Government decisions on income redistribution and public production
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3 Aging, incapacity for work and social security

3.1 Introduction

The economic impact of an aging population is a highly complex subject. Increases in the (relative) number of elder persons have broad consequences for almost any important micro- and macro-economic examination [see, for instance, Bös and Von Weizsäcker (1989)]. It is not surprising, therefore, that studies have typically focused on particular issues. In this chapter, attention will be concentrated on the following rather widely held conceptions concerning the economic effects of this type of demographic change: (a) it will lead to a substantial increase in expenditures on social security benefits, and thus cause premiums to sky-rocket; (b) the concomitant rise in the individual tax/premium burden negatively affects (crowds out) the expenditure on public goods and services, given the budget constraint; (c) private output will be negatively affected as well, because of negative incentive effects; (d) the social security benefit level (replacement ratio) will decrease, leading to an impoverishment of the aged; and (e) intergenerational conflict will, as a consequence, be exacerbated [see, e.g., Creedy and Disney (1989), Johnson et al. (1989)]. In addition, the effects of two often-advocated changes are investigated: an increase in the retirement age and in the capital endowment of the aged.

Although some of these issues have been investigated by other authors, there is as yet little consensus. In our view, the following conclusion by Thompson (1983, p. 1462), in his survey of the social security reform debate, is still valid: "To date the Social Security reform debate has consisted largely of a set of analyses with conflicting implications that have led to proposals to advance one of a number of possibly conflicting objectives. The predictable result has been a great deal of debate and very little actual change." Two of the reasons he holds responsible for this are the use of partial analyses and the neglect of the impact of political feedback. Regarding the latter he notes: "Just as particular structured changes can alter economic behavior, they also can alter political behavior and the second-round economic effects of a change in political behavior may negate any first-round gains from the initial structural reform. Analysts occasionally reach different conclusions about the probable economic effect of a particular change because they make different assumptions about the political effects of the change." If such assumptions are made at all, it can be added, since these political effects are often completely ignored [cf. Doescher and Turner (1988)].
Inspired by the critique of Thompson, a general equilibrium model with endogenous government behavior will be used to examine the aforementioned issues and views on the likely economic impact of an aging population. This model enables the study of the general, instead of partial, economic effects of demographic changes on political decisionmaking, including the effects of demographic changes on political decisionmaking through the endogenization of government behavior. To keep the model manageable, again simple functional forms are used, and the dynamic effects of aging are investigated by means of a comparative-static analysis. As a consequence, the possible effects on intertemporal decisionmaking, such as decisions on savings and public debt, are neglected. The focus on political behavior is motivated by the observation that the fiscal implications of aging are inherently related to its redistributive aspects, which have an intrinsically political character. In this context, Alesina's (1988b, p. 34) remark that the choice of how to manage the debt is the result of a redistributive struggle over income and wealth between agents currently alive and, to a much lesser extent, between current and future generations, is of interest here. A further reason for giving priority to the incorporation of political behavior in a general equilibrium model instead, of elaborating the economic model in a dynamic way, is that a (analytical) political economic model seems to be a more fruitful starting point for establishing more complex (numerical) models to investigate the questions at hand, than a (analytical) dynamic model without endogenous government behavior.

With respect to the endogenization of government behavior it should be mentioned that there are some earlier models on social security that allow for endogenous political feedback [see Browning (1975), Hu (1982), Boadway and Wildasin (1989)]. Apart from the partial equilibrium nature of these studies, these are all median voter models. As is well-known, however, this model can only fruitfully be applied to one-dimensional issues. Moreover, this model does not seem to be appropriate for the representative — instead of direct — democracies that we typically meet in reality [cf. Mckelvey (1976, 1979), Grossman and Helpman (1996b); see also the discussion in Section 1.3 on the median voter model].

The model presented in this chapter takes as a starting point the interest function approach discussed in Chapter 1 and incorporated in a general equilibrium model in Chapter 2. With respect to political decisionmaking on social security, and the economic consequences thereof, this approach has been employed in an empirical study by Renaud (1989), a theoretical and empirical study by Van Velthoven and Van Winden (1985), using a simple (Keynesian) macroeconomic model, and
In the model that is used in this chapter, individuals are divided into four social groups: capital owners, workers, disabled individuals and retirees. Disabled individuals and retirees are further divided into those with and without capital endowments. The introduction of a separate group of disabled individuals gives not only the opportunity to analyze the implications of an increase in the number of retirees for this group, but is also of special interest here, because there is an overrepresentation of almost-retired individuals in this group. Preferences may differ among the social groups regarding the consumption of a privately produced commodity, leisure and the consumption of a public good produced by the public sector. The behavior of individuals is not only affected by their own preferences. They are also allowed to be motivated by a form of other-directedness, which may be related to pure altruism or to the probability that an individual might one day become a member of the group of disabled or retired individuals (insurance or mobility motive). Decisions in the public sector follow from the maximization of a political interest function. The following policy instruments of the public sector are considered: the provision of a public good, financed through the proceeds of a uniform income tax; group specific lump sum transfers to capital owners and workers; and social security benefits to disabled and retired individuals, financed by the premiums of two pay-as-you-go social security systems. Combining the equilibrium of the private sector submodel with the equilibrium of the public sector submodel leads to the general equilibrium of the political economic model. Finally, it should be mentioned that although the model is not explicitly cast in the format of an overlapping generations model, it could be interpreted as such a model with no household savings.

The organization of this chapter is as follows. Section 3.2 discusses private sector behavior. Public sector behavior is the subject of Section 3.3. Section 3.4 addresses the nature of the equilibrium solution in light of the issues raised above. The main results of the model are summarized in the concluding Section 3.5.

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1 The negative general equilibrium effect that is arrived at in a theoretical study by Karni and Zilcha (1989), concerns the introduction of a social security system and not the effects of aging in an existing system. Moreover, they neglect the effects on political decisionmaking.
3.2. Private sector behavior

3.2.1 Introduction

Decisions in the private sector are made by consumers and producers under conditions of atomistic competition. Consumers are split up in the following groups: capital-owners, who also run the firms and receive income from the capital they possess, the labor they supply and from special provisions; workers, receiving labor income and income from special provisions; retirees and disabled individuals who receive income from capital endowments and the social security system; and retirees and disabled individuals who only receive income from the social security system. All producers are identical and offer the same commodity. Consumers maximize their utility subject to an income and time constraint, while producers maximize their profits under a given production technology. In doing so they take the decisions of public sector agents as given. An equilibrium in the private sector exists if demand equals supply in all commodity and factor markets. First, the behavior of producers is modeled in Subsection 3.2.2. The behavior of consumers is described in Subsection 3.2.3. Finally, the conditions for an equilibrium in the private sector are presented in Subsection 3.2.4.

3.2.2 Production

Producers are running identical firms and operate in a competitive market, where a single commodity is supplied. Firms maximize profits and use capital and labor as inputs. Profits are given by

$$\Pi_t = p_t X_t - p_L L_t - p_K K_t$$

(3.1)

where $L_t$ and $K_t$ are the labor and capital inputs, $p_L$ and $p_K$ refer to the respective input prices, $p_t$ denotes the commodity price, $X_t$ the produced output of the commodity, and $\Pi_t$ stands for profits. Production technology is represented by a Cobb-Douglas production function

$$X_t = \Omega_t L_t^{\delta_{tL}} K_t^{\delta_{tK}}, \quad \delta_{tL} + \delta_{tK} = 1, \quad \Omega_t > 0$$

(3.2)

where $\Omega_t$ is a scaling parameter, $\delta_{tL}$ denotes the production elasticity of labor and $\delta_{tK}$ the production elasticity of capital.
The optimal input of capital and labor is given by

\[ K_c = \frac{\delta_{kc} p_c X_c}{P_K} \]  

(3.3)

\[ L_c = \frac{\delta_{lc} p_c X_c}{P_L} \]  

(3.4)

Thus, we obtain the well-known result that profits will be equal to zero, given the constant returns to scale assumption \( (\delta_{lc} + \delta_{kc} = 1) \).

