Social Security Reform and the Labor Market: Assessing the Distribution of Welfare Gains and Losses*

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Abstract

We develop a measure of compensating variation in a random utility model for retirement choice. The features of the measure are shown in a numerical example. We then apply the measure to a model for retirement choice estimated on a random sample of about 15 000 Swedish workers observed between 1983 and 1997. A welfare analysis on the simulated outcome of a hypothetical reform of the Swedish income security system is performed.

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1 Introduction and Motivation

The global aging pattern, combined with a trend towards earlier retirement, threaten the financial stability of the social security schemes in most Western industrialized countries. This has led to a widespread debate on social security reforms - in particular - proposals for cuts in pension benefits and delays in eligibility ages for these benefits. To evaluate welfare and distribution effects of these reform proposals, it is essential, not only to understand how the workers labor market behavior is affected by changes in the social security system, but also to be able to calculate the individual welfare change rather than to just predict how the income streams are affected.

The choice between retiring or remaining in the labor force is typically a discrete choice between two states in each time period. This feature has implied that most empirical studies on retirement choice have, implicitly or explicitly, used a random utility framework. It is a well known that there is no exact formula for the compensating or equivalent variation in random utility models if they include income effects, i.e., a non-constant marginal utility of money. In retirement choice models income effects are likely to be present, and of a major importance, since most pension schemes typically only replaces some fraction of annual earnings from labor.

In this paper we use a forward-looking random utility model based on the option value model developed by Stock and Wise (1990). We formulate a nested logit model for the choice between retiring in the current period and delaying retirement to some later time. One common option value model follows by taking the maximum of the values (indirect utilities) associated with retiring in the future, and compare it with the value of retiring at present time. Such an option value model, based on a maximum criterion, is one specific case of our nested logit model. In this paper, we will test the importance to also consider the multinomial choice of retirement age, rather than the binomial choice of retirement and remaining in the labor force. In particular, we will test whether the maximum criterion can be empirically supported.

We will assess the welfare impacts of hypothetical reforms, by using microeconomic consistent welfare measures in a random utility framework. Welfare economics in a random utility framework was developed together with the random utility methodology by, e.g., Ben-Akiva (1973), McFadden (1978), and Hanemann (1985). In the context of labor force participation choice, it is important to be able to consider income effects, which has received attention in various fields, but it is not until quite recently that theoretically sound and feasible methods has been devised. McFadden (2000) demonstrates that a representative individual approximation can be misleading, and proposes a simulation method to calculate expected compensating variation, and Karlstrom (1998) develops a tractable formula that can easily be applied in the case of generalized extreme value (GEV) models.

We use a simple numerical example including only one individual to illustrate how the welfare measure works. Finally, we use Swedish panel data and estimate an option value model. The estimated model is used to simulate the effects of two hypothetical reforms of the social security system. The first reform is simply a 10 percent cut, for each time period, in the present value of the expected future retirement benefits. In a second reform (to be included in a later version of this paper) the present system is replaced by a benefit which, at the normal retirement age at 65, replaces 55 percent of the earnings the year before retirement, but it can be claimed from age 60 with and actuarial reduction. We calculate the compensating variation measure for different sub-groups in the sample and also decile groups in the lifetime earnings distribution for each of these hypothetical reforms.

2 Modeling Retirement and Measuring Welfare

2.1 Option Value in a Random Utility Model

We use a random utility formulation based on the Stock and Wise (1990) option value model. The expected utility in period t of retiring at age r, is defined as

$$V(t,r) = \sum_{s=t}^{r-1} U_W(Y_{ts};\theta) + \sum_{s=r}^{\max age} U_R(B_{rs};\theta), \tag{1}$$

where Y_{ts} is expected net income before retirement in period s at time t; B_{rs} is expected net income after retirement in period s if the individual retires at age r; θ is a vector of socio-economic variables; $U_W(\cdot)$ and $U_R(\cdot)$ measures the individual's utility of income allowing for different individual valuation of income depending on if the income is received before or after retirement, i.e., the difference between these functions reflects the utility of leisure.

We will use a linear formulation of the indirect utility function:

$$\begin{aligned} V(t,r) &= \alpha_W \sum_{s=t}^{r-1} \beta^{s-t} Y_{ts} p(s \mid t) + \alpha_R \sum_{s=r}^{\max age} \beta^{s-t} B_{rs} p(s \mid t) + \gamma'_{tr} x_{tr} & (2) \\ &= \alpha_W \widetilde{Y}_{tr} + \alpha_R \widetilde{B}_{tr} + \gamma'_{tr} x_{tr}, & (3) \end{aligned}$$

where $p(s \mid t)$ is survival probability conditional on survival at age t; β is the subjective discount rate; x_{tr} is a vector of socio-economic characteristics and γ_{tr} a parameter vector. We allow the individual to have different marginal valuation of income after retirement. The marginal utility of money associated with working (α_W) and retirement (α_R), may be different, implying a marginal valuation of leisure[1]

In our random utility model, the individual may have different idiosyncratic preferences for retirement at different time periods. There are different sources for such a random utility component. In the framework of option value modeling, an individual predicts his future income (and pension benefits). We will assume

[1] In the option value model, a parameter $k = \alpha_R/\alpha_W$ is often estimated or assumed, see Stock and Wise (1990), and Samwick (1998).

that the individual can project his future income deterministically, but it may be the case that we as researchers has less possibility to project the future income of the individual, than the individual himself. Also, the individual may have idiosyncratic preferences towards retirement at different time periods, implying that the choice appears random for us as researchers, whereas the utility is known to the individual. In this random utility framework the individual will achieve the utility

$$V(t,t)+\epsilon_{tt} \tag{4}$$

The individual will compare this utility with the utility that is associated with retiring in a future period r, given by

$$V(t,r)+\epsilon_{tr} \tag{5}$$

where, again, $V(t,r)$ is the indirect deterministic utility of retiring at time r, evaluated at time $t<r$. The ϵ_{tt} and ϵ_{tr} reflects the random utility components, that will throughout this paper be assumed to be known to the individual, but unknown to the researcher. This is conjunction with the standard random utility framework, see, e. g. McFadden (1999, 2000).

