much as he can pay back with probability one, that is, there is a Hakansson–Miller or "natural" borrowing limit (Hakansson, 1970; Miller, 1974; Ljungqvist and Sargent, 2000).[6] In this model the agent's lowest possible income level before retirement is set by transfers b; after retirement, there are no transfers and, therefore, the lowest possible income level is zero. This sets the natural borrowing limit at $\tilde{B}_t = -\sum_{s=t}^{T} b/(1+r)^{T-s} = -b(1+r)/r(1 - 1/(1+r)^{T-t+1})$. With a utility function satisfying the Inada condition $\lim_{C\to 0} U(C) = \infty$, the agent will not run down his assets below $\tilde{B}_t$ because $\tilde{B}_t + b - \tilde{B}_{t+1}/(1+r) = 0$, so any constraint $B_t < \tilde{B}_t$ is redundant. The individual is said to face borrowing constraints when he is allowed to borrow only up to the amount he can repay with certainty, i.e., $B_t > \tilde{B}_t$. A parameter s measures the

[5] Search costs and choice of search intensity can be explicitly included in this model. The identification of these additional parameters is, however, not feasible given the available data.

[6] When lenders are fully risk averse and unwilling to share risk with borrowers, payback must be certain. As discussed by Grossman et al. (1979), if the borrowing limit is the expected lifetime income, bankruptcy has to be possible, which cannot happen with utility functions satisfying the Inada condition. Moreover, incorporating the full set of Arrow–Debreu contingent contracts would require allowing for default and dealing with problems of adverse selection or moral hazard that are beyond the scope of this article.

tightness of the borrowing constraint as a fraction of the natural borrowing limit, that is, $B_t = s\tilde{B}_t, s \in [0, 1]$.

The present discounted utility of a retired agent $V_t^R, t = T+1, \ldots, T_F$, depends on asset holdings A_t

$$V_t^R(A_t) = \max_{\{A\}_{s=t+1}^{T_F}} \sum_{s=t}^{T_F} \beta^{s-t} U\left(A_s - \frac{A_{s+1}}{1+r}\right)$$

where, in the absence of bequest motives, $A_{T_F+1} = 0$. With agents saving voluntarily for retirement, with full control over their pension funds, the dynamic problem becomes "a cake-eating problem."[7]

Expected lifetime utility in the unemployment state at time t, V_t^u, is characterized by asset holdings A_t

$$\begin{aligned} V_t^u(A_t) = \max_{A_{t+1}^u \geq B_{t+1}} &\left\{ U\left(A_t + b - \frac{A_{t+1}^u}{1+r}\right) \right. \\ &+ \beta \left[\lambda^u \int \max\left[V_{t+1}^e\left(A_{t+1}^u, x, 0\right), V_{t+1}^u\left(A_{t+1}^u\right)\right] dF(x) \right. \\ &\left.\left. + (1-\lambda^u) V_{t+1}^u\left(A_{t+1}^u\right) \right] \right\} \end{aligned}$$

In the employment state, expected lifetime utility V_t^e at time t depends on asset holdings A_t, wage ω and tenure k_t

$$\begin{aligned} &V_t^e(A_t, \omega, k_t) \\ &= \max_{A_{t+1}^e \geq B_{t+1}} \left\{ U\left(A_t + w(\omega, k_t) - \frac{A_{t+1}^e}{1+r}\right) \right. \\ &\quad + \beta \left[(1-\theta) \left(\lambda^e \int \max\left[V_{t+1}^e\left(A_{t+1}^e, x, 0\right), V_{t+1}^e\left(A_{t+1}^e, \omega, k_{t+1}\right), \right.\right.\right. \\ &\quad\quad \left. V_{t+1}^u\left(A_{t+1}^e\right)\right] dF(x) + (1-\lambda^e) \\ &\quad\quad \left. \times \max\left[V_{t+1}^e\left(A_{t+1}^e, \omega, k_{t+1}\right), V_{t+1}^u\left(A_{t+1}^e\right)\right] \right) \\ &\quad + \theta \left(\lambda^e \int \max\left[V_{t+1}^e\left(A_{t+1}^e, x, 0\right), V_{t+1}^u\left(A_{t+1}^e\right)\right] dF(x) \right. \\ &\quad\quad \left.\left.\left. + (1-\lambda^e) V_{t+1}^u\left(A_{t+1}^e\right) \right) \right] \right\} \end{aligned}$$

We have thus a dynamic programming (DP) problem with a finite horizon T and a "salvage value" that is the present discounted utility at retirement:

[7] The institutional mechanisms of a pension system (characterized by schemes of contribution during working lifetime and pensions during retirement) are beyond the goal of this article. This highly stylized analysis, however, will prove able to generate savings for life cycle motives.

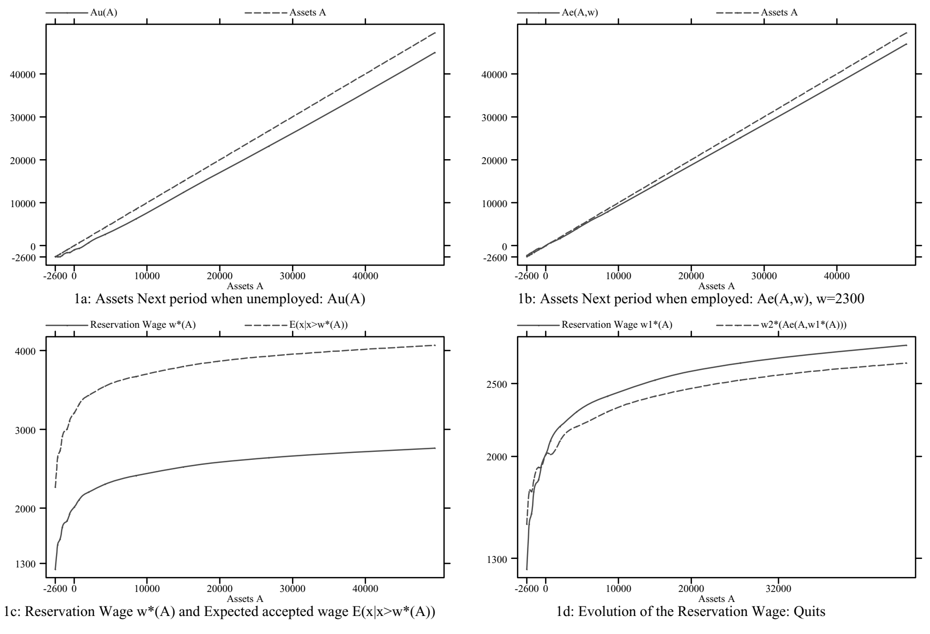

FIGURE 1

POLICY RULES AT $t = 1$: ASSETS WHEN UNEMPLOYED, ASSETS WHEN EMPLOYED, RESERVATION WAGES, AND ASSETS WHEN EMPLOYED AT THE RESERVATION WAGE

$V_t^u(A_t) = V_t^R(A_t)$, $V_t^e(A_t, \omega, k_t) = V_t^R(A_t)$, at $t = T + 1$. Two policy rules $A_{t+1}^u(A_t)$ and $A_{t+1}^e(A_t, \omega, k_t)$ solve this problem. Whether the individual is employed or unemployed, there exists a reservation wage that indicates the lowest acceptable wage to start working for a new employer, that is, $\omega_t^*(A_t) = \{\omega \mid V_t^u(A_t) = V_t^e(A_t, \omega, 0)\}$. Because of on-the-job search and wage growth there is a second reservation wage that emerges from the comparison between the value of switching to a new employer and the value of staying at the current job and accumulating human capital: $v_t(A_t, \omega, k_t) = \{v \mid V_t^e(A_t, v, 0) = V_t^e(A_t, \omega, k_t)\}$.

Because the optimal solution to the DP problem does not admit an analytical expression, I compute a numerical approximation to the value functions and to the policy rules. This estimation procedure discretizes the continuous state variables into a grid of points and assumes specific functional forms: a constant relative risk aversion (CRRA) utility function $U(C) = (C^{1-\gamma} - 1)/(1 - \gamma)$, where γ is the coefficient of risk aversion, a truncated lognormal wage offer distribution $\ln x \sim N(\mu, \sigma^2 \mid \ln \underline{w}, \ln \bar{w})$, and a wage function $w(\omega, k_t) = \omega \exp(\alpha_1 k_t + \alpha_2 k_t^2)$. Appendix A.1 describes in detail the discretization and the solution technique.

Figure 1 illustrates the policy rules at period 1 under the assumption that there is no on-the-job wage growth.[8] Figures 1a and 1b present cross sections of A^u and A^e as a function of A. In the first figure, unemployed agents decumulate assets monotonically until hitting the borrowing limit, that is, they use their accumulated

[8] In that case, the value functions can be expressed as $V_t^u(A)$ and $V_t^e(A,w)$, and the policy rules as $A_t^u(A)$, $A_t^e(A, w)$ and $w_t^*(A)$. Table 3 reports the parameter values used to compute these policy rules.

assets to maintain their consumption while searching for a job. The next figure shows that employed agents accumulate assets until reaching some steady-state level, thereby hedging against future unemployment spells. Figure 1c depicts the reservation wage $w_1^*(A)$ and expected accepted wage $E(x \mid x \geq w_1^*(A))$ as a function of assets. They are both clearly increasing in assets, which means that wealthier agents are more selective and have higher accepted wages. The policy rules imply that during unemployment spells agents decumulate assets, decrease their reservation wages, and increase hazard rates, whereas during employment spells they build up assets and increase reservation wages. In this manner, savings decisions interact with labor market dynamics and create time dependence in employment states and wages.

