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Idiosyncratic Risk in the United States and Sweden: Is There a Role for Government Insurance?[1]

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We examine the effects of government redistribution schemes in an economy where agents are subject to uninsurable, individual specific productivity risk. In particular, we consider the trade-off between positive insurance effects and negative distortions on labor supply and saving. We parameterize the model by estimating productivity processes on Swedish and U.S. data. The estimation results show that agents in the United States are subject to more idiosyncratic risk than agents in Sweden. Although distortions are significant, the welfare benefits of government redistribution and insurance systems can be substantial. *Journal of Economic Literature* Classification Numbers: E20, H21.

Key Words: idiosyncratic risk; inequality; social insurance; redistribution; distributions.

1. INTRODUCTION

Two important motivations for government taxation are that it provides insurance of individual specific income variations if private insurance

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markets are absent and that it redistributes wealth from those who were born lucky to those who were not. As all feasible tax systems are to some extent distortionary, there is a trade-off between insurance and redistribution on the one hand and efficiency on the other. In some countries, such as Sweden, taxes are considerably higher than in other countries, for example, the United States; tax receipts are over 50% of GDP in Sweden but only 30% of GDP in the United States. Can these differences in tax levels be motivated by differences in income distributions and income risks? Obviously, there are other reasons for government taxation than those mentioned. A more interesting question is how much government taxation is motivated by insurance and redistribution arguments.

There are two main purposes of this paper. The first is to estimate the degree of individual specific income risk in Sweden and the United States and the second is to investigate to what extent government insurance via taxes and transfers should be provided. To quantify the degree of idiosyncratic risk in the respective countries, we use micro data on wages and hours worked. The estimated wage processes are then used to parameterize a general equilibrium model, in which labor supply is endogenous and agents are subject to a no-borrowing constraint. We assume that the government uses proportional taxes to redistribute income among agents and that the government wishes to maximize the ex ante utility of agents.

The wage processes are found to be highly persistent in both countries, especially in the United States. The variance of temporary as well as permanent wage shocks is also higher in the United States. Consequently, the wage uncertainty in the United States seems to dominate that in Sweden by any measure.

In the absence of tax distortions, it would be optimal for the government to redistribute almost all income equally across agents. However, we find that distortions are significant. When we calibrate the model with the estimated wage processes, the optimal level of transfers is 2% of output in Sweden and 15% in the United States for our baseline calibration, whereas the corresponding levels in the data are 21% in Sweden and 8% in the United States. The welfare gains of changing to the optimal insurance levels are 8% of annual consumption in Sweden and 2% in the United States. The results are sensitive to the parameterization of the utility function. For the alternatives we consider, the optimal transfer level varies between 0 and 7% in Sweden and between 7 and 21% in the United States.

The calibrated models also imply Laffer curves. These curves are of separate interest since there may be reasons for taxation in addition to the insurance motive, for example, the provision of public goods. We find that the Laffer curves peak when tax rates on labor income are high, approximately 50% or more. As a fraction of total production, taxes levied are then around 45%. The shape of the Laffer curve depends on the labor-supply elasticity and on the level of other taxes, but seems to be invariant to a variety of other changes in parameter values and specifications of the model.

Our paper is closely related to that of Aiyagari and McGrattan (1998). They consider the welfare effects of government debt in a model where agents face idiosyncratic and uninsurable wage uncertainty and are subject to a no-borrowing constraint. Government debt increases the liquidity in the economy and effectively loosens the borrowing constraint for individuals, but it also has negative side effects. Distortive taxation is needed to finance interest payments, and debt crowds out accumulation of real capital and hence lowers production in the economy. For their benchmark calibration of the model, Aiyagari and McGrattan find the optimal level of government debt in the United States to be 2/3 of GDP. The income tax rate needed to sustain this debt is approximately 8 percentage points higher than in the economy with no debt. However, the welfare loss of having no debt at all instead of the optimal level would be less than 0.1% of consumption. Recent work by Floden (forthcoming) confirms that, in providing insurance, government debt is a weak instrument compared to direct transfers. In addition to allowing for government debt and not considering variations in the transfer level, the key difference from our paper is that Aiyagari and McGrattan use a considerably less persistent and slightly less volatile wage process than what we found in U.S. data.

The persistence and magnitude of wage shocks is indeed central for our results. Much previous work, for example, Heaton and Lucas (1996), Aiyagari (1994), Aiyagari and McGrattan (1998), and Krusell and Smith (1997, 1998), has built on less volatile income or wage processes. In these papers, the effects of uninsurable idiosyncratic risk are in most cases small. When the persistence of shocks is low, a small buffer of wealth offers good insurance against bad outcomes, and most agents are able to build up such a buffer. Heaton and Lucas estimate the AR(1) coefficient to be 0.53 in annual U.S. income. Our estimation, and similar estimations by Card (1991), Hubbard et al. (1994), and Storesletten et al. (1997), result in higher persistence—we estimate a coefficient of 0.91 for the United States and 0.81 for Sweden.

There are two main differences between Heaton and Lucas' approach and that of the latter papers. First, Heaton and Lucas remove the mean from individual income series, while we estimate permanent wage differences based on observable characteristics such as education, occupation, and age. One has to take a position on what uncertainty agents face and what information agents have about their own level of productivity. Consider two agents with similar background in the beginning of the sample.

One gets the income series 10, 11, 12, while the other gets the income series 10, 11, 6. Could the bad third-period outcome have happened to the first person, or is there an inherent difference between these two individual? If there is such a difference, did the agents know about it in the first period? Second, the latter papers allow for measurement error in wage and income data. If measurement errors exist but are neglected, the estimated persistence will be downward biased.

Hansen and İmrohoroğlu (1992) explored the potential benefits of unemployment insurance in an economy where agents are subject to unemployment risk. The capital stock is exogenous, as is the working time of the employed. They find that unemployment insurance has positive welfare effects, as long as unemployed can be forced to accept all job offers. The result in that setting is not surprising since neither taxes nor unemployment benefits have any distortionary effects. Hansen and İmrohoroğlu also consider the case where unemployed can, with some probability, reject job offers but still keep their benefits. Allowing for these moral hazard considerations, the welfare gains of unemployment insurance become small or even negative.

Our paper is different from Hansen and İmrohoroğlu's in several ways. First, the uncertainty and heterogeneity we consider is richer and more important. Hansen and İmrohoroğlu only allow for two different income states, employment and unemployment, and the amount of persistence in this process is negligible. For example, the expected earnings in a six-week period one year from now for an unemployed worker is 99.7% of the expected earnings of an agent who is employed today, if unemployed agents accept all job offers. Second, the possible distortions from the insurance programs in the two papers are quite different. In our paper, since the capital stock is endogenous, government policy will affect the return agents get on their private savings. As the insurance program becomes more extensive, savings fall and the interest rate increases. The cost of self-insurance is then effectively reduced. Moreover, we allow for taxes and transfers having effects on labor supply, not only on the extensive margin, but also on hours worked for those who work. On the other hand, we do not allow for an explicit unemployment state, as Hansen and İmrohoroğlu do.

Some important assumptions underlying our study are worth commenting on. We abstract from aggregate uncertainty. The motivation for doing so is that a number of studies, for example, İmrohoroğlu (1989) and Krusell and Smith (1999), indicate that aggregate uncertainty is negligible in this setting. Also, the estimation results in Heaton and Lucas (1996) show that aggregate shocks only account for a few percent of the variability in household income.

We rule out private insurance contracts by assumption.[2] This market failure can be motivated by assuming that agents cannot observe each others' income. The government, on the other hand, is assumed to observe agents' income but not their productivity. Moreover, the government, contrary to private institutions, can force agents to participate in programs that have negative expected value for specific individuals. It should also be pointed out that the intention of this paper is not to look for efficient contracts and redistribution schemes. It is, for example, possible that it would be more efficient to condition tax rates and transfers on the income that agents have. Thus when we use the phrase "optimal tax," we do not mean this in a strict sense.

We do not explicitly allow for unemployment when estimating the wage process. Instead, we assume that log productivity (that is, the log of the relative wage) follows an AR(1) process, but we have in mind that individuals with low productivity are unemployed. However, unemployed workers need not be completely unproductive. There are, for example, opportunities for home production or informal services. Consequently, we believe that an "unemployed" person with no accumulated wealth and no or very low guaranteed income will spend much of his time on some kind of working activity.

The structure of the paper is as follows. In the next section, we outline the model, describe how to parameterize it, and describe how to compute the equilibrium. The data and the strategy used to estimate the wage processes in Sweden and the United States are then presented in Section 3, together with the results of these estimations. In Section 4, we first evaluate the performance of the model. We then consider policy experiments and look for the optimal size of insurance programs. In Section 5, we try to assess how sensitive the results are to parameter choices. We also consider some changes in the specification of the model. Finally, Section 6 concludes.

