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EFFICIENCY–EQUALITY TRADE-OFF OF SOCIAL INSURANCE

RADIM BOHÁČEK
Economics Institute
and
Charles University

This paper studies the effects of social insurance policies on efficiency and distribution of resources in a general equilibrium model of a closed economy with heterogeneous agents and repeated moral hazard. I compare optimal allocations in stationary recursive equilibria for economies with different guaranteed minimum consumption levels (social insurance). I show that the efficiency–equality trade-off associated with social insurance does not hold: Efficiency and inequality decrease as the minimum guaranteed consumption increases to around one third of the average consumption. However, if social insurance expands even further, the efficiency loss becomes very high and inequality increases.

Keywords: Macroeconomic Policy, Computable General Equilibrium Models, Asymmetric and Private Information, Provision and Effects of Welfare Programs

1. INTRODUCTION

This paper analyzes the trade-off between the cost of social insurance and inequality in a dynamic general equilibrium model with moral hazard and heterogeneous agents. It is a positive quantitative study that evaluates the effects of increasing generosity of social insurance on aggregate levels, efficiency, and the distribution of resources in a stationary equilibrium of a closed economy. This paper is among the first that simultaneously considers efficiency, welfare, and distributional issues in a general equilibrium dynamic model with capital accumulation and asymmetric information.

In the model economy, the government's allocations are constrained by its commitment to guarantee a minimum consumption level to each agent in periods when his or her income realization is low. The level of minimum guaranteed

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TABLE 1. Social insurance expenditures: OECD countries, 1990s

Country	Social expend. (% GDP)	Ratio of minimum to average wage	Unemployment Replacement Ratio	Unemployment Duration	OECD benefit entitlements (% income)
United States	9.5	0.39	0.50	0.5	12.6
European Union	15.3	0.53	0.59	2.6	33.3
France	18.3	0.50	0.57	3.0	37.1
Germany	15.8	0.55	0.63	4.0	28.5
Sweden	22.2	0.52	0.80	1.2	27.2
United Kingdom	14.2	0.40	0.38	4.0	17.0

Sources: Nickell and Layard (1999) and OECD (2002). Averages for 1990–1999. Social expenditures do not include old age support. European Union defined as the fifteen EU countries, excluding Luxembourg and Greece. Average wage for 1991–1994. Unemployment benefit duration in years. The OECD Summary Measure of Benefit Entitlements is the unweighted average of 18 gross replacement rates: three household types (single, dependent spouse, and spouse in work); three time periods (the first year, the second and third years, and the fourth and fifth years of unemployment); and two earnings levels (average earnings and two-thirds of this level).

consumption is interpreted as generosity of social insurance. It is natural that in an environment exposed to moral hazard, an increasingly generous social insurance becomes a costly policy. The question of this paper is whether this increasing efficiency cost is counterbalanced by gains in other measures that social insurance aims at: reduced inequality, reduced poverty, or increased welfare. In other words, the goal of this paper is to assess whether there is a monotone trade-off between efficiency and equality, and if so, how steep it is at different levels of social insurance.

The main motivation for studying this tradeoff comes from the large and persistent differences in government spending and insurance policies in Organisation for Economic Co-operation and Development (OECD) countries summarized in Table 1.

General government spending in the European Union averages 48% of gross domestic product (GDP) (with 38% in the United Kingdom and 60% in Sweden). General government spending in the non-European OECD countries is smaller; in the United States it is at 36% of GDP. Alesina, Glaeser, and Sacerdote (2001) document that the largest differences in government spending between the non-European countries and Europe are exactly in transfers to households and subsidies in times of need. These two categories of spending are almost twice as large, as a share of GDP, in Europe as in the United States. Social expenditures (excluding old-age support) in the United States was about 9% of GDP in 1995, whereas the European average was about 15%. The differences are particularly large in family allowances, unemployment compensation, and other labor market programs.[1] In the last column of Table 1, the OECD Summary Index of Benefit Entitlements shows a similar evidence on the social insurance generosity of European countries.

In this model, the efficiency cost of providing such social insurance protection is assumed to come from a moral hazard problem. The moral hazard consists of labor effort being private information of each agent. Naturally, as the minimum guaranteed consumption level increases, the cost of incentives needed to induce a high incentive-compatible labor effort increases too. I study the effects of social insurance on allocations and distribution of resources in a dynamic version of the standard model of private information developed by Prescott and Townsend (1984), in which the government (social planner) minimizes the cost of resources subject to the promise-keeping and incentive compatibility constraints.[2] All functional forms and parameters follow the standard neoclassical macroeconomic model.

The assumption on modeling social insurance as the minimum level of consumption guaranteed to each agent in each state has two important consequences for the model: First, different levels of social insurance necessarily imply different steady states that can be compared in terms of allocations, distribution of resources, and prices. Second, it defines a lower bound on utility allocations needed for the existence of stationary recursive equilibrium with endogenous distribution of resources without the immiseration result established in the moral hazard literature.[3]

To evaluate the effects of social insurance, I numerically solve for steady state equilibria defined by different levels of social insurance generosity. The results do not support the monotone efficiency–equality trade-off. On the one hand, efficiency falls monotonically with social insurance. Whereas the efficiency loss is relatively small for low and medium levels of social insurance, it rapidly grows to 17% of GDP in the most generous insurance regime that guarantees 48% of the average consumption to all agents. On the other hand, and rather surprisingly, inequality is a U-shaped function of social insurance. It falls only from low to medium levels of social insurance: The most equal economy with the lowest Gini coefficient, 0.23, corresponds to social insurance guaranteeing 36% of average consumption. Increasing the generosity above this level has a negative impact on equality.

The main forces behind these efficiency and equality outcomes are labor supply incentives and general equilibrium effects. The initial reduction of inequality comes from improving the condition of the poor agents, basically from eliminating the left tail of the distribution. As the left tail vanishes in the very generous social insurance regimes, the top quintile of agents becomes more important, having a negative effect on the distribution. These results are compatible with the evidence from the OECD countries discussed in detail in the paper.[4]

Moreover, the structure of incentives responds to general equilibrium effects that accommodate different social insurance policies: The higher social insurance, the more the equilibrium interest rate declines. This has two implications for government optimal policies and the distribution of resources. First, when current incentive "punishments" are no longer available in the generous social insurance regimes, a lower interest rate reduces the cost of providing incentives in the future. Rewarding agents relatively more in the future contributes to the increase of inequality in the most generous social insurance regimes. Second, at lower equilibrium interest rates the government can substitute from the declining incentive-compatible labor supply toward the capital input. OECD data show that average annual working hours per person in employment decrease while the capital per worker increases in social insurance. This mechanism also allows a country such as Sweden to offer generous welfare state policies while producing a high level of output.