Figure 1(d) illustrates how quits to unemployment can happen in this model.[9] An agent with wealth A and employed at wage $w_1^*(A)$ enters next period with wealth $A_1^e(A, w_1^*(A))$, whereas his reservation wage becomes $w_2^*(A_1^e\,(A, w_1^*(A)))$. For low asset levels, if this new reservation wage exceeds his current wage and there is no acceptable wage offer from another employer, he will voluntarily leave his current job to become unemployed. This is equivalent to saying that quits to unemployment can happen if the reservation wage allows agents to accumulate assets: $A_1^e(A, w_1^*(A)) > A$. This incentive to quit exists if the wage offer rate is considerably higher while unemployed than while employed. An agent with little wealth and a low paying job accumulates wealth and finds that his current job is no longer acceptable because he can search for better jobs while unemployed with a higher probability of receiving wage offers. Accumulating assets and quitting to unemployment are thus part of the whole search strategy for attaining higher wages.[10]

I also use the policy rules to simulate the employment, wages, and asset trajectories for individuals with zero initial assets and for individuals with \$10,000 worth of initial assets. Figure 2 shows the time paths for assets, consumption, wages, and unemployment rate for both types of individuals, from high school graduation to retirement. Figure 2a shows that in the years immediately after graduation wealthy agents decumulate, whereas poor agents accumulate; then, in midlife, both maintain their asset levels stable, and, finally, both groups accumulate intensively in the years prior to retirement.[11] The difference in initial wealth between both groups, although diminishing over time, persists for more than 60 quarters after

[9] Unlike quits to switch employer, common in models with on-the-job-search (Burdett, 1978), explanations for quits to unemployment are less frequent in the literature. One explanation is that workers may take jobs without knowing their true wage; once wages are revealed to be low, they quit to unemployment (Jovanovic, 1979). Another argument, which explains observed procyclical quits, is that economic booms change wage offer distributions or arrival rates in such a way that workers find it profitable to quit and search while unemployed (Jovanovic, 1987; Lippman and Mamer, 1989). Finally, in a finite horizon model in which wages and arrival rates depend on work experience and tenure, individuals quit because the value of investing in working decreases over time (Wolpin, 1992).

[10] Unlike in dynamic models of consumption and labor supply where agents decide on their income directly by choosing the number of hours worked (Heckman and MaCurdy, 1980; MaCurdy, 1981), in job search models agents decide indirectly on their income through a stopping rule.

[11] This coincides with the pattern of asset accumulation prior to retirement explained by Rust, et al. (2003), who use a model with contributions during the working lifetime and pension schemes.

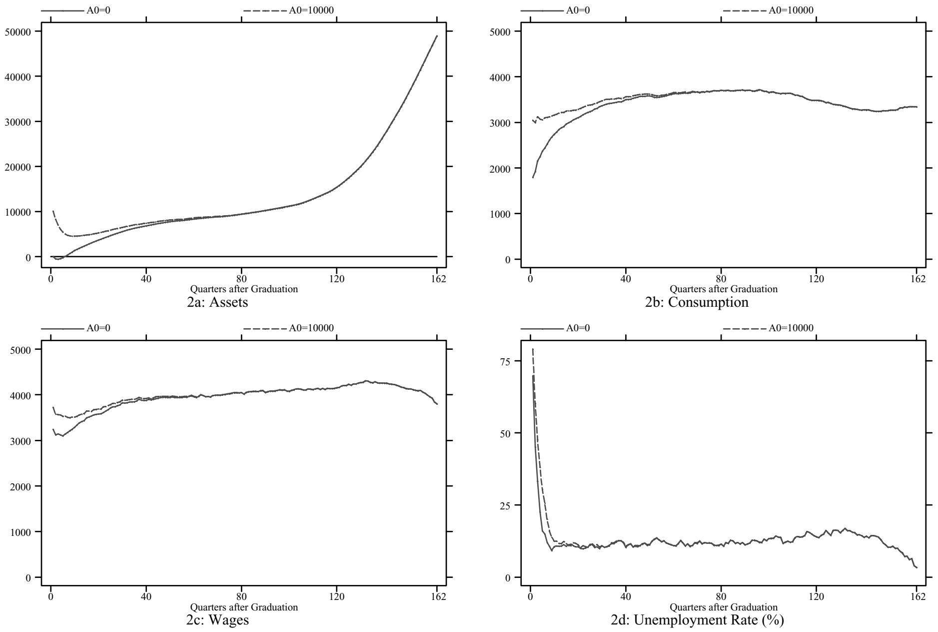

FIGURE 2

QUARTERLY EVOLUTION OF ASSETS, CONSUMPTION, WAGES, AND UNEMPLOYMENT RATE BY INITIAL ASSETS

graduation. Consumption, shown in Figure 2b, increases over time at the beginning of the employment career and is higher for wealthier individuals; however, it declines slightly in the years prior to retirement. Figure 2c shows that although wealthier individuals start off with higher average wages, their first and longer unemployment spell pulls their reservation wages down and decreases average wages for a few quarters. Nevertheless, wages increase systematically over time, decreasing only after quarter 130, due to an end-of-working-lifetime decrease in reservation wages. Figure 2d reports the unemployment rate over time, which decreases substantially in the first quarters after graduation, remains relatively constant over time, and decreases at the end of the working lifetime.

Table 3 presents a summary of the variations of the main variables in quarters 1, 20, and 40 caused by changes in different parameters of the model for individuals who start off their careers with zero assets. Larger unemployment transfers raise reservation wages, thereby increasing unemployment rates, wages, consumption, and welfare. They also reduce the need for a buffer stock, so assets go down but, as wages are higher, saving rates decline as well. Increases in λ^u or λ^e reduce unemployment rates and increase wages, consumption, saving rates, and welfare. However, a higher λ^u increases assets, suggesting that the effect of higher wages dominates over the effect of a less painful unemployment. In contrast, a higher λ^e decreases assets, which implies that the effect of faster job-to-job transitions that make agents less afraid of becoming unemployed is stronger than the effect of

TABLE 3

SENSITIVITY ANALYSIS: STATISTICS FOR BASELINE PARAMETERS AND FOR VARIATIONS OF ONE PARAMETER AT A TIME

Levels		Variation in Statistics from a Change in One Parameter at a Time								
Period	Parameter	b	λ_u	λ_e	θ	μ	σ	α_1, α_2	γ	s
	Baseline	400	0.90	0.20	0.04	6.5	0.90	0, 0	1.2	0.1
	Variation	100	0.05	0.05	0.01	0.2	0.10	0.01, −0.001	0.3	0.4
Unemployment rate										
1	68.63	2.36	−1.60	−3.16	−3.16	−1.32	−2.17	0	−3.16	7.12
20	11.37	0.56	0.47	−1.61	1.79	0.28	0.38	0	−1.04	0.23
40	12.22	1.32	−0.19	−1.61	1.80	0.33	1.13	0.23	−0.14	1.36
Wages										
1	3211	97	18	−118	−118	237	319	0	−118	325
20	3647	61	49	11	−43	333	517	52	−79	97
40	3946	64	40	32	−108	362	576	59	−44	71
Assets										
20	4006	−681	51	−411	546	688	1283	139	869	−6361
40	8148	−741	70	−420	506	1117	2074	96	1946	−6338
Consumption										
1	1796	85	33	74	−6	83	97	23	−7	837
20	3124	43	23	58	−104	263	412	46	−82	22
40	3403	6	35	69	−146	298	471	51	−43	−118
Saving rates										
1	−40.11	−2.96	2.85	−0.54	5.48	5.53	9.54	−1.80	5.56	−86.78
20	4.70	0.07	0.10	0.03	0.40	0.23	0.30	−0.07	1.43	1.56
40	3.13	0.44	0.15	0.38	−0.16	−0.08	−0.66	−0.26	0.29	03.7
Welfare										
40	107.45	0.13	0.06	0.16	−0.18	0.40	0.55	0.06		0.66
Percentage of quits in transition from employment to unemployment										
20	27.96	−6.12	1.39	−6.01	−10.91	−5.61	−5.72	−3.54	−8.68	1.94

higher wages. Higher layoff rates produce higher unemployment rates and lower wages, consumption, and welfare, but increase asset holdings because of the need to buffer against a more likely unemployment spell. A better wage offer distribution, characterized by a higher mean or variance of log wages, implies higher unemployment rates and wages, but also more wealth and more consumption, with a lower saving rate. Similar effects are obtained by faster on-the-job wage growth, which produces a more persistent decline in saving rates.

Agents who are more risk averse are less selective in their job search. Accordingly, they have lower unemployment rates, wages, and consumption, but also more wealth, as they avoid future unemployment spells. Conversely, agents with access to larger credit are more selective and have higher unemployment rates, wages, and welfare, but lower assets, as they rely on credit rather than on their own buffer stock. They also display lower consumption, as their assets are lower and they receive less interest income.

Quits to unemployment deserve particular attention. As they are generated by better conditions to search for a job while unemployed, a higher λ^u increases quits, whereas a higher λ^e reduces them. With a higher layoff rate, individuals quit less to unemployment because they can just wait to be laid off. Similarly, larger unemployment transfers, a better wage offer distribution, and faster wage growth reduce the incentive for quitting to unemployment. Finally, agents that are more risk averse quit less to unemployment, whereas agents with access to a larger amount of credit quit more.

This comparative statics exercise summarizes the effects of the parameters of the model on the observables. The next section describes how to use the observed data to recover the parameters of the behavioral model.

3. DATA

The data come from the National Longitudinal Survey of Labor Market Experience Youth Cohort (NLSY), a national stratified sample of 12,686 individuals who are between 14 and 21 years of age in January 1979, and who have been interviewed annually from 1979 onward. It provides data on personal characteristics, household composition, educational status and attainment, military experience, labor market activity and transitions, detailed week-by-week work history, income, and assets. Therefore, it is possible to construct an individual's complete weekly work history from year 1978 onward.

