IOWA STATE UNIVERSITY

A Positive Theory of the Income Redistributive Focus of Social Security

Joydeep Bhattacharya, Robert Reed

July 2003

Working Paper # 03022

Department of Economics Working Papers Series

Ames, Iowa 50011

A POSITIVE THEORY OF THE INCOME REDISTRIBUTIVE FOCUS OF SOCIAL SECURITY*

Joydeep Bhattacharya[†]
Iowa State University and CentER, Tilburg

Robert R. Reed
University of Kentucky

First Version: October 2001, Current Version: November 2003

Abstract

Many countries around the world have large public pension programs. Traditionally, these programs have been used to induce retirement by the elderly in order to free up jobs for the young and to redistribute income across generations. This paper provides an efficiency rationale for the intergenerational income redistribution focus of such programs in a framework which explicitly accounts for the role of the lifecycle as well as search and matching frictions in the labor market. In our model, public pension programs alter the age composition of the labor force by inducing the jobless elderly to retire. By requiring a long history of labor market attachment in order to receive benefits, these programs raise the future value of current employment for the young which serves to redistribute bargaining power, and hence income, from the young to the old. The paper argues that pension programs through their effect on the wage structure, the age distribution of the labor force and firm entry decisions, can improve the operation of the labor market and might therefore be desirable on efficiency grounds alone (abstracting from equity and insurance motives).

Keywords: Search, labor market efficiency, unemployment, lifecycle, pensions
JEL Classification: J 41, J 64, E 24

*We thank Casey Mulligan for stimulating our interest in this topic. We have also benefited from detailed comments by Todd Keister and Martin Schindler on an early draft of the paper which circulated under the title "Age-Specific Employment Policies". Additional material included in the paper circulated as "Aging, Unemployment and Wefare in a Life-Cycle Model with Costly Labor Market Search." We also acknowledge useful feedback from Satyajit Chatterjee, John Duffy, Jim Heckman, Ben Heijdra, Aarti Singh, Chris Waller, Dave Wildasin, Randy Wright, and seminar participants at the Center for European Integration Studies at the University of Bonn, University of Groningen, University of Kentucky, Southern Methodist University, Tilburg, 2003 Tinbergen Week at Rotterdam, the Midwest Macro Meetings at the Federal Reserve Bank of Chicago, the Midwest Theory Meetings at Indiana University, the Federal Reserve Bank of Cleveland Central Bank Institute Summer Program on Monetary Economics (August 2002), 2003 Winter Meetings of the Econometric Society in Washington, and the 2002 UT-ITAM conference.

[†]Please address all correspondence to Joydeep Bhattacharya, Department of Economics, Iowa State University, Ames IA 50011-1070. Phone: (515) 294 5886, Fax: (515) 294 0221; E-mail: joydeep@iastate.edu

1 Introduction

At least one hundred countries around the world have public old-age pension programs. These share several common striking features.[1] First, over 70% of these countries pay pension benefits in a way as to discourage work by their elderly citizens. This is starkly evident from the fact that retirement, nearly everywhere, is a necessary condition for receiving full public pension benefits. In addition, governments use a variety of "stick and carrot" measures to dissuade the elderly from seeking work: high implicit taxes and earnings penalties on income earned beyond a certain age act as sticks while generous benefits act as carrots. Second, an important prerequisite for receiving public pension benefits in almost every case is a documented history of labor market participation. Finally, public pension programs generally have pay-as-you-go features implying substantial intergenerational redistribution. In fact, the cross-cohort redistribution is quantitatively much more important than redistribution in any other dimension by these programs.[2]

In this paper, we provide a positive theory of why pension programs exist and why they exhibit these features. In particular, our current focus is on the intergenerational income redistribution motive of social security. Assuming away political economy considerations or equity concerns, how can we explain the fact that cross-cohort income redistribution is such a major focus of pension programs around the world? Our reasoning for *how* pension programs achieve this redistribution is as follows. First, by requiring a long employment history as a prerequisite for participation in the program, pension programs induce the young to work for less in return for future transfer payments. In this manner, they also redistribute bargaining power, and hence income away from the young and towards the elderly and eligible. Second, as a result of high implicit taxes on elderly work, public pensions clearly have the potential to affect the labor market participation decisions of the elderly. By discouraging work among the jobless old, they may improve the allocation of workers to jobs in the labor market.[3] Such redistribution can have important welfare effects and this may explain *why* cross-cohort income redistribution is such a primary focus of pension programs around the world.[4] Indeed, as we demonstrate below, public pensions can generate higher aggregate welfare than if no pension program exists. In

[1] For a complete and illuminating discussion of these and many other features of old age pension programs, see Mulligan and Sala-i-Martin (2003), and Gruber and Wise (1999).

[2] See Mulligan and Sala-i-Martin (2003) for details.

[3] In related work, Shimer (2001) also studies the implications of population aging for the labor market. He shows that young workers work for less due to their lack of labor market experience while we show this effect can be entirely induced by public pension programs. In contrast to our work, all workers in his model are infinitely-lived and in each period, a new generation of workers is born. Our methodology is most closely related to Pissarides (1992) who utilizes a two-period overlapping generations model with labor market frictions to study the implications of the loss of productivity that may accompany long-term unemployment. In contrast to our framework, all jobs in his model only last for one period, and there are no costs to labor market participation. While his analysis provides a number of interesting implications for aggregate labor market outcomes, it does not address the important interactions between wages at each stage of the lifecycle, age-targeted labor market policies (such as public pension programs), and retirement decisions.

[4] Mulligan (2000) discusses a number of explanations for the design of social security programs. Based on his analysis, he determines that public pension programs emphasize *both* induced retirement and intergenerational income redistribution.

short, having a pension program makes good welfare sense because it encourages the aforementioned, efficiency-enhancing, cross-cohort income redistribution.

We produce an analytically tractable overlapping generations model with a labor market characterized by search and matching frictions. In the simplest setting, new born workers live for two periods but old workers, further ahead on the lifecycle, have only a period of life left. All young agents are jobless to begin with; they must incur some costs before they may search for employment opportunities. Firms post vacancies also at a cost and enter the labor market only if there are profits to be made from doing so. There is a standard non-discriminating matching technology that connects vacancies to workers.[5] Newly established employment relationships produce less revenue than when a worker is retained with a firm from the previous period.[6] For these reasons, an individual worker's position along the lifecycle will have a significant impact on labor market outcomes. Once job matches are formed, production takes place, and payoffs to workers and firms are determined by a process of symmetric Nash bargaining. Matches survive for a minimum (maximum) length of one (two) period(s). If a worker gets separated from a match, he becomes a displaced worker, and may re-enter the labor market to seek employment the following period.

We go on to introduce a simple and stylized old-age pension program with the following feature: any old worker who worked when young is eligible to receive a fixed level of benefits. We focus on a particular pattern of labor market participation, one in which pension benefits successfully induce *only* displaced workers to withdraw from the labor force.[7] We then address the question: why do pension programs foster inter-generational income redistribution? To see this, first consider a world without any public pension programs. In such a world, young workers, by virtue of having more time remaining in the labor market to search for jobs would have higher bargaining power than older workers in wage negotiations. As a consequence, the young who form the bulk of the job seekers, would earn higher wages than a significant number of old workers, thereby leading to high aggregate payroll costs.

The cross-cohort income redistributive nature of pension programs can now be explained as a consequence of the eligibility criteria for receiving benefits: workers must have a documented history of labor market participation. By requiring the young to work in order to receive transfer payments when old, pension programs raise the future value of current employment, thereby allowing employers to recruit

[5] One could interpret this matching technology as representing an economy with full enforcement of age discrimination laws.

[6] In this manner, we incorporate the role of quasi-fixed costs [Oi (1965)] and firm-specific human capital as stressed in the labor economics literature. See also Hurd (1996) and OECD (1994).

[7] Can the allocation of workers to jobs be improved by removing some old jobless workers from the labor market? We offer the following argument. If the age composition of the labor force is heavily skewed towards the elderly, then firms may not find it profitable to incur the upfront (unrecouperable) cost and create a vacancy. Why? While post-match bargaining ensures a correct division of the post-match surplus, it does not compensate the firm for its pre-match sunk cost. The firm can best spread this cost (and allow for accumulation of firm-specific knowledge) if it becomes matched with a young worker, who is likely to stay with the firm for two periods, as opposed to an old worker. It follows that policies that change the age-composition of the labor force may have real effects on job creation.

the young at lower wages. In turn, they also raise the option value to not working for the old and eligible. In fact, if there are significant implicit taxes on elderly work, older workers through wage negotiations will seek additional compensation to make up for the loss of retirement benefits.

A novelty of our analysis is that we identify a new channel by which pension programs engineer redistribution. In our setup, cross-cohort redistribution can take place *indirectly* via firms in the form of higher (lower) wages for the old (young) in addition to the standard pay-as-you-go transfers. Importantly, we show the magnitude of redistribution via firms can be non-trivial. The potential substitutability of one form of redistribution for another is an important, yet neglected dimension in the debate about social security reform currently in progress in all OECD countries.

Using analytical tools, we go on to study additional features of pension programs that successfully induce only the old and displaced workers to withdraw from the labor market. We find that increasing the generosity of such programs raises the employment rate and may also generate higher aggregate welfare. In contrast, increased aging of the workforce reduces the employment rate since it lowers the likelihood of firms meeting a young worker. Therefore, the problem of youth unemployment may actually be exacerbated by population aging since older workers will be crowding out young workers in the labor market. This suggests that in a world with increased "greying" of populations, shifting policy attention to the unemployment problems of the elderly at the cost of reduced focus on youth unemployment can worsen the allocation of workers to jobs. Finally, we demonstrate the precise sense in which stiffer earnings penalties and more generous benefits are complementary instruments for improving labor market efficiency.

We extend our framework to examine the general equilibrium consequences of policy-induced retirement by formally incorporating a government budget constraint along with other stylized features of public pension programs into the model. Although introducing these additional aspects of pensions allows us to draw additional insights into the consequences of induced retirement, it also renders our model less tractable. In particular, now the tax rates respond endogenously to the parameters of the pension program and other labor market variables. We use numerical simulations to show that our earlier insights are robust to settings where pension programs are internally funded. Our main results are summarized as follows. For a given earnings restriction on elderly labor market income, policy-induced retirement can lead to higher aggregate labor market welfare by lowering payroll costs for the young and also encouraging the formation of firm-specific human capital during a worker's lifetime. However, in an economy where the earnings test is eliminated, pension programs achieve: (i) better income redistribution, (ii) more labor market participation, and (iii) more vacancy creation due to the effect of pension programs on age earnings profiles in the economy. Therefore, although we demonstrate that policy-induced retirement may lead to higher welfare than in the absence of public pensions, recent reforms aimed at reducing work disincentives towards the elderly allow the redistributive role of social security to function more effectively. Our results also suggest that the welfare effects of promoting *total* employment may be more important than improving the *quality* of employment (by encouraging the elderly to "free up" jobs for the young).

The paper that is closest in spirit to our paper is Sala-i-Martin (1996). In his setup, the old are assumed to be less productive than the young. Moreover, since there are spillovers in the production technology resulting from the average level of labor productivity, the old lower the productivity of the young in the economy. Social security helps induce the old to pull out of the labor force, thereby raising the average level of labor productivity in the economy and promoting economic growth. In contrast, we abstract away from possible differences between young and old workers, except for their naturally different positions along the lifecycle and their labor market experiences. In particular, we consider that older workers who retain employment with the same firm will be more productive due to the accumulation of firm-specific human capital. Also, in our setting, gross output from a match with either a young or a newly employed old worker is the same. Interestingly, our mechanisms are sufficient to open a efficiency-enhancing role for social security.

The plan for the rest of the paper is as follows. In the next section, we outline the model environment, specify the timeline of events, describe the various search-related costs, and compute payoffs to firms and workers. In Section 3, we compute wages and discuss the properties of the wage function for young workers, especially its connection to pension benefits. Section 4 defines an equilibrium in our model and describes a result on existence and uniqueness. As a benchmark for the effects of social security and induced retirement, Section 5 outlines an equilibrium in which there are no public pensions and all workers participate in the labor market. Section 6 establishes the "positive" aspect of our analysis by demonstrating that economies can obtain higher welfare under public pension programs that cause retirement to occur. In Section 7, we study the general equilibrium effects of changes in the level of pension benefits on various endogenous variables. In addition, it also considers the role of population aging for the effects of pension programs. In Section 8, we discuss general equilibrium effects of the design of pension programs along with their impact on labor supply decisions across the lifecycle. Section 9 contains some concluding remarks. Proofs of important results are contained in the appendices.

2 The Model

2.1 Environment

Consider an economy consisting of an infinite discrete sequence of two-period lived overlapping generations and populated by two types of agents, workers and firms. There is no population growth. In each period, there are workers of two different ages – the young (with measure $\frac{1}{2}$) and the old. A fraction d of all young workers die at the end of the first period of life implying that the total population of workers is equal to $(2-d)/2$ each period.[8]

At birth, all workers are jobless. Old workers may be in one of three possible states: the long-term unemployed (those who did not find jobs when young), displaced (they were employed while young, but have involuntarily lost their job; see discussion below), or employed.[9] All workers are risk-neutral. There are no saving instruments. Firms produce a homogeneous consumption good each period using labor as the sole factor of production. Production is the result of pairwise matching between one worker and a firm. Firms are infinitely-lived with a total population of measure $\mathcal{F}$ in each period. They each have access to the same technology and seek to maximize the present discounted stream of revenues net of all costs. Workers and firms share the same discount factor $\beta \in (0,1)$.