2. THE MODEL

Consider an economy with a continuum of ex ante identical agents. Each year a fraction γ of the agents dies and new agents with no asset holdings enter the economy. Each agent is endowed with a level of productivity, $q_t^i = e^{\psi^i + z_t^i}$, where ψ^i is a permanent component and z_t^i is a

[2] There is a significant literature studying such contracts in models with information asymmetries. Recent contributions are Atkeson and Lucas (1995) and Cole and Kocherlakota (1998).

temporary component. The temporary component evolves stochastically over time according to the process

$$z_t^i = \rho z_{t-1}^i + \varepsilon_t^i, \tag{1}$$

where ρ determines the degree of persistence in the temporary productivity shocks. The permanent component ψ^i and the temporary shock ε^i are both assumed to be i.i.d. normally distributed with mean zero and variance σ_ψ^2 and σ_ε^2, respectively. Hence, the lower bound of the possible realizations of the productivity level is zero.

Each agent is also endowed with one unit of time, which is divided between labor, h, and leisure, l. There is no aggregate uncertainty in the economy. The interest rate, the wage rate, and the aggregate labor supply and capital stock will therefore be constant. The government insures agents by transferring b to each agent in every period.[3] These transfers are financed by proportional taxes on labor income (τ^h), capital income (τ^k), and consumption (τ^c). An agent's disposable resources are then

$$y_t^i = b + (1 - \tau^h) w q_t^i h_t^i + \left[1 + (1 - \tau^k) r\right] a_t^i,$$

where $(1 + r)a_t$ is the agent's asset holdings in the beginning of the period. The agent's budget constraint is

$$(1 + \tau^c) c_t^i \leq y_t^i - \hat{a}_{t+1}^i, \tag{2}$$

where $\hat{a}_{t+1}^i$ is the assets the agent chooses to hold for the next period.

In the beginning of a period, after new agents are born, a fraction γ of the population is randomly picked to be heirs to the deceased agents. The wealth of the deceased agents is then evenly distributed among the heirs.[4] Let g_t^i denote agent i's received bequests in period t, and let $\bar{a}$ denote the average wealth of an agent. Then $g_t^i = \bar{a}$ with probability γ and $g_t^i = 0$ with probability $1 - \gamma$.

A crucial assumption in the model is that agents are subject to a no-borrowing constraint, i.e., that $\hat{a}_t \geq 0$. This assumption is not entirely ad hoc. If government transfers cannot be used as a security for loans, the lower bound on the present value of future incomes is zero.[5] In that case there is no positive debt which an agent can repay for sure.[6]

[3] A more efficient redistribution scheme would condition transfers on agents' productivity level, but we assume that q is unobservable to the government.

[4] This is similar to Huggett's (1996) "accidental bequests."

[5] Alternatively, the transfer can be in a nontradable form.

[6] See Aiyagari (1994) for a discussion of this.

Let s_t^i denote the exogenous productivity state of agent i, $s_t^i = (\psi^i, z_t^i) \in \mathbf{S}$. The agents' asset holdings are restricted to be in the interval $[0, \overline{A}] = \mathbf{A}$, where $\overline{A}$ is chosen high enough to never be a binding restriction. Further, let $\lambda(a, s)$ be the measure of agents, and normalize the mass of agents to unity.

Agents maximize their expected lifetime utility,

$$U_0 = E_0 \sum_{t=0}^{\infty} (1-\gamma)^t \beta^t u(c_t^i, l_t^i),$$

where β is the time discount rate. The Bellman equation to the consumer's problem is then

$$v(a_t^i, s_t^i) = \max_{\{\hat{a}_{t+1}^i, h_t^i\}} u(c_t^i, l_t^i) + (1-\gamma)\beta E\left[v(a_{t+1}^i, s_{t+1}^i) \mid \hat{a}_{t+1}^i, s_t^i\right] \quad (3)$$

subject to (2), and

$$h_t^i + l_t^i = 1,$$

$$a_t^i = \hat{a}_t^i + g_t^i,$$

$$h_t^i \geq 0,$$

$$\hat{a}_{t+1}^i \geq 0.$$

Each period the government has tax incomes given by

$$T(\tau, b) = \int_{\mathbf{A}\times\mathbf{S}} \left[\tau^h w q(s) h(a,s) + \tau^k r a(a,s) + \tau^c c(a,s)\right] d\lambda,$$

where h, a, and c are the agent's decision rules for labor supply, saving, and consumption, and $q(s)$ is the productivity level associated with state s. In addition to the lump sum transfers, $B = \int b \, d\lambda$, the government must finance public consumption C^G which is exogenously fixed (as a proportion of output). Its per period expenses are thus

$$G = B + C^G.$$

There is a continuum of firms which have Cobb–Douglas production functions and behave competitively in product and factor markets. Let K denote the aggregate capital stock and let H denote the aggregate labor supply in efficiency units; i.e., $H = \int q(s) h(a,s) \, d\lambda$. Aggregate production is then given by

$$F(K, H) = K^{\theta} H^{1-\theta}.$$

Finally, let δ denote the depreciation rate of capital.

2.1. Equilibrium

A stationary equilibrium of this economy is given by (i) constant tax rates, $\tau = [\tau^h \tau^k \tau^c]$, and a level of transfers b, (ii) a constant interest rate r and wage rate w, (iii) time invariant decision rules for agents' asset holdings, $\hat{a}^i_{t+1} = \hat{a}'(a^i_t, s^i_t; \tau, b, r, w)$, and hours worked, $h^i_t = h(a^i_t, s^i_t; \tau, b, r, w)$, (iv) a measure of agents over the state space, $\lambda(a, s)$, (v) aggregate values for asset holdings, $A(\tau, b, r, w) = \int \hat{a}'(a, s)\, d\lambda$, and for the number of efficiency hours worked, $H(\tau, b, r, w) = \int q(s) h(a, s)\, d\lambda$, such that the following equilibrium conditions are fulfilled:

—The decision rules solve agents' maximization problem, given by (3).

—Tax revenues equal government expenses,

$$T(\tau, b, r, w) = G(\tau, b, r, w).$$

—Factor markets clear,

$$r = F_K(K, H) - \delta,$$

$$w = F_H(K, H).$$

—Aggregate supply of savings is equal to firms' demand for capital,

$$(1 + \gamma) A(\tau, b, r, w) = K(\tau, b, r, w).$$

—The measure of agents over the state space is invariant; i.e.,

$$\lambda(\mathbf{a}, \mathbf{s}) = \int_{\mathbf{A} \times \mathbf{S}} P(a, s, \mathbf{a}, \mathbf{s})\, d\lambda,$$

for all $\mathbf{a} \times \mathbf{s} \subseteq \mathbf{A} \times \mathbf{S}$. The transition function P is the probability that an agent with state (a, s) will have a state belonging to $\mathbf{a} \times \mathbf{s}$ next period,

$$\begin{aligned} P(a, s, \mathbf{a}, \mathbf{s}) = \int_{\mathbf{s}} \Big\{ & (1-\gamma)^2 \mathscr{I}[\hat{a}'(a, s) \in \mathbf{a}] \\ & + (1-\gamma)\gamma \mathscr{I}[\hat{a}'(a, s) + \bar{a} \in \mathbf{a}] \\ & + \gamma(1-\gamma) \mathscr{I}[0 \in \mathbf{a}] + \gamma^2 \mathscr{I}[\bar{a} \in \mathbf{a}] \Big\} \Gamma(s, ds'), \end{aligned}$$

where $\mathscr{I}$ is an indicator function and $\Gamma(s, \mathbf{s}')$ is the probability that the exogenous state next period belongs to $\mathbf{s}' \subseteq \mathbf{S}$, given that it is s today.

2.2. Computation of Equilibrium

To find the agent's decision rules for saving and labor supply, we discretize the state space and make a piecewise linear approximation of agents' decision rules over this.[7] To solve for the equilibrium, we use an algorithm inspired by Huggett (1993) and Aiyagari (1994). The algorithm consists of the following steps: Fix the tax rates, τ, and guess an interest rate, r, and the average efficiency hours of labor supply, $\hat{H}$. Then solve for the capital stock K, aggregate consumption C, and the wage per efficiency unit of labor as functions of r and $\hat{H}$, and calculate the transfer level implied by government budget balance, by setting $B = \tau^h \hat{H} w + \tau^k K + \tau^c C - C^G$. The agents' decision rules are then solved for and average asset holdings and efficiency hours worked are calculated from simulations.[8] If the implied aggregate saving of agents does not equal firms' demand for capital, or if the implied labor supply is different than the guess, then make new guesses and start over. If both equalities hold, the equilibrium of the economy with tax rates τ has been found.