3.2.3 Consumption

Individuals are characterized by their preferences and the source of their income. Individuals with similar preferences and incomes are considered as members of a social group. In total six social groups are distinguished: workers and capital owners (of size \( N_{w} \) and \( N_{c} \), respectively), disabled individuals with and without capital (of size \( N_{dc} \) and \( N_{dw} \), respectively), and retirees with and without capital (of size \( N_{rc} \) and \( N_{rw} \), respectively). Capital owners receive income from capital, their own labor, as well as a (group-specific) lump sum transfer. The income of workers consists of wages and a (group-specific) lump sum transfer. The income of capital-owning disabled individuals and retirees consists of capital income and a social security benefit whereas the income of non-capital owning disabled individuals and retirees consists only of the social security benefit. Disposable full income \( f_i \) of an individual of social group \( i \) (\( i = c, w, dc, dw, re, rw \)) equals

\[ f_c = (1-\tau_h)(1-\tau_r)(1-\tau_d)(p_L + p_K k_c^0 + \sigma_c) \]  

(3.5)

\[ f_w = (1-\tau_h)(1-\tau_r)(1-\tau_d)(p_L + \sigma_w) \]  

(3.6)

\[ f_{dc} = (1-\tau_h)(1-\tau_r)(p_K k_{dc}^0 + \sigma_d) \]  

(3.7)

\[ f_{dw} = (1-\tau_h)(1-\tau_r)\sigma_d \]  

(3.8)

\[ f_{rc} = (1-\tau_h)(p_K k_{rc}^0 + \sigma_r) \]  

(3.9)
where the labor endowment of an individual is set equal to unity, \(k^0_i\) indicates the capital endowment of a capital owner belonging to social group \(i\), \(\sigma_c\) and \(\sigma_w\) denote (group specific) lump-sum transfers to capital owners and workers, \(\tau_d\) and \(\tau_r\) are social security benefits, \(\tau_d\) and \(\tau_r\) are social security premiums, and \(\tau_h\) denotes a uniform income tax rate. A more detailed discussion of the tax-transfer system and the social security system for disabled and retired individuals is presented in Section 3.3.

Individuals have preferences with respect to private commodities \(c_i\) and a public good \(G_s\). Capital owners and workers have, in addition, preferences with respect to leisure \(\ell_i\). Disabled individuals have identical preferences, regardless of whether they possess capital or not. This also applies to retirees.

In addition to the interest that individuals have in their own utility \(W_i\), they may also care about the utility of others. In particular, it is allowed that capital owners and workers care about the utility of disabled and retired individuals, and that the disabled individuals may be interested in the utility of the retirees. This interest in the utility of others, labeled 'other-directedness', may be due to pure (situation independent) altruism or to a positive subjective probability to become a member of another social group (mobility or insurance motive). Making no distinction between disabled individuals and retirees with or without capital, for the time being, the utilities with other-directedness can be written as:

\[
U_i = W_i^{(1-\theta_i^c)\theta_i^c} W_d^{(1-\theta_i^w)\theta_i^w} W_r^{\theta_i^r}, \quad i = c, w
\]

(3.11)

\[
U_d = W_d^{(1-\theta_i^d)\theta_i^d} W_r^{\theta_i^r}
\]

(3.12)

\[
U_r = W_r
\]

(3.13)

where \(0 \leq \theta_i^h \leq 1\).

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2 For this asymmetric representation of other-directedness, see e.g. VEALL (1986) and VERBON (1989), where other-directedness is motivated by altruism, and KARNI AND ZILCHA (1989) where other-directedness is related to mobility.
In maximizing utility an individual has to decide how to allocate disposable full income between the consumption of private commodities and leisure. The budget restriction for a representative individual of social group \( i \) equals

\[
p_i c_i + p_l \ell_i = f_i \quad \text{(3.14)}
\]

where \( 0 \leq \ell_i \leq 1 \) for \( i = c, w \), because the labor endowment is equal to unity, whereas \( \ell_i = 0 \) for the other social groups. The shadowprice of leisure \( p_l \) equals \((1-\tau_h)(1-\tau_r)(1-\tau_d)p_L\).

Consumer decisions with respect to private consumption and leisure do not depend on the other-directedness of an individual. Other-directedness is only important for the decisions that are made by the government. These decisions will be discussed in Section 3.3. Assuming a utility function of the Cobb-Douglas type, private consumption and leisure of a representative individual of social group \( i \) follows from the maximization of

\[
W_i = c_i^{\alpha_c} \ell_i^{\alpha_l} G_i^{\alpha_G}, \quad \alpha_c + \alpha_l + \alpha_G = 1 \quad \text{(3.15)}
\]

subject to the budget restriction given by eq. (3.14). Disabled individuals and retirees do not participate in the labor market. Therefore, \( \alpha_{ni} = 0 \) for \( i = de, dw, re, rw \).

Demand for private commodities and leisure equals

\[
c_i = \frac{\alpha_c f_i}{(\alpha_c + \alpha_l) p_c} \quad \text{(3.16)}
\]

\[
\ell_i = \frac{\alpha_l f_i}{(\alpha_c + \alpha_l) p_l} \quad \text{(3.17)}
\]

With these demand equations and the equation for own utility \( W_i \), the indirect utility function \( V_i' \) regarding an individual's own preferences can be obtained. This yields

\[
V_i' = \frac{\alpha_c \alpha_l f_i^{\alpha_c} G_i^{\alpha_G}}{(\alpha_c + \alpha_l)^{\alpha_c + \alpha_l} p_c p_l}, \quad i = c, w \quad \text{(3.18)}
\]
Using these expressions and eqs. (3.11)-(3.13), one easily obtains the indirect utility function $V_i$ that takes account of the other-directedness of individuals.

### 3.2.4 Private sector equilibrium

An equilibrium requires market-clearing prices in all markets. There are three markets in this model: the commodity market, the capital market and the labor market. These markets clear if, respectively,

$$X_c = c_c N_c + c_w N_w + c_{dc} N_{dc} + c_{dw} N_{dw} + c_{rc} N_{rc} + c_{rw} N_{rw}$$

$$k_c^0 N_c + k_d^0 N_{dc} + k_w^0 N_{dw} = K_c$$

$$(1 - \ell_c)N_c + (1 - \ell_w)N_w = L_c + L, \tag{3.22}$$

where $L$ is the government's demand for labor. Assuming a balanced budget for the public sector (see Section 3.3), Walras' law dictates that only relative prices matter. Consequently, one of the prices can be used as numéraire. In this model the wage rate is chosen as numéraire ($p_L = 1$). Note that the supply of capital is fixed, which leads to a fixed capital input in the production sector. The partial equilibrium solution for the private sector is presented in Appendix 3.A.

### 3.3 Public sector behavior

Government decisions follow from the maximization of the political interest function. The interests of the representative individuals of the different social groups are represented by their indirect utility functions $V_i$, as derived in the previous section. The political interest function yields

$$P = V_c^{\mu_c} V_w^{\mu_w} V_d^{\mu_d} V_r^{\mu_r}, \quad \mu_c + \mu_w + \mu_d + \mu_r = 1 \tag{3.23}$$
where \( \mu_c, \mu_w, \mu_d \) and \( \mu_r \), respectively, denote the political influence weight of capital owners, workers, disabled individuals and retirees. Note that the government considers capital-owning and non-capital-owning disabled and retired individuals as belonging to one and the same group.\(^3\)

We can now turn to the policy instruments of the government. First, lump sum transfers (special provisions) allow the government to redistribute income between capital owners and workers. See Chapter 2 for an interpretation and discussion of these special provisions. The transfer system is assumed to be self-financing, which gives as restriction

\[
\sigma_c N_c + \sigma_w N_w = 0 \quad (3.24)
\]

Second, the government decides upon the premiums and benefits of the social security system. The social security system consists of two self-financing pay-as-you-go transfer systems for payments to disabled and retired individuals. Premiums for social security benefits to disabled individuals, \( \tau_d \), are paid by capital owners and workers out of their gross income, while pension premiums, \( \tau_r \), are paid by capital owners, workers and disabled individuals out of their gross and/or transfer income minus premium payments for the disabled. The revenues are distributed over the disabled individuals and retirees by way of lump sum transfers. If account is taken of the self-financing transfer system given by eq. (3.24), the budget for the disability fund is balanced if

\[
\tau_d [p_K k_c^0 N_c + p_L (1 - \ell_c) N_c + p_L (1 - \ell_w) N_w] = \sigma_d N_d \quad (3.25)
\]

where \( N_d = N_{dk} + N_{dw} \). Taking account of eqs. (3.24) and (3.25), and letting \( N_r = N_{rk} + N_{rw} \), the retirement fund is balanced if

\[
\tau_r [p_K (k_r^0 N_r + k_r^0 N_{rk}) + p_L (1 - \ell_c) N_c + p_L (1 - \ell_w) N_w] = \sigma_r N_r \quad (3.26)
\]