The theoretical model applies more closely to the male labor force and does not include the decision to attend college or to join the military. Thus, out of the total number of respondents, I have selected high school white male graduates born after December 31, 1960, who never went to college or had any type of military experience and for whom asset data are available. Individuals born before 1961 are excluded from the sample because a complete employment history cannot be constructed for them, as their careers started before 1978. Out of all white males, the modal group in the NLSY, 212 individuals satisfied all the selection criteria. In this final sample each individual has up to 40 quarterly observations for assets, wages, employment status, and the reason for leaving their current employer.[12] Assets are observed only annually since year 1985. Appendix A.2 provides detailed explanations of these variables.

Table 4 presents summary statistics for the duration of the first unemployment spell, employment transitions, quits, wages, and assets. The first unemployment spell lasts on average 2.52 quarters. Whereas 42% of the unemployed become employed in the next quarter, 6% of the employed become unemployed in the next quarter, and about 9% of the employed change employers in the next quarter. Clearly, an important proportion of individuals voluntarily abandon their current

[12] This sample selection is stringent and aims to reduce the adverse consequences of making inferences based on individuals with heterogeneous labor market environments. See Flinn (1986), and Wolpin (1987, 1992) for examples of stringent data selections in structural estimations. In Rendon (2003) I use a larger sample, which also includes black individuals, and determine the effect of capital markets in black–white differences in labor market outcomes. This larger sample corroborates the basic results found here.

TABLE 4
SUMMARY STATISTICS

Variable	
Average duration of first unemployment spell (quarters)	2.52
Percentage of unemployed becoming employed	41.92
Percentage of employed becoming unemployed	6.31
thereof quit (in percent)	32.32
thereof are laid off (in percent)	45.46
Percentage of employed changing employer	8.53
thereof quit (in percent)	61.85
thereof are laid off (in percent)	26.29
Average wage growth (in percent)	
per quarter	2.20
when changing employer	14.52
Average asset growth (in percent)	
per quarter	3.25

NOTE: Data on the reason for leaving the current employer are not available for every employment transition. Consequently, the sum of quits and layoff is less than 100.

job to work for another employer or to become unemployed. At least 32% of the employed who become unemployed do so voluntarily. Wages grow on average 2.2% per quarter; however, changing employers increases wages on average by 15%. Asset accumulation is relatively fast: Assets grow on average 3.25% per quarter.

As shown in Tables 1 and 2, asset accumulation and labor dynamics derived from sample data exhibit systematic comovements, which are in line with the predictions of the theoretical model. Accumulation of assets and work experience also imply a change in the composition of assets, as presented in Table 5. Wealthier individuals tend to have a larger proportion of their assets in residential property, business, farms, or other forms of property. Among the individuals less than 6 years into the labor market, those with no more than \$10,000 in assets have only 7% of their wealth in residential property; whereas individuals with more than \$30,000 in assets hold 23% of their wealth in the form of residential property. Also, the proportion of wealth in the form of residential property increases over time:

TABLE 5
COMPOSITION OF NET ASSETS ACCORDING TO ASSET LEVEL AND YEARS AFTER GRADUATION

	Years ≤ 6				Years > 6			
	Asset Bracket in Thousands				Asset Bracket in Thousands			
	0–10	10–20	20–30	+30	0–10	10–20	20–30	+30
Residential	6.99	17.44	23.51	22.53	15.98	31.08	31.92	25.96
Financial	23.79	18.82	15.09	19.04	21.85	19.43	21.21	38.56
Business	5.13	5.30	13.78	42.32	5.40	3.37	4.13	22.35
Vehicles	50.11	33.02	33.07	6.18	52.51	28.53	26.17	7.03
Other	13.96	25.40	14.54	9.92	4.24	17.57	16.56	6.10

Agents more than 6 years away from graduation and with no more than $10,000 in assets hold about 16% of their wealth in residential property, whereas individuals with more than $30,000 in assets hold around 26% of their assets as residential property. On the other hand, the proportion of financial assets, the most liquid component of wealth, is first decreasing and later increasing in wealth. In contrast, whereas the proportion of business property is increasing in wealth level,[13] the proportion of vehicles is decreasing: Around half the wealth of individuals with less than $10,000 is held in cars. In short, poor individuals own vehicles, whereas wealthy individuals own houses, financial assets, and businesses.[14] A matter of future research is to relate these changes in the composition of assets to labor market dynamics.

4. ESTIMATION

The estimation strategy is designed to recover the behavioral parameters of the theoretical model. The procedure entails using the policy rules of the dynamic programming problem to construct probability statements for each individual transition in employment status, wages, and assets. A likelihood function is computed at each iteration of the parameters. The estimated parameters are maximizers of this function.[15]

The estimation starts at the period in which assets are first observed, t_0, so that data between 1978 and 1985 are not used in estimation. The log-likelihood function is the sum of the individuals' log likelihood, which is the density for the sequence of observables conditional on the observation at t_0 and the parameters Θ

$$\ln \mathcal{L}(\Theta) = \sum_{i=1}^{N} \ln \mathcal{L}_i \left(\{Z_{it}\}_{t=t_0+1}^{T_i} \mid Z_{it_0} \Theta \right)$$

The observed variables are $Z_{it} = \{A_{it}^{obs}, w_{it}^{obs}, d_{it}, h_{it}, l_{it}\}$, that is, assets, wages, employment status (unemployed or employed: $d = \{u, e\}$), employer ($z = 1$, employer change, or $z = 0$, otherwise), and the reason for leaving the current employer ($l = 1$, layoff, or $l = 0$, otherwise). Work experience k depends solely on d and z. Let wages net of work experience ω^{obs} be such that $w^{obs} = w(\omega^{obs}, k)$, that is, $\ln \omega^{obs} = \ln w^{obs} - \alpha_1 k - \alpha_2 k^2$. The individuals' likelihood contribution can be decomposed into a product of conditional and marginal densities for each transition denoted by $g_t(A_{t+1}, \omega_{t+1} \mid A_t, \omega_t)$. There are five possible employment transitions.

[13] Using a static framework, Evans and Jovanovic (1989) find that having more assets under borrowing constraints increases the probability that a worker starts a business.

[14] These patterns in the composition of assets are also shown by Sobol (1979), Jianakoplos et al. (1989), Blau and Graham (1990), Wolff (1994), and Gittleman and Wolff (2004).

[15] I also recovered the structural parameters of the model by a method of moments, consisting of minimizing the distance between predicted and observed moments. These results are available from the author upon request. They differ somewhat from the maximum-likelihood results, but both methods coincide in their replication of the main features of the data.

1. From unemployment to unemployment, $d_t = 0$, $d_{t+1} = 0$

$$g_t(A_{t+1}, 0 \mid A_t, 0) = \lambda^u F\big[\omega_t^*(A_{t+1})\big] + (1-\lambda^u), \text{ if } A_{t+1} = A_{t+1}^u(A_t)$$

2. From unemployment to employment, $d_t = 0$, $d_{t+1} = 1$

$$g_t(A_{t+1}, \omega_{t+1} \mid A_t, 0) = \lambda^u f(\omega_{t+1}),$$
$$\text{if } \omega_{t+1} \geq \omega_{t+1}^*(A_{t+1}) \text{ and } A_{t+1} = A_{t+1}^u(A_t)$$

3. From employment to unemployment, $d_t = 1$, $d_{t+1} = 0$, $z_{t+1} = 0$

Layoff, $l_t = 1$:

$$g_t(A_{t+1}, 0 \mid A_t, \omega_t) = \theta\big[\lambda^e F\big[\omega_{t+1}^*(A_{t+1})\big] + (1-\lambda^e)\big]$$
$$\text{if } A_{t+1} = A_{t+1}^e(A_t, \omega_t, k_t)$$

No Layoff, $l_t = 0$:

$$g_t(A_{t+1}, 0 \mid A_t, \omega_t) = (1-\theta)\big[\lambda^e F\big[\omega_{t+1}^*(A_{t+1})\big] + (1-\lambda^e)\big],$$
$$\text{if } \omega_{t+1}^*(A_{t+1}) > v_t(A_{t+1}, \omega_t, k_{t+1})$$
$$\text{and } \quad A_{t+1} = A_{t+1}^e(A_t, \omega_t, k_t)$$

4. Same employer, $d_t = 1$, $d_{t+1} = 1$, $z_{t+1} = 0$

$$g_t(A_{t+1}, \omega_t | A_t, w_t) = (1-\theta)\big[\lambda^e F(v_t) + (1-\lambda^e)\big],$$
$$\text{if } v_t(A_{t+1}, \omega_t, k_{t+1}) \geq \omega_t^*(A_{t+1})$$
$$\text{and } A_{t+1} = A_{t+1}^e(A_t, \omega_t, k_t)$$

5. Change employer, $d_t = 1$, $d_{t+1} = 1$, $z_{t+1} = 1$

Layoff, $l_t = 1$:

$$g_t(A_{t+1}, \omega_{t+1} | A_t, \omega_t) = \theta\lambda^e f(\omega_{t+1}), \quad \text{if } \omega_{t+1} \geq \omega_{t+1}^*(A_{t+1})$$
$$\text{and } A_{t+1} = A_{t+1}^e(A_t, \omega_t, k_t)$$

No Layoff, $l_t = 0$:

$$g_t(A_{t+1}, \omega_{t+1} \mid A_t, \omega_t) = (1-\theta)\lambda^e f(\omega_{t+1}),$$
$$\text{if } \omega_{t+1} \geq \max\big(\big[v_t(A_{t+1}, \omega_t, k_{t+1}), \omega_t^*(A_{t+1})\big]$$
$$\text{and } A_{t+1} = A_{t+1}^e(A_t, \omega_t, k_t)$$

where $k_{t+1} = \min(k_t + 1, \bar{k})$. And $g_t(A_{t+1}, \omega_{t+1} \mid A_t, \omega_t) = 0$, if the corresponding condition is not met.[16]

[16] To improve readability, I drop the individual subscript i and the parameter vector Θ, as well as employment status (expressed by a wage equal to zero), employer change, and layoffs.

