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Social Security as a Monopoly

André Drost
Bernhard Felderer

Institut für Höhere Studien
Institute for Advanced Studies
Vienna

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Author(s):
André Drost, Bernhard Felderer

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Institute for Advanced Studies, Vienna

Contact:

André Drost
Department of Economics
University of Cologne
Albertus-Magnus-Platz
D-50923 Cologne, Germany
☎: +49/221/470-2735
email: drost@wiso.uni-koeln.de

Bernhard Felderer
Institute for Advanced Studies
Stumpergasse 56
1060 Vienna, Austria
☎: +43/1/599 91-125
email: felderer@ihs.ac.at

Abstract

The typical social security program is designed as follows: (1) It is organized as a pay-as-you-go system. (2) It is financed with a payroll tax. (3) Employers and employees share the tax. (4) Benefits are largely independent of asset income. (5) Benefits are increasing with the taxes paid. (6) Benefits induce retirement. We present a model that can explain these stylized facts. Our model refers to an economy where workers want to monopolize the labor market. For this purpose, they bring about a social security act, which requires old workers to retire and young workers to pay transfers to retirees. The first prescription serves to reduce labor supply in order to realize a monopoly gain. The second prescription serves to give old workers share to the gain. As we will show, the social security program emerging in our model is similar to the typical program described above.

Keywords

Social security, public pensions, political economy, monopolistic labor market, Nash bargaining solution

JEL Classifications

H55

Comments
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Contents

1 Introduction

In many countries politicians try to reform social security programs. Economists assist them and provide academic advice. For the advice to be good, it is necessary that economists have a good positive theory of social security. Without having this theory, they may misconceive people's political preferences and support the wrong reform proposals. To illustrate this point, consider the following example. Assume that the majority of people wants to have a social security program that induces the elderly to retire. Economists, however, believe in a theory which predicts that people want to have a program which makes them save for their old age. Due to this theory, they support reform proposals maximizing the rate of return on savings instead of inducing retirement. This is just the opposite of what people want to have. The advice economists give in this example is misleading.

The example shows that it is quite important to have a good positive theory of social security. But what distinguishes a good theory from a bad one? A good theory should be able to explain the properties of a typical social security program. These properties were explored by Mulligan and Sala-i-Martin (1999a), who studied the social security programs of 89 countries and found that the programs are surprisingly similar (see also Mulligan and Sala-i-Martin 1999b and Sala-i-Martin 1996). The typical program is designed as follows:

1. It is organized as a pay-as-you-go system (98 percent of the 89 countries).
2. It is financed with a payroll tax (96 percent).
3. Employers and employees share the tax (90 percent).
4. Benefits are largely independent of asset income (89 percent).
5. Benefits are increasing with the taxes paid (85 percent).
6. Benefits induce retirement (75 percent of the 73 countries for which data were available).

In what follows, we will refer to these properties as the stylized facts of social security.

Beginning with Browning (1975), economists have produced quite a lot of theories of social security. The models are surveyed by Boadway and Wildasin (1989), Breyer (1994), Drost (1998), Mulligan and Sala-i-Martin (1999b, 1999c), and Verbon (1988, 1993). Hardly any model is able to explain all stylized facts, however. An exception is the model developed by Sala-i-Martin (1996), which we shall briefly review for this reason. The model refers to an economy that exhibits an externality in human capital. Due to this externality, workers whose human capital stock is low supply an inefficiently high amount of labor. These workers are usually old, and thus it is efficient to pay a pension to old workers who are willing to leave the labor force. The result is a social security program similar to the typical one described above. Since the young generation pays a pension to the old generation, the program is pay-as-you-go. Since the pension serves to buy the elderly out of the labor force, it induces retirement. Since retirement is beneficial for employees and employers, it is financed by both of these groups. So we could continue and show that Sala-i-Martin's model explains all stylized facts. Therefore we should classify it as a good positive theory of social security.

Although Sala-i-Martin's model already replicates the stylized facts, we will present an alternative model in this paper. Our motivation is that Sala-i-Martin uses a nonstandard assumption and that he gets a controversial result. The nonstandard assumption is that the economy exhibits an externality in human capital. Though some empirical studies support this assumption (for references see Sala-i-Martin 1996), it is only used in a minority of economic models. The controversial result is that the social security program is efficient. This result is a direct consequence from the externality, but many liberal economists will not believe in it. Our model is not based on the assumption of an externality in human capital, nor does it produce the result of an efficient social security program. Nevertheless it can replicate the stylized facts of social security.

The intuition behind our model can be explained as follows. Consider an economy where workers aim at monopolizing the labor market. To achieve this aim, they convince the parliament to pass a social security act that consists of two parts:

§ 1 Old workers retire.

§ 2 Young workers pay transfers to old workers.

The first part serves to reduce labor supply, to push up wages, and, hence, to realize a monopoly gain. The second part serves to give old workers share to the gain. Of course, entrepreneurs do not like this policy. To defend themselves against it, they enter into negotiations with the workers. As a result, the act is modified as follows:

§ 1 Old workers retire.

§ 2 Young workers pay transfers to old workers.

§ 3 The age of retirement is higher than in the original act.