2.2 Time line

The time line is as follows. At the start of each period, the labor market opens. At that time, jobless workers, be they old or young (the new born agents), choose whether to search for vacancies or not. If they decide to search, they incur a search cost, s, which is expressed in terms of disutility of search. As described in Pissarides (2000), s represents the imputed value of leisure in terms of output (utility). On the other side of the market, firms make the decision whether to pay some upfront costs (described below) and enter the labor market to look for employees. Each firm may employ at most one worker. Let U (F_v) denote the total mass of unemployed workers (unfilled vacancies) at the start of a period.

A stochastic matching technology connects all job seekers with open vacancies. The technology does not discriminate on the basis of age, and therefore, *any* job seeker (old or young) faces the *same* (endogenous) probability α of getting matched with a vacancy.[10] Once the labor market opens, firms and workers have at most one opportunity to meet and match. At the end of any period, the employment relationship between a worker and a firm ends involuntarily with a given probability b.[11] Put differently, a given match lasts for a minimum (maximum) length of one (two) period(s).

At the beginning of the period, a surviving old worker finds himself in one of three possible employment categories: employed [attached to a match from the previous period with probability $\alpha(1-b)$], unemployed [with probability $(1-\alpha)$], or displaced (working when young, but lost the job with probability αb).[12] On-the-job search is disallowed by our assumption regarding timing of labor market openings.

[8] Then, the fraction of old to young people in the population is given by $(1-d)$. We can think of a fall in d as increased longevity that leads to a steady-state representing aging of the population.

[9] Following Pissarides (1992), we refer to those who did not find jobs when young as the long-term unemployed. Since displaced workers are individuals who found job matches when young, but incurred a job separation, we can also refer to them as 'separated' workers. Hence, we use the terms 'displaced' and 'separated' interchangeably.

[10] Our matching structure bears many similarities to Pissarides (1992). As in his framework, workers and firms may make at most one job contact each period, and the probabilities of matching are the same for each type of worker irrespective of age (i.e., we also assume a *non-discriminating* matching technology).

[11] All job separations in the model are exogenous and outside of the worker's influence. In this sense, b is a measure of the frequency of involuntary job separations, and therefore, parameterizes the degree of job security. See Gottschalk and Moffitt (1999) for related discussion.

[12] Long term job attachment is an important feature of labor market behavior. For example, 34% of U.S. male workers

For future reference, note that the long-term unemployed, unlike displaced workers, have no prior history of labor force attachment. This will create a distinction between them if governmental transfer payments are contingent on their employment history.[13] At the end of the period, young employed workers learn their employment status for the following date (i.e., whether their current match survives to the next period or gets dissolved); at this time, old workers die for sure.

2.3 The Labor Market

As discussed in the introduction, public pension programs in many countries aim to induce retirement by the elderly so as to alleviate unemployment among the young. In this paper, we focus solely on the role played by public pension programs in encouraging the *jobless* elderly to withdraw from the labor market.[14] In many European countries, for example, workers can collect early retirement benefits after an involuntary separation. In France, the "contrat de solidarité" recognizes the "double need to encourage 55-59 year-old workers to stop work and to bring young workers into the labor market, as rising youth unemployment was a growing concern to society as a whole." A precondition to receiving unemployment benefits for people over the age of 55 is that they stop "seeking employment".[15]

We formally motivate these ideas in a setting where an individual's position along the lifecycle affects his opportunities in the labor market. Furthermore, the participation decisions of all workers have general equilibrium implications through their impact on the number of job vacancies created by firms. En route to studying the possible desirability of policies that affect labor market participation by the elderly, we analyze a setting where a particular subset of workers chooses to retire. In particular, we consider the general equilibrium consequences of public policies that encourage displaced (separated) workers to withdraw from the labor market.

In terms of deriving the endogenous labor market participation decisions of all workers (in particular,

aged 25 and over had worked for their current employer for 10 years or more in February 2000; for workers aged 55-64, 28% had worked for their current employer 20 years or more. In addition, Hall (1982) finds that after a job has lasted 5 years, the probability that it will eventually last 20 years or more in all rises to close to 0.5 among workers in their early thirties. These data imply that tenure with a firm can be quite long. The low frequency nature of our overlapping generations setup is well-suited to capture this aspect of the labor market. It bears emphasis that job turnover in our framework is entirely involuntary.

[13] This is one of the benefits of our deterministic, discrete-time model. Since each worker receives only one job contact each period, it is very easy to trace an old worker's employment status to his employment history. The linkages between eligibility for transfer payments (such as social security) and a worker's prior labor market history are clearly important, yet often ignored in models of the labor market.

[14] Displacement is an important route towards retirement in many OECD countries. For example, Chan and Stevens (2002) show that displacement increases the probability of retirement in the U.S. labor market. Specifically, they emphasize that this may be due to the costs of job search and loss of firm-specific human capital. O'Leary and Wandner (2000) conclude that while less than 10% of displaced workers under the age of 55 permanently exit the labor force, more than 25% between the ages of 55 and 64 and almost half of workers over the age of 65 opt for retirement instead of searching for alternative sources of employment upon displacement. Diamond and Hausman (1984) also discuss how job loss among older workers leads to retirement.

[15] In Britain, the Job Release Scheme which ran between 1977 and 1988, "specifically encouraged older workers to stand down to make way for younger ones. Once out of employment, changes to the unemployment benefit regime in 1983 removed the requirement for men over 60 to look for work, encouraging them to see themselves as retired." For more details, see the OECD (1995) study on "The Labor Market and Older Workers".

old workers), we adopt the following algorithm. We first condition on a set of strategies where all separated workers have chosen to withdraw from the labor market by accepting retirement benefits rather than incurring the costs of job search. We then study how public pensions must be designed in order to support the conjectured steady-state equilibrium. We proceed by verifying that a separated worker is better off choosing to collect pension benefits rather than searching for a job. This is the algorithm we adopt in order to endogenize labor force participation for every type of worker at each stage of the lifecycle.

2.4 Costs

Firms incur sunk costs of posting vacancies, denoted by a. Once they have incurred this cost and searched for workers, all firms are equally likely to find a worker. The probability that a vacancy finds a worker is θ (to be determined in equilibrium below). The probabilities of meeting a given type of worker, however, will depend on the proportion of each type in the labor market. In our conjectured equilibrium, only the young and the long-term unemployed actively search for jobs. While the total measure of unemployed workers is U, the total measures of the young and long-term unemployed are u_y and u_o. The probability of finding a young unemployed worker is $\theta\tilde{u}_y$, where $\tilde{u}_y \equiv \frac{u_y}{U}$. Similarly, the probability that a vacancy locates a long-term unemployed worker is $\theta\tilde{u}_o$. The next lemma reports these population proportions for future use.

Lemma 1

$$U = \frac{1 + (1-\alpha)(1-d)}{2}$$

$$\tilde{u}_y \equiv \frac{u_y}{U} = \frac{1}{1 + (1-\alpha)(1-d)}$$

$$\tilde{u}_o \equiv \frac{u_o}{U} = \frac{(1-\alpha)(1-d)}{1 + (1-\alpha)(1-d)}$$

An important point to note here is that the population proportions are all endogenous variables since they depend on α. An implication of this is that policies aimed at altering the age-composition of the labor force also change these proportions, and thereby affect the probability with which firms encounter workers of other age groups. This general equilibrium effect is at the heart of our analysis.

Following the insights of Oi (1962) and Hutchens (1986), we posit that there are costs which must be incurred at the beginning of an employment relationship. We refer to these as "hiring" costs, and denote them as h. Let the exogenously-determined market value of the firm's output be normalized to 1. Matches with new hires require the firm and the worker to incur the costs of "hiring and training" so that the net output from new matches is $(1-h)$ while net output from a match with an old, retained worker is 1.[16] Under this interpretation, one may view h as a cost that is incurred each time a firm makes a new hire. Alternatively, h may proxy a productivity differential between new and old matches. In the latter sense, one may also interpret h as a parameter which reflects the importance of firm-specific human capital. Firms therefore derive higher net revenues from employing workers with longer expected tenure.

The wage rate(s) for the different types of workers are determined (see below) in accordance with the protocols of Nash bargaining. As shown there, the presence of age-targeted labor market policies and the aforementioned accumulation of firm-specific human capital will cause the wages of workers (with different employment histories) to vary.

2.5 Specification of Labor Market Policies

We incorporate various aspects of real-world age-specific labor market policies, such as public pension programs and long-term old-age unemployment insurance programs, into our model. These take a particularly simple and stylized form. Old workers, currently or previously employed, are eligible for transfer payments from the government. As is common in many countries, these payments are tied to a worker's prior attachment to the labor market. In that vein, we assume that an individual who worked when young is potentially eligible for a fixed lump sum benefit of B_0. In Section 8, we allow for pension benefits to be directly tied to past wages.

We also allow for aspects of earnings reductions, as observed in many programs, in our framework. We capture the notion of an "earnings test" by asserting that workers who work when old receive only a fraction δ of benefits due to them.[17′18] For example, suppose that an old worker who retained her job from a previous match receives a wage of w_o^e. Then gross of pension benefits, he obtains total income in the amount $w_o^e + \delta B_0$. Since we conjecture that displaced workers choose to retire, in equilibrium, they earn total income B_0. The long-term unemployed are not eligible for benefits since they have no documented history of labor force attachment.[19]

[16] Note that our framework differs from the standard search-theoretic model with ex-ante heterogeneity. Although one may view the old, retained workers in our setup as "high" types and the displaced and the long-term unemployed workers as "low" types, the probability of becoming a "high" type is endogenous. This is an important distinguishing feature of our model. In particular, as we demonstrate below, the chance of becoming a "high" type will be crucially affected by policy.

[17] The "earnings test" that was applied in the United States until 2000 could be described as follows. In 1999, a worker age 62 to 65 could earn up to $9,600 without the loss of any benefits, then benefits were reduced $1 for each $2 of earnings above this amount; for workers age 65 to 69, the earnings test floor was $15,500 and benefits were reduced at a rate of $1 for each $3 in earnings. Although our framework is not suited to capture the specific features of various versions of the earnings test, we can consider its implications, more broadly defined, for retirement behavior and wages of older workers.

[18] In our specification, the higher the value of δ, the lower is the implicit tax rate on elderly work. Gruber and Wise (1999) find that while this tax is relatively low in the United States (around 20%), it is much higher in a number of European countries (as much as 80%).

[19] For now, we ignore issues relating to funding of these programs. The consequent analytical tractability allows us to explicitly endogenize the labor market participation patterns on the basis of the design of public pension programs and formally prove existence of the conjectured steady-state equilibrium. In Sections 6 and 8, we study the effects of pension programs under a balanced budget constraint.

In order to study the desirability (or lack thereof) of public pension programs that induce workers of certain ages and employment histories to withdraw from the labor market, we will henceforth construct the model under the conjecture that public policies successfully induce *only* the separated workers to leave the labor market, and collect B_0. In our analysis below, we will provide a set of sufficient conditions under which this conjectured equilibrium exists.[20]

2.6 Workers' Payoffs

Let J_y denote the expected lifetime utility accruing to a worker who decides to search when young, J_o^e the expected utility of an old worker who begins the period employed and continues his employment, J_o^u the expected utility of an old worker who did not get matched when young and is back in the labor market seeking employment, and J_o^s the expected utility of an old separated (displaced) worker. Then, it is easy to see that

$$J_y = -s + \alpha \left[w_y + (1-d)(1-b)\beta J_o^e + b(1-d)\beta J_o^s \right] + (1-\alpha)(1-d)\beta J_o^u \tag{1}$$

$$J_o^u = -s + \alpha w_o^u; \quad J_o^e = w_o^e + \delta B_o \tag{2}$$

$$J_o^s = B_o \tag{3}$$

It is instructive to explore the economic interpretation of eq. (1), as the explanations of the other value functions follow straightforwardly. A young worker seeking employment incurs an upfront cost s. Upon entering the labor market, he gets matched with a firm with probability α. In that case, he gets a wage w_y and, if he survives, also the expected discounted continuation payoffs from possible employment and separation the following period. If he is unsuccessful in finding a job, and if he is alive at the start of the next period, he will find himself in the state of being a long-term unemployed worker.

>From (1), it is also clear that the value of a job to a young worker is much more than just the current wage. Because jobs are potentially durable (long-lasting), a match today bestows certain continuation privileges to the worker, a fact that will play a prominent role during the wage-bargaining phase.[21]

2.7 Payoffs to firms

Firms begin each period in one of two possible states. They may currently have a vacancy, or they may be matched with an old worker from a previous employment relationship. Letting Π_v (Π_f) be the

[20] Pissarides (1976), in an infinite-horizon model with sequential search, also studies the choice of labor market participation. He derives the optimal number of times individuals will choose to search for jobs before becoming "discouraged" and withdrawing from the labor market. However, he does not consider the role of the lifecycle in his analysis. His model also does not address how labor market participation is influenced by pension or labor market policies.

[21] Davidson, Martin, and Matusz (1994) demonstrate how the durability of jobs results in a social surplus when workers have finite lives in an infinite-horizon economy. However, unlike their paper, we embed this idea into an overlapping generations framework. In addition, we explicitly introduce important features of pension programs which reinforce the role of employment beyond current compensation thereby leading to intergenerational income redistribution.

expected lifetime profits of a firm that has an unfilled (filled) vacancy at the beginning of the period, the following equations describe the associated expected present discounted profits of a firm in each state:

$$\begin{aligned}\Pi_v &= -a + \theta\tilde{u}_y \{(1-h-w_y) + (1-d)[(1-b)\beta\Pi_f + b\beta\Pi_v] + d\beta\Pi_v\} \\ &\quad +\theta\tilde{u}_o \{[1-h-w_o^u] + \beta\Pi_v\} + (1-\theta)\beta\Pi_v\end{aligned} \tag{4}$$

$$\Pi_f = (1-w_o^e) + \Pi_v \tag{5}$$

As indicated above, if the firm is currently matched with an old worker, it will have a vacancy next period it if incurs the cost a. Note that the firm does not face any hiring costs if the employment relationship from the previous period is retained. Also note that firms take the proportions, $\tilde{u}_y$ and $\tilde{u}_o$, as given when deciding whether to enter the labor market.

