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Asynchronous risk: retirement savings, equity markets, and unemployment

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Abstract

Retirement savings in defined contribution plans vary as a result of the timing and frequency of unemployment spells. We hypothesize that unemployment is coincident with negative shocks to equities prices, implying workers may systematically miss investment opportunities. First we match historic stock returns to unemployment hazards by gender, and earnings quartile. Next we test the relationship between unemployment, equity returns, and pension savings, by repeated simulation. Finally, we find that the timing of unemployment spells amplifies retirement savings losses on average for all worker-types in our analysis. Timing impacts are observed to be largest for high earnings workers and to increase with unemployment losses disproportionately.

1 Introduction

In the United States, pension savings are increasingly carried in defined contribution plans. The change from defined benefit to defined contribution structures has been widespread affecting men and women across the earnings distribution.[1] Restructuring American retirement savings has also influenced thinking about the nation's public pension system, spawning interest in moving Social Security toward a defined contribution framework.

Defined contribution (DC) structures have worthwhile qualities. They allow workers greater labor force mobility and greater control in timing their retirement.

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[1] Appendix A gives evidence of DC participation from the 1996, and 2001 SIPP panels by earnings quartile.

DC plans also reduce single-firm risks, allow explicit ownership of pension assets, and better contour investment and bequest allocations to individual preferences. Considering unemployment, DC plans protect workers from complete or partial pension loss that can occur when job-loss happens prior to full defined benefit (DB) vesting.

Indeed, many predict that these changes will positively affect individual retirement savings. Poterba, Venti, and Wise (1995, 1996) have documented the shift toward DC plans, and their work suggests that net savings have increased. Samwick and Skinner (2004) compare DB and DC plans in the United States, predicting that most future workers will do better within the DC environment.[2] Prior to Samwick and Skinner's results, Disney and Whitehouse (1996) found that British workers were empirically better off with DC plans due to the distribution of tenure durations and 'back-loading' formulae of DB plans.

However, DC plans are not a clear-cut improvement for all workers; these plans have risks associated with asset management both during working years, and into retirement. This raises one residual concern – the risk of inadequate retirement savings via DC plans. Without proper management and diversification, these DC programs expose workers to increased longevity risk (Brown, 2001; Hurd, 1989), portfolio risk (Benartzi and Thaler, 2001), and equity market timing risk (Burtless, 2000). Empirically, whereas Burtless focuses on equity market timing risk, we focus on the labor market, and the co-integration of the labor and equities markets via unemployment.

In order to save adequately for retirement, workers must develop accurate expectations about lifetime workforce absences. Unemployment is an important source for these absences – one over which the worker has limited control. We ask whether, and to what extent, missed contributions and the related *timing* of unemployment may reduce retirement savings. Indeed, any evidence of correlation between equity and labor markets would suggest that workers who save through DC-type plans may systematically miss opportunities to purchase when equity prices are relatively low. This in turn would increase the probability that workers may systematically under-save for retirement.

We consider how much one might expect to lose as a function of unemployment spells, contingent on worker characteristics. In addition, we offer the reader evidence regarding the sensitivity of our results by presenting a full distribution of outcomes for each worker-type, adjusting savings rates by income, and allowing for wage mobility over the life cycle. All of these modeling features are compared with baseline cases derived from a fixed dollar contribution case, a zero unemployment case, a random unemployment case, and a zero wage mobility case, respectively. This enables the reader a better understanding of the impact of each of these features, and allows us to investigate whether certain workers might more or less easily anticipate losses, and thereby better compensate for expected retirement savings losses during unemployment. After all, if losses are small enough, or relatively easy to predict, then

[2] Samwick and Skinner (2004) compare DB and DC plans directly and simulate returns from a range of plans documented in the Survey of Consumer Finances. They find that most workers in the United States do better with the average DC plan. Because of the nature of their exercise however they do not include periodic unemployment in their simulations.

precautionary savings may afford adequate protection, whereas if either the expected loss or the variance surrounding this expectation is too great, the opportunity to self-insure with precautionary savings is more limited.

In the following section we discuss the literature related to labor market risk and retirement savings. Most of this literature focuses on portfolio management in the context of employment income risk. We then focus on specific aspects of labor market risk and their implications for retirement savings under a system of DC accounts. Following the literature review, we discuss our data, method, results, and policy implications in the context of both employer-based and public pension systems.

2 Review of literature and theory

A number of researchers have highlighted a risk inherent in defined contribution plans: unanticipated shocks to labor income due to business cycle fluctuations. If we consider labor income a non-tradable implicit asset, then it can be balanced with other explicit assets to achieve a household's optimal portfolio allocation (Campbell *et al.*, 2000; Storesletten *et al.*, 1999; Viceira, 2001). For instance, if labor income is riskless, then it is most reasonable for a young household's portfolio to contain mainly risky assets (Bodie *et al.*, 1992). If labor income is risky but unrelated to financial market risks, the portfolio allocation in risky assets is projected to be reduced (Viceira, 2001). If labor income is risky and correlated with financial market returns, households should be more likely to invest in less risky assets (Campbell *et al.*, 2000).

Despite the theoretical developments underlying these recommended allocations, the empirical relationship between the equity and labor markets is not well understood. Given an equity shock, how would we expect labor to respond? It seems clear that the firm's production technology ties together capital and labor valuations. The most direct way for capital and labor to be linked is through prices, but if prices do not adjust rapidly enough in labor markets, then disequilibria would be expected. New Keynesians have considered why labor income may adjust less rapidly than the markets for other inputs: efficiency wages, menu costs and aggregate demand externalities, firm-specific human capital, and all have been cited as reducing the adjustment of labor income – Yellen (1984), Mankiw and Romer (1991), Farber (1999), respectively. Consequently, equity shocks, in the presence of partial labor income rigidity may result in increases in unemployment. Clearly, these mechanisms are not mutually exclusive and partial adjustments resulting from price changes and unemployment may both occur.

