View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by Research Papers in Economics

NBER WORKING PAPER SERIES

SEARCHING FOR BETTER PROSPECTS: ENDOGENIZING FALLING JOB TENURE AND PRIVATE PENSION COVERAGE

Leora Friedberg
Michael T. Owyang
Tara M. Sinclair

Working Paper 11808
http://www.nber.org/papers/w11808

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
December 2005

The authors wish to thank Marcus Berliant, Rob Dittmar, Richard Johnson, Éva Nagypál, Stan Panis, Garey Ramey, John Stevens, Jay Stewart, seminar participants at Washington University, and participants at the North American Summer Meeting of the Econometrics Society and the American Economic Association annual meetings for helpful comments. Abbigail J. Chiodo and Kristie M. Engemann provided excellent research assistance. The views in this paper are the authors.alone and do not re.ect the views of the Federal Reserve Bank of Saint Louis or the Federal Reserve System. All remaining errors are our own. The views expressed herein are those of the author(s) and do not necessarily reflect the views of the National Bureau of Economic Research.

©2005 by Leora Friedberg, Michael T. Owyang, and Tara M. Sinclair. All rights reserved. Short sections of text, not to exceed two paragraphs, may be quoted without explicit permission provided that full credit, including © notice, is given to the source.

Searching for Better Prospects: Endogenizing Falling Job Tenure and Private Pension Coverage
Leora Friedberg, Michael T. Owyang, and Tara M. Sinclair
NBER Working Paper No. 11808
December 2005
JEL No.E24, J32, J41, J63, J64

ABSTRACT

Recent declines in job tenure have coincided with a shift away from traditional defined benefit (DB) pensions, which reward long tenure. Recent evidence also points to an increase in job-to-job movements by workers, and we document gains in relative wages of job-to-job movers over a similar period. We develop a search model in which firms may offer tenure-based contracts like DB pensions to reduce the incidence of costly on-the-job search by workers. Reduced search costs can, under fairly general conditions, lower the value of deterring search and the use of DB pensions.

Leora Friedberg
University of Virginia
Department of Economics
P.O. Box 400182
Charlottesville, VA 22904-4182
and NBER
lfriedberg@virginia.edu

Michael T. Owyang
Research Department
Federal Reserve Bank of Saint Louis
P.O. Box 442
St. Louis, MO 63166
michael.t.owyang@stls.frb.org

Tara M. Sinclair
Economics Department
George Washington University
1922 F Street, NW
Old Main, Suite 208
Washington, DC 20052
tsinc@gwu.edu

1 Introduction

Workers in the United States have experienced significant changes in both job tenure and the structure of employer-provided pensions over the past twenty years. Traditional defined benefit (DB) pensions, which reward long tenure, have become steadily less common, while both actual and expected job tenure have fallen over the same period. The link between job tenure and pension trends has not been closely examined but offers insights about both phenomena. This paper investigates how on-the-job (OTJ) search by workers provides a motive for the use of deferred compensation and how that motive may have changed over time.

Spurred by evidence of a long-term increase in job-to-job mobility (Stewart [41]), we show that these increased job-to-job flows have been associated with rising relative wages. We develop a model in which workers may search for new, more productive matches while on the job. A key feature of the model is that both OTJ search and the resulting quits are costly to the firm. We show conditions under which the firm, to avoid this loss, might offer a contract that dissuades workers from searching. The contract takes the form of delayed compensation that is conditioned on the worker not quitting. These contracts look much like DB pensions. In a recent paper, Friedberg and Owyang [13] (hereafter FO) argued that the value of long-term jobs has fallen, which has reduced expected job tenure and thus undermined the effectiveness of DB pensions at deterring moral hazard. This paper pursues a related line of research, incorporating a more realistic representation of job search and thus highlighting another change in the nature of long-term jobs.

In this framework, an increase in the gains from OTJ search caused by, for example, lower search costs, results in more search, more quits, and consequently shorter job tenure, all of which undermines the incentive to offer pensions. Although a decline in search costs has a theoretically ambiguous effect on relative wages of job-to-job movers in our model, our evidence that their relative wages have improved in recent years bolsters the premise that OTJ search has grown more rewarding. We emphasize an endogenous shift in the use of pensions in this paper, as opposed to exogenous changes resulting from new government regulations that have been highlighted in the pension literature. Also, in contrast to FO where the decline in job tenure and DB pension use results from an increase in endogenous match destruction, we consider the role played by increased *voluntary* worker flows, which are involuntary to the firm.

This paper draws on research in several areas. The model is motivated by the empirical importance job-to-job flows by workers and the role they play in explaining the decline in job tenure. The paper also builds on an emerging literature that documents a variety of evidence about reduced search costs. Anecdotal reports suggest that search costs have dropped, most recently as use of the internet has expanded and over a longer period due to structural shifts in the economy, some of them associated with thicker local labor markets.[1] In the search literature, a reduction in search frictions is generally predicted to increase the productivity range over which agents search, thus raising job-to-job flows (Pissarides [34]) and reducing average job tenure.[2] The greater incentive to search diminishes the effectiveness of pensions in deterring search – thus linking recent trends in job tenure and pension structure.[3]

This paper also extends the literature focusing on DB pensions as incentive contracts, building on work by Lazear [25]. Notably, this paper complements other recent work incorporating tenure-based contracts that deter OTJ search (Burdett and Coles [5], Stevens [39]). The essential similarity of those two papers and ours is that a worker in a job may choose not to seek outside offers if the firm offers a rich enough incentive, for example by tying compensation to tenure, even though productivity need not rise with tenure. The papers differ in the details of search and match formation, which determine the particular costs and benefits of search. Both Stevens and Burdett and Coles assumed that firms post wages for jobs in which productivity is known in advance and workers choose among jobs offering differing starting points on the tenure-based wage profile. Job offers arrive costlessly, but workers are less likely to quit the higher they are on the wage profile. Firms face a tension between starting workers at a lower point on the wage profile and raising current profits, or at a higher point and raising retention rates and future profits.[4] In Stevens, firms post not a wage but a contract taking the form that all pay is deferred until a date T agreed

[1] For example, local labor markets are changing so that workers with given skills seem to have more firms to match with in a particular location. This is a consequence of trends like the shift into services and out of manufacturing, in which firms tend to be local monopsonists; of rising urbanization and resulting agglomeration economies, either within or across industries *[16]*; and of reductions in communication and transportation costs, which increase the gain to decentralizing production (Gersbach and Schmutzler [15]).

[2] If the matching function exhibits increasing returns to scale (Sato [36] reported evidence of this), then developments like these will have a magnified effect in raising matching efficiency and hence the gains to search.

[3] This emphasis complements recent papers that explore conditions under which reductions in search frictions undermine long-term relationships (Ramey and Watson [35], McLaren and Newman [27], Matouschek, Ramezzana, and Robert-Nicoud [26]).

[4] The starting point on the wage profile is heterogeneous across firms since they differ by size (as they can hire more than one worker) and by productivity (in Stevens).

to at the outset. In Burdett and Coles, workers are risk-averse, so firms offer a contract with rising wages.

In comparison, our model simplifies some aspects of job markets in order to expand on others. Instead of posted contracts for jobs with known productivity, we assume bargaining after risk-neutral agents meet and get a permanent productivity draw. That draw determines whether the worker accepts the match and, in addition, a pension contract to forgo OTJ search. In our case, search is costly, which explains why (as in the real world) only some and not all workers search OTJ. We also assume that a firm cannot post a vacancy while a worker occupies the job, and that a firm faces uncertainty in the value of future matches. The resulting costs of search borne by firms motivate the firms to discourage workers from searching. Compared to the papers by Burdett and Coles and by Stevens, we offer a more stylized contract. The contract consists of wages determined by Nash bargaining, together with a lump-sum paid out to the worker in the event that a match ends exogenously but forfeited if the worker quits.[5]

Besides incorporating asymmetries in the costs and benefits of search, another key contribution that we make is the analysis of changes in the economic environment that undermine tenure-based contracts. While the papers by Burdett and Coles and by Stevens concentrate on proving the existence of the tenure-based contract in the steady state, we emphasize the fragility of the contract in response to plausible changes in the economic environment. Our hypothesis of an endogenous motive for the shift in pension structure also contrasts with the pension literature that focuses on exogenous changes in federal regulations. The shift in emphasis here suggests the possibility that regulatory changes *responded to* an underlying increase in the gains to worker mobility.

The paper is organized as follows. In Section 2, we discuss trends in private pension coverage, job tenure, job-to-job flows, and job search costs. We also present evidence that wages of people moving job-to-job rose over time, relative to wages of both people staying in the same job and people starting a new job after a spell of unemployment. In Section 3, we present the baseline model with OTJ search. In Section 4, we introduce the pension contract which may prevent OTJ search. In Section 5, we show how a reduction in the cost of OTJ search may reduce the value of a job and hence render the pension contract. Section 6 concludes.

[5] We prove that such a contract are feasible, while the other papers proved that the contracts are optimal.

2 Background on Worker Mobility and Pensions

In this section, we discuss trends in job tenure and private pensions. We then present evidence developed by others about the incidence of on-the-job search and job-to-job flows, which are important in magnitude, and about trends in search, job-to-job flows. Lastly, we present data that we have constructed analyzing wage changes associated with job-to-job flows.