The following closed form expression for steady state payoff to entry will be of considerable use below:

$$\Pi_v = \frac{-a + \theta\tilde{u}_y(1-h-w_y) + \theta\tilde{u}_y(1-d)(1-b)\beta(1-w_o^e) + \theta\tilde{u}_o(1-h-w_o^u)}{\left[1-\theta\tilde{u}_y(1-d)(1-b)\beta^2 - \theta\tilde{u}_y(1-d)b\beta - \theta\tilde{u}_y d\beta - \theta\tilde{u}_o\beta - (1-\theta)\beta\right]}. \tag{6}$$

2.8 Matching

Unemployed workers and unfilled vacancies are brought together each period through a stochastic matching technology. The matching technology describes the total number of matches, $m = \mu\mathcal{M}(U, F_v)$, that are formed at the beginning of each period, depending on the total masses of unemployed workers and unfilled vacancies. Since α represents the probability that an unemployed worker will find any vacancy in the time period and θ is the probability that any unfilled vacancy will find an unemployed worker, it follows that the total number of workers who find employment $(\alpha \cdot U)$ must equal the total number of firms that filled their vacancies $(\theta \cdot F_v)$: $\alpha \cdot U = \theta \cdot F_v$. It is important to note that α and θ are determined in equilibrium, and that both workers and firms take them as given when making their decisions. Noting that $m = \theta \cdot F_v$, we have

$$\alpha U = \theta F_v = m = \mu\mathcal{M}(U, F_v) \tag{7}$$

the *matching condition.* It is standard to assume that the matching technology takes the Cobb-Douglas form: $m = \mu(U)^{1-\phi}(F_v)^{\phi}$ where $\phi \in [0,1]$. Noting that $\theta F_v = \mu(U)^{1-\phi}(F_v)^{\phi}$, it follows that $\theta = \left[\mu\left(\frac{U}{F_v}\right)\right]^{1-\phi}$. An increase in either the number of unemployed workers or unfilled vacancies increases the number of matches each period, but at a decreasing rate. Ceteris paribus, more matches occur when μ is higher.

For analytical tractability, in some of what we do below, we will assume $\phi = 1$. Then, $\theta = \mu \leq 1$ obtains. In fact, it is easiest to conduct our analysis (and obtain closed form solutions to various endogenous variables) for the case where $\theta = \mu = 1$. This implies that $\mathcal{M}(U, F_v) = F_v$. Vacancies always find a worker, but workers may find a vacancy only with a probability $\alpha \in (0, 1)$ that will be determined below.[22] In such an economy, the congestion problems facing unemployed workers are severe. Below, we will remark on how our results depend on the extent of congestion problems encountered by both workers and vacancies.

3 Bargaining and Wage Determination

The friction inbuilt into the job-firm matching process creates the possibility that a firm may remain unproductive or a worker may remain unemployed in any period. Firms and workers must therefore weigh the implications of finding themselves in these states and their outside options when bargaining over their share of current and future surplus produced. Two important things deserve mention here. First, the outside options available to workers are crucially affected by policy, and second, these outside options are dependent on past employment history *and* on one's position in the lifecycle. Below, we will demonstrate the powerful implications of this last observation. To foreshadow, we will establish the presence of a "skewness" in bargaining power towards the young, and the role played by pension programs in "undoing" some of the resultant inequities.

3.0.1 Wage functions

We now turn to the determination of the wage offer functions for both young and old workers. Matches between workers and unfilled vacancies leads to a surplus that is to be divided between the worker and the firm. Nash bargaining dictates that the total match surplus be shared by the firm and the worker; principally for analytical tractability, we assume symmetric Nash bargaining. For an old worker with an unbroken employment relationship from the previous period, the gain from the match is $[w_o^e + \delta B_0] - B_0$. The corresponding gain to the firm is $(1 - w_o^e + \Pi_v) - \Pi_v = 1 - w_o^e$.[23] Then, Nash bargaining implies

$$w_o^e = \frac{1 + (1 - \delta) B_o}{2} \tag{8}$$

Analogously, it follows that the wages to a long-term unemployed worker (one who has no history of labor force attachment) is given by

$$w_o^u = \frac{(1 - h)}{2}. \tag{9}$$

[22] We only study equilibria in which there are more unemployed workers than vacancies. Hence, we have both $U < F_v$ and $\alpha < 1$ in our analysis.

[23] We assume that even when a match survives on to the second period, wages are determined by a fresh process of bargaining at the start of the second period.

Finally, we turn to the wage determination for a young worker. The gains from trade for the firm are given by

$$1 - h - w_y + \beta \left[(1-d)\, b\Pi_v + (1-b)(1-d)\, \Pi_f + d\Pi_v - \Pi_v \right] \tag{10}$$

while the young worker's surplus from finding employment is given by

$$w_y + \beta \left[b(1-d)\, J_o^s + (1-b)(1-d)\, J_o^e - (1-d)\, J_o^u \right] \tag{11}$$

The analytical expression for the wages accruing to a young worker is described in the following lemma.

Lemma 2 *a) The expression for the wage function for the young is given by*

$$2w_y = (1-h)\left(1 + \frac{\beta\alpha(1-d)}{2}\right) - (1-d)\,\beta\,(B_0 + s) \tag{12}$$

b) If $(1-h) > \beta(B_0 + s)$*, then* $w_y > 0$.

Note that part b) of Lemma 2 is a *sufficient* condition for young workers to earn positive wages, since it holds for any possible value of α.

Ceteris paribus, higher search costs s, reduce the wages to the young by reducing the option value to waiting and searching in the future. It also follows that, ceteris paribus, a higher pension benefit B_0, reduce the wages to the young, an issue to which we now turn.

3.0.2 Discussion of the wage function for the young

Suppose for the moment that all public pension programs are absent, i.e., $B_0 = 0$. In this case, using (8)-(9), we have:

$$w_o^u = \frac{(1-h)}{2}, \quad w_o^e = \frac{1}{2}$$

Also, using (11), the young worker's surplus from finding employment is given by:

$$w_y + \beta(1-b)(1-d)\, w_o^e - \beta(1-d)\, J_o^u.$$

and, using (10), the firm's surplus (assuming free entry) from hiring the young worker is given by:

$$1 - h - w_y + \beta(1-b)(1-d)(1 - w_o^e).$$

Equating, we get

$$w_y = \frac{(1-h)}{2} + \beta(1-b)(1-d)(1 - w_o^e) - \beta(1-b)(1-d)\, w_o^e + \frac{\beta(1-d)}{2} J_o^u \tag{13}$$

A young worker can expect that his job will last beyond the current period. The wage function for young workers reflects this via the fact that the value of employment this period is more than just the current wage. Several insights are immediate from an examination of (13). First, ceteris paribus, higher wages (if the worker is alive and retained in the future) serve to lower current wages. This is additional surplus that a young worker will obtain in the future if the match is sustained. Since this represents a source of gain from working when young, the firm extracts this future surplus by paying the worker lower wages this period. In addition, if the employment relationship is sustained, then the firm will have more net revenues next period. Since the surplus, $(1 - w_o^e)$, represents additional revenues that the firm will obtain in the future from hiring a young worker, the worker is able to extract his share of that expected surplus. Second, if the young worker's "threat point" in bargaining increases in the sense that the value to waiting for a period and then searching rises, his wages must rise.

Now consider a situation where employment is possibly temporary $(b < 1)$ but workers live for two periods for sure $(d = 0)$. Then,

$$w_y = \left[\frac{(1-h)}{2} + \frac{1}{2}\beta J_o^u\right] > w_o^u$$

would obtain. It is now apparent that inequities in bargaining power over the lifecycle arise, *purely* because of agents' positions on the lifecycle. Young workers, who have the option of searching for jobs when old, will have a higher threat point in negotiating over wages than old workers (who have no such outside option). [24]

We are now in a position to isolate a key social function played by pension programs towards reducing the aforementioned inequity. To see this, recall that young workers (by virtue of the fact that they likely have a period ahead of them) have higher bargaining power than the old. Also a fundamental eligibility criterion for receiving pensions when old is a history of labor force attachment. Employment when young therefore raises the worker's expected net income in the future. The bargaining power of a young worker (arising from their position in the lifecycle) is therefore partially reduced because the firm is aware that having a job today implies current (and future) benefits to the employee; the firm naturally extracts part of that surplus. It is in this sense that public pensions help redistribute bargaining power from young to old workers, raising the wages for the old and eligible and reducing the wages of the young.[25]

The above discussion was based entirely on "ceteris paribus" arguments, since α was held constant throughout the discussion. We now turn to the determination of α along with all other endogenous variables.

[24] It is important to note here that past private earnings do not affect a worker's *current* bargaining strength because of our earlier assumption ruling out any form of asset accumulation or saving.

[25] Black (1987) also finds that social security affects age-earnings profiles. In his model, workers would rather receive private pension payments than wages as a result of social security taxes. As workers become older, they switch from pension payments to wages since the returns from pension savings would be lower. Therefore, social security tends to generate upward-sloping age earnings profiles. In his work, the retirement date is exogenous (he does not explore the early retirement incentives in the social security system). In addition, there is no unemployment in his model.

4 Equilibrium

4.1 Definition and Existence

We focus exclusively on time-invariant equilibria. This will allow us to investigate the properties of long-run equilibria in the labor market. A steady-state equilibrium with no labor market participation by the displaced (separated) workers is formally defined below.

DEFINITION *A steady-state equilibrium with no labor market participation by displaced workers* [an *"induced retirement equilibrium"*] *consists of wage functions* w_y, w_o^e, and w_o^u [*defined in* (8), (9), and (12)], *policy parameters,* B_0 and δ, *and a quadruple* (α, θ, U, F_v) *satisfying the following conditions: (i) Symmetric Nash bargaining; (ii) (Unrestricted Entry for firms):* $\Pi_v = 0$ *; (iii) (Steady-State):* $\alpha U = \theta F_v = \mu M(U, F_v)$*, with* $\theta = 1$*, and (iv) the labor market participation/non-participation constraints hold:* $J_o^u > 0, J_y > (1-d)\,\beta J_o^u, J_o^e > B_o$ and the displaced worker constraint holds (see below).

4.2 Labor Market Participation Conditions

As stated in the definition of the equilibrium, we impose a pattern of labor market participation across workers of different age groups and employment histories and then state conditions under which this pattern emerges as an equilibrium. In particular, we study a steady-state equilibrium in which old workers who have experienced job loss during the course of their careers choose to accept their pension benefits and withdraw, rather than incur the costs of job search. Old individuals who have retained their jobs continue working since they have higher productivity than when they were initially employed. In contrast, the long-term unemployed with no access to pension benefits choose to look for jobs. We also provide conditions to ensure that the young actively search for jobs.

We begin with a discussion of the participation conditions for old workers who have retained jobs from their youth. In order for them to continue working, we must have

$$J_o^e = w_o^e + \delta B_o > B_o. \tag{14}$$

which using (8) reduces to $1 > (1-\delta)\, B_o$, a sufficient condition for which is $1 > B_o$.

The next step is to find conditions under which displaced workers choose to accept pension benefits and retire rather than incur the costs of job search. If a separated worker chooses to accept pension benefits, his expected utility is: $J_o^s = B_o$. However, the decision to withdraw from the labor force must yield higher expected utility. Therefore, the following condition must hold:

$$B_o > -s + \alpha w^s + \alpha\delta B_o + (1-\alpha)B_o \tag{15}$$

Under the assumption that an individual displaced worker chooses to search for a job (an 'individual' deviation), with probability α the displaced worker would be able to obtain employment and would earn total income $(w^s + \delta B_o)$. In this event, the wage he would earn is given by:

$$w^s = \frac{(1-h) + (1-\delta)\, B_o}{2} \tag{16}$$

Alternatively, if unable to find employment, the worker would still be able to collect pension benefits. Using (16) in (15), it follows that policy- induced withdrawal by displaced workers occurs if $(1-h) > (1-\delta)B_o$ and

$$\alpha < \frac{2s}{[(1-h) - (1-\delta)B_o]} \tag{17}$$

holds. This provides an upper-bound for α.

In contrast, for the long-term unemployed to search for jobs, we require that:

$$J_o^u = -s + \alpha w_o^u > 0$$

Using (9), this condition may be rewritten to provide a minimal value for α for which the long-term unemployed remain active in the labor market:

$$\alpha > \frac{2s}{(1-h)} \tag{18}$$

Obviously, if the search costs are too high, the long-term unemployed would be better off choosing not to search for jobs. A quick comparison of (17) and (18) reveals the following insight regarding the earnings test.

Lemma 3 *For an induced retirement equilibrium to exist, it is necessary but not sufficient that there be an earnings penalty, i.e., $\delta < 1$ must obtain.*

If $\delta = 1$, an induced retirement equilibrium does not exist. Finally, in order for young workers to search for jobs, the expected utility of participation when young must exceed the value of waiting and looking for a job when old. This implies that:

$$J_y = -s + \alpha\left[w_y + (1-d)\,(1-b)\beta J_o^e + b\,(1-d)\,\beta J_o^s\right] + (1-\alpha)\,(1-d)\,\beta J_o^u > (1-d)\beta J_o^u \tag{19}$$

The following lemma provides conditions on α such that young workers choose to actively search in the labor market.

