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DEMOGRAPHY, PENSIONS AND WELFARE:
Fertility Shocks and the Finnish Economy

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Abstract

The economic effects of an ageing population are preoccupying policy-makers in most industrial countries. In this paper, we study the economic impact of the demographic shock in Finland, a country for which the post-war fertility shock was particularly large. The framework for our analysis is an overlapping generations simulation model parametrised to mimic the current state of the Finnish economy. We conclude that the impact of the demographic shock on capital formation, labour supply and output are considerable. Welfare effects are smaller and the fiscal pressure from higher pension expenditures easier to accomodate than suggested by many commentators. Nevertheless, different approaches to financing increased social security expenditures can have quite large effects on the welfare of certain generations. The difference between the best and the worst policy may amount to 2% of lifetime endowment for some households.

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1 INTRODUCTION

Many industrial countries will experience steep increases in the cost of their state pensions in the next few decades. The main problem is the growing fraction of the population over 65. Though this partly reflects increasing life expectancy, a bigger effect for most countries is the fertility shock of the 1940s and 1950s. One of the countries most affected is Finland. The old age dependency ratio[1] in Finland which was 20% in 1990, is likely to reach 25% by 2010 and 40% by 2030.[2] Averaged across other OECD countries, the same ratio was 19% in 1990 and is projected to equal 23% in 2010 and 33% in 2030.

In this study, we address a series of important questions facing Finnish policy-makers. In particular, we ask what are the likely economic effects of the demographic shock? How will it affect the relative welfare of different generations? If the state pension system is to be modified, what is the preferable approach? The framework of analysis we employ is a general equilibrium simulation model of the Finnish economy. The model is fully dynamic. Overlapping generations of households make consumption, bequest and labour supply decisions over the life-cycle while firms maximise profits over time, altering their capital stocks subject to adjustment costs. Our model generalizes the work of Auerbach and Kotlikoff (1987), Auerbach, Kotlikoff, Hagemann, and Nicoletti (1989) in that we include variable terms of trade and an imperfectly elastic supply of world savings, and Perraudin and Pujol (1991) in that we incorporate non-stationary population and technological change.

Our main conclusions are as follows. The economic effects of the post-war fertility shocks on real economic magnitudes such as capital formation, labour supply and output are considerable. For example, output fluctuates substantially, falling 2% below, rising 9% above and finally again falling 8% below the path it would have followed with smooth population growth. The shock has a smaller impact on household welfare, however. The maximum utility gains and losses of individual generations

[1]This is the ratio of those aged 65 and above to those between 18 and 65.

[2]See OECD (1992). This forecast presumes zero net immigration. Even substantial immigration would not greatly reduce the increase in the ratio.

relative to what they would have received in the absence of a demographic shock are respectively 0.8% and 0.5% of lifetime endowment.

To cope with the fiscal pressure imposed by the demographic shock, the Finnish government could (i) rely on lump-sum taxes, (ii) cut pension benefits, (iii) increase pension contributions, or (iv) raise the retirement age. Our simulations suggest that the best policy response to the demographic shock would be an increase in the retirement age. This would raise the welfare of almost all generations. Cutting back pension benefits is the next best policy response. This would raise the welfare of generations born in the period 1990 to 2040. Increasing pension contributions represents the worst policy. It is interesting to note that the generation that suffers most from the demographic shock is that of the baby-boomers themselves and this is true no matter which of the four different policy responses the government adopts.

The structure of our model may be summarized as follows. There are two domestic sectors producing a non-tradeable and an export. Households consume the two domestically produced goods plus an import. We suppose that households become adult at the age of twenty and live for thirteen periods of five years each. They possess nested Constant Elasticity of Substitution (CES) utility functions over the three consumption goods and leisure, while labour-endowment-augmenting technological change increases their productivity over time. Households care about subsequent generations in that they derive utility from bequests they make when they die.

Domestic firms produce using CES production functions of capital and labour and face convex costs of adjusting capital inputs. The demand for the country's export is incompletely elastic, as is the supply of savings from the rest of the world. We permit complex non-stationary population dynamics with the only restriction being that the population is assumed to start and end on a balanced growth path. (On such a path, each age cohort makes up a constant fraction of the population.) Along the transition path, we can then permit complicated patterns of baby boom and bust.

To solve the model, we employ a Gauss-Seidel algorithm written in the computer language Gauss. This algorithm is quite robust and works well with a range of different starting values. Starting from a guessed vector of prices in each of fifty five year periods, we calculate an up-dated vector by solving sequentially for the prices in each period that eliminate excess demands in the different markets holding future prices fixed at the currently guessed values. Roughly fifty such iterations are required to find equilibrium state variables to a satisfactory degree of precision.

Our study is part of a substantial and growing literature on the economic effects of population aging. The first round economic impact of population aging was examined by several authors using simple projections based on accounting models. See, for example, Heller, Hemming, and Kohnert (1986), Halter and Hemming (1987), and Hagemann and Nicoletti (1989). Auerbach and Kotlikoff (1987) and Auerbach, Kotlikoff, Hagemann, and Nicoletti (1989) examined population aging within a general equilibrium model that represents a special case of that employed in this paper. Other recent research that employs similar techniques includes Broer, Westerhout, and Bovenberg (1994) and the papers in Broer and Lassila (1996).