§ 4 Entrepreneurs pay transfers to old workers.

Again the first and the second part serve to realize a monopoly gain and to give old workers share to it. The third and the fourth part serve to reduce the gain by re-increasing labor supply and to compensate the workers for the reduction.

The social security program defined by this act turns out to be very similar to the typical program described above: it is pay-as-you-go, it induces retirement, it is financed by workers and entrepreneurs, and so on. Our model can therefore replicate the stylized facts of social security without making use of the externality assumption or producing the efficiency result.

We analyze the idea of a monopolistic social security program in an equilibrium model that is combined with a bargaining game. To keep the analysis as transparent as possible, we make two simplifications. First, we use a static and not a dynamic equilibrium model. This way we deviate from what is usual in the literature (and due to important intertemporal effects advisable), but a dynamic model would become very complicated so that we could not explain our idea in a transparent way. Second, we use a bargaining solution where bargaining inefficiencies are exogenous and not endogenous. This way we ignore some interesting game theoretic developments, but we are able to keep the degree of complexity low and the degree of transparency high. After presenting our model in detail, we will briefly discuss the consequences of these simplifications.

The rest of the paper is organized as follows. In section 2 we describe a benchmark economy where a social security program does not exist. In section 3 we examine an economy where workers convince the parliament to introduce a social security program. In section 4 we analyze an economy where entrepreneurs and workers negotiate for a modification of the program. In section 5 we conclude and discuss, among other things, the predictions our model generates about the future of social security.

2 Omitting Social Security

Consider a simple economy that consists of old workers, young workers, and entrepreneurs. The agents are heterogeneous and differ in human capital and wealth. Each old worker $o \in \{1, 2, ..., N_o\}$ has an exogenous asset income $a_o \in (-\infty, \infty)$. She also has an exogenous human capital endowment $h_o \in [0, \infty)$. If she chooses to work for $\ell_o \in [0, 1]$ units of time and earns the wage $w \in [0, \infty)$ per unit of human capital and working time, she will receive the labor income $wh_o\ell_o$. She spends her asset and her labor income on consumption c_o. Her budget constraint is

$$c_o = wh_o\ell_o + a_o. \tag{1a}$$

The old worker chooses consumption and working time so as to maximize utility. Her utility function is

$$u_o = c_o - \beta\ell_o, \tag{1b}$$

where $\beta \in [0, \infty)$ is a parameter measuring the marginal disutility of labor. If we assume that β is sufficiently small ($\beta < wh_o$), the old worker wants to work as much as possible. Her labor supply then is

$$\ell_o = 1. \tag{1c}$$

This implies that her maximum level of utility is

$$u_o = wh_o + a_o - \beta. \tag{1d}$$

Note that we assume the utility function to be linear. This assumption serves to simplify the analysis of the bargaining games, which will be discussed later on.

Young workers are modeled in a similar way. Each young worker $y \in \{1, 2, ..., N_y\}$ has an exogenous asset income $a_y \in (-\infty, \infty)$ and an exogenous human capital endowment $h_y \in [0, \infty)$. If she works for $\ell_y \in [0, 1]$ units of time, she will earn the labor income $wh_y\ell_y$. She uses her asset and her labor income for consumption c_y. Her budget constraint is

$$c_y = wh_y\ell_y + a_y. \tag{2a}$$

The young worker chooses consumption and working time so as to maximize utility. Her utility function is

$$u_y = c_y - \beta\ell_y. \tag{2b}$$

If we assume that the marginal disutility of labor β is sufficiently small ($\beta < wh_y$), the young worker will supply

$$\ell_y = 1 \tag{2c}$$

units of labor. As a result, her maximum level of utility is

$$u_y = wh_y + a_y - \beta. \tag{2d}$$

Note that the young worker does not save for her old age. Moreover, she does not take account of future utility. These assumptions are mainly used to keep the model as transparent as possible. They also serve to underline that the motivation for creating a social security program is purely intratemporal in our model (as opposed to the intertemporal savings motive that dominates in other models).

Each entrepreneur $e \in \{1, 2, ..., N_e\}$ has the asset income $-a_e \in (-\infty, \infty)$. She does not have any labor income, but if she hires $h_e \in [0, \infty)$ units of human capital from the workers and uses it to produce a homogeneous good $y_e = h_e^\gamma$ with $\gamma \in (0, 1)$, she will obtain the profit income $h_e^\gamma - wh_e$. She spends her asset and her profit income on consumption c_e. Her budget constraint is

$$c_e = h_e^\gamma - wh_e - a_e. \tag{3a}$$

The entrepreneur chooses consumption and human capital input so as to maximize utility

$$u_e = c_e. \tag{3b}$$

The necessary condition for a utility maximum is

$$w = \gamma h_e^{\gamma-1}. \tag{3c}$$

The condition implies that each entrepreneur hires the same amount of human capital ($h_e = (\gamma/w)^{1/(1-\gamma)}$). It also implies that the entrepreneurs' maximum level of utility is

$$u_e = (1-\gamma)\, h_e^{\gamma} - a_e. \tag{3d}$$

Note that we do not distinguish between young and old entrepreneurs. Distinguishing between generations would be possible, but it would merely complicate the model without yielding any additional insights.