Because these densities only account for one level of assets and for certain admissible values of wages, the estimation requires another source of randomness. Since there are justified reasons to believe that assets and wages are measured with errors, one way to make the estimation feasible is to define observed assets and wages as the model's predicted level plus a measurement error. Thus, $A_t^{obs} = A_t + \varepsilon_A$ and $\ln \omega_t^{obs} = \ln \omega_t + \varepsilon_w$, where ε_A and ε_w are normally distributed with zero mean and standard deviation σ_A and σ_w, respectively.

The joint density for a given sequence of observables is obtained by integrating over all possible sequences of assets and wages, expressed as the product of the conditional densities over all transitions, conditional on the first observation at period t_0

$$\mathcal{L}\big(\{Z_t\}_{t=t_{0+1}}^{T} \mid Z_{t_0}, \Theta\big) = \int \cdot \cdot \int \prod_{t=t_0}^{T} g_t(A_t, \omega_t \mid A_{t-1}, \omega_{t-1}) \frac{1}{\sigma_A} \phi\left(\frac{A_t^{obs} - A_t}{\sigma_A}\right) \times \frac{1}{\sigma_w} \phi\left(\frac{\ln \omega_t^{obs} - \ln \omega_t}{\sigma_w}\right) dA_t\, d\omega_t$$

where $g_0(A_{t_0}, \omega_{t_0} \mid A_{t_0-1}, \omega_{t_0-1}) = 1$. Computing this function requires a numerical approximation, which I, in turn, compute by exploiting the discretization performed to solve the DP problem as described in Appendix A.3. The parameters to estimate are $\Theta = \{b, \lambda^u, \lambda^e, \theta, \mu, \sigma, \alpha_1, \alpha_2, \gamma, s, \sigma_A, \sigma_w\}$. The interest rate r and the discount factor β are fixed at 0.015 and 0.98, respectively. The iteration algorithm used to maximize this likelihood function is the Powell algorithm (see Press et al., 1992), which only requires function evaluations, not derivatives.

After recovering the behavioral parameters, the data from period 1 to period t_0 can be used to recover the initial asset distribution. I derive the posterior distribution of initial assets conditional on subsequent behavior ($\{Z_t\}_{t=1}^{t_0}$) under the assumption of a uniform prior on initial assets (an uninformative prior). The likelihood of observing these data conditional on asset level A_0, or $Z_0 = \{A_0, 0, 0, 0, 0\}$, is $\mathcal{L}(\{Z_t\}_{t=1}^{t_0} \mid Z_0, \Theta)$. The density function of initial assets for each individual is, thus,

$$p\big(A_0 \mid \{Z_t\}_{t=1}^{t_0}, \Theta\big) = \frac{\mathcal{L}\big(\{Z_t\}_{t=1}^{t_0} \mid Z_0, \Theta\big)}{\int \mathcal{L}\big(\{Z_t\}_{t=1}^{t_0} \mid Z_0, \Theta\big)\, dA_0}$$

This distribution is necessary to simulate the model from the very beginning of the individuals' employment careers.

5. RESULTS

5.1. *Parameter Estimates.* The maximum-likelihood estimates and the corresponding asymptotic standard errors are reported in Table 6. As I will show in the next subsections, they are able to mimic the observed trends of labor turnover, assets, and accepted wages.

The estimated amount of net transfers while unemployed is about \$660. While unemployed, the probability of receiving an offer is 0.94; whereas employed the

TABLE 6
PARAMETER ESTIMATES AND ASYMPTOTIC STANDARD ERRORS
(IN PARENTHESES)

Θ	Estimate	(Asy. St. Error)
b	656.87	(39.01)
λ_u	0.938092	(0.051156)
λ_e	0.158281	(0.021573)
θ	0.046283	(0.009304)
μ	6.877250	(0.085290)
σ	0.894435	(0.094311)
α_1	0.002969	(0.000755)
α_2	−0.000622	(0.000014)
γ	1.483435	(0.093012)
s	0.135897	(0.012541)
r	0.015	
β	0.98	
σ_A	19818.69	(812.12)
σ_w	0.578638	(0.011378)
$-\ln\mathcal{L}$	5632.20	

probability of receiving an offer is 0.16, and the layoff probability is 0.046. The estimated mean of the underlying distribution of log wages is 6.88, and the corresponding variance is 0.89. Except for λ^e and λ^u, which allow the model to account for quits to unemployment because of asset accumulation, Wolpin (1992) finds similar labor market parameters.

The coefficient of risk aversion is 1.48, which is comparable with prior estimations, whereas the estimated parameter s is 0.14, revealing an environment with very tight borrowing constraints. The rate of discount is fixed at 0.98 and the interest rate is fixed at 0.015.

Measurement errors in both wages and assets are large, probably because of sizeable asset fluctuations in the data.[17] In particular, as quits to unemployment only happen at low asset levels, quits at higher observed asset levels increase the measurement error in assets and also in wages, which in the model are closely related to assets. The measurement error in wages represents 39% of the total variation in wages, well above the already large 20% that Wolpin (1992) finds in a job search model without assets. Unfortunately, as discussed by Bound and Krueger (1991), large measurement errors are usual in applied research, especially in longitudinal analysis. Asymptotic standard errors are calculated using the outer-product gradient estimator and provided in parentheses; they are, in general, small.

5.2. *Model Fit.* To assess whether these parameter estimates capture the essential features of the data, I compare the observed and the predicted choice distributions of employment status, employment transitions, assets, and wages.

[17] See Rust (1990) for a discussion on the severity of measurement errors in asset data from the Retirement History Survey (RHS).

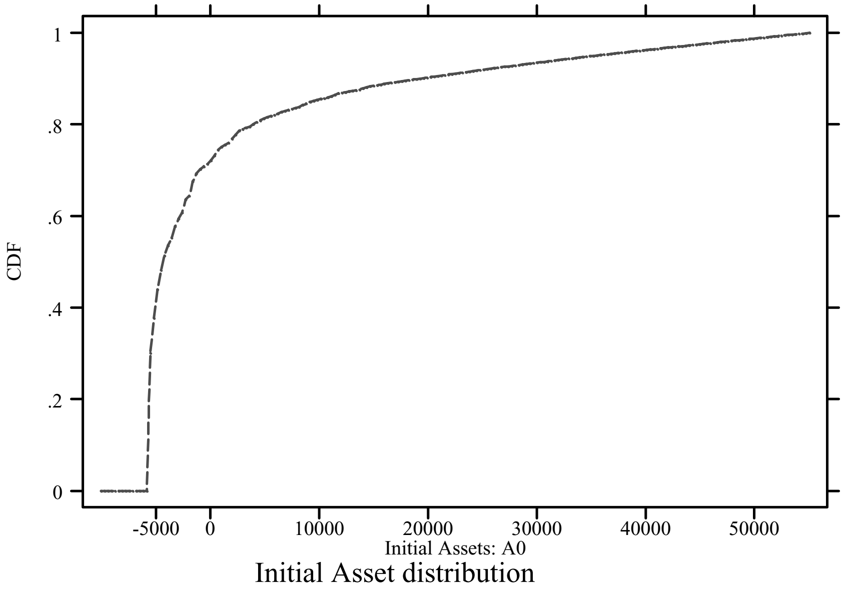

FIGURE 3

RECOVERED INITIAL ASSET CDF: $P(A_0 \mid \Theta)$

Figure 3 presents the estimated initial asset distribution (cdf) for all individuals, which coincides with previous descriptions of asset distributions of young agents (Budría et al., 2002) in that they are significantly skewed to the right, reveal a high level of wealth concentration, and allow for an important proportion of negative assets. The implied lower bound of assets at period 1 is −\$6,000. With these initial conditions I simulate several career paths, as explained in Section 2, and compute hazard rates for the first unemployment spell and predicted moments by quarter after graduation.

Figure 4 shows the actual and the predicted hazard rates for the first unemployment spell, both decreasing over time. Note that the unemployed run down their assets and reduce their reservation wages, so hazard rates ought to increase. However, with a nongenerate distribution of initial assets, poor individuals, with high hazard rates, are the first to exit unemployment, so that predicted average hazard rates decline over time.

Table 7 provides a summary of actual and predicted distributions of all variables for years 3, 6, and 9 after graduation. It also shows goodness of fit tests[18] to evaluate whether the cell-by-cell distribution of the data can be produced by the theoretical model at the estimated parameters. In addition, Figure 5 presents

[18] The simplest test statistic across choices j at time t is defined as $\chi_t^2 = \Sigma_{j=1}^{J} \frac{(n_{jt} - \hat{n}_{jt})^2}{\hat{n}_{jt}}$, where n_{jt} is the actual number of observations of choice j at time t, $\hat{n}_{jt}$ is the model predicted counterpart, J is the total number of possible choices and T is the number of years. This statistic has an asymptotic χ^2 distribution with $J - 1$ degrees of freedom.