Lemma 4 *a) Suppose that the displaced worker constraint is satisfied and $(1-h) > (B_0 + s)$. In addition, let $b_1 \equiv [(1-h) - (1-d)\,\beta\,(B_0+s)]$. If $\alpha w_y(\alpha) > s$, then (19) is satisfied and young workers will choose to search for jobs, which obtains when*

$$\alpha > \alpha_L \equiv \frac{-b_1 + \sqrt[2]{b_1^2 + 4\beta(1-h)(1-d)s}}{\beta\,(1-d)\,(1-h)} > 0 \tag{20}$$

b) $\alpha_L > \frac{2s}{(1-h)}$

To summarize, a valid induced retirement equilibrium value of α must satisfy (17), (18), and (20); additionally, the level of benefits B_0 must satisfy $(1-h) > \max\left[(1-\delta)B_o, \beta\left(B_0+s\right)\right]$. Henceforth we will maintain the assumption:

Assumption 1 *a)*

$$(1-h) > \max\left[(1-\delta)B_o, \beta\left(B_0+s\right)\right] \tag{21}$$

b)

$$3\left(1-h\right) > 4a \tag{22}$$

4.3 Equilibrium Entry Condition

Firms enter the labor market in search of employees until all profit opportunities from new jobs are driven to zero. This "free-entry condition" dictates that the expected present value of future profits attributable to filling the marginal vacancy must equal the cost of vacancy-posting and hiring the next worker. Utilizing the wage functions described above, along with $\Pi_v = 0$ [see (6)], we have

$$\left(\frac{a}{\theta}\right)\frac{1}{\tilde{u}_y} = (1-h-w_y) + (1-b)(1-d)\beta\left(1-w_o^e\right) + \left(\frac{\tilde{u}_o}{\tilde{u}_y}\right)\left(1-h-w_o^u\right) \tag{23}$$

Then, setting $\theta = 1$, candidate equilibrium values of α are derived from (23) using Lemma 1, (8), (9), and (12). One of the major benefits of using a simple matching technology like ours is that closed-form solutions to (23) can be analytically derived.

The following proposition describes the conditions required for existence of an induced retirement equilibrium.

Proposition 1 *a) The unique solution to (23) in terms of* α, *is given by*

$$\alpha \equiv \alpha\left(B_0;\delta\right) = 2\left\{\frac{\beta s + \beta(1-b) + \beta B_0\left[1-\left(1-b\right)\left(1-\delta\right)\right] + \left(\frac{1}{(1-d)}+1\right)\left[(1-h)-2a\right]}{\left[(1-h)\left(2+\beta\right)-4a\right]}\right\}. \tag{24}$$

b) Suppose Assumption 1 holds. Then, for α *in (24) to be part of an induced retirement equilibrium with* $\theta = 1$, *(17), (18), and (20) must hold or, more compactly, the condition*

$$\alpha \in \left\{\alpha_L, \min\left(\frac{2s}{\left[(1-h)-(1-\delta)B_o\right]}, 1\right)\right\}$$

holds.[26]

We close this section by presenting two numerical examples of valid steady-state equilibria with induced retirement, one for the linear-matching ($\phi = 1$) and the other for the non-linear matching ($\phi < 1$) case.

Example 1 *Let* $s = 0.03$, $a = 0.266$, $h = 0.585$, $d = 0.41$, $\delta = 0.2, \beta = 0.99$, $\mu = 1, B_0 = 0.102$, *and* $b = 0.785$. *For this parametric specification,* $\alpha = 0.1471$, *and for this value of* α, *all other conditions outlined in the definition of the induced retirement equilibrium hold.*

Example 2 *Let* $s = 0.15$, $a = 0.2$, $h = 0.4$, $d = 0.2$, $\delta = 0.2$, $\beta = 0.95$, $\mu = 0.4$, $B_0 = 0.4$, $b = 0.2$, *and* $\phi = 0.8$. *For this parametric specification,* $\alpha = 0.7874$, *and for this value of* α, *all other conditions outlined in the definition of the induced retirement equilibrium hold.*

5 The absence of policy

In this section, as a benchmark for considering the effects of induced retirement, we briefly outline the environment in the absence of any policy intervention. Since much of the basic structure of the economy remains the same, we choose to minimize detailed discussion of the analysis. Additionally, without loss of generality, we will assume $d = 0$.

We start by revisiting the value functions describing the expected lifetime utility of workers.

$$J_y = -s + \alpha \left[w_y + (1-b)\beta J_o^e + b\beta J_o^u\right] + (1-\alpha)\beta J_o^u; \quad J_o^e = w_o^e; \quad J_o^u = -s + \alpha w_o^u$$

Recall that in the absence of policy, the old separated are indistinguishable from the old never-before-employed, and can be lumped into the single category of jobless elderly. The value functions for the firms are the same as before.

It is clear that the wage functions for old jobless workers and retained individuals are the same as in the previous section since they do not depend on the probability of finding a job. In contrast, the wage paid to the young is however different. Even though the gains from trade to the firm from hiring a young worker remain the same as before, a young worker's surplus from finding employment is now given by

$$w_y + b\beta J_o^u + (1-b)\beta J_o^e - \beta J_o^u = w_y + \beta (1-b) s - \beta (1-b) \alpha w_o^u + (1-b)\beta w_o^e$$

[26] For a generic θ, it is easily checked that (24) is given by

$$\alpha = \frac{2}{(1-h)(2+\beta) - \frac{4a}{\theta}} \left[\left\{\frac{1}{(1-d)} + 1\right\}\left(1 - h - \frac{2a}{\theta}\right) + (1 - (1-b)(1-\delta))\beta B_0 + \beta s + \beta(1-b)\right]$$

which we use later when doing numerical computations with a non-linear matching technology.

In particular, the surplus reflects that young workers will choose to search for jobs when they become old since induced retirement does not occur. Under symmetric bargaining, and free entry, it can be shown that

$$w_y^{np} = \frac{(1-h)}{2}\left[1 + \frac{\beta(1-b)\alpha}{2}\right] - \frac{\beta(1-b)s}{2} \tag{25}$$

where the superscript "*np*" signifies "no policy".

The most crucial difference between the environment with and without policy is in the nature of the equilibrium. As we have discussed earlier, the case with policy focuses on an equilibrium in which pension benefits successfully induce the old and separated to withdraw from the labor force. The appropriate comparison is with a setting without policy intervention in which *every* jobless worker is in the labor force.

DEFINITION *A steady-state equilibrium without policy intervention and with labor market participation from all workers consists of wage functions* w_o^u, w_o^e, and w_y [*defined in* (8), (9), and (25)], *and a quadruple* (α, θ, U, F_v) *satisfying the following conditions: (i) Symmetric Nash bargaining; (ii) (Unrestricted Entry for firms):* $\Pi_v = 0$*; (iii) (Steady-State):* $\alpha U = \theta F_v = \mu\mathcal{M}(U, F_v)$*, with* $\theta^{np} = 1$*, and (iv) the labor market participation constraints hold:* $J_o^u > 0, J_y > \beta J_o^u$, and $J_o^e > 0$.

As before, firms enter until $\Pi_v^* = 0$. Analogous to the equilibrium entry condition derived in the model with policy, it can be checked that

$$\alpha^{np} = \frac{4(1-h) - 8a + 2(1-b)(1+s)\beta}{(1-b)\left[(1-h)\beta + 2(1-h) - 4a\right]} \tag{26}$$

We conclude this section with an important result.

Proposition 2 *Young workers always earn higher wages in the absence of induced retirement. That is,* $w_y^{np} > w_y$ *where* w_y *is defined in eq. (12).*

This is the crux of the income redistribution argument. Pension policies, by their very nature, raise the future value of employment, and thereby reduce wages to the young. In the absence of such policies, as Proposition 2 indicates, the wages of the young are relatively high. Since they form the bulk of the job seekers, ceteris paribus, a higher wage to the young adversely affects firm entry, and possibly reduces aggregate worker welfare.

Furthermore, by encouraging old displaced workers to retire, social security programs can play an important role in improving the allocation of workers to jobs since they allow young workers to more easily find jobs and accumulate firm-specific human capital. In what follows below, we first aim to demonstrate our efficiency rationale for public pensions and induced retirement. In order to accomplish this objective, we explicitly introduce a government budget constraint into our framework so that pensions are funded within the economy. Specifically, we present a setting where payroll taxes imposed on both firms and workers are used to pay for pension benefits. Section 6 below establishes that public pensions through induced retirement can lead to higher welfare than when public pensions are absent.

6 Are pension programs welfare enhancing?

The principal point of this paper is to argue that pension programs, through their effect on the wage structure, their inducement to pull the old displaced workers out of the labor market, and thereby encourage firms to create more job vacancies, can improve the operation of the labor market and might therefore be desirable on efficiency grounds alone (abstracting from the more standard equity and insurance motives). To that end, before discussing the overall effects of pension programs and their interactions with labor market conditions, we first seek to demonstrate that endogenously funded pension programs and publicly induced retirement can lead to higher welfare than having no pension program at all. Below we sketch a version of our model that introduces payroll taxes on workers and firms which are then used to pay the old separated to stay away from the labor market. We compute aggregate welfare (defined below) for this economy and compare it to aggregate welfare for the economy described in Section 5.

Much of the analysis set forth above will remain valid in this section; without loss of generality, we continue to set $d = 0$. To begin with, the value functions for workers of different types are given by

$$J_y = -s + \alpha \left[(1-\tau)w_y + (1-b)\beta J_o^e + b\beta J_o^s\right] + (1-\alpha)\beta J_o^u$$

$$J_o^u = -s + \alpha(1-\tau)w_o^u, \qquad J_o^e = \left[(1-\tau)w_o^e + (1-\tau)\delta B_o\right],$$

and, under the conjectured equilibrium that displaced workers do not search,

$$J_o^s = (1-\tau)B_o$$

where τ is the common tax rate on wage and benefit income. In addition, in the steady-state we observe:

$$\Pi_v = -a + \theta\tilde{u}_y \left\{[1-h-(1+\tau)w_y] + (1-b)\beta\Pi_f + b\beta\Pi_v\right\} + \theta\tilde{u}_o \left\{[1-h-(1+\tau)w_o^u] + \beta\Pi_v\right\} + (1-\theta)\beta\Pi_v$$
$$\Pi_f = 1-(1+\tau)w_o^e + \beta\Pi_v$$

It is easily verified that

$$\Pi_v = \frac{-a + \theta\tilde{u}_y\left[1-h-(1+\tau)w_y\right] + \theta\tilde{u}_y(1-b)\beta\left[1-(1+\tau)w_o^e\right] + \theta\tilde{u}_o\left[1-h-(1+\tau)w_o^u\right]}{\left[1-\theta\tilde{u}_y(1-b)\beta^2 - \theta\tilde{u}_y(1-b)b\beta^2 - \theta\tilde{u}_o\beta - (1-\theta)\beta\right]}$$

Using the process of wage determination analogous to the one described in Section 3 above, it can be shown that

$$w_o^u = \frac{(1-h)}{2}; \qquad w_o^e = \frac{1+(1-\delta)\,(1-\tau)\,B_o}{2} \tag{27}$$

$$2w_y = [(1-h) + (1-b)\beta \{1 - (1+\tau)w_o^e\}] \tag{28}$$
$$- [\beta b(1-\tau)B_o + (1-b)\beta \{(1-\tau)w_o^e + \delta(1-\tau)B_o\} - \alpha(1-\tau)w_o^u]$$

Utilizing the wage functions described above, along with $\Pi_v = 0$, we have the same equilibrium entry condition as in (23) given by

$$\frac{a}{\theta}\left(\frac{1}{\tilde{u}_y}\right) = [1 - h - (1+\tau)w_y] + (1-b)\beta [1 - (1+\tau)w_o^e] + \left(\frac{\tilde{u}_o}{\tilde{u}_y}\right)[1 - h - (1+\tau)w_o^u] \tag{29}$$

What remains for us to describe is the government budget constraint. The payroll taxes paid by firms are given by

$$F_v\theta\tilde{u}_o\tau w_o^u + F_v\theta\tilde{u}_y\tau w_y + F_f\tau w_o^e$$

since some job vacancies will be filled by the long-term unemployed and others by the young. In addition, some taxes will be paid by firms with retained workers from prior established employment relationships. In contrast, taxes paid out by all the workers are given by

$$\frac{\alpha\tau w_y}{2} + \frac{\alpha(1-b)\tau\,(w_o^e + \delta B_o)}{2} + \alpha u_o\tau w_o^u + \frac{\alpha b}{2}\tau B_o$$

The expenditure by the government on workers is given by

$$\frac{\alpha(1-b)}{2}\delta B_o + \frac{\alpha b}{2}B_o$$

We assume that the government balances its budget. It is also easy to verify that the

$$F_f = \frac{\alpha(1-b)}{2}; \qquad F_v = \frac{\alpha(1-b)\,(2-\alpha)}{\theta\,[2(1-b) + \alpha(1-\alpha)]}; \qquad \mathcal{F} = \frac{\frac{\alpha(1-b)}{2}}{\theta\left[1 - \frac{b}{2-\alpha} - \frac{1-\alpha}{2}\right]} + \frac{\alpha(1-b)}{2}$$

For completeness sake, we define an equilibrium below.