2.1 Trends in job tenure

Over the last 20 years, both actual and expected job tenure have fallen. Expected tenure data are noisier than actual tenure data but show a greater decline. Average current tenure of male full-time employees in the Survey of Consumer Finances fell from 9.7 in 1983 to 8.8 years in 1998, while expected remaining tenure fell from 18.6 in 1983 and 16.2 in 1989 to 14.7 in 1998.[6] Changes in job tenure among women reflect a combination of cohort-specific increases in labor force attachment and secular declines in job tenure. Average current tenure of female full-time employees rose from 7.4 years in 1983 to 8.1 years in 1992 and then fell back to 7.3 in 1998, while expected remaining tenure fell from 15.9 in 1983 to 12.5 in 1989, rose to 14.4 in 1992, and then fell to 12.8 in 1998.[7] Adding together current and expected remaining tenure yields subjective estimates of total expected job duration. For men, total expected tenure fell from 27.3 years in 1983 to 24.6 years in 1989 and 23.0 years in 1998, a 15.5% decline between 1983 and 1998 and a 6.3% decline between 1989 and 1998. For women, expected tenure fell by 12.9% between 1983 and 1998 and by 10.3% between 1992 and 1998.

A decline in expected remaining job tenure may indicate either a greater willingness to change jobs or a greater fear of involuntary job loss. We do not have evidence about whether the rate of voluntary quits has risen. However, Farber [11] noted that the decline in job tenure in the CPS was not matched by an increase in layoffs, indicating that increases in mobility are to some extent voluntary. In any case, a perceived increase in the risk of involuntary job loss should induce more

[6] See FO for more details. Since the mid-1990s, researchers have found mounting evidence of a decline in male job tenure in the Current Population Survey (Neumark, Polsky, and Hansen [31]; Bureau of Labor Statistics [6]), the Panel Study of Income Dynamics (Jaeger and Stevens [20]), and the National Longitudinal Surveys (Bernhardt, et. al., [3]), although not the Survey of Income and Program Participation (Gottschalk and Moffitt [17]). Other researchers have not investigated data on expected tenure.

[7] The wording and organization of questions regarding future work plans was different enough that the 1983 SCF may not be comparable to later years.

on-the-job search as well.

2.2 The structure of private pensions

At any given time, over half of all full-time workers in the U.S. have pension coverage in their current job, and a greater number have been in a job with a pension at some point.[8] Fundamental differences in the structure of pension plans affect the incentive to stay in a particular job. DB plans discourage mobility for many years after a worker starts a job, while DC plans are largely tenure-neutral. The path of pension wealth accrual in a typical DB plan is characterized by sharp spikes, as in Figure 1.[9] Allen, Clark, and McDermed [2] estimated that the pension loss associated with switching jobs for the average worker with a DB plan aged 35-54 was approximately half a year's earnings. The smooth path of DC pension wealth accruals, which consist of contributions to an account and accumulated returns, as shown in Figure 1, stands in stark contrast.

Workers have experienced a major shift in pension coverage in the last twenty years. Among full-time employees with a pension in the SCF, 69% had a DB plan and 45% had a DC plan in 1983, while 40% had a DB plan and 80% had a DC plan in 1998 (some have both types). FO demonstrated that workers with DB pensions have longer current and expected total job tenure than workers with DC pensions or no pensions, and that the same workers are generally experiencing declines in tenure and in DB pension coverage.

In a series of papers summarized in [25], Lazear developed models in which employers structure compensation to deter shirking by workers whose effort cannot be observed perfectly. A DB pension, whose value rises with job tenure, motivates effort by workers who do not want to get fired and lose their "bond." Early models of pensions, however, did not typically incorporate uncertainty about job duration, nor make explicit the nature of the worker's outside option. FO incorporated moral hazard in a matching model which clarifies the value of tenure-based contracts, while this paper allows workers in jobs to seek new opportunities as well, which provides another motive for pension contracts.

[8] The rate of pension coverage in the current job among full-time employees declined a little from 67% in the 1983 SCF to 58% in 1998.

[9] Pension wealth in year t is the actuarially discounted real present value of expected pension benefits if the job ends at year t. Pension wealth accrual is the discounted change in pension wealth if the worker stays another year and then leaves. Figure 1 shows pension wealth accrual in two plans from the Health and Retirement Study (Friedberg and Webb [14]).

Recent research on private pensions has focused on changes in federal pension regulations. Regulatory changes have enhanced DB funding provisions and DC tax incentives and placed limits on the structure of DB and DC plans. FO discussed a variety of reasons why regulatory changes do not appear to fully explain the shift in pension structure. For example, pension structure has not changed uniformly in all jobs; instead, workers have moved over time from jobs that typically offer DB plans to jobs that typically offer DC plans (Clark and MacDermed [7], Gustman and Steinmeier [18], Kruse [23], Ippolito [19], Papke [32]). Also, inequality in pension coverage by skill group has increased, mirroring trends in earnings inequality that have been attributed to structural changes in the economy (Bloom and Freeman [4], Even and Macpherson [9]).

2.3 Existing research on worker mobility

Data limitations severely hamper the measurement of job-to-job flows, on-the-job search, and search costs. Nevertheless, U.S. data that has become available since the mid-1990s offer several pieces of relevant evidence. First, job-to-job moves are relatively frequent. Second, on-the-job search is common. Third, search costs appear to be declining, as, for example, internet use has expanded.

2.3.1 Job-to-job flows

In 1994, the Current Population Survey (CPS) started to ask people whether they were still working for the same employer as they had been a month earlier, which provided a much more accurate view of job-to-job flows than was available before. Fallick and Fleischman [10] computed employment-to-employment flows in the 1994-2003 CPS. They found that an average of 2.6% of employed workers changed employers each month, accounting for almost 40% of both job separations and new job starts – a major share of all labor market flows.[10] It remains difficult at this point to distinguish between cyclical characteristics and secular trends in the data, however. The magnitude of job-to-job flows dipped from 1994 to 1996 and rose slowly from 1996 to 2000, then fell considerably from 2000 to 2003 during a time of labor market weakness.

Stewart [41],[42] recently developed a much longer series, though with a smaller sample size,

[10] It should be kept in mind that this method will underestimate job-to-job flows. The CPS follows residents of the same address from month to month, rather than following the same individuals, so it misses job changes that involve a change of residence.

based on retrospective data from March CPSs.[11] Stewart [41] documented a substantial increase in job-to-job flows (defined as occurring with two or fewer weeks of unemployment) from 1975 to 2000 of 59%. This was matched by a decline in job-to-unemployment flows, suggesting that workers are increasingly better at searching while on-the-job. While the series rose and then fell during the 1970s to roughly the same level in 1982, it then increased steadily afterwards, save for a dip during the economic downturn of 1989 to 1991.

2.3.2 On-the-job search

In February 1995, 1997, and 1999, the CPS asked questions designed to elicit information about on-the-job search by workers. Meisenheimer and Ilg [28] tabulated data on active search by employed wage-and-salary workers.[12] They found that, in February 1999, 4.5% had actively looked for a new job within the previous three months.[13] Fallick and Fleischman [10] linked information on search in February 1997 and 1999 with job-to-job flows a month later and concluded that those who had actively searched for a job in the three months prior to February were much more likely to have changed jobs (11.3% versus 2.1% for non-searchers) by March. Thus, on-the-job search is followed by job changes.

Nevertheless, it appears that traditional survey methods do not capture all forms of job search. Only about 1/5 of those who had moved from one job to another in March had actively looked for a job earlier, according to Fallick and Fleischman. A similarly low rate (about 1/3) of those who had started a new job in March after being out of work in February were classified in February as unemployed, i.e. actively searching for a job. There may be a few explanations for the apparent low rate of active job search among those subsequently starting new jobs: contacts initiated by potential employers may not be reported as active search; active search may have only taken place a few weeks immediately prior to starting a new job; and some new jobs resulting from active job search are associated with residential moves and thus not followed in the CPS.

[11] Fallick and Fleischman discussed the drawbacks of other attempts to use the CPS to develop longer series of worker flows. Kamborouv and Manovskii [21] noted the difficulty of identifying *occupational* mobility using Stewart's method, arising because of high rates of error in occupational coding. We are not directly concerned with occupational mobility, though.

[12] Active job search involves contacting an employer, employment agency, school employment center, or acquaintances about a job; sending out resumes; filling out applications; checking union or professional registers; or placing or answering ads. Passive job search involves reading the want-ads or attending a job training program.

[13] The incidence of on-the-job search declined between 1995, when it was 5.6%, and 1999. It is, again, impossible to distinguish between cyclical and secular shifts in behavior with a short series.

2.3.3 Search costs and the internet

While we have no data on long-term trends in search costs, many researchers have focused on the reduced cost of conveying information brought about by the expansion of the internet since the early 1990s. The incidence of internet search is high. In the December 1998 CPS, Kuhn and Skuterud [24] found that 7.1% of people with jobs, 15.9% of people with jobs and with internet access at home, and half of the unemployed with internet access at home used the internet for job search. The rate of internet search by those with jobs exceeds earlier estimates of on-the-job search using all other methods, as we noted above (Meisenheimer and Ilg [28]).

Moreover, there is growing evidence of an impact on labor markets. It is many times cheaper for firms to post vacancy announcements on the internet than in newspapers (Autor [1]), and almost all major employers now accept online job applications (Freeman [12]). These changes may have subtler effects too; heterogeneity in the way jobseekers use the internet may explain simultaneous claims that individuals who use the internet are positively selected on unobservable qualities (according to internet search firms cited in Kuhn and Skuterud [24]) or negatively selected (a belief commonly held by employers, according to Autor). Meanwhile, Autor suggested that employers are increasingly using the internet to target employed "passive candidates"; activity of this type would help explain the increase in job-to-job flows together with the relatively low rate of job search reported by job movers.

Two recent papers attempted to estimate the causal effect of internet search on labor market outcomes, but they were limited by the scope of the available data as well as the identification strategies. Kuhn and Skuterud [24] focused on the unemployed. They found that, after controlling for observable differences correlated with both internet use and shorter unemployment durations (like education and previous occupation), the unemployed who used the internet for job search were neither more nor less likely to be employed a year later than other unemployed. Estimates that attempted to control for unobservable differences suggested that those who used the internet may have been less likely to be employed a year later.