Old workers, young workers, and entrepreneurs interact in the markets for assets, human capital, and goods. The market for assets clears if $\sum_{o=1}^{N_o} a_o + \sum_{y=1}^{N_y} a_y = \sum_{e=1}^{N_e} a_e$. By introducing the definitions $A_o \equiv \sum_{o=1}^{N_o} a_o$, $A_y \equiv \sum_{y=1}^{N_y} a_y$, and $A_e \equiv \sum_{e=1}^{N_e} a_e$, we can write this market clearance condition more simply as

$$A_o + A_y = A_e. \tag{4a}$$

The market for human capital clears if $\sum_{o=1}^{N_o} h_o + \sum_{y=1}^{N_y} h_y = h_e N_e$. By introducing the definitions $H_o \equiv \sum_{o=1}^{N_o} h_o$ and $H_y \equiv \sum_{y=1}^{N_y} h_y$, we can rewrite this condition as

$$H_o + H_y = h_e N_e. \tag{4b}$$

Due to Walras' Law, equations (4a) and (4b) also imply the clearance of the goods market.

In the equilibrium the old workers, the young workers, and the entrepreneurs must maximize utility, and the markets for assets, human capital, and goods must clear. This means that the equations (1a) to (4b) must hold simultaneously. Using these equations, we can compute the equilibrium distribution of utility. The old workers' equilibrium level of utility is

$$u_o = \gamma \left(\frac{H_o + H_y}{N_e}\right)^{\gamma-1} h_o + a_o - \beta, \tag{5a}$$

the young workers' equilibrium level of utility is

$$u_y = \gamma \left(\frac{H_o + H_y}{N_e}\right)^{\gamma-1} h_y + a_y - \beta, \tag{5b}$$

and the entrepreneurs' equilibrium level of utility is

$$u_e = (1-\gamma)\left(\frac{H_o + H_y}{N_e}\right)^{\gamma} - a_e. \tag{5c}$$

As we will see in the next section, these utility levels change when a social security program is introduced into the benchmark model. This will generate political support for or resistance against the introduction.

3 Introducing Social Security

Everybody knows that it is profitable to be a monopolist. The workers in our model have this knowledge too. They understand very well that they would be better off if they could form some kind of stable cartel. The problem with cartels is that they tend to be unstable. So what can workers do in order to stabilize their cartel? One possibility they have is to protect it by law. They can use their political power (which is based on the fact that $N_o + N_y$ is usually larger than N_e) and bring about a law that forces all or some of them to reduce labor supply. In particular, they can convince the parliament to pass a social security act that forces the old workers to retire. Of course, retirees will only support this law if they participate in the monopoly gain. So it is necessary to give them a pension which transfers part of the gain from the active workers to the passive ones.

For a better understanding of this idea, consider the diagram which is depicted in figure 1. The diagram shows the labor demand curve D (which is drawn as a straight line, for simplicity) and the two labor supply curves S_1 and S_2. While S_1 refers to the situation before the introduction of a social security program, S_2 refers to the situation after it. Due to the retirement regulations, the introduction of the program shifts the labor supply curve to the left. As a consequence, equilibrium labor supply falls from H_1 to H_2 and the equilibrium wage rises from w_1 to w_2. This implies that the workers' surplus rises from $d+e$ to $b+d$ and the entrepreneurs' surplus falls from $a+b+c$ to a. So workers are better off and entrepreneurs are worse off when a social security program is introduced. The effect of the program thus is similar to that of a monopoly. Next we integrate this idea into the model developed in the previous section.

The introduction of a social security program changes the equilibrium distribution of utility. Because old workers do not work any longer and receive benefits $b_o \in [0, \infty)$, their equilibrium level of utility changes into

$$v_o = a_o + b_o. \tag{6a}$$

Because young workers experience a wage increase from $\gamma\left[(H_o + H_y)/N_e\right]^{\gamma-1} h_y$ to $\gamma\left(H_y/N_e\right)^{\gamma-1} h_y$ and pay taxes $t_y \in [0, \infty)$, their equilibrium level of utility

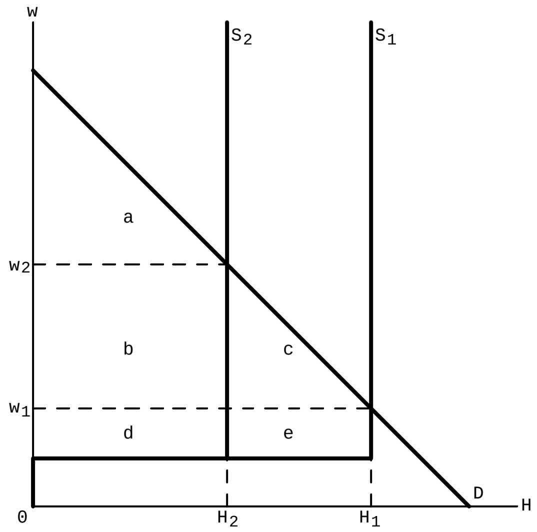

Figure 1: The Effects of Introducing a Social Security Program

changes into

$$v_y = \gamma \left(\frac{H_y}{N_e} \right)^{\gamma - 1} h_y + a_y - \beta - t_y. \tag{6b}$$

Because entrepreneurs pay higher wages and hire less workers, their new equilibrium level of utility is

$$v_e = (1 - \gamma) \left(\frac{H_y}{N_e} \right)^{\gamma} - a_e. \tag{6c}$$

Obviously, entrepreneurs must suffer a utility loss. Workers, however, can have a utility gain (at least in the aggregate), which we will show next.