2.3. Parameterization

We have calibrated one benchmark economy for each country. In these economies government policy is specified to be similar to actual policy (we refer to this as the benchmark policy), and parameter values are set to their empirical counterparts (the baseline calibration).

The benchmark policy consists of three tax rates, τ^h, τ^k, τ^c, the transfer b, and public consumption C^G. We let τ^h be determined by the government's budget constraint. For the United States, we set $\tau^k = 0.397$ and

[7] More precisely, we solve the Euler equation by fitting a cubic spline between gridpoints. In the simulations, the decision rules for asset holdings are approximated with piecewise linear functions. Consumption and labor decisions are solved as functions of asset choices and are therefore allowed to be nonlinear between gridpoints. The state space is approximated by a grid consisting of 50 values for asset holdings, 1 high and 1 low value for the permanent shock, and 7 values for the temporary productivity level. The AR(1) process for productivity is approximated with the algorithm by Tauchen (1986). We use a spread of $\pm\, 3\sigma_\varepsilon/(1-\rho^2)^{1/2}$ for the productivity grid. The step size in the grid for asset holdings is increasing in wealth.

[8] We simulate an economy populated by 100 agents with low permanent productivity and 100 agents with high permanent productivity for 2500 periods. When one agent dies, he is replaced by a new agent with no accumulated wealth. The initial productivity of this agent is drawn from the stationary distribution of the productivity process. We discard the first 500 periods and use the remaining 400,000 observations to calculate statistics for the economy.

$\tau^c = 0.054$ (Domeij and Heathcote, 2000), $B/Y = 0.082$ and $C^G/Y = 0.217$ (Aiyagari and McGrattan, 1998). For Sweden, we set τ^k to 30% which has been the flat tax rate on capital income since 1991, $\tau^c = 0.177$ (Lindé, 1998), $B/Y = 0.212$, and $G/Y = 0.291$ (averages from the SNEPQ data base for 1970–1993).

For our baseline calibration, the agents' utility function is assumed to be in the class of CES utility functions with unit elasticity of substitution between consumption and leisure; i.e.,

$$U(c_t, l_t) = \frac{\left(c_t^{\alpha} l_t^{1-\alpha}\right)^{1-\mu}}{1-\mu}.$$

This utility function has been extensively used in the real business cycle literature and it is consistent with the observation that hours worked have remained more or less constant although real wages have increased sharply the last century. However, evidence from microstudies (for example, MaCurdy, 1981, and Altonji, 1986) indicates that the intertemporal elasticity of labor supply is smaller than what is implied by this specification of utility. When doing sensitivity analysis, we consider a utility function with less elastic labor supply.

We set the inverse of the intertemporal elasticity of substitution, μ, to 2 which implies that the risk aversion toward consumption fluctuations is 1.5. The time discount rate, β, is calibrated so that the capital-output ratio equals 2.0 in Sweden (De Nardi, 2000) and 2.6 in the United States (Prescott, 1986).[9] The death probability, γ, is set to 2%. Hence, the average length of an agent's work life is 50 years.

The parameter α is set to 0.50. This implies that the average time an agent spends in market activities under the benchmark policies is 36% of available time in the United States and 28% in Sweden. In data we see that people work less in Sweden than in the United States although the difference obtained here is somewhat large. However, since α affects attitudes to risk and the labor supply elasticity we chose not to calibrate separate values of α for the two countries. In the sensitivity analysis, we see that the choice of α is of little importance.

On the production side of the economy, the capital share, θ, is set to 0.36 and the depreciation rate of physical capital, δ, is set to 1% per year. These values are consistent with empirical findings for both countries (see, e.g., Prescott, 1986; Hansson, 1991).

The parameters ρ, σ_{ψ}^2, and σ_{ε}^2 in the productivity process are estimated in the next section.

[9] The implied values for β are 0.9632 for Sweden and 0.9822 for the United States.

3. DATA AND ESTIMATION

In this section, we discuss the data sets for the United States and Sweden and how we estimate the productivity processes in (1). Our measure of productivity, which captures the degree of individual specific risk in the model, is an agent's hourly wage rate relative to all other agents.

3.1. Data

We use the Panel Study of Income Dynamics (PSID) data set for 1988 to 1992 to estimate ρ, σ_ψ^2, and σ_ε^2 for the United States.[10] For Sweden we use the Household Income Survey (HINK) for the years 1989, 1990, and 1992. HINK is a two-year overlapping household panel collected by Statistics Sweden, but in 1992 the collected panel is partly the same as in 1989 and 1990.

Our measure of productivity is a worker's hourly wage rate relative to all other agents. To obtain these data, we proceed as follows: For the United States, we only look at individuals who were heads of the same household in the 1988 to 1992 surveys and who were in the labor force (working, unemployed or temporarily laid off) all of these years. To avoid problems with oversampling of poor people in the PSID data set, we exclude people stemming from the Survey of Economic Opportunity sample. We also exclude people for whom relevant data on labor supply and earnings are of poor quality (major assignments or top-coding have been done). For Sweden, we look at adults who remained in the same household and who were in the labor force all of these years.[11]

The measure of the hourly wage which interests us is one which will hold for a wide range of hours worked for a specific individual. For example, someone who was unemployed 1000 hours in a year and worked 900 hours at the wage rate 8 dollars per hour is not assigned a wage of 8 dollars per hour but rather $8 \times 900/1900 = 3.79$ dollars per hour. Of course, unemployment is to some extent voluntary since most people could get some job at some small but positive wage rate. We will not control for this problem of inference when estimating the wage process. To avoid some of the worst problems, however, we assume that nobody has a wage rate less than 10% of the average wage. This assumption also captures our

[10] The reason for not using a longer period is that the sample size becomes considerably smaller. The period 1988–1992 is chosen to match the Swedish data period.

[11] We include all adults for Sweden, and not only the heads of households, since there is no good definition of "heads" in the HINK database and since it is very common in Sweden that both men and women in a household participate in the regular labor market. Consequently, the share of women is higher in the Swedish sample.

TABLE I
Descriptive Statistics for Relative Wages

	United States					Sweden		
Statistic	1988	1989	1990	1991	1992	1989	1990	1992
$\overline{W}$	12.48	13.31	14.11	14.79	15.60	71.20	81.42	88.83
Std(w^i)	0.64	0.62	0.65	0.66	0.71	0.40	0.40	0.45
Max(w^i)	8.18	5.53	8.27	10.11	12.14	4.63	4.53	4.82
Min(w^i)	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10

Note. $\overline{W}$ is the average hourly wage in USD and SEK, respectively. w^i is the relative wage, Std(w^i) the standard deviation in w^i, and Max(w^i) and Min(w^i) are the maximum and minimum relative wage in the constructed relative wage series in a given year.

belief that all agents have some productivity, although some activities are unobservable in data.

For the United States, we calculate work hours supplied as the sum of the variables hours worked, hours in unemployment, and work hours lost due to illness. These are directly observable in the PSID. For Sweden, we calculate work hours supplied as the sum of the variables hours worked and work hours lost due to illness, which are directly observable in the HINK. To this sum, we then add the estimated time in unemployment, since time spent in unemployment is not directly observable in the HINK.[12]

For people spending most of their time out of the labor force, it is difficult to infer the wage they would get if working more. Therefore, all agents with less than 1000 work hours supplied are excluded from the sample. The hourly wage rates in a year for the 1789 and 2856 persons remaining in the sample for the United States and Sweden respectively are then computed as the wage sums divided by the total work hours supplied.[13]

We are only interested in fluctuations in relative wages. Therefore, we remove year effects in the data by expressing agent i's hourly wage rate as a function of the average hourly wage rate in that year, and we denote this by w_t^i.

Descriptive statistics for the constructed relative hourly wages are reported in Table I. For information, we also include the average hourly rate $\overline{W}$ in USD for the United States and in Swedish Kronor (SEK) for Sweden

[12] The estimated time in unemployment is an increasing function of the unemployment benefits such that the total sum of hours worked for an individual who has received unemployment benefits is set equal to the stipulated work time in Sweden, which presently is 2080 hours per year.