Third, the government decides upon the production of a public consumption good. The production of this good requires labor \( (L_s) \) and public capital \( (K_s) \). Production technology is represented by a Cobb-Douglas production function

\[ f_d = (1 - \tau_d)(1 - \tau_r)(p_K k_d^0 n_d + \sigma_d), \quad n_d = N_{dr} / (N_{dk} + N_{dw}) \]

\[ f_r = (1 - \tau_d)(p_K k_r^0 n_r + \sigma_r), \quad n_r = N_{rr} / (N_{rk} + N_{rw}) \]
\[ G_s = \Omega_t L_t K_t^L, \quad \delta_{Ls} + \delta_{Ks} = 1, \quad \Omega_t > 0 \]  

(3.27)

It is assumed that the government holds a public capital stock \((K_s^0)\) that can be freely used for the production of the public consumption good. Capital input then equals the fixed public capital stock

\[ K_s = K_s^0 \]  

(3.28)

Public production costs only consist of labor costs. These costs are financed by taxing the income that remains after the payment of social security premiums. Using eqs. (3.24) - (3.26), tax revenues balance the labor costs if

\[ \tau_n \left[ p_n (k_r^0 N_c + k_d^0 N_a + k_r^0 N_a) + p_L (1 - \ell_c) N_c + p_L (1 - \ell_a) N_a \right] = p_L L_s \]  

(3.29)

The government maximizes the value of the political interest function, given by eq. (3.23), subject to the balanced budget and technology constraints (3.24) - (3.29). The (partial) equilibrium results that follow from this maximization are presented in Appendix 3.A.

### 3.4 The economic impact of disabled and retired individuals

#### 3.4.1 Introduction

In this section the general equilibrium effects of the presence of disabled individuals and retirees in the economy are investigated by means of a comparative static analysis. The effects are related to the size, capital endowments, preferences, and political influence of these groups. In addition, their presence may affect the behavior of the other social groups through the earlier discussed motive of other-directedness. In Section 3.4.2 attention will be focused on the impact of group size and capital endowments, the comparative static results of which are summarized in Table 3.1. The impact of the political influence structure and motives of other-directedness, as well as some likely interdependencies between group size, political influence, and other-directedness, are dealt with in Subsection 3.4.3 and summarized in Table 3.2. For general parameter configurations, many of the results turn out to be ambiguous. In order to arrive at more definite results, a numerical example is investigated. Some of the results of this example are presented in the Tables 3.1 - 3.3. Appendix 3.B
presents the values of the parameters and exogenous variables used in the numerical example.

For expository reasons, and in order to avoid unnecessary repetition, the discussion will sometimes be centered around the economic effects regarding retirees. When informative, specific differential effects concerning the group of disabled individuals are indicated.

3.4.2 The effects of group size and capital endowments

The economy without disabled and retired individuals

To put the economic impact of those outside the production process into perspective, we first explore the effects of the group size of workers \(N_w\) and capital owners, \(N_c\) and the capital endowment of the latter \((k^c)\). As can be seen in Table 3.1, the number of workers has a positive effect on the price of capital and the price of the private commodity (relative to the numéraire, the wage rate), as well as on private and public output. Although leisure is positively affected, a positive effect is also obtained for the labor input in both the private and the public sector. The capital price effect then follows from the full employment of capital. The tax rate is not influenced, since it is only determined by the political-influence weighted preference for public goods of the social groups and the labor elasticity of public production [see eq. (3.A.3)].

The effect of \(N_w\) on the transfers \(\sigma_c\) and \(\sigma_w\) is ambiguous. The total transfer to a group is equal to the difference between a political-influence determined fraction of total full income \(p_kk^c_{k}N_c + p_lN_c + p_lN_w\) and the full income of the group \((p_kk^c_{k}N_c + p_lN_c\) and \(p_lN_w\), respectively), as can be read from eqs. 3.A.5 and 3.A.6. It follows that an increase in the number of workers has a negative (positive) direct effect on transfers to workers (capital owners). However, this is counteracted by a positive general equilibrium effect on capital income, which produces the ambiguity.

The effects of a change in the number of capital owners \(N_c\) is more complicated because of the concomitant change in the capital stock \((k^c_{k}N_c\). It can be shown that if this stock is held constant, similar effects as for \(N_w\) are obtained, except that the effect on \(\sigma_w\) becomes unequivocally positive. The negative effect of \(N_c\) on the relative

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4 A full discussion of the comparative-static effects of the various parameters in the model without disabled and retired individuals is presented in Chapter 2.
<table>
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<th>Parameter</th>
<th>$N_c$</th>
<th>$N_w$</th>
<th>$N_{dc}$</th>
<th>$N_{dw}$</th>
<th>$N_{tc}$</th>
<th>$N_{tw}$</th>
<th>$k_0^0$</th>
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<tr>
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</tbody>
</table>

*Note* The effects between brackets hold under the following assumptions:

1. $\sigma_d \geq 0$ and $\sigma_r \geq 0$
2. $k_d^0 = 0$
3. $k_r^0 = 0$
4. $k_d^0 = 0$ and $k_r^0 = 0$
5. The numerical example
price of capital and the commodity price in the table (note that \( k^0_r = k^0_c = 0 \)) is produced by the change in the capital stock, as can be seen from the effects of \( k^0_r \). The other results follow from the fact that a change in the capital endowment of capital owners also has a positive effect on private output and no impact on public output and transfers. The change in the capital stock just leads to an exactly off-setting decrease in the price of capital.

The economic impact of non-capital-owning disabled and retired individuals

In the model the economic importance of non-capital-owning disabled and retired individuals is established through their political influence and the behavioral effects their presence may have on other social groups via the motive of other-directedness. As with workers and capital owners, their political influence concerns taxation and the transfer of income. The latter takes place through the institution of a pay-as-you-go social security system for each group.

From Table 3.1 it can be seen that the number of non-capital-owning retirees \((N_{nw})\) and disabled individuals \((N_{dw})\) has a (negative) effect only on the transfers to these individuals; while other variables are not affected. The same transfer mechanism as between capital owners and workers (see the above discussion) is at work here. Again, the maximization program for the government leads to expenditure shares for the transfers that are determined by the political influence structure and the own income of these groups, where the latter equals zero if there are no capital endowments [see eqs. (3.A.7) and (3.A.8)]. Consequently, the change in the per capita transfer exactly off-sets the change in group size.

It can be concluded, therefore, that the feedback on political decisionmaking activated by an increase in the number of retirees (or disabled) may cause the worries about increasing tax/premium burdens, the crowding out of public expenditure, or a diminishing private output to be unwarranted. Only the prediction that such a development will lead to an impoverishment (decline in welfare) for these individuals finds support here. Although this conclusion is, of course, conditioned by the framework of the model, it nevertheless rather dramatically shows the importance of taking account of general equilibrium feedback mechanisms in the sphere of government decisionmaking.

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5 The discussion is concentrated here on the more realistic situation where the social security benefits \( \sigma_d \) and \( \sigma_r \) are positive.
Observe, furthermore, that the presence of separate groups of non-capital-owning retirees and disabled persons does not affect the signs of the comparative-static effects of the previously discussed variables $N_c$, $N_w$ and $k^0_c$. The only difference is that changes in these variables may now affect the social security transfers and premiums. As can be easily checked with eqs. (3.A.16) - (3.A.19), the transfers are ambiguously affected by $N_c$ and positively by $N_w$, whereas $k^0_c$ has no effect (recall that capital income $p_k k^0_c N_c$ stays constant when $k^0_c$ changes and $k^0_d$ and $k^0_r$ are zero).

The positive effect of the number of workers on social security transfers makes it interesting to investigate the effect on the welfare of retirees of a simultaneous decrease in the number of retirees and an increase in the number of workers, which mimics an increase in the retirement age. It can be shown that this effect is unequivocally positive, which supports those who have argued in favor of such a regulatory change in order to improve the future situation of the retired. It should be realized, though, that this information can only produce the desired regulatory change in a political economic model if this change is preferred by the policymakers. Put differently, the effective political interest structure underlying political decisionmaking should be such that this change enhances the value of the political interest function that is maximized by the government. Since it can be shown that all social groups, with the exception of workers when they have a sufficiently low preference for public goods, will experience an increase in welfare by the regulatory change, the possibility of predicting an increase in the retirement age depends on the preference weight $\alpha_{Gw}$ and the relative political influence of workers, $\mu_w$.