Previous research has examined periods following equity market shocks for evidence of wage adjustment with little success. For example, Davis and Willen (2000) research this topic directly and found virtually no short-term relation between capital and labor prices.[3] There are a number of reasons to believe that the standard

[3] Davis and Willen argue that when standard asset pricing relationships and conventional specifications of the aggregate production technology hold, high positive correlation between aggregate equity returns and shocks to the aggregate value of human capital should result, in line with standard economic models which hypothesize that labor income adjusts to reflect the new return on capital. However, Davis and

technology, asset pricing, and equilibrium assumptions fail to hold. Indeed, without these assumptions it is unclear that a capital productivity shock would, *necessarily*, lead to a covariance of movements in wages.

Since equity shocks do not appear to have a substantive direct impact on wages, we posit that equity shocks may impact labor through increases in unemployment. This position is not unique to our paper. Recent research has investigated possible cointegration between equity valuations and unemployment. Domian and Louton (1995) estimate the relationship between US equity indices and the US unemployment rate. They find negative stock returns are followed by sharp increases in unemployment. Recoveries are followed by slower reductions in the unemployment rate – revealing an asymmetry in labor market response across the business cycle. Silvapulle and Silvapulle (1999) find additional evidence of this asymmetric relationship, again finding that negative stock returns have a pronounced effect on the labor market. Earlier research by Neftçi (1984) and Davis (1987) also found evidence of a relationship between equity markets and unemployment and, in particular, an asymmetric relationship between equities and unemployment over the business cycle.

We build on these previous findings to consider how both the extent and timing of unemployment impacts retirement savings. The asymmetric response of unemployment to equities shocks proves particularly important in determining the extent that the timing of unemployment spells exacerbates or ameliorates individual shortfalls in pension-based equity market savings. While previous research indicates that equity market shocks may be more likely to directly impact unemployment rather than wages, we make no assumptions about the equity/unemployment relationship – none of the various simulation models developed herein, regardless of included features, embeds any structural assumptions about the cointegration of unemployment and equities markets. Thus we model these inter-relationships non-parametrically.

An example serves to illustrate the importance between equities shocks and unemployment and how the asymmetry of the impacts may result in market timing effects that increase savings losses. Consider a worker who invests her DC pension exclusively in a broad-based index fund comprised of the S&P500 and loses her job shortly after equities decline in value. She has purchased relatively expensive equities during her employment, and during her unemployment spell does not have the resources to purchase equities at relative discount. Opportunities for dollar-cost-averaging are somewhat muted for a worker in this situation. Figure 1 provides a conceptual rendering of such a case.

Alternative scenarios may be equally likely. For example, the effect of unemployment on pension savings may be in part mitigated if spells of unemployment coincide with periods of below average investment performance. Thus workers' expected retirement income losses could be amplified via a loss of purchasing opportunities or mitigated with a serendipitous spell of unemployment.

Willen find no evidence of a relationship between occupation-specific income and other broad-based equity indices such as the S&P 500, the NYSE, the Wilshire 5000, or any of their re-weighted composites.

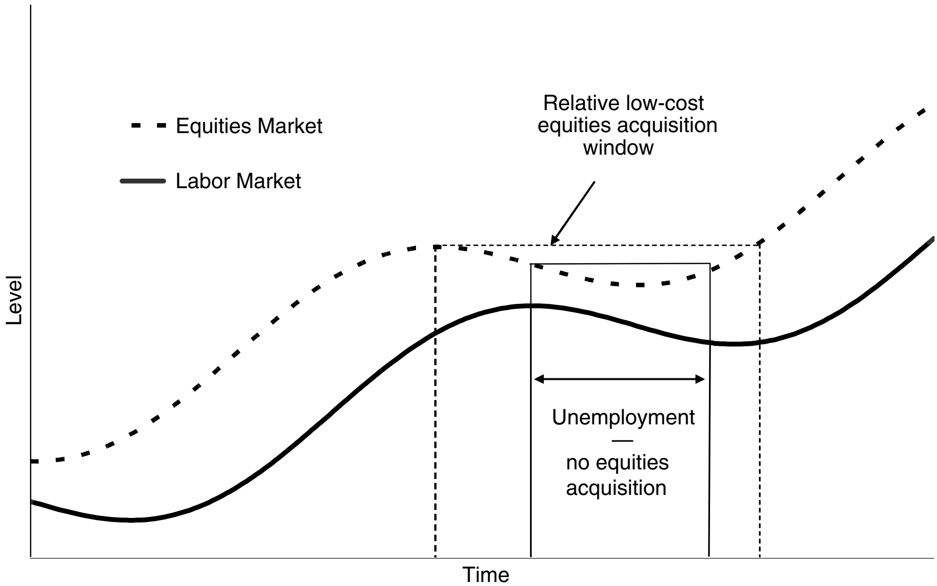

Figure 1. Asynchronous equities & labor markets (stylized example)

3 Data and method

We examine the relationship between the probability of job loss and the associated impact on retirement savings in a simulation framework. The simulations match historic unemployment rates and spells to coincident equities prices. To generate our unemployment spells we use data from the Current Population Survey Outgoing Rotation Groups for unemployment, earnings and demographics. These are joined to monthly equities market data from the Center for Research in Security Prices (CRSP). The simulations use historical rates of return on investments and coincident probabilities of unemployment, allowing exogenous and stochastic shocks of varying sizes to impact the economy overall. These exogenous macroeconomic conditions are compared numerically with historic worker-type specific probabilities of unemployment in order to generate spells of displacement. For example, when a worker experiences an exogenous shock in excess of the historic unemployment probability in any particular month, she becomes unemployed in that month. We record the savings performance for all worker-types in terms of retirement accumulation losses and isolate the impact associated with market timing by randomizing unemployment spells across each individual earnings history. This exercise is iterated one-hundred-thousand times, and we report both summary statistics, and the full distribution of outcomes that emerge.