Stevenson [40] documented some of the consequences of internet job search using an instrumental variable strategy. She focused on average internet penetration rates across U.S. states and found, after instrumenting, several positive and statistically significant relationships. In states with higher internet penetration, the unemployed used a greater number of types of search activities; employment-to-employment flows among more skilled workers rose; and interstate mobility rates of younger and more skilled individuals rose – all evidence that the internet facilitates job search. As Stevenson remarked, this is clearly an area that awaits further investigation in order to understand how to match theoretical concepts of job search with those that can be observed and measured.

2.4 New evidence on wages and job-to-job flows

Earlier, we discussed the new method developed by Stewart [41] that allows for a long-term investigation of job-to-job flows. We have extended his method to study wages associated with job-to-job flows from 1983-2001. While we cannot examine wage changes directly, we can compare hourly wages in a given March CPS for two groups of workers who have been continuously employed for the last 14.5 months – those who experienced a job-to-job flow relative to those who stayed in the same job continuously.[14] We make this comparison by running a regression in each year's sample, putting log hourly earnings on the left-hand side and an indicator variable on the right-hand side for people experiencing a job-to-job flow within the last year, along with controls for gender, education, age, and race.[15]

Our results are shown in Figures 2 and 3. The hourly wage of people in the CPS who experienced a job-to-job flow is lower throughout than the hourly wage of people staying in the same job continuously. However, Figure 2 shows a major, steady, and statistically significant decline in this relative wage gap in the 1990s, with the gap closing from -17.6% in 1992 at the end of a recession to -3.0% in 2001. Because job-to-job flows are cyclical, we went further by regressing this relative wage gap for job changers on the contemporaneous unemployment rate, with the resulting residual shown in the heavy lower line in Figure 3. Except when this cyclically-adjusted relative wage gap experienced a dip during the 1990 recession, it otherwise shrank steadily during both the 1980s (from -15.7% in 1983 to -11.6% in 1990) and the 1990s (from -13.6% in 1993 to -10.4% in 2001),

[14] We focus on almost the same sample as Stewart, as described in the Figure 2 notes. We limit our focus to the CPS outgoing rotation groups, who reported data on current hourly earnings. Our resulting sample is roughly 1/4 of the total available and ranges from 7,000-9,000 per year. While we could try computing wage changes by getting hourly earnings data for the same people a year earlier, this would involve matching across CPSs and incurring substantial attrition that is probably correlated with job changes.

[15] These demographic controls account for changes in wages due to changes in the composition of the labor force. The results were virtually the same when we allowed the coefficients on the demographics to change from year to year; we report results when the covariates are held constant over the sample period. The coefficient on the relative wage of job-to-job movers is statistically significant every year, based on Huber-White standard errors.

declining by one-third overall.

The CPS cannot be used to make a further comparison with people who changed jobs but experienced an intervening spell of unemployment. Instead, we identify those who were in a job in March and experienced any unemployment spell within the previous 14.5 months.[16] Then, we compare current wages for those experiencing a job-to-job flow with those experiencing some kind of unemployment-to-job flow (without knowing whether the period began with a job or not). We find that the job-to-job movers experienced relative wage gains on this front as well. The lighter line near the top of Figure 3 shows the difference between residual wages, after controlling for demographics and then business cycle effects as above, of unemployment-to-job movers and of job-to-job movers. The relative wage gap for the unemployment-to-job movers rose from -4.2% in 1983 to -7.7% in 2001, relative to the job-to-job movers.

To sum up, we find that job-to-job movers experienced relative wage gains over the same period in which job-to-job flows rose and DB pension use declined. The wage gap among those who moved job-to-job within the previous 14.5 months narrowed significantly and substantially, compared to those staying in a job continuously. Moreover, the wage gap compared to those in a job but with an unemployment spell in the previous 14.5 months widened significantly.

3 The Model

Spurred by evidence of a long-term increase in job-to-job flows and of gains in relative wages of job-to-job movers, we develop a model in which workers may search for new, more productive matches while on the job. The framework we employ here is based on stochastic job matching models with incomplete contracting.[17] Our contribution is to incorporate flows to new jobs out of employment as well as unemployment.

Deterring OTJ search offers a motive to defer compensation when firms cannot directly contract to prevent quits, although the willingness of agents to commit to long-term contracts depends crucially on the degree of uncertainty – hence the importance of assuming stochastic match draws.

[16] The problem is that we cannot distinguish those who began the period in a job, became unemployed, and then got a new job versus those who were unemployed at the outset and then got a job. These two groups are probably somewhat heterogeneous.

[17] The stochastic job matching framework builds on den Haan, Ramey, and Watson [8]. Few other models combine OTJ search and match-specific productivity. Our model of OTJ search is based on Mortensen [29] and Pissarides [33] and [34].

Because we are specifically interested in this compensation, we will focus almost exclusively on currently employed workers (rather than the unemployed) as we discuss the model. After developing the model, we show how an increase in the expected gains from OTJ search undermine the pension contracts.

3.1 Basic framework

The matching market. A unit mass of risk-neutral workers and a continuum of firms search in the labor market during a given period and match with probability λ.[18] Workers searching in the labor market may be either employed (E) or unemployed (U). Workers searching while employed incur a search cost $c(Y)$, which is manifested as a reduction in output and increases with match productivity. Firms, however, cannot search for a worker unless the position is vacant. This assumption prevents the firm from firing a worker if it were to find a more productive one. A newly matched worker and firm receive a productivity draw Y, which is drawn from a cumulative distribution function $F(y)$ that is homogeneous for all new matches. They either commence production if the productivity draw exceeds a reservation value or re-enter the market to seek a new match next period.

Separation and Search. Unlike some related models (see FO), we assume that a match's productivity stays fixed after it is initially drawn. We impose the alternative simplifying assumption of exogenous layoffs in order to preserve our focus on quits. Thus, matches end because of one of the following:

- *(Involuntary) Layoff.* At the beginning of the period, an exogenous shock arrives with probability δ, independent of current match-specific productivity. Layoff shocks are idiosyncratic and generate the worker flow to unemployment.

- *(Voluntary) Quit.* If a worker searches OTJ and matches with a new firm, the pair draws a new level of productivity Y'. If the new draw exceeds the worker's reservation productivity, the new match is established and the old one destroyed. Otherwise, the old match is preserved, and the worker and old firm continue to produce Y, less the cost of search $c(Y) > 0$.

[18] For simplicity, we assume that the match probability is fixed, instead of allowing it to vary with the vacancy and unemployment rate. Thus, we ignore potential decreasing (increasing) returns to scale in the matching function, which would mitigate (magnify) the effects of an exogenous increase in the gains from search.

If a layoff occurs, the worker returns to unemployment and receives the outside option b^w representing unemployment benefits, home production, or leisure, while the firm receives the outside option b^f and opens a vacancy. In the event of a quit, the worker goes to the new job and the firm again receives b^f outside option and opens a vacancy. This leads to an asymmetry when the worker finds a better match: the firm is indifferent as to the cause of separation but the worker is better off with a quit than a layoff.[19]

Division of Output. Workers and firms bargain over the surplus of the match which is net of search costs, with shares determined by bargaining weights. Thus, the worker receives a share of current productivity $\tau(Y) < Y$ if there is no search or $\tau(Y - c(Y)) < Y - c(Y)$ if the worker searches OTJ. This leads to an additional asymmetry – the firm bears part of the costs of search but enjoys none of its benefits.[20]

Output is allocated via the function $\tau(Y)$, determined by Nash bargaining.[21] The Nash bargaining solution maximizes the weighted product of the worker's and firm's net surplus from the job match, where a higher value of γ, the worker's bargaining weight, raises $\tau(Y)$. Thus, the value of the match for each agent is determined by the split of current productivity $\tau(Y)$.[22] The total value of the match depends on both current output and the expected discounted stream of future production.

3.2 The value of jobs

The productivity distribution can be divided into three regions. For a productivity draw Y above a threshold $Y > \underline{R}$, an unemployed worker will accept the job. If the draw exceeds some higher threshold $Y > \overline{R} > \underline{R}$, the worker will not search after accepting the job. In the intermediate range $\overline{R} > Y > \underline{R}$, the worker will search after accepting the job and accepts any new offer with a draw exceeding her reservation productivity, determined as follows.

[19] We assume that the firm cannot write a contract conditioned on the worker not searching.

[20] Search is thus viewed as a substitute for effort at work. While the resulting moral hazard adds to the asymmetry in the costs and benefits of OTJ search, this assumption does not change the qualitative results. In principle, we could impose some intermediate assumption about leisure-time search.

[21] We assume that the worker's surplus is the difference between the value of the new match and unemployment regardless of the worker's current employment status. Shimer [37] analyzed how Nash bargaining differs when current productivity is the threat point. In that case, the worker's share of output depends on her past productivities. For tractability, we abstract from the possibility here.

[22] From Pissarides [34], we know that the Nash bargaining allocative mechanism $\tau(.)$ is continuous and differentiable and that $\tau'(.) \geq 0$.

If a worker's current productivity exceeds the search-deterring threshold $\overline{R}$, the cost of search outweighs the expected gain from potentially finding a more suitable match. This is because the cost of search is increasing in Y while the likelihood of finding an acceptable alternative is shrinking in Y. We compute the worker's value of a job in this case as

$$V_{ns}^{w}(Y) = \tau(Y) + \beta\left[\delta U^{w} + (1-\delta)\left(V_{ns}^{w}(Y)\right)\right], \tag{1}$$

where U^w is the value of unemployment. In this case, the worker only separates from the firm if there is a layoff, while in this case there are no search costs to be paid. Similarly, the value to the firm is:

$$V_{ns}^{f}(Y) = Y - \tau(Y) + \beta\left[\delta U^{f} + (1-\delta)V_{ns}^{f}(Y)\right]. \tag{2}$$

where U^f is the value to the firm of holding a vacancy.