The workers' aggregate change in utility is

$$\Delta U = \sum_{o=1}^{N_o} (v_o - u_o) + \sum_{y=1}^{N_y} (v_y - u_y). \tag{7a}$$

By inserting equations (5a), (5b), (6a) and (6b), we can express the change as

$$\begin{aligned} \Delta U = & \sum_{o=1}^{N_o} \left[b_o - \gamma \left(\frac{H_o + H_y}{N_e} \right)^{\gamma - 1} h_o + \beta \right] \\ & + \sum_{y=1}^{N_y} \left[\gamma \left(\frac{H_y}{N_e} \right)^{\gamma - 1} h_y - t_y - \gamma \left(\frac{H_o + H_y}{N_e} \right)^{\gamma - 1} h_y \right]. \end{aligned} \tag{7b}$$

After rearranging, we get

$$\begin{aligned} \Delta U = & \sum_{o=1}^{N_o} b_o - \gamma \left(\frac{H_o + H_y}{N_e} \right)^{\gamma - 1} H_o + \beta N_o \\ & + \gamma \left(\frac{H_y}{N_e} \right)^{\gamma - 1} H_y - \sum_{y=1}^{N_y} t_y - \gamma \left(\frac{H_o + H_y}{N_e} \right)^{\gamma - 1} H_y. \end{aligned} \tag{7c}$$

By assuming that the social security budget is balanced ($\sum_{o=1}^{N_o} b_o = \sum_{y=1}^{N_y} t_y$), we obtain

$$\Delta U = \beta N_o - \left[\gamma \left(\frac{H_o + H_y}{N_e} \right)^{\gamma - 1} (H_o + H_y) - \gamma \left(\frac{H_y}{N_e} \right)^{\gamma - 1} H_y \right]. \tag{7d}$$

So the aggregate change in utility is

$$\Delta U = \beta N_o - \gamma \left[\left(\frac{H_o + H_y}{N_e} \right)^{\gamma} N_e - \left(\frac{H_y}{N_e} \right)^{\gamma} N_e \right]. \tag{7e}$$

This equation shows that the workers' utility change is composed of two parts. The first part (βN_o) is a utility gain, which results from the fact that old workers have more leisure now. The second part ($\gamma\,[\cdot]$) is a utility loss, which results from the fact that aggregate output and, hence, the workers' share in it are lower now. If we assume that the marginal disutility of labor measured by β is sufficiently large, the utility gain will outweigh the utility loss so that the total change in aggregate utility is positive. In this case workers can achieve a monopoly gain and will introduce a social security program.

Given that workers introduce the program, how do they distribute the monopoly gain, i.e. how do they determine taxes and benefits? We assume that workers negotiate for the distribution of the gain and that the outcome of the negotiation is determined by the Nash bargaining solution. This solution implies that the gain is distributed equally among old and young workers so that each worker receives the same share:[1]

$$v_o - u_o = v_y - u_y = \frac{\Delta U}{N_o + N_y}. \tag{8a}$$

If we combine this equation with equations (5a), (5b), (6a) and (6b) and rearrange, we obtain the benefit formula

$$b_o = \left\{ \frac{\Delta U}{N_o + N_y} \right\} - \left\{ \beta - \gamma \left(\frac{H_o + H_y}{N_e} \right)^{\gamma - 1} h_o \right\} \tag{8b}$$

and the tax formula

$$t_y = \left\{ \left[\gamma \left(\frac{H_y}{N_e} \right)^{\gamma-1} - \gamma \left(\frac{H_o + H_y}{N_e} \right)^{\gamma-1} \right] h_y \right\} - \left\{ \frac{\Delta U}{N_o + N_y} \right\}. \tag{8c}$$

The benefit formula shows that benefits serve to close the gap between the target utility gain $\Delta U / (N_o + N_y)$ and the actual utility gain $\beta - \gamma\left[(H_o + H_y)/N_e\right]^{\gamma-1} h_o$ (which results from a rise in leisure and a loss of wages). The higher a retiree's human capital stock, the wider is the utility gap (because of a larger wage loss)

[1] To prove this implication, maximize the log Nash product

$$\sum_{o=1}^{N_o} \ln (v_o - u_o) + \sum_{y=1}^{N_y} \ln (v_y - u_y),$$

with u_o, u_y, v_o, v_y being defined by (5a), (5b), (6a), (6b), subject to the budget constraint

$$\sum_{o=1}^{N_o} b_o = \sum_{y=1}^{N_y} t_y.$$

The implication can be derived from the first-order conditions.

and the higher are the retiree's benefits. Likewise, the tax formula shows that tax payments serve to close the gap between the actual utility gain $\gamma \left(H_y/N_e\right)^{\gamma-1} h_y - \gamma \left[\left(H_o + H_y\right)/N_e\right]^{\gamma-1} h_y$ (which results from a rise in wages) and the target utility gain $\Delta U/\left(N_o + N_y\right)$. The higher a young worker's human capital stock, the wider is the utility gap (because of a larger wage rise) and the higher are the worker's tax payments.