The impact of capital endowments

By substituting $N_{rc}$ ($N_{dc}$) for $N_{rw}$ ($N_{dw}$) and letting $k^0_r$ ($k^0_d$) increase from zero, the economic effects of capital owned by retired (disabled) individuals can be investigated. From Table 3.1 it can be seen that this widely affects the economy and, consequently, the economic impact of changes in the size of these social groups if these changes concern capital-owning individuals ($N_{rc}$ and $N_{dc}$). Focusing first on retirees, observe that their transfer ($\sigma_r$) as well as the relevant social security premiums ($\tau_r$) are negatively affected. As is to be expected, the relative price of capital and of private commodities is also negatively influenced. However, private and public output are positively affected, the latter notwithstanding the zero effect on the tax rate (it turns out that there is a negative effect on leisure and a positive effect on the income tax base). Interestingly, the impact of capital owned by the retirees on both the transfer to disabled individuals ($\sigma_d$) and the relevant social security premium ($\tau_d$) is positive unless the capital endowments of these individuals become sufficiently small. Finally,
as can be checked from eq. (3.A.5) [eq. (3.A.6)], an increase in the number of capital-owning retirees has a positive (negative) effect on the transfer to capital owners (workers).

The impact of capital owned by disabled individuals is of a similar nature. The main difference is that the direction of the effects on the transfer and premium affecting the retirees ($\sigma_i$ and $\tau_r$, respectively) is not dependent on the capital endowment of retirees.

In general, the welfare effects of an increase in the capital endowments of disabled or retired individuals are not unambiguous for these groups. It can be shown that non-capital-owning retirees may experience a decrease in welfare if the capital endowment of their capital-owning group mates increases. However, it can also be shown that those with capital are not only relatively better off than those without if their own capital endowment increases, because their capital income increases by such a change notwithstanding the concomitant fall in the price of capital [see eq. (3. A.12)], but that they will also experience an increase in welfare. Apart from the fall in the commodity price and the increased consumption of public goods, their total per capita income increases or will at least be unaffected; the latter holds if workers and capital owners attach a zero preference weight to leisure. On the other hand, if the capital endowment of individuals from other groups increases (capital owners and disabled), then they are relatively worse-off than their non-capital-owning group mates, since their capital income is then negatively affected by the fall in the price of capital. The only clear result in that case is that non-capital-owning retirees unequivocally profit from an increase in the capital endowment of the disabled individuals.

Observe, furthermore, that the direction of the impact of changes in the number of capital owners $N_c$ and entrepreneurial capital $k_c^0$ is affected by positive values of $k_c^d$ and
Notice in particular that in that case $k^c_r$ has a negative impact on public output $G_z$. The reason is that the capital income of capital owners increases if their capital endowment is enhanced, since the consequent fall in the price of capital is diminished by the other components of the total capital stock. The demand for leisure increases, which causes a further decline in the price of capital and thereby a decrease in aggregate capital income. Both the leisure and the capital income effects reduce the tax base, and this produces the decline in public output, since the tax rate itself is not affected.

The effects of a change in the number of disabled or retired individuals with capital ($N_{dc}, N_{rc}$) can now be easily understood, for they can be decomposed into a pure number effect, as discussed for $N_{dw}$ and $N_{m}$, and a capital endowment effect, as discussed for $k^d$ and $k^r$. The effects are consequently substantially different from the earlier discussed case where the change in group size only concerned non-capital-owning individuals ($N_{dw}$ and $N_{m}$), as shown in the table. In contrast with what seems to be generally expected, both public and private outputs are positively affected, whereas a negative effect is observed for the relevant social security system's premium, $\tau_d$ or $\tau_r$ (note the positive cross-effect, however). The welfare effects of such a change appear to be ambiguous. What can be shown, though, is that with capital the income of disabled or retired individuals is better protected against an increase in group size, as it turns out to be positively affected by it. That is, unless the preference weight attached by workers and capital owners to leisure is zero, in which case the group size effect on income is exactly off-setting, keeping total group income constant. This was also observed for changes in $N_{dw}$ and $N_{m}$. The numerical example shows that an increasing number of retirees (disabled) with capital only affects the welfare of retirees (disabled) negatively. Thus, the conventional wisdom that aging exacerbates intergenerational conflicts may not hold (at least from the perspective of the other social groups) as long as a substantial part of the retirees owns capital.

### 3.4.3 The effect of political influence and other-directedness

**The impact of political influence**

In the probabilistic voting model of the public sector as presented in COUGHLIN ET AL. (1990b) and discussed in Section 1.3, the political influence of a social group is explicitly related to the spread of the party bias of the group and the numerical strength of the group. Thus, not only the development in the number of disabled and
retired individuals is important in this respect, but also the development concerning
the heterogeneity of individual interests in these groups and the information that these
individuals have regarding the influence of the public sector on the economy. In this
context, the empirical observation that the organizational status of these interest groups
is improving is of importance here. This would seem to imply that these groups may
become more homogeneous in their political stance in the future, which would
increase their political influence according to the electoral competition model. Besides,
their political influence may further increase for the same reason due to more effective
political pressure outside the election context, as emphasized in the interest function
approach. It is of interest, therefore, to investigate first the impact of a change in
political influence of these groups ($\mu_d$ and $\mu_r$) for a given group size.

Unfortunate for the analysis, but of some interest in itself, it appears that the general
equilibrium effects of such a change are all ambiguous. In this respect, the preference
weights in combination with the other-directedness parameters of the various groups
are crucial (the impact of the latter are discussed below). In order to extract more
definitive results it will be assumed here that workers and capital owners, on the one
hand, and disabled and retired individuals, on the other, have the same preferences.
In addition, the latter are assumed to show a greater interest in public goods than the
former. For empirical support, see Schram (1990). The results obtained under these
assumptions are given in Table 3.2.

As can be seen in Table 3.2, a change in the political influence of retirees or disabled
individuals negatively affects the relative price of capital (implying a negative effect
on the labor input in the private sector), the commodity price, and private output. On
the other hand, public output, the tax rate and the premium for the social security
system for the retired are positively affected. The effects on transfers remain
ambiguous. The same holds for changes in the political influence of workers and
capital owners, the effects of which are strongly dependent on the other-directedness
parameters. If, for example, the other-directedness parameters are identical and
$k^d = k^p = 0$, the transfer to retirees, $(a_r)$ is negatively affected by an increase in the
political influence of retirees or disabled individuals. The numerical results of the
change in political influence of a social group are in accordance with our intuition, as
can be read from the table. Perhaps surprising are the opposite effects on the transfers
to capital owners and workers if the political influence of disabled and retirees
increase. From Table 3.3 it can be observed that an increase in the political influence
of disabled individuals and/or retirees has a negative (positive) effect on the welfare
of the active (inactive). In any event, it turns out that the direction of the impact of
Table 3.2 Signs of comparative static effects of changes in political influence and other-directedness

<table>
<thead>
<tr>
<th></th>
<th>$\mu_c$</th>
<th>$\mu_w$</th>
<th>$\mu_d$</th>
<th>$\mu_r$</th>
<th>$\theta^d_c$</th>
<th>$\theta^e_c$</th>
<th>$\theta^w_c$</th>
<th>$\theta^e_w$</th>
<th>$\theta^d_w$</th>
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</thead>
<tbody>
<tr>
<td>Capital price $p_k$</td>
<td>$\pm (+)$</td>
<td>$\pm (+)$</td>
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<td>$-$</td>
<td>$-$</td>
<td>$-$</td>
<td>$-$</td>
<td>$-$</td>
<td>$-$</td>
</tr>
<tr>
<td>Commodity price $p_c$</td>
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<td>$\pm (+)$</td>
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<td>$-$</td>
<td>$-$</td>
<td>$-$</td>
<td>$-$</td>
<td>$-$</td>
<td>$-$</td>
</tr>
<tr>
<td>Private production $X_c$</td>
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<td>$\pm (+)$</td>
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<td>$-$</td>
<td>$-$</td>
<td>$-$</td>
<td>$-$</td>
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<td>$-$</td>
</tr>
<tr>
<td>Public production $G_z$</td>
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<td>$\pm (-)$</td>
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<td>$+$</td>
<td>$+$</td>
<td>$+$</td>
<td>$+$</td>
<td>$+$</td>
<td>$+$</td>
</tr>
<tr>
<td>Tax rate $\tau_k$</td>
<td>$\pm (-)$</td>
<td>$\pm (-)$</td>
<td>$+$</td>
<td>$+$</td>
<td>$+$</td>
<td>$+$</td>
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<td>$+$</td>
</tr>
<tr>
<td>Transfer capital owners $\sigma_e$</td>
<td>$\pm (+)$</td>
<td>$\pm (-)$</td>
<td>$\pm (-)$</td>
<td>$\pm (+)$</td>
<td>$\pm (-)$</td>
<td>$\pm (-)$</td>
<td>$+$</td>
<td>$+$</td>
<td>$+$</td>
</tr>
<tr>
<td>Transfer workers $\sigma_w$</td>
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<td>$\pm (+)$</td>
<td>$\pm (+)$</td>
<td>$\pm (-)$</td>
<td>$\pm (+)$</td>
<td>$\pm (+)$</td>
<td>$-$</td>
<td>$-$</td>
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<tr>
<td>Benefit disabled $\sigma_d$</td>
<td>$\pm (-)$</td>
<td>$\pm (-)$</td>
<td>$\pm (+)$</td>
<td>$\pm (-)$</td>
<td>$\pm (+)$</td>
<td>$\pm (+)$</td>
<td>$\pm (+)$</td>
<td>$\pm (+)$</td>
<td>$-$</td>
</tr>
<tr>
<td>Benefit retirees $\sigma_r$</td>
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<td>$\pm (-)$</td>
<td>$\pm (+)$</td>
<td>$\pm (+)$</td>
<td>$\pm (+)$</td>
<td>$\pm (+)$</td>
<td>$+$</td>
<td>$+$</td>
<td>$+$</td>
</tr>
<tr>
<td>Premium disabled $\tau_d$</td>
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<td>$\pm (-)$</td>
<td>$\pm (+)$</td>
<td>$\pm (+)$</td>
<td>$\pm (+)$</td>
<td>$\pm (+)$</td>
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<td>$+$</td>
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<tr>
<td>Premium retirees $\tau_r$</td>
<td>$\pm (-)$</td>
<td>$\pm (-)$</td>
<td>$\pm (+)$</td>
<td>$\pm (+)$</td>
<td>$\pm (+)$</td>
<td>$\pm (+)$</td>
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<td>$+$</td>
</tr>
</tbody>
</table>

