The Welfare Costs of Worker Displacement[*][†]

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Abstract

Recent work has documented the large persistent earnings losses associated with the displacement of high tenure workers. In this paper we assess the welfare costs of this risk, assuming that workers do not have access to insurance markets. We find that the cost is substantial, on the same order of magnitude of the cost associated with unemployment risk. We also argue that long duration unemployment insurance is likely to exacerbate this cost, and that government-financed severance payments are a far more effective way of dealing with the displacement risk.

Keywords: Worker Displacement, Welfare Costs, Incomplete Markets, Unemployment Insurance, Severance Payments

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1. Introduction

Recent empirical work has documented the nature and extent of earnings losses associated with the displacement of workers with long tenure.[1] These studies show that the affected workers experience very large and persistent decreases in their labor earnings. For example, Jacobson, LaLonde and Sullivan (1993) find that the earnings of displaced workers remain 25% lower than those of similar non-displaced workers even five years after displacement.

Apparently, the possibility of displacement exposes workers to a significant amount of earnings uncertainty, most of which is idiosyncratic in nature. In an incomplete markets setting this idiosyncratic earnings uncertainty may entail significant welfare losses relative to what would obtain with complete insurance markets. Although much recent work has documented the earnings losses experienced by displaced workers, there has been no attempt to assess the welfare cost associated with the uncertainty induced by the prospect of such losses in an environment with incomplete markets. The objective of this paper is to assess the magnitude of this welfare cost and analyze the extent to which various income maintenance programs may help to alleviate this cost.[2]

Our work parallels that of Hansen and Imrohoroğlu (1992). They carried out a similar analysis that focused on idiosyncratic earnings variability associated with unemployment spells in the US and analyzed the extent to which unemployment insurance programs can offset the welfare costs that result in an incomplete markets setting. Both analyses assume that individuals can accumulate assets to self insure, but cannot purchase insurance against idiosyncratic earnings shocks.

Several features distinguish our analysis from theirs. One key difference is the nature of the idiosyncratic earnings uncertainty. They assume that earnings are constant over time but that there is uncertainty as to whether a worker will have a job opportunity. In contrast, we assume that workers always have a job opportunity but there is uncertainty as to what the earnings will be. Since most unemployment spells are very short, the earnings variability that they analyzed is largely transitory. In contrast, the earnings losses associated with displacement are very persistent. This distinction is important, since a priori, one would expect that self-insurance may be more effective in dealing with transitory shocks than with persistent shocks.

A second difference is that we examine three policies that may partially compensate for the missing insurance markets–unemployment insurance, social security, and severance payments. Although offering long duration unemployment benefits may be effective in reducing the earnings variability associated with displacement, we argue that such policies have negative consequences for aggregate welfare because they effectively discourage labor supply–in order to collect benefits a worker must not work. Severance

[1] Examples include Jacobson, LaLonde and Sullivan (1993), Topel (1990), Farber (1993) and Stevens (1997).

[2] In complementary work, Hamermesh (1987) assesses the cost of the specific human capital destroyed by displacement, but abstracts from the costs associated with income variability.

payments, on the other hand, are a more effective device for dealing with the earnings variability induced by displacement, since they provide a cash transfer to the worker that is not contingent on the worker choosing not to work.

Third, because of the significance that life-cycle factors play in the context of displacement, we carry out our analysis in a life-cycle setting rather than an infinite lived agent setting. Lastly, Hansen and Imrohoroğlu's (1992) analysis focused exclusively on the case in which the real rate of return on assets is exogenous. In contrast, we also consider the case in which this rate of return is endogenously determined. Because the missing insurance markets lead individuals to accumulate assets to self-insure, this effect can be significant.

We find that the risk associated with mid-career displacement entails substantial welfare costs, on the order of one-half or one percent of output. These costs are likely to be as large as those associated with unemployment spells, and possibly much larger, even though the fraction of the population affected is much smaller. Our findings complement those in a recent paper by Davis and Willen (1999). They estimate the welfare gains that could be achieved by workers if additional financial assets were available in order to help them insure against labor income risks. They find sizeable gains could be achieved. However, since they consider synthetic individuals distinguished by age, sex and education, they do not focus on individual events such as worker displacement which are the focus of our study. Hence, both papers suggest that there are components of earnings uncertainty that entail large welfare losses relative to a complete markets setting.

Our work is also related to recent work on European unemployment. Ljungqvist and Sargent (1998) argue that a significant component of the rise in European unemployment can be accounted for by the fact that displaced workers in Europe can receive unemployment benefits for very long periods. While their analysis abstracted from risk aversion, and hence the potential benefits from improved risk-sharing, our analysis suggests that UI is a very costly way to provide insurance to these workers. Instead, we show that severance payments are a far more cost effective way to deal with this risk.

In the following section, we examine a simple model of worker displacement and examine its implications for the costs of displacement. We also complement our analysis by considering a richer displacement structure. In Section 3 we explore the implications of different policies to mitigate the welfare costs associated with worker displacement, including social security, unemployment insurance, and severance payments. In Section 4 we conclude.

2. A Simple Model of Displacement

2.1. Model

We study a general equilibrium overlapping-generations model. Each generation consists of a continuum of individuals who live for $T = 50$ periods. There is no population growth, and we normalize the size of the total population to one. In order to focus attention on the uncertainty directly associated with mid-career displacement, we abstract from many other sources of heterogeneity and uncertainty, such as uncertain lifetimes. Hence, we assume that everyone in the cohort enters the labor market at age 25, remains in the labor force until retirement at age 65, and dies at age 75. The length of a model period is one year. All agents have preferences given by:

$$\sum_{t=1}^{T} \beta^{t-1} u(c_t) = \sum_{t=1}^{T} \beta^{t-1} \frac{c_t^{1-\rho}}{1-\rho}$$

where c_t is consumption in period t, $0 < \beta < 1$ is the discount factor and $\rho \geq 0$ is the coefficient of relative risk aversion. For simplicity, we assume leisure is not valued, implying that labor is supplied inelastically as long as the earnings from working exceed those that may be obtained from not working, such as UI benefits.