[13] All the definitions of variables and the data programs are provided in an appendix which is available on request from the authors. However, the HINK data set is not available upon request without a permission from Statistics Sweden.

in the table. We see that the variability in the relative wage series is larger in the United States than in Sweden and slightly increasing over time in both countries. The minimum relative wage is 0.10 for all years as a consequence of our assumption that no individual has a wage lower than 10% of the average. However, it should be noted that this adjustment has been made for very few individuals.[14]

3.2. Estimation

Taking logarithms of the data, we now observe $x_t^i \equiv \ln w_t^i$ for $t = 1988$ to 1992 in the United States and $t = 1989$, 1990, and 1992 for Sweden. We want to estimate the process

$$\begin{aligned} x_t^i &= \psi^i + z_t^i + \xi_t^i, \\ z_t^i &= \rho z_{t-1}^i + \varepsilon_t^i, \end{aligned} \tag{4}$$

where we allow for a measurement error ξ and where $\psi^i + z^i$ is the logarithm of the wage rate for agent i, relative to all other agents. Both ε and ξ are assumed to be identically and independently distributed over time and across individuals.

Since our data series are short, we do not try to estimate ψ^i directly from each individual's data. Instead, we assume that the permanent wage differences can be captured by individual specific characteristics such as age, education, and occupation. Hence, we estimate

$$\begin{aligned} x_{1988}^i = {} & \varphi_1 + \varphi_2 \mathrm{AGE}_i + \varphi_3 (\mathrm{AGE}_i)^2 + \varphi_4 \mathrm{DMALE}_i + \varphi_5 \mathrm{EDUC}_i \\ & + \boldsymbol{\varphi}_{\mathbf{O}} \mathbf{OCC}_i + v_{1988}^i \end{aligned} \tag{5}$$

for the United States with OLS where AGE is the individual's age, DMALE is a dummy for the individual's gender, EDUC is the agent's number of years spent in school, and $\mathbf{OCC}_i = [\mathrm{OCC}_{1,i}, \ldots, \mathrm{OCC}_{8,i}]^T$ are occupation dummies.

For Sweden, we estimate

$$\begin{aligned} x_{1989}^i = {} & \varphi_1 + \varphi_2 \mathrm{AGE}_i + \varphi_3 (\mathrm{AGE}_i)^2 + \varphi_4 \mathrm{DMALE}_i + \boldsymbol{\varphi}_{\mathbf{E}} \mathbf{EDUC}_i \\ & + \boldsymbol{\varphi}_{\mathbf{O}} \mathbf{OCC}_i + v_{1989}^i, \end{aligned} \tag{6}$$

[14] In the United States, X^i was adjusted upwards to 0.10 for 19, 18, 20, 31, and 28 individuals in 1988, 1989, 1990, 1991 and 1992, respectively. For Sweden, X^i was set to 0.10 for 6, 10, and 26 individuals in 1989, 1990, and 1992. Changing the minimum relative wage assumption to 0.05 has no impact on the results.

where $\mathbf{EDUC}_i = [\text{EDUC}_{1,i} \cdots \text{EDUC}_{3,i}]^T$ is a vector containing dummies for the agent's education level, and $\mathbf{OCC}_i = [\text{OCC}_{1,t} \cdots \text{OCC}_{4,i}]^T$ is a vector containing occupation dummies. The variables considered in the regressions above are similar to those used by, for example, Blau and Kahn (1995) and Edin and Holmlund (1995). The estimation results for (5) and (6) are reported in Table II.

As seen from Table II, most of the variables are highly significant and the F-statistics are satisfactory both for the United States and for Sweden.

TABLE II
OLS Estimation Results for the Initial Relative Wage Level

United States—1988			Sweden 1989		
Variable	Estimate	p-value	Variable	Estimate	p-value
CONSTANT	−3.330	0.000	CONSTANT	−1.079	0.000
AGE	0.076	0.000	AGE	0.033	0.000
$\text{AGE}^2/100$	−0.077	0.000	$\text{AGE}^2/100$	−0.035	0.000
DMALE	0.272	0.000	DMALE	0.194	0.000
EDUC	0.074	0.000	EDUC_1	0.099	0.000
OCC_1	0.421	0.000	EDUC_2	0.218	0.000
OCC_2	0.320	0.000	EDUC_3	0.475	0.000
OCC_3	0.277	0.001	OCC_1	0.061	0.000
OCC_4	0.231	0.042	OCC_2	0.068	0.013
OCC_5	0.257	0.000	OCC_3	0.055	0.006
OCC_6	0.171	0.017	OCC_4	0.083	0.002
OCC_7	−0.558	0.000			
OCC_8	0.076	0.233			
F	59.166	0.000	F	120.238	0.000
$\bar{R}^2$	0.281		$\bar{R}^2$	0.295	
N	1789		N	2856	

Note. Dependent variables are the ratio between the hourly wage and average hourly wage in the United States 1988 and Sweden 1989 in natural logarithms. For the United States, EDUC is the number of years spent in school, $\text{OCC}_1, \ldots, \text{OCC}_8$ are dummy variables equal to 1 if the individual is a professional or technical worker, manager, sales worker, clerical worker, craftsman, operative, farm worker, or service worker, respectively, and 0 otherwise. A dummy for unclassified occupations is excluded in the regression. For Sweden, $\text{EDUC}_1, \ldots, \text{EDUC}_3$ are dummy variables equal to 1 if the individual has between 2–3, 3–6, and over 6 years education after primary school, respectively, and 0 otherwise. A dummy for those with less than 2 years education after primary school is excluded. $\text{OCC}_1, \ldots, \text{OCC}_4$ are occupation dummies equal to 1 if the individual works in the private industry, building industry, sales sector, and the communication and transport sector. A dummy variable for those who work in the public sector and in banks is excluded. Finally, DMALE is a dummy variable equal to 1 if the individual's gender is male and 0 otherwise.

The adjusted r-squares are reasonably high and similar for both countries. All the estimated parameter values are also reasonable. The point estimates for gender and age in Sweden are of the same magnitudes as the ones presented in Edin and Holmlund's (1995) wage regressions.

We use the regression results from Table II to calculate estimates of the permanent wage component, $\hat{\psi}^i = \hat{x}^i_{1988}$ in the United States and $\hat{\psi}^i = \hat{x}^i_{1989}$ in Sweden, and then to calculate the variance of these differences. For the United States, we get $\sigma_\psi^2 = 0.1175$, and for Sweden we get $\sigma_\psi^2 = 0.0467$. Hence, there is more wage inequality in the United States than in Sweden in the sense that permanent wage differences between individuals are larger.

To extract the risk which remains for individuals in the United States after permanent differences have been removed, we construct the variable $\tilde{x}^i_t \equiv x^i_t - \hat{\psi}^i$ for $t = 1988, \dots, 1992$. For Sweden, we construct the variable $\tilde{x}^i_t \equiv x^i_t - \hat{\psi}^i$ for $t = 1989$, 1990, and 1992. Summary statistics for the transformed relative wage variables are reported in Table III. A comparison of the figures reported in Tables I and III reveals that the variability in the data, quite naturally, becomes lower for both countries after the systematic factors have been removed from the data. We also see that there still is a slight increase in wage variability over time.

Finally, we use $\tilde{x}^i_t$ in (4) to construct the unconditional moment conditions

$$E\left[\left(\tilde{x}^i_t\right)^2\right] - \frac{\sigma_\varepsilon^2}{1-\rho^2} - \sigma_\xi^2 = 0,$$
$$E\left[\tilde{x}^i_t \tilde{x}^i_{t-s}\right] - \rho^s \frac{\sigma_\varepsilon^2}{1-\rho^2} = 0 \qquad (7)$$

TABLE III
Descriptive Statistics for Transformed Relative Wages

	United States					Sweden		
Statistic	1988	1989	1990	1991	1992	1989	1990	1992
Std($\overline{w}^i$)	0.57	0.56	0.59	0.59	0.64	0.31	0.30	0.37
Max($\overline{w}^i$)	5.73	4.37	5.79	7.09	8.51	2.95	3.27	4.10
Min($\overline{w}^i$)	0.09	0.08	0.08	0.08	0.08	0.10	0.07	0.07

Note. $\tilde{w}^i \equiv \exp(\tilde{x}^i)$, that is, the relative wage where the estimated systematic component due to permanent differences between individuals in the sample has been removed. Std($\tilde{w}^i$) the standard deviation in $\tilde{w}^i$ and Max($\tilde{w}^i$) and Min($\tilde{w}^i$) are the maximum and minimum relative wage in the constructed relative wage series in a given year.