If, on the other hand, the productivity draw is not sufficiently high to deter search, the worker's valuation of the match is

$$V_{s}^{w}(Y) = \tau\left(Y - c(Y)\right) + \beta(\delta U^{w} + (1-\delta)J_{s}^{w}(Y)), \tag{3}$$

where the worker's expected value of matching with a new firm is

$$J_{s}^{w}(Y) = (1-\lambda)V_{s}^{w}(Y) + \lambda\left[V_{s}^{w}(Y)F(R(Y)) + \int_{R(Y)}^{\overline{R}} V_{s}^{w}(y)dF(y) + \int_{\overline{R}}^{1} V_{ns}^{w}(y)dF(y)\right].$$

The value of employment with search is, therefore, the worker's share of current output less search costs plus the worker's discounted expected future income.

When the worker searches, the value of the job to the firm is defined as follows:

$$V_{s}^{f}(Y) = Y - c(Y) - \tau\left(Y - c(Y)\right) + \beta\left(\delta U^{f} + (1-\delta)J_{s}^{f}(Y)\right), \tag{4}$$

where

$$J_{s}^{f}(Y) = (1-\lambda)V_{s}^{f}(Y) + \lambda\left[V_{s}^{f}(Y)F(R(Y)) + U^{f}(1-F(R(Y)))\right].$$

Now, the nature of the asymmetry between worker and firm becomes apparent. Both share the surplus of the current job, but the worker (who can search OTJ) has access to better opportunities than the firm, since the firm loses a productive match in case of a quit and cannot post a vacancy before the quit. Therefore, the value of the job to the worker versus the firm diverges when the worker searches, compared to the value when the worker does not search. It is because of this asymmetry that the firm might offer a pension contract. If the firm can offer a contract which will prevent the worker from searching by, in effect, lowering the search-deterring threshold, then the firm will neither share the costs of search nor face the loss resulting from a quit.

3.3 The value of search

We next focus on determining the conditions under which workers search OTJ. A worker with a job yielding Y will accept any new job with productivity draw Y' such that its value $V^w(Y') > V_s^w(Y)$, where the lack of the subscript on the left-hand side explicitly assumes the possibility of matching to a search-deterring job. However, as we demonstrate shortly, any search-deterring job necessarily yields a higher valuation, so the job-to-job acceptance threshold is determined by a new job offer that would entail continued search. The acceptance condition can be summarized in the following lemma:

Lemma 1 *Acceptance Threshold–Job to Job. Given (3), a worker currently in a match yielding productivity $Y < \overline{R}$ and therefore searching on-the-job will accept any new match with productivity $Y' > Y$.*[23]

Since new matches are only formed with vacant jobs, Nash-bargaining of wages implies that the firm will hire any worker who would accept the job.

Although better offers are possible, above productivity $\overline{R}$ a worker does not search because the expected gain is outweighed by the search cost. $\overline{R}$ is the value such that the worker's expected return from searching just equals the cost of search. Consider a worker in a match currently yielding Y. The worker's gain from search $GS(Y)$ is

$$GS(Y) = V_s^w(Y) - V_{ns}^w(Y) = \tau\left(Y - c(Y)\right) - \tau\left(Y\right) - \beta(1-\delta)\left(V_{ns}^w(Y) - J_s^w(Y)\right) \tag{5}$$

[23] For tractability, we abstract away from conditions like an endogenous matching rate or endogenous job destruction as in FO. Such conditions would generate a wedge between the current productivity and the acceptance threshold.

The gain from search $GS(Y)$ decreases in Y, since higher Y makes the current match increasingly attractive relative to other possible matches. At the search-deterring threshold, the worker is indifferent between searching and receiving $V_s^w(\overline{R})$ or not searching and receiving $V_{ns}^w(\overline{R})$ – that is, $GS(\overline{R}) = 0$. We summarize this condition in the following lemma:

Lemma 2 ***Search-Deterring Threshold.*** *A worker is indifferent between searching and not searching at a productivity level* $\overline{R}$ *which solves*

$$\tau\left(\overline{R}\right) - \tau\left(\overline{R} - c(\overline{R})\right) = \frac{\beta\lambda(1-\delta)}{1-\beta(1-\delta)}\left[\int_{\overline{R}}^{1} \tau(y)dF(y) - \tau\left(\overline{R}\right)\left(1 - F(\overline{R})\right)\right].$$

The left-hand side of the expression shows the gain in current output from not incurring search costs, while the right-hand side shows the expected gain from seeking a better match. A consequence of the preceding lemmas is that the support of the productivity distribution over which the worker engages in OTJ search is not state- or time-dependent, but rather is uniform across all worker-history combinations, so the thresholds do not depend on the idiosyncratic match-specific productivity, work history, etc. This will allow us to compute a pension contract that depends only on the current productivity level. The worker's gain from search (5) reveals the worker's incentives at varying levels of productivity and will play an important role in determining the existence of the pension contract that we outline next.

4 The Pension Contract

A firm matched to a worker with current productivity $Y < \overline{R}$ who is searching OTJ experiences losses from three sources. Search itself costs the match $c(Y)$; output is lost when the firm stands idle immediately after the worker departs; and the match with known productivity is replaced by an uncertain future draw. Consequently, the firm is willing to compensate the worker for not searching as long as the compensation does not exceed the gain to the firm from deterring search. Similarly, the worker is willing to accept the compensation as long as it exceeds the value of opportunities lost from not searching. We demonstrate that the contract may fail to deter search in some matches, but it will deter search in relatively more productive matches in the range $Y < \overline{R}$, since the surplus is high enough to make it worth forgoing search.

Specifically, we consider contracts that, like DB pensions, defer a portion of output destined for the worker, with the payment forfeited if the worker quits. This payment is made in addition to the wages that continue to be determined by Nash bargaining. Since we do not model retirement, we assume that workers get the payment in a lump-sum when the layoff shock inevitably hits.[24] Once we abstract away from the risk that the worker loses the pension because the match ends unexpectedly early, then we can simply characterize the total value of the contract without saying more about its structure – how much is deferred for how long.[25]

4.1 Will the firm offer the pension contract?

A firm may offer a pension – a lump-sum payment at the end of the match that is forfeited if the worker quits – for the purpose of preventing OTJ search.[26] The size of the pension a firm is willing to offer depends on the gain if the worker does not search. The maximum pension $MP(Y)$ which the firm in a match with output draw Y will offer at the outset of the match is the difference between the value to the firm of the same production level with and without search, so $MP(Y) = V_{ns}^f(Y) - V_s^f(Y)$.[27] Substituting (4) and (2), we have:

$$MP(Y) = \tau(Y - c(Y)) + c(Y) - \tau(Y) + \beta(1-\delta)[V_{ns}^f(Y) - J_s^f(Y)], \tag{6}$$

where the first set of terms reflects the gain from avoiding search costs and the second set reflects the gain from avoiding a vacancy. Equation (6) represents one step toward demonstrating that

[24] Figure 1 showed that DB pension accruals in the real world eventually turn negative after 20-30 years, encouraging retirement. Since we do not include a retirement motive here, we ignore this aspect of DB pensions. FO argued on several grounds that it is unlikely that an exogenous increase in optimal retirement ages caused the decline in DB pension use.

[25] FO and Stevens [39] elaborated on the tension that arises in a risky environment between the promised pension benefit and the pension's termination date. If we extended our model so that the pension were forfeited by any early end to the match, even involuntary, it would not change the qualitative predictions of the model but would further narrow the productivity range defining a feasible contract (since relatively unproductive matches would not finance a large enough deferred payment to get the worker to accept the early termination risk). In Burdett and Coles [5], risk-averse workers prefer upfront pay in order to smooth consumption, which in our model would again narrow the productivity range over which pensions are feasible. Lastly, we ignore the possibility that the firm breaches the pension contract. DB pensions are partially insured, and in addition, there is little empirical evidence of obvious breach by employers .

[26] Our pension is also similar in flavor to the efficiency wage of Shimer [38], which transfers a portion of output from the firm to the worker to prevent search.

[27] Once the firm promises a pension $P(Y)$ at the outset, it no longer has to set aside any additional funds because the problem is stationary and the initial amount $P(Y)$ will continue to deter search. The *ex post* gain to the firm from deterring search will almost certainly differ from $P(Y)$, depending on when the layoff shock δ occurs. We may assume that an insurance market eliminates the risk of early or late termination.

the pension contract is feasible. The following proposition lays out the next step:

Proposition 3 ***A Firm's Gain from Deterring OTJ Search.*** *For all productivity levels in the range* $\overline{R} > Y > \underline{R}$, $MP(Y) > 0$.

The proposition shows that the firm always benefits from deterring OTJ search. This occurs because the firm bears some of the costs of search but receives none of the benefits. Moreover, the maximum value of the pension $MP(Y)$ rises monotonically with Y, since higher productivity matches have increasing value over a new match and since search costs rise with Y.[28]

4.2 Will the worker accept the pension contract?

While (6) reveals the firm's willingness to sacrifice some of its surplus to deter the worker from searching, the firm need offer no more than the worker's gain from OTJ search $GS(Y)$, as determined in (5). The resulting pension is incentive-compatible if the maximum value $MP(Y)$ that the firm is willing to offer exceeds $GS(Y)$ and, thus, prevents the worker from searching. Therefore, the value of the offered (and accepted) pension $P(Y)$ will be

$$P(Y) = \begin{cases} 0 & \text{if } \; GS(Y) > MP(Y) \\ GS(Y) & \text{if } \; GS(Y) \leq MP(Y) \end{cases} . \tag{7}$$

If the maximum pension $MP(Y)$ is smaller than $GS(Y)$, then any pension the firm is willing to offer will not be incentive-compatible, since it fails to discourage search. A pension is effective, therefore, if total expected losses from search exceed expected gains – thus fully internalizing the costs and benefits of search that accrue to agents in the match. Essentially, through the pension, the firm voluntarily reallocates a portion of its share of output in order to avoid productivity losses caused by search and periods of idleness caused by quits resulting from search.