Now we have determined all elements of the social security program emerging in our model. We summarize them in

Proposition 1 (Original Social Security Program) *The original social security program is organized as follows. First, old workers completely retire so that*

$$\ell_o = 0.$$

Second, old workers receive benefits that are determined by the formula

$$b_o = k_1 h_o + k_2.$$

Third, young workers pay taxes that are determined by the formula

$$t_y = k_3 h_y - k_4.$$

In these formulas the variables k_1 to k_4 are positive constants that are independent of individual parameters like h_o or a_y.

As the proposition shows, the program is similar to the typical program described in the introduction:

1. It is pay-as-you-go.
2. It is financed with a payroll tax (because taxes depend on human capital and, thus, on wages).
3. Benefits are independent of asset income.
4. Benefits are increasing with the taxes paid (because both benefits and taxes are positively related to human capital).
5. The program induces retirement.

Altogether, our model can thus explain five of the six stylized facts of social security. The only fact it cannot explain is why entrepreneurs contribute to the financing of the social security program. In the next section, we will extend our basic model to incorporate employer contributions.

4 Modifying Social Security

Everybody knows that a monopolistic market is inefficient. The entrepreneurs in our model have this knowledge too. They understand very well that everyone could be better off if the labor market were competitive. But what can the entrepreneurs do to de-monopolize the market? One thing they can do is to negotiate for a modification of the social security act. They can offer the workers to take over part of the tax payments if these are willing to re-increase labor supply. Because this offer leads to a Pareto-superior situation, the workers will accept it. The result is a new social security act where entrepreneurs pay taxes $t_e \in [0, \infty)$ and old workers do not retire completely, but supply labor $\overline{\ell} \in (0,1)$.

For a better understanding of this idea, consider the diagram in figure 2. The diagram is similar to that in figure 1, but it additionally shows the supply curve S_3 that refers to the situation after the modification of the social security program. Because retirement regulations are less strict in this situation, the modification shifts the supply curve from S_2 to S_3. As a consequence, equilibrium labor supply rises from H_2 to H_3 and the equilibrium wage falls from w_2 to w_3. This implies that the workers' surplus falls from $b+d+g$ to $d+e+g+h$, the entrepreneurs' surplus rises from a to $a+b+c$, and the total surplus rises from $a+b+d+g$ to $a+b+c+d+e+g+h$ (so that the deadweight loss falls from $c+e+f+h+i$ to $f+i$). Given appropriate side payments, workers and entrepreneurs are therefore better off when they modify the social security program.

Note that workers and entrepreneurs are best off when their negotiation leads to a complete suspension of the retirement regulations. If the modified social security act is free from these regulations, S_3 will be identical to S_1 and the total surplus will reach its maximum. However, an efficient bargaining outcome like this requires the absence of imperfections in the negotiation process. Because this is not very realistic (otherwise one could not observe strikes, delayed agreement, and other inefficient bargaining outcomes in reality), we exclude the case that retirement regulations are suspended completely. We thus assume that $\overline{\ell} < 1$. By using this assumption we exogenously introduce an inefficiency in the bargaining model. It would be possible to generate this inefficiency endogenously (see Calabuig 1999 and Myerson 1985), but this would merely increase the complexity of our model without yielding additional insights.

The modification of the social security act changes the equilibrium distribution of utility. The equilibrium utility level of the old workers now is

$$v_o' = a_o + b_o' + \gamma \left(\frac{\overline{\ell} H_o + H_y}{N_e} \right)^{\gamma - 1} h_o \overline{\ell} - \beta \overline{\ell}. \tag{9a}$$

The equilibrium utility level of the young workers is

$$v_y' = \gamma \left(\frac{\overline{\ell} H_o + H_y}{N_e} \right)^{\gamma - 1} h_y + a_y - \beta - t_y'. \tag{9b}$$

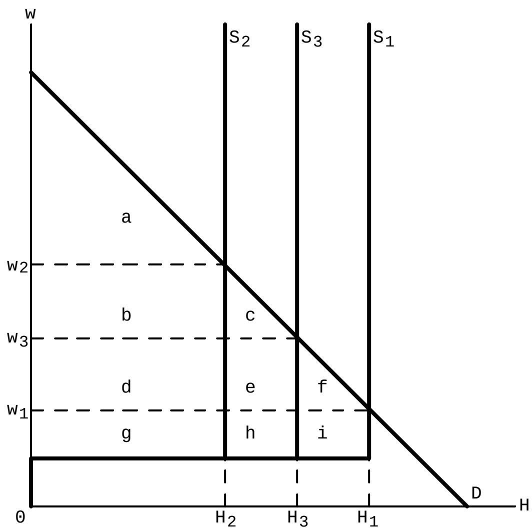

Figure 2: The Effects of Modifying the Social Security Program

The equilibrium utility level of the entrepreneurs, finally, is

$$v_e' = (1-\gamma)\left(\frac{\bar{\ell}H_o + H_y}{N_e}\right)^{\gamma} - a_e - t_e'. \tag{9c}$$

Note that we have marked some variables with primes in order to distinguish them from the corresponding variables in the last section.