Data

Throughout this paper we use two primary data sets: the Center for Research in Security Prices (CRSP) data for the S&P500 and the Current Population Survey – Outgoing Rotation Group (CPS-ORG) files. CRSP data are monthly; we use end of month prices as the basis for our calculations and include dividend returns. Both data sets cover the period from 1980 through 2002. We thus simulate worker savings in a defined contribution plan invested solely in a broad-based equity account (represented by the S&P500). Estimates of unemployment rates by wage quartiles and gender are calculated using the CPS-ORG. These earnings and gender groups represent eight worker-types: four female types, one in each earnings quartile, representing the average unemployment experiences of women by earnings quartile, and a similarly situated set of male types. All wages and returns are inflation adjusted using the Bureau of Economic Analysis (BEA) GDP Implicit Price Deflator to constant year 2000 dollars.

The structure of the CPS data allows us to match individuals across years, effectively creating a series of one-year panel data sets (see Madrian and Lefgren, 2000 for details on matching individual observations in CPS data). In essence, we have a synthetic panel of experienced unemployed allowing us to observe wages prior to the spell of unemployment.[4] We measure unemployment as the one year hazard rate of the experienced unemployed. Only those who were initially employed and then became unemployed one year later are counted as unemployed in our sample. This allows us to examine not only the unemployment experience of these workers but also their earnings prior to a spell of unemployment. The CPS is the optimal data source for unemployment estimates, since it forms the basis for the official unemployment rate.

Workers are classified into quartiles based on their hourly wage rate prior to unemployment. Separate earnings quartiles are calculated for men and women. All quartiles have balanced age profiles; that is, one-fourth of each age group is classified in each quartile. We then match each worker to their employment outcome in the following year and calculate the probability of being unemployed for each gender-earnings quartile pair. In this way, eight sets of monthly hazards are generated by the procedure for the period of January 1980 through December of 2002, yielding 23 years of data.[5]

The other major component of income loss related to spells of unemployment is the duration of the spell. Clearly, short spells of unemployment are less costly for worker's retirement savings. We model unemployment duration based on

[4] The Current Population Survey (CPS) is unique in character among US government data in that it is a broad questionnaire which follows a relatively large group for a relatively short period of time. Importantly for our work the CPS is also the source for official US unemployment data (which are produced from the CPS by the Bureau of Labor Statistics). Specifically, regarding unemployment, workers are surveyed at the fourth month, and then again at the sixteenth month following initial involvement. Because the CPS follows respondents for but a brief period, to use its data in a more continuous setting, such as ours, requires the creation of a series which adjoins several one-year panels for consistent worker-types (controlling for age, gender, and income quartile simultaneously). For each CPS cohort we observe the characteristics just described and employment status at the two points just mentioned. Again worth note, these points of observation are 12 months apart. The timing of the observations is fortuitous, allowing us to control for seasonality in employment. We construct a series for each indvidual worker-type by attaching the one-year panels from each CPS cohort together over the period of study.

[5] Within this period there are two merges which are not possible 1984–1985 and 1994–1995 due to decennial changes in the CPS panel. For these periods (totaling 24 months) we impute a hazard rates using a series of labor market indicators such as the unemployment rate and employment-to-population ratios. Imputation results are available from authors upon request.

period-specific duration distributions using published Bureau of Labor Statistics (BLS) data.[6]

To estimate the probability of switching quartiles after a spell of unemployment we use data from the CPS displaced worker surveys from 1994 through 2002. These surveys allow us to determine the pre- and post-displacement earnings of workers over this time period, and thus the probabilities of post displacement mobility across earnings quartiles. We aggregate results and implement a single earnings transition matrix for each gender type. Finally to control for changes in the level of prices, we employ BEA's Implicit GDP Deflator data, converting all dollar denominated data into year 2000 dollars.[7]

In summary the CRSP, CPS-ORG, and CPS-DWS, BLS, and BEA data provide five sets of measures for the parameterization of our analysis. CRSP data provide monthly prices for the S&P500 which forms the basis of our retirement investment returns. The CPS-ORG allows us to estimate gender and earnings-specific unemployment hazard rates, while the CPS-DWS allows us to estimate the wage transition after a spell of unemployment. The BLS provides information about the distribution of unemployment durations, and the BEA provides the implicit price deflator.

Method

Our method is to use the underlying unemployment rates, unemployment durations, and rates of worker mobility between earnings quartiles to simulate different earnings and savings histories for workers by gender, and entering quartile of earnings, over the period of study. We generate a series of stochastic economy-wide shocks which are then fitted to the relative probabilities of job loss by gender and current earnings quartile. Under these conditions all workers face the same series of stochastic shocks (which may be considered analogous to a general macro-economy), but differing unemployment hazards and durations generate unique employment outcomes across time and worker-type.

Each month, a random draw is taken and compared with each worker-type's baseline unemployment hazard. For each worker-type, if the random draw is observed to be above group- and time-specific hazards, unemployment occurs. Results are calibrated by adjusting the range of the uniform distribution so that the average unemployment rate in the simulation approximates the average rate of unemployment for men and women over age 20 from 1980 to 2002.[8]

[6] The BLS classifies unemployment duration into four categories: four weeks or less, five to 15 weeks, 16 to 26 weeks, and 27 weeks or more. We re-classify unemployment duration in terms of discrete weekly segments by using a piecewise linear spline of the durations and percentages in each category.

[7] BEA's Implicit GDP data are quarterly. These data are made monthly with a linear deconstruction of changes between observations. In spite of the original data being quarterly, we chose the GDP deflator since we are interested in controlling for economy-wide changes in prices (both stock and labor markets are adjusted). Other monthly series such as the Consumer Price Index (CPI) or the Producer Price Index (PPI) are too narrowly constructed for our purposes.