Finally, it turns out that one of the most important features of the model is the general equilibrium framework with capital accumulation [see Bohacek (2005)]. It is only because of the general equilibrium effects that the government is able to find feasible allocations for the most generous social insurance policies. I provide a counterexample showing that studying social insurance in partial equilibrium would be misleading and incompatible with observations from the OECD countries.

This paper is an application of a theoretical model of optimal accumulation and distribution of capital in an economy with heterogeneous agents and moral hazard developed by Bohacek (2005). It builds on the seminal contributions by Prescott and Townsend (1984), Atkeson and Lucas (1992), Atkeson and Lucas (1995), and Aiyagari and Williamson (1999) and the partial equilibrium models of Green (1987), Spear and Srivastava (1987), Atkeson (1991), or Phelan and Townsend (1991). In comparison with the above models, the standard neoclassical production technology and capital accumulation are incorporated into a general equilibrium, dynamic private-information economy with heterogeneous agents. For this purpose, I decentralize the economy using the concept of component planners developed by Atkeson and Lucas (1995). The capital stock is accumulated from component planners' surpluses. Capital input is traded among component planners at a market-clearing interest rate. Except for Aiyagari and Williamson (1999), previous models with private information and capital accumulation have studied only special cases with restrictions on preferences and technology [as in Khan and Ravikumar (1997) with privately owned capital or Khan and Ravikumar (2001)]. In my decentralized economy, there are no special restrictions on preferences, production technology, information structure, or contracts.

The paper is organized as follows. In the next section, I describe the economy and outline a social planner's problem. In Section 3, I decentralize the economy and define a stationary recursive equilibrium. Model parameterization and characterization of optimal social insurance policies are presented in Section 4. In Section 5 I state and interpret the results of numerical simulations and compare them to OECD data. Section 6 concludes.

2. THE ECONOMY

I consider an economy populated by a continuum of agents operating stochastic neoclassical technologies with capital and labor inputs. To ensure against bad realizations of output, the risk-averse agents enter into insurance contracts with a zero profit insurance agency, modeled as a principal (social planner, government). The principal is constrained by social insurance, defined as a guaranteed minimum consumption level to each agent.[5] As the labor supply is private information of each agent, the principal cannot provide full insurance. Instead, it must overcome the moral hazard problem by conditioning each agent's insurance transfer on the entire history of his output realizations, rewarding high realizations of output with high current, as well as future, consumption levels.

In each period each agent is endowed with one unit of time and derives utility from consumption, c_t, and leisure, $1 - l_t$, $u(c_t, 1 - l_t)$, discounted over time at $\beta \in (0, 1)$. The utility function is bounded, strictly increasing and strictly concave in c, and is strictly decreasing in labor supply l.

Each agent operates a Cobb–Douglas production technology $f(k_t, l_t) = k_t^\alpha l_t^{1-\alpha}$, with $\alpha \in (0, 1)$. An agent's labor supply, l, is not observable by the principal. For each possible choice of incentive compatible labor supply $l \in L = \{0, l_1, \ldots, \bar{l}\}$, the capital input k is assigned according to the efficient capital–labor ratio, x, derived from the Cobb–Douglas technology and equilibrium prices. An agent's labor effort l determines a probability distribution over output realizations, $y \in Y$, where Y is the finite set of possible outputs determined by the Cobb–Douglas production technology, $Y = \{0, l_1 x^\alpha, \ldots, \bar{l} x^\alpha\}$. Both inputs are allocated before the output uncertainty is realized. Let $P(y|k, l)$ denote the probability that the realization of output is y, given that the capital and labor inputs are (k, l), with $P(y|k, l) > 0$ for all $y \in Y$ and all positive pairs (k, l). No other restrictions are put on the technology except for an assumption that more effort implies higher expected output.[6] The output realizations drawn from this stochastic technology are independent across agents and time periods. Finally, the capital stock depreciates at a rate $\delta \in (0, 1)$.

The risk-neutral, cost-minimizing principal and risk-averse agents write incentive compatible contracts. The principal effectively controls all allocations in the economy and accumulates the capital stock from the surpluses obtained from individual agents, that is, from all the goods produced but not consumed by the agents.

The insurance contract is an allocation sequence specifying each agent's inputs and consumption for each period $t \geq 0$. The sequence must satisfy the promise-keeping and incentive compatibility constraints. As is usual in the private-information literature, the principal identifies each agent by an initial entitlement to expected, discounted utility $w_0 \in W = [\underline{w}, \overline{w}] \subset \mathbf{R}$ and by a history of output realizations, $y^t = \{y_0, y_1, \ldots, y_t\} \in Y^{t+1}$. All agents identified with the same w_0 and the same history receive the same treatment.

The contract for an agent $w_0 \in W$ is an allocation sequence $\sigma = \{k_t(w_0, y^{t-1}), l_t(w_0, y^{t-1}), c_t(w_0, y^t)\}_{t=0}^\infty$, weighted by the conditional probability P^{t+1} that a history $y^t \in Y^{t+1}$, conditional on inputs $[k_t(w_0, y^{t-1}), l_t(w_0, y^{t-1})]$ employed in the production technology, occurs. An agent w_0's initial expected discounted utility can be written as

$$U(w_0, \sigma) = \sum_{t=0}^{\infty} \beta^t \int_{Y^{t+1}} \{u(c_t(w_0, y^t), 1 - l_t(w_0, y^{t-1}))\}$$
$$\cdot P^{t+1}(dy^t | k_t(w_0, y^{t-1}), l_t(w_0, y^{t-1})).$$

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The participation constraint requires the principal to deliver the expected discounted utility w_0 to the agent entitled to w_0,

$$U(w_0, \sigma) = w_0 \text{ for all } w_0 \in W. \tag{1}$$

Second, the incentive compatibility constraint ensures that each agent prefers the recommended labor supply to any labor supply deviation,

$$U(w_0, \sigma) \geq U(w_0, \hat{\sigma}) \text{ for all } w_0 \in W, \tag{2}$$

where $\hat{\sigma}$ contains any labor supply deviation $\hat{l} \in L$ from the recommended $l \in L$ in any period of time. Third, the social planner cannot assign a lower consumption than it is guaranteed by social insurance:

$$c_t(w_0, y^t) \geq \underline{c} > 0, \quad \text{for all } w_0 \in W \text{ and all } y^t \in Y^{t+1}. \tag{3}$$

From the economy-wide point of view, an efficient social planner minimizes the cost of the insurance scheme subject to the aggregate feasibility conditions for a closed economy. These conditions are obtained from aggregating the individual allocations according to the distribution of agents. Let λ_0 denote an arbitrary initial distribution of expected utility entitlements on $(W, \mathcal{B}(W))$. I will interpret $\lambda_0(A)$ as a fraction of the population entitled to expected discounted utility in $A \in \mathcal{B}(W)$.