Note: The results hold under the assumptions that $\alpha_{dj} = \alpha_{jw}$ and $\alpha_{jdr} = \alpha_{jwr}$, for $j = c, t, G$, and $\alpha_{Gd} \geq \alpha_{Gw}$. The results between brackets are for the numerical example.
the political influence of the disabled and retired is discriminatory with respect to the sizes of the public and private sectors, which is in contrast with the impact of changes in their respective group sizes (cf. Table 3.1).

The last observation already indicates that the analysis of changes in political influence that are due to changes in group size is more complicated. This is less so if the latter only concern individuals without capital (that is, $N_{\text{dw}}$ or $N_{\text{mr}}$), in which case the combined effects are the same as discussed above for changes in the political influence of these groups. For, as we have seen, the partial (isolated) effect of $N_{\text{dw}}$ and $N_{\text{mr}}$ is only non-zero for the transfers to these groups. If the change in group size concerns individuals with capital ($N_{\text{dc}}$ or $N_{\text{rc}}$), then the combined effect is identical to the partial effects of $N_{\text{dc}}$ and $N_{\text{rc}}$ in so far as the capital and commodity price (negative effect) and public output (positive effect) are concerned. However, the combined effect on the tax rate becomes positive, whereas the effect on private output and the social security premium for the retired becomes ambiguous. If the change in group size is due to both an increase in capital-owning and non-capital-owning individuals, it can be observed from Table 3.3 that the welfare effect of a simultaneous change in group size and political influence is negative for the members of the social groups as far as changes for retirees are considered and is only positive for retirees if the group size and political influence of disabled individuals changes.

The impact of other-directedness
Public transfers to disabled and retired individuals can only be explained by reference to the political influence of these social groups and/or the other-directedness of other influential social groups, where the latter can be related to pure altruism or mobility (see above). In the electoral competition model of the public sector the numerical strength of a social group and the homogeneity of its interests are important determining factors of its political influence. In reality these factors are more likely to function as substitutes than as complements, unless increases in group size are accompanied by organization. Interesting in this respect is the earlier cited empirical study of RENAUD (1989) concerning the Netherlands, where numerical strength is used as a proxy for political influence in a partial model of the public sector (based on the interest function approach), which is similar to the model of the previous section. Whereas the development of the (relative) numerical strength of self-employed, private sector workers and public sector workers is reported to have had a significant impact on transfers and exhaustive government expenditure, the number of pensioners turned out to be unimportant. The author notes in this context (p. 103): "This result points to the fact that a large relative numerical strength as such is not sufficient for political
influence. The degree of organization of a group will also be important. In this respect, the social group of the pensioners scores badly in the Netherlands, in contrast with the groups of government sector employees, private sector employees and self-employed, which are all very well organized. Following our line of reasoning one would have to rely then on the motive of other-directedness in order to explain the (substantial) transfers to retirees in the Netherlands in the past. In any event, these empirical results are at least suggestive for the importance of an investigation into the effects of the other-directedness parameters in the present model. For the same (theoretical and empirical) reasons as advanced when discussing the impact of the political influence parameters, it will again be assumed that workers and capital owners, on the one hand, and disabled and retired individuals, on the other, have the same preferences, and that the latter are relatively more interested in public goods.

Focusing first on the parameters concerning the retired ($\theta_r^c$, $\theta_r^s$ and $\theta_r^d$) the most straightforward effects are obtained for disabled individuals. Since they have the same preferences as retirees, a change in their other-directedness positively affects the transfer and social security premium concerning the retired ($\alpha_r$, $\tau_r$) whereas the transfer and premium concerning the disabled ($\alpha_d$, $\tau_d$) are negatively influenced. All the other variables remain constant. The results in Table 3.3 suggest that the welfare of disabled individuals is negatively affected by this change, whereas the welfare of retirees is positively affected. This picture strongly changes if the other-directedness of workers or capital owners vis-à-vis the retired is involved. In that case there is a positive effect on public output and the tax rate, which is not surprising because retirees are assumed to have a stronger preference for public goods. However, the transfer and the social security premium concerning this group is then also positively affected. Three partly counteracting effects are responsible for this. First, the change in other-directedness has a positive effect on the share of the aggregate capital and labor income (that determines the tax and premium base) that is transferred to retirees [i.e. the first part of the numerator in eq. (3.A.10)]. Second, although total labor supply is positively affected, there is a negative effect on private labor input. Because the wage rate is numéraire, the relative price of capital and thereby capital income of retirees are also negatively affected by the change in other-directedness. The lower capital income of retirees has a positive effect on the retirement transfer [i.e. the second part of the numerator in eq. (3.A.10)]. These positive effects are counteracted by a negative effect on the premium base due to the change in the price of capital. The change in $\theta_r^c$ and $\theta_r^s$ has, furthermore, a negative effect on private output (which follows from the change in labor input in the private sector) and on the commodity
<table>
<thead>
<tr>
<th>Utility capitalist $U_c$</th>
<th>$N_i$</th>
<th>$N_r$</th>
<th>$\mu_d$</th>
<th>$\mu_r$</th>
<th>$\theta^h_i$</th>
<th>$\theta^c_i$</th>
<th>$N_i, \mu_d$</th>
<th>$N_r, \mu_r$</th>
<th>$N_i, \theta^m_n$</th>
<th>$N_r, \theta^c_n$</th>
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<th>$N_r, \mu_r, \theta^c_n$</th>
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</thead>
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<tr>
<td>Utility workers $U_w$</td>
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<td></td>
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<td>Value interest funct. $P$</td>
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</tbody>
</table>

*Note* The effects are for the numerical example. Changes in $\theta^i_i$ concern changes in one other-directedness variable, where $i = c, w,$ and $d = d, r$. $\theta^m_n$ implies a change in all other-directedness variables for which $n = c, w, d$ and $m = d, r$. 

Table 3.3 Signs of comparative static effects on utilities and the value of the political interest function.
price (cf. Table 3.2). These changes in other-directedness lead to a Pareto improvement in the numerical example of Table 3.3.

Changes in the other-directedness parameters concerning the disabled ($\theta_v^d$ and $\theta_v'^d$) produce similar results, except that the impact on the transfer, as determined by the three effects discussed above, is now ambiguous. Table 3.3 shows a Pareto improvement for the numerical example.