[8] Our sample of unemployment hazards over this period is such that, generally workers in lower earnings quartiles find themselves more likely to become unemployed, however higher quartile earners face higher unemployment hazards in a minority of periods. Over the period studied, we find that men in the first (lowest) earnings quartile experience greater hazard than second quartile men 78% of the time, while for the third and forth quartile the numbers are 88%, and 95%, respectively. For women the situation is

Once a period of unemployed begins, a second draw yields the duration of unemployment. Again, the assignment is based on the published distribution of unemployment durations over time. In general, drawing smaller numbers leads to faster exits; however, the same draw generates longer durations in periods when documented durations are longer. The worker is re-employed when the period specified by the second draw is completed. Periods are described in months to allow integration with our wage and stock data. Durations in our simulation are top coded to be no greater than six months (26 weeks), and bottom coded to be no less than one month (four weeks).[9] We take the underlying duration distribution in each month as constant across all gender and earner groups.[10]

In later simulations we allow for labor mobility across earnings quartiles following unemployment.[11] This is accomplished by the introduction of a final lottery at the end of each unemployment period to determine the earnings quartile of re-employment. Our earlier described transition matrix determines sorting across particular earnings quartiles for men and women separately. The underlying probabilities of earnings mobility are fixed by our transition matrix over time.[12] (Our table is reported in Appendix B.) Once re-employed, workers again contribute to their DC pension balances and re-enter the lottery for unemployment. The process continues in this way for the whole period of study. Finally, results are rescaled to reflect a 40-year career.

By this method, a worker's experience is defined by three series of economy-wide stochastic draws for unemployment onset, unemployment duration, and earnings quartile of rehire. To get a robust sense of the underlying patterns of losses, this process is iterated one-hundred-thousand times. For each simulation eight generic worker-types, a male and a female worker representing each earnings quartile, manifest contemporaneous experiences – allowing for direct comparison across worker-type. Thus we simulate economy-wide unemployment shocks and then determine the savings and investment return effects for men and women in each earnings quartile. To estimate timing impacts, we generate eight direct counterparts who experience the same number of months of unemployment, and the same overall quartile mobility, but for whom the unemployment periods are randomly distributed.

similar, but with a more pronounced hierarchy; lowest quartile female earners experiencing higher hazard than their second, third, and forth quartile contemporaries 94 %, 97 %, and 100 % of time, respectively.

[9] On average, our duration estimates are likely to under-report retirement savings losses. From 1980 to 2002, 15 % of unemployment experiences lasted in excess of 26 weeks. When switching directly between firms, workers often must wait a month or more to join pension plans, and sometimes face transaction costs in moving DC pension balances. The bottom coded unemployment period in part substitutes for these types of technical issues affecting overall accumulations.

[10] This is due to limitations of the BLS duration data, which are not broken down by wage quartile, or gender. To the extent that lower-earnings workers have shorter (but more frequent) spells of unemployment this assumptions may overstate the earnings losses for low income workers, while potentially understating losses for higher income workers.

[11] There is no explicit process for a worker to switch quartiles without unemployment in our work. This limitation is, arguably, inconsequential for two reasons. First, the net effect of quartile switching is to damp inter-quartile variation, and not to change central tendencies. Second, quartiles are age-contoured which allows for real wage growth over the life cycle.

[12] For example, men previously in the first earnings quartile have a 56 % chance of staying in the first quartile, and a 44 % chance of moving up. For those who move up, a move to the second quartile is most likely. Conversely, men who become unemployed while holding a fourth earnings quartile job have a 4 % chance of taking a job in the first earnings quartile, and a 62 % chance of staying in their current earnings quartile. Appendix A provides full details on parameters of mobility from the CPS DPS.

This allows us to estimate the losses from unemployment that are due to the particular timing of the calibrated unemployment probabilities and historic pattern of stock returns.[13] For each worker-type, in each simulation, we record the lifetime percentage and dollar losses from unemployment against a counterfactual of full employment. We also record the time unemployed in percent and in absolute terms (number of months).

We structure our DC accounts according to the following assumptions:

(a) There is no account-related transaction costs derived from unemployment.
(b) The employer pays the administrative costs of the retirement savings program.
(c) The unemployed do not withdraw from these accounts prematurely.[14]
(d) All workers invest the same percentage of their pay in the S&P500 with full reinvestment of dividends, regardless of age and earnings quartile.

With respect to the patterns of wages and contributions we assume:

1 There is earnings mobility, which follows from the process of unemployment described above.
2 Once re-employed, workers earn the real median wage of his or her now current earnings quartile, and face the unemployment hazards consistent with their new worker-type.

At the end of each simulation, we compare the balances of workers' retirement savings with the retirement balance of a consistently employed worker with similar characteristics (earnings quartile pattern, basic age–earnings profile, and gender). The difference of savings and resulting accumulations is attributed to periods of unemployment. We generate and report descriptive statistics for the universe of outcomes for each initial worker-type.

With this structure we are able to assess real market returns for periods in which workers are out of the labor force and compare them with average returns across the observed period, thus we observe any 'market timing effects' which might aggravate or reduce DC pension losses.

One potential criticism of our method lies in the possibility that workers in the lowest earnings quartiles do not have DC pension risks resulting from unemployment because they typically do not participate in DC plans. However, our analyses of the 1996 and the 2001 Survey of Income and Program Participation data indicate that prime age male and female workers (ages 25–54) in the bottom earnings quartiles have considerable DC participation. More than 60 % of workers in the first quartile of the earnings distribution enjoy pension coverage. Of those with a pension, more than half had a defined contribution pension by 2001. Thus approximately one-in-three workers in the bottom earnings quartile have a DC pension. Pension coverage increases as incomes increase, so, too, does the percentage in DC type plans. A second

[13] *Ex ante*, it is unclear whether the market timing effect should be positive or negative. A timing effect could be negative if retirement losses were ameliorated with fortuitous spell-timing, or, conversely, losses could be exacerbated by unfortunate spell timing.

[14] We thus assume either that workers finance consumption entirely from their unemployment benefit, or the existence of other precautionary savings, keeping balances in the DC accounts higher than they might be in actual job loss situations.

potential criticism of our method is that workers with a pension are less likely to be unemployed than workers without a pension. Turning to the 2001 SIPP panel we find that this is in fact the case. Men who did not have a pension were 2.4 times as likely to be unemployed relative to men with a pension. For women the relative rate was 2.3 times. We find no differential effect by pension type (either DB or DC). As discussed in more detail below we account for this in two ways. First, we examine unemployment only for 'prime-age' workers, 25–54 years old; thereby eliminating many of the unemployed without pensions from our sample. Secondly, we calculate unemployment rates only for the experienced unemployed. We use the CPS-ORG data to calculate the year-over-year unemployment rates for those who were employed in year one. This significantly lowers our unemployment rate (relative to the national rate) and better reflects the probability of unemployment for a pension holder. A final criticism revolves around the savings of the unemployed and whether they continue to purchase equities during periods of unemployment. If so, lifetime returns should meet worker expectations However, it is much more likely that workers are liquidity constrained and instead of purchasing equities will sell them during periods of unemployment (Gruber, 1997; Burman *et al.*, 1999).