The aggregate feasibility conditions require that in each period the social planner divides the accumulated aggregate capital stock, $\bar{K}_t$, into capital input assignments for all agents $w_0 \in W$,

$$\bar{K}_t \geq \int_{W \times Y^t} k_t(w_0, y^{t-1})\, P^t(dy^{t-1} | k_{t-1}(w_0, y^{t-2}), l_{t-1}(w_0, y^{t-2}))\, \lambda_0(dw_0), \tag{4}$$

and that the allocations to all agents are feasible,

$$\int_{W \times Y^{t+1}} \{y_t - c_t(w_0, y^t)\}\, P^{t+1}(dy^t | k_t(w_0, y^{t-1}), l_t(w_0, y^{t-1}))\, \lambda_0(dw_0) \geq \bar{K}_{t+1} - (1 - \delta)\bar{K}_t. \tag{5}$$

Note that the last equation serves as the law of motion for the capital stock: All goods produced but not consumed by the agents are added by the social planner to the depreciated current capital stock.

The distribution of utility entitlements evolves over time according to a stationary distribution λ.[7] The goal of this paper is to study the economy in such a *stationary recursive equilibrium*. For this purpose in the next section I formulate the principal–agent problem recursively and study a steady state of a closed economy in which the distribution of utility entitlements is time invariant, the levels of aggregate variables are constant, and the allocations are feasible.

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3. DECENTRALIZED ECONOMY IN A STATIONARY RECURSIVE EQUILIBRIUM

It is standard in the literature [see Atkeson and Lucas (1995) or Phelan and Townsend (1991)] to show that the sequential planning problem is equivalent to a recursive formulation with a utility entitlement $w \in W$ as a state variable for each agent. The utility entitlement w summarizes the history of output realizations of each agent at the beginning of each period.

Following Atkeson and Lucas (1995), the problem of finding efficient allocations in an economy with heterogeneous agents can be solved by a partial decentralization with prices and "component planners" each responsible for allocating resources only to agents entitled to a particular utility entitlement w. Each component planner chooses an allocation that minimizes the cost of attaining w evaluated at equilibrium prices of goods traded with other component planners.

The component planners are price takers and trade goods in the following way. They borrow capital according to the willingness of their agents to supply labor effort. Agents who supply high labor effort are assigned larger capital input in their production function according to the optimal capital–labor ratio, and vice versa for the agents working less. One can imagine the capital trading intermediated by a zero-profit financial intermediary called "capital planner." The capital planner manages the accumulated aggregate stock of capital, which he lends to the component planners in each period at the interest rate r. Given the interest rate r, a w-component planner assigns an agent w inputs, $k(w)$ and $l(w)$, as functions of the current utility entitlement. The incentive compatibility requires the consumption $c(w, y)$ and the continuation utility entitlement $w'(w, y)$, the next-period state variable, to be also functions of the current output realization. At the end of each period, each component planner repays the capital loan $(r + \delta)k(w)$ and deposits all remaining surplus $y - c(w, y)$ with the capital planner.

For a constant interest rate r, define an allocation policy of a component planner associated with subpopulation $w \in W$ as $\sigma_r \equiv \{k(w), l(w), c(w, y), w'(w, y)\}$. The objective of each component planner is to minimize the present value of resources evaluated at the intertemporal price of resources $1/(1+r)$ subject to the promise-keeping, incentive compatibility, and minimum guaranteed consumption constraints. For all $w \in W$ define a value function $V_r : W \to \mathbf{R}$ for the component planning problem and an operator T_r on the space of bounded, continuous functions $D(W)$ as

$$(T_r V_r)(w) = \min_{\sigma_r} \sum_{Y} \left\{ c(w, y) + (r + \delta)k(w) - y + \frac{1}{1+r} V_r(w'(w, y)) \right\} P(y|k(w), l(w)), \tag{6}$$

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subject to the promise keeping constraint,

$$w = \sum_{Y} \left\{u(c(w, y), 1 - l(w)) + \beta w'(w, y)\right\} \; P(y|k(w), l(w)), \tag{7}$$

the incentive constraint,

$$l(w) \in \arg\max_{\hat{l} \in L} \sum_{Y} \{u(c(w, y), 1 - \hat{l}) + \beta w'(w, y)\} \, P(y|k(w), \hat{l}), \tag{8}$$

and the minimum guaranteed consumption constraint,

$$c(w, y) \geq \underline{c}, \tag{9}$$

specified for each social insurance regime.

The steady state for a closed economy will exhibit a constant market-clearing interest rate, r, time invariant decision rules for all agents, σ_r, and a time-invariant distribution of utility entitlements, λ_r. The aggregated allocations of all component planners must satisfy the market-clearing conditions for a closed economy, namely that all the capital stock is lent out and the aggregate surplus exactly equals the depreciated capital stock.

DEFINITION 1. *A stationary recursive equilibrium for a decentralized economy with a social insurance regime guaranteeing minimum consumption $\underline{c}$ is a constant interest rate r, a value function V_r, an allocation policy σ_r, a probability measure λ_r, and a law of motion for aggregate capital stock $\bar{K}_r$, such that:*

1. *At interest rate r, for all $w \in W$, the allocation policy σ_r minimizes the objective function of each component planner* (6) *subject to the promise keeping constraint* (7)*, the incentive constraint* (8)*, and the social insurance regime constraint* (9)*;*
2. *the probability measure $\lambda_r \in \Lambda(W, \mathcal{B}(W))$ is time invariant,*

$$\lambda_r(A) = \int_{\{w'(w,y) \in A\}} \sum_{Y} P(y|k(w), l(w)) \, \lambda_r(dw) \quad \text{for all } A \in \mathcal{B}(W);$$

3. *the aggregate capital stock is constant and finite,*

$$\bar{K}_r \equiv \int_{W} k(w) \, \lambda_r(dw) < \infty;$$

4. *the aggregate feasibility condition holds,*

$$\int_{W} \sum_{Y} \{y - c(w, y)\} \, P(y|k(w), l(w)) \, \lambda_r(dw) = \delta \bar{K}_r.$$

It follows from Theorems 9.2 in Stokey, Lucas, and Prescott (1989) that at a constant interest rate, the optimal allocations of the recursive and sequential formulations are equivalent. It is straightforward to apply the first welfare theorem as in Atkeson and Lucas (1992) in order to establish the efficiency outcome of the component planning problem.

4. COMPUTATION OF SOCIAL INSURANCE REGIMES

In this section, I specify the parameters for preferences and production technology, define social insurance regimes, and outline an algorithm for computing the stationary equilibrium.