The individual faces the problem of retiring or not in each year over the period of time observed in the data $(1,2,......,\tau)$. The random utility formulation asserts that the probability of retiring in a particular point of time t can be written

$$\Pr\left\{V(t,t)+\varepsilon_{tt}\geq V(t,r)+\varepsilon_{tr};\forall r\geq t\right\}, \tag{6}$$

where we have assumed that the random utility components follows a joint cumulative distribution function $F(\epsilon_{11},\epsilon_{12},...,\epsilon_{\tau\tau})$ that is continuous, with density everywhere, with zero probability for ties.

We will assume that $(\epsilon_{ts},\epsilon_{ij})$ are independent for any $t\neq i$. That is, in every time period, the random utility components are redrawn. Assuming a cumulative normal distribution function F, the estimated model is a probit model. Using simulation techniques, it is becoming increasingly feasible to estimate probit models with serial correlated error terms. In our empirical example, we have at the most 17 observations, and over 13000 observations, which makes a probit model with serial correlation costly to estimate. Moreover, with normal distributed error terms, the compensating variation will not collapse into a closed form solution.

In contrast, assuming that all random utility components are independent and follows a type two extreme value distribution, then the probability of retiring a particular year can be written

$$P_{(t)R} = \frac{e^{V(t,t)}}{e^{V(t,t)} + \sum_{r>t}^{\tau} e^{V(t,r)}} \tag{7}$$

i.e., it can be characterized by a multinomial logit model. Substituting for the functional form in used in 2 we get

$$P_{(t)r} = \frac{e^{\alpha_R \widetilde{B}_{tt} + \gamma'_{tr} x_{tr}}}{e^{\alpha_R \widetilde{B}_{tt} + \gamma'_{tr} x_{tr}} + \sum_{r>t}^{\tau} e^{\alpha_W \widetilde{Y}_{tr} + \alpha_R \widetilde{B}_{tr} + \gamma'_{tr} x_{tr}}}. \tag{8}$$

This expression allows us to estimate the parameters in the model.

However, we want to be able to allow for serial correlation of the error terms across different future retirement dates. That is, we will allow for $(\epsilon_{ts}, \epsilon_{tr})$ to be correlated. It seems to be a strong assumption that the idiosyncratic random utility for retiring in a future year r should be independent of retiring in a year s, in particular if r and s are close.

As a relaxation of the iid assumption, we will assume that the error terms follow a multivariate extreme value distribution, i.e. their cumulative distribution function can be written

$$H(y_1, y_2, ..., y_n) = exp(-G(e^{-y_1}, e^{-y_2}, ..., e^{-y_n})) \tag{9}$$

where G is termed the *generating function*[2]. A GEV model is fully specified by its indirect utilities and its generating function, and the choice probability is given by

$$P_i = \frac{e^{v_i} G_i(e^{v_1}, ..., e^{v_n})}{G(e^{v_1}, ..., e^{v_n})} \tag{10}$$

[2]The generating function must fulfil certain properties, see McFadden (1978).

where G_i denotes the partial derivative with respect to argument i.

It is natural to think that the random utility terms may be correlated. In particular, similar alternatives may share unobserved characteristics, giving rise to a correlated error structure across alternatives. Here, future retirement years may share unobserved characteristics. Therefore, we will allow $\epsilon_{tr}, \epsilon_{ts}$ to be correlated for $s, r > t$. The traditional nested logit model is given by the generating function

$$G(x_{t,t}, x_{t,t+1}, ..., x_{t,\tau} = x_{t,t} + (\sum_{s>t} x_{t,s}^{\frac{1}{\lambda}})^{\lambda} \quad (11)$$

In this framework, the probability of retiring in a particular point of time t, i.e., leave the labor force in the period succeeding period t, can be written

$$\frac{e^{V(t,t)}}{e^{V(t,t)} + e^{\frac{V(t,r)}{\lambda} + \lambda \log \sum_{s>t} V(t,s)/\lambda}} \quad (12)$$

where λ is a log sum parameter ($\lambda \in [0, 1]$) which can be estimated. If λ is one, then the choice alternatives are seen as independent and the model for independent choices developed above (MNL) applies.

Note that if $0 < \lambda < 1$, there is a positive correlation of the temporal error structure. On the other hand, as λ approaches zero, the random utility components ϵ_{ts} becomes perfectly correlated for all $s > t$. In such case the conditional choice probability of having time r being associated with the highest (stochastic) utility at time t is given by

$$P_{(t)r|W} = \begin{cases} 1 & \text{if } r = r_{\max}, \\ 0 & \text{otherwise}. \end{cases} \quad (13)$$

where $r_{\max} = argmax_r\{V(t, r)\}$. That is, as the dissimilarity parameter λ approaches zero, only the alternative r with the highest indirect utility matters. This case corresponds to the maximum criterion of the option value model as applied by, e.g., Stock and Wise (1990), and the corresponding model boils down to a binomial logit model. In this specific case, the probability of retiring at time t becomes

$$P_{(t)R} = Prob\{V_{(t)R} + \epsilon_{tt} \geq V_{(t)W} + \epsilon_{tr_{\max}}\} \quad (14)$$

where

$$V_{(t)W}(\cdot) = \alpha_w \tilde{Y}_{tr^o_{max}} + \alpha_r \tilde{B}^o_{tr^o_{max}} \quad (15)$$
$$V_{(t)R}(\cdot) = \alpha_r \tilde{B}^o_{tt} \quad (16)$$

2.2 Measuring Welfare in a Multiperiod Random Utility Model

In this section we will outline the approach used for welfare calculations within the multiperiod random utility model. We will start with a simple two period model to highlight the considerations and problems that has to be assessed in doing such a welfare calculation.

Let us assume that we want to evaluate a policy that decrease the benefits received when being retired, leaving the income from work unaffected. The policy will be a deterioration for most individuals, and will not be perceived as an improvement by any one. The indirect deterministic utilities associated with the original state is given by

$$V^o_{(t)W} = \alpha_w \tilde{Y}_{tr^o_{max}} + \alpha_r \tilde{B}^o_{tr^o_{max}} \quad (17)$$
$$V^o_{(t)R}(t) = \alpha_r \tilde{B}^o_{tt} \quad (18)$$

The policy to be evaluated will decrease the benefits, such that $B^1_{tr} \leq B^o_{tr} \; \forall t, r$. The indirect utilities associated with the state after the change is therefore given by

$$V^1_{(t)W} = \alpha_w \tilde{Y}_{tr^1_{max}} + \alpha_r \tilde{B}^1_{tr^1_{max}} \quad (19)$$
$$V^1_{(t)R} = \alpha_r \tilde{B}^o_{tt} \quad (20)$$

In a given time period t, the individuals can be classified into three different groups on the basis how they react on the reform. These are:

- Group A: Individuals that retire in period t both before and after the change
- Group B: Individuals who under the pre reform regime retired in period t, but delay their retirement after the reform.