Proposition 4 ***Existence.*** *Suppose the partition of the productivity distribution's support over which workers search on-the-job is non-degenerate – that is,* $\overline{R} > \underline{R}$. *Then, there exists some* Y

[28] Our results differ from Pissarides [34], who found that search by workers makes firms better off. First, in our model workers and firms share search costs. Second, firms in our model do not know what match-specific productivity they will draw next, whereas Pissarides assumed that firms always match at the highest level of productivity. Finally, firms in Pissarides' model open vacancies until their value is equal to zero, whereas in our model a continuum of firms exist and have vacancies only when they are not producing.

such that $\overline{R} > Y > \underline{R}$ *and* $\Psi(Y) = MP(Y) - GS(Y) > 0$. *Moreover,* $\Psi(Y) > 0$ *implies that there exists some* $P(Y) > 0$.

This proposition shows, and Figure 4 illustrates, that over at least some portion of the relevant region $\overline{R} > Y > \underline{R}$ of the productivity distribution, the pension is indeed effective. As shown in Figure 4, $GS(Y)$ falls with Y and defines $\overline{R}$ at the point where $GS(Y) = 0$, while $MP(Y)$ is positive and rises with Y. The pension will consequently be effective at $Y = \overline{R} - \epsilon$, since $GS(\overline{R}) = 0$ and $MP(\overline{R}) > 0$.

However, as Figure 4 demonstrates, it is possible that in some matches OTJ search cannot be discouraged by pensions. While firms want to eliminate search at all productivity levels (since $MP(Y) > 0$), there may be some values of Y such that the worker's incentives cannot be changed for less than the firm will sacrifice. If pensions are infeasible in some matches, it would be in the lowest productivity matches with OTJ search, i.e. over some range of Y beginning at $Y = \underline{R}$. This occurs in Figure 4, since $GS(Y)$ and $MP(Y)$ intersect at a value of $Y > \underline{R}$. We denote this value as R^P, defined as the reservation productivity level which, if it lies between $\underline{R}$ and $\overline{R}$, renders the pension contract infeasible for matches with $Y < R^P$. It is likely that the threshold R^P is relevant in the real world, since we observe that DB pensions are much less common in low-wage jobs.

To sum up, pension contracts exist in medium-productivity jobs (matches with $\overline{R} > Y > R^P \geq \underline{R}$) and not in the highest-productivity search-deterring jobs (with $Y > \overline{R}$).[29] Moreover, as Figure 4 shows, the pension benefit might not be effective in the lowest productivity jobs (near $\underline{R}$). We cannot further characterize the level of $R^P \in (\underline{R}, \overline{R})$ at which the firm would be just indifferent between offering a pension that deters search or not without assuming a particular distribution of productivity.

While these pension contracts enhance the value of the current job, they may raise or lower aggregate welfare. On the one hand, pension contracts reduce excessive OTJ search arising from the asymmetry in how its costs and benefits are distributed. On the other hand, though, new matches that dominate current ones are not formed. Welfare considerations depend on specific

[29] In the real world, many very high-wage workers have pensions. Some likely explanations are that high-wage workers have higher marginal tax rates and higher saving rates; these motivations are not contract-theoretic and lie beyond the scope of this paper.

assumptions about the productivity distribution.[30]

5 A Decline in Search Costs

The feasibility and value of the pension contract shift if the value of the match to the worker or the firm changes. In this section, we analyze how a decline in search costs alters the value of the current job relative to alternatives. This discussion ties into important trends that we discussed earlier – notably, the increased incidence of job-to-job flows and the increase in relative wages associated with such flows, and indirect evidence of declining search costs and more frequent OTJ search.

We will consider the effect of a simple reduction in search costs in order to capture these changes. Suppose that search costs uniformly decrease from $c_0(Y)$ to $c_1(Y) \leq c_0(Y)\ \forall Y$. This alters the worker's gains from search $GS(Y)$ and the firm's maximum pension offer $MP(Y)$, and in turn the value of the pension $P(Y)$ and possibly the threshold of productivity R^P at which the pension is rendered incentive-incompatible. To summarize the consequences for the match, we offer the following proposition:

Proposition 5 ***Decrease in Search Costs****. Given a productivity distribution $F(y)$ and the fixed allocative mechanism $\tau(y)$, a decrease in search costs causes (i) an increase in the search-preventing threshold $\overline{R}$, (ii) an increase in the worker's gains from search $GS(Y)$, and (iii) a decrease in the firm's gains from preventing search $MP(Y)$.*

These effects are illustrated in Figure 5 and arise because both $\tau\left(Y - c_1(Y)\right) > \tau\left(Y - c_0(Y)\right)$ and $Y - c_1(Y) > Y - c_0(Y)$.[31] Because the worker gets to keep more of current output in the event of search, it boosts the gains from search $GS(Y)$, defined in (5). That in turn raises the search threshold from $\overline{R}_0$ computed from search costs $c_0(Y)$ to $\overline{R}_1$ computed from search costs $c_1(Y)$. Therefore, in the absence of pension contracts, some workers previously satisfied with Y will begin to search.

These changes will clearly influence the viability and size of the pension contract. The increase in $GS(Y)$ makes it more costly for firms to discourage search. Also, because the firm gets to keep

[30] In a very different model than ours, Nagypál [30] investigated the aggregate welfare consequences of employment protection policies that raise the cost of dismissal when there is learning in matches. She studied inefficiencies generated by the use of legal employment protection to prevent layoffs, while we study pensions that prevent quits.

[31] Note that there may be enough workers with $\overline{R}_1 > Y > \overline{R}_0$ such that total output net of search costs decreases rather than increases.

more of current output in the event of search, it reduces the gain from preventing search and hence the maximum pension $MP(Y)$ the firm is willing to offer, as defined in (6).

We argue that under realistic parameters the pension-feasible region will probably shrink as a result, and hence the total number of pensions offered in the economy will decrease while the number of workers who search will increase – as has been observed in recent years.[32] The ambiguity arises because of two countervailing effects. The pension-feasible region may get squeezed at the lower end while expanding at the upper end, so the actual outcome depends primarily on the density of the productivity distribution in different regions. On the one hand, R^P may increase, so pensions in some of the less productive matches in which search used to be deterred are no longer feasible. This will definitely happen if it was already the case that $R^P > \underline{R}$, as in Figure 5, so pensions were failing to deter some OTJ search. We already argued that this is likely to be the case. If there is a great deal of density in the region over which R^P rises, then even a small decrease in search costs could cause a large decrease in the use of pension contracts and an associated increase in search.

On the other hand, the pension-feasible region gets expanded from above, as the search-deterring threshold $\overline{R}$ rises. In the matches in which search is now attractive but was not before, $GS(Y)$ is small relative to $MP(Y)$, so firms will begin to offer pensions. However, unless the productivity distribution is skewed strongly to the right and therefore the mass of matches without search is large (which seems unlikely, or else OTJ search and job-to-job flows would be very uncommon), then the first effect (the squeeze from below) will dominate the second (the expansion from above), and the number of pensions will decline.[33]

It should be noted that the effect of a decrease in the cost of search is robust to other specifications of search costs. If search costs are borne entirely by the worker, then a decrease induces more search because $GS(Y)$ rises and the incentive-compatibility constraint binds for more matches, with no increased funding for pensions to counteract the effect. If search costs are borne entirely by the firm, then a decrease induces more search because $MP(Y)$ falls as search becomes less costly for the firm, so fewer pensions will be offered. The same effects occur whether search costs are a

[32] The economy will immediately enter a new steady state like this one if existing pensions contracts are renegotiated. If not, then all existing pensions will be too small to deter search and will be abandoned, and the economy will reach the new steady state after workers reshuffle into new jobs with new pensions.

[33] It is also likely that the average value of remaining pensions will change, depending on the density of Y and on other parameters. At the lower end, the largest pensions will disappear but remaining pensions will get bigger; while at the upper end, the new pensions that appear will be small. Evidence in FO suggests that remaining DB pensions are becoming less valuable on average.

function of productivity Y or are constant.

Thus, our model implies that the number of pensions is likely to fall when the costs of OTJ search decline. Earlier, we discussed evidence of such a decline, so our results may help explain the recent decline in job tenure and in DB pensions.

6 Conclusions

In the midst of the economic boom of the 1990s, the New York Times suggested that "the notion of lifetime employment has come to seem as dated as soda jerks, or tail fins" (Kolbert and Clymer [22]).[34] While many media reports have highlighted the supposed decline in job stability, economists have only recently found confirmation that job tenure has declined, while over a similar period job-to-job flows have increased in frequency.

In this paper we propose a model of on-the-job search and job-to-job flows to help explain these changes. Recent data makes it clear that these activities occur commonly, yet they are actively discouraged by DB pensions. The decline in the use of DB pensions suggests an important link with trends in tenure and job-to-job flows. Other recent theoretical papers have also tied together the motive to search on-the-job with the use of tenure-based deferred compensation contracts. We propose a model with some distinct features that add to our understanding of the costs and benefits of on-the-job search and, consequently, the feasibility of tenure-based contracts. Then, we highlight changes in the expected value of search that can explain the declining use of such contracts. We focus on a decline in search costs which, under fairly general conditions, would reduce the use of DB pensions and boost worker mobility. A jump in the expected gains from search tallies with observed growth in relative wages of job-to-job movers.

Further research on the causes and consequences of the recent decline in job tenure and the connection to job-to-job flows will be important. Identifying the causes will ultimately allow a careful evaluation of the welfare consequences for workers and firms. Such an analysis might reveal that DB pensions have become socially inefficient, even if they remain privately efficient. In our model, pensions internalize the costs and benefits of search within the match but impede matches that offer higher surplus to a new firm from being formed. It is relevant that some of

[34] We have appropriated this quote, with thanks, from Neumark, Polsky, and Hansen [31].

the federal pension regulations implemented since 1974 constrain the degree to which DB pensions can be designed to condition compensation on tenure (Clark and McDermed [7]). This raises the possibility that regulations were implemented in response to rising social gains from mobility resulting from the types of changes we have outlined here. Our paper represents a step towards understanding the causes and consequences of increased mobility.