The utility function is of the standard logarithmic form $u(c, 1-l) = (1-\phi)\ln c + \phi \ln(1-l)$, with $\phi = 2/3$ as in Prescott (1986). The time discount parameter is set $\rho = 0.1$ as in Phelan and Townsend (1991), the capital share in the production technology $\alpha = 0.36$, and the depreciation rate for capital $\delta = 0.1$. There are 31 levels of labor supply $l \in L = \{0, 0.025, 0.05, \ldots, 0.75\}$. At the market-clearing interest rate r the capital input is assigned according to the efficient capital–labor ratio for each level of labor effort, $x = [\alpha/(r+\delta)]^{1/(1-\alpha)}$. Without a loss of generality, for each level of labor supply there are only two possible output realizations, $\underline{y} = 0$ with probability $P(\underline{y}|k, l) = 1 - l$ and $\overline{y} = 0.75x^{\alpha}$ with probability $P(\overline{y}|k, l) = l$.

A social insurance regime is defined by the level of minimum consumption, $\underline{c}$, guaranteed to each agent. In each regime, the exogenous lower bound on utility entitlements is defined as $\underline{w} = (1-\beta)^{-1}u(\underline{c}, 1)$, that is, the discounted present value of forever receiving the minimum guaranteed consumption together with full leisure. It is straightforward to show that an agent cannot be asked to supply any labor effort without consumption incentives and that $\underline{w}$ must be the lowest utility entitlement. In Aiyagari and Alvarez (1995) terminology, "misery is not attainable" because the agent can always enjoy leisure. Obviously, a higher minimum guaranteed level of consumption implies a higher lower bound on utility entitlements. Correspondingly, define the upper bound as $\overline{w} = (1-\beta)^{-1}u(\overline{c}, 1)$. I set the upper bound $\overline{c}$ so that it is not binding in equilibrium and the ergodic set of the distribution has an endogenous upper bound, $w^* < \overline{w}$. Altogether, the planners cannot punish agents below $\underline{w}$ and it is not cost efficient to reward them beyond the endogenous upper bound.[8]

As in Kehoe and Levine (1993), Huggett (1997), and Lucas (1992), in a private-information economy the market-clearing interest rate is less than the agents' time preference parameter. If $r > \rho$, the distribution is degenerate and the stationary equilibrium is not feasible in a closed economy. The intuition is that if the component planners discount the future more than the agents, they shift their costs too much into the future by increasing agents' continuation utility entitlements. In the limit, agents with the lowest utility entitlement $\underline{w}$ stay put while all the others end up at the exogenous upper bound $\overline{w}$. If $r = \rho$, there are many ergodic sets at utility levels where labor supply is zero. In sum, allocations with $r \geq \rho$ are not feasible because agents amass at utility entitlements where nobody works but everyone consumes.

For $r < \rho$, it is standard to prove that the distribution weakly converges to a unique, time-invariant distribution λ from any initial distribution λ_0 [see Atkeson and Lucas (1995), Aiyagari and Williamson (1999), and Chapter 12 in Stokey et al. (1989)]. In such a nondegenerate stationary equilibrium, component planners associated with relatively poor agents have a surplus while those associated with wealthy agents have a deficit. The feasibility condition for a closed economy requires an interest rate at which the distribution of agents over all utility entitlements be such that the aggregate surplus equals the depreciated stock of capital.

Models with moral hazard usually exhibit nonconvexity of the constraint set for the component planner's problem. In numerical simulations, I follow Phelan and Townsend (1991) in discretizing the economy and in using lotteries to transform the problem into a linear program. With lotteries, each w-component planner's allocation is a probability measure over a (k, l, y, c, w')-tuples that minimizes the component planner's value function subject to the constraints. For details on the formulation with lotteries, see Phelan and Townsend (1991).

For each level of the guaranteed minimum consumption, an algorithm for finding a steady state in a closed economy iterates on the market-clearing interest rate: 1) Guess an initial interest rate; 2) find the optimal policies for all component planners; 3) compute the invariant distribution of utility entitlements; 4) compute aggregate levels of output, consumption, and capital; 5) if the aggregate allocations are not feasible, that is, if consumption of all agents and the aggregate investment exceeds aggregate output, repeat with a lower interest rate (and vice versa for a surplus).

5. RESULTS

In this section I compare social insurance steady states in terms of their efficiency, equality, and aggregate levels. There are 12 social insurance regime steady states defined by the minimum guaranteed consumption. Each steady state is denoted by a ratio of its minimum guaranteed consumption to the average steady state consumption. I will use the following labels: A benchmark "low social insurance regime" corresponds to this ratio equal to 0.01, a "medium social insurance regime" to that of 0.36, and a "high social insurance regime" to that of 0.48. It was not possible to simulate a steady state with more generous social insurance: The planners were no longer able to enforce incentive-compatible allocations that would produce enough output needed for feasible allocations.

5.1. Efficiency-Equality Trade-Off

Although I will later compare aggregate levels and distributions of resources of individual steady states, a direct comparison of their efficiency is not possible: Given the minimum guaranteed consumption, each social insurance regime is a closed economy with optimal and efficient allocation of resources.

Obviously, a more generous social insurance imposes severer constraints on component planners' allocations and must be relatively inefficient. In other words, allocations in a steady state with generous social insurance must be feasible for any economy with less generous social insurance. Therefore, I define efficiency of

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TABLE 2. Efficiency, inequality, and welfare in steady states

			Relative poverty		Welfare	
Regime[a]	Efficiency[b]	Gini[c]	Head count[d]	Poverty gap[e]	Average	Median
0.01	100.0	0.33	29.2	4.2	100.0	100.0
0.04	99.9	0.32	27.4	3.8	99.3	94.5
0.08	99.9	0.31	25.1	3.2	98.6	88.2
0.12	99.8	0.29	22.0	2.3	98.1	82.6
0.17	99.7	0.28	19.6	1.8	98.0	78.8
0.22	99.6	0.26	18.3	1.7	98.2	77.1
0.26	99.4	0.25	18.4	1.8	98.1	76.6
0.31	98.7	0.24	20.1	2.0	97.7	76.2
0.36	97.3	0.23	22.8	2.3	97.7	75.7
0.40	94.4	0.24	26.4	2.7	98.6	75.5
0.45	89.4	0.25	20.1	3.1	100.4	75.7
0.48	82.7	0.26	36.1	3.6	102.8	75.6

Notes: [a] Social insurance regime defined as the ratio of minimum guaranteed consumption to average consumption. [b] Relative to the benchmark, low social insurance regime (100%). [c] Gini coefficient of per-period expected consumption equivalent. [d] Percentage of population below 50% of the median consumption equivalent. [e] Percentage of aggregate consumption equivalent redistributed to agents below 50% of the median consumption equivalent to bring their consumption equivalent to this level.

each social insurance regime as the expected present value of goods the component planners would save if the constraints of social insurance were removed.