- Group C: Individuals that do not retire in period t, either before or after the reform.

For individuals in group A, the compensation needed to restore the achieved life time utility is defined by

$$V^o_{(t)R} + \epsilon_{tt} = V^1_{(t)R}(\tilde{B}_{tt} + c_{\max}) + \epsilon_{tt} \tag{21}$$

We will assume that the random utility components do not change by the policy reform[3]. Therefore, the random utility terms cancel out, and the compensation $c_{\max}$needed to restore the achieved utility is deterministically just the difference in the present value of the expected benefits under the pre and post reform regimes, i.e.,

$$c_{max} = \tilde{B}^o_{tt} - \tilde{B}^1_{tt}. \tag{22}$$

Note that this is the maximum compensation needed for any individual that choose to retire at time t under the pre reform regime.

In order to calculate the expected compensating variation, we need to find the compensated (hicksian) choice probability. That is, we need to calculate the choice probability of switching from retire to work (being in group B). The compensated variation c for these individuals is given as the solution to the implicit equation

$$V^o_{(t)R}(\tilde{B}_{tt}) + \epsilon_{tt} = V^1_{(t)W}(\tilde{B}_{tt} + c) + \epsilon_{tr^1_{max}} \tag{23}$$

Since, by definition, $r^1_{\max} \neq t$, the compensating variation c is here a stochastic variable.

The stochastic variable c is bounded below by those individuals that before the reform were indifferent between working and retiring at time t. The minimum

[3]This is a standard assumption in welfare evaluation in a random utility framework. It is difficult to see why the a policy reform should change random utilities for any individual. In fact, it can be argued that such an assumption would violate microeconomic theory. However, in a repeated choice framework, the random utility components may change over time, which is a different setting than the one considered here.

compensation, c_{min}, needed for these individuals is given by

$$\alpha_W \tilde{Y}_{tr^o_{max}} + \alpha_R \tilde{B}^o_{tr^o_{max}} = \alpha_W \tilde{Y}_{tr^1_{max}} + \alpha_R \tilde{B}^1_{tr^1_{max}} + \alpha_R c_{min}. \qquad (24)$$

Hence, $c_{min} = (V^o_W - V^1_W)/\alpha_R$. For those individuals who are indifferent between working or retiring under the pre reform regime will not have to be compensated if the alternative to work is unaffected by the policy change. These individuals require, like those in Group C, zero compensation ($c_{min} = 0$). The other extreme are those who are indifferent between working and retiring under the post reform policy. Those require the same compensation as the individuals in Group A to remain on the same utility level.

To be able to calculate the expected compensated variation, we need to find the density distribution of the stochastic variable c. To find this, we will consider a hypothetical choice situation between retiring under the pre reform system and working under the post reform one. The utility associated with retiring pre reform is given by V^o_R, whereas the utility associated with working post reform is given by $V^1_W + \alpha_R c$. Thus, using the logit formulation, the choice probability of retirement in this hypothetical situation is given by

$$\tilde{P}_r(c) = \frac{e^{V^o_R}}{e^{V^o_R} + e^{V^1_w + \alpha_r c}} \quad , \quad c_{\min} < c < c_{\max}. \qquad (25)$$

This expression gives in fact the density distribution of the compensating variation. To see this, consider an individual who chooses to retire in the hypothetical choice situation, achieving a utility of $V^o_R + \epsilon_R$. By revealed preference, this individual will not be fully compensated by the amount c, since he prefers to have the original utility level before the utility level in the new state. On the other hand, if the individual choose work in the hypothetical choice situation, he can achieve a higher utility than in the original state by delaying his retirement and being compensated by the amount c. Therefore, the probability that the individual choose to retire in the original state and needs more than c to be compensated is identical to $\tilde{P}_r(c)$, given by equation (25).

The individuals in Group C are not affected by the benefit levels in the pension system in period t, therefore they will not require any compensations to remain on the pre reform utility level in this period.

Given the partitioning into the three groups, the expected compensating variation is given by

$$\mathrm{E}[cv] = c_A + c_B + c_C \tag{26}$$

where c_i is the expected compensated variation associated with the three groups $i = A, B, C$, where $c_C = 0$. For group A, those who stick with the retirement alternative both before and after the change, we have

$$c_A = P_R^c c_{\max} \tag{27}$$

where P_R^c is the compensated (hicksian) choice probability, i.e. the choice probability of choosing retirement under the post reform regime after being compensated. The compensated choice probability can easily be calculated by noting that it is the probability that at least $c_{\max}$ is needed to be compensated. Therefore we have that $P_R^c = \tilde{P}_R(c_{\max})$.

Finally, we need to calculate the expected CV for those who switch alternative, and delay their retirement (Group B). For these individuals we have

$$c_B = \int \alpha_R c \frac{\partial \tilde{P}_R(c)}{\partial c} dc \tag{28}$$

since $\tilde{P}_R(c)$ is the density distribution of the compensating variation. In a more general case, this integral may not have an analytical solution. Note however, that even in the case with multiple alternatives, the integral is finite and one dimensional in the case of GEV (such as logit) models. On the other hand, if marginal utility of money is constant, the associated integral do have an analytical solution, collapsing into the famous log-sum formula (see McFadden, 1999).

Fortunately, there is also one special case where we have an analytical solution for the compensating variation. This case is when we only have two alternatives.[4]

[4]This is, in turn, a special case of the situation where individuals only switch to only one alternative after the change. In this situation, we are able to normalize with the marginal utility of money associated with that alternative, and therefore the analytical solution will be a scaled log-sum formula, similar to our case.