If changes in other-directedness are not related to pure altruism but to mobility, matters become more complicated. In that case it stands to reason that one would have to simultaneously consider changes in the number of disabled or retired. As with simultaneous changes in numerical strength and political influence that were discussed earlier, the easiest case would involve a change in the number of disabled or retired individuals without capital ($N_{dw}$ and $N_{mr}$) causing a change in the other-directedness of workers ($\theta_v^w$ and $\theta_v'^w$). According to Table 3.3 all the combined effects will be similar to those of $\theta_v^w$ or $\theta_v'^w$, except for the effect of $N_{nr}$ on the transfer to retirees, which becomes ambiguous. Regarding the case where the changes involve capital-owning disabled or retired ($N_{dc}$ and $N_{rc}$) it can be observed that the combined effects are similar to the partial impact of a change in $\theta_v^d$ and $\theta_v'^d$, respectively, except for the effects on private output, the directly involved social security premium, and the transfer to retirees, which become ambiguous. The most interesting consequences of a change in other-directedness following a change in the (relative) number of disabled or retired individuals are the following: (a) the non-positive partial group size effect on the relative capital and commodity prices is accompanied (reinforced) by a negative other-directedness effect; (b) the non-negative partial group size effect on private output is counteracted by a negative other-directedness effect; (c) the non-negative partial group size effect on public output is accompanied (reinforced) by a positive other-directedness effect; (d) the non-positive partial group size effect on the directly relevant social security premium is counteracted by a positive other-directedness effect; (e) the zero partial group size effect on the tax rate is turned into a positive effect through the consequent change in other-directedness; and (f) the negative partial group size effect of $N_{rc}$ and $N_{nt}$ on the transfer to retirees (assuming that $\sigma_r$ is positive) is counteracted by a positive other-directedness effect; (g) the negative group size effect on the welfare of capital owners and workers is counteracted by a positive other-directedness effect, leading to a mitigation of intergenerational conflicts (this result follows from the numerical example).
If it is assumed that changes in the group size of disabled or retired individuals do not only affect other-directedness, but also (and positively) the political influence of these groups, then the aforementioned other-directedness effects concerning relative prices, private and public output, and the tax rate are further reinforced.

From the analysis of this section it is, first, concluded that in general the effects of changes in political influence or other-directedness are much more ambiguous than the effects of group size and capital endowments considered in the previous subsection, which is caused in particular by the sum restriction of the political influence weights. Nevertheless, they show the importance of taking account of these effects, which, according to the electoral competition model and the mobility argument, may be a further consequence of changes in the size of the groups of disabled and retired individuals. Second, the more definitive results obtained under the assumption that the disabled and retired are relatively more interested in public goods than workers and capital owners show that, in contrast with the non-discriminatory (and non-negative) impact of the size and capital endowments of the former groups, the political influence and other-directedness parameters concerning these groups (except $\theta^p_d$) have a discriminatory effect on private and public output, which is negative for the former and positive for the latter. Moreover, and again in contrast with the group size and capital endowment effects, they have a positive impact on the tax rate and the directly relevant social security premiums, as well as the transfer to retirees (the retired related parameters, that is). Finally, the earlier conclusion that public (exhaustive) expenditure will not be crowded out by an increase in the number of retirees is reinforced by the positive impact on public output of a possibly concomitant change in their political influence and the other-directedness of other groups with respect to them. Furthermore, these concomitant changes may even lead to an increase in the transfer (public pension) to retirees, notwithstanding the negative partial group size effect. Note that insofar as an increase in other-directedness is involved, such an increase will meet no political resistance.

3.5 Concluding remarks

In this Chapter some fiscal implications of aging and growing incapacity for work were investigated. Attention was particularly concentrated on the implications for social security benefits and premiums, the provision of public goods and services, private output, taxation and intergenerational conflicts. These issues were investigated by means of a general equilibrium model into which a positive model of government
behavior was incorporated. This construction gave us the opportunity to take account of general equilibrium effects in the private sector, as well as those caused by political feedback.

In the analysis of the political economic impact of aging particular attention was paid to four aspects: a change in the number of retirees (group size), a (consequent) change in capital endowments of retirees, a change in the political influence of retirees, and a change in the care for the utility of retirees by other individuals (motive of other-directedness). In addition, attention was focused on the political economic effects of an increase in the retirement age and the capital endowment of the elderly. It appeared from the analysis that the effects of changes in political influence and other-directedness were substantially more ambiguous than the effects of changes in group size and capital endowments. In order to arrive at more definitive results the (empirically plausible) assumption was made that the elderly care relatively more about public goods and services than workers and capital owners. Nevertheless, the analysis of simultaneous changes, for example in group size and political influence, as suggested by the behavioral model of the public sector, only produced limited insights because of ambiguous effects. More definitive results of such simultaneous changes were obtained for a numerical example. The rapidly increasing complexity of the model suggests the use of simulation methods and specification of a numerically solvable general equilibrium model that allows for an endogenous treatment of government behavior for a further analysis of the fiscal impact of aging. The well-known price to be paid for such models is the loss in analytical tractability; on the other hand, they allow the use of more flexible functional forms.

The main results regarding the aforementioned four aspects of an aging population can be summarized as follows. An increase in the number of retirees without capital only appears to affect the level of transfers to retirees. If, however, the number of capital-owning retirees increases, both the provision of public goods and private output are positively affected while the transfer (pension) to retirees as well as the pension premium decreases. The tax rate is not affected. These effects are reinforced if, in addition, capital per retiree increases. In general we cannot conclude that the welfare of all retired individuals will be improved if a fraction of them becomes less dependent on transfer income through the possession of capital. Except for the effect on the transfer to retirees, these results concerning an increase in the number of retirees (with capital) are strongly in contrast with the conventional wisdom.
If an increase in the number of retirees leads to an increase in the political influence of this group, the positive effect on private output is mitigated, while the positive effect on the provision of public goods is reinforced. Furthermore, an increase in the political influence of the elderly increases the tax rate and the pension premium, while the influence on the transfer to retirees is ambiguous. Similar effects are observed if capital owners and workers care more strongly for the utility of retirees (entailing an increase in the respective other-directedness parameters). However, in that case the transfer to retirees becomes unambiguously positive.

The direction of the effects on private and public output and taxation of a change in the number of disabled individuals (which is of special interest here as almost-retired individuals are overrepresented in this group), their capital endowments, political influence, and other-directedness parameters are in accordance with the effects of the changes in the corresponding parameters regarding retirees. The direction of the effects on social security transfers and premiums is slightly different.

An increase in the retirement age was observed to have a positive effect on private and public output and the social security transfers, with no influence on the tax rate and the social security premiums. Moreover, it turned out that an increase in the retirement age positively affects the welfare of retirees.

Concerning the generally expected exacerbation of intergenerational conflicts as a consequence of aging it was concluded that this may not occur if aging is accompanied by an increased probability for the nonretired to become a retiree (captured by the other-directedness parameter) or by a relative increase in the number of capital owners among the retirees.

Finally, the empirical relevance of the model presented in this chapter is shortly addressed by comparing its main results with some stylized facts concerning the Dutch economy.

As a preliminary remark, it is noticed that a distinction should be made between the short run and longer run economic impact of an aging population. In the short run, the effects of changes in the relative number of retirees and disabled individuals and their capital endowments are predominant. The consequent potential changes in the political influence of these social groups and the other-directedness of individuals can be expected to manifest themselves with a lag and will, therefore, have a weak effect in the short run. It is further noticed that retirees and disabled individuals have been
poorly organized in the past, which negatively affected the transformation of their increasing numerical strength into political influence [cf. RENAUD (1989)].

The relevant stylized facts concerning the Dutch economy over the past two decades can be summarized as follows: (a) the real disposable social security benefits of retirees and disabled individuals have followed the real disposable income of workers between 1970 and 1985: they increased till 1979 and then decreased. Although these benefits increased after 1985 they decreased relatively to the real disposable income of workers. Since 1981 the income of retirees from other sources increased; (b) the overall burden of taxation and social security premiums increased in the seventies and stayed more or less the same in the eighties. The composition of this burden has gradually shifted towards taxation; (c) there are no clear indications that the development of private output has been negatively affected by aging; (d) public output, relative to national product, fluctuated between 1970 and 1979 and decreased afterwards; (e) although the official retirement age did not change during the last two decades, the possibilities to retire earlier have been extended since 1980; (f) the number of capital owners decreased during the seventies, stabilized in the early eighties and increased afterwards. The increased number of capital owners caused the appreciation of entrepreneurship to increase, which seems to have had a positive effect on the political influence of this group. The number of workers increased absolutely, but decreased relatively in the last two decades, while both the absolute and relative numbers of retirees and disabled individuals increased. The increase in the number of disabled was explosive in the seventies.

To compare these stylized facts with the outcomes of our model, we discuss whether the facts (a)-(e) can be understood from the facts (f), that are exogenous in the model.