TABLE IV
GMM Estimation Results for the Wage Process

	United States		Sweden	
Parameter	Estimate	Standard error	Estimate	Standard error
ρ	0.9136	0.0090	0.8139	0.0268
σ_ε^2	0.0426	0.0048	0.0326	0.0059
σ_ξ^2	0.0421	0.0039	0.0251	0.0046
χ^2_{obs}	23.45		46.35	
p-value	0.051		0.000	

Note. White's heteroskedasticity consistent standard errors. The p-values are simulated probabilities of obtaining a χ^2 higher than χ^2_{obs} when the model is correctly specified.

in order to estimate ρ, σ_ε^2, and σ_ξ^2 for the United States and Sweden with the general method of moments. Since we have observations from five periods in the United States, (7) implies that we can use 15 moments. For Sweden, (7) implies that we can use 6 moments. Since we have more moments than estimated parameters, the model is overidentified, and we use Hansen's (1982) χ^2-test to test the overidentifying restrictions. However, it is well known that Hansen's test may fail (see Newey, 1985). Therefore, the p-values for Hansen's test, reported in Table IV, were generated with a Monte Carlo simulation.[15]

The GMM estimation results are reported in Table IV. We see that the relative hourly wage series are highly persistent, especially in the United States. Moreover, the variance of temporary shocks is considerably higher in the United States than in Sweden. Consequently, the wage risk that agents face after having observed their permanent productivity level is higher in the United States. The estimates of ρ and σ_ε^2 are precise for both countries. As indicated by the simulated p-values, one possible shortcoming is that the overidentifying restrictions do not seem to hold, in particular not for Sweden. One reason for this result might be that the estimated AR(1)-process for the agent's productivity process is a too crude approximation of reality.

If we assume that all unemployment is voluntary (which here in practice means that we do not add time in unemployment to hours worked in the calculation of hourly wages), the estimated σ_ψ^2, ρ, and σ_ε^2 are practically unchanged ($[0.1075, 0.9165, 0.0379]$ and $[0.0421, 0.8545, 0.0227]$ for the United States and Sweden, respectively). But the χ^2-statistics are now

[15] In the Monte Carlo study, we have simulated the process $x_t^i = z_t^i + \xi_t^i$ where $z_t^i = \rho z_t^i + \varepsilon_t^i$, using $\hat{\rho}$, $\hat{\sigma}_\varepsilon^2$, and $\hat{\sigma}_\xi^2$ from Table IV, and calculated χ^2 from these simulated series.

changed to 15.02 and 12.12 with p-values 0.27 and 0.03, respectively. Thus, we can no longer clearly reject the model.

The findings for the U.S. wage process resemble those in Card (1991). He estimated a similar wage process for the United States based on men in the PSID from 1969 to 1979. The estimated persistence was 0.886 while the estimates of variances were 0.124, 0.027, and 0.039, for permanent shocks, temporary shocks, and measurement errors, respectively.

Because of the rejection of the overidentifying restrictions for the Swedish wage process, and since we do not have any previous estimates of the wage process to compare our findings with, we have examined the Swedish data closer. We suspected that the problem might be that the parameters in the wage process are different for different subsamples in the data. As a general result, we find that (see Table V) women and those with little education have higher year-to-year variability in wages and less persistence of wage shocks. Further, the estimation results are most well behaved when we control both for gender and education. Because of computation time, however, our model must be calibrated with a parsimonious specification of the wage process, and we are not able to allow for many different types of agents. We feel confident in calibrating the model with the full-sample estimates of the wage process since the process estimates for that process are close to the averages of the estimates in the subsamples.

To sum up, we have found that individuals in the United States are subject to more wage inequality as well as more wage uncertainty. The estimated variance of permanent log wage differences is 0.1175 in the United States and 0.0467 in Sweden. The estimated variance of temporary log wage shocks is 0.0426 in the United States and 0.0326 in Sweden, and temporary shocks are more persistent in the United States with the estimate of ρ equal to 0.9136 against 0.8139 in Sweden.

4. RESULTS

4.1. The Benchmark Economies

Before turning attention to the policy experiments, we examine the properties and empirical relevance of the model. We present distributional implications for the model economies under benchmark policies in Tables VI and VII. In Table VIII, we present correlations for earnings, income, and asset holdings. In addition to reporting the implications under benchmark policy, we also show the implications of the optimal policies found in the next subsection.

TABLE V
Estimates of Swedish Wage Process for Different Subsamples

Subsample	ρ	s.d.	σ_ε^2	s.d.	σ_ξ^2	s.d.	σ_z^2	N	χ^2_{obs}	p-val.
Full sample	0.814	0.027	0.033	0.006	0.025	0.005	0.098	2856	46.4	0.000
Permanent component										
Low ψ	0.700	0.049	0.056	0.013	0.013	0.010	0.110	1428	25.5	0.000
High ψ	0.895	0.027	0.018	0.005	0.029	0.005	0.091	1428	23.7	0.000
Education										
< 2 years	0.673	0.058	0.066	0.018	0.007	0.013	0.121	957	18.1	0.000
2–3 years	0.779	0.044	0.038	0.010	0.022	0.008	0.097	855	12.2	0.003
3–6 years	0.903	0.042	0.015	0.007	0.025	0.005	0.081	679	10.7	0.006
6 years	0.910	0.046	0.017	0.009	0.008	0.006	0.099	365	14.3	0.001
Gender										
Woman	0.744	0.047	0.043	0.011	0.018	0.008	0.096	1425	17.2	0.000
Man	0.864	0.029	0.024	0.006	0.030	0.005	0.095	1431	33.5	0.000
Education and gender										
< 2 years, woman	0.592	0.088	0.089	0.033	−0.015	0.025	0.137	606	18.1	0.000
2–3 years, woman	0.855	0.068	0.022	0.011	0.034	0.009	0.082	375	1.9	0.210
3–6 years, woman	0.825	0.076	0.019	0.010	0.022	0.009	0.060	329	5.8	0.052
> 6 years, woman	0.873	0.059	0.017	0.010	0.011	0.007	0.046	115	7.7	0.023
< 2 years, man	0.740	0.061	0.047	0.017	0.025	0.013	0.104	351	2.2	0.196
2–3 years, man	0.752	0.052	0.043	0.013	0.015	0.010	0.099	480	16.9	0.000
3–6 years, man	0.955	0.052	0.008	0.010	0.024	0.006	0.091	350	11.8	0.004
> 6 years, man	0.980	0.052	0.004	0.009	0.017	0.006	0.101	250	13.8	0.001

Note. White's heteroskedasticity consistent standard errors. N is the number of observations in the subsample, and $\sigma_z^2 \equiv \sigma_\varepsilon^2/(1-\rho^2)$ is the total unconditional variance in the temporary process. The p-value is the asymptotic probability of obtaining a χ^2 higher than χ^2_{obs}. Education is the number of years spent in school after primary school.

TABLE VI
Distributional Implications—United States

	Gini	Percent of total			
		Bottom 40%	Top 20%	Top 10%	Top 1%
Wealth					
Actual U.S. data	0.78	1.4	79.5	66.1	29.5
Model, benchmark policy	0.65	2.3	65.2	44.5	8.6
Model, optimal policy	0.66	1.9	66.3	45.5	8.8
Earnings					
Actual U.S. data	0.63	2.8	61.4	43.5	14.8
Model, benchmark policy	0.50	10.1	53.5	34.2	6.7
Model, optimal policy	0.54	7.6	56.7	36.5	7.3
Total income					
Actual U.S. data	0.57	8.8	59.9	45.2	18.6
Model, benchmark policy	0.42	14.6	48.4	30.3	5.8
Model, optimal policy	0.42	14.7	48.5	30.4	5.9

Note. U.S. data adapted from Díaz-Giménez, et al. (1997). $\tau^h = 0.36$ under benchmark policy and $\tau^h = 0.46$ under optimal policy. Earnings are defined as net labor income before taxes. Total income is defined as net factor income plus transfers but before taxes. Note that U.S. data refer to households while the income process in the model is calibrated to match individual wage processes.

It is a well known fact that models with plausible parameterizations of income processes and risk aversion have problems generating asset and income distributions which are as skewed as in U.S. data. This is documented in, e.g., Quadrini and Ríos-Rull (1997).[16] The wealth distributions implied by our model are skewed but are not as skewed as the actual Swedish and U.S. distributions. In particular, the model cannot generate wealth holdings that are as extreme as for the top few percent of households in the data However, for our purposes it is most important to capture the asset and income distributions of the poor agents, because it is for these that social security really matters. The model does fairly well in this respect.

The tables show that asset holdings are unequally distributed, with Gini coefficients around 0.60, but still not as skewed as in the actual economies. In particular, the wealthiest agents (households) in the model are not as wealthy as in the data. The richest 1% of agents hold 9% of aggregate wealth in the model, but in the United States they hold 29% of all wealth.

[16] Examples of such studies are Aiyagari (1994) and Huggett (1996). A recent exception is the paper by Castañeda et al. (1998). They calibrate the underlying productivity process so that asset and income distributions are matched.