To summarize, our model only counts periods of involuntary unemployment as effecting retirement savings, assumes that workers resist the temptation to 'raid' their retirement savings, assumes workers pay no administrative fees as part of the DC plan, experience at most 26 weeks of unemployment for any single spell, and suffer no wage penalty for labor force absence relative to like-type workers in their next job. These assumptions serve both to simplify our analysis and to reduce the likelihood of a finding in line with the hypothesis that unemployment and its timing are both substantively important components of retirement savings risk. Thus our estimates are arguably a lower bound of the estimated effect of unemployment on retirement savings.

4 Results

Our first set of simulations assumes workers contribute 10% of earnings toward retirement, allowing contributions to vary by earnings quartile and age.[15] Table 1 reports these results. Average retirement savings for men range from $260,000 to $793,000 for the lowest- and highest-earnings quartiles, respectively. Women saved considerably less, owing to lower wages; savings ranged from $196,000 to $600,000. Average losses due to unemployment range from $21,000 to $36,000 for men, and $14,000 to $18,000, for women. Both men and women workers in the highest earnings quartile lost the most money as a result of unemployment. However, these workers lost the smallest percentage of their savings due to unemployment. Men in the lowest earning quartile lost approximately 8% of their retirement savings, whereas a man in the highest earnings quartile could expect to lose 4.5% of their retirement savings relative to someone who experienced no unemployment.

[15] As a check on the sensitivity of our results we estimated an alternative set of simulations where each worker group was assumed to save the same dollar amount monthly. Under this scenario the percentage losses were identical to results presented throughout the included tables; however total losses for the lowest income quartile were considerably higher.

Table 1. *Losses in retirement accumulations by earnings quartile and gender* (contributions at 10 % of observed earnings – workers' earnings quartile fixed)

Worker type	Avg. monthly contribution	Avg. dollar loss	Percentage loss	Unemployment over career	Total savings
Men					
Quartile 1	$140.23	$20,746	8.0 %	7.4 %	$260,036
Quartile 2	$222.64	$25,377	6.3 %	5.6 %	$404,434
Quartile 3	$309.00	$29,776	5.4 %	4.8 %	$551,085
Quartile 4	$462.18	$35,752	4.5 %	4.1 %	$793,163
Women					
Quartile 1	$106.26	$14,126	7.2 %	6.6 %	$196,200
Quartile 2	$159.32	$15,336	5.3 %	4.8 %	$287,249
Quartile 3	$226.27	$17,078	4.3 %	3.8 %	$398,432
Quartile 4	$350.99	$17,878	3.0 %	2.8 %	$599,709

Notes: Earnings derived from CPS-ORG for workers ages: 26–30 in 1980.
Dollar values amplified to show 40 year career equivalents in year 2000 dollars.

Spells of unemployment explain only part of the variation in retirement savings; earnings dynamics are another component. Table 1 assumes that once a spell of unemployment is complete, workers remain in the same earnings quartile throughout their career. In Table 2 we relax this assumption and allow interquartile wage mobility.

There are two interesting implications of introducing wage mobility. First, introducing wage mobility raises the likelihood that workers at the bottom and top of the wage distribution move toward the center (convergence in experienced lifetime earnings). Second, once a worker switches earnings quartiles we assume they take on all the attributes of that new quartile: contribution amounts, unemployment probabilities, and transition probabilities.

In general, the results from our earnings-quartile switching model confirm the findings from our other models. Mean and median savings losses are similar across the models with some convergence in observed losses across the earnings distribution, as expected. In terms of total savings for retirement, workers who begin their careers in the lowest earnings quartile did considerably better than under the static wage model, now exiting with an average savings of just under $401,000 for men and just over $296,000 for women. Workers who begin careers in the highest earnings quartile fared worse with the dynamic wage model. Reductions in savings for this group were on the order of 22 to 25 % of total accumulations compared to the no wage mobility model.

Market timing effects

The retirement income losses shown in Tables 2 and 3 are largely a result of the foregone contributions to retirement savings resulting from periods of unemployment. However, a portion of these losses are due to the *timing* of unemployment

Table 2. *Losses in retirement accumulations by earnings quartile and gender*

(contributions at 10% of observed earnings – quartile switching allowed)

Initial Worker Assignment	Median dollar loss	Average Dollar loss	Average Percentage loss	Unemployment over career	Full-employment savings
Men					
Quartile 1	$21,793	$24,495	6.1%	5.8%	$400,951
Quartile 2	$23,773	$26,371	5.9%	5.5%	$446,798
Quartile 3	$25,958	$28,978	5.0%	4.9%	$583,257
Quartile 4	$28,609	$32,439	5.1%	4.6%	$634,404
Women					
Quartile 1	$13,444	$15,223	5.1%	4.9%	$296,111
Quartile 2	$13,760	$15,595	4.8%	4.6%	$321,603
Quartile 3	$14,215	$16,477	4.4%	4.1%	$372,233
Quartile 4	$13,479	$16,966	3.5%	3.3%	$480,592

Notes: Earnings derived from CPS-ORG for workers ages: 26–30 in 1980.
Quartile switching based on transition probabilities in Appendix B.
Dollar values amplified to show 40 year career equivalents in year 2000 dollars.