The indefinite integral in equation (28) does have an analytical solution in our case, since (ignoring the integration constant)

$$c_B \equiv \int \alpha_r c \frac{e^{V_w^1+\alpha_r c}}{e^{V_r^o}+e^{V_w^1+\alpha_r c}} \frac{e^{V_r^o}}{e^{V_r^o}+e^{V_w^1+\alpha_r c}} dc = \\ = \frac{1}{\alpha_r}(V_w^1 - \ln\left(e^{V_r}+e^{V_w+\alpha_r c}\right)) + c - c\tilde{P}_r(c) \quad (29)$$

Note also that we can find the conditional compensating variation associated with group B by taking

$$\mathbf{E}[cv \mid B] = \frac{c_B}{\text{Prob}(inB)} = \frac{c_B}{P^o_{(t)R} - P^c_{(t)R}} \quad (30)$$

Numerical Example

To illustrate how the welfare analysis of a social security reform is carried out, we will consider a simple numerical example with one individual and three time periods. The set up of the example is summarized in Table 1. As can be seen in the Table, the individual receives a net income (Y) of 10 units in each time period if he remains in the labor force. The pre reform pension system replaces 70 percent of this income if he retires in period 2. If he decides to retire in period 1 there is a permanent actuarial reduction of 6 percent of the pension benefit and a permanent actuarial increase of the benefit if he decides to delay retirement to period 3. These rules are shown in the $B^o_{r=t}$ column in Table 1.

The hypothetical reform, shown in the $B^1_{r=t}$ column, decreases the replacement level to 65 percent. The actuarial adjustment of 6 percent if the individual leaves the labor force in period 1 is maintained. In order to simplify, since we assume that the individual leaves the labor force with probability one in period 3, the level of the pension benefit is maintained in this period.

We use the linear value function, shown in equation (2). In this specification, the marginal utility of money is implicitly set to one. The subjective discount rate is set to 3 percent, i.e. $\beta = 0.97$. The parameter for the relation between the valuation of income received when the individual is in the labor force and

t	Y_t^o	$B_{r=t}^o$	Y_t^1	$B_{r=t}^1$	$\widetilde{B}_{tr_{\max}}^o$	$\widetilde{B}_{tr_{\max}}^1$	V_R^o	V_W^o	V_R^1	V_W^1
1	10	6.58	10	6.11	20.11	20.53	28.73	30.17	26.68	30.17
2	10	7.00	10	6.50	20.11	20.53	30.68	30.80	29.21	30.80
3	-	7.42	-	7.42	-	-	-	-	-	-

Table 1: Set up of the numerical example.

t	P_R^o	P_R^1	$c_{\max}$	$E(cv \mid B)$	$E[cv]$
1	0.19	0.03	1.36	0.60	0.14
2	0.47	0.17	0.98	0.45	0.29

Table 2: Results from the numerical example.

income received when the individual is out of the labor force, k, is set to 1.5. This means that the individual values 2 units of income received as pension benefits equivalently as 3 units of money received when the individual is in the labor force. Finally, the variance of the type two extreme value distributed error term is set to one.

The columns $\widetilde{B}_{tr_{\max}}^o$ and $\widetilde{B}_{tr_{\max}}^1$ show the present value of the retirement benefits if the individual chooses to retire when the value function reaches its maximum under the pre and post reform regimes respectively. The columns for V_R^o and V_R^1 shows the value function if the individual chooses to retire in the current period. It can be seen in the Table that the value function decreases after the reform if the individual chooses to retire in the first or second period. V_W^o and V_W^1 show the value functions while working when it is assumed that the worker chooses to retire in the optimal time period. Since this is the third period, and we have set the retirement benefit in the third period at the same amount under the two alternative regimes, the value functions take the same values under both regimes in this example.

Table 2 shows the results of the numerical example. The P_R^o and P_R^1 columns show the predicted probabilities for the individual to retire under the pre and post reform regimes respectively. The results shows that the predicted probability for the individual to retire in period 1 decreases from 19 to 3 percent and in the second period from 47 to 17 percent. This means that the probability is 80 percent, compared to 34 pre reform, for the individual to retire in the last period after the reform.

The $c_{\max}$ column shows the compensation for the event that the individual do not change his retirement behavior, i.e., when he will require the maximum compensation $(\tilde{B}_{tt}^{o} - \tilde{B}_{tt}^{1})$ to remain on the pre reform utility level. The $E\left(cv \mid B\right)$ shows the expected compensation for the more complicated case in the event that the individual chooses to delay retirement as a result of the reform. As is described in the previous Section, this will require that we obtain the probability density function for the hypothetical choice between retiring under the pre reform regime and continue to work under the post reform one. This probability density function is displayed in Figure 1.

Finally, the $E\left[cv\right]$ shows the expected compensating variation. Since there is a 34 percent probability for the event that the individual retires in the third period under both the pre and post reform regimes, and as we have chosen not to change the pension system for those who retire in the third period, the compensation under this event will be zero.

There are at least three different ways of evaluating how the economic welfare of this individual is affected by the reform. The first one, which is probably the most common in the public policy debate, is to compare the present value of the lifetime income assuming that the individual does not change his labor market behavior as a result of the reform. An obvious disadvantage with this measure is that it does not take into account that the individual may counteract the decrease in the pension benefit by increasing the probability of delaying retirement. Therefore, it will in general overestimate the welfare effect of the reform.

An intuitively attractive alternative to this measure is the change in lifetime income taking into account that the probability of retiring later on may increase as a result of the reform. However, since this measure fails to account for that the individual thereby also increase the probability of giving up valuable leisure time

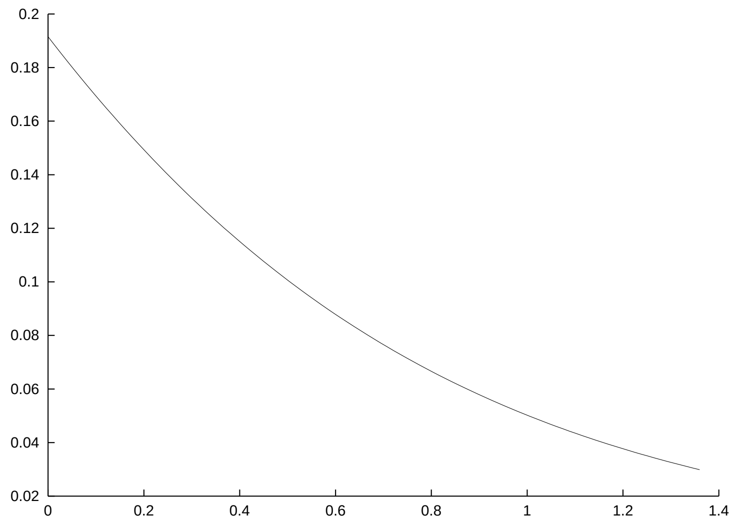

Figure 1: $\tilde{P}_R(c)$ in the numerical example.

it will in general underestimate the true welfare effect of the reform.