TABLE VII
Distributional Implications—Sweden

	Gini	Percent of total: Bottom 40%	Top 20%	Top 10%	Top 1%
Wealth					
Actual Swedish data	0.79	−6	72	49	13
Model, benchmark policy	0.60	4	60	39	6
Model, optimal policy	0.58	5	58	38	6
Earnings					
Actual Swedish data	0.48	8	47	29	5
Model, benchmark policy	0.43	12	46	28	4
Model, optimal policy	0.32	19	39	23	3
Total income					
Actual Swedish data	0.33	19	37	14	5
Model, benchmark policy	0.28	22	38	21	3
Model, optimal policy	0.28	22	37	21	3

Note. Swedish data adapted from Domeij and Klein (1998). $\tau^h = 0.57$ under benchmark policy and $\tau^h = 0.27$ under optimal policy. Earnings are defined as net labor income before taxes. Total income is defined as net factor income plus transfers but before taxes. Note that Swedish data refer to households while the income process in the model is calibrated to match individual wage processes.

For Sweden, the richest 1% hold 6% of all wealth in the model and 13% of all wealth in the data.

The asset distribution for the poorest agents is better matched by the model. The bottom 40% of agents (households) in the wealth distribution hold approximately 1% of the U.S. wealth in the data and 2% in the model. In Swedish data they hold −6% of all wealth and 4% in the model. Data problems may explain the many observations of negative wealth holdings among Swedish households. The value of privately owned apart-

TABLE VIII
Correlations of Earnings, Income, and Wealth

	United States			Sweden		
		Model			Model	
	Data	$\tau^h = 0.36$	$\tau^h = 0.46$	Data	$\tau^h = 0.57$	$\tau^h = 0.27$
corr(*earnings*, *income*)	0.93	0.98	0.98	0.78	0.94	0.92
corr(*earnings*, *assets*)	0.23	0.33	0.31	0.17	−0.04	0.04
corr(*income*, *assets*)	0.32	0.50	0.49	0.37	0.30	0.43

Note. Data adapted from Díaz-Giménez et al. (1997) and Domeij and Klein (1998).

ments is approximated by the taxable value, which is considerably lower than the market value. Moreover students' loans are measured at the full value but human capital is not included in wealth. Considering these data problems, we think that the model gives a satisfactory fit of the poor agents in the asset distribution.

The earnings and income distributions for Sweden are well captured by the model, both for those in the bottom and those in the top of the distributions. The model generates too compressed distributions for the United States, however. For example, the bottom 40% in the earnings distribution have only 3% of earnings in the data but around 10% in the model. In the U.S. data, entrepreneurs who report losses significantly contribute to the low earnings for the bottom percentiles in the distribution. In the model, wage rates are observable in the beginning of a period, and we do not allow for negative wages.

Maybe surprisingly, changes in tax rates have negligible effects on wealth distributions. For both countries, an increase in taxes actually increases Gini coefficients. When transfers increase, there is less need for poor agents to save for bad times, and in bad times they do not need to work as hard as when there are no transfers.

4.2. Optimal Tax and Transfer Levels

To find the optimal tax level, we solve the model for labor tax rates up to 65% with increments of 1 percentage point and the restriction that transfers are non-negative. Taxes on capital income and consumption are held fixed at the benchmark values. We look for the tax rate that maximizes average utility of the agents in the economy. Equilibrium outcomes for some selected tax rates are shown in Tables IX and X. As a reference we also report the outcome we get when agents are provided with full insurance.[17]

We use the utilitarian welfare measure when evaluating policies. The welfare effects are quantified with the compensating variation premium with the economy under benchmark policy as the benchmark. More precisely, when we say that x is the welfare gain of having taxes $\tilde{\tau}$ instead of benchmark policy, we mean that the average utility in the $\tilde{\tau}$- and benchmark worlds are the same when consumption is reduced by x percent for all agents in the $\tilde{\tau}$-world.

We find that social insurance programs can have an important impact on welfare. For the baseline calibration, the optimal tax rate on labor income is 46% for the United States and 27% for Sweden. The associated transfer levels are 15 and 1.6% of output, respectively. This result is

[17] By full insurance, we mean that all agents insure before observing their first productivity level. The insurance then yields the same marginal utility of total expenditure in each state.

TABLE IX
Results for Different Tax Rates—United States

τ^h	w.g.	r	K/Y	H	Y	C/Y	$\bar{h}$	B/Y	T/Y	T
Benchmark										
0.361		3.85	2.60	0.428	0.732	0.524	0.358	0.082	0.299	0.219
Experiments										
0.25	−6.32	3.19	2.72	0.472	0.830	0.511	0.421	0.005	0.222	0.184
0.30	−2.84	3.50	2.67	0.453	0.786	0.517	0.393	0.040	0.257	0.202
0.35	−0.04	3.78	2.61	0.432	0.742	0.522	0.364	0.074	0.291	0.216
0.40	1.10	4.06	2.56	0.412	0.698	0.527	0.335	0.109	0.326	0.228
0.45	1.78	4.33	2.51	0.390	0.655	0.532	0.306	0.143	0.360	0.236
0.50	1.60	4.59	2.47	0.367	0.611	0.537	0.275	0.177	0.394	0.241
0.55	0.47	4.85	2.42	0.344	0.566	0.541	0.247	0.211	0.428	0.242
0.60	−1.75	5.10	2.38	0.319	0.521	0.545	0.218	0.245	0.462	0.241
0.65	−5.30	5.35	2.34	0.294	0.474	0.549	0.189	0.278	0.495	0.235
Full insurance										
0.204	24.34	6.46	2.19	0.477	0.741	0.564	0.313	0.000	0.217	0.161
0.361	22.38	6.46	2.19	0.428	0.664	0.564	0.262	0.101	0.318	0.211

Note. w.g. = welfare gain in percent of consumption, relative to economy with benchmark policy, r = real interest rate, K = aggregate capital stock, H = aggregate efficiency units of hours worked, Y = aggregate output, C = aggregate consumption, $\bar{h}$ = average hours worked, and T = total tax revenues.

TABLE X
Results for Different Tax Rates—Sweden

τ^h	w.g.	r	K/Y	H	Y	C/Y	$\bar{h}$	B/Y	T/Y	T
Benchmark										
0.570		8.00	2.00	0.318	0.469	0.509	0.276	0.212	0.503	0.236
Experiments										
0.25	8.45	7.27	2.08	0.446	0.673	0.501	0.420	0.009	0.294	0.198
0.30	8.43	7.38	2.07	0.431	0.650	0.502	0.403	0.036	0.327	0.213
0.35	8.07	7.50	2.06	0.413	0.620	0.504	0.383	0.068	0.359	0.223
0.40	7.28	7.62	2.04	0.393	0.588	0.505	0.360	0.101	0.392	0.230
0.45	5.98	7.73	2.03	0.373	0.555	0.506	0.337	0.134	0.425	0.236
0.50	4.09	7.85	2.02	0.351	0.521	0.508	0.312	0.166	0.457	0.238
0.55	1.37	7.96	2.00	0.328	0.484	0.509	0.287	0.199	0.490	0.237
0.60	−2.38	8.07	1.99	0.303	0.446	0.510	0.259	0.231	0.523	0.233
0.65	−7.58	8.18	1.98	0.277	0.406	0.511	0.231	0.264	0.555	0.225
Full insurance										
0.235	19.09	8.49	1.95	0.449	0.653	0.514	0.380	0.000	0.291	0.190
0.570	7.63	8.49	1.95	0.319	0.464	0.514	0.246	0.215	0.506	0.235

Note. See Table IX.

visualized in Fig. 1. The relatively large difference between the United States and Sweden is not surprising, given the differences in the estimated wage processes. The welfare gain of changing from the benchmark policy to the optimal level of transfers in the United States is 1.8% of annual consumption. In Sweden, the welfare gain is 8.5%.

To understand how important the wage uncertainty and wage inequality is in the United States, let us compare the economy with no transfers to the economy with optimal policy. Figure 2 shows that output in the latter economy is less than 80% of output in the economy with no transfers. Still, Fig. 1 shows that welfare is more than 8% higher because of the reduction in income fluctuations. In the Swedish economy, income is less uncertain and the distortions seem to dominate the insurance value of transfers already at small transfer levels.