7 Appendix

Proof of Lemma 1:

The worker's current continuation value is

$$V_s^w(Y) = \tau\left(Y - c(Y)\right) + \beta\left[\delta U^w + (1-\delta)J_s^w(R(Y))\right]$$

and the value of the new match is

$$V_s^w(Y') = \tau\left(Y' - c(Y')\right) + \beta\left[\delta U^w + (1-\delta)J_s^w(R(Y'))\right].$$

The acceptance threshold is defined as the minimum Y' that satisfies $V_s^w(Y') > V_s^w(Y)$. By construction, $V_s^w(Y)$ is monotonically increasing in Y, which yields the result.[35]□

Proof of Lemma 2:

Indifference at $\overline{R}$ implies $V_{ns}^w(\overline{R}) = V_s^w(\overline{R})$. Then, equating (3) and (1) evaluated at $\overline{R}$ gives

$$\tau\left(\overline{R}\right) + \beta(1-\delta)\left(V_{ns}^w(\overline{R})\right) = \tau\left(\overline{R} - c(\overline{R})\right) + \beta(1-\delta)J_s^w(\overline{R}). \tag{8}$$

Since $V_{ns}^w(\overline{R}) = V_s^w(\overline{R})$, we can substitute for $J_s^w(R(Y))$:

$$\tau\left(\overline{R}\right) = \tau\left(\overline{R} - c(\overline{R})\right) + \beta\lambda(1-\delta)\left[V_{ns}^w(\overline{R})\left(F(\overline{R}) - 1\right) + \int_{\overline{R}}^1 V_{ns}^w(y)dF(y)\right]. \tag{9}$$

However, from (1), it can be shown that

$$V_{ns}^w(Y) = \frac{\tau\left(Y\right) + \beta\delta U^w}{1 - \beta(1-\delta)}. \tag{10}$$

[35] Monotonicity also implies that the worker accepts $Y' > \overline{R} > Y$.

Substituting (10) into (9) yields the result.□

Proof of Proposition 3:

Consider $\tau(Y-c(Y))+c(Y)-\tau(Y)$. By definition, $\tau(Y)-\tau(Y-c(Y)) < Y-(Y-c(Y)) = c(Y)$. Thus, $\tau(Y-c(Y))+c(Y)-\tau(Y) > 0$ and $MP(Y) > 0$ if $V^f_{ns}(Y) - J^f_s(Y) \geq 0$. It is straightforward to show that

$$J^f_s(Y) = V^f_s(Y) - \lambda(1 - F(R(Y))\left(V^f_s(Y) - U^f\right).$$

For $\overline{R} > Y > \underline{R}$, $V^f_s(Y) - U^f > 0$ by Nash bargaining[36], and, thus, $V^f_s(Y) > J^f_s(Y)$. Define

$$\widehat{V}^f_s(Y) = Y - \tau(Y - c(Y)) - c(Y) + \beta\delta U^f + \beta(1-\delta)\widehat{V}^f_s(Y) > V^f_s(Y),$$

hence $\widehat{V}^f_s(Y) > V^f_s(Y) > J^f_s(Y)$. Moreover,

$$V^f_{ns}(Y) = \frac{Y - \tau(Y) + \beta\delta U^f}{1-\beta(1-\delta)} > \frac{Y - \tau(Y - c(Y)) - c(Y) + \beta\delta U^f}{1-\beta(1-\delta)} = \widehat{V}^f_s(Y)$$

since $\tau(Y) < \tau(Y - c(Y)) + c(Y)$. Thus, $V^f_{ns}(Y) > \widehat{V}^f_s(Y) > J^f_s(Y)$. The result follows.□

Proof of Proposition 4:

$\Psi(Y) = MP(Y) - GS(Y) > 0$ if $c(Y) + \beta(1-\delta)[V^f_{ns}(Y) - J^f_s(Y)] > \beta(1-\delta)\left[J^w_s(Y) - V^w_{ns}(Y)\right]$. From Proposition 3, $V^f_{ns}(Y) - J^f_s(Y) > 0$, which implies that $\beta(1-\delta)[V^f_{ns}(Y) - J^f_s(Y)] > 0$ for all Y. From Lemma 2, at $Y = \overline{R}$, $V^w_{ns}(\overline{R}) = V^w_s(\overline{R})$, implying $\tau(\overline{R}) - \tau\left(\overline{R} - c(\overline{R})\right) = \beta(1-\delta)\left[J^w_s(\overline{R}) - V^w_{ns}(\overline{R})\right]$. Further, $c(\overline{R}) > \tau(\overline{R}) - \tau\left(\overline{R} - c(\overline{R})\right)$, implying

$$c(\overline{R}) > \beta(1-\delta)\left[J^w_s(\overline{R}) - V^w_{ns}(\overline{R})\right].$$

Finally, since $Y < \overline{R}$ implies $V^w_{ns}(Y) < V^w_s(Y)$, continuity and the definition of P give the result.□

Proof of Proposition 5:

Consider $c_0(Y)$ and $c_1(Y)$, where $c_1(Y) < c_0(Y)$ for all $Y \geq 0$.

(i) $\overline{R}_1 > \overline{R}_0$: Recall that $\overline{R}_i$ solves $GS_i(\overline{R}_i) = 0$. Since $GS'_i(Y)$ is negative at $Y = \overline{R}_i$, if $GS_0(Y) < GS_1(Y)$, the result follows.

(ii) $GS_1(Y) > GS_0(Y)$ follows directly from (i).

[36] It is also true for $Y \geq \overline{R}$, $V^f_{ns}(Y) - U^f > 0$.

(iii) $MP_1(Y) < MP_0(Y):$ By definition, $\tau(Y - c_1(Y)) - \tau(Y - c_0(Y)) - c_0(Y) + c_1(Y) < 0$. Thus, if $V^f_{ns,1}(Y) - V^f_{ns,0}(Y) < J^f_{s,1}(Y) - J^f_{s,0}(Y)$, the result obtains. From (4), we have

$$\begin{aligned} J^f_{s,1}(Y) - J^f_{s,0}(Y) &= (1-\lambda+\lambda F(Y))\left[V^f_{s,1}(Y) - V^f_{s,0}(Y)\right] \\ &\quad +\lambda\left(U^f_1 - U^f_0\right)(1-F(Y)) \\ &= \frac{(1-\lambda(1-F(Y))}{1-\beta(1-\delta)(1-\lambda+\lambda F(Y))} \times \\ &\quad \left[\begin{array}{c} -c_1(Y) + c_0(Y) - \tau(Y - c_1(Y)) + \tau(Y - c_0(Y)) \\ +\beta\delta\left(U^f_1 - U^f_0\right) \end{array}\right]. \end{aligned}$$

It can then be shown that $\Gamma = \left[J^f_{s,1}(Y) - J^f_{s,0}(Y)\right] - \left[V^f_{ns,1} - V^f_{ns,0}\right]$

$$\begin{aligned} \Gamma &= \frac{(1-\lambda(1-F(Y))\left[-c_1(Y) + c_0(Y) - \tau(Y - c_1(Y)) + \tau(Y - c_0(Y))\right]}{1-\beta(1-\delta)(1-\lambda+\lambda F(Y))} \\ &\quad + \left[\frac{(1-\lambda(1-F(Y))}{1-\beta(1-\delta)(1-\lambda+\lambda F(Y))} - \frac{1}{1-\beta(1-\delta)}\right]\beta\delta\left(U^f_1 - U^f_0\right) \\ &= \frac{(1-\lambda(1-F(Y))\left[-c_1(Y) + c_0(Y) - \tau(Y - c_1(Y)) + \tau(Y - c_0(Y))\right]}{1-\beta(1-\delta)(1-\lambda+\lambda F(Y))} \\ &\quad + \frac{\lambda(1-\beta)(1-F(Y))\left(U^f_1 - U^f_0\right)}{(1-\beta(1-\delta)(1-\lambda+\lambda F(Y)))(1-\beta(1-\delta))}. \end{aligned}$$

Since $U^f_1 - U^f_0 > 0$, we have $\left[J^f_{s,1}(Y) - J^f_{s,0}(Y)\right] - \left[V^f_{ns,1} - V^f_{ns,0}\right] > 0$.□

References

[1] Autor, David H. "Wiring the Labor Market." *Journal of Economic Perspectives*, Winter 2001, 15(1), pp. 25-40.

[2] Allen, Steven G.; Clark, Robert L. and McDermed, Ann A. "The Pension Cost of Changing Jobs." *Research on Aging*, December 1988, 10(4), pp. 459-471.

[3] Bernhardt, Annette; Morris, Martina; Handcock, Mark S. and Scott, Marc A. "Trends in Job Instability and Wages for Young Adult Men." *Journal of Labor Economics,* October 1999, 17(4) Part 2, pp. S65-S90.

[4] Bloom, David E. and Freeman, Richard B. "The Fall in Private Pension Coverage in the United States." *American Economic Review Papers and Proceedings*, May 1992, 82(2), pp. 539-545.

[5] Burdett, Ken and Coles, Melvyn. "Equilibrium Wage-Tenure Contracts." *Econometrica*, September 2003, 71(5), pp. 1377-1404.

[6] Bureau of Labor Statistics. "Employee Tenure in 2000." Press report, U.S. Department of Labor, August 29, 2000.

[7] Clark, Robert L. and McDermed, Ann A. *The Choice of Pension Plans in a Changing Regulatory Environment.* AEI Studies, No. 509, Washington, D.C.: AEI Press, 1990.