In particular, I calculate the present discounted value of goods saved by the component planners during a transition from each social insurance steady state to the steady state of a benchmark regime, defined by the lowest guaranteed consumption level, $\underline{c}_B$.[9] The transition starts from the inherited distribution of utility entitlements in the original steady state. In the initial period of transition, the minimum guaranteed consumption is permanently reduced to $\underline{c}_B$. Such a reform enlarges the set of component planners' feasible allocations, and the distribution of utility entitlements converges to the stationary distribution of the benchmark regime. Note that the utility entitlements are duly delivered during the transition process, although in different allocation sequences. The efficiency loss of the original steady state is defined as the expected present value of goods per period the planners are able to save on their path to the unconstrained benchmark steady state while attaining the original utility entitlements of their agents.

Table 2 summarizes the main results for all social insurance regimes. The first column defines each social insurance regime by its ratio of the minimum guaranteed consumption to the steady state average consumption. The second column shows the efficiency loss of each social insurance regime as a percentage of the original regime's steady state GDP. The efficiency loss is relatively small (less than 1% of GDP) in regimes that guarantee minimum consumption up to 26% of their average steady state consumption. However, for the most generous

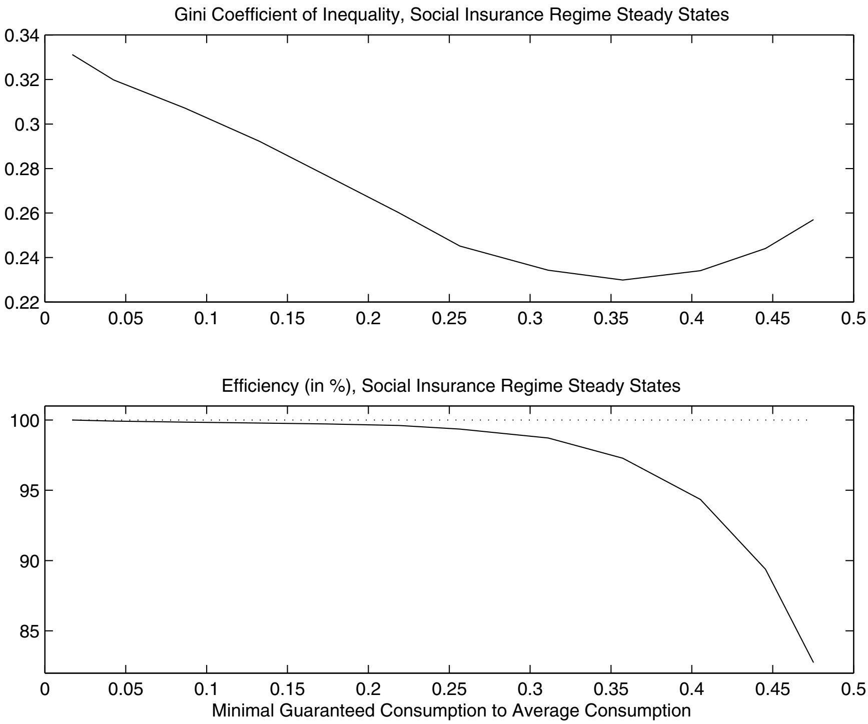

FIGURE 1. Equality and efficiency in social insurance regime steady states.

social insurance regimes the efficiency loss rises to more than 17% of GDP. The efficiency loss grows because increasing minimum guaranteed consumption levels do not allow the component planners to enforce high labor effort.

The third column of Table 2 displays Gini coefficients of inequality in each steady state.[10] Compared to efficiency losses above, inequality does not monotonically decrease in the degree of social insurance. The Gini coefficient falls from 0.33 in the low social insurance regime to 0.23 in the medium social insurance regime. After that it increases up to 0.26 in the high social insurance regime.

Figure 1 summarizes the efficiency–equality trade-off for all social insurance regimes: The trade-off exists only for the low-to-medium social insurance regimes in which equality improves with increased social insurance. If social insurance increases beyond the medium social insurance regime, the inequality measure starts to grow.[11]

The shape of the inequality measure is caused by the effects that social insurance policies have on different groups of agents. The initial reduction in inequality comes from improving the condition of the bottom quintile of agents, basically from eliminating the left tail of the distribution. In the low social insurance regime, the poorest quintile provides 40% of the total labor supply. As social insurance increases, the labor supply of the poor halves while their consumption rises by one-third. Altogether, their utility in terms of the consumption equivalent is 2.9 times higher in the high than in the low social insurance regime.

On the other hand, the top quintile agents work much more in the high social insurance regime than in the low social insurance regime (2.66 times more; they also consume 15% less). And as the left tail of the distribution vanishes in the medium social insurance regimes, the top quintile of agents becomes more important for the distribution of resources. The increased labor effort (and, therefore, increased probability of high output and future rewards) of the top quintile starts to have a negative effect on the distribution.

Finally, inequality increases in the high social insurance regimes also due to the shift in the incentive tools used by the component planners. As consumption "punishments" are no longer available, the planners must rely more on future "rewards" in terms of continuation utility entitlements. Beyond the medium social insurance regime, the component planners use so much of future incentives that inequality begins to increase. This process is made further possible by general equilibrium effects: To make labor more productive in more generous social insurance regimes, the equilibrium interest rate falls and the capital–labor ratio increases. This mechanism leads to key improvements in the incentive-compatible allocations.[12] The lower interest rate is a part of other general equilibrium effects that will be discussed below.

5.2. Poverty Measures and Welfare

These efficiency–equality results reflect the recent studies of inequality and social programs in the OECD countries. Atkinson (1995) finds that the greater inequality in the United States does not stem from the top decile being particularly wealthy relative to the median, so much as from the bottom decile being particularly poor. For instance, in the 1980s the average income among the lowest decile was around 35% of the median in the United States, compared with more than 55% in continental Europe and 60% in Scandinavia. In my simulations, these numbers are 42% for the low social insurance regime, 63% for the medium insurance regime, and 70% for the high insurance regime.

Atkinson, Rainwater, and Smeeding (1995) measure inequality in terms of top decile to bottom decile of household disposable income. For the United States this ratio is 5.94, whereas the European countries average around 3 and the Scandinavian countries around 2.7. The model delivers similar numbers: This ratio decreases monotonically, from 5.61 to 2.23, in degree of social insurance.

To evaluate whether social insurance actually reduces or eliminates poverty, I compare the steady states in their relative poverty measures. The fourth column in Table 2 shows the proportion of the population below 50% of the median consumption equivalent [the so called head-count relative poverty measure; see Mitchell (1991)]. The fifth column offers the poverty gap measured as the percentage of the aggregate consumption equivalent needed to be redistributed to agents below 50% of the median to bring them to this level.