The structure of our paper is as follows. Section 2 describes the Finnish retirement income system. Section 3 briefly discusses the overlapping generations model we employ. Section 4 details the simulations and discusses the results. Section 5 concludes. Appendix A provides a more detailed mathematical exposition of the model while Appendix B discusses the parametrisation.

2 PENSION SYSTEM RULES

2.1 State Pension

In this section, we describe the pension system we shall be analysing. In Finland, the "national pension scheme"[3] is the basic safety-net for the older population. Dating from the 1930s, the scheme comprises four pension entitlements: (i) an old-age pension consisting of a flat amount indexed to the CPI and subject to means testing; (ii) a disability pension; (iii) pensions for surviving spouses and children; and (iv) unemployment pensions for 60-64 year olds. National pensions are funded by a payroll

[3]This description draws on OECD (1992).

tax on employers, employee contributions levied at a constant rate on earned income, and by central and local government contributions. The basic entitlement under the national pension in 1993 was just over Fmk 2,000 per month.

2.2 Occupational Pensions

In addition to national pensions, Finland has a well-developed system of occupational pension schemes,[4] regulated by six different laws.[5] The schemes have full vesting and individuals build up entitlements under different schemes which are then aggregated to derive final entitlement. Private sector employment pension schemes were introduced in 1962 under the TEL and LEL laws. Employment pensions now cover almost 95% of the population.

From 1962 to 1975 pension entitlements accrued at a rate of 1% a year with the understanding that the maximum pension would be 42% of an individual's terminal wage. After July 1975, entitlements accrued at 1.5% per annum to a maximum of 60%. There is also a minimum pension equal to 38% of terminal wages if the individual has been working continuously since the start of the employment pensions law. (Before 1975 there was no minimum and between 1975 and 1983 the minimum was 25%.) The age at which one becomes entitled to a pension is 65 and entitlement depends on cessation of employment. Since 1986, individuals have been able to retire early. In this case, the entitlement decreases by 0.5% for each month of early retirement. (Similarly, continuing work past 65 increases entitlement.) Individuals may choose to retire partially and receive reduced entitlements. Four fifths of new pensioners currently retire before 65.

Up to 1977, employment pensions were indexed on wages. Since that date, they have been linked to the average of changes in the CPI and wages. Over the period 1981-90, prices rose at an average annual rate of 6.8% while pensions increased by 8.4%. The national and employment pension schemes are fully integrated. In 1991,

[4]The description given here draws on Central Pension Security Institute (1991).

[5]There are separate schemes for private sector employed and self-employed, and for employees of the state, communes, churches and some private societies.

for each $1 that pensionable earnings exceeded Fmk 6,581 per month, the national pension entitlement was reduced by 50c., with the maximum reduction being the total national pension. Figure 1 shows the income testing of pensions for a childless single pensioner.

Of contributions to private plans entitling individuals to pension income above the basic pension level, 60% is deductible against income tax up to a ceiling of Fmk 30,000. Lump sum contributions are not deductible. Pension income counts as earned income and is fully taxable. Lump sum payments are taxed at rates varying between 10 and 60% depending on the age of the beneficiary.

2.3 Funding of Pension Schemes

The Finnish pension system is a mixture of pay-as-you-go and funded elements. The private sector employment pension scheme under the TEL law has partial funding while even the public sector schemes have some funding. At the end of 1991, the total funding of all schemes amounted to 28% of GDP. The private sector portion of this funding is sufficient to cover pension liabilities for less than seven years.[6]

Under the current system, the costs of employment pensions are met out of employer contributions. These contributions are split between (i) a pooled component, and (ii) a funding component. The funding component is intended to contribute to funding for future pension payments. But the income flow on accumulated past funding contributions is far less than is required to meet current pension liabilities so these latter are largely paid for out of pay-as-you-go pooled funds. About 3/4 of employment pension expenditure is, in fact, pay-as-you-go.[7]

Contributions for a given employee depend in a complicated way on age as one may see from Figure 2. They also vary over time since the contribution formulae depend on life-expectancies which are up-dated, and because the pay-as-you-go component changes, as the number of recipients evolves. Both these factors are likely to lead to

[6]OECD (1992).
[7]Central Pension Security Institute (1991).

higher contributions in future years even without overt policy changes.

3 THE MODEL

The model employed in this paper is similar to the overlapping generations model applied by Auerbach and Kotlikoff (1987) in their study of the United States economy and builds on the open economy model of Perraudin and Pujol (1991). The Perraudin and Pujol model generalized Auerbach-Kotlikoff by introducing a demand curve for exports, a supply curve for savings from the rest of the world and export- and non-tradeable-producing domestic industries. The model described here generalizes the Perraudin-Pujol framework by introducing bequests,[8] labour–endowment–augmenting technological change and a growing population. Furthermore, the solution algorithms here employed are new to this study.