We assume that individuals accumulate human capital over the course of their careers and hence become more productive. We model this by assuming that the number of efficiency units of labor that an individual can supply changes over the life cycle. We also assume that the value of this human capital is subject to idiosyncratic shocks. To simplify the model we assume that individuals are ex ante identical, but face idiosyncratic shocks to their lifetime profiles of efficiency units, or productivity. Realizations are iid across individuals, and we assume that each cohort is sufficiently large that the cohort as a whole faces no aggregate risk. Transitions between the different earnings states evolve according to the transition matrices

$$\Pi_t = \begin{bmatrix} 1-\lambda_t & \lambda_t \\ 0 & 1 \end{bmatrix} \qquad t = 1, \ldots, T$$

where $\Pi_t(i, j) = \Pr(s' = j | s = i)$ and where λ_t denotes the probability that an individual worker becomes displaced at age t (equivalently, it is the fraction of workers that become displaced at age t). State 1 is identified as the non-displaced state and state 2 is the displaced state. Note that displacement is an absorbing state. We consider a more general displacement structure later, but for expositional ease, we first consider the special case in which all displacement occurs at a given age, i.e., we set $\lambda_{\hat{t}} = \lambda > 0$ and $\lambda_t = 0$ for $t \neq \hat{t}$, where $\hat{t}$ denotes the age at which the single displacement shock is realized. That is, the only source of idiosyncratic earnings uncertainty is whether a given worker will be displaced in the middle part of their working life.

No information is revealed until period $\hat{t}$, at which point individuals find out if they experience displacement. Hence, until age $\hat{t}$, all individuals are identical, but in period $\hat{t}$ they are split into two groups: those that become displaced and those that do not become displaced. Since there is no additional uncertainty to be resolved subsequently, individuals in each of these two groups will evolve identically from that point forward, and so there will be a "representative" displaced worker and a "representative" non-displaced worker.

Displacement risk is further characterized by parameter θ, which gives the fraction of efficiency units (or equivalently, earnings) that are lost if displacement occurs. Denoting the ex post life-cycle profile of efficiency units by l_t^s $(s = g, b)$, we define

$$l_t^g = \omega_t \quad t = 1, \ldots, T$$

for a worker who does not experience displacement, and

$$l_t^b = \begin{cases} \omega_t & t = 1, \ldots, \bar{t} - 1 \\ (1 - \theta)\omega_t & t = \bar{t}, \ldots, T \end{cases}$$

for a worker who does experience displacement. We assume productivity to be zero after retirement, and hence we set $\omega_t = 0$ for $t \geq 41$. Note that this model is not intended to represent all separations. Rather, it is our goal to focus on those separations that involve workers with substantial tenure and arise because of shocks that are not related to the individual worker.

We let p_l be the wage rate per efficiency unit of labor and p_k the (gross) rental rate of capital in the steady state. The ex post lifetime labor income profiles can then be written as $y_t^g = p_l l_t^g$ for workers who do not experience displacement, and $y_t^b = p_l l_t^b$ for workers who do experience displacement $(t = 1, \ldots, T)$.

One advantage of the very specialized process described above is that it provides a parsimonious and transparent representation of the displacement process. This comes at the cost of abstracting from several features found in the data. First, we abstract from heterogeneity in idiosyncratic wage growth over the pre-displacement period of the life cycle. Many authors (e.g., Topel and Ward, 1992) have documented the process of match formation and dissolution and wage growth characterizing the experiences of workers in the early part of their career. Second, we abstract from the considerable heterogeneity that characterizes individual experiences subsequent to mid-career displacement. Third, we abstract from labor market frictions that may impact on the outcomes experienced by workers immediately following displacement. To the extent that incorporating these last two features would presumably increase the cost associated with displacement risk, our results may be viewed as a lower bound. However, we complement our analysis of this highly simplified case by examining more general processes for life-cycle earnings further below.

Our benchmark model also includes a pay-as-you-go social security system. All individuals receive social security benefits b_t. We assume that $b_t = 0$ except during retirement periods $t = T - 9, \ldots, T$. The payment during retirement is the same in each period for all individuals. As described in more detail below, this feature implies that the system will redistribute income from those who are not displaced to those who are displaced. The system is financed via a proportional tax τ on labor income. We assume that b_t is the after tax value of benefits.

To conduct our analysis we need to specify the market structure. We assume that individuals are able to borrow and lend at a constant one-period (net) interest rate equal to r. All debts must be repaid in full at the time of death and there are no insurance markets. This market structure combined with the information structure implies that in steady state each individual will choose one consumption stream for the first $\hat{t}-1$ periods of life, and then two different streams from $\hat{t}$ on, one corresponding to being in the displaced state and the other corresponding to being in the non-displaced state. This gives rise to the following consumer maximization problem:

$$\max \sum_{t=1}^{\hat{t}-1} \beta^{t-1} u(c_t^p) + \sum_{t=\hat{t}}^{T} \beta^{t-1}[(1-\lambda)u(c_t^g) + \lambda u(c_t^b)] \tag{2.1}$$

s.t.

$$\sum_{t=1}^{\hat{t}-1} \frac{c_t^p}{(1+r)^{t-1}} + \sum_{t=\hat{t}}^{T} \frac{c_t^g}{(1+r)^{t-1}} \leq \sum_{t=1}^{T} \frac{(1-\tau)y_t^b + b_t}{(1+r)^{t-1}}$$

$$\sum_{t=1}^{\hat{t}-1} \frac{c_t^p}{(1+r)^{t-1}} + \sum_{t=\hat{t}}^{T} \frac{c_t^b}{(1+r)^{t-1}} \leq \sum_{t=1}^{T} \frac{(1-\tau)y_t^b + b_t}{(1+r)^{t-1}}$$

where c_t^p, $t = 1, \ldots, \hat{t}-1$, is consumption prior to finding out about displacement, and c_t^s, $t = \hat{t}, \ldots, T$ is consumption in state s, $s = g, b$ once the displacement shock has been realized. Given a solution to this problem one can also derive sequences of asset holdings, a_t^p, $t = 1, \ldots, \hat{t}-1$, and a_t^s, $t = \hat{t}, \ldots, T$ and $s = g, b$.

For notational purposes, it is useful to introduce a variable that represents the fractions of a cohort in the displaced and non-displaced groups. We use μ_t^s to denote these for $t = 1, \ldots, T$ and $s = p, g, b$. It follows that $\mu_t^p = 1$ for $t = 1, \ldots, \hat{t}-1$; and 0 otherwise, while $\mu_t^g = (1-\lambda)$ and $\mu_t^b = \lambda$ for $t = \hat{t}, \ldots, T$, and 0 otherwise.

Aggregate output Q is produced by a representative firm with CRS production technology:

$$Q = F(K, L) = K^{\theta} L^{1-\theta}$$

where $\theta \in (0, 1)$ is capital's share of output, K is aggregate capital input, and L is aggregate labor input measured in efficiency units. Capital depreciates at rate δ and output can be used either as consumption or to augment the capital stock.