The aggregate change in utility is

$$\Delta V = \sum_{o=1}^{N_o}(v_o' - v_o) + \sum_{y=1}^{N_y}(v_y' - v_y) + \sum_{e=1}^{N_e}(v_e' - v_e). \tag{10a}$$

As we prove appendix A, this equation is identical to

$$\Delta V = \left(\frac{\bar{\ell}H_o + H_y}{N_e}\right)^{\gamma} N_e - \left(\frac{H_y}{N_e}\right)^{\gamma} N_e - \beta\bar{\ell}N_o. \tag{10b}$$

This result shows that the aggregate change in utility is composed of two parts. The first part is a utility gain, which results from the fact that aggregate output is higher now. The second part is a utility loss, which results from the fact that old workers have less leisure now. If we assume that β is sufficiently small, the total change in aggregate utility is positive. In this case it is advantageous for the workers and the entrepreneurs to modify the social security program. (Up to this point we have introduced various restrictions for β. Levels of β satisfying these restrictions exist whenever γ is sufficiently small. For a proof see appendix B.)

Given that agents modify the program, how do they determine the workers' and the entrepreneurs' tax payments and the retirees benefits? We again assume that taxes and benefits are determined in a negotiation, which is modeled using the Nash bargaining solution. As a consequence, the aggregate utility gain is distributed equally among agents:[2]

$$v_o' - v_o = v_y' - v_y = v_e' - v_e = \frac{\Delta V}{N_o + N_y + N_e}. \tag{11a}$$

[2] This can be proved by maximizing the log Nash product

$$\sum_{o=1}^{N_o}\ln(v_o' - v_o) + \sum_{y=1}^{N_y}\ln(v_y' - v_y) + \sum_{e=1}^{N_e}\ln(v_e' - v_e)$$

subject to the budget constraint

$$\sum_{o=1}^{N_o} b_o' = \sum_{y=1}^{N_y} t_y' + \sum_{e=1}^{N_e} t_e'$$

and analyzing the first-order conditions.

If we combine this equation with equations (6a), (6b), (6c), (8b), (8c), (9a), (9b), and (9c) and rearrange, we obtain a benefit formula and two tax formulas. The benefit formula is

$$b'_o = \left\{ \frac{\Delta U}{N_o + N_y} + \frac{\Delta V}{N_o + N_y + N_e} \right\} \\ - \left\{ \beta \left(1 - \bar{\ell}\right) - \left[\gamma \left(\frac{H_o + H_y}{N_e} \right)^{\gamma - 1} - \gamma \left(\frac{\bar{\ell} H_o + H_y}{N_e} \right)^{\gamma - 1} \bar{\ell} \right] h_o \right\}, \quad (11b)$$

the tax formula for the workers is

$$t'_y = \left\{ \left[\gamma \left(\frac{\bar{\ell} H_o + H_y}{N_e} \right)^{\gamma - 1} - \gamma \left(\frac{H_o + H_y}{N_e} \right)^{\gamma - 1} \right] h_y \right\} \\ - \left\{ \frac{\Delta U}{N_o + N_y} + \frac{\Delta V}{N_o + N_y + N_e} \right\}, \quad (11c)$$

and the tax formula for the entrepreneurs is

$$t'_e = \left\{ (1 - \gamma) \left(\frac{\bar{\ell} H_o + H_y}{N_e} \right)^{\gamma} - (1 - \gamma) \left(\frac{H_y}{N_e} \right)^{\gamma} \right\} - \left\{ \frac{\Delta V}{N_o + N_y + N_e} \right\}. \quad (11d)$$

These formulas are similar to those obtained in the last section. They show that benefits and taxes serve to close the gap between the actual and the target utility gain.

Now we have determined all elements of the modified social security program. We summarize them in

Proposition 2 (Modified Social Security Program) *The modified social security program is organized as follows. First, old workers partially retire so that*

$$\ell'_o = \bar{\ell}.$$

Second, old workers receive benefits that are determined by

$$b'_o = k'_1 h_o + k'_2.$$

Third, young workers pay taxes that are determined by

$$t'_y = k'_3 h_y - k'_4.$$

Fourth, entrepreneurs pay taxes that are determined by

$$t'_e = k'_5.$$

In these formulas the variables k'_1 to k'_5 are positive constants that are independent of individual parameters like h_o or a_y (for k'_1 to be positive we assume that $\bar{\ell}$ is sufficiently large).

As the proposition shows, the modified program is similar to the typical program described in the introduction:

1. It is pay-as-you-go.
2. It is financed with a payroll tax.
3. Entrepreneurs and workers share the tax.
4. Benefits are independent of asset income.
5. Benefits are increasing with the taxes paid.
6. The program induces retirement.