Table 3. *Decomposition of total losses: timing and unemployment effects*

(contributions at 10% of observed earnings – quartile switching allowed)

Initial Worker Assignment	Average Timing loss	Average Unemployment loss	Average Total loss	Timing as % of total loss	Months unemployed
Men					
Quartile 1	$1,377	$23,118	$24,495	6.0%	27.8
Quartile 2	$1,933	$24,438	$26,371	7.9%	26.4
Quartile 3	$2,525	$26,454	$28,978	9.5%	24.8
Quartile 4	$2,798	$29,641	$32,439	9.4%	22.2
			Average	8.2%	
Women					
Quartile 1	$763	$14,460	$15,223	5.3%	23.5
Quartile 2	$981	$14,614	$15,595	6.7%	22.0
Quartile 3	$1,113	$15,365	$16,477	7.2%	19.8
Quartile 4	$691	$16,275	$16,966	4.2%	16.0
			Average	5.9%	

Notes: Earnings derived from CPS-ORG for workers ages: 26–30 in 1980.
Quartile switching based on transition probabilities in Appendix B.
Dollar and time values amplified to show 40 year career equivalents.
Year 2000 dollars.

spells. To distill the effect of unemployment timing we compare the results from Table 2 to a set of duration-matched results where unemployment timings have been randomized. By comparing the difference directly, we isolate the impact of timing on losses, and estimate the impact of any observed co-integration of the labor and equities markets. Table 2 presents these results.

Table 3 shows the decomposition of total losses in retirement savings. The timing column represents the difference between the systematic and random losses. A male worker in the first quartile is expected to lose $1,377 due to the unfortunate timing of his unemployment spells, while a fourth quartile male worker should expect to lose $2,798 in addition to his $29,641 in foregone contributions and associated returns. Timing losses represent, *on average*, 6% of total losses for women and 8% for men. These losses are of very manageable size, and can well be afforded by relatively minor increases in precautionary savings – thus we take our summary results to be good news for average workers who save via equities markets for retirement in DC frameworks.

Distribution of effects

Average savings losses and timing losses described in Tables 1, 2, and 3 fail to capture the full nature of our findings. Figures 2a and 3a illustrate the distribution of losses. Indeed, the variation in unemployment related savings losses is considerably larger than workers might anticipate. While some workers avoid unemployment related losses altogether, some losses are so great as to call into question the ability to compensate for unemployment risks though precautionary savings. The figures indicate that 5% of workers will experience total retirement savings losses between 10% and 13% (depending on starting quartile and gender). In the tail of the distribution, 1% of workers will experience losses ranging from 16% to 20% of potential savings. This is largely due to the probability that some workers will be unlucky in the job lottery and will consequently experience both downward wage mobility and the more frequent spells of unemployment that occur for those in lower earnings quartiles.

Figures 2b and 3b extend our distributional analysis to the timing effects just described. We find rather stark differences in the timing effects across the loss distribution. Indeed, workers with small losses can experience positive timing effects (i.e., the timing of their unemployment helped ameliorate losses). However, for workers with greater losses negative timing effects are prevalent. Of particular interest, we find that the timing effect grows as unemployment losses mount. For each quartile the trend is nearly the same, a timing effect damps losses at the low end of the loss distribution, but increasingly exacerbates larger losses. In general, these findings are more concerning; while mean losses are indeed manageable, a great deal of variance and uncertainty surrounds the expected loss, limiting individuals' capacity to self insure with precautionary savings. We believe that this finding is new and important; a priori, it is possible for us to have found that timing effects to be a greater share of small losses. Our analysis indicates that fortune is not so fair. Figures 2b and 3b serve to document these findings.

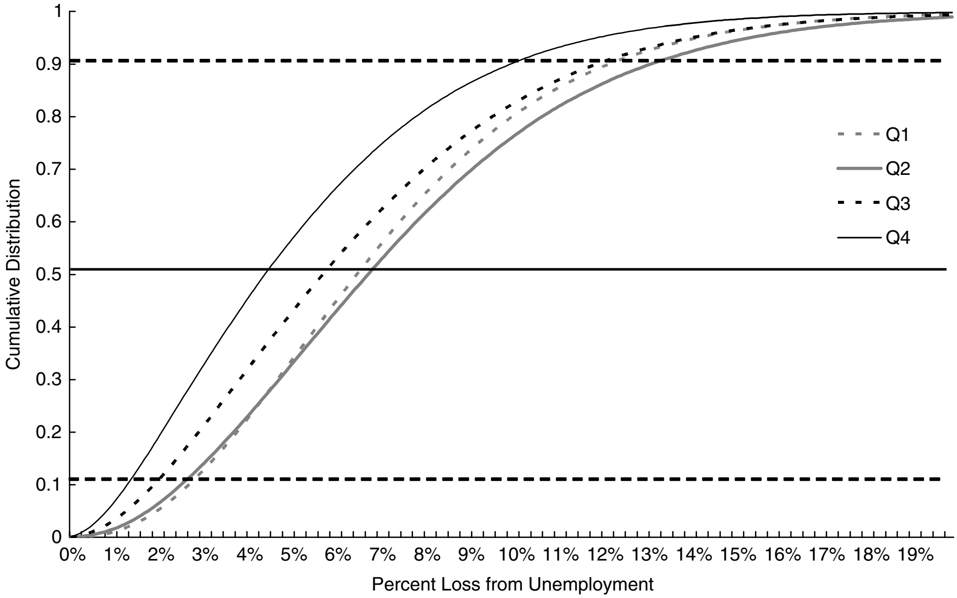

Figure 2a. Men: simulated retirement savings losses. Constant portfolio, stochastic unemployment, with earnings quartile mobility