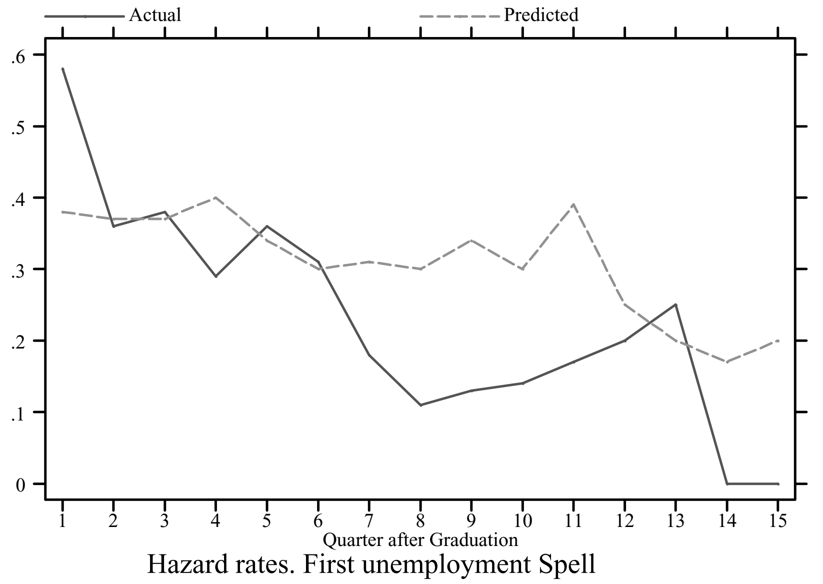

FIGURE 4

ACTUAL AND PREDICTED HAZARD RATES

a graphical comparison of actual and predicted variables by quarter after graduation. Figure 5a shows that the predicted path of the unemployment rates is relatively close to the actual path, especially at the beginning of the employment careers, which can be confirmed by looking at the χ^2 statistics. The predicted transitions between unemployment and employment, shown in Figures 5b and 5c, present also a fairly good replication of the actual paths. The model overpredicts transitions from employment to unemployment in the last quarters of the sample, which explains the overprediction in the unemployment rate in those periods. The χ^2 statistics for the transitions from unemployment fall below the critical value at 0.5% significance. In contrast, as shown in Figure 5d, the model underpredicts job-to-job transitions at the beginning of the employment careers, although there is a notorious convergence over time to the actual path. Despite the choice distributions of the transitions from employment not passing the χ^2 test, the value of the χ^2 statistics goes down over time as the predicted paths approach the actual paths.

The percentage of layoffs in the transitions from employment to unemployment and job-to-job is shown in Figures 5e and 5f, respectively. The estimated parameters, in particular the lower arrival rate while employed, produce quits to unemployment and thereby a predicted path that is close to the actual one and passes the χ^2 tests. For layoffs in job-to-job transitions the model underpredicts the actual path.

Figures 5g and 5h show, respectively, the evolution of assets and wages. In spite of the noise in the assets data, the model is able to mimic well the trend of the observed asset accumulation. Similarly, the model reproduces

TABLE 7

SUMMARY. ACTUAL, AND PREDICTED CHOICE DISTRIBUTION (IN PERCENT): ALL VARIABLES FOR THREE SELECTED YEARS AFTER GRADUATION

	Years after Graduation					
	Year 3		Year 6		Year 9	
	Act.	Pred.	Act.	Pred.	Act.	Pred.
Employment status						
Unemployment	18.34	15.86	10.94	14.53	8.83	15.83
Employment	81.66	84.14	89.06	85.47	91.17	84.17
χ^2	3.90		8.64		29.53	
Transitions from unemployment						
to unemployment	62.58	61.49	54.95	67.37	52.11	67.37
to employment	37.42	38.51	45.05	32.63	47.89	32.63
χ^2	0.07		8.49		24.91	
Transitions from employment						
to unemployment	8.41	6.08	6.48	5.24	5.59	5.31
to same employer	80.29	91.63	85.02	92.84	89.22	92.63
to a new employer	11.30	2.28	8.50	1.92	5.18	2.06
χ^2	317.22		194.83		39.07	
Transitions from employment to unemployment						
Layoffs	69.39	64.75	56.76	76.05	62.07	82.85
Quits	30.61	35.25	43.24	23.95	37.93	17.15
χ^2	0.46		7.56		8.81	
Transitions from employment to a new employment						
Layoffs	34.33	7.36	20.00	5.76	33.33	12.93
Quits	65.67	92.64	80.00	94.24	66.67	87.07
χ^2	71.44		20.57		12.21	
Assets						
Average	6023	2335	9278	6112	13329	9370
Distribution						
$A \leq 0$	6.25	55.53	12.32	33.86	10.00	25.44
$0 < A \leq 10{,}000$	75.00	29.46	57.25	40.83	47.14	39.56
$10{,}000 < A \leq 20{,}000$	9.38	8.89	18.12	14.15	17.14	17.49
$20{,}000 < A \leq 30{,}000$	6.25	4.41	3.62	6.51	10.71	8.48
$A > 30, 000$	3.13	1.71	8.70	4.66	15.00	9.03
χ^2	74.31		36.15		21.50	
Wages						
Average	3363	4111	4114	4384	4552	4535
Distribution						
$w \leq 2, 000$	16.72	0.88	8.45	0.44	4.64	0.21
$2{,}000 < w \leq 4{,}000$	58.19	60.03	50.69	52.46	38.17	47.48
$4{,}000 < w \leq 6{,}000$	18.56	26.04	27.65	31.07	40.72	35.32
$w > 6{,}000$	6.52	13.05	13.21	16.03	16.47	16.99
χ^2	1731.86		951.42		641.80	

Crit. values at 0.5 percent signif.: $\chi^2_{(1)} = 7.88$, $\chi^2_{(2)} = 10.60$, $\chi^2_{(3)} = 12.84$, $\chi^2_{(4)} = 14.86$.

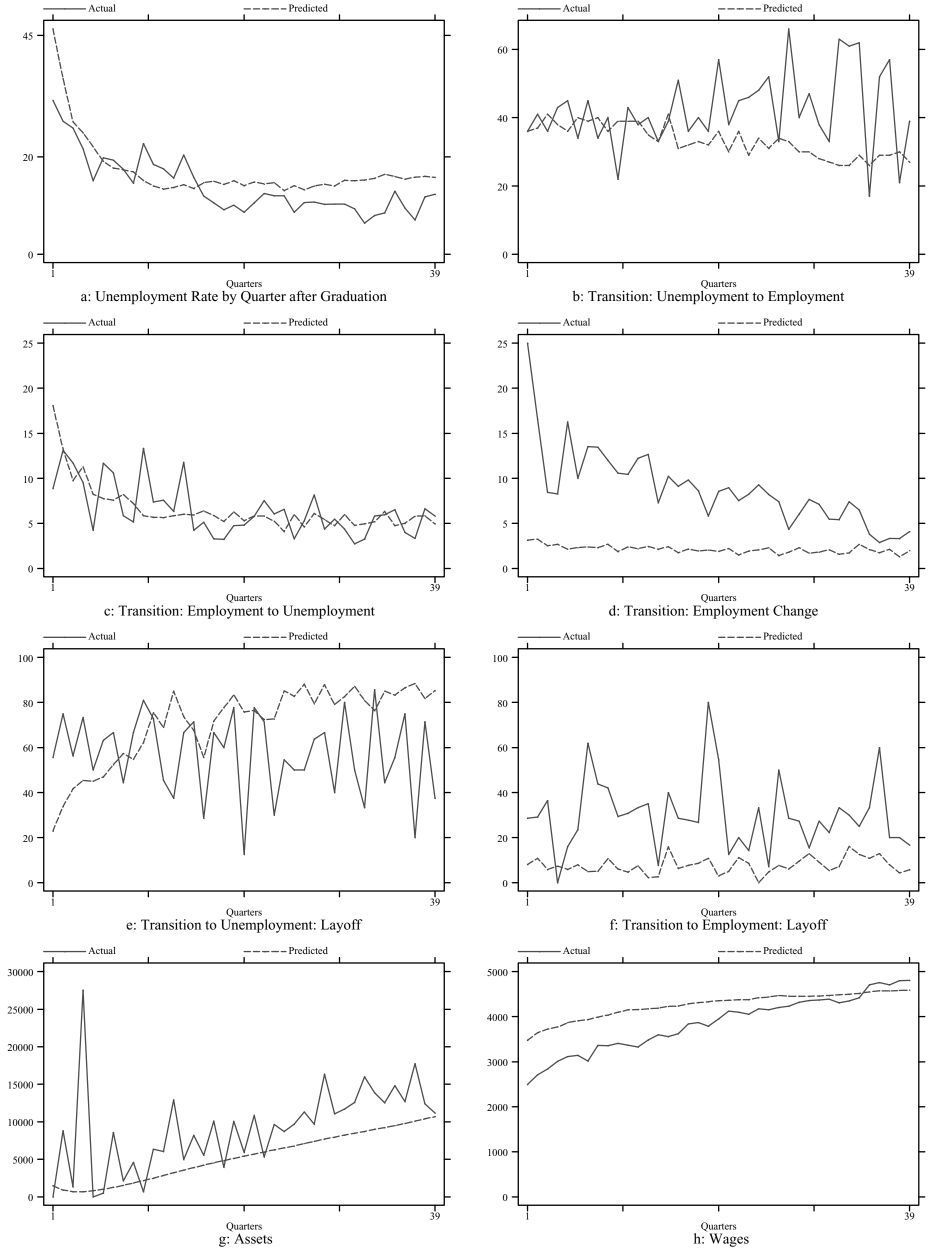

FIGURE 5

ACTUAL AND PREDICTED VARIABLES BY QUARTER AFTER GRADUATION well the wage distribution, especially in the later periods. Note that the overprediction at the beginning of the employment careers comes mainly from the underprediction in the wage bracket of at most \$2,000, which also explains the high value of the χ^2 statistics. The model, however, replicates fairly well the other brackets. Moreover, the χ^2 statistics of both assets and wages diminish over time, reflecting the convergence over time of predicted to actual distributions.

In short, both graphically and formally the model is fairly successful in replicating the main features of the data.

6. POLICY EXPERIMENTS

After recovering the underlying parameters of the model and assessing their success in replicating the data, I perform two regime changes and report them in Table 8. These experiments measure the variations in several observables produced by increasing initial assets and relaxing borrowing constraints.