Definition 1. A steady-state equilibrium is a collection of individual policy rules for consumption and assets, c_t^s, and a_t^s, aggregate capital K, prices of labor and capital $\{p_l, p_k\}$, such that the following holds:

i. Utility Maximization:
given prices p_l, p_k, the individual decisions c_t^s and a_t^s solve the consumer's problem (2.1), where $y_t^s = p_l l_t^s$ and $r = p_k - \delta$;

ii. Profit Maximization:

$$p_k = F_1(K; L) \quad \text{and} \quad p_l = F_2(K; L);$$

iii. Consistency:

$$K = \sum_s \sum_t \mu_t^s a_t^s / T;$$

iv. Market Clearing:

$$L = \sum_s \sum_t \mu_t^s l_t^s / T \quad \text{and}$$

$$\sum_s \sum_t \mu_t^s \left[c_t^s + a_{t+1}^s \right] / T = F(K; L) + (1 - \delta) \sum_s \sum_t \mu_t^s a_t^s / T;$$

v. Self-Financing Social Security System:

$$\tau = \frac{\sum_{t=T-9}^{T} b_t}{\sum_s \sum_{t=1}^{T-10} \mu_t^s y_t^s}$$

We contrast this allocation with that which would result if agents had access to an insurance market that allowed them to purchase actuarially fair insurance to guard against idiosyncratic income uncertainty. If agents can perfectly insure against the income risk, the resulting allocation is identical to that which would be chosen by an individual whose objective function is the equally weighted sum of all individual utilities from a given cohort and who receives the entire income of the cohort each period. It follows that the (cohort) social planner will give the same consumption profile to each individual and that this profile is the solution to:

$$\max \sum_{t=1}^{T} \beta^{t-1} u(\hat{c}_t) \tag{2.2}$$

$$\text{s.t.} \quad \sum_{t=1}^{T} \frac{\hat{c}_t}{(1+r)^{t-1}} \le \sum_{t=1}^{T} \frac{(1-\tau)\bar{y}_t + b_t}{(1+r)^{t-1}}$$

where the social planner's consumption and asset paths are denoted by $\{\hat{c}_t\}$ and $\{\hat{a}_t\}$ and where $\bar{y}_t = (1 - \lambda) y_t^g + \lambda y_t^b$ is the cohort's aggregate per-period income. This problem involves no uncertainty since by assumption there is no uncertainty regarding the aggregate lifetime income of this cohort. One can now define a steady-state equilibrium for the complete markets economy analogously to that defined above.

2.2. Welfare Cost of Displacement Risk

We use the life-cycle consumption profiles $c_t^p; c_t^g; c_t^b$ and $\hat{c}_t$ to calculate the welfare cost associated with displacement risk. We emphasize that we are not assessing the cost of displacement per se, but rather the cost associated with the risk that individuals are exposed to because of displacement in an incomplete markets setting. In choosing to focus on this aspect of the cost, we are taking the perspective that displacement is likely to be a robust feature of optimal resource allocations in environments with specialized production and idiosyncratic shocks to production opportunities and preferences. Hence, we take the amount of displacement as given and analyze the welfare consequences of various arrangements for dealing with the risk that is associated with this volume of displacement. There are, of course, interesting questions to ask concerning the optimal volume of displacement. Moreover, one would expect that the amount of displacement that occurs is also dependent on the markets that exist to diversify the risk associated with displacement. We leave these questions for future work.

Our welfare measure is analogous to that used by Hansen and Imrohoroğlu (1992) in their study of unemployment spells. Specifically, we ask by what fraction the consumption profile $\hat{c}_t$ would have to be shifted down at all dates in order to equalize the resulting individual lifetime utility with the ex ante expected utility of an individual in the incomplete markets setting. Because $\hat{c}_t$ is linearly related to aggregate discounted lifetime income, it follows that this also corresponds to the amount by which the lifetime income profile would have to be adjusted to equalize welfare in the two economies (conditional on prices being held constant).

More formally, we define steady-state welfare as

$$W^{IM} = \sum_{t=1}^{\tilde{t}-1} \beta^{t-1} u(c_t^p) + \sum_{t=\tilde{t}}^{\bar{T}} \beta^{t-1} \left[(1-\lambda) u(c_t^g) + \lambda u(c_t^b) \right]$$

in the incomplete markets setting, and

$$W^{CM} = \sum_{t=1}^{\bar{T}} \beta^{t-1} u(\hat{c}_t)$$

in the complete markets setting. Our measure of the welfare costs can then be written as

$$\gamma = \left(1 - \left(\frac{W^{IM}}{W^{CM}} \right)^{\frac{1}{1-\rho}} \right) \cdot 100.$$

One qualification should be issued concerning this welfare measure. If agents have access to insurance markets there is no need for them to self-insure through accumulation of capital, and not surprisingly, therefore, we will find that introducing insurance markets leads to a lower steady-state capital stock. When comparing welfare across steady states that involve different levels of capital, a steady state with more capital looks "artificially" good relative to what one would find if transition dynamics were included. The reason for this is that, even though the additional capital generates more output in the steady state, we neglect to measure the cost associated with accumulating that capital in the first place. In view of this, the above welfare measure is expected to be less than the welfare gain that would be experienced if the economy were to introduce markets for risk-sharing into the incomplete markets economy. This effect will of course be larger the larger is the decrease in the steady-state capital stock.

2.3. Results

In order to proceed, we must assign parameter values. One period in our model is one year. The preference parameter ρ dictates the extent to which individuals are risk averse and is likely to be a key parameter. As is well known, there is no strong consensus as to a reasonable value for this parameter. For example, Hubbard et al. (1994) suggest that $\rho = 3$ is a reasonable benchmark, while Hansen and Imrohoroğlu (1992) assumed $\rho = 1.5$. In view of this, we consider a range of values: $\rho = 1$, $\rho = 1.5$, $\rho = 3$, and $\rho = 4$. This range seems to include most values that have been suggested by empirical work.

For the technology parameters we assume $\eta = .3$ and $\delta = .1$. These parameter values are consistent with those chosen in the related literature. For example, Lucas (1990) sets the share of physical capital equal to .24 while King et al. (1988) choose a value of .4. Our choice for η is a compromise. A depreciation rate of .1 is a standard value in this literature; see, for example, Kydland and Prescott (1982) and King et al. (1988).

As is typically done in the macro literature, we choose a value of β so as to generate a steady-state real interest rate equal to 4%. Although the mapping from the preference parameter β to the steady-state interest rate is more complicated in an overlapping generations economy such as that studied here, this can still be done.

Next we specify the life-cycle earnings profile (or equivalently in our model, the life-cycle profile of productivity) for a non-displaced worker. As is well known, the standard shape for life-cycle earnings obtained from a single cross-section is an inverted U that peaks between 45 and 55. Our choice of age earnings profile for non-displaced workers is based on the findings in Hubbard et al. (1994) who estimated earnings processes for male workers using data from the PSID. We normalize this profile such that $\omega_1 = 1$. Based on this choice, earnings peak at age 45 and are roughly equal to 1.5 times earnings at age 25.