DEFINITION *A steady-state equilibrium with no labor market participation by displaced workers and internally funded pensions consists of wage functions* w_o^u, w_o^e, and w_y [*defined in* 27), and (28)], *and a quadruple* (α, θ, U, F_v) *satisfying the following conditions: (i) Symmetric Nash bargaining; (ii) (Unrestricted Entry for firms):* $\Pi_v = 0$*; (iii) (Steady-State):* $\alpha U = \theta F_v = \mu\mathcal{M}(U, F_v)$*, (iv) the labor market participation constraints hold:* $J_o^u > 0, J_y > \beta J_o^u$, and $J_o^e > (1-\tau)B_o$ *and the discouraged worker constraint holds*[27]*, and v) the government's budget is balanced.*

[27] In this case, the discouraged worker constraint requires

$$(1-\tau)B_o > -s + \alpha\,[w^s(1-\tau) + \delta\,(1-\tau)\,B_o] + (1-\alpha)(1-\tau)B_o \tag{30}$$

where

$$w^s = \frac{1 - h + (1-\delta)\,(1-\tau)\,B_o}{2}$$

We choose a population-based average of expected lifetime utility of each group of workers as our welfare criterion. In particular, we adopt the following measure of social welfare as our welfare criterion:[28]

$$W \equiv W(B_0, \delta) = \frac{1}{2}J_y + \frac{1}{2}\alpha\beta(1-d)(1-b)J_o^e + \frac{1}{2}\alpha\beta b(1-d)J_o^s + \frac{1}{2}\beta(1-\alpha)(1-d)J_o^u$$

The task ahead is to compare aggregate welfare in the presence and absence of policy. In the presence of (internally-funded) policy, the old and separated stay out of the labor market. In the absence of such policy intervention, every worker participates in the labor market but there are no pension payments or taxes. The question for us is: is aggregate welfare higher when no pension programs are present and all workers remain active in the labor force?

As is readily apparent, a number of non-linearities enter the model with the introduction of the government budget constraint especially when benefits are funded by distortionary taxes. Therefore, we use numerical computations to illustrate our reasoning.

Example 3 *Let* $s = 0.15$, $a = 0.2$, $\mu = 0.4$, $h = 0.25$, $d = 0$, $\phi = 0.5$, $B_0 = 0$, $\beta = 0.9$, *and* $b = 0.2$. *Under this parametric specification, pension programs are not present, and it can be checked that all workers stay active in the labor market. The aggregate welfare in this case is* 0.2095. *Now consider an otherwise identical parametric specification except that* B_0 *is allowed to go from* 0.25 *to* 0.4 *and* $\delta = 0.8$. *By the government budget constraint, it follows that* τ *varies from* 0.108781 *to* 0.17043. *For this specification, it can be verified that all the conditions defined in the definition of equilibrium in this section are satisfied. As illustrated in Figure 1, aggregate welfare under induced retirement is higher than when there are no public pension benefits and retirement does not occur. Importantly, wages to the young are lower under policy than in the absence of pension programs.*

Note that policy-induced retirement occurs as long as pension benefits are sufficiently generous and the implicit tax on elderly work is sufficiently high ($\delta = 0.8 < 1$). Once pension benefits are equal to 0.25, induced retirement occurs. In particular, we observe that publicly induced retirement generates higher welfare since the vertical intercept in Figure 1 is equal to 0.24724. As mentioned in the above example, welfare in the absence of pension programs is 0.2095.

Having established the desirability of publicly induced retirement based on welfare grounds, we now turn to studying the interactions between pension benefits and other labor market conditions such as population aging in an economy with induced retirement. In order to focus on explicit analytical results, we choose to initially demonstrate our results in a partial equilibrium setting where pension benefits are externally funded. However, as will be apparent in Section 8 below, the insights derived here are robust to settings where a government balances pension benefits with required tax revenues.

[28] See Davidson et. al. (1994) for a similar welfare criterion.

7 Partial equilibrium analysis

7.1 Increasing generosity of benefits

As discussed in Mulligan and Sala-i-Martin (2003), many OECD countries have munificent pension programs that induce the jobless elderly to retire and make way for the young. In this section, we establish the effects of varying the generosity of pension programs within an induced retirement equilibrium. Assuming that an equilibrium exists, we are able to analytically derive the effects of pension benefits on employment and the age-composition of the labor force. We begin by reporting the results of some comparative static exercises conducted with respect to B_0. It bears emphasis here that all the upcoming results assume away any issues relating to funding of B_0 and are hence to be understood as being "partial equilibrium" in nature. As Section 8 will demonstrate, these insights are robust to settings in which pension benefits are funded endogenously by payroll taxes. The principal benefit of the "partial equilibrium" perspective is that it allows us to derive a number of interesting clean results analytically.

Proposition 3 *Under Assumption 1, an increase in B_0 raises the probability of finding employment. In particular, we have:*

$$\frac{\partial \alpha}{\partial B_0} = \frac{2\beta \left[1 - (1-b)(1-\delta)\right]}{\left[(1-h)(2+\beta) - 4a\right]} > 0. \tag{31}$$

Holding α fixed, an increase in B_0 reduces the wages of the young and at the same time raises the wages of old workers with jobs. This raises the benefit from firm entry, and more firm entry makes it easier for any given worker to find a vacancy thereby raising the employment rate. Therefore, we refer to this transmission channel of pension programs as the "vacancy creation effect." On the face of it, Proposition 3 is a formal statement of the type of argument governments use to defend generous pension programs ostensibly intended to free up jobs for the young.

An immediate consequence of Proposition 3 is the following corollary.

Corollary 1 *An increase in B_0 changes the age-composition of the labor force via*

$$\frac{\partial \tilde{u}_y}{\partial B_0} = -\frac{1}{(\tilde{u}_y)^2}(1-d)\left(-\frac{\partial \alpha}{\partial B_0}\right) > 0$$

$$\frac{\partial \tilde{u}_o}{\partial B_0} = -\frac{1}{\left[1 + \frac{1}{(1-\alpha)(1-d)}\right]^2}\left(\frac{1}{(1-d)}\right)\frac{-1}{(1-\alpha)^2}(-)\frac{\partial \alpha}{\partial B_0} < 0$$

As established by Proposition 3, higher pension benefits increase the probability that any worker is able to obtain employment. In particular, since there will be less workers who are unable to find jobs when young, the pool of the long-term unemployed will be lower. Consequently, more generous pension benefits raise the probability with which firms are likely to encounter a young worker. As we describe below, from examining (8), (9), and (12), this "vacancy creation effect" has implications for age-earnings profiles in the economy:

Proposition 4 *An increase in B_0 raises the wages to the old and employed and has no effect on the wages of the never-before-employed. The effect on young wages is ambiguous.*

The effect on w_y can be seen from the expression for w_y, reproduced here for convenience:

$$2w_y = (1-h)\left(1 + \frac{\alpha\beta\,(1-d)}{2}\right) - (1-d)\,\beta\,(B_0 + s)$$

On the one hand, a higher B_0 raises α which serves to raise w_y [the "vacancy creation effect" i.e., workers can find jobs more easily and hence their "price" must go up], but on the other hand, a higher B_0 serves to reduces w_y [this is the "bargaining power redistribution effect" that was discussed in Section 3]. The net impact is ambiguous and depends on the relative strength of the two aforementioned effects. In particular, the vacancy creation effect somewhat compromises the income redistributive goal of social security.

Under the linear matching technology, the effect of an additional vacancy on the probability of finding of a job can be substantial. This may even cause the wages of the young to rise with benefits. Numerical computations confirm that with a small degree of non-linearity ($\phi < 1$) in the matching function, the "vacancy creation effect" (an indirect influence) is muted and dominated by the direct "bargaining power redistribution effect". Intuitively, the bargaining power redistribution effect will dominate the vacancy creation effect as long as firms also encounter congestion problems in the labor market, i.e., there is some degree of diminishing returns to the addition of another vacancy.[29]

Example 4 *Consider the parametric specification of Example 2. Using this configuration, it is apparent from Figure 2 that raising the level of benefits reduces the wages to the young and raises the wages to the old and eligible, thereby accomplishing cross-cohort income redistribution.*

This, in some sense, is a major punchline of the paper. In the model, pension programs raise the incomes of the old with jobs and tend to reduce the incomes of the young, thereby engineering an intergenerational income distribution towards the elderly. The novelty of our paper lies in the fact that we can demonstrate the presence of such intergenerational income distribution in the complete absence of any equity or political economy concerns.

The effects of increasing benefits on variables such as the probability of employment, age-composition of the labor force etc. are fairly similar to the results established analytically using a linear matching technology. As is evident from Figures 3.1 and 3.2, higher benefits raise the employment probability and reduce the chance that a firm will find a worker.

[29] See Bhattacharya, Mulligan, and Reed (2003) for further discussion.

The next section studies the effects of population aging and the design of pension programs for the labor market.

7.2 Aging

The populations of many developed countries around the world have increasingly become older over the past century. In the United States, for example, while 4% of the population was aged sixty-five years or older in 1900, this number rose to 12.5% in 1994, and is projected to spiral up to 20% by 2050. At the same time, the age composition of the labor force is also changing in a dramatic fashion. The median age of the workforce in the United States is expected to cross 40 by 2005 compared to 34.7 in 1979. Our structure allows us to study, albeit in a very stylized fashion, the general equilibrium effects of aging. Recall if d *falls*, then the increased longevity leads to a steady-state with population aging. Our first result studies the effect of increased longevity on the employment rate.

Proposition 5 *Given a level of pension benefits, B_0, aging (a lower value of d) reduces α thereby increasing the unemployment rate.*

The proof of this result follows straightforwardly from partially differentiating (24) with respect to d, and is hence omitted. In our economy, unemployment is an equilibrium phenomenon. If workers tend to live longer, then the population size of the long-term unemployed will increase. Consequently, the total size of the pool of workers actively engaged in job search will be higher and each worker will be less likely to find employment. This result again highlights the inter-generational conflicts which occur in our framework.

Interestingly, with increased "greying" of their populations, many countries are shifting their attention to the unemployment problems of the elderly at the cost of reduced focus on youth unemployment. The proposition makes the interesting point that, with aging, perhaps the concerns about youth unemployment are even more valid. That is, the problem of youth unemployment may actually be exacerbated by population aging since older workers will be further crowding out young workers in the labor market. In fact, it is easy to verify that $\frac{\partial \tilde{u}_o}{\partial d} < 0$ and $\frac{\partial \tilde{u}_y}{\partial d} > 0$ after taking into account the effect of d on α. The implication is that aging increases (reduces) the likelihood of firms getting matched with an old (young) worker. The next result concerns the effect of aging on young workers' wages.

Proposition 6 *Given a level of pension benefits, B_0, aging reduces wages to the young.*

The value of current employment to a young worker depends not only on the current level of wages, but also on the anticipated continuation benefits derived from work if the worker survives till old age. A fall in d raises this likelihood of survival and hence increases the expected future benefits, not only from employment, but also from job displacement. As explained in Section 3, the firm extracts part of this surplus that it creates for the young worker; his wage is now lower. In addition, there is also the general equilibrium effect of population aging through the probability of finding a job – in an economy with a lower d, there will be more workers engaged in job search which further lowers wages of the young. It follows that aging also lowers the expected utility of the long-term unemployed. It has no effect on those who retain their jobs or those who retire. In a sense, aging itself engineers an income redistribution from the young to the old with jobs, one that is totally independent of and complementary to, the income redistributive effect of pension programs discussed earlier.

7.3 The earnings penalty

Governments use a variety of "stick and carrot" measures to dissuade the jobless elderly from seeking work. High implicit taxes and stringent earnings penalties on income earned beyond a certain age act as sticks and are commonly utilized.[30] In our setup, it is fairly straightforward to demonstrate that a stiffer earnings test (fall in δ), given a level of pension benefits, reduces the probability of employment. In other words, if maximizing employment is a goal of the government, then removal of the earnings test is a movement in the right direction. It can also be verified that the earnings test has no effect on wages of the long-term unemployed while it raises wages of the old who have retained their jobs. The intuition is clear. Earnings penalties reduce the value of working when old thereby making it more attractive to withdraw from the labor market and collect their full benefits. Consequently, firms must compensate by offering higher wages. In addition, it can be shown that old workers obtain higher *total* incomes when the earnings penalty is less severe. For a given α, this lowers the value of employment for young workers causing w_y to increase.

Proposition 7 *(a) Given a level of pension benefits, B_0, reducing the earnings penalty (an increase in δ) raises the employment probability. (b) Given a level of pension benefits, B_0, reducing the earnings penalty (an increase in δ) raises the wages of the young and reduces the wages of the old with jobs.*

The proof of Proposition 7 follows straightforwardly from differentiating (24) with respect to δ, and using (12). The result highlights an interesting tension: on the one hand, by Lemma 3 a stiff earnings penalty is a necessary condition for publicly induced retirement to make room for the young. On the other hand, from part (b) of Proposition 7, it is evident that increasing the stiffness of the earnings penalty (reducing δ) interferes with the redistributive goals of public pension programs.

We conclude the section by presenting a result on the interaction between the generosity of pension benefits and stiffness of earnings penalties. The result serves to show how the interaction between the two instruments is quite like that between "the carrot and the stick".

[30] Gruber and Wise (1999) report for the early 1990's, the "typical" implicit tax rate for "someone of retirement age" ranged from roughly 20% for Japan, U.S., and Canada, to more than 80% for Belgium and the Netherlands.

Proposition 8 *Suppose the government raises the level of pension benefits infinitesimally. If the probability of employment is held fixed, then the stiffness of the earnings penalty must also rise.*

Proposition 8 describes a downward sloping iso-α curve on the (B_0, δ) space. It captures the essence of the interaction of the two instruments as being complementary to each other. If the level of benefits is raised, and α is held fixed, then wages to young workers fall while wages to the old and eligible rise. This makes it more attractive for the displaced workers to want to search. In a induced retirement equilibrium, therefore, the earnings penalty must rise to keep them away from the labor market.

We now proceed to study the aggregate welfare consequences of changing the generosity of the pension benefits or the strength of the earnings penalty.