Figure 2 also shows that increases in transfers (and hence in τ^h) reduce output more in the United States than in Sweden. The intuition behind this result is that an increase in the transfer level has larger insurance effects in a country with much idiosyncratic risk than in a country with

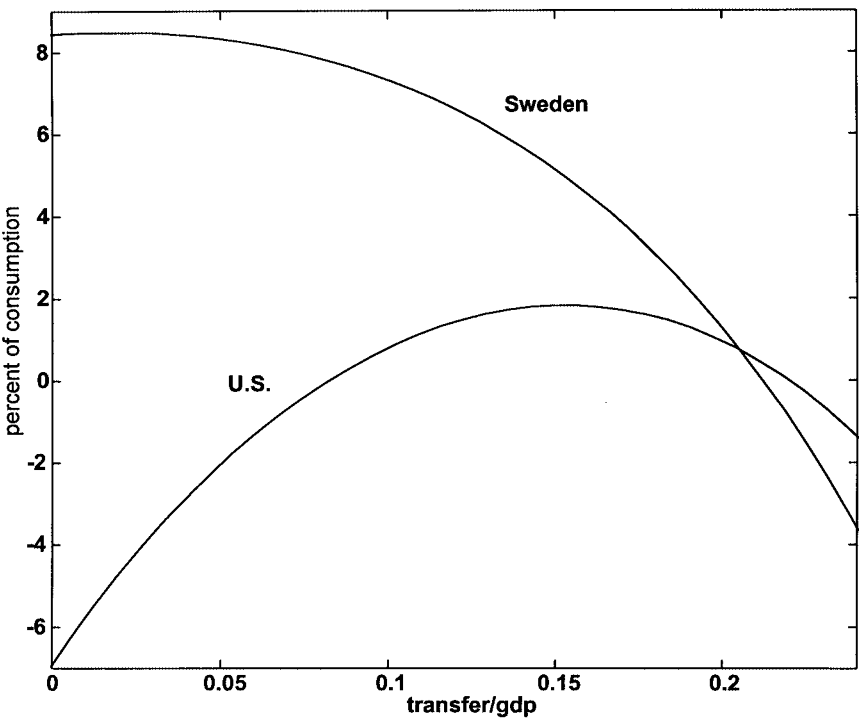

FIG. 1. Welfare gain relative to economy with benchmark policy.

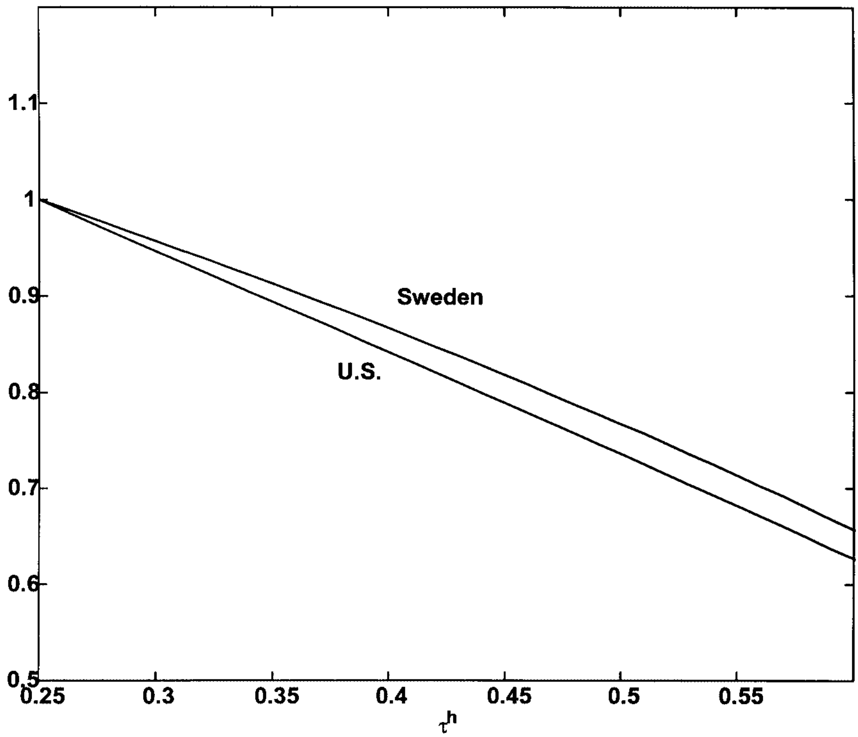

FIG. 2. Output relative to economy with $\tau^h = 0.25$.

little risk. As transfers increase, agents in the United States therefore reduce their holding of precautionary wealth more than what agents in Sweden do.

We also note that a volatile income process is "good" for the agents if they can insure against periods with low productivity and "bad" if they cannot. This result emerges when comparing the utility under full insurance to utility with incomplete markets in economies with different wage processes. The explanation behind this result is as follows. When agents are fully insured, they are able to smooth consumption by borrowing and lending. The agents can then choose to work more when their productivity is high and less when productivity is low, and the higher the degree of idiosyncratic risk, the more agents can increase their utility by working when their productivity is high and staying at home when it is low.[18] But

[18] This mechanism is most clearly seen by comparing the benchmark and full insurance rows in Tables IX and X. Labor supply in efficiency units is the same but actual hours worked is considerably lower with complete markets.

when asset markets are incomplete, agents can no longer smooth consumption and leisure independently. If they have little wealth and low productivity, they must work to be able to consume. Because the utility function is concave, productivity fluctuations will decrease agents' utility.

When looking for the optimal tax rate, we have taken a utilitarian approach and put equal weight on every agent's utility. To understand for which individuals, when considering the stationary distribution of agents, government transfers really matter, we have computed optimal tax rates for different percentile agents in this distribution. The main value of the experiment is that it gives a picture of inequality and a sense of which agents experience that social security really matters. The results show that government transfers, at the level suggested by the previous analysis, benefit the lowest 30 percentiles in the utility distribution. The median utility in both countries is maximized when transfers are close to zero.

5. SENSITIVITY TO PARAMETER CHOICE AND MODEL SPECIFICATION

In this section, we examine how sensitive the results are with respect to the most important parameters and some specific model assumptions. The results are summarized in Tables XI and XII. For all experiments where it is possible, we recalibrate the discount rate β to get the desired capital-output ratios under benchmark policy (i.e., $K/Y = 2.6$ in the United States and $K/Y = 2.0$ in Sweden).

5.1. The Utility Function

Plausible values for the intertemporal elasticity of substitution are often claimed to be in the interval $[0.2, 1]$. We considered the extreme values, $\mu = 5$ and $\mu = 1$. Not surprisingly, the chosen value for μ is is important for the results obtained. When μ is increased from 1 to 5, the optimal tax rate increases from 43 to 51% in the United States and from 24 to 36% in Sweden.

Estimates of the wage elasticity of labor supply vary widely between studies. However, most estimates of the elasticity are less than 0.5 for men, and the estimated elasticity for women is typically higher than that for men —see, for example, MaCurdy (1981) and Altonji (1986) for estimates on U.S. data and Flood and MaCurdy (1992) and Aronsson and Palme (1998) for Swedish estimates. As mentioned earlier, the labor-supply elasticity implied by the Cobb−Douglas utility function is higher than what was found in these studies. To allow for a less elastic labor supply, we consider

TABLE XI
Sensitivity Analysis—United States

Experiment		Optimal policy				Max tax revenues		
		τ^h	$\frac{T}{Y}$	$\frac{B}{Y}$	w.g.	τ^h	$\frac{T}{Y}$	$\frac{B}{Y}$
Benchmark		0.46	0.37	0.15	1.8	0.55	0.43	0.21
Risk aversion								
$\mu = 1.0$		0.43	0.34	0.13	0.6	0.57	0.44	0.22
$\mu = 5.0$		0.51	0.41	0.19	6.3	0.51	0.41	0.19
Wage process								
ρ	σ_ε^2							
0.850	0.0426	0.40	0.32	0.11	0.2	0.55	0.42	0.21
0.950	0.0426	0.54	0.42	0.21	7.3	0.56	0.44	0.22
0.914	0.0330	0.45	0.36	0.14	1.0	0.55	0.43	0.21
0.914	0.0522	0.48	0.38	0.16	2.7	0.55	0.43	0.21
0.600	0.0576	0.35	0.29	0.07	0.1	0.56	0.43	0.21
Utility function[a]		0.52	0.41	0.19	2.8	0.70	0.53	0.31
Infinite lives ($\gamma = 0$)		0.46	0.37	0.15	1.9	0.55	0.43	0.21
Only temporary risk ($\sigma_\psi = 0$)		0.42	0.34	0.12	0.6	0.54	0.42	0.20

Note. w.g. is the welfare gain in percent of annual consumption.
[a] The row "utility function" refers to the case where utility is $(c^{1-\mu} - 1)/(1-\mu) + \Lambda(l^{1-\lambda} - 1)/(1-\lambda)$, $\mu = 1.5$, and $\lambda = 2.5$.

the utility function

$$u(c,l) = \frac{c^{1-\mu} - 1}{1-\mu} + \Lambda \frac{l^{1-\lambda} - 1}{1-\lambda},$$

where $1/\lambda$ is the labor-supply elasticity. To fix risk aversion to consumption fluctuations at the benchmark level, we set $\mu = 1.5$. We set $\lambda = 2.5$ to get a labor-supply elasticity of 0.40. The optimal transfer level then increases to 19% in the United States and 7.5% in Sweden.