The first experiment consists of displacing the initial asset distribution to the right by \$5,000. Making agents wealthier by this amount increases the duration of the first unemployment spell 0.84 quarters as well as the unemployment rate by

TABLE 8
SUMMARY OF TWO POLICY EXPERIMENTS

		Variations	
	Baseline	Displace $p(A_0)$ by 5000	Relax s to 0.5
First unemployment spell			
Duration of unemployment	2.74	0.84	0.80
First accepted wage	3450	449	436
Unemployment rate			
1st quarter	62.41	13.67	13.06
20th quarter	15.09	0.24	0
40th quarter	15.80	0.05	0.76
Wages			
1st quarter	3477	788	743
20th quarter	4355	43	52
40th quarter	4609	12	39
Assets			
1st quarter	1470	4596	0
20th quarter	5418	998	−3589
40th quarter	11014	489	−3599
Consumption			
1st quarter	2290	785	646
20th quarter	3606	98	24
40th quarter	3803	44	−55
Saving rate at 40th quarter	4.55	−0.90	1.44
Welfare	54.98	0.05	0.05

14 percentage points. It also raises the first accepted wage by around \$450 and average wages in the first quarter by around \$800. The increase in the unemployment rate and in wages is persistent and fairly notorious 20 quarters after graduation, but it dies out in the 40th quarter.

The increase in initial assets produces increases in assets and consumption in later periods: even 40 quarters after graduation, when the increase in wages has practically disappeared, the increase in wealth is still significant: \$490. This persistent increase in the level of wealth undermines the need for saving and, consequently, the saving rate declines. Not surprisingly, this regime change increases welfare. The second experiment consists of relaxing borrowing constraints by setting them to half the natural borrowing limit, that is, $s = 0.5$. This variation produces an increase in the duration of the first unemployment spell of 0.8 quarters, and in the unemployment rate over time of 13 percentage points. As individuals with access to larger credit are more selective, they search longer for a job and end up with higher wages: The first accepted wage increases by \$440. Similarly, accepted wages also show an important and persistent increase: \$740 in the first quarter, \$50 in the 20th quarter, and \$40 in the 40th quarter. Given that a relaxation of the borrowing constraints is a permanent change, it is not surprising that effects are more persistent than in the previous experiment.

Since less constrained agents can rely on debt for their job search and consumption, their need for building up a buffer stock is less pressing. In this experiment relaxing borrowing constraints means a decline in assets of \$3,600. Thus, at the beginning of their employment careers less constrained agents consume more than constrained ones. However, as the wage gap between these two types narrows down, less constrained agents display lower wealth, lower consumption, and a higher saving rate. As one would expect, relaxing borrowing constraints increases welfare and, interestingly, by the same amount as the previous regime change.

7. CONCLUSIONS

The model proposed in this article generalizes Danforth's (1979) model to allow for on-the-job search, wage growth, retirement, and a parametric borrowing limit. By incorporating these additional features, the model accounts for key features of the data such as asset decumulation during unemployment to maintain consumption and asset accumulation during employment to build a buffer stock against future unemployment. In particular, this model generates quits to become voluntarily unemployed as an optimal decision motivated by the desire of the individual to search for better jobs.

Using a maximum-likelihood procedure, I fit this model to data from the NLSY and recover the behavioral parameters and the initial asset distribution. The model is shown to display a fairly good replication of the main observables, namely, the hazard rate during the first unemployment spell and the cross-sectional distributions of assets, wages, and employment transitions over time.

The estimates show that borrowing constraints are relatively tight: 14% of the natural borrowing limit. Moreover, borrowing constraints reinforce the influence of wealth on individuals' job acceptance decisions. An increase of \$5,000 in initial assets raises accepted wages by \$800 in the first quarter after graduation and by lower amounts several periods afterward. Relaxing borrowing constraints increases wages for several periods after graduation: If borrowing constraints were half the natural limit, wages in the first quarter after graduation would increase by \$750 and remain higher for several periods afterward.

These results are encouraging for further applied research based on utility-maximizing search models. Future work can easily use and extend this framework to study other issues in labor economics, such as job search and saving behavior prior to retirement or the effect of unemployment transfers on saving decisions.

APPENDIX

A.1. *Numerical Solution of the Model.* As mentioned in the main body of the article, the model is solved on a discretized state space. The table below gives further details of this discretization.[19]

Discretization of Variables

	Assets	Wages
Original variable	A	ω
Discretized variable	$A(i)$	$\omega\,(j)$
Gridpoints	$i = 1, \ldots, N_A$	$j = 1, \ldots, N_w$
Number of grid points	$N_A = 201$	$N_w = 51$
Lower bound	$\underline{A} = -10,250$	$\underline{w} = 1,000$
Upper bound[20]	$\bar{A} = 55,250$	$\bar{w} = 10,000$
Gridsize	$\Delta_A = \frac{\bar{A}-\underline{A}}{N_A}$	$\Delta_w = \frac{\ln \bar{w} - \ln \bar{w}}{N_w}$

The discrete probability for a wage draw $\omega(j)$ is

$$\hat{f}(j) = \frac{\Phi\left(\frac{\ln \omega(j) + \Delta_w/2 - \mu}{\sigma_w}\right) - \Phi\left(\frac{\ln \omega(j) - \Delta_w/2 - \mu}{\sigma_w}\right)}{\Phi\left(\frac{\ln \bar{w} - \mu}{\sigma_w}\right) - \Phi\left(\frac{\ln \underline{w} - \mu}{\sigma_w}\right)}$$

Wage as a function of tenure $w(\omega, k)$ is also discretized and becomes $w(j, k) = \omega(j)\exp(\alpha_1 k + \alpha_2 k^2)$. The maximum attainable tenure level is $\bar{k} = 8$.

The numerical solution proceeds in the following steps:

[19] The computation of the DP and the likelihood function is sensitive to the discretization of the state variables, especially of assets. Few gridpoints for assets reduce the accuracy of the model in replicating observed quits and savings, and in estimating the borrowing limit. The choice of 201 gridpoints for assets, almost four times the number of gridpoints for wages, aims to ameliorate this problem.

[20] Fewer than 9% of asset observations and 3% of wage observations lie outside the admissible range defined by these bounds.

1. For $t = T + 1$ define the discretized value functions:

$$\hat{V}^u[i,t] = V_R(A(i)), \text{ and}$$
$$\hat{V}^e[i,j,k,t] = V_R(A(i))$$

where $V_R(A(i))$ is the discretized value of being retired. For a CRRA utility function, this value function admits an analytical expression

$$V_t^R(A_t) = \max_{\{A\}_{s=t}^{T_F}} \sum_{s=t}^{T_F} \beta^{s-t} \frac{\left(A_s - \frac{A_{s+1}}{1+r}\right)^\gamma - 1}{1-\gamma} = \frac{A_t^{1-\gamma}}{1-\gamma} c_1^\gamma - \frac{1}{1-\gamma} c_2$$

where $c_1 = \frac{1-[\frac{g}{1+r}]^{T_F-T+1}}{1-\frac{g}{1+r}}$, $g = [\beta(1+r)]^{\frac{1}{\gamma}}$, $c_2 = \frac{1-\beta^{T_F-T+1}}{1-\beta}$, and $A_{T_F+1} = 0$. Analytical solutions for consumption and assets are $C_t = A_T g^{t-T}/c_1$ and $A_t = g^{t-T}/c_1 A_T(1-(g/1+r)^{T_F-t+1})/(1-g/1+r)$, respectively. With $\beta(1+r) < 1$, consumption and assets of the retired decrease monotonically over time. Individuals are assumed to live for 20 years (80 quarters) after retirement.
2. Integration. Define the discretized expected values

$$W^u[i,t] = \lambda^u \sum_{j=1}^{N_w} \max[\hat{V}^e[i,j,0,t], \hat{V}^u[i,t]] f(j) + (1-\lambda^u)\hat{V}^u[i,t]$$

$$\begin{aligned} W^e[i,j,k,t] = (1-\theta) &\left(\lambda^e \sum_{l=1}^{N_w} \max[\hat{V}^e[i,j,k,t], \hat{V}^e[i,l,0,t], \hat{V}^u[i,t]] f(l)\right. \\ &\left. + (1-\lambda^e)\max[\hat{V}^e[i,j,k,t], \hat{V}^u[i,t]]\right) \\ &+ \theta\left(\lambda^e \sum_{l=1}^{N_w} \max[\hat{V}^e[i,l,0,t], \hat{V}^u[i,t] f(l)\right. \\ &\left. + (1-\lambda^e)\hat{V}^u[i,t]\right). \end{aligned}$$

3. Compute the value function for the previous period

$$\begin{aligned} \hat{V}^e[i,j,k,t] = \max_{q \ge i^*(t+1)} &\left\{U\left(A(i) + w(j,k) - \frac{A(q)}{1+r}\right)\right. \\ &\left. + \beta W^e[q,j,k',t+1]\right\} \end{aligned}$$

$$\hat{V}^u[i,t] = \max_{m \ge i^*(t+1)} \left\{U\left(A(i) + b - \frac{A(m)}{1+r}\right) + \beta W^u[m,t+1]\right\}$$

where $A(i^*(t+1)) = B_{t+1}$. The maximizers to these problems are $q^* = q^*(i, j, t)$ and $m^* = m^*(i, t)$; the reservation wage is $j^*(i, k, t) = \{j \mid \hat{V}^e[i, j, k, t] \geq \hat{V}^u[i, t] > \hat{V}^e[i, j-1, t]\}$.