The three parameters π, θ and λ, characterize the displacement process. Choices for these values depend on exactly how one defines displacement. We look at several studies to guide us in this task. One of the most detailed studies of the long term consequences of job loss for high tenure workers is Jacobson, LaLonde and Sullivan (1992). Their sample consists of workers in Pennsylvania during the 1970's and 1980's. In their sample of high tenure workers (more than six years), the fraction that experiences a displacement over a five year period is almost 40%. Five years after displacement, this group has wages that are 25% lower on average than their non-displaced control group. The immediate losses tend to be even larger but this is presumably in part due to spells of nonemployment, which we abstract from in our theory.[3] When they restrict attention to those displacements that are part of mass layoffs, the fraction that experiences displacement drops to about 25% but the persistent loss in earnings is even greater. In view of this, we consider $\lambda = .25$ and $\theta = .30$ as our benchmark specification.[4] The average age of the displaced worker group in their sample was roughly forty at the time of separation, and 45 at the time at which the persistent loss of earnings was measured. The tenth percentile for the age distribution at displacement was 30, while the ninetieth percentile was 50. For our benchmark case we set $\bar{t} = 21$, implying that displacement occurs at age 46.

Our choices of parameter values to characterize displacement risk are consistent with those found in other data sets as well. For example, Farber (1993) examines data from the Displaced Workers' Surveys that supplement the CPS and finds that over a two year period the probability of displacement for workers with tenure between 15 and 19 years exceeds 5%. He also reports that each additional year of tenure results in approximately an additional one percent reduction in post-displacement earnings relative to pre-displacement earnings. Topel (1990) examines the same data set and reports that workers with more than ten years of tenure experience earnings losses of more than 40%. Stevens (1997) examines displacement using data from the PSID. She finds substantial heterogeneity in the losses associated with displacement, with some groups experiencing little if any long term consequences. However, workers with high tenure who lose jobs in plant closings suffer persistent earnings losses exceeding 20%. If one further conditions on years of education, the losses are substantially greater for some groups.

Although our choices of parameters are consistent with many studies, we also carry out a sensitivity analysis to check the robustness of our findings. We report these results later on in the paper.

Finally, we set the level of social security benefits to 40% of the average steady-state income in the economy. This results in individual replacement ratios (relative to an individual's non-discounted lifetime average income) of 38.53% for non-displaced workers and 45.19% for displaced workers. These values are consistent with the current U.S. social-security system. For example, a worker in the U.S. with an average lifetime

[3] Jacobson et al. (1992) do not have measures of nonemployment in their data set and therefore cannot assess this issue. Ruhm (1991) finds that incidence of nonemployment is significantly higher for displaced workers than for other workers in the period immediately following displacement, but that this effect is close to zero four years after the displacement.

[4] To assess the reasonableness of a given displacement rate for our parameterization, it is useful to compute a slightly different rate. For workers with 15-24 years of tenure in our model the average displacement rate is approximately 2.5% per year. Based on the Displaced Worker Survey, Farber (1993) found a corresponding figure of about 4%. This number is obviously slightly larger than that implied by the Jacobson et al data, which reflects the fact that our 25% number measures the fraction displaced through mass layoffs.

income of \$50,000 (in 1999 \$) receives benefits equal to about 40%, while a worker with a 30% lower average income faces a replacement ratio of about 45%.

Given this parameterization, Figures 1, 2 and 3 show the resulting steady-state earnings, asset and consumption profiles by age, for both the average worker as well as the average displaced and non-displaced worker. As can be seen, assets peak slightly before retirement for the average worker, but the peak is much less for displaced than for non-displaced workers.

– INSERT FIGURES 1, 2 AND 3 ABOUT HERE. –

Table 1 presents the welfare loss and properties of the equilibrium for four different values of the risk aversion parameter.

– INSERT TABLE 1 ABOUT HERE. –

The tax rate necessary to finance the social security system is calculated as $\tau = .091$. The welfare cost ranges from .19% ($\rho = 1$) to .41% ($\rho = 3$), measured as a fraction of output. These costs are substantial. By way of comparison, Lucas (1987) estimated the welfare costs of consumption fluctuations associated with business cycles to be smaller by more than an order of magnitude. Perhaps more interestingly, Hansen and Imrohoroğlu (1992) found that the welfare cost associated with unemployment risk was slightly less than .7% assuming a value of $\rho = 1.5$. However, they assumed an annual discount factor of .96 and a real interest rate of zero and performed the analysis in a partial equilibrium environment. A zero interest rate serves to make self-insurance less effective and hence increases the size of the welfare cost. They also ignored social security which potentially mitigates the incomplete markets problem. We return to the cases of zero interest rates and no social security below.

In interpreting these welfare numbers the reader should keep in mind the qualification mentioned earlier about comparing steady-state welfare. The above calculations show that introducing insurance markets leads to a lower steady-state capital stock, thus making the incomplete markets steady state look "artificially" better. In the above calculations the decrease in capital is relatively small, though it is increasing in the value of ρ: e.g., when $\rho = 1$, the change in steady-state capital is only .42%, and when $\rho = 4$, it is roughly equal to 5%. In fact, it is because of this effect that the welfare measure is not monotone in ρ. A fuller analysis would therefore also model transitional dynamics.

While we do not pursue this here, we do provide results for the case with exogenous prices, which can alternatively be thought of as the case of a small open economy with a fixed real interest rate. In this case there are no transition dynamics, in the sense that the first generation born in the presence of complete markets will move immediately to the "steady-state" allocation. For this calculation we fix r at 4% and set β equal to the values that were obtained from calibrating the general equilibrium version. We normalize the wage rate to $p_l = 1$, implying $y_t^s = l_t^s$ for all s, t.

– INSERT FIGURE 4 ABOUT HERE. –

In the case of fixed prices it is possible to provide a much sharper characterization of the effects of incomplete markets on the consumption profiles. Figure 4 provides a graphical view. Analytically, one can show that subsequent to the resolution of uncertainty, displaced workers are consuming "too little" and non-displaced workers are consuming "too much" relative to what would occur in the presence of complete insurance markets. Prior to the resolution of uncertainty, all individuals consume "too little" compared to the complete markets case. These results are fairly intuitive–prior to the resolution of uncertainty consumption is depressed as agents accumulate capital to self-insure, but self-insurance is not complete so consumption profiles diverge after the resolution of uncertainty. How important is this distortion of consumption profiles caused by incomplete markets? The following table summarizes the results.

– INSERT TABLE 2 ABOUT HERE. –

The welfare losses we now find are significantly higher than those obtained in the general equilibrium analysis. This suggests that general equilibrium effects are significant in this context. As mentioned earlier, relatively more capital is accumulated in the economy with incomplete markets. If one ignores transitional dynamics, as we do here, then the welfare costs stemming from the distortion of consumption profiles is at least partly offset by the economy's higher output that is due to the higher capital stock.