Although labor supply seems inelastic, microdata display considerable variability in hours worked. The evidence reported in Altonji and Paxson (1985), Abowd and Card (1989), and Card (1991) suggests that the coefficient of variation for hours worked, conditional on hours being positive, is between 0.25 and 0.40 in the United States. Aronsson and Palme (1998) report coefficients of variation of 0.14 and 0.41 for married Swedish men and women, respectively. Both utility functions considered here, in particular, the one with low elasticity, are consistent with these facts. For the baseline specification of the utility function, the standard deviation of changes in log hours worked is 0.44 in the United States under benchmark

TABLE XII
Sensitivity Analysis—Sweden

Experiment		Optimal policy τ^h	$\frac{T}{Y}$	$\frac{B}{Y}$	w.g.	Max tax revenues τ^h	$\frac{T}{Y}$	$\frac{B}{Y}$
Benchmark		0.27	0.31	0.016	8.5	0.51	0.46	0.17
Risk aversion								
$\mu = 1.0$		0.24	0.29	0.000	9.4	0.52	0.47	0.18
$\mu = 5.0$		0.36	0.36	0.072	6.1	0.50	0.46	0.16
Wage process								
ρ	σ_ε^2							
0.750	0.0326	0.24	0.29	0.000	9.0	0.51	0.47	0.17
0.850	0.0326	0.30	0.33	0.035	7.5	0.51	0.46	0.17
0.814	0.0208	0.26	0.30	0.011	9.5	0.51	0.46	0.17
0.814	0.0444	0.31	0.33	0.041	7.6	0.51	0.46	0.17
Utility function		0.36	0.37	0.075	3.0	0.65	0.55	0.26
Infinite lives ($\gamma = 0$)		0.25	0.29	0.003	8.8	0.51	0.46	0.17
Only temporary risk ($\sigma_\psi = 0$)		0.24	0.29	0.000	10.4	0.51	0.46	0.17
Same β[a]		0.31	0.32	0.025	—	0.53	0.46	0.17
Same labor supply ($\alpha = 0.59$)		0.29	0.32	0.029	7.0	0.54	0.48	0.19
Open economy[b]		0.32	0.33	0.023	9.0	0.54	0.46	0.16

Note. See Table XI.
[a] See Section 5.1.
[b] See Section 5.4.

policy. With the new utility function this figure drops to 0.23. For the Swedish setup of the model, the values are 0.53 and 0.31, respectively.

In the baseline calibration we set α, the weight on consumption relative to leisure in the utility function, to 0.50 for both countries. With this α and the benchmark policies, agents work 36% of available time in the United States and 28% of available time in Sweden. Although labor supply is higher in the United States than in Sweden, this difference appears large, and we examined the effects of calibrating a separate α for Sweden so that Swedish labor supply reaches the U.S. level. The results with this α ($= 0.59$) were similar to the original results.

In the benchmark calibration of the models, households in the two countries have different preferences since we use different discount factors β. The results did not change much when we set the Swedish β to 0.9822, the value we used for the United States.

5.2. The Wage Process

As we mentioned in the introduction, there is no clear consensus in the literature on which wage process best captures the income uncertainty that households face. We have therefore examined how sensitive the results are to the parameterization of this process.

Persistence

Tables XI and XII shows that the results, at least for the United States, appear to be sensitive to what look like minor changes in the persistence of wage shocks. This is not surprising. When ρ is close to unity, the total unconditional variance of the wage process is sensitive to small changes in ρ.

Volatility

We added and subtracted two standard deviations to our estimates of σ_ε^2 and solved the models again. Results did not change much for either country.

The Aiyagari and McGrattan Values

Building on Heaton and Lucas' (1996) estimates, Aiyagari and McGrattan (1998) set $\rho = 0.60$ and $\sigma_\varepsilon^2 = 0.0576$. When we solved the model for the United States with this process, the optimal transfer level fell to 7%.[19]

Only Temporary Risk ($\sigma_\psi = 0$)

The U.S. wage process displays more temporary risk as well as more permanent inequality than the Swedish process. Which of these differences is most important for our results? Although we prefer to think of both the permanent wage differences and the temporary fluctuations as risks for which the government can provide insurance, in daily life transfers because of the former would usually be thought of as redistribution.

By ignoring the permanent wage differences in the calibration of the wage process, we get an impression of which source of risk is driving our results. We find that with only temporary wage uncertainty, the optimal transfer level is 12% in the United States while no redistribution is motivated in Sweden.

5.3. Infinitely Lived Agents

In the baseline calibration of the model, agents live 50 years on average, bequests are random over the life cycle, and newly born agents have no wealth. We think that this is a good way to describe reality in a parsimonious way, but the assumptions are nonstandard. One might suspect that our results hinge on the poor situation for newly born agents who have not

[19] Note that we still allow for the permanent effects with $\sigma_\psi^2 = 0.1175$.

had time to accumulate a buffer of wealth. However, if we assume that agents have infinite lives ($\gamma = 0$), the optimal policy is unaffected in the United States. In Sweden, the optimal transfer falls slightly.

We are a bit surprised by this small effect of changes in γ. With $\gamma = 0$, agents live forever and hence have time to accumulate some wealth to self-insure against bad times. There are then few agents who have both very little wealth and low productivity, the state which agents want to avoid almost at any cost. However, the accumulation of individual buffer stocks is inefficient in itself, and although government redistribution schemes distort labor supply, they seem to provide better insurance than private savings.

5.4. Open Economy

Sweden is often thought of as a small, open economy which faces a given world interest rate, but until now we have assumed that both Sweden and the United States are closed economies. In Table X, we see that the equilibrium capital stock in Sweden is decreasing in the tax rate. Does this mean that distortions are less important when the world capital stock is given? We conducted some experiments to answer this question. We solved the model economy for Sweden with the interest rate fixed at 3.85%, which is the equilibrium interest rate for the benchmark U.S. economy.[20, 21]

The results for this scenario are similar to what we found with the original specification. The optimal transfer increases marginally and the Laffer curve peaks at slightly higher tax rates. The reason for the small change in the optimal insurance level is that the interest rate is not the sole determinant of the capital stock. More important is the supply of efficiency units of labor, and this supply is sensitive to tax rates. So, although the world interest rate is given and capital is totally mobile, the equilibrium capital input in Swedish production is sensitive to changes in the tax rate.

[20] This approach could have been invalid if the Swedish interest rates in autarky had been lower than the U.S. interest rate. People in Sweden might then want to hold much wealth when the high world interest rate prevails. Consequently, even if the Swedish population is small, it could have a significant impact on capital formation.

[21] Here β was calibrated so that the Swedish net position against the world economy is zero under benchmark policy.

6. CONCLUDING REMARKS

We want to stress the main findings of the paper. Wage inequality and wage fluctuations seem to be important features of the economies studied but are more severe in the United States than in Sweden, and it seems as if agents, at least in the United States, are willing to give up a significant amount of consumption in order to insure against this uncertainty.

One possible explanation for the results is that agents in the United States are less risk averse than agents in Sweden choose higher average wages at the price of higher wage fluctuations. This interpretation is consistent with the fact that GDP per capita is higher in the United States than in Sweden.

For all the specifications we have considered, the Laffer curve has peaked when tax rates on labor income have been 50% or higher. In our experiments, only changes in the labor-supply elasticity matter for the shape of the Laffer curve. To claim that the Laffer curve peaks at lower tax rates, one has to believe that the elasticity of labor supply is considerably higher than what is typically estimated from data.

There are also some caveats we want to point out to the reader. First, a lot has happened in Sweden after the period examined. Unemployment has increased drastically and in particular employment in the government sector has fallen. It is therefore possible that the income risk in Sweden has increased.

Second, although we look at wages before taxes and transfers, the relatively low degree of wage risk in Sweden may be a result of the big government sector. For example, a large fraction of the population work in the government sector and wage setting there seems to imply a significant amount of risk sharing. Also, many old persons who become unemployed go into early retirement and hence fall out of the labor force and our sample. Moreover, we take labor market and wage setting institutions as given. That is, we do not try to understand or explain why wage processes are different in different countries. Arguably, some of these differences are a result of government policy. If, for example, wages are a result of bargaining between unions and firms, the bargaining position of low income groups may improve relative to that of high income groups if transfers are increased. We abstract from such issues.

With this remark in mind, our interpretation of the Swedish results is not that there is no clear role for government insurance in Sweden. However, it seems clear that the extensive insurance programs cannot be motivated by the maximization of a utilitarian welfare function. The policy implication of our paper is that a marginal reduction in insurance would enhance the Swedish welfare function while an extension of insurance programs would be motivated in the United States. After the change in insurance programs, the wage processes could be reestimated.

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