Both measures have shapes similar to that of Gini coefficients. The most effective poverty reduction occurs in the social insurance regime guaranteeing 22% of average consumption (only 18% of population in poverty and a poverty gap of 1.7%). Note that the high social insurance regime is the worst in the head-count poverty measure: The distribution is so concentrated near the minimum guaranteed consumption level that 36% agents live in relative poverty. On the contrary, the low social insurance regime needs more goods to bring its agents to the poverty line: The absolute difference between the poor and the rest of the society is the greatest.

A similar increase in inequality and poverty measures at very high levels of social insurance is documented for Sweden by Lindbeck (1997). Swedish social expenditures reached 40% of GDP in the late 1980s and early 1990s. At this peak of welfare protection the distribution of income widened by three to five points of the Gini coefficient. There was also a rise in the fraction of households below the poverty line, if poverty is defined in terms of relative incomes. Lindbeck (1997) attributes this growth of inequality to Swedish social insurance policies' negative incentive effect on education, labor supply, and labor market participation.[13]

The last two columns of Table 2 present the steady state levels of average and median agent utility, measured in consumption equivalent units. The main difference is again in the labor effort incentives. The average agent's utility is very similar across the regimes, with some improvement in the more generous ones. Although consumption decreases in regimes' generosity (by 3%), the total utility improvement comes from a reduced labor supply (by 9%; see below). On the contrary, the median agent is 24% worse off: Not only is he consuming 10% less, but also his labor supply increases by 36%. Ex ante, the average risk-averse agent would be better off born into the high social insurance economy while the median agent, who might be politically more decisive, is much more worse off as social insurance increases.

5.3. Empirical Evidence from the OECD Countries

As part of the OECD Jobs Study, an index was constructed for the OECD member countries summarizing social insurance provisions for unemployed people without income. (Recall that in the model, a low realization of income is zero.) The OECD Summary Index of Benefit Entitlements is a comprehensive measure of gross unemployment benefit entitlements relative to gross earnings from 1963 to 1999. It is the unweighted average of 18 gross replacement rates: three household types (single, dependent spouse, and spouse in work), three time periods (the first year, the second and third years, and the fourth and fifth years of unemployment), and two earnings levels (average earnings and two-thirds of this level).[14]

Figure 2 shows annual OECD data on income inequality and social insurance between 1963 and 1999, with a denoted average value for each country. The line

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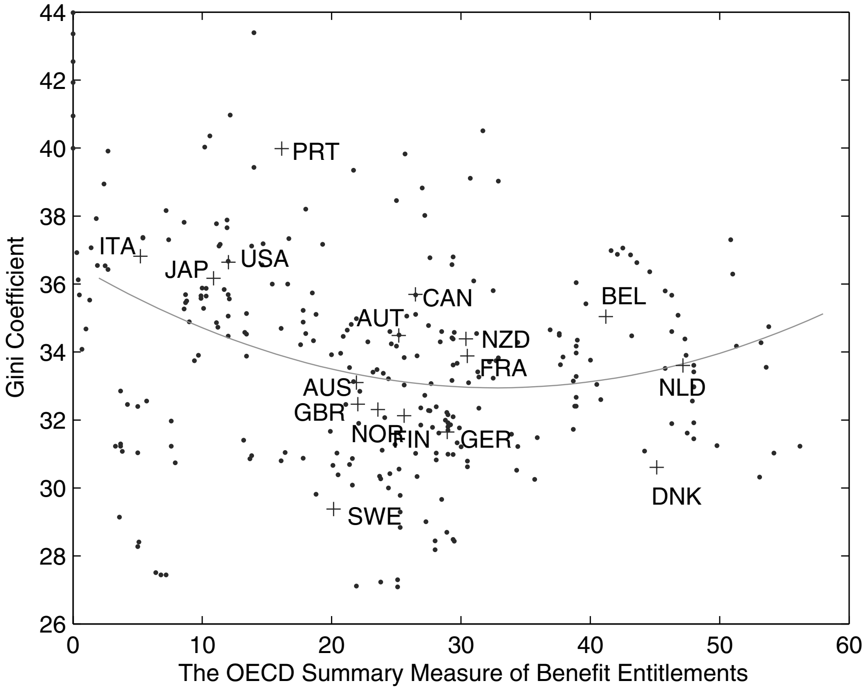

FIGURE 2. Inequality and social insurance in the OECD countries. Annual data and country averages for 1963–1999.

is the fitted least-squares regression in which the dependent variable is inequality and independent variables are the linear and the squared level of the OECD Summary Measure of Benefit Entitlements (see regression I in Table 3). Although such a simple regression for the panel data must be taken with care, both terms are highly significant and robust across different specifications of the regression. The other columns in Table 3 show results with added data on GDP per capita, aggregate capital stock per worker, average labor hours supplied by workers, and unemployment rate.

In these regressions, the linear term on benefit entitlements is always negative and the squared term is always positive, both statistically significant. This combination delivers the U-shaped form of the inequality–social insurance relationship also obtained from this paper's model. The U-shaped pattern in data is also preserved for most of individual country's panel data and for groups of geographically or institutionally similar countries. Other specifications of the regression (with the Theil index of inequality, for example, in place of Gini coefficients) deliver similar results. GDP, labor supply, and especially unemployment are significant across different specifications. Adding other variables slightly improves the fit but does not affect the main result.[15]

TABLE 3. Regression results: Gini coefficient of inequality, OECD 1963–1999

Regression	I	II	III	IV
Constant	36.3559	33.3154	15.2436	14.0339
	(70.8222)	(36.6491)	(4.1373)	(4.1483)
Benefits	−0.1816	−0.2195	−0.2213	−0.1717
	(−4.2120)	(−4.7172)	(−4.6638)	(−3.6455)
Benefits^2	0.0025	0.0028	0.0040	0.0028
	(3.1351)	(3.3324)	(4.6558)	(3.1813)
GDP		0.0002	0.0002	0.0002
		(5.0916)	(2.9767)	(2.1669)
Capital stock			0.0001	0.0001
			(0.7297)	(0.1097)
Labor supply			0.0083	0.0086
			(5.3425)	(5.9580)
Unemployment				0.4247
				(6.9849)
R^2	0.09	0.19	0.26	0.48
N obs.	316	248	153	126

Notes: t-statistics in parentheses. Benefits: The OECD Summary Benefit Entitlements defined in Table 1. Data from Galbraith and Kum (2003), Easterly and Sewadeh (2002), and OECD (2002). OECD countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Portugal, Sweden, United Kingdom, and United States.

5.4. General Equilibrium Effects

The steady state allocations are feasible through general equilibrium effects related to the market-clearing interest rate: The higher the guaranteed minimum consumption, the more the equilibrium interest rate declines in order to satisfy the market-clearing condition.

From the point of view of planners, a lower interest rate has two important effects: First, it reduces the cost of continuation utility entitlements. These future rewards are important in more generous social insurance regimes in which consumption punishments are no longer available. Only in this way are component planners able to induce labor effort that is not drastically lower than that in the low social insurance regime. Second, substituting from the unobservable labor effort toward capital input is the optimal policy as interest rates decline.