Continuing to keep prices fixed, we can now more easily compare our results to those by Hansen and Imrohoroğlu (1992), who also considered the case of a constant interest rate. If we repeat our analysis with $r = 0$, $\beta = .96$ and omit social security, as in their study, then even when $\rho = 1.5$ we find a welfare cost of .88%. We conclude that even though displacement risk affects many fewer people than does unemployment risk, its welfare cost is quite possibly larger.[5]

[5] More recently, Wang and Williamson (2000) have suggested that the Hansen and Imrohoroğlu estimates are lowered significantly if one allows for endogenous search effort. In this case, our estimates for the costs associated with displacement risk are substantially larger.

2.4. Sensitivity Analysis

We have also carried out sensitivity analyses with regard to our parameterization of the displacement process. We considered changes in all three of the parameters: $\bar{t}$, λ, and θ. First, with regard to $\bar{t}$ we found that if $\bar{t}$ is reduced to 16, which seems consistent with the data reviewed above, welfare costs increase by roughly two-thirds. Conversely, if $\bar{t}$ is increased to 26, then welfare costs are reduced by roughly one-half. And if $\bar{t}$ were increased to 31, then the welfare costs would be only about one-fifth as large as for the benchmark case reported above. This suggests that displacement for individuals of age 55 or older is much less significant from a welfare perspective.

For the parameters θ and λ we considered values of θ in the range of $.15$ to $.50$ and values of λ in the range of $.025$ to $.45$. Our basic finding is that the welfare cost is increasing and convex in θ holding λ fixed, and increasing and concave in λ holding θ fixed, over the range of values considered. Note that for λ sufficiently large our welfare measure must be decreasing in λ–as λ approaches 1 the welfare cost of displacement risk goes to zero since there is no risk associated with displacement at this point. However, even for very small values of λ, the welfare costs remained substantial as long as θ was relatively large. For example, for $\lambda = .025$ and $\theta = .5$ the welfare cost was $.14\%$ when $\rho = 3.0$.

So far, our specification of displacement has been highly stylized by assuming that displacement can occur in only one period. A natural generalization is to allow for displacement in more than one period. To determine the extent to which our previous results are affected by this, we now allow displacement to occur in $n \in \{3; 5; 10\}$ periods. In each potential displacement period, we set the displacement probability to $\lambda = .25/n$, and adjust θ such that the discounted productivity loss is constant in the incomplete markets equilibrium across the different specifications. For each ρ and for each n, we re-calibrate β so as to have $r^{IM} = 4\%$. This leads to the parameterization shown in Table 3.

– INSERT TABLE 3 ABOUT HERE. –

In Table 4, we present the resulting welfare losses. For simplicity, we restrict the analysis to $\rho = 1.5$ and $\rho = 3$.

– INSERT TABLE 4 ABOUT HERE. –

Perhaps not surprisingly, while similar to the benchmark results, the welfare costs are now somewhat higher. The lesson we take away from this exercise is that, while stylized, the benchmark specification has very similar implications to those resulting from more general displacement speci…cations. If anything, the benchmark results seem to understate the cost of worker displacement relative to more reasonable speci…cations of the displacement process. We conclude that our benchmark speci…cation provides a reasonable representation of the displacement phenomenon and so proceed in our analysis with the simple model.[6]

3. Policy Analysis

In the context of the incomplete markets setting, we have seen that the costs associated with displacement risk may be substantial. To what extent can various sorts of government programs help o¤set the e¤ects of the missing markets? In this section we discuss three such policies: social security, unemployment insurance (UI) and severance payments. In each case, we compare the welfare losses induced by displacement in an environment with the policy and incomplete markets to those resulting in an economy without the policy and complete markets. As before, our benchmark model and parameterization are those reported in Table 1.

3.1. Social Security

Because the social-security system in this model implicitly redistributes income from non-displaced workers to displaced workers, it does have the potential of mitigating the income uncertainty induced by displacement and thus reducing the associated welfare losses. In order to quantify this, we calculate the allocation that would result if social security were abolished, i.e., we set all parameters as in the benchmark speci…cation except $b_t = 0$ for all t, and again repeat the analysis, i.e., we calculate the welfare gains associated with adding insurance markets for displacement risk. The results are summarized in Table 5.

– INSERT TABLE 5 ABOUT HERE. –

Comparing Table 5 with Table 1 we see that in all cases the welfare costs are larger in this case than they were in the case which allowed for a redistributive social security system. The extent of this increase is increasing in the value of ½. For ½ = 1:0 the increase is only from :1874 to:2400, but for ½ = 4:0 the increase is from :3964 to 1:8332. Social security, it appears, can indeed provide substantial insurance bene…ts from the

[6] In Rogerson and Schindler (2001), we consider more realistic general earnings processes using estimates by Hubbard et al. (1994), where workers face upward and downward risk of transitory and persistent earnings shocks in each period of their life. We …nd that in this context of much more complex earnings ‡uctuations, the welfare loss from incomplete insurance increases slightly compared to our …ndings here. This suggests that the very special type of persistent earnings uncertainty that we focus on in this paper, displacement risk, is a key contributor to general earnings uncertainty in the labor market.

perspective of displacement. This is not to say that social security is a "good" way to provide this insurance. As is well known, social security systems have potentially large effects on the incentives to save and these effects are likely to be much more significant in evaluating the costs and benefits of social security.

3.2. Unemployment Insurance

Hansen and Imrohoroğlu (1992) found that in the absence of any informational problems, a simple UI scheme (fixed replacement rate for an unlimited duration) could effectively fully compensate for missing markets in their model. There is, of course, no reason to think that UI would fully compensate for missing markets in our context. Rather, our reason for studying UI is to illustrate the potentially large and negative effects that a generous UI system may have in a setting with persistent earnings losses.

The reason for this is simple–in our model it is not desirable for workers to abstain from production. Even though a displaced worker experiences a large drop in productivity, it is still optimal (from a planner's perspective) for them to work. Though a standard system of UI provides them with income insurance, it also requires that they not work in order to benefit from the availability of the insurance.[7] We now examine this more formally in the context of our calibrated model.

Consider an UI system that is indexed by two parameters: the replacement ratio, which gives the level of benefits relative to pre-unemployment earnings, and the duration of benefits. As in the context of social security, we require that the system be financed in steady-state (pay-as-you-go) by imposing a proportional tax on all earnings, including UI benefits. The replacement rate is set to .75, but we consider various settings for the duration of benefits. Given this replacement level, with our benchmark settings displaced workers will opt to collect benefits rather than work as long as benefits are offered. Following Ljungqvist and Sargent (1998), we assume that the UI system does not require individuals to accept jobs that entail sufficiently large earnings losses relative to their previous employment. Or alternatively, in the framework of Hansen and Imrohoroğlu, the UI system cannot tell if displaced workers are receiving offers.