Finally, the third measure is the one developed in the previous section: the present value of the expected compensating variations. The outcome of this measure will, for any reform, be bounded by the other two measures and the exact location will depend on the elasticity of the labor supply response.

For the data in the numerical example, evaluated in the first period with a discount rate on three percent, the first measure predicts a decrease of lifetime income by 0.71 monetary units. The second measure increases by 1.99. This, at first sight non-intuitive, result is explained by the fact that the probability of retiring in the third period, which does not alter the benefit levels compared to under the pre reform state, increases considerably. The third measure decreases by 0.42, which is, as expected, between the previous two measures.

To sum up, this example shows that these three welfare measures can give very different results. The first measure give an almost 70 percent higher welfare loss compared to the compensating variation measure and the second one gives a qualitatively different outcome.

3 Analyzing a Hypothetical Reform of the Swedish Income Security System

3.1 The Swedish Income Security System

This Section describes the different parts of Sweden's income security system briefly. Palme and Svensson (1999 and 2001) give a more complete description.

3.1.1 The Public Old-age Pension System

Sweden's public old-age pension system consists of three parts: a basic pension, a supplementary pension (ATP) and a part time-retirement pension. All Swedish citizens are entitled to the basic pension which is unrelated to previous earnings. The normal retirement age for this pension is 65, but it can from age 60 with a permanent actuarial reduction of 0.5 percent for each month of early withdrawal. If withdrawal is delayed after age 65 the level is permanently increased by 0.7 percent for each month up to age 70.

All social insurance in Sweden are indexed by the basic amount (BA), which follows the CPI very closely. The level of the basic pension is 96 percent of a BA for a singled pensioner and 78.5 percent for married. In the year 2001 the level of one BA was 36 900 SEK.[5] The basic pension also contains a survivor's pension.

The supplementary pension is related to the worker's previous earnings. The amount of the benefit is calculated using the following formula

$$Y_i = 0.6 \cdot AP_i \cdot \min\left(\frac{N_i}{30}, 1\right) \cdot BA,$$

where AP_i is individual average pension points, BA is the basic amount, N_i is the number of years the individual has recorded a pension-rights income greater than zero. The average pension points are calculated as the average of the annual

[5] In 2001 the exchange rate was 1\$ $\approx$ 10 SEK.

earnings below the social security ceiling on 7.5 BA of the worker's fifteen best years during his career. The normal retirement age for the supplementary pension is 65 and the same rules for actuarial adjustment for early and delayed withdrawal as for the basic pension described above applies.

A *partial retirement pension* allows workers aged 61 and older to reduce their hours of work and receive a benefit to replace lost earnings. As of July 1, 1994, the benefit is 55% of the difference in earnings before and after part-time retirement.

3.1.2 Occupational Pensions

Sweden has a highly unionized labor market. More than 95 percent of all employees are covered by central agreements between the unions and the employers confederations. These agreements regulate pension programs and other insurances for the employees. There are four main pension schemes: one for blue collar workers and one for white collar workers in the private sector. In addition to that, there is one scheme for employees in central government and one for workers in local governments.

The blue collar workers in private sector included in our sample are under two different occupational pension schemes. Those born 1927 to 1931 are covered by the STP scheme. The amount of the benefit in this scheme is calculated as 10 percent of the average annual earnings below the social security ceiling of the three best years of the five years between age 55 and 59. At least three years of earning between age 55 and 59 are required to be eligible for the pension. The benefits is paid out starting when the worker is aged 65.

In 1996 the STP scheme was replaced by a fully funded scheme. The cohorts between 1938 and 1940 are covered by a transition scheme and those who are born between 1932 and 1937 are able to choose between STP and the transition scheme. The benefits in this scheme are calculated as 10 percent of annual earning under the social security ceiling after age 30 plus the amount which the worker receives from the fully funded system. The contributions to the fully funded scheme was 2.0 percent of annual earning between 1996 and 1999. The amount was changed to 3.5 percent in 2000.

White collar workers in private sector are in general covered by the ITP and ITPK schemes. The amount of the ITP pension is calculated as 10 percent of the worker's earning the year before retirement up to the social security ceiling at 7.5 BA, 65 percent between 7.5 and 20 BAs, and 32.5 percent between 20 and 30 BAs. The normal retirement age for the ITP pension is 65, but it can be claimed with an actuarial adjustment from age 60. ITPK is a fully funded scheme which was introduced in 1977. The contributions to this scheme amounts to 2 percent of gross annual earnings.

Up to 1992, employees in central government were covered by a gross pension scheme which replaced 65 percent of annual earnings the year before retirement. This scheme was replaced with a net pension which is quite similar to the ITP scheme. However, the benefit is determined on the average of annual earning during the five years preceding retirement. The employees in central government are also covered by fully funded scheme which was introduced in 1992. The contributions to this scheme is 1.7 percent of the annual wage sum.

Finally, employees in local government are covered by a gross pension which is determined by the average of annual earnings of the five best years of the seven years preceding retirement. It replaces 96 percent below 1 BA, 78.5 percent between 1 and 2.5 BA, 60 percent between 2.5 and 3.5 BAs, 64 percent between 3.5 and 7.5 BAs, 65 percent between 7.5 and 20 BAs, and 32.5 percent between 20 and 30 BAs. It can be claimed with an actuarial adjustment from age 60.

3.1.3 Labor Market Insurances

There are three important labor market insurances: the disability insurance (DI), the sickness insurance (SI) and the unemployment insurance (UI). Eligibility for *disability insurance* requires that the individual's capacity to work is permanently reduced by at least 25 percent. Full compensation requires that the capacity is completely lost. Between 1970 and 1991 disability insurance could be granted for labor market reasons. The benefits consists of a basic pension and a supplementary pension (ATP). The level of the basic pension is the same as for the old-age scheme and the supplementary pension is determined in the same way as for the old-age scheme with no actuarial reduction for early retirement. ”Assumed” pension points are calculated for each year between the date of retirement and age 64.