Table 4 shows the average aggregate levels for each social insurance regime relative to the benchmark low social insurance regime. The more generous social insurance regimes accumulate larger capital stock and exhibit greater capital–output and especially capital–labor ratios. The capital–output ratio is 2.25 in the low social insurance regime and 2.87 in the high social insurance regime. The increase is even higher for capital–labor ratios.

However, maintaining a larger stock of capital in a steady state is also costly. Thus generous social insurance regimes do not deliver their agents higher consumption despite producing higher levels of output: The level of aggregate

TABLE 4. Average levels in steady states

Regime[a]	Output	Capital	Consumption	Labor supply
0.01	100.0	100.0	100.0	100.0
0.04	100.2	100.8	98.9	99.5
0.08	100.5	101.8	97.9	99.1
0.12	100.7	102.9	97.2	98.7
0.17	101.2	104.1	97.1	98.4
0.22	101.5	105.3	97.0	98.2
0.26	101.9	106.5	96.8	97.9
0.31	102.3	108.2	96.0	97.4
0.36	102.8	111.4	95.4	96.4
0.40	103.6	116.9	95.3	94.9
0.45	104.5	124.1	95.6	93.0
0.48	105.5	131.4	97.0	91.1

Notes: Relative to the benchmark, low social insurance regime (100%). [a]Social insurance regime defined as the ratio of minimum guaranteed consumption to average consumption.

output is 5.5% greater in the high social insurance regime than in the benchmark regime, but consumption per capita is 3% lower. These changes in consumption and labor supply (lower by 9%) are behind the welfare changes in Table 2. It is apparent that changes in labor supply are more important than changes in consumption.

To compare this shift in the use of productive inputs to the evidence from the OECD countries in the 1990s, Figure 3 shows the levels of capital per worker and the average annual hours actually worked per person in employment. The bottom panels show the ratios of GDP to these measures. The solid line is the least-squares fit to the OECD data with the same independent variables as in regression I in Table 3.[16] The dashed line represents the aggregate levels from numerical simulation of social insurance regimes. The data are normalized to the mean, and social insurance measures are in percentage terms.

It is apparent that increasing social insurance in the OECD countries leads to fewer hours worked. The actual data show a more pronounced fall in labor supply than in the model. As labor supply decreases, these countries accumulate higher capital stock per worker: Otherwise, they would not be able to produce the high levels of output observed.

Finally, I could not find in the data the same pattern of decreasing interest rate predicted by the model. Figure 4 shows that in the OECD data (solid line), there is no monotone relationship between the interest rate and social insurance in the model (dashed line). The long-run real interest rate is decreasing only at very generous social insurance levels.[17]

5.5. Partial Equilibrium Example

These results show the importance of incorporating capital accumulation within the general equilibrium framework. Just for a contrasting comparison, I have also

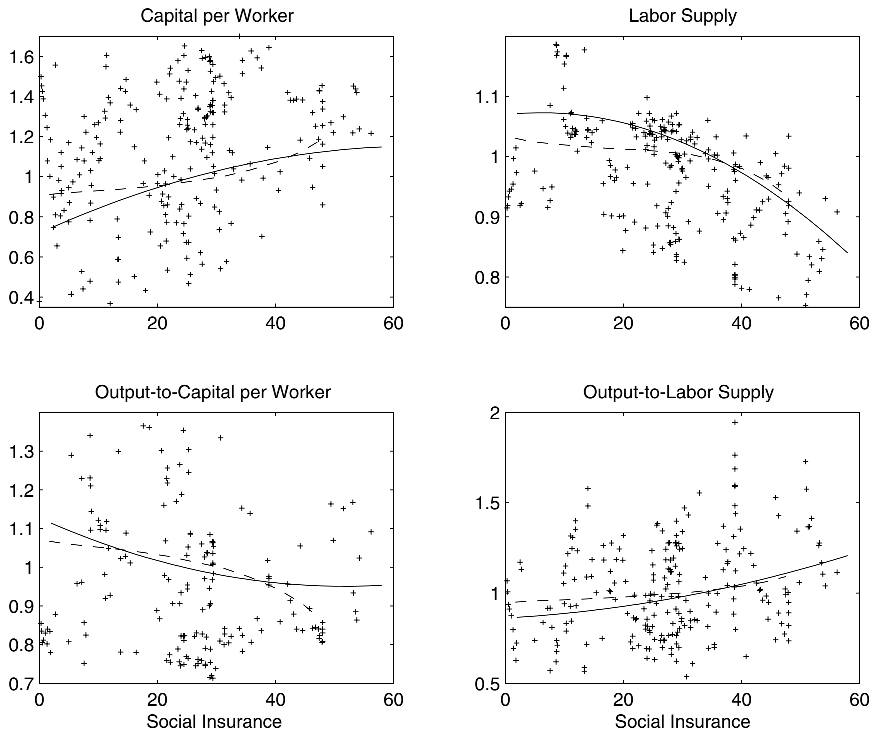

FIGURE 3. Capital per worker, labor supply, output-to-capital per worker, and output-to-labor supply in OECD countries, annual data 1990–1999, normalized to the mean. Solid line, fitted, OECD data; dashed line, model simulations.

simulated the same steady states in partial equilibrium at a fixed interest rate taken from the benchmark regime.[18]

By fixing the interest rate, I ignore the aggregate feasibility condition. The error is huge: In the most generous social insurance regime, the aggregate feasibility is violated by 60% of the steady state output. Because the fixed interest rate is relatively high, the planners do not provide as many future incentives (by increasing the continuation utility entitlement) and the agents stay close to the exogenous lower bound defined by the minimum guaranteed consumption. Therefore, as social insurance increases, Gini coefficients do decline monotonically to 0.16 in the high social insurance regime. (They decline at an increasing rate with a shape similar to that of the efficiency loss in Figure 1.) Without the general equilibrium effects on incentives, the average labor effort falls by more than 40% compared to the benchmark regime. Because the partial equilibrium framework imposes the same capital–labor ratio, both aggregate capital stock and output decline by 40% as well.