Because entrepreneurs and workers share the social security tax, the modified program is even closer to the typical program than the original one. With the program being modified, our model can therefore replicate all stylized facts of social security.

5 Conclusion

In this paper we have presented a model that can explain the stylized facts of social security. The main idea of the model is that workers introduce a social security program in order to monopolize the labor market. The program forces the old workers to retire and the young workers to transfer part of the resulting monopoly gain to the old. In order to defend themselves against the monopoly, entrepreneurs negotiate with the workers for a modification of the program. The outcome of the negotiation is that retirement regulations are relaxed and that entrepreneurs take over part of the tax payments. Social security can therefore be seen as an instrument used by the workers to exploit the entrepreneurs, where the degree of exploitation is limited as long as entrepreneurs accept to finance part of the program.

Before we conclude, we are going to discuss three additional points. The first point refers to an interesting implication of our model. It implies that the size of a social security program positively depends on the political power of the workers. The more power the workers have, the stricter are the retirement regulations passed by the parliament, the higher is the monopoly gain enjoyed by the workers, and the higher are the transfers paid to the retirees. The workers will be particularly powerful if they are organized in strong unions. The social security program should therefore be large in countries where unions are strong, and small in others. In order to test this hypothesis, we have collected cross-country data measuring the strength of the union sector and the size of the social security program. A proxy for the strength of the union sector is the bargaining coverage rate (workers covered by collective agreements/all workers), data for which are published by the OECD (1997). A proxy for the size of the social security program is the social security share (expenditures for social security and welfare/gross national product), data for which are given in Tabellini (1990). Using these data, we can construct a sample that includes 17 industrialized countries and refers to a period around 1980. In this sample the correlation coefficient between the bargaining coverage rate and the social security share is 0.5. This indicates that the size of a country's social security program is indeed positively correlated with the strength of the union sector and, thus, with the political power of the workers in this country.

Another interesting point is that we can use our model to predict the future of social security. To generate this prediction, we assume that the workers and the entrepreneurs will eventually overcome the imperfections in the bargaining process. When they reach this point, they will create an efficient social security program that looks as follows. First, old workers are allowed to re-increase labor supply to the competitive level. Returning to this level is necessary because the economy would be inefficient otherwise. Second, entrepreneurs are forced to pay a higher social security tax. Raising the entrepreneurs' tax payments is necessary because the workers require compensation for accepting the rise in labor supply. Third, old workers are granted uniform benefit payments. Unifying benefit payments is necessary because old workers do no longer retire, which implies that they do no longer suffer from reductions in wages, differences in which have to be neutralized by differences in benefit payments. Altogether, we thus predict a suspension of the retirement regulations, a rise in the entrepreneurs' tax payments, and a unification of old-age pensions.

As a last point, we discuss the simplifying assumptions used in our model. In particular, we examine whether these assumptions are crucial for our results. One simplification is that the model is static. In a static model we can show quite clearly that the introduction of a social security program leads to a monopoly gain for the workers. We must ignore, however, that it may also lead to a loss resulting from a decline in capital accumulation and economic growth. Nevertheless, as long as the monopoly gain is larger than this loss, our basic argument will not change and our main results will continue to hold. Another simplification is that the number of entrepreneurs is fixed in our model. By fixing this number at a given level, we can analyze the monopolistic power of the workers in a very pointed way. We must disregard, however, that in practice the workers' power is restricted by the occupational or regional mobility of the entrepreneurs. These can simply become workers or move abroad when the social security legislation gets too monopolistic. Nevertheless, as long as the entrepreneurs' mobility is limited, our main results remain valid. A final simplification is that imperfections in the bargaining process are exogenous. Modelling them exogenously helps us to keep the model as transparent as possible. As we believe, endogenizing them would not change our main results.

Appendix A

In this appendix we compute the aggregate change in utility that can be achieved by modifying the social security program. According to equation (10a), the aggregate change in utility is

$$\Delta V = \sum_{o=1}^{N_o} (v'_o - v_o) + \sum_{y=1}^{N_y} (v'_y - v_y) + \sum_{e=1}^{N_e} (v'_e - v_e). \tag{10a}$$

By inserting equations (6a), (6b), (6c), (9a), (9b), and (9c), we can express the change as

$$\begin{aligned}\Delta V = &\sum_{o=1}^{N_o} \left[b'_o + \gamma \left(\frac{\bar{\ell} H_o + H_y}{N_e} \right)^{\gamma-1} h_o \bar{\ell} - \beta \bar{\ell} - b_o \right] \\ &+ \sum_{y=1}^{N_y} \left[\gamma \left(\frac{\bar{\ell} H_o + H_y}{N_e} \right)^{\gamma-1} h_y - t'_y - \gamma \left(\frac{H_y}{N_e} \right)^{\gamma-1} h_y + t_y \right] \\ &+ \sum_{e=1}^{N_e} \left[(1-\gamma) \left(\frac{\bar{\ell} H_o + H_y}{N_e} \right)^{\gamma} - t'_e - (1-\gamma) \left(\frac{H_y}{N_e} \right)^{\gamma} \right].\end{aligned}$$