The only effect in the model of an increase in the number of retirees and disabled individuals ($N_{rv}$ and $N_{dw}$) is that it negatively affects the social security benefits. This negative effect is mitigated, however, by the positive effect on these benefits of an increasing number of workers, $N_w$. According to the model, the decrease in the number of capital owners ($N_c$) causes their political influence ($\mu_c$) to decrease and leads, furthermore, to an increase in the relative prices of private commodities and capital ($p_c$ and $p_K$). Workers and dependents could prevent the consequent decrease in their real disposable income through an increment in their political influence (to the extent that their numerical strength transformed into political influence). At the end of the seventies the real disposable income of these social groups was negatively affected, however, by price effects and unexpected negative economic developments.
[fact (a)]. This may have lead to more selfish workers. In that case the model suggests that the decrease in care for the welfare of retirees and disabled individuals of workers (θ_w and θ_iw) causes public production and the burden of the social security premiums to decrease [facts (b) and (d)]. The decrease in public production was reinforced when the appreciation of entrepreneurship increased in the eighties, which probably had a positive effect on the political influence of capital owners and private production [fact (c)]. According to the model, the increase in private production lead to an increase in the demand for labor and, consequently, to an increase in the wage rate. The increase in social security benefits in the latter half of the eighties [fact (a)] fell short of the increase in the wage rate, however, because of the aforementioned changes in the other-directedness of workers and in the political influence of capital owners, and because of the increased income of retirees from other sources (increase in k_P). Note, finally, that the effect of aging on the retirement age is ambiguous in our model; it depends in particular on the political influence and preferences for public goods of workers. The observed decrease in the retirement age [fact (e)] was not the result of aging, however, but part of the government's policy to suppress the official unemployment rate. In countries with lower unemployment rates, such as the United States, there is indeed a tendency to increase the retirement age, as the model suggests.

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6 The decrease in trade-union membership at the end of the seventies seems suggestive in this respect.
Appendix 3.A Partial and general equilibrium solutions

For a convenient representation of the equilibrium solutions, the following definitions are used throughout this Appendix:

\[ \tilde{\mu}_c = \mu_c (1 - \theta_c^e) (1 - \theta_c^w) \]
\[ \tilde{\mu}_w = \mu_w (1 - \theta_w^c) (1 - \theta_w^w) \]
\[ \tilde{\mu}_d = \mu_c \theta_c^d (1 - \theta_c^c) + \mu_w \theta_w^d (1 - \theta_w^w) + \mu_d (1 - \theta_d^d) \]
\[ \tilde{\mu}_r = \mu_c \theta_c^r + \mu_w \theta_w^r + \mu_d \theta_d^r + \mu_r \]
\[ \tilde{\alpha}_{ci} = \frac{\alpha_{ci}}{\alpha_{ci} + \alpha_{ti}}, \quad i = c, w \]
\[ a_j = \tilde{\mu}_c \alpha_{jc} + \tilde{\mu}_w \alpha_{jw} + \tilde{\mu}_d \alpha_{jd} + \tilde{\mu}_r \alpha_{jr}, \quad j = c, \ell, G \]
\[ \tilde{\alpha}_c = \tilde{\mu}_c \alpha_{cc} + \tilde{\mu}_w \alpha_{cw} \]
\[ \tilde{\tau}_i = (1 - \tau_h)(1 - \tau_c)(1 - \tau_r), \quad i = c, w \]
\[ \tilde{\tau}_d = (1 - \tau_h)(1 - \tau_d) \]
\[ \tilde{\tau}_r = (1 - \tau_h) \]
\[ L_{cs} = (1 - \ell_c) N_c + (1 - \ell_w) N_w \]
\[ K_{cs} = k_c^0 N_c + k_d^0 N_d + k_r^0 N_r \]

3.A.1 The private sector equilibrium

For the private sector equilibrium, where private sector variables are written as a function of public sector variables, parameters and exogenous variables, the price of the private commodity, \( p_c \), and the capital price, \( p_K \), can be written as

\[
p_c = \left[ \frac{\tilde{\alpha}_{cc} \tilde{\tau}(1+\sigma_c)N_c + \tilde{\alpha}_{cw} \tilde{\tau}^w(1+\sigma_w)N_w + \tilde{\tau}_d \sigma_d N_d + \tilde{\tau}_r \sigma_r N_r}{(1-\tilde{\alpha}_{cc} \delta_{Kc} \tilde{\tau}) k_c^0 N_c + (1-\delta_{Kc} \tilde{\tau}^w) k_d^0 N_d + (1-\delta_{Kc} \tilde{\tau}^w) k_r^0 N_r} \right]^{\delta_c} \frac{1}{\Omega_c \delta_{Kc}^0}
\]  
(3.A.1)
\[ p_X = \frac{\delta_{kc} \left[ \bar{\alpha}_{ce} \bar{\tau} \left( 1 + \sigma_c \right) N_c + \bar{\alpha}_{cw} \bar{\tau} \left( 1 + \sigma_w \right) N_w + \bar{\tau} \sigma_d N_d + \bar{\tau} \sigma_r N_r \right]}{(1 - \bar{\alpha}_{ce} \delta_{kc} \bar{\tau}) k_c^0; N_c + (1 - \delta_{kc} \bar{\tau}) k_c^0; N_{dc} + (1 - \delta_{kc} \bar{\tau}) k_c^0; N_{re}} \]  

(3.A.2)

where it is noticed that the wage rate \( p_L \) is the numéraire. Using eqs. (3.A.1) and (3.A.2), and the fact that demand for capital equals the fixed supply, the supply of private commodities \( X_c \), the demand for labor in the private sector \( L_c \), and the demand for private commodities \( c \) and leisure \( \ell \), follow immediately from the eqs. (3.2), (3.4), (3.16) and (3.17), respectively.

3.A.2 The public sector equilibrium

The partial equilibrium equations for the tax rate \( \tau_h \) the demand for labor in the public sector \( L_s \) the lump sum transfers to capital owners, workers, disabled and retired \( \sigma_c, \sigma_w, \sigma_d \) and \( \sigma_r \), respectively, and the premiums for the social security benefits to the disabled individuals and retirees \( \tau_d \) and \( \tau_r \) are equal to

\[ \tau_h = \frac{a_G \delta_{Ls}}{a_c + a_t + a_G \delta_{Ls}} \]  

(3.A.3)

\[ L_s = \frac{a_G \delta_{Ls}}{a_c + a_t + a_G \delta_{Ls}} \left[ \frac{p_K k_c^0 + p_L (1 - \ell_c) N_c + p_L (1 - \ell_w) N_w}{p_L} \right] \]  

(3.A.4)

\[ \sigma_c = \frac{\bar{\mu}_c (\alpha_{cc} + \alpha_{ct}) \left( p_K k_c^0 N_c + p_L N_c + p_L N_w \right)}{(\bar{a}_c + a_l) N_c} - (p_K k_c^0 + p_L) \]  

(3.A.5)

\[ \sigma_w = \frac{\bar{\mu}_w (\alpha_{cw} + \alpha_{ctw}) \left( p_K k_c^0 N_c + p_L N_c + p_L N_w \right)}{(\bar{a}_c + a_l) N_w} - p_L \]  

(3.A.6)

\[ \sigma_d = \frac{\bar{\mu}_d \alpha_{cd} \left( p_K k_c^0 N_c + p_L L_{rd} \right) - (\bar{a}_c + a_l) p_K k_d^0 N_{dc}}{(\bar{a}_c + \mu_d \alpha_{cd} + a_l) N_d} \]  

(3.A.7)

\[ \sigma_r = \frac{\bar{\mu}_r \alpha_{cr} \left( p_K K_{wr} + p_L L_{r} \right) - (a_c + a_l) p_K k_r^0 N_{rc}}{(a_c + a_l) N_r} \]  

(3.A.8)
3.A.3 The general equilibrium

Inserting eqs. (3.A.3), (3.A.5) - (3.A.10) of the public sector equilibrium into eqs. (3.A.1) and (3.A.2) gives the following expressions for the prices of the private commodity and private capital

\[
P_c = \left[ \frac{(a_c + a_t)\tilde{a}_c(N_c + N_e)}{(a_c + a_t)(a_c + a_t)\tilde{a}_c + a_c a_t \delta_{Kc}} K_{ex} + (a_c + a_t) a_t \delta_{Kc} k^0_c N_c \right] \delta_K
\]

(3.A.11)

\[
P_K = \frac{(a_c + a_t)\tilde{a}_c \delta_{Kc} (N_c + N_e)}{(a_c + a_t)(a_c + a_t)\tilde{a}_c + a_c a_t \delta_{Kc}} K_{ex} + (a_c + a_t) a_t \delta_{Kc} k^0_c N_c
\]

(3.A.12)

The expressions for the private production level \(X_c\), and the demand for labor \(L_c\), follow immediately from eqs. (3.3) and (3.4).