3.1 Household behaviour

The model of households follows the life–cycle approach. Aggregate consumption, saving and labour supply are derived from the intertemporal optimising behaviour of forward–looking individual age cohorts. Each cohort has an economic life of 60 years, becoming active at age 21 and dying at 85. While this latter age may seem high, life expectancy is currently increasing and one should think of this as the maximum lifespan of the two members of a given household. To limit the computational burden, we assume that a time period equals five years. Hence, in any given period, 13 cohorts of different ages are economically active. We suppose that the population increases over time at a constant rate.

Household utility functions are assumed to be time–separable, nested Constant Elasticity of Substitution (CES) functions of consumption, leisure and bequests. Leisure endowments are normalised to unity. The lifetime utility, U, of a household

[8]Empirical studies by Kotlikoff and Summers (1981) and Gale and Scholz (1994) on savings behaviour suggest that bequest motives are important determinants of savings behaviour.

is:

$$U \equiv \frac{1}{1-1/\alpha}\sum_{t=1}^{n}\frac{1}{(1+\delta)^{t-1}}u_t^{1-1/\alpha}+\frac{\alpha_B}{1-1/\alpha}\frac{b_n^{1-1/\alpha}}{(1+\delta)^n}, \quad (1)$$

Here, $n = 13$ is the last period of life while b_n is a bequest made at the start of the household's n^{th} period. u_t is a utility index which depends on leisure l_t and consumption of goods 1, 2, and 3, denoted c_{1t}, c_{2t}, and c_{3t}, in the following way:

$$u_t \equiv [c_t^{1-1/\rho}+\alpha_L l_t^{1-1/\rho}]^{1/[1-1/\rho]} \quad (2)$$

$$c_t \equiv [c_{1t}^{1-1/\rho_1}+\alpha_T c_{0t}^{1-1/\rho_1}]^{1/[1-1/\rho_1]} \quad (3)$$

$$c_{0t} \equiv [c_{2t}^{1-1/\rho_2}+\alpha_X c_{3t}^{1-1/\rho_2}]^{1/[1-1/\rho_2]} \quad . \quad (4)$$

α, ρ, ρ_1, and ρ_2 are respectively the elasticities of substitution between utility in different periods, leisure and consumption, tradeables and nontradeables, and imports and exportables. α_L, α_T, α_X and α_B are the utility intensity (or expenditure share) parameters for leisure, tradeables, exports and bequests.

We assume that all households retire at the start of some given period. We suppose that households' marginal labour productivities vary over the life cycle. Within each group, productivity and therefore wages are assumed to increase initially, peaking at period 4 and declining slightly thereafter.

Taxation and transfers affect household behaviour through their influence on income and prices. Lump-sum transfers have a direct impact on income, VAT affects consumer prices, and direct taxation (including social security contributions) influence interest rates and wages. Households maximize utility subject to an intertemporal wealth constraint. Let W be the household's total lifetime wealth. Then if r_t is the interest rate at t and τ_r is the tax rate on household interest income, the lifetime wealth constraint is:

$$W=\frac{b_n}{\prod_{t=2}^{n}[1+(1-\tau_r)r_t]}+\sum_{t=1}^{n}\frac{(1+\tau_v)p_t c_t}{\prod_{s=2}^{t}[1+(1-\tau_r)r_s]} \quad (5)$$

where τ_v is the rate of value added tax and p_t is a price index defined in the Appendix which involves parameters of the utility function.

Total lifetime wealth (W) equals the sum of human wealth (W_h), pension wealth (W_p), and anticipated future bequests (W_b). Let τ_i for $i = x, w, r, d, g, v$ denote the rates of employee social security contributions, wage income tax, interest income tax, dividend income tax, capital gains and value added tax, respectively. z_t denotes lump–sum transfer received from the government. w_t is the wage rate, and e_t is the "effective labour input." Human wealth inclusive of lump sum transfer payments can then be written as:

$$\text{Human wealth} \equiv W_h = \sum_{t=1}^{n} \frac{(1-\tau_x-\tau_w)w_t e_t(1-l_t)+z_t}{\prod_{s=2}^{t}[1+(1-\tau_r)r_s]} \tag{6}$$

Let us define the parameters of the pension system as follows. γ_{ac} is the accrual factor, n_r is the retirement age, $\bar{n}$ is the number of years worked to qualify for the maximum level of old age pension benefit, $\bar{w}$ is the average weighted wage rate calculated by taking into account wage income and working hours during the period specified for this purpose by the pension authorities, and λ is the factor used to index pension income to wages. Then, social security wealth may be written as:

$$\text{Pension wealth} \equiv W_p = \gamma_{ac} \sum_{t=n_r}^{n} \frac{\bar{n}\bar{w}^{\lambda} w_t^{1-\lambda}}{\prod_{s=2}^{t}[1+(1-\tau_r)r_s]} \tag{7}$$

Finally, if b_{rt} is bequests received in period t, anticipated future bequests may be written as:

$$\text{Bequest wealth} \equiv W_b = \sum_{t=1}^{n} \frac{b_{rt}}{\prod_{s=2}^{t}[1+(1-\tau_r)r_s]} \tag{8}$$

We assume in our simulations that bequests are made in the last period of life. Households have offspring in the first period of adult life (i.e., when 20