The *sickness insurance* replaces a share of foregone earnings due to temporary illnesses up to the social security ceiling. The replacement level in the insurance has been changed on several occasions during the time period covered by this study. In a reform in 1987 the replacement level was set to 90 percent of the worker’s insured income. Since then, the replacement has been decreased on several occasions. The first time was in a reform in 1991. Since 1996 it is set to 75 percent of the insured income for long sickness spells.

The *unemployment insurance* benefit consists of two parts: one basic part, which is unrelated to the worker’s insured income, and one part which require membership in an unemployment benefit fund and is related to the worker’s insured income. Unemployed workers who actively search for a new job are eligible for compensation. The main difference between the benefit level in the unemployment and sickness insurance is the construction of the ceiling. The ceiling of the latter is the same as for other parts of the social insurance system, while that of the former is not indexed but subject to discretionary changes. The replacement level in the unemployment insurance has also been changed on several occasions during the time period analyzed in this empirical example. These changes have roughly followed the changes in the sickness insurance.

3.1.4 Income Taxes and Housing Allowances

Sweden went through a major income tax reform in 1991. Before the reform, all income were included in the same tax base and taxed with a proportional local government tax (around 30 percent depending on municipality) and a progressive national tax. The maximum marginal tax rate was set to 75 percent. The main elements of tax reform was that the tax base was divided into capital income and earned income. Income from capital are taxed on the national level on 30 percent and earned income are taxed with the local government tax and above a certain break-point by a 20 percent national tax. The marginal tax rates were thus substantially reduced.

Old-age, disability, and survivor's pensioners with low income are entitled to a housing allowance. In 1995, this allowance was at most 85 percent of the housing cost up to a certain ceiling and above a certain floor. About 30 percent of all old-age pensioners received housing allowances.

3.2 Data

We use the Longitudinal Individual Data (LINDA) panel. LINDA is a pure register sample. It contains data from the Income and Wealth register, which is a register containing data from the income tax returns for the entire Swedish population; the Population Census, which is data on primarily on occupation and housing conditions from mailed questionnaires made every five years to the entire population; the National Social Insurance Board registers, which contains data on contributions to the pension schemes. The sample size of LINDA is about 300 000 individuals. It is a panel and data on the detailed income components are available from 1983 and onwards. Contributions to the national supplementary pension scheme (ATP) are available from 1960.

We have selected men, as we want to keep the analysis as focused as possible, born between 1927 and 1940. They should also be at least 50, employees and have not emigrated when we start to observe them. Since, e.g., the youngest cohort, born in 1940, are just are just 43 years old in 1983, we exclude the first seven observations for each individual from this cohort. The reason for excluding self-employed is that the quality of the income data, since they can always accumulate wealth within their business, can be questioned. Furthermore, it is not possible to obtain information on their pension rights from the data.

When these selections were made 15,619 observations remained from the originally 22,375 in the included cohorts. The total number of observations from these individuals are 127,390.

Table 3 shows the distribution of main income source the year after the worker's exit from the labor market. It is notable that almost 35 percent of the newly retired receive their main income from the labor market insurances - in particular the sickness and unemployment insurance. A closer analysis of how they change

1.	State old-age pension	33.70
2.	Occupational pension	13.68
3.	Disability pension (DI)	6.55
4.	Survivor's pension	-
5.	Wife's supplement	0.02
6.	Severance payments from employer	0.60
7.	Private pension	0.86
8.	Sickness insurance	20.53
9.	Unemployment insurance	8.35
10.	Partial retirement benefit	10.04
11.	No income source more than 50 %	5.67

Note: The 10.02 percent of the sample who not yet retired by the end of the panel are included in source 1. Source 5 also includes some other minor benefits in addition to wife's supplement.

Table 3: Percentage share of the pathways to permanent exit from the labor market showing main source of income (more than 50 percent from the indicated source); cohorts born 1927-1932; by gender.

main income source after retirement shows that those who use the sickness and unemployment insurance as a main income source immediately after retirement switch after on average about two years to disability insurance. This analysis also shows that older workers on average switch faster to disability insurance.

3.3 Estimation

A problem in the estimation of the model is the possible endogeneity of the benefit levels. As is apparent from the previous Section, a large fraction of those who permanently exit from the labor market relatively early on use the labor market insurances as main income source after retirement. The level of the benefits are in general higher for the labor market insurances compared to in the old-age pension system. If the labor market insurances were available for all workers in the sample the benefit level of these be used for the variable measuring the benefit levels. However, this is obviously not the case since there is a health test for being eligible for both sickness as well as the disability insurance and a requirement of active search for being eligible for unemployment insurance. If the benefit levels of the labor market insurances were used it would predict larger economic incentives for leaving the labor market than they actually act on. This will, in turn, lead to that the effect of economic incentives on retirement will be underestimated. On the other hand, if the more generous benefit level of the labor market insurances are allocated only to those who use these insurances when retiring we will overestimate the effect of the economic incentives since these workers tend to leave the labor force early on.

We use a pseudo-IV, or probabilistic, approach to deal with this problem. This requires that when calculating the benefit variable we should assign the probability of each path out from the labor force actually seen in the data. Since we discovered a very large number[6] of different paths out of the labor force in the data we will for practical reasons follow a simplified approach.

In the first step, we will construct a ”synthetic” insurance path. We use the

[6] 911 in the entire sample.

observation that the most common route for those who retire by using labor market insurances is to use the sickness or unemployment insurance for some time before they switch to disability insurance. Figure **??** shows that the time period on sickness or unemployment insurance is highly related to the worker's age. It also shows that the average time can be fairly accurately described by a second order polynomial. For each age we use the predicted time period before the switch to disability insurance from the polynomial in age, i.e., we assume that at this age the worker can expect the predicted time with the higher benefit level from the sickness or unemployment insurance if he is eligible for getting compensation from a labor market insurance before he switch to the disability insurance. Since the benefit level of sickness and unemployment insurances are quite similar we will, to facilitate, use the benefit level of the sickness insurance for both.