7.4 Welfare

As discussed earlier, we adopt the following measure of social welfare as our welfare criterion:

$$W \equiv W\left(B_0; \delta\right) = \frac{1}{2} J_y + \frac{1}{2}\alpha\beta\left(1-d\right)\left(1-b\right) J_o^e + \frac{1}{2}\alpha\beta b\left(1-d\right) J_o^s + \frac{1}{2}\beta(1-\alpha)\left(1-d\right) J_o^u \tag{32}$$

It is easy to verify that W may be written as

$$\begin{aligned} 2W\left(B_o; \delta\right) &= -s - 2\left(1-d\right)s + 2\alpha\left(1-d\right)s + \alpha w_y + 2\alpha\left(1-d\right)\left(1-b\right) w_o^e \\ &+ 2\alpha\left(1-d\right)\left(1-b\right)\delta B_o + 2\alpha b\left(1-d\right)B_o + 2\left(1-d\right)\alpha w_o^u - 2\alpha^2\left(1-d\right) w_o^u \end{aligned}$$

Our next proposition writes down a simple sufficient condition on parameters that ensures that more generous pension benefits, as long as they successfully induce the separated to withdraw, cause aggregate welfare to go up.

Proposition 9 *Suppose that the conditions in Proposition 1 are satisfied and additionally*

$$\frac{3\left(1-h\right)}{4a} > \max\left\{\frac{\left[2\delta\left(1-b\right) + 3\left(1-2b\right)\right]}{\left[\left(1+b\right) + \left(1-b\right)\delta\right]}, 0\right\} \tag{33}$$

holds. Then, $W_{B_o}\left(B_o; \delta\right) > 0$.

It bears emphasis here that Proposition 9 does not say anything about the optimal design of public pension programs. All that it shows is that for a fixed earnings test and a pattern of labor force participation induced by a public pension program, increasing the generosity of benefits can be welfare-enhancing.

As motivated in Section (3), holding α fixed, an increase in pension benefits leads to a large income redistribution from the young to the old. In equilibrium, there are additional effects arising from the impact of pension benefits on the incentives of firms to create more vacancies. This may raise the probability of employment for the jobless. In turn, young workers can negotiate higher wages since the outside option of searching again when old has higher value. Therefore, an increase in pension benefits raises welfare here because all workers are more likely to be employed and with higher wages (except, of course, the long-term unemployed). Nevertheless, we find that the total expected income of the old who receive benefits increases more than the average earnings of the young. This welfare result is corroborated by Figure 4 which shows the positive welfare effects of higher pension benefits using the parameters from Example 2.

We conclude this section by investigating the impact of the earnings test on welfare in the economy. As observed above, a lower earnings test further achieves the redistributive goals of social security because it provides old individuals with even more income.

Proposition 10 *Suppose an induced retirement equilibrium exists with $\alpha < \frac{1}{4}$. Then, given a level of pension benefits, B_0, an increase in the earnings penalty (fall in δ) reduces welfare (W).*

The above result express an interesting quandary: on the one hand, by Lemma 3 a stiff earnings penalty is a necessary condition for publicly induced retirement to make room for the young. On the other hand, it lowers old workers' total incomes. Our findings imply that the earnings penalty should be set high enough to generate retirement by the eligible jobless elderly, but not any further due to the lost income of the old.

In summary of our results so far, we have established a number of important insights. First, public pension programs exhibit a number of redistributive features. Notably, they can engineer income redistribution from the young to the old via explicit transfer payments or through firms in the form of higher wages since many social security programs have significant implicit taxes on elderly work. Second, we have established a positive theory of public pensions since we have shown that retirement induced by the structure of the public pension program can lead to higher welfare than when public pensions are not available. Importantly, we have shown this occurs when pension benefits are funded by payroll taxes imposed equally on both firms and workers. In addition, the effects of social security interact with population demographics in the labor market. Finally, as established by Proposition 10, it is important to carefully design pension programs to balance their income redistributive goals with the requirements to encourage retirement. In the next section, we turn to some additional issues regarding the design of public pension programs along with an explicit government budget constraint.

8 General Equilibrium Effects of Public Pension Design

In this section, we examine various features of social security programs in a setting where benefits are funded by payroll taxes, as in Section 6. We conduct numerical experiments aimed at providing *qualitative* general equilibrium insights into the effects of various labor market policies. Since we are using numerical techniques, we choose to study an economy with a) a non-linear matching technology, and b) a larger class of pension policies: benefits are no longer fixed and instead they depend on prior contributions (earnings). In particular, we assume that pension benefits are equal to a fixed fraction η of young wages. In this manner, η serves as our proxy for the replacement rate. We fix the values of the following parameters to: $\beta = 0.9$, $s = 0.1$, $a = 0.2$, $\mu = 0.4, \phi = 0.5$, $b = 0.3$, and $h = 0.3$.[31] Starting from this benchmark set of parameters, we vary the replacement rate and the earnings penalty to gain some insight into the effect of each factor on aggregate labor market outcomes.

We begin by considering a case where there is a very high tax on elderly work – in this setting, public pension programs mimic long-term unemployment insurance for older workers. Setting $\delta = 0.1$, we find that our conjectured induced retirement equilibrium exists starting with replacement rates equal to 81%. That is, for replacement rates equal to and higher than 81%, all displaced workers choose to withdraw from the labor market rather than incur the costs of job search and participate. Although higher pension benefits are associated with higher tax rates, all other variables appear to behave qualitatively the same as when pensions are externally funded. Importantly, under higher replacement rates, the young earn less and older workers obtain higher incomes. Consequently, there is an increase in vacancies and a lower unemployment rate.

As Figure 5 demonstrates, for a given earnings restriction (for example, $\delta = 0.1$), policy-induced retirement can improve aggregate labor market welfare. By effectively allowing young workers to purchase jobs from old individuals, public pension programs can improve the allocation of workers to jobs since young workers will have a higher chance of finding long-term employment. As in many search models of the labor market, workers here impose a congestion externality on the unemployed – for a fixed number of vacancies, an increase in the number of workers renders it less likely that a given worker will find a job. Furthermore, due to the possibility for the accumulation of firm-specific human capital in our setup, allowing young workers to have a greater chance of finding employment improves the allocation of workers to jobs in the economy.

Interestingly, since cross-cohort redistribution is achieved, more generous pensions are associated with higher welfare despite any change in the labor market participation decisions of old workers. As mentioned above, induced retirement occurs when the replacement rate is sufficiently high. Thus, there is a discontinuity in the welfare function when the induced retirement equilibrium is observed. This

[31] To reiterate, ours is *not* intended to be a fully-developed calibration exercise. While it would no doubt be interesting to extend our framework to many-period OG models, this is not our focus here. The two period model allows us to easily trace an old worker's current employment status to his previous job history. It therefore provides a relatively tractable structure to analytically demonstrate some important interactions between the design of public pension programs and age-earnings profiles in the economy. The numerical exercises illustrate the general equilibrium effects of such policies. The two period framework provides a simple departure from standard infinite-horizon models of the labor market. Thus, our parameter choices are not guided by the dictums of proper calibration; there is little available knowledge on these parameters over a 25-30 year horizon, the real life length equivalent of a two-period OG model.

takes place solely because of the change in the labor market participation decisions of displaced workers – since there is a better alignment of workers to jobs in the labor market, the economy earns higher welfare.

However, are there other combinations of η and δ that achieve higher aggregate welfare? The second experiment focuses on the effects of higher replacement rates when the earnings restriction is much less severe – that is, for brevity, we consider the case of a zero earnings penalty. Thus, this corresponds to a setting in which there is no earnings test. In many ways, the results are qualitatively similar to the analysis in the first experiment. However, as alluded to in Lemma 3, induced retirement does not occur. In contrast to economies in which there is a tax on work ($\delta < 1$), wages of older workers are unaffected by the provision of pension benefits. However, cross-cohort distribution still occurs since public pensions raise the value of employment for the young causing w_y to fall. Thus, redistribution through firms in the form of higher wages no longer occurs. Since we assume that workers do not extract all of the benefits from matching (symmetric Nash bargaining), the total incomes of older individuals are higher for a given replacement rate when there are no taxes on elderly work.

As illustrated in Figures 6.1 and 6.2, we find the following: (i) for a given earnings test (δ fixed), increasing the generosity of public pension programs improves aggregate welfare, and (ii) reducing the severity of the earnings test may also be welfare-enhancing. Completely eliminating the earnings test improves the redistribution of income over the lifecycle. Furthermore, at higher replacement rates, the drop in the payroll costs of young workers outweigh the higher costs of employing old workers so that there is more employment as a result of the redistribution.

Thus, for a given earnings test, policy-induced retirement will improve labor market welfare. This occurs for two reasons: (i) allocating a higher proportion of jobs towards young workers leads to a more efficient allocation in the labor market due to the accumulation of firm-specific human capital and (ii) public pension programs play a role in terms of redistribution of bargaining power and income across the lifecycle. However, in contrast to policy-induced retirement, completely eliminating work disincentives in pension programs leads to the following: (i) better income redistribution, (ii) more labor market participation, and potentially (iii) more vacancy creation due to the effect of the pension programs on age-earnings profiles in the economy. Therefore, we illustrate that recent policy reforms aimed at reducing work disincentives towards the elderly allow the redistributive role of social security to function more effectively and that the welfare effects of promoting *total* employment may be more important than improving the *quality* of employment (by encouraging the elderly to "free up" jobs for the young).

9 Conclusion

Most countries have large public pension programs. Traditionally, these programs have been used to induce retirement by the elderly in order to free up jobs for the young and to redistribute income across generations. This paper provides an efficiency rationale for the inter-generational income redistribution focus of such programs in a framework which explicitly accounts for the role of the lifecycle in the labor market. It develops a model of the labor market characterized by search and matching frictions and embeds it into an overlapping generations framework. In our model, public pension programs alter the age composition of the labor force by inducing the jobless elderly to retire in exchange for pension benefits. By requiring a long history of labor market attachment in order to receive benefits, these programs raise the future value of current employment for the young. In turn, this raises the future value of current employment which serves to redistribute bargaining power, and hence income, from the young to the old. In addition, depending on the design of the pension program, we show that the redistribution can take place directly via the government (explicit transfer payments) or indirectly via firms in the form of higher wages. This substitutability of one form of redistribution for another is an important, yet neglected dimension in the debate about social security reform currently in progress in all OECD countries.

We believe that careful general equilibrium analysis of the underlying issues can shed important light and offer some guidance to policymakers. In this regard, we have ventured to study the efficiency and desirability of publicly-funded pension programs within the context of a dynamic general equilibrium model. In order to consider how age-targeted labor market policies such as social security should be designed in light of the ongoing trend towards an increasingly older population, we adopted the OG setup because it allows a natural and explicit separation of the workforce into young and old workers. The framework captures an important inter-generational conflict between the young and old since, in the model, these groups concurrently compete for the same jobs; additionally, the bargaining power of the two during wage negotiations are different due to their different positions on the lifecycle. Moreover, the OG structure is naturally conducive to studying pension programs that tie in with the lifecycle and other "low frequency" aspects of the labor market, such as, long job tenure, and the accumulation of firm-specific human capital.

We used the search framework in the labor market for three important reasons. First, it allows us to endogenize both the supply side (through labor market participation choices) and the demand side (via endogenous creation of vacancies) of the labor market, a clear departure from the "lump-of-labor" line of thought in which there is a fixed stock of job vacancies. Importantly, we see that the amount of job creation responds to the design of pension programs through their impact on age earnings profiles in the economy.

Second, the retirement literature suggests that social security programs are designed to reduce labor market congestion problems for the young. The diminished prospects for job search are also a prominent factor in the labor market participation decisions of older workers. In this regard, we argue that a model with undirected search is appropriate since it allows us to demonstrate how labor market congestion contributes to potential intergenerational conflicts in the labor market. If firms were perfectly able to discriminate on the basis of age, this would imply that there are not any intergenerational congestion difficulties between workers and therefore, there would be little role for policy-induced retirement.

Finally, the decentralized notion of wage bargaining used in our framework allows us to study the effects of public pension programs on wage determination at each stage of the lifecycle. This is especially important given the fact that most real-world pension benefits are generally related in some way to the number of years worked and tend to increase with lifetime earnings. In this context, an important new effect that we identify is the role of social security in redistributing bargaining power over the lifecycle. In our setup, younger workers have the option of waiting while older (equally productive) workers do not. This bargaining-power inequity translates into high wages for the young, escalating labor costs (since young workers constitute the largest pool of the unemployed from which firms will have to find workers), and reduces firm entry. Positive replacement rates, raise the lifetime value of working when young and thereby reduces this inefficiency. Our work therefore offers a positive explanation for the prevalence of social security programs around the world.