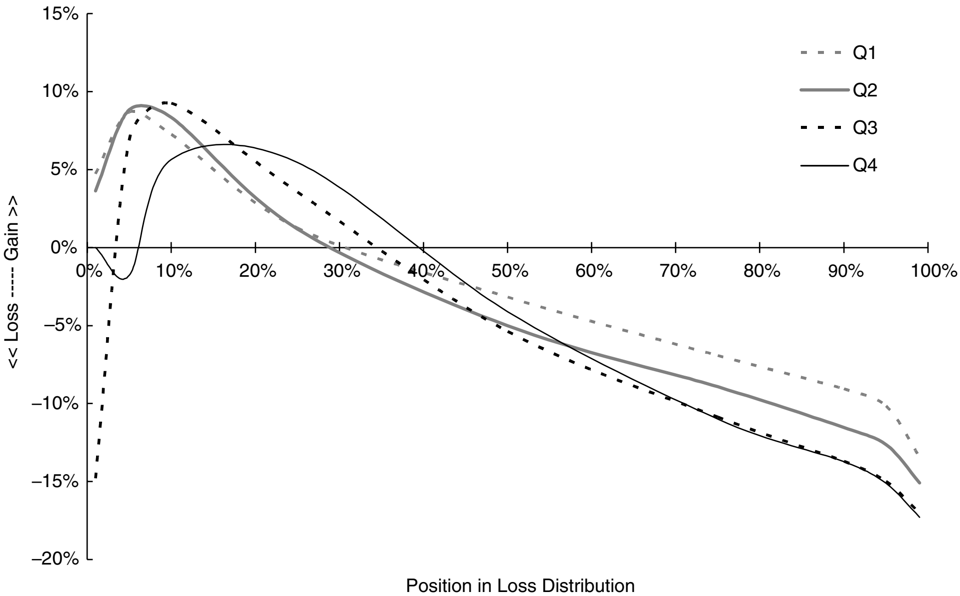

Figure 2b. Men: timing effect as a percent of total losses (by location in the loss distribution)

One final and important issue for interpreting the likely impact of our work on actual savings revolves around whether workers are liquidity constrained. If so, then even when equity prices are relatively lower in a recession workers would have only limited opportunities to purchase equities. One option would be for workers to shift

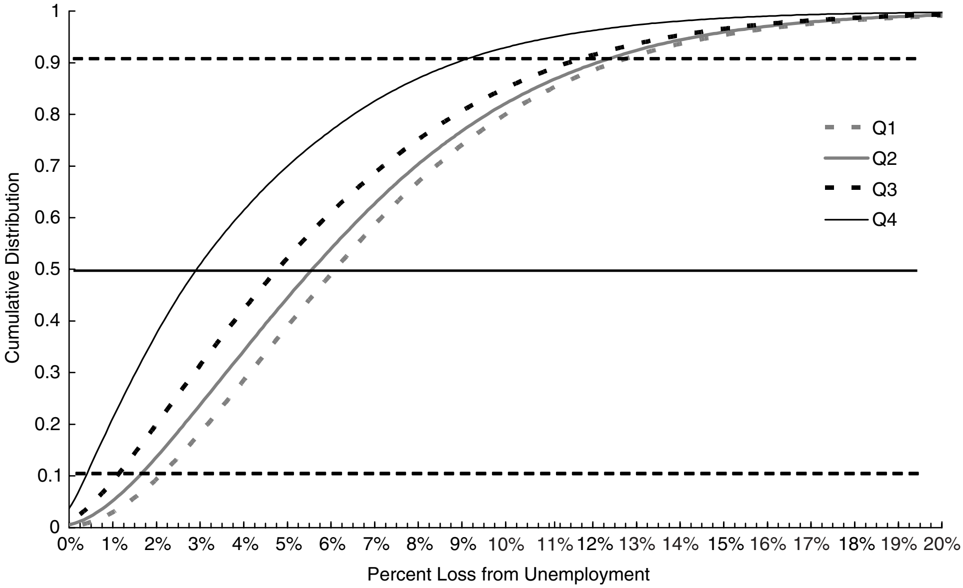

Figure 3a. Women: simulated retirement savings losses. Constant portfolio, stochastic unemployment, with earnings quartile mobility

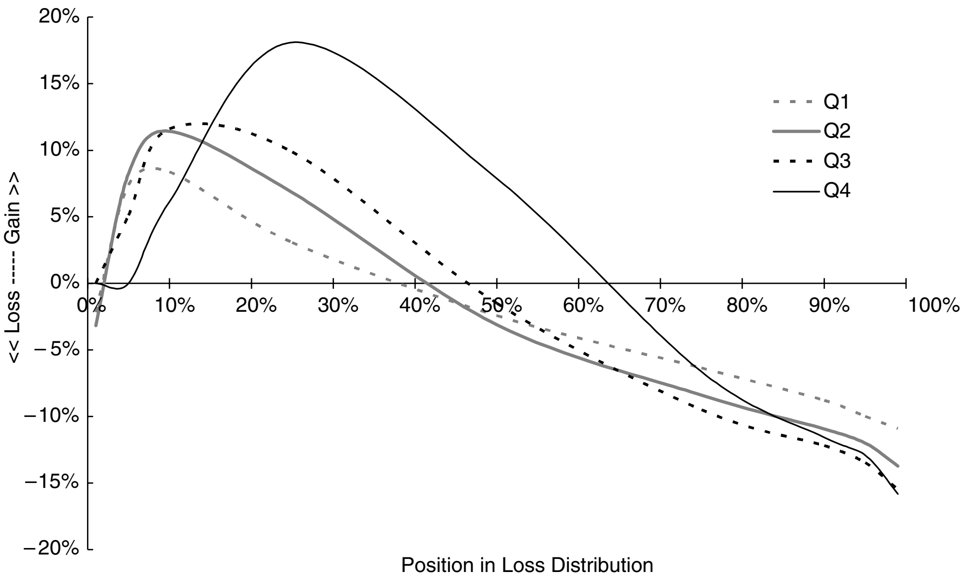

Figure 3b. Women: timing effect as a percent of total losses (by location in the loss distribution)

assets away from fixed income and bonds toward equities. However, based on age and risk tolerance this may either be infeasible (younger workers have virtually no investments in these asset classes) or courting disaster (older workers may not have sufficient time to wait for returns and equity prices to recover). This implies that if the unemployed are liquidity constrained and unlucky, retirement savings goals may be difficult to reach.