While we refer to this program as a UI program, our analysis is not limited to UI programs per se. Rather, it can encompass any income support programs in which not working in the market is a condition of the program. General public assistance programs and some job training programs are examples of other programs that are relevant. Table 6 presents the results.

– INSERT TABLE 6 ABOUT HERE. –

[7] In Hansen and Imrohoroğlu, UI has the potential of reaching the first-best allocation because individuals do not always have a job opportunity. Hence, in the absense of moral hazard effects, UI provides income insurance without sacrificing output.

The welfare losses in this table are again relative to the complete markets allocation. As the table indicates, this type of UI system produces lower welfare than the incomplete markets allocation in all cases. As the duration of benefits increases, the welfare losses become quite substantial. Recall that the welfare cost in the case with no benefits for these parameter settings was .265 for $\rho = 1.5$ and .4069 for $\rho = 3.0$.

To be sure, the above calculations embody assumptions that minimize the role for UI. Specifically, we assume that a displaced worker has immediate access to a job paying 70% of their pre-displacement earnings; i.e., there is no period of search required to locate this opportunity. Second, by assuming that all displaced workers suffer exactly the same wage loss we are perhaps exaggerating the extent to which displaced workers would opt to collect UI rather than work. In reality, even if the mean loss in earnings is 30%, there are many workers who lose much less. Third, because we assume that leisure is not valued, we are biasing upward the costs associated with not working. On the other hand, if leisure is valued then even with smaller benefits workers might prefer to collect benefits rather than accept employment at the reduced wage. Nonetheless, we think this calculation illustrates a simple but important point–offering long term unemployment benefits (or any other type of public assistance that requires non-employment) is not an effective way to cope with the earnings uncertainty associated with persistent shocks.

These findings bear on recent work by Ljungqvist and Sargent (1998) who argue that the rise in European unemployment can be largely attributed to generous UI programs and the incentives they create for displaced workers to opt out of the labor market. Our analysis shows that the welfare consequences of this outcome can be quite extreme. However, while UI programs have some unfavorable consequences in the context of displaced workers, it remains true that displacement does expose individuals to a substantial amount of risk. Because Ljungqvist and Sargent (1998) considered risk neutral workers they abstracted from the costs associated with incomplete markets for risk sharing and focused on the interaction between displacement, UI benefits and subsequent employment profiles.

3.3. Severance Payments

This analysis leaves unanswered the important question of what would constitute an effective way to deal with the costs associated with displacement risk. Our model suggests a simple but effective alternative to UI, namely, a fully-funded severance payment system that makes a payment to displaced workers and is financed in a present value sense by proportional taxation of labor income. One can show that a severance payment system of this form is capable of reproducing the complete markets allocation, and hence eliminating any welfare losses. For example, in the case of $\rho = 1.5$, the size of the severance payment turns out to be 4.81, which is slightly less than 4 years of pre-displacement wages. The tax rate needed to finance this payment is equal to 2.3%. Note that the size of these severance payments is roughly in accord with the amount of transfers that would be paid in the UI system analyzed above with a duration of benefits equal to 5 years.

The optimal payments just described are rather large. Even moderate, pay-as-you-go financed severance payments offer substantial benefits, however. For example, if $\rho = 1.5$, a severance payment equal to nine months of pre-displacement earnings reduces the welfare loss by more than one fifth to $\gamma = .207$. Note that the associated cash outlays are the same as those required to offer unemployment insurance of one year's duration with a replacement rate of 75%, with a tax rate of roughly one-half of one percent.

The above calculation has assumed that there are no informational problems to deal with in the administering of a severance payment program. In practice, however, such issues may be important, in which case the above calculations may be overstating the ability of severance payment programs to deal with displacement risk. For such a program to be of interest one has to be able to identify who the displaced individuals are and what the extent of their loss is. How can one distinguish between a worker who has lost their job due to a technological innovation and a worker who has lost their job because they have not updated their skills? Or between a worker who was laid off but has still has good opportunities available versus a worker who does not search hard for those good opportunities? Or what if a firm is going out of business because they hired low quality workers? These issues suggest that the issues of moral hazard and adverse selection may be important in the context of severance payments. Of course, these same types of issues arise in the context of designing unemployment insurance systems. (See Hansen and Imrohoroğlu, 1992, for a discussion of the role of moral hazard in this context and Wang and Williamson, 2000, for a formal analysis). While we do not model these informational problems here we note them as a serious caveat in interpreting the above result on the efficacy of severance payments.

At the same time, however, targeting a program at high tenure workers who are involved in mass layoffs would seem to mitigate some of the moral hazard problems from the perspective of an individual worker or firm. In fact, this is the sample that Jacobson et al. (1992) studied and for whom our benchmark results apply.[8]

On a related point, one may also ask why firms do not offer severance payments to their workers in order to take care of the missing markets. However, this option would simply move the risk from the workers to the firms. In the case of a large corporation with many business interests the firm may be able to effectively self-insure against these risks, but that is not the case for smaller firms whose business is highly concentrated.

[8] As emphasized by Hansen and Imrohoroğlu (1992), the issue of targeting unemployment benefits is also a serious issue.

3.4. Discussion

The above findings are of interest in the context of cross-country differences in the nature of outcomes experienced by displaced workers.[9] Caution is always recommended in comparing cross-country data, but these papers suggest the following general findings. First, the phenomenon of mid-career displacement is observed in all countries, though the intensity does vary from country to country. Second, however, is that the phenomenon of large (average) earnings losses associated with mid-career displacement is apparently unique to a few countries. Consistent with the evidence already discussed, this is observed in the US. Additionally, it is observed for older workers (greater than 50) in Japan, high tenure workers in Canada and to some extent in the UK and Australia. But in many countries, including France, Germany and the Netherlands, there is little evidence that mid-career displacement leads to a large loss in earnings. However, an important qualification for this finding is that these statements simply reflect the experience of those individuals who are displaced and subsequently become employed. The analysis of the last subsection suggests an important factor which may help to partially account for these cross country differences. Namely, if income maintenance programs are sufficiently generous, then one will not observe individuals working when their opportunities entail large losses in earnings.

Aggregate data for the US, Germany and France, for example, reveal another interesting pattern. According to data published by the OECD, in 1995 the employment-to-population ratios for men aged 35-45 and 45-55 are roughly equal for all three countries. However, for men aged 55-65, the employment rates are significantly less for France and Germany. This is consistent with older displaced workers in these countries simply withdrawing from employment.

These studies also note that in all countries there are many workers who are displaced and move almost immediately into new jobs and experience little if any loss in earnings. This is not inconsistent with the above analysis if one were to allow for heterogeneity in the post-displacement income options that individuals face. In this case all countries would have some individuals who despite being displaced are still presented with good market outcomes and continue to be employed.