After rearranging, we get

$$\begin{aligned}\Delta V = &\sum_{o=1}^{N_o} b'_o + \gamma \left(\frac{\bar{\ell} H_o + H_y}{N_e} \right)^{\gamma-1} \bar{\ell} H_o - \beta \bar{\ell} N_o - \sum_{o=1}^{N_o} b_o \\ &+ \gamma \left(\frac{\bar{\ell} H_o + H_y}{N_e} \right)^{\gamma-1} H_y - \sum_{y=1}^{N_y} t'_y - \gamma \left(\frac{H_y}{N_e} \right)^{\gamma-1} H_y + \sum_{y=1}^{N_y} t_y \\ &+ (1-\gamma) \left(\frac{\bar{\ell} H_o + H_y}{N_e} \right)^{\gamma} N_e - \sum_{e=1}^{N_e} t'_e - (1-\gamma) \left(\frac{H_y}{N_e} \right)^{\gamma} N_e.\end{aligned}$$

By assuming that the social security budget is balanced ($\sum_{o=1}^{N_o} b_o = \sum_{y=1}^{N_y} t_y$ and $\sum_{o=1}^{N_o} b'_o = \sum_{y=1}^{N_y} t'_y + \sum_{e=1}^{N_e} t'_e$), we obtain

$$\begin{aligned}\Delta V = &\gamma \left(\frac{\bar{\ell} H_o + H_y}{N_e} \right)^{\gamma-1} (\bar{\ell} H_o + H_y) + (1-\gamma) \left(\frac{\bar{\ell} H_o + H_y}{N_e} \right)^{\gamma} N_e \\ &- \gamma \left(\frac{H_y}{N_e} \right)^{\gamma-1} H_y - (1-\gamma) \left(\frac{H_y}{N_e} \right)^{\gamma} N_e - \beta \bar{\ell} N_o.\end{aligned}$$

So the aggregate change in utility is

$$\begin{aligned}\Delta V = &\gamma \left(\frac{\bar{\ell} H_o + H_y}{N_e} \right)^{\gamma} N_e + (1-\gamma) \left(\frac{\bar{\ell} H_o + H_y}{N_e} \right)^{\gamma} N_e \\ &- \gamma \left(\frac{H_y}{N_e} \right)^{\gamma} N_e - (1-\gamma) \left(\frac{H_y}{N_e} \right)^{\gamma} N_e - \beta \bar{\ell} N_o,\end{aligned}$$

which is identical to our result in equation (10b):

$$\Delta V = \left(\frac{\bar{\ell} H_o + H_y}{N_e} \right)^{\gamma} N_e - \left(\frac{H_y}{N_e} \right)^{\gamma} N_e - \beta \bar{\ell} N_o. \tag{10b}$$

Appendix B

In this appendix we examine whether there are levels of β that satisfy

$$\begin{aligned}
\beta &< \gamma\left(\frac{H_o+H_y}{N_e}\right)^{\gamma-1} h_o,\ o\in\{1,\dots,N_o\}\,, \\
\beta &< \gamma\left(\frac{H_o+H_y}{N_e}\right)^{\gamma-1} h_y,\ y\in\{1,\dots,N_y\}\,, \\
\beta &> \frac{\gamma}{N_o}\left[\left(\frac{H_o+H_y}{N_e}\right)^{\gamma} N_e-\left(\frac{H_y}{N_e}\right)^{\gamma} N_e\right], \\
\beta &< \frac{1}{\bar{\ell}N_o}\left[\left(\frac{\bar{\ell}H_o+H_y}{N_e}\right)^{\gamma} N_e-\left(\frac{H_y}{N_e}\right)^{\gamma} N_e\right].
\end{aligned}$$

For these levels of β to exist, it is a necessary and sufficient condition that

$$\begin{aligned}
\frac{1}{N_o}\left[\left(\frac{H_o+H_y}{N_e}\right)^{\gamma} N_e-\left(\frac{H_y}{N_e}\right)^{\gamma} N_e\right] &< \left(\frac{H_o+H_y}{N_e}\right)^{\gamma-1} h_o,\ o\in\{1,\dots,N_o\}\,, \\
\frac{1}{N_o}\left[\left(\frac{H_o+H_y}{N_e}\right)^{\gamma} N_e-\left(\frac{H_y}{N_e}\right)^{\gamma} N_e\right] &< \left(\frac{H_o+H_y}{N_e}\right)^{\gamma-1} h_y,\ y\in\{1,\dots,N_y\}\,, \\
\frac{1}{N_o}\left[\left(\frac{H_o+H_y}{N_e}\right)^{\gamma} N_e-\left(\frac{H_y}{N_e}\right)^{\gamma} N_e\right] &< \frac{1}{\gamma\bar{\ell}N_o}\left[\left(\frac{\bar{\ell}H_o+H_y}{N_e}\right)^{\gamma} N_e-\left(\frac{H_y}{N_e}\right)^{\gamma} N_e\right].
\end{aligned}$$

This condition holds for $\gamma \to 0$ (use L'Hôpital's rule where necessary) and for small γ (because terms are continuous in γ). So levels of β that satisfy the restrictions listed above exist whenever γ is sufficiently small.

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