5 Conclusions

Our simulations of retirement savings find that lower income workers' unemployment experiences and timing of unemployment spells result in considerable savings losses relative to a baseline case of no unemployment. Lower income workers experience the largest average percentage declines of retirement savings, ranging from 6% for men and 5% for women (using our quartile-switching model); workers who begin careers in the highest quartile of earnings experienced retirement savings losses of 5% (men) and 3% (women). These averages mask considerable variation in losses. In the tails of the loss distributions nearly 10% of the population can expect to lose between 8 and 13% of their retirement income as a result of unemployment. Equally important, we find that the timing of unemployment spells amplifies savings losses for this group, as workers miss out on purchases of equities through employer plans during periods of relatively low equity prices. In the absence of these timing effects, retirement savings losses would have been, on average, 7% smaller. The effect of unemployment on defined contribution pension savings has a direct impact on worker's financial well-being in retirement. For workers who annuitize their DC balances at age 65, these average savings losses translate into a reduction in monthly benefits payments ranging from $133 to $176 for women and from $177 to $236 for men, in the lowest to highest earnings cohorts, respectively.[16]

We note that our estimates may understate the true retirement savings losses associated with unemployment since we assume that all workers are equally facile in managing their retirement portfolio, do not 'raid' their retirement savings when unemployed, restrict our consideration to only involuntary periods of unemployment identified in the CPS, and assume that spells of unemployment do not extend beyond 26 weeks. The effects of other limitations of the model are unclear, *ex ante*. In particular we do not allow workers to alter their portfolios in order to diversify away some of their employment income risk. It is unclear to us that allowing workers with risky income streams to balance their portfolio with less risky assets would raise overall savings; however, it would likely reduce the variation in losses.

Of course, involuntary unemployment is only one of many risks related to workforce participation that workers face while saving for retirement, investment, and market timing risks, and the cost of annuitization may alter accumulations and retirement security considerably. Additionally, retirees who choose not to annuitize must contend with longevity and inflation risks. Ideally, researchers would investigate these associated risks simultaneously and policy makers would work to facilitate insurance markets to mitigate against large losses. The interrelationship of these risks, in particular integrating interest rate risk into our analysis, is likely to be a fruitful direction for future research.

[16] These estimates are based on Annuity Calculations available from the Federal Thrift Savings Plan at age 65 for a single life level payment. The credited interest rate used in these transactions was taken as given at 4.125%.

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Appendix A. Pension type by earnings quartile: prime age workers

	2001 SIPP				Proportion DC(*)	
	Any	DB	DC	CB	2001 SIPP	1996 SIPP
1st (lowest) quartile	62.5%	31.5	32.5	5.2	52.0	48.2
2nd quartile	79.0	38.9	43.4	6.3	54.9	50.3
3rd quartile	87.8	46.1	49.1	7.0	56.0	52.4
4th (highest) quartile	91.9	49.8	53.7	8.1	58.5	58.1
Overall	80.7	41.8	45.0	6.7	55.7	52.7

Notes: (*) conditional on coverage.
Proportions sum to more than 100% as some workers hold more than one pension type.
Data: 2001, 1996 SIPP panels.

Appendix B. Labor mobility by earnings quartile from matched CPS-ORG files

		Men						
Starting Quartile = 1		1994	1996	1998	2000	2002	2004	Average
Transition Quartile	1	52.7	54.4	56.6	51.2	59.8	52.6	54.54
	2	24.8	20.9	25.4	23.1	22.4	22.8	23.23
	3	15.0	12.0	8.1	8.1	13.8	12.7	11.62
	4	9.7	9.4	5.8	6.0	6.2	8.8	7.65
Starting Quartile = 2		1994	1996	1998	2000	2002	2004	
Transition Quartile	1	29.4	34.3	29.5	29.0	28.7	32.6	30.60
	2	34.2	36.7	42.2	41.8	39.7	38.5	38.82
	3	20.7	23.0	24.2	25.3	19.1	20.0	22.06
	4	10.8	9.7	5.9	8.6	8.9	7.9	8.64
Starting Quartile = 3		1994	1996	1998	2000	2002	2004	
Transition Quartile	1	14.0	7.3	9.3	14.5	9.0	12.4	11.09
	2	31.9	32.0	28.3	25.9	29.2	30.6	29.64
	3	35.6	35.3	41.6	41.2	40.9	40.5	39.19
	4	20.9	21.3	18.7	16.8	19.8	16.6	19.04
Starting Quartile = 4		1994	1996	1998	2000	2002	2004	
Transition Quartile	1	3.9	4.0	4.6	5.3	2.6	2.3	3.77
	2	9.2	10.4	4.2	9.2	8.7	8.2	8.31
	3	28.7	29.7	26.1	25.5	26.2	26.8	27.14
	4	58.6	59.7	69.6	68.6	65.1	66.6	64.68

		Women						
Starting Quartile = 1		1994	1996	1998	2000	2002	2004	
Transition Quartile	1	47.1	50.6	55.2	49.8	46.8	46.6	49.35
	2	24.7	17.9	22.1	25.7	30.2	24.6	24.19
	3	13.7	14.1	10.1	11.3	12.3	12.9	12.40
	4	9.2	10.1	7.7	6.7	6.9	10.0	8.44
Starting Quartile = 2		1994	1996	1998	2000	2002	2004	
Transition Quartile	1	30.2	33.9	31.2	30.4	33.3	34.4	32.25
	2	37.4	42.9	43.1	43.7	35.3	38.9	40.22
	3	22.3	18.2	15.6	18.8	27.6	22.1	20.77
	4	13.5	9.4	8.0	5.9	9.7	9.4	9.31
Starting Quartile = 3		1994	1996	1998	2000	2002	2004	
Transition Quartile	1	15.0	12.4	10.5	13.6	16.2	12.8	13.43
	2	25.3	24.2	24.4	20.8	26.0	27.9	24.75
	3	37.3	43.7	45.4	45.3	33.3	40.0	40.81
	4	18.4	16.6	17.7	19.1	13.6	20.0	17.57
Starting Quartile = 4		1994	1996	1998	2000	2002	2004	
Transition Quartile	1	7.7	3.0	3.1	6.2	3.7	6.2	4.98
	2	12.7	15.1	10.4	9.9	8.4	8.6	10.85
	3	26.8	24.0	28.9	24.6	26.9	25.0	26.02
	4	58.9	63.9	66.6	68.3	69.7	60.6	64.68

Notes: Average values (derived above) are used to predict labor mobility from last previous quartile just prior to most recent unemployment spell.