A policy that we have not discussed here but which has received much attention in public policy discussions about European labor markets is one which makes it costly for firms to lay off workers. This may decrease the costs associated with displacement risk by decreasing the volume of displacement. However, from the perspective of efficiency, these gains need to be weighed against the costs of having workers employed at plants in which productivity is low. Hopenhayn and Rogerson (1993) and Veracierto (2000) find these costs to be large.

[9] See the papers prepared for the Canadian International Labour Network and the Upjohn Institute project on "Losing Work, Moving On: International Comparisons of Worker Displacements." The countries studied include the US, Canada, Japan, Australia, Belgium, Denmark, France, Germany, and the Netherlands.

4. Conclusion

Many recent studies have documented the large and persistent losses in earnings that are associated with mid-career displacement of highly tenured workers. Our objective in this paper was to assess the welfare cost associated with this risk in a world in which workers do not have access to insurance markets to insure against displacement. We found that the cost of this risk is about the same order of magnitude as the cost associated with earnings risk due to unemployment spells, and may exceed one percent of GNP. We conclude that this risk is signi…cant.

We also argue that typical programs used to deal with income uncertainty, such as unemployment insurance, are likely to interact with displacement risk in a very negative fashion, since they o¤er support to workers who do not work rather than to workers who work but su¤er large and persistent wage losses. Severance payments are a natural alternative that do not su¤er from this drawback.

Our analysis has been conducted in a simple setting in order to highlight the main issues. These simpli…cations naturally raise several questions. As stressed by Kletzer (1998), assessing these costs in a larger perspective undoubtedly requires understanding why these losses arise in the …rst place. Is it shocks to the value of speci…c human capital? Or is it the loss of union rents? Another issue is the extent to which wages re‡ect compensating di¤erentials for exposure to displacement risk. On this issue we note that while …rms may o¤er higher wages in order to compensate for higher risk, in general this is not likely to bring about e¢ cient risk-sharing if there is uncertainty as to which …rms will be initiating the displacement. More generally, it will be useful to incorporate our analysis into a richer framework where outcomes for wages and separations are determined endogenously rather than viewing displacement as an exogenous event. For current work along these lines, see Schindler (2001).

Related to recent work by Acemoglu and Shimer (2000) on the bene…ts of UI provision, it may be that displacement risk has negative consequences for the nature of production that takes place in the economy, if workers are reluctant to expose themselves to risk. There are also many informational considerations of interest in devising a system of mandatory severance payments if there is private information about …rm level productivity and worker characteristics. Conditioning on events that involve plant closings or mass layo¤s may be e¤ective in this context, and based on our analysis would still provide substantial bene…ts.

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Figures

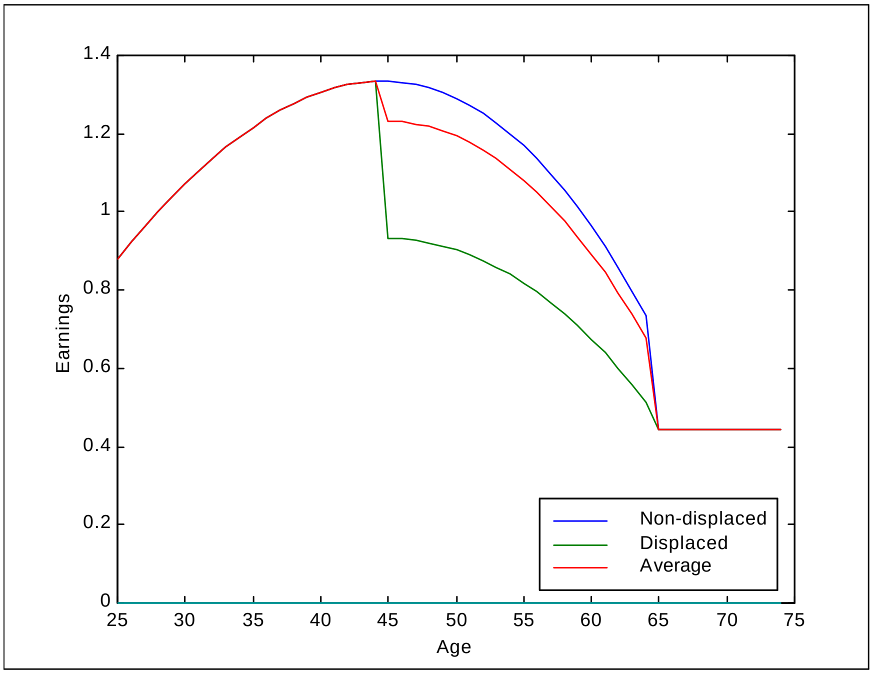

FIGURE 1: Earnings Pro…les in the Benchmark Speci…cation (½ = 1:5)

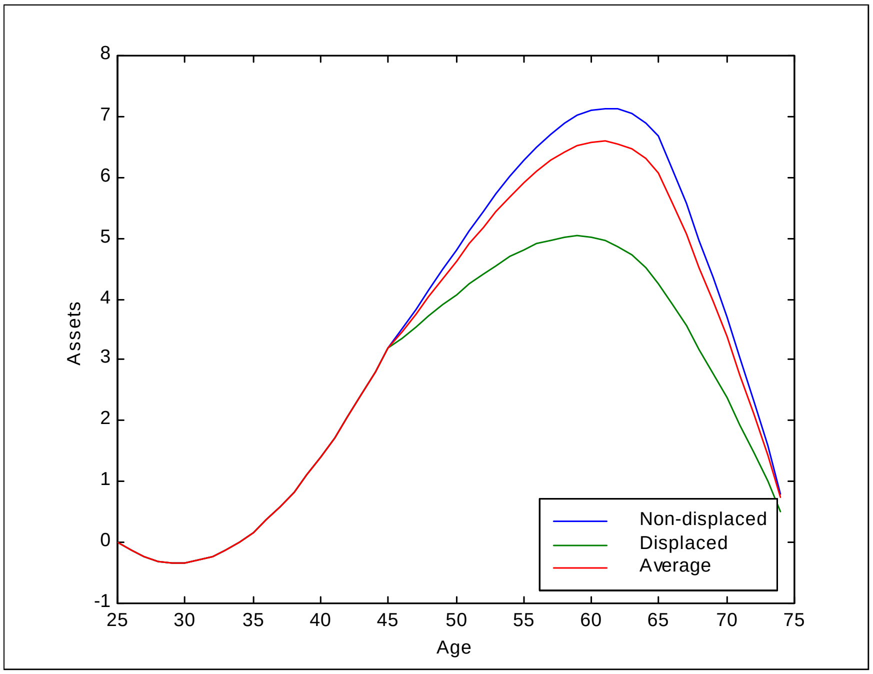

FIGURE 2: Asset Pro…les in the Benchmark Speci…cation (½ = 1:5)