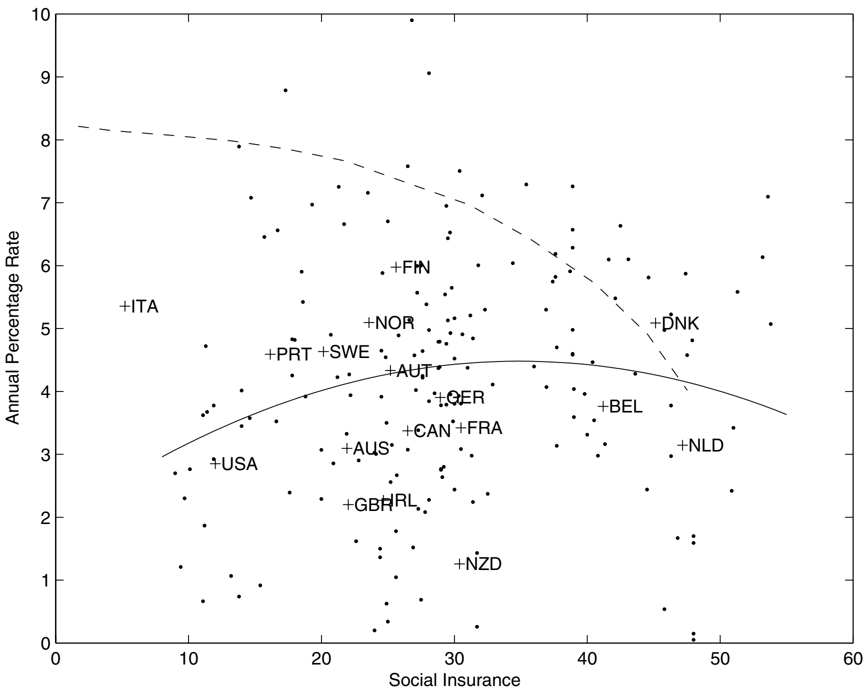

FIGURE 4. Long-term real interest rate. Annual data and country averages for 1963–1999. Solid line, fitted OECD data; dashed line, model simulations.

This experiment documents the importance of general equilibrium and the dynamic, intertemporal incentives. First, without intertemporal incentives the inequality measures would fall monotonically at an increasing rate. Second, without endogenous capital accumulation at equilibrium prices, economies that provide generous social insurance would generate very low levels of output, living standards, and capital stock. Such patterns would be clearly at odds with the data.

6. CONCLUSIONS

Many important issues are related to social insurance this paper is abstracting from: higher and distorting taxation, more intrusive regulation, or optimal government polices studied in the new public finance literature [see Kocherlakota (2005)]. This model focuses on incentive effects from a moral hazard problem related to social insurance programs. It examines the existence of the social insurance trade-off between efficiency and equality in a general equilibrium model with heterogeneous agents and moral hazard. The main result does not support the existence of the trade-off. Efficiency falls and equality improves as social insurance increases from low to medium levels. However, this tendency stops at higher levels of social insurance at which efficiency rapidly declines while inequality begins to rise. Numerical simulations show that the efficiency loss can be quite heavy for the most generous welfare regimes and that general equilibrium effects are important for matching the OECD data.

Is there an optimal level of social insurance that would lower inequality without worsening too much the efficiency of the economy? The answer depends on each society's priorities. Numerical simulations of social insurance steady states point to a reasonable compromise between the efficiency loss and the gain in equality with a minimum guaranteed consumption around 30% of the average consumption. Such a level of social insurance balances the efficiency loss at around 1%–2% of GDP for a sizable reduction of inequality and poverty, compared to the least generous but efficient social insurance regime. In light of these results, some European countries might have gone too far in their social insurance programs. Their current policies aimed at a reduction of the welfare system seem to be justified.

NOTES

1. Nickell and Layard (1999) show that despite a significant variation of data in Europe, on all measures (minimum wage, labor standards, employment protection, unemployment benefit replacement ratio, and duration) the United States score much lower than the European average.

2. Other objective functions could be considered for studying social insurance (to minimize inequality, for example). However, such assumptions would miss the goal of understanding the tradeoff between efficiency and equality in the standard asymmetric information literature framework. Also, it brings the standard social planner's problem with asymmetric information developed by Prescott and Townsend (1984) and Phelan and Townsend (1991) to data.

3. The immiseration property is robust and obtained in partial [Green (1987); Thomas and Worrall (1990)] as well as in general (Atkeson and Lucas (1992)) equilibrium, under weak assumptions on preferences (Phelan (1998)), and holds in adverse selection and moral hazard [Pavoni (in press)] environments.

4. In particular, Atkinson (1995) finds that the greater inequality in the United States does not stem from the top decile being particularly wealthy, so much as from the bottom decile being particularly poor.

5. In the principal–agent formulation, the agent consumes the whole income received from the principal. In the model, therefore, consumption and income are equivalent. There is no private storage technology, and the principal prevents each agent from trading with other agents.

6. Naturally, zero effort leads to zero output with probability one.

7. The stationary distribution is not degenerate because of the idiosyncratic productivity shocks and the moral hazard problem. The minimum consumption level that defines a social insurance regime, $\underline{c} > 0$, serves as the exogenous lower bound on the utility entitlements. The existence of a unique, nondegenerate stationary distribution is discussed in a greater detail in Section 4.

8. Detailed analysis related to existence and uniqueness as well as the properties of optimal allocations and the stationary distribution of utility entitlements can be found in Bohacek (2005).

9. I am grateful to Fernando Alvarez for suggesting this measure.

10. Inequality is measured in terms of a consumption equivalent measure, defined as the amount of consumption good needed to attain an agent's per-period expected present discounted value.

11. This outcome seems to be robust for various specifications of the stochastic production function I have used in numerical simulations. The minimum point of Gini coefficients has occurred between 0.30 and 0.38 of the ratio of minimum guaranteed to average consumption levels.

12. Pavoni (in press) shows that when the lower bound on utility entitlement becomes binding, the planner uses rewards rather than punishments to exert high effort from unemployed workers.

13. Freeman, Topel, and Swedenborg (1997) conclude that "much of Sweden's welfare state went beyond what was necessary to eliminate poverty" and that the solution to the Swedish crisis in the 1990s "necessitates contraction of the welfare state."

14. Social assistance benefits are not generally included, unless there is a general entitlement. The gross replacement rate would be greater than the net replacement rate if tax systems were progressive, if children were included in the household types, and if housing benefits were included. The latter form a significant part of income of households without earnings. For details, see OECD (2002). Data on inequality are from The University of Texas Inequality Project, Galbraith and Kum (2003).

15. The data on aggregate levels are from Easterly and Sewadeh (2002), unemployment rates are from OECD (2002). The data and more detailed results are available upon request from the author. The U-shape is present also for cross sections but the number of data points is small.

16. Data are from Easterly and Sewadeh (2002) and OECD (2002). Basic statistics on fitted lines in Figure 3 with Benefits and Benefits^2 are as follows: The linear term is significant and positive for data on capital and output and significant and negative for output-to-capital ratio. The squared term is significant and negative for labor supply. Details available upon request.

17. Data are from the OECD Leading Indicators time series. The regression coefficients for the fitted line are all significant, but the R^2 is low. A similar or no obvious pattern was found for other definitions of interest rate.

18. I am grateful to V. V. Chari for suggesting this experiment.

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