In the second step we estimate a probit regression with the dependent variable is being eligible for a labor market insurance and the independent variables are a polynomial in age and indicator variables for county of living, socio-economic group, and education level. We then predict the probability for each individual to get compensation from a labor market insurance. Finally, we calculate the benefit variable as

$$SSW = SSW_{OAP} + p\left(SSW_{LI} - SSW_{OAP}\right). \tag{31}$$

where SSW_{LI} is the social security wealth for the ”synthetic” labor market insurance path to retirement, SSW_{OAP} is the social security wealth if the old-age pension alternative is used and p is the predicted probability of being eligible for a labor market insurance.

3.4 Estimation results

The estimates of the binary logit model as described in equation (**??**) is shown in Table **??**. To save space, the estimated parameters for each county is omitted[7].

[7] The parameters for 23 county dummies were estimated, with maximum 1.1, minimum -.13, mean .35, standard deviation .31.

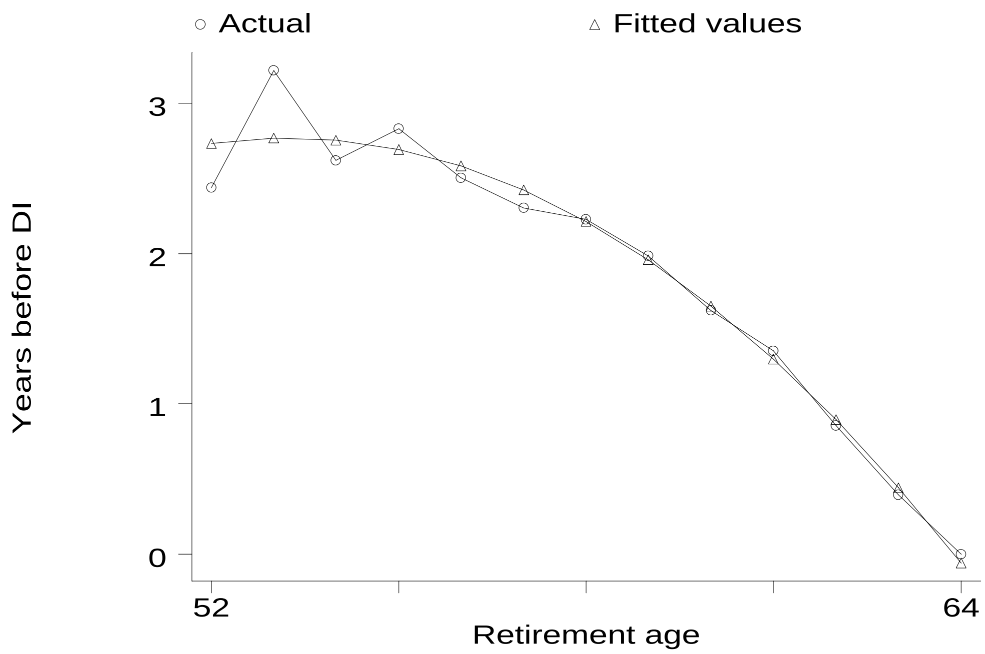

Figure 2: Fitted values from regressing the average number of years with sickness or unemployment insurance as the main source of income before DI becomes the main source on a quadratic function in retirement age along with actual sample averages.

Figure 3: Fitted values from regressing the average number of years with sickness or unemployment insurance as the main source of income before DI becomes the main source on a quadratic function in retirement age along with actual sample averages.

The dissimilarity parameter could not be estimated to be significant different from zero. For numerical reasons, the likelihood function becomes undetermined as μ approaches zero, and it is difficult to estimate this parameter close to zero. From the estimation result, it is clear that the log likelihood function attains it maximum at a dissimilarity parameter that could not be significantly different from zero. This gives empirical support to assuming that only the *maximum* of future utilities is the adequate variable when modeling the timing of retirement. Therefore, we conclude we have empirical support for the maximum approach suggested by Stock and Wise (1990).

3.5 Welfare Analysis of Hypothetical Reforms

3.5.1 Two Hypothetical Reforms

This Section presents a welfare analysis of a hypothetical reforms of the Swedish income security system. In in later elaborations of this paper, we will consider two reforms. The first reform is designed to have very clear and predictable welfare effects, in that the retirement probability will decrease for individuals at all ages. Therefore, as in our numerical example, individuals will only change their behavior by delaying their retirement. The hypothetical reform is constructed by decreasing lifetime pension benefits by 10 %, while lifetime earnings if not retiring is decreased by 5 %. In later version of this paper we will also consider a second hypothetical reform where the current system, including labor market insurances, is replaced by a benefit which replaces 55 percent of labor earnings the year before retirement. The ”normal” retirement age is 65, but the benefit can be claimed from age 60 with an actuarial adjustment of 6 percent per year of early withdrawal. It can also be delayed with a symmetric actuarial adjustment.

3.5.2 Results of the Welfare Analysis

As we described in Section 2.2, the expected CV measure can be calculated for each individual in each point of time. Figure 4 shows the distribution of the

	MNL		NL	
variable	coeff	t-stat	coeff	t-stat
const	-4.6541	-20.418	-4.6482	-19.799
α_W	0.03598	2.104	0.03123	1.4673
α_R	0.19262	3.994	0.20405	4.1272
SSW	-0.52763	-3.6923	-0.54652	-3.8238
married	0.040702	0.43186	0.043933	0.46415
EduLevel 1=	0	–	0	–
EduLevel 2	0.43969	1.908	0.43955	1.9085
EduLevel 3	0.47023	4.1413	0.47088	4.1479
EduLevel 4	0.27065	1.9857	0.26977	1.9798
EduLevel 5	0.20815	1.2482	0.20874	1.2518
EduLevel 6	0.13942	0.80177	0.13895	0.7989
Avt 1=0	0	–	0	–
Avt 2	-0.13655	-1.2229	-0.13824	-1.2431
Avt 3	0.16632	1.2707	0.16103	1.2299
Avt 4	-0.35077	-2.5269	-0.35115	-2.5255
age	0.27942	16.919	0.28026	16.783
λs	–	–	0.02	–
log of likelihood	-2438.5		-2439.9	

Table 4: Estimation results.