Appendix

A Proof of Lemma 1

In a steady state, contribution to the unemployed pool come from two sources, young workers (measure 0.5) and never-before-employed workers, of measure $\frac{(1-\alpha)(1-d)}{2}$. Then, it follows that

$$U = \frac{(1-\alpha)(1-d)}{2} + \frac{1}{2} = \frac{1 + (1-\alpha)(1-d)}{2}$$

$$\tilde{u}_y \equiv \frac{u_y}{U} = \frac{1}{1 + (1-\alpha)(1-d)}$$

$$\tilde{u}_o \equiv \frac{u_o}{U} = \frac{(1-\alpha)(1-d)}{1 + (1-\alpha)(1-d)}$$

B Proof of Lemma 2

a) Using (10), we can compute the gains from trade for the firm from hiring a young worker as:

$$1-h-w_y+(1-d)\,b\beta\Pi_v+(1-b)\,(1-d)\,\beta\Pi_f+d\beta\Pi_v-\beta\Pi_v = 1-h-w_y+(1-b)\,(1-d)\,\beta\Pi_f+[(1-d)\,b+d-1]\,\beta\Pi_v$$

which using (5) and rearrangement yields

$$= (1-h-w_y) + (1-b)\,(1-d)\,\beta\,(1-w_o^e)$$

Using (11), and (1)-(3), the young worker's surplus from finding employment is given by:

$$\begin{aligned} & w_y + b\,(1-d)\,\beta J_o^s + (1-b)\,(1-d)\,\beta J_o^e - \beta\,(1-d)\,J_o^u \\ = \; & w_y + b\,(1-d)\,\beta B_o + (1-b)\,(1-d)\,\beta w_o^e + (1-b)\,(1-d)\,\beta\delta B_o + \beta\,(1-d)\,s - \beta\,(1-d)\,\alpha w_o^u \end{aligned}$$

and further to

$$= w_y + b\,(1-d)\,\beta B_o + (1-b)\,(1-d)\,\beta w_o^e + (1-b)\,(1-d)\,\beta\delta B_o + \beta\,(1-d)\,s - \frac{\beta\,(1-d)\,\alpha\,(1-h)}{2}$$

Then, equating the gains from trade, we get

$$2w_y = (1-h)+(1-b)\,(1-d)\,\beta\,(1-2w_o^e)-b\,(1-d)\,\beta B_o-(1-b)\,(1-d)\,\delta\beta B_o-\beta\,(1-d)\,s+\frac{\beta\,(1-d)\,\alpha\,(1-h)}{2}$$

which simplifies to

$$= (1-h) - (1-d)\,\beta B_0\,[(1-b)\,(1-\delta) + b + (1-b)\delta] - \beta\,(1-d)\,s + \frac{\beta\,(1-d)\,\alpha\,(1-h)}{2}$$

Notice that $[(1-b)\,(1-\delta) + b + (1-b)\delta] = 1$. Then, we have

$$2w_y = (1-h)\left(1 + \frac{\alpha\beta\,(1-d)}{2}\right) - (1-d)\,\beta\,(B_0 + s)\,.$$

b) obvious.

C Proof of Lemma 4

a) It is easily seen that, as long as the discouraged worker constraint holds, the young will choose to search as long as there are positive gains from entry within the period:

$$\alpha w_y(\alpha) > s$$

which reduces to

$$(1-h)(1-d)\alpha^2 + 2[(1-h) - (1-d)(B_0+s)]\alpha - 4s > 0.$$

Solving the above condition for a value of α in which it holds with equality provides us with a minimal value for α. Note that if $(1-h) > (1-d)(B_0+s)$, then we must use the positive root as the solution for α. Define α_L as the value of α which satisfies the condition (note, this is the same sufficient condition that was required for young wages to be positive). It is given by:

$$\alpha_L \equiv \frac{-[(1-h) - (1-d)\beta(B_0+s)] + \sqrt[2]{[(1-h) - (1-d)\beta(B_0+s)]^2 + 4\beta(1-h)(1-d)s}}{\beta(1-h)(1-d)}$$

which is always positive as long as there are some search costs to be incurred by workers.

b) We seek to find conditions where $\alpha_L > \frac{2s}{(1-h)}$. First, recall $b_1 \equiv [(1-h) - (1-d)(B_0+s)]$.Thus,

$$\alpha_L \equiv \frac{-b_1 + \sqrt[2]{b_1^2 + 4\beta(1-h)(1-d)s}}{\beta(1-d)(1-h)} > \frac{2s}{(1-h)}$$

reduces to

$$-b_1 + \sqrt[2]{b_1^2 + 4\beta(1-h)(1-d)s} > 2\beta(1-d)s$$

and further to

$$\sqrt[2]{b_1^2 + 4\beta(1-h)(1-d)s} > b_1 + 2\beta(1-d)s$$

Next, squaring both sides yields:

$$b_1^2 + 4\beta(1-h)(1-d)s > (b_1 + 2\beta(1-d)s)^2$$

which upon simplifying obtains:

$$0 > -2(1-d)\beta B_0 - \beta(1-d)s$$

which always holds.

D Proof of Proposition 1

a) Using (23), and setting $\theta = 1$, we get

$$\left(\frac{a}{\tilde{u}_y}\right) = (1-h-w_y) + (1-b)(1-d)\beta(1-w_o^e) + \left(\frac{\tilde{u}_o}{\tilde{u}_y}\right)(1-h-w_o^u)$$

We begin by substituting in the steady-state population conditions from Lemma 1. Then, we use (8), (9), and (12) to get

$$a[1+(1-\alpha)(1-d)] = (1-h-w_y) + \beta(1-b)(1-d)\left(1 - \frac{1+(1-\delta)B_o}{2}\right) + (1-\alpha)(1-d)\left(1-h-\frac{(1-h)}{2}\right).$$

Simplification yields

$$\begin{aligned} 2a+2a(1-\alpha)(1-d) &= (1-h)+(1-d)\beta B_0+(1-d)\beta s-\frac{(1-d)\beta\alpha(1-h)}{2} \\ &\quad +\beta(1-b)(1-d)-\beta(1-b)(1-d)(1-\delta)B_o+(1-\alpha)(1-d)(1-h) \end{aligned}$$

which further simplifies to

$$(1-\alpha)\left[2a-(1-h)\right]+\frac{\alpha\beta(1-h)}{2}=\frac{(1-h)}{(1-d)}+\beta s+\beta(1-b)+\beta B_0\left[1-(1-b)(1-\delta)\right]-\frac{2a}{(1-d)}$$

and finally to

$$\alpha=\frac{\frac{2(1-h)}{(1-d)}+2\beta s+2\beta(1-b)+2\beta B_0\left[1-(1-b)(1-\delta)\right]-\frac{4a}{(1-d)}-\left[4a-2(1-h)\right]}{\left[(1-h)(2+\beta)-4a\right]}$$

Notice that

$$\frac{2(1-h)}{(1-d)}-\frac{4a}{(1-d)}-\left[4a-2(1-h)\right]=2\left(\frac{1}{(1-d)}+1\right)\left[(1-h)-2a\right].$$

Then, it follows that

$$\alpha=2\left\{\frac{\beta s+\beta(1-b)+\beta B_0\left[1-(1-b)(1-\delta)\right]+\left(\frac{1}{(1-d)}+1\right)\left[(1-h)-2a\right]}{\left[(1-h)(2+\beta)-4a\right]}\right\}$$

E Proof of Proposition 3

Recall that firms enter until $\Pi_v=0$, or until the revenue from entry equals the upfront cost a. Also recall that firms take $\tilde{u}_y$ and $\tilde{u}_o$ as given, and that w_o^u does not depend on B_0. Then the revenue from entry R can be written as

$$R=\tilde{u}_y(1-h-w_y)+\tilde{u}_y(1-b)(1-d)\beta\left(1-w_o^e\right)+\tilde{u}_o\left(1-h-w_o^u\right)$$

Using (8), (9), and (12), we get

$$\begin{aligned} R &= \tilde{u}_y\left((1-h)-\frac{(1-h)}{2}\left(1+\frac{\alpha\beta(1-d)}{2}\right)+\frac{(1-d)\beta(B_0+s)}{2}\right) \\ &\quad +\tilde{u}_y(1-b)(1-d)\beta\left(1-\frac{1+(1-\delta)B_o}{2}\right)+\tilde{u}_o\left(1-h-w_o^u\right) \end{aligned}$$

which simplifies ultimately to

$$\begin{aligned} R &= \tilde{u}_y\left[\frac{(1-h)}{2}-\frac{(1-h)}{2}\frac{\alpha\beta(1-d)}{2}+\frac{(1-d)(B_0+s)}{2}\right] \\ &\quad +\frac{\tilde{u}_y(1-b)(1-d)\beta}{2}\left[1-(1-\delta)B_o\right]+\tilde{u}_o\left(1-h-w_o^u\right) \end{aligned}$$

It follows that

$$\begin{aligned} \frac{\partial R}{\partial B_o} &= \tilde{u}_y\frac{(1-d)}{2}-\frac{\tilde{u}_y(1-b)\beta(1-d)(1-\delta)}{2} \\ &= \frac{\tilde{u}_y(1-d)}{2}\left[1-(1-b)\beta(1-\delta)\right]>0 \end{aligned}$$

so, an increase in B_0 raises the benefit from entry but does not raise the cost. Hence, ceteris paribus, there will be more firm entry with higher B_0. The fact that more firm entry leads to a higher probability of employment follows immediately from differentiating (24) to get

$$\frac{\partial \alpha}{\partial B_0} > 0$$

F Proof of Proposition 6

Using (12), we can write

$$w_y = \frac{(1-h)}{2} + \frac{(1-h)\,\alpha\beta\,(1-d)}{4} - \frac{(1-d)\,\beta\,(B_0+s)}{2}$$

Then, straightforward differentiation yields

$$\frac{\partial w_y}{\partial d} = \frac{(1-h)}{4}\left[\frac{\partial \alpha}{\partial d}\beta\,(1-d) - \alpha\right] + \frac{\beta\,(B_0+s)}{2}$$

which using (9) yields

$$\frac{\partial w_y}{\partial d} = \frac{(1-h)}{4}\frac{\partial \alpha}{\partial d}\beta\,(1-d) - \frac{1}{2}\left[\alpha w_o^u - \beta\,(B_0+s)\right]$$

Recall that the displaced worker constraint implies

$$B_o > -s + \alpha w^s + (1-\alpha)B_o$$

which reduces to

$$\alpha B_o > -s + \frac{\alpha}{2}(1-h) + \frac{\alpha}{2}B_o$$

and further to [using (9)]

$$\frac{\alpha}{2}B_o - B_o > \alpha w_o^u - \beta s - \beta B_o$$

and finally to

$$0 > \frac{1}{2}B_o\left(\frac{\alpha}{2} - 1\right) > \frac{1}{2}\left[\alpha w_o^u - \beta\,(B_0+s)\right]$$

Using Proposition 5, it follows that $\frac{\partial w_y}{\partial d} > 0$.

G Proof of Proposition 8

Fix α at $\bar{\alpha}$. Then the question is: if B_o increases, how should δ change to keep α fixed at $\bar{\alpha}$? Rearranging (24), we can write

$$\beta B_0\left[1-(1-b)\,(1-\delta)\right] = \frac{\bar{\alpha}}{2\left[3\,(1-h)-4a\right]} - \left(\frac{1}{(1-d)}+1\right)\left[(1-h)-2a\right] - \beta s - \beta(1-b) \qquad \text{(h.1)}$$

The derivative of the r.h.s of (h.1) with respect to B_0 is clearly 0. The derivative of the l.h.s of (h.1) with respect to B_0 reduces to

$$\frac{d\delta}{dB_0} = \frac{-\left[1-(1-b)\,(1-\delta)\right]}{\beta B_0(1-b)} < 0$$

so the earnings penalty has to increase when generosity of benefits increases, so as to keep employment rate fixed.

H Proof of Proposition 9

For future use, note that

$$\frac{\partial w_y}{\partial B_o} = \frac{(1-h)}{2}\frac{\beta(1-d)}{2}\frac{\partial \alpha}{\partial B_0} - \frac{\beta(1-d)}{2}$$

$$\frac{\partial w_o^e}{\partial B_o} = (1-\delta)/2$$

Simple differentiation establishes

$$\begin{aligned} W_{B_o}(B_o;\delta) &= \alpha\left[\frac{\partial w_y}{\partial B_o} + 2(1-d)(1-b)\frac{\partial w_o^e}{\partial B_o} + 2(1-d)(1-b)\delta + 2b(1-d) - 2(1-d)w_o^u\frac{\partial \alpha}{\partial B_0}\right] \\ &\quad + \left[2W(B_o;\delta) + s + 2(1-d)s\right]\frac{\partial \alpha}{\partial B_0} \end{aligned}$$

which upon rearrangement simplifies to

$$\begin{aligned} W_{B_o}(B_o;\delta) &= \alpha\left[\frac{(1-h)}{2}\frac{(1-d)}{2}\frac{\partial \alpha}{\partial B_0} - \frac{(1-d)}{2} + (1-d)(1-b)(1+\delta) + 2b(1-d) - (1-d)(1-h)\frac{\partial \alpha}{\partial B_0}\right] \\ &\quad + \left[2W(B_o;\delta) + s + 2(1-d)s\right]\frac{\partial \alpha}{\partial B_0} \end{aligned}$$

Note that

$$2b(1-d) - \frac{(1-d)}{2} = (1-d)\left[2b - \frac{1}{2}\right] = -\frac{(1-d)(1-4b)}{2}.$$

Then it follows that

$$\begin{aligned} W_1(B_o;\delta) &= \alpha(1-d)\left[\frac{(1-h)}{2}\frac{1}{2}\frac{\partial \alpha}{\partial B_0} - \frac{(1-4b)}{2} + (1-b)(1+\delta) - (1-h)\frac{\partial \alpha}{\partial B_0}\right] \\ &\quad + \underbrace{\left[2W(B_o;\delta) + s + 2(1-d)s\right]\frac{\partial \alpha}{\partial B_0}}_{\equiv V>0} \end{aligned}$$

which simplifies to

$$W_1(B_o;\delta) = -\frac{\partial \alpha}{\partial B_0}\frac{3\alpha(1-d)(1-h)}{4} + \frac{\alpha(1-d)}{2}\left[2(1-b)(1+\delta) - (1-4b)\right] + V$$

Using (31), we can then write

$$W_1(B_o;\delta) = -\frac{2\left[1-(1-b)(1-\delta)\right]}{\left[3(1-h)-4a\right]}\frac{3\alpha(1-d)(1-h)}{4} + \frac{\alpha(1-d)}{2}\left[2(1-b)(1+\delta) - (1-4b)\right] + V$$

and finally,

$$W_1(B_o;\delta) = \frac{\alpha(1-d)}{2}\left\{\left[2(1-b)(1+\delta) - (1-4b)\right] - \frac{\left[1-(1-b)(1-\delta)\right]3(1-h)}{\left[3(1-h)-4a\right]}\right\} + V$$