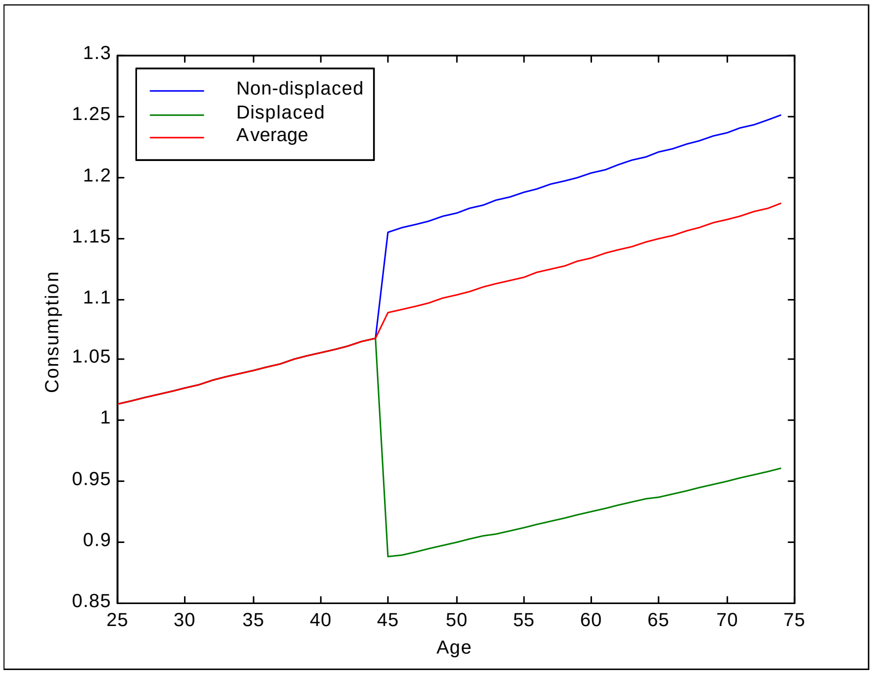

FIGURE 3: Consumption Profiles in the Benchmark Specification ($\rho = 1.5$)

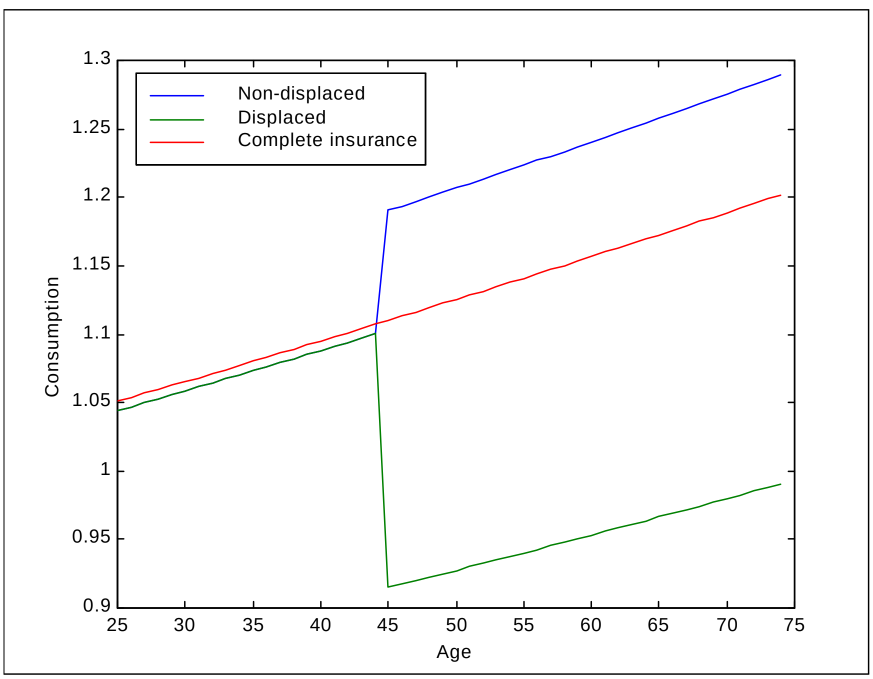

FIGURE 4: Consumption Profiles in Partial Equilibrium ($\rho = 1.5$, $r = .04$)

Tables

TABLE 1
Welfare Costs and Equilibrium Properties

	$\rho = 1.0$	$\rho = 1.5$	$\rho = 3.0$	$\rho = 4.0$
γ	.1874	.2650	.4069	.3964
β	.9643	.9655	.9685	.9699
	Incomplete Markets			
K/Q	2.1429	2.1429	2.1429	2.1429
r^{IM}	.0400	.0400	.0400	.0400
	Complete Markets			
K/Q	2.1365	2.1307	2.1012	2.0706
r^{CM}	.0404	.0408	.0428	.0449

TABLE 2
Welfare Costs in Partial Equilibrium

	$\rho = 1.0$	$\rho = 1.5$	$\rho = 3.0$	$\rho = 4.0$
γ	.2401	.3675	.7767	1.0675

TABLE 3
Alternative Parameterizations

			β	
Displacement periods	λ	θ	$\rho = 1.5$	$\rho = 3.0$
$t = 21$	$.25$	$.3$	.9655	.9685
$t = 20, \ldots, 22$	$.0833$	$.32459$	.9654	.9681
$t = 19, \ldots, 23$	$.05$	$.327805$	.9654	.9680
$t = 16, \ldots, 25$	$.025$	$.31317$	.9656	.9685

TABLE 4
Welfare Costs for More General Displacement

Displacement periods	$\rho = 1.5$	$\rho = 3.0$
$t = 21$	.2650	.4069
$t = 20, \ldots, 22$	.3025	.4625
$t = 19, \ldots, 23$	.3120	.4787
$t = 16, \ldots, 25$	.3210	.5150

TABLE 5

Welfare Costs without Social Security

	½ = 1:0	½ = 1:5	½ = 3:0	½ = 4:0
°	.2400	.3799	1.062	1.8332
¯	.9643	.9655	.9685	.9699
	Incomplete Markets			
K=Q	2.2936	2.3864	2.7410	3.0170
r^{IM}	.0308	.0257	.0094	-.0006
	Complete Markets			
K=Q	2.2832	2.3649	2.6554	2.8700
r^{CM}	.0314	.0269	.0130	.0045

TABLE 6

Welfare E¤ects of UI

Duration	Welfare Loss	Tax Rate (%)
	a. ½ = 1:5	
1	.789	.57
2	1.313	1.14
5	2.884	2.87
10	5.440	5.73
	b. ½ = 3:0	
1	.926	.57
2	1.446	1.14
5	3.007	2.87
10	5.568	5.73