[8] den Haan, Wouter; Ramey, Garey and Watson, Joel. "Job Destruction and the Experiences of Displaced Workers." *Carnegie-Rochester Conference Series on Public Policy,* June 2000, 52(0), pp. 87-128.

[9] Even, William E. and Macpherson, David A. "The Changing Distribution of Pension Coverage." *Industrial Relations,* April 2000, 39(2), pp. 199-227.

[10] Fallick, Bruce C. and Fleischman, Charles A. "Employer-to-Employer Flows in the U.S. Labor Market: The Complete Picture of Gross Worker Flows." Finance and Economics Discussion Series 2004-34, Board of Governors of the Federal Reserve System, May 2004.

[11] Farber, Henry S. "Trends in Long Term Employment in the United States, 1979-96." Working Paper No. 384, Industrial Relations Sections, Department of Economics, Princeton University, July 1997.

[12] Freeman, Richard B. "The Labour Market in the New Information Economy." Working Paper No. 9254, National Bureau of Economic Research, October 2002.

[13] Friedberg, Leora and Owyang, Michael T. "Explaining the Evolution of Pension Structure and Job Tenure." Working Paper No. 2002-022B, Federal Reserve Bank of St. Louis, October 2002.

[14] Friedberg, Leora and Webb, Anthony. "Retirement and the Evolution of Pension Structure." National Bureau of Economic Research Working Paper No. 9999, 2003.

[15] Gersbach, Hans and Schmutzler, Armin. "Declining Costs of Communication and Transportation: What Are the Effects on Agglomerations?" *European Economic Review*, October 2000, 44(9), pp. 1745-1761.

[16] Glaeser, Edward, Kallal, Hedi, Scheinkman, José, and Shleifer, Andre. "Growth in Cities." *Journal of Political Economy*, December 1992, 100 (6), pp. 1126-1152.

[17] Gottschalk, Peter and Moffitt, Robert. "Changes in Job Instability and Insecurity Using Monthly Survey Data." *Journal of Labor Economics,* October 1999, 17(4) Part 2, pp. S91-S126.

[18] Gustman, Alan L. and Steinmeier, Thomas L. "The Stampede Toward Defined Contribution Pension Plans: Fact or Fiction?" *Industrial Relations*, Spring 1992, 31(2), pp. 361-369.

[19] Ippolito, Richard A. "Toward Explaining the Growth of Defined Contribution Plans." *Industrial Relations,* January 1995, 34(1), pp. 1-20.

[20] Jaeger, David A. and Stevens, Ann Huff. "Is Job Stability in the United States Falling? Reconciling Trends in the Current Population Survey and Panel Study of Income Dynamics." *Journal of Labor Economics,* October 1999, 17(4) Part 2, pp. S1-S28.

[21] Manovskii, Iourii, and Gueorgui Kambourov. "A Cautionary Note on Using (March) CPS Data to Study Worker Mobility." Draft, University of Pennsylvania, April 2004.

[22] Kolbert, Elizabeth, and Clymer, Adam. "The Politics of Layoffs: In Search of a Message." *New York Times*, March 8, 1996, p.A23.

[23] Kruse, Douglas L. "Pension Substitution in the 1980s: Why the Shift toward Defined Contribution?" *Industrial Relations*, April 1995, 34(2), pp. 218-241.

[24] Kuhn, Peter and Skuterud, Mikal. "Internet Job Search and Unemployment Durations." *American Economic Review*, March 2004, 94(1), pp. 218-232.

[25] Lazear, Edward P. "Retirement from the Labor Force." In Ashenfelter, Orley and Layard, Richard, eds., *Handbook of Labor Economics*, Volume 1. New York: Elsevier Science Publishers, 1986.

[26] Matouschek, Niko; Ramezzana, Paolo and Robert-Nicoud, Frédéric. "Labor Market Frictions, Job Insecurity, and the Flexibility of the Employment Relationship." Draft, Northwestern University, November 2003.

[27] McLaren, John and Newman, Andrew. "Globalization and Insecurity." Discussion Paper 02-06, Department of Economics, University College London, July 2002.

[28] Meisenheimer II, Joseph R. and Ilg, Randy E. "Looking for a 'Better' Job: Job-Search Activity of the Employed." *Monthly Labor Review*, September 2000, 123(9), pp. 3-14.

[29] Mortensen, Dale T. "Wages, Separations, and Job Tenure: On-the-Job Specific Training or Matching?" *Journal of Labor Economics,* October 1988, 6(4), pp. 445-471.

[30] Nagypál, Éva. "The Cost of Employment Protection in the Presence of Match-Specific Learning." Draft, Northwestern University, 2002.

[31] Neumark, David; Polsky, Daniel and Hansen, Daniel. "Has Job Stability Declined Yet? New Evidence for the 1990s." *Journal of Labor Economics,* October 1999, 17(4) Part 2, pp. S29-S64.

[32] Papke, Leslie E. "Are 401(k) Plans Replacing Other Employer-provided Pensions? Evidence from Panel Data." *Journal of Human Resources*, Spring 1999, 34(2), pp. 346-368.

[33] Pissarides, Christopher A. "Search Unemployment with On-the-job Search." *Review of Economic Studies*, July 1994, 61(3), pp. 457-475.

[34] Pissarides, Christopher A. *Equilibrium Unemployment Theory,* Second Edition. Cambridge, MA: MIT Press, 2000.

[35] Ramey, Garey and Watson, Joel. "Bilateral Trade and Opportunism in a Matching Market." *Contributions to Theoretical Economics*, 1(1), http://www.bepress.com/bejte/contributions/vol1/iss1/art3, 2001.

[36] Sato, Yasuhiro. "Labor Heterogeneity in an Urban Labor Market." *Journal of Urban Economics*, September 2001, 50(2), pp. 313-337.

[37] Shimer, Robert. "Dynamics in a Model of On-the-Job Search." Manuscript, University of Chicago, June 2003.

[38] Shimer, Robert. "A Note on Nash Bargaining with On-the-job Search." Manuscript, University of Chicago, August 2003.

[39] Stevens, Margaret. "Wage-Tenure Contracts in a Frictional Labour Market: Firms' Strategies for Recruitment and Retention." *Review of Economic Studies*, forthcoming.

[40] Stevenson, Betsey. "The Internet, Job Search, and Worker Mobility." Manuscript, University of Pennsylvania, November 2003.

[41] Stewart, Jay. "Recent Trends in Job Stability and Job Security: Evidence from the March CPS." U.S. Bureau of Labor Statistics, BLS Working Paper 356, March 2002.

[42] Stewart, Jay. "Using March CPS Data to Analyze Labor Market Transitions." Manuscript, U.S. Bureau of Labor Statistics, July 2005.

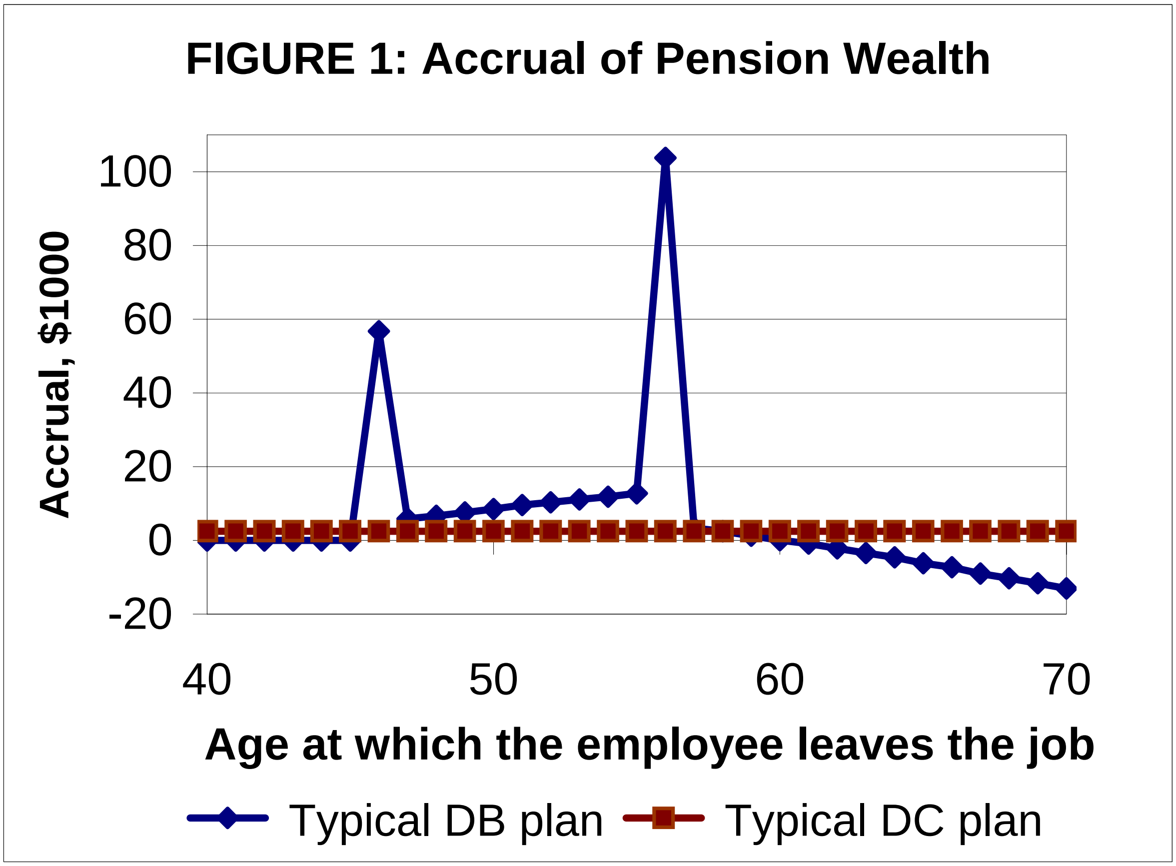
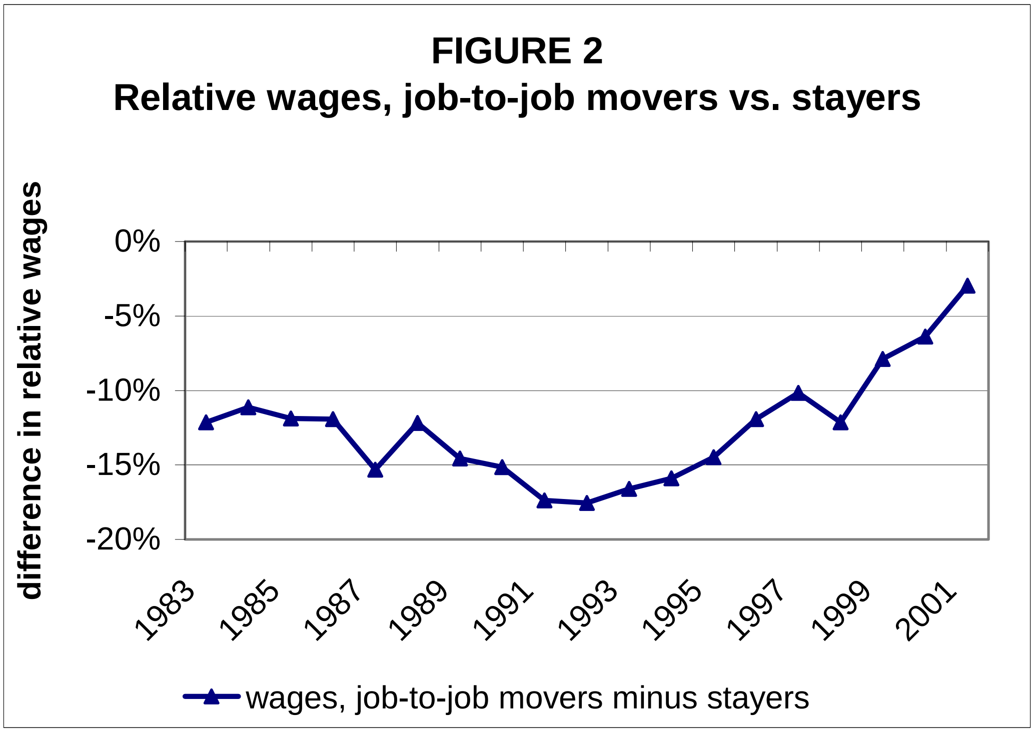