Then, a sufficient condition for welfare to rise with B_0 is that

$$2(1-b)(1+\delta) - (1-4b) > \frac{\left[1-(1-b)(1-\delta)\right]3(1-h)}{\left[3(1-h)-4a\right]}$$

hold. This last inequality upon multiple rearrangements reduces to

$$\frac{3\left(1-h\right)}{4a}>\frac{\left[\left(1-4b\right)+2(1-b)\left(1+\delta\right)\right]}{\left[2(1-b)\left(1+\delta\right)-\left(1-4b\right)-1+\left(1-b\right)\left(1-\delta\right)\right]}$$

and finally to

$$\frac{3\left(1-h\right)}{4a}>\frac{\left[2\delta\left(1-b\right)+3\left(1-2b\right)\right]}{\left[\left(1+b\right)+\left(1-b\right)\delta\right]}$$

I Proof of Proposition 10

For the purposes of evaluating the effect of an increase in δ on welfare, the only relevant terms are

$$\alpha\left[2\left(1-d\right)s+w_y+2\left(1-d\right)\left(1-b\right)w_o^e+2\left(1-d\right)\left(1-b\right)\delta B_o+2b\left(1-d\right)B_o+2\left(1-d\right)w_o^u-2\alpha\left(1-d\right)w_o^u\right]$$

Then, differentiating with respect to δ yields

$$\begin{aligned}W'\left(\delta;B_o\right) &= \frac{\partial\alpha}{\partial\delta}\left[2W\left(\delta;B_o\right)+s+2\left(1-d\right)s\right]\\ &+\alpha\left[\frac{\partial w_y}{\partial\delta}+2\left(1-d\right)\left(1-b\right)\frac{\partial w_o^e}{\partial\delta}+2\left(1-d\right)\left(1-b\right)B_o-2\left(1-d\right)\frac{\left(1-h\right)}{2}\frac{\partial\alpha}{\partial\delta}\right]\end{aligned}$$

Using (8)-(9) and noting that

$$\frac{\partial w_y}{\partial\delta}=\frac{\left(1-h\right)\left(1-d\right)}{4}\frac{\partial\alpha}{\partial\delta},$$

we get

$$\begin{aligned}W'\left(\delta;B_o\right) &= \frac{\partial\alpha}{\partial\delta}\left[2W\left(\delta;B_o\right)+s+2\left(1-d\right)s\right]\\ &+\alpha\left[\frac{\left(1-h\right)\left(1-d\right)}{4}\frac{\partial\alpha}{\partial\delta}-\left(1-d\right)\left(1-b\right)B_o+2\left(1-d\right)\left(1-b\right)B_o-\left(1-d\right)\left(1-h\right)\frac{\partial\alpha}{\partial\delta}\right]\end{aligned}$$

Repeated simplification yields

$$W'\left(\delta;B_o\right)=\frac{\partial\alpha}{\partial\delta}\left[2W\left(\delta;B_o\right)+s+2\left(1-d\right)s-\frac{3}{4}\alpha\left(1-d\right)\left(1-h\right)\right]+\alpha\left(1-d\right)\left(1-b\right)B_o$$

and further

$$W'\left(\delta;B_o\right)=\alpha\frac{\partial\alpha}{\partial\delta}\left[\begin{array}{c}2\left(1-d\right)s+w_y+2\left(1-d\right)\left(1-b\right)w_o^e+2\left(1-d\right)\left(1-b\right)\delta B_o\\ +2b\left(1-d\right)B_o+2\left(1-d\right)w_o^u-2\alpha\left(1-d\right)w_o^u-\frac{3}{4}\left(1-d\right)\left(1-h\right)\end{array}\right]+\alpha\left(1-d\right)\left(1-b\right)B_o$$

and finally

$$\begin{aligned}W'\left(\delta;B_o\right) &= \underbrace{\alpha\frac{\partial\alpha}{\partial\delta}}_{>0}\left[\left(2s-\frac{3}{2}w_o^u\right)+\underbrace{\frac{w_y}{1-d}+2(1-b)w_o^e+2(1-b)\delta B_o+2bB_o+2w_o^u\left(1-\alpha\right)}_{>0}\right]\\ &+\underbrace{\alpha\left(1-d\right)\left(1-b\right)B_o}_{>0}.\end{aligned}$$

Suppose

$$2w_o^u\left(1-\alpha\right)>\frac{3}{2}w_o^u$$

then it follows that $1>4\alpha$ holds. The rest is immediate.

References

[1] Bhattacharya, J., C.B. Mulligan, and R.R. Reed. (2003), "Labor Market Search and Optimal Retirement Policy," forthcoming, *Economic Inquiry.*

[2] Black, D. (1987), "The Social Security System, the Provision of Human Capital, and the Structure of Compensation," *Journal of Labor Economics*, 5(2), 242-254.

[3] Burtless, G. and R. Moffit (1984), "The Effect of Social Security Benefits on the Labor Supply of the Aged," in H.J. Aaron and G. Burtless (eds.), *Retirement and Economic Behavior*, (The Brookings Instituttion, Washington,D.C.), 135-174.

[4] Chan, S. and A.H. Stevens (2002), "How Does Job Loss Affect the Timing of Retirement?" NBER Working Paper #8780.

[5] Coile, C., and J. Gruber (2000a), "Social Security and Retirement", NBER Working Paper #7830.

[6] ——— (2000b), "Social Security Incentives and Retirement," NBER Working Paper #7651.

[7] Davidson, C., L. Martin, and S. Matusz (1994), "Jobs and Chocolate: Samuelsonian Surpluses in Dynamic Models of Unemployment," *Review of Economic Studies,* 61*,* 173-192.

[8] Diamond, P. and J. Gruber (1999), "Social Security and Retirement in the U.S." in J. Gruber and D. Wise (eds), *Social Security and Retirement Around the World.* Chicago: University of Chicago Press for NBER, 1999.

[9] ______, and J.A. Hausman (1984), "The Retirement and Unemployment Behavior of Older Men," in H.J. Aaron and G. Burtless (eds.), *Retirement and Economic Behavior*, (The Brookings Instituttion, Washington, D.C.), 97-126.

[10] Gottschalk, P.M. and R. Moffitt (1999), "Changes in Job Instability and Insecurity Using Monthly Survey Data," *Journal of Labor Economics*, 17(4), S91-S126.

[11] Gruber, J. and D. Wise (1999), *Social Security and Retirement Around the World,* (Chicago: University of Chicago Press (for NBER)).

[12] Hurd, M.D. (1996), "The Effect of Labor Market Rigidities on the Labor Force Behavior of Older Workers," in Wise, D.A. (ed), *Advances in the Economics of Aging,* (Chicago: University of Chicago Press (for NBER)).

[13] Hutchens, R. (1986), "Delayed Payment Contracts and a Firm's Propensity to Hire Older Workers," *Journal of Labor Economics*, 4, 439-457.

[14] Jacobson, L.S., R.J. Lalonde, and D.G. Sullivan (1993), "Earnings Losses of Displaced Workers," *American Economic Review*, 83, 685-709.

[15] Mulligan, C.B., and X. Sala-i-Martin. (2003) "Social Security in Theory and Practice with Implications for Reform" mimeo, University of Chicago

[16] Organization for Economic Co-operation and Development. 1994. *The Transition from Work to Retirement.* Paris: OECD. Social Policy Studies No. 16.

[17] _____ (1995) The Labour Market and Older Workers. Paris: OECD. Social Policy Studies No. 17.

[18] _____ (1998) Workforce Aging: Consequences and Policy Responses, Working Paper AWP 4.1

[19] ______, "Is Job Security on the Increase in OECD Countries?" *OECD Employment Outlook 1997*, OECD, Paris, France, 1997.

[20] Oi, W. (1962), "Labor as a Quasi-Fixed Factor," *Journal of Political Economy*, 70, 538-555.

[21] O' Leary, C. J. and S. A. Wandner (2000), "Unemployment Compensation and Older Workers," mimeo, W.E. Upjohn Institute for Employment Research.

[22] Pissarides, C. (1976), "Job Search and Participation," *Economica*, 43, 333-49.

[23] ______ (1992), "Loss of Skill During Unemployment and the Persistence of Employment Shocks," *Quarterly Journal of Economics*, 107, 1371-1391.

[24] ______ (2000), *Equilibrium Unemployment Theory*, (Cambridge: MIT Press).

[25] Sala-i-Martin, X. (1996), "A Positive Theory of Social Security." *Journal of Economic Growth*, 2, 277-304.

[26] Shimer, R. (2001), "The Impact of Young Workers on the Aggregate Labor Market," *Quarterly Journal of Economics,* 116, 969-1007.

[27] *Social Security Retirement Test, Hearing Before the Subcommittee on Social Security of the Committee on Ways and Means of the House of Representatives.* Serial 102-28. May 23, 1991. Government Printing Office, 1991.

[28] Youth, older workers and social exclusion: Some aspects of the problem in G-7 countries. G7/1997/1. International Labour Office, Geneva. October 1997.

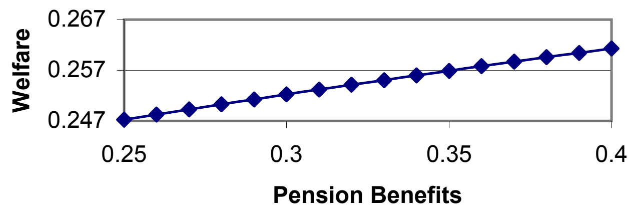

Figure 1: Welfare Effects of Publicly Induced Retirement

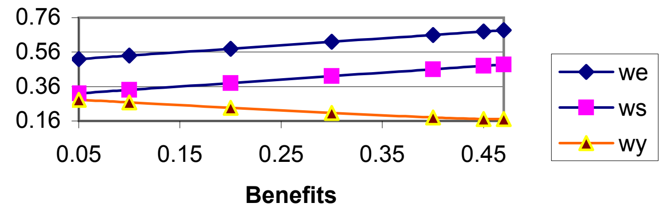

Figure 2: Effects of Higher Pension Benefits on Wages

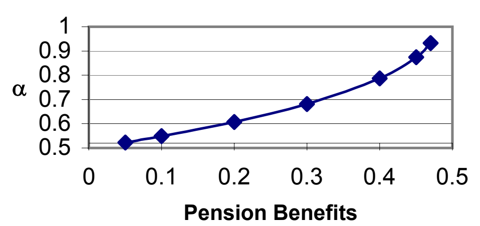

Figure 3.1: Effect of Higher Pension Benefits on Probability of Employment under Cobb Douglas Matching Technology

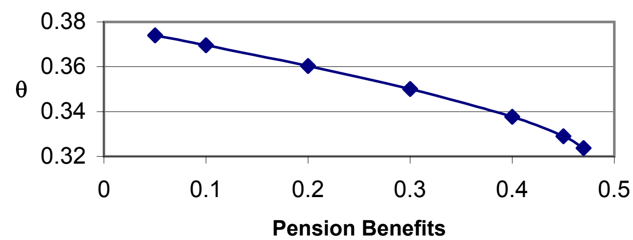

Figure 3.2: Effects of Higher Pension Benefits on Probability of Filling Job Vacancy Under Cobb Douglas Matching Technology

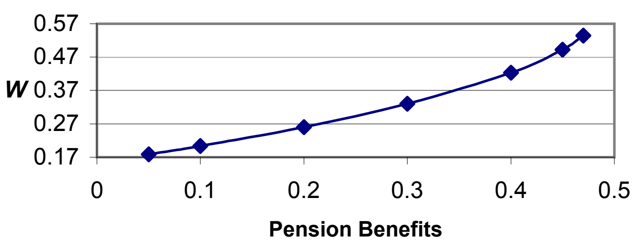

Figure 4: Effects of Higher Pension Benefits on Welfare under Cobb Douglas Matching Technology

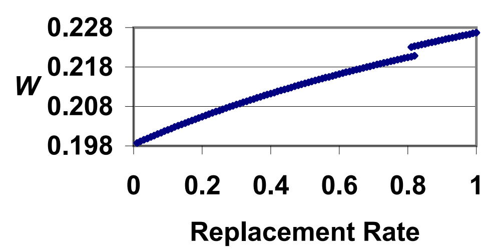

Figure 5: Aggregate Welfare (δ =.1)

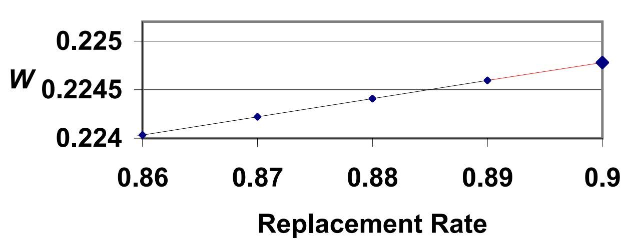

Figure 6.1: Aggregate Welfare (δ =.9)

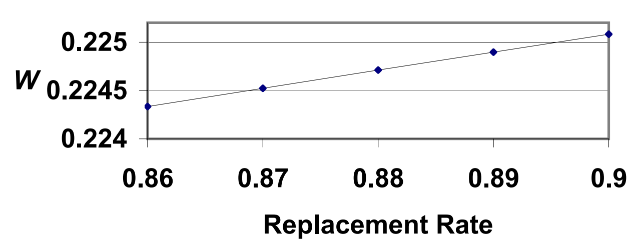

Figure 6.2: Aggregate Welfare (δ =1)