Using eq. (3.A.12) for the price of capital and the fact that \(p_L\) is the numéraire, the expressions for the transfers \(\sigma_c\) and \(\sigma_w\) can be determined, with the help of eq. (3.A.5) and (3.A.6), respectively.

\[
\sigma_c = \frac{\tilde{\mu}_w (\alpha_{cw} + \alpha_{tc}) N_w - \tilde{\mu}_w (\alpha_{cw} + \alpha_{tw}) N_e - \tilde{\mu}_w (\alpha_{cw} + \alpha_{tw})}{(a_c + a_t)N_e} \frac{\tilde{\mu}_w (\alpha_{cw} + \alpha_{tw})}{a_c + a_t}
\]

\[
\cdot \frac{(a_c + a_t)\tilde{a}_c \delta_{Kc} (N_c + N_e) k^0_c}{(a_c + a_t)(a_c + a_t)\tilde{a}_c + a_c a_t \delta_{Kc}} K_{ex} + (a_c + a_t) a_t \delta_{Kc} k^0_c N_c
\]

(3.A.13)
\[
\sigma_w = - \frac{\sigma_c N_c}{N_w} \\
= \frac{\tilde{\mu}_w (\alpha_{cw} + \alpha_{lw}) N_c - \tilde{\mu}_c (\alpha_{wc} + \alpha_{kc}) N_w}{(\bar{a} + a) N_w} + \frac{\tilde{\mu}_w (\alpha_{cw} + \alpha_{lw}) N_c}{(\bar{a} + a) N_w} \\
= \frac{(a_c + a_i) \bar{a}_c \delta_{kc} (N_e + N_w) k_e^0 N_c}{(\bar{a} + a) \delta_{tc} + a_c \delta_{tc}} K_{tc} + \frac{(a_c + a) a_i \delta_{kc} k_e^0 N_c}{(\bar{a} + a) N_e} \tag{3.A.14}
\]

Using eqs. (3.5), (3.6), (3.17), (3.A.11), (3.A.13) and (3.A.14), the demand for leisure \( t_i \) \((i = c, w)\) can be written as

\[
t_i = \frac{\tilde{\mu}_w \alpha_i [((a_c + a_i) \delta_{tc} + a_c \delta_{tc}) \delta_{tc} + (a_c + a_i) \delta_{kc} \delta_{tc} k_e^0 N_e]}{[(\bar{a} + a) ((a_c + a_i) \delta_{tc} + a_c \delta_{tc}) \delta_{tc} + (a_c + a_i) a_i \delta_{kc} k_e^0 N_e]} \tag{3.A.15}
\]

Using eqs. (3.A.11) and (3.A.15) the expressions denoting the benefits for disabled individuals and retirees \((\sigma_d\) and \(\sigma_r)\) and the premiums for financing the payment of these benefits \((\tau_d\) and \(\tau_r)\) follow from eqs. (3.A.7) - (3.A.10).

\[
\sigma_d = \frac{\tilde{\mu}_d \alpha_{cd} (a_c + a_i) \delta_{tc} \delta_{tc} \delta_{tc} k_e^0 N_c + \tilde{\mu}_d \alpha_{cd} k_e^0 N_c}{(\bar{a} + a) \delta_{tc} + \tilde{\mu}_d \alpha_{cd} N_d} \tag{3.A.16}
\]

where \( \tilde{k} = (\bar{a} + a + \tilde{\mu}_d \alpha_{cd}) k_e^0 N_c + \tilde{\mu}_d \alpha_{cd} k_e^0 N_c \)

\[
\sigma_r = \frac{\tilde{\mu}_r \alpha_r (a_c + a_i) \delta_{tc} \delta_{tc} \delta_{tc} k_e^0 N_c - (a_c + a_i) \delta_{tc} k_e^0 N_e}{(\bar{a} + a) ((a_c + a_i) \delta_{tc} \delta_{tc} \delta_{tc} k_e^0 N_c + \tilde{a}_c (N_c + N_w))} \tag{3.A.17}
\]

\[
\tilde{a}_c (N_c + N_w) \tag{3.A.17}
\]
\[
\tau_d = \frac{\bar{\mu}_c \alpha_{cd}(a_c + a_t + a_G \delta_{Lc})K^c_{nt} - (a_e + a_i)\delta_{kk} \bar{c}^*}{(a_c + a_t + a_G \delta_{Lc})K^i_{nt} - (a_e + a_i)\delta_{kc}(k^o_{ic}N_{dc} + k^p_{rc})}
\]

where \( \bar{c} = (a_c + a_t + \bar{\mu}_c \alpha_{cd})k^o_{ic}N_{dc} + \bar{\mu}_d \alpha_{cd}k^0_{rc} N_{rc} \)

Finally, using eqs. (3.4.18), (3.4.19) and (3.4.15), the demand for labor in the public sector is given by

\[
\tau_r = \frac{\bar{\mu}_r \alpha_{cr}(a_c + a_t + a_G \delta_{Lc})K^c_{rr} - (a_e + a_i)\delta_{kk} k^0_{rr} N_{rc}}{(a_c + a_t)\{(a_c + a_t + a_G \delta_{Lc})K^i_{rr} - (a_e + a_i)\delta_{kc} k^0_{rc} N_{rc} \}}
\]

The amount of the public good then follows from the production function for the public good, represented by eq. (3.27).
Appendix 3.B Parameter values for the numerical example

The values of the parameters and exogenous variables are derived from some stylized macro-economic facts: the capital/output ratio has a value between 2 and 2.5; the amount of public capital is circa one tenth of private capital; 15 percent of the labor force is self-employed. Because of their low degree of organization the political influence weights of disabled individuals and retirees are chosen to equal half of their relative numerical strength. The benchmark values for preferences, political influence weights, other-directedness, numerical strength and capital endowments are given in Table 3.B.1.

<table>
<thead>
<tr>
<th></th>
<th>capitalists</th>
<th>workers</th>
<th>disabled</th>
<th>retirees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preference weight private good $\alpha_{ci}$</td>
<td>0.6</td>
<td>0.6</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Preference weight leisure $\alpha_{ti}$</td>
<td>0.1</td>
<td>0.1</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Preference weight public good $\alpha_{gi}$</td>
<td>0.3</td>
<td>0.3</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Numerical strength $N_t$</td>
<td>100</td>
<td>500</td>
<td>100</td>
<td>300</td>
</tr>
<tr>
<td>Political influence weight $\mu_i$</td>
<td>0.14</td>
<td>0.66</td>
<td>0.05</td>
<td>0.15</td>
</tr>
<tr>
<td>Other-directedness, disabled $\theta_i^d$</td>
<td>0.15</td>
<td>0.15</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Other-directedness, retirees $\theta_i^r$</td>
<td>0.20</td>
<td>0.20</td>
<td>0.30</td>
<td>---</td>
</tr>
<tr>
<td>Capital endowments $k_i^0$</td>
<td>1.00</td>
<td>---</td>
<td>0.80</td>
<td>1.20</td>
</tr>
</tbody>
</table>

The number of individuals that are incapable of work are further divided into individuals with capital ($N_{dc} = 15$) and without capital ($N_{dw} = 85$). For retirees it is assumed that one-sixth owns capital ($N_{rc} = 50$), while the other retirees possess no capital ($N_{rv} = 250$).

With respect to the technical parameters, it is assumed that the scale parameters are identical for the private and public sector, $\Omega_c = \Omega_r = 0.3$, and that public production is more labor intensive than private production, $\delta_{Lr} = 0.90$, while $\delta_{Lc} = 0.75$. Finally the public capital stock is about one-tenth of total private capital: $K^0 = 17$ and $K_{io}^t = 172$. 
### Table 1. Parameter values for the American eagle

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a$</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>$b$</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>$c$</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>$d$</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>$e$</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>$f$</td>
<td>0.0</td>
<td></td>
</tr>
</tbody>
</table>

The table above lists the values of various parameters used in the model for the American eagle. Each parameter has a specific role in determining the eagle's behavior and population dynamics. Further details on the model can be found in the supplementary material. For more information, please refer to the original publication. 

The model is based on the principles of ecological systems, where the eagle's population is influenced by factors such as food availability, predation, and environmental conditions. The equations used in the model are as follows:

\[
\frac{dN}{dt} = rN \left(1 - \frac{N}{K}\right) - \alpha \cdot N^2
\]

where:
- $N$ is the eagle population at time $t$.
- $r$ is the intrinsic growth rate.
- $K$ is the carrying capacity of the environment.
- $\alpha$ is the predation rate.

The model predicts that the eagle population will grow exponentially at first, but as it approaches the carrying capacity, growth slows due to increased competition and predation. Beyond the carrying capacity, the population will decline due to resource scarcity and predation. The model is validated using historical data and field observations.