4. Go to step 2. This process goes backward and it is repeated until period $t = 1$ is reached.

This procedure, applied to the simulation in Section 2, is too time consuming to be applied to the estimation. The entire working lifetime T is assumed to be 162 quarters. As in Wolpin (1992), the estimation is made tractable by assuming that the individual solves the DP problem using longer period lengths for the more distant future value functions. Let n be the period length measured in quarters. From quarter 162 through quarter 83 the individual acts as if optimization occurs over 2-year periods ($n = 8$), from quarter 82 through quarter 51 over 1-year periods ($n = 4$), and from quarter 50 through quarter 1 over quarterly periods ($n = 1$). This is illustrated by the following scheme:

	50 quarterly periods	8 annual periods	10 biannual periods
Quarters:	$1, 2, 3, \ldots\ldots, 49, 50$	$51, 52, 53, \ldots\ldots, 81, 82$	$83, 84, \ldots\ldots, 161, 162$

The DP problem has to be converted to match these varying period lengths. Thus, the arrival and discount rates are adjusted to the corresponding period lengths, $n = \{1, 4, 8\}$

$$\lambda_n^u = 1 - (1-\lambda^u)^n; \quad \lambda_n^e = 1 - (1-\lambda^e)^n; \quad \theta_n = 1 - (1-\theta)^n; \quad \beta_n = \beta^n$$

For annual and biannual period lengths, the quarterly consumption is assumed to be constant. If the agent is unemployed and consumes C_u in each quarter, assets at the end of a period of length n are

$$A_n = (1+r)^n A + b\sum_{j=1}^{n}(1+r)^j - C_u\sum_{j=1}^{n}(1+r)^j$$

The utility function for a period of length n from quarterly consumption C_u is then

$$U_n(C_u) = \sum_{t=0}^{n}\beta^t U(C_u) = \frac{1-\beta^n}{1-\beta}U(C_u) = \frac{1-\beta^n}{1-\beta}U\left(g_n A_n + b - g_n\frac{A_n}{(1+r)^n}\right)$$

$$\text{where:} \quad g_n = \frac{(1+r)^n}{\sum_{j=1}^{n}(1+r)^j} = \frac{1-\frac{1}{(1+r)}}{1-\frac{1}{(1+r)^{n+1}}}$$

Consumption is also constant when the individual is employed without changes in the wage offer distribution, but with an adjustment for wage growth. I assume that in annual and biannual periods quarterly consumption is determined by the average level of work experience within those periods, that is, by half of the employment duration. Let k_n be the experience accumulated in one period of length n; then quarterly experience is $k = k_n n/2$, and the maximum attainable tenure is $\bar{k}_n = \bar{k}/s$ (The choice of $\bar{k} = 8$ facilitates this adjustment, as $n = \{1, 4, 8\}$). The quarterly wage for a person with tenure of k_n periods of length n is, thus,

$$w_n(\omega, k_n) = \omega \exp\left(\alpha_1 k + \alpha_2 k^2\right) = \omega \exp\left(\alpha_{1n} k_n + \alpha_{2n} k_n^2\right)$$

where $\alpha_{1n} = \alpha_1 n/2$ and $\alpha_{2n} = \alpha_2 n^2/4$. Hence, the utility function for a period of length n from a constant quarterly consumption C_e of an employed agent with initial wage ω and tenure k_n is

$$U_n(C_e) = \sum_{t=0}^{n} \beta^t U(C_e) = \frac{1-\beta^n}{1-\beta} U\left(g_n A_n + w_n(\omega, k_n) - g_n \frac{A_n}{(1+r)^n}\right)$$

This way, the DP problem is solved by choosing assets next period regardless of the period length, just by making the necessary adjustments in the utility function and its arguments during the backward solution.

A.2. *Definition of the Variables.* For tractability, the data have been aggregated to quarters based on the calendar quarter in which the individual starts his employment history. The last week that the individual reports being enrolled in school is assigned to its corresponding calendar quarter; employment history starts in the quarter thereafter. The relevant time unit is quarters after graduation, not calendar time. Along with attrition and missing data, this implies that not all individuals are observed through 1993. The unavoidable consequence of the aggregation to quarterly data is some definitional arbitrariness. An individual is considered to be working if he is employed during the first week of the quarter; otherwise he is unemployed for that quarter. The job corresponding to that quarter is also the first job of the quarter; any other job held during the quarter is ignored (unfortunately, any construction of quarterly data implies missing transitions when there is a high turnover). The quarterly wage related to that job is the wage of the first week of the quarter in 1985 dollars times 13. Since the NLSY provides information on multiple jobs held by a person at the same period, the main job is taken to be the one with the most hours of work. A person is given the status of employed if he works 20 or more hours per week. The Consumer Price Index is used to transform the monetary values into real amounts.

The survey has data on the reason for leaving a given employer, which are classified into voluntary or involuntary reasons. It is considered a layoff when the respondent reports having been laid off, fired, or discharged, that the program ended or that the plant closed. Family reasons, spouse changing jobs, finding a better job, quits to look for another job, and other reasons are classed as quits. Since the model does not incorporate temporary layoffs, individuals returning to work for their old employers are considered as having taken new jobs.

The NLSY contains annual data on the financial characteristics of the household, for years 1985 through 1993, with exception of year 1991. Respondents report the market value of their assets at the moment of the interview; this information is therefore assigned to its particular calendar quarter, leaving blank all other quarters. There are five types of assets: residential property, financial assets, business assets, vehicles, and other; all these components are computed at their "market value," which the NLSY defines as the amount the respondent would reasonably expect someone else to pay if the particular asset were sold today in its present condition. Because the model does not incorporate explicitly the existence of heterogeneous assets, they are treated as equally liquid.[21] This definition corresponds to the notion of wealth as a store of value used in the standard national accounting framework (Wolff, 1990). Accordingly, the net value reported for total assets is the sum of the components. If the respondent does not report at least one of them, the assets variable is reported as not available.

The five components of assets are defined as follows:

1. Residential property refers to the net value of the respondent's house or apartment owned or being bought by the individual. That is the market value of the property, net of liabilities such as mortgages, back taxes, home improvement loans, or debts such as assessments, unpaid amounts of home improvement loans, or home repair bills.
2. Financial assets contain money in saving or checking accounts, saving and loan companies, money market funds, credit unions, U.S. saving bonds, individual retirement accounts (IRA or KEOGH), or certificates of deposit, common stock, stock options, bonds, mutual funds, rights to an estate or investment trust, or personal loans to others or mortgages held by the respondent. This concept also includes money owed to the respondent by other people.
3. Business assets refer to the net market value of a farm, business, or other property. Examples of this category are investment in a farm operation, a business or professional practice, or any other real estate, including tools and equipment, livestock, and stored crops. Debts or liabilities owned on this operation or property are subtracted; unpaid mortgages are included; commodity credit loans are excluded.
4. "Vehicles" include the market value of vehicles, including cars, motorcycles, trucks, a motor home or trailer, net of debts.
5. Other assets refer to the difference of the value of other assets worth more than $500 minus the amount of other debts over $500. Examples of these assets are a piece of furniture, an appliance, stereo, a boat, a piece of jewelry, a valuable collection for investment purposes, and so forth. Examples of debts are those owed to any stores, doctors, hospitals, banks, or anyone else, excluding 30-day charge accounts.

A.3. *Likelihood Function.* To construct the likelihood function, I exploit the discretization of the continuous variables to solve the DP problem, explained in Appendix A.1, and compute the likelihood as a Markov chain. The multiple integrations required to construct this function become summations that are computed recursively. Similarly, the densities of the measurement errors described in

[21] Admittedly, an important reason for saving is the down payment of home purchasing (Engelhardt, 1994). However, studying the interaction between buying a house and employment decisions is beyond the goal of this article and is left for future research.

Section 4 become discrete probabilities, defined as

$$h_A(i_A) = \Phi\left(\frac{\epsilon_A(i_A) + \Delta_A/2}{\sigma_A}\right) - \Phi\left(\frac{\epsilon_A(i_A) - \Delta_A/2}{\sigma_A}\right), \qquad \text{and}$$
$$h_w(i_\omega) = \Phi\left(\frac{\epsilon_w(i_\omega) + \Delta_w/2}{\sigma_w}\right) - \Phi\left(\frac{\epsilon_\omega(i_\omega) - \Delta_w/2}{\sigma_w}\right)$$

where i_A indexes the discretized version of ϵ_A and i_w indexes ϵ_ω.

Define $\Lambda(i, j)^t$ as the joint probability of reaching assets $A(i)$ and wages net of work experience $\omega(j)$, at time t and observing the past sequence of assets and wages up to this point

$$\Lambda(i, j)^t = \Pr\left(A(i), \omega(j), \{i_l^{obs}, j_l^{obs}\}_{l=t_0+1}^{t} \mid i_{t_0}^{obs}, j_{t_0}^{obs}\right)$$

When an individual is employed, $j \geq 1$; when the individual is unemployed, $j = 0$. Given that employment status and layoffs are not observed with error, this array can account for all possible true values of assets, employment status, and wages. At period t_0 the joint probability that an individual has assets of $A(i)$ and net wages of $\omega\,(j)$, conditional on observed assets and wages is

$$\Lambda_{t_0}(i, j) = h_A\left(i_1 - i_1^{obs}\right) \times h_w\left(j_1 - j_1^{obs}\right)$$

From this first observation, $\Lambda(i, j)^t$ is computed iteratively using the expression

$$\Lambda_{t+1}(i', j') = \sum_i \sum_j \Lambda_t(i, j) \times \hat{g}(i', j' \mid i, j, t) \times h_A\left(i'(i, j) - i_1^{obs}\right) \times h_w\left(j' - j_1^{obs}\right)$$

where $\hat{g}(i', j' \mid i, j, t)$ is a discretized version of the five transition probabilities shown in the main text.

Analogously to $\Lambda(i, j)^t$, $\Lambda(i', j')^{t+1}$ is defined as the joint probability of reaching assets $A'(i')$, and wages $\omega(j')$, and observing the past sequence of assets and wages at time $t + 1$. For each value of the unobservables $A(i)$ and $\omega(j)$, we have to compute the probability of moving to assets $A'(i')$, and net wages $\omega'(j')$.

The likelihood contribution for an individual is computed by integrating $\Lambda(i, j)^T$ over all possible values of the unobservables $A(i)$, and $\omega\,(j)$, i.e.,

$$\mathcal{L} = \Pr\left(\{i_l^{obs}, j_l^{obs}\}_{l=2}^{t} \mid i_1^{obs}, j_1^{obs}\right) = \sum_i \sum_j \Lambda_T(i, j)$$

Note that the unobservable true values only intervene in these expressions to facilitate the recursive computation of multiple integrals. At the end of the iteration, the likelihood function is the probability of observing the data given certain parameter values.