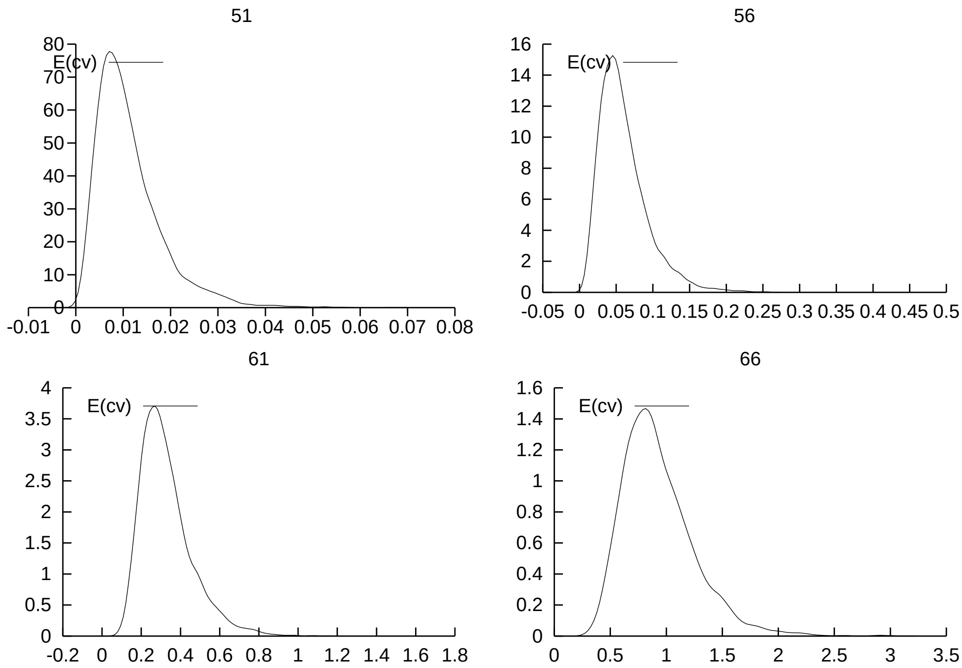

Figure 4: Expected compensating variation for retirement age 51,56,61, and 66.

predicted expected CV measures for the first hypothetical reform for four different age groups.

The mean and the dispersion of the distribution increases with age. The reason for this pattern is that in relatively young ages the probability of retiring is relatively low for all workers. This implies that very few require the maximum compensation in the group of workers who are retired under both the pre- and post-reform regimes. Furthermore, the workers will be predicted to have a very small probability to change state as a result of the reform. Therefore, the compensations will be very small for all in young ages. However, in older ages, the probability of being retired as well a switching state as a result of the reform will both increase the mean and the variance of the expected compensations.

In the numerical example in Section 2.2 we established three different measures

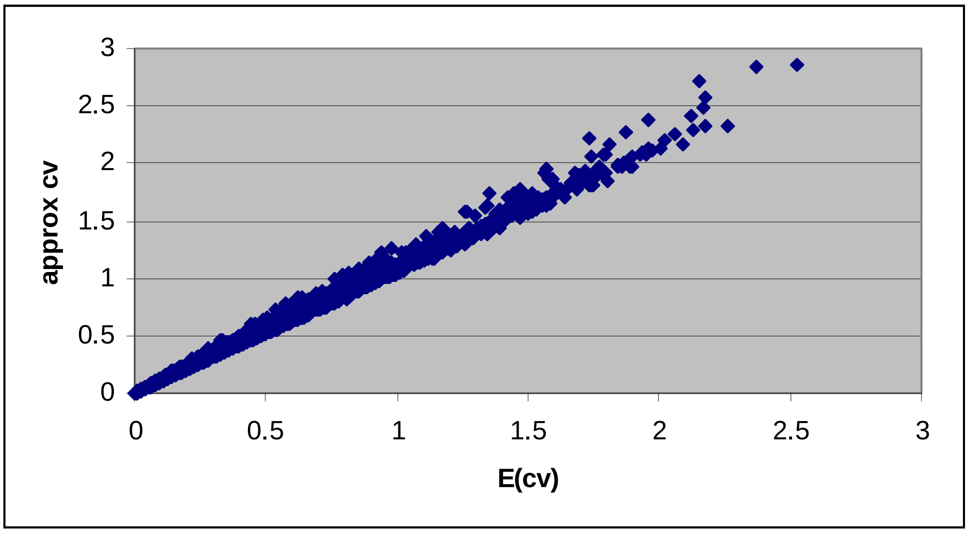

Figure 5: Expected compensating variation, compared with the approximated welfare measure given by expected lifetime income change, $P_R^o \cdot c_{\max}$, assuming behavioral change.

of the individual welfare effect of social security reforms. We will use these three measures in the welfare analysis of the hypothetical reforms. The first measure, the change in social security wealth were changes in labor market behavior are ignored, is included since it is probably the most common way to analyses the effects of such reforms in the public policy debate.

The difference between a measure based on the expected decrease of lifetime earnings, ignoring behavioral response, and the more exact expected compensated variation as derived in Section 2, can be illustrated by Figure 5, where the approximation is plotted together with the true expected CV for a sample of individuals for each time period. The approximation is, as expected, an overestimation of the true welfare change, and increases with the size of the welfare impact. For small changes, the approximation is certainly a good approximation, while the error becomes larger for those experiencing a larger welfare impact.

The second measure, the change in the social security wealth where predicted changes in labor market behavior, is, in addition to being the best possible income based welfare measure, a prediction on the implied budget effects of the reforms. By relating the predicted budget effects to third measure, the aggregate welfare loss implied by the reform measured as the present value of CV, we get a measure of the efficiency of the reform.

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4 Conclusions

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Group	Mean of CV, measure 3	Mean life-time labor income
Socio-economic Group		
Blue collar workers	1.90	106
White collar workers	3.36	158
Contral government workers	2.28	130
Local government workers	1.94	143
Education Level		
Compulsory schooling	2.02	109
Vocational schooling	2.25	123
Highschool	2.13	155
University/College	2.14	195
Total	2.11	131

Table 5: Results of the welfare analysis for the three different reforms.

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Decile	Mean of CV, measure 3	Share of CV, measure 3	Share of lifetime income from labor
1	2.05	0.097	0.0485
2	2.28	0.108	0.0697
3	2.20	0.104	0.0761
4	2.12	0.101	0.0815
5	2.01	0.095	0.0870
6	1.97	0.094	0.0931
7	2.01	0.095	0.1009
8	1.93	0.092	0.1117
9	2.08	0.099	0.1302
10	2.40	0.114	0.2013
Total	2.11	1	1

Table 6: Results of the welfare analysis for the three different reforms.

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