FIGURE 1: Accrual of Pension Wealth
Accrual, $1000
100
80
60
40
20
0
-20
40
50
60
70
Age at which the employee leaves the job
Typical DB plan
Typical DC plan

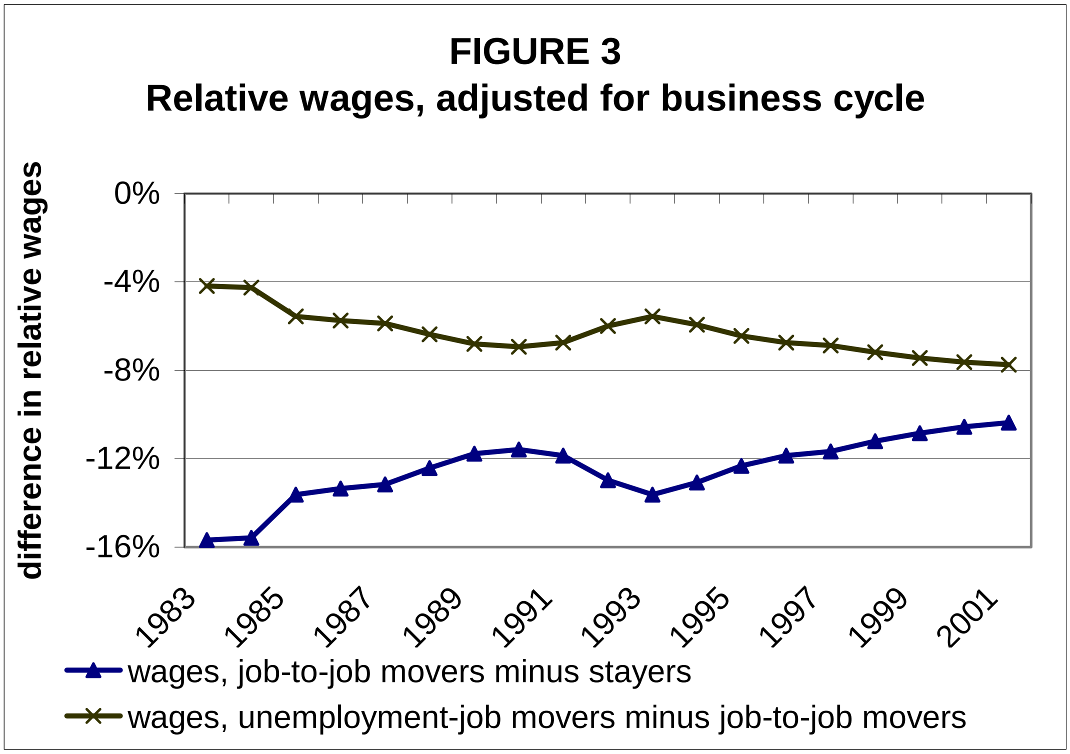


NOTES

(1) We used the method described in Stewart (2002, 2005) to identify people in March CPSs from 1983-2001 who had moved job-to-job (with an intervening unemployment spell of 0-2 weeks) within the previous 14.5 months, versus those who had stayed in the same job continuously. We used the sample selection criteria from Stewart (workers aged 19-55, with at least one year of potential labor market experience, who are not currently and were not self-employed in the previous year, and who worked full-time in the previous year) but limited the sample to people in the outgoing rotation groups, for whom the CPS collected data on current hourly earnings. Our resulting sample ranges from 7,000-9,000 per year.

(2) We ran a regression on each year's sample, putting log hourly earnings on the left-hand side and putting an indicator variable on the right-hand side for people experiencing a job-to-job flow, along with controls for gender, education (did not finish high school, high school diploma, attended but did not finish college, finished a college degree), age (and its square), and race (white, black, other). We computed Huber-White standard errors and used earnings weights.

(3) Figure 2 reports the coefficient estimates on the indicator variable for people experiencing a job-to-job flow from these regressions. Thus, it shows the percentage difference in wages each year for job-to-job movers compared to job stayers, controlling for demographics.



NOTES (continued from Figure 2)

(4) We took the coefficient estimates reported in Figure 2, which show the percentage difference in wages each year for job-to-job movers compared to job stayers, and regressed them on the contemporaneous unemployment rate in order to remove business cycle effects. The residuals are shown as the heavy lower line in Figure 3. Thus, it shows the percentage difference in wages for job-to-job movers compared to job stayers, controlling for demographics and for business cycle effects.

(5) Next, we adapted Stewart's method to identify people in March CPSs who had moved to a new job within the previous 14.5 months and *had* experienced a spell of unemployment lasting more than 2 weeks (which may have occurred at any time during the previous 14.5 months). We ran a similar regression as in (2) above, putting log hourly earnings on the left-hand side and now putting two indicator variables on the right-hand side – one for people experiencing a job-to-job flow and one for people experiencing an unemployment-to-job flow – along with the same controls for gender, education, age, and race.

(6) The regressions yielded two coefficient estimates of interest, the percentage difference in wages for job-to-movers compared to job stayers and for unemployment-to-job movers compared to job stayers. As in (4) above, we regressed the coefficient estimates on the contemporaneous unemployment rate in order to remove business cycle effects. The difference between these residuals is shown as the light upper line in Figure 3. Thus, it shows the percentage difference in wages for unemployment-to-job movers compared to job-to-job movers, controlling for demographics and for business cycle effects.

FIGURE 4: Initial Steady State

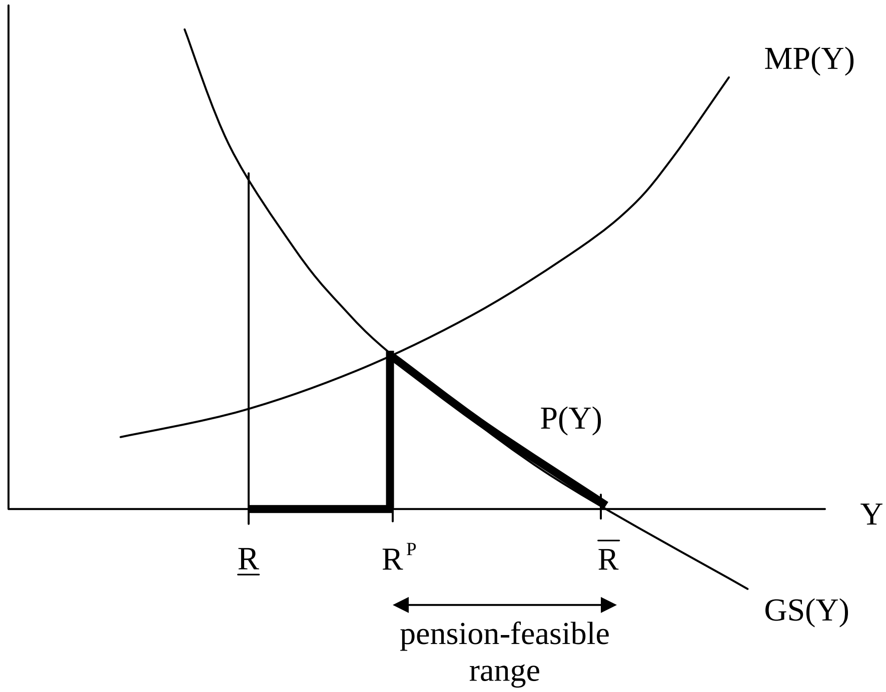


FIGURE 5: New Steady State after Decline in Search Costs