REFERENCES

ACEMOGLU, D., AND R. SHIMER, "Efficient Unemployment Insurance," *Journal of Political Economy* 107 (1999), 893–928.

ALGAN, Y., A. CHÉRON, J.-O. HAIRAULT, AND F. LANGOT, "Wealth Effect on Labor Market Transitions," *Review of Economic Dynamics* 6 (2002), 156–78.

ANDOLFATTO, D., "Business Cycles and Labor Market Search,"*American Economic Review* 86 (1996), 112–32.

BERTOLA, G., "Uninsurable Risk in the Labor Market," Mimeo, European University Institute, 2002.

BLAU, F., AND J. W. GRAHAM, "Black–White Differences in Wealth and Asset Composition," *Quarterly Journal of Economics* 105 (1990), 321–39.

BLOEMEN, H., AND E. STANCANELLI, "Individual Wealth, Reservation Wages, and Transitions into Employment," *Journal of Labor Economics* 19 (2001), 400–39.

BLUNDELL, R., T. MAGNAC, AND C. MEGHIR, "Savings and Labour Market Transitions," *Journal of Business and Economic Statistics* 15 (1997), 153–64.

BOUND, J., AND A. B. KRUEGER, "The Extent of Measurement Error in Longitudinal Earnings Data: Do Two Wrongs Make a Right?" *Journal of Labor Economics* 9 (1991), 1–24.

BROWNING, M., T. F. CROSSLEY, AND E. SMITH, "Asset Accumulation and Short Term Unemployment," Mimeo, University of Essex, 2002.

BUDRÍA, S., J. DÍAZ-GIMÉNEZ, V. QUADRINI, AND J.-V. RÍOS-RULL, "Updated Facts on the U.S. Distributions of Earnings, Income and Wealth," *Federal Reserve Bank of Minneapolis Quarterly Review* 26 (2002), 2–35.

BURDETT, K., "Employee Search and Quits," *American Economic Review* 68 (1978), 212–20.

COSTAIN, J. S., "Unemployment Insurance with Endogenous Search Intensity and Precautionary Savings," Mimeo, Universitat Pompeu Fabra, 1997.

DANFORTH, J. P., "On the Role of Consumption and Decreasing Absolute Risk Aversion in the Theory of Job Search," in S. A. Lippman and J. J. McCall, eds., *Studies in the Economics of Search* (New York: North-Holland, 1979), 109–31.

DYNARSKI, M., AND S. M. SHEFFRIN, "Consumption and Unemployment," *Quarterly Journal of Economics* 102 (1987), 411–28.

ECKSTEIN, Z., AND K. I. WOLPIN, "The Specification and Estimation of Dynamic Stochastic Discrete Choice Models," *Journal of Human Resources* 24 (1989), 562–98.

ENGELHARDT, G. V., "House Prices and the Decision to Save for Down Payments," *Journal of Urban Economics* 36 (1994), 209–37.

EVANS, D. S., AND B. JOVANOVIC, "An Estimated Model of Entrepreneurial Choice under Liquidity Constraints," *Journal of Political Economy* 97 (1989), 808–27.

FLEMMING, J. S., "Aspects of Optimal Unemployment Insurance. Search, Leisure, Savings and Capital Market Imperfections," *Journal of Public Economics* 10 (1978), 403–25.

FLINN, C., AND J. HECKMAN, "Models for the Analysis of Labor Force Dynamics," *Advances in Econometrics* 1 (1982a), 35–95.

——, AND ——, "New Methods for Analyzing Structural Models of Labor Force Dynamics," *Journal of Econometrics* 188 (1982b), 115–68.

FLINN, C. J., "Wages and Job Mobility of Young Workers," *Journal of Political Economy* 94 (1986), S88–S110.

GITTLEMAN, M., AND E. N. WOLFF, "Racial Differences in Patterns of Wealth Accumulation," *Journal of Human Resources* 39 (2004), 193–227.

GOMES, J., J. GREENWOOD, AND S. REBELO, "Equilibrium Unemployment," *Journal of Monetary Economics* 48 (2001), 109–52.

GROSSMAN, S., D. LEVHARI, AND L. MIRMAN, "Consumption under Uncertainty," in J. R. Green and J. A. Scheinkman, eds., *General Equilibrium, Growth and Trade. Essays in Honor of Lionel McKenzie* (New York: Academic Press, 1979), 105–24.

Hakansson, N., "Optimal Investment and Consumption Strategies under Risk for a Class of Utility Functions," *Econometrica* 38 (1970), 587–607.

Hamermesh, D. S., "Social Insurance and Consumption: An Empirical Inquiry," *American Economic Review* 72 (1982), 101–13.

Hansen, G., and A. Imrohoroglu, "The Role of Unemployment Insurance in an Economy with Liquidity Constraints and Moral Hazard," *Journal of Political Economy* 100 (1992), 118–42.

Heckman, J., and T. MaCurdy, "A Life Cycle Model of Female Labor Supply," *Review of Economic Studies* 47 (1980), 47–74.

Hopenhayn, H. A., and J. P. Nicolini, "Optimal Unemployment Insurance," *Journal of Political Economy* 105 (1997), 412–38.

Jianakoplos, N. A., P. L. Menchik, and F. O. Irvine, "Using Panel Data to Assess the Bias in Cross-sectional Inferences of Life-Cycle Changes in the Level and Composition of Household Wealth," in R. Lipsey and H. S. Tice, eds., *The Measurement of Saving, Investment and Wealth* (Chicago: University of Chicago Press, 1989), 553–644.

Joseph, G., and T. Weitzenblum, "Optimal Unemployment Insurance: Transitional Dynamics vs. Steady State Equilibrium," *Review of Economic Dynamics* 6 (2003), 869–84.

Jovanovic, B., "Job Matching and the Theory of Turnover," *Journal of Political Economy* 87 (1979), 972–89.

——, "Work, Search and Rest: A Theoretical Analysis of the Cyclical Behavior of Unemployment," *Journal of Labor Economics* 5 (1987), 131–48.

Kiefer, N., and G. Neumann, "An Empirical Job Search Model with a Test of the Constant Reservation Wage Hypothesis," *Journal of Political Economy* 87 (1979), 69–82.

Lentz, R., "Unemployment Insurance in a Structurally Estimated Job Search Model with Savings," Mimeo, Northwestern University, 2001.

——, and T. Tranæs, "Job Search and Savings: Wealth Effects and Duration Dependence," CESifo Working Paper No. 461, 2001.

Lippman, S., and J. McCall, "The Economics of Job Search: A Survey," *Economic Inquiry* 14 (1976), 155–89.

Lippman, S. A., and J. W. Mamer, "A Simple Search Model with Procyclical Quits," *Journal of Economic Dynamics and Control* 13 (1989), 247–53.

Ljungqvist, L., and T. J. Sargent, *Recursive Macroeconomics* (Cambridge, MA: MIT Press, 2000).

MaCurdy, T., "An Empirical Model of Labor Supply in a Life Cycle Setting," *Journal of Political Economy* 89 (1981), 1059–85.

Marimon, R., and F. Zilibotti, "Unemployment vs. Mismatch of Talents: Reconsidering Unemployment Benefits," *Economic Journal* 109 (1999), 266–91.

Meyer, B., "Unemployment Insurance and Unemployment Spells," *Econometrica* 58 (1990), 757–82.

Miller, B. L., "Optimal Consumption with a Stochastic Income Stream," *Econometrica* 42 (1974), 253–66.

Mortensen, D., "Job Search and Labor Market Analysis," in O. Ashenfelter and R. Layard, eds., *Handbook of Labor Economics*, Vol. 2, C (Amsterdam: North Holland, 1986), 849–920.

Pissarides, C., "Consumption and Savings with Unemployment Risk: Implications for Employment Contracts," Mimeo, CEPR Working Paper. No. 3367, 2002.

Press, W. H., S. A. Teutolsky, W. T. Vetterling, and B. P. Flannery, *Numerical Recipes in FORTRAN: The Art of Scientific Computing* (New York: Cambridge University Press, 1992).

Rendon, S., "Job Search and Asset Accumulation under Borrowing Constraints." Ph.D. Dissertation, New York University, 1997.

——, "Does Wealth Explain Black–White Differences in Early Employment Careers?" Mimeo, Universidad Carlos III. Working Paper 03-23, 2003.

Rust, J., "Maximum Likelihood Estimation of Discrete Control Processes," *SIAM Control and Optimization* 26 (1988), 1006–24.

——, "Behavior of Male Workers at the End of the Life Cycle: An Empirical Analysis of States and Controls," in D. Wise, ed., *Issues in the Economics of Aging* (Chicago: University of Chicago Press, 1990), 317–79.

——, M. Bushinsky, and H. Benítez-Silva, "Dynamic Structural Models of Retirement and Disability," Mimeo, 2003.

Sobol, M., "Factors Influencing Private Capital Accumulation on the 'Eve of Retirement'," *Review of Economics and Statistics* 61 (1979), 585–93.

Stancanelli, E., "Do the Wealthier Stay Unemployed Longer? An Empirical Study for the UK," *Oxford Bulletin of Economics and Statistics* 61 (1999), 295–14.

Wolff, E., "Methodological Issues in the Estimation of the Size Distribution of Household Wealth," *Journal of Econometrics* 43 (1990), 179–95.

——, "Trends in Household Wealth in the United States," *Journal of Income and Wealth* 43 (1994), 143–74.

Wolpin, K., "Estimating a Structural Search Model: The Transition from School to Work," *Econometrica* 55 (1987), 801–17.

——, "The Determinants of Black–White Differences in Early Employment Careers: Search, Layoffs, Quits, and Endogeneous Wages," *Journal of Political Economy* 100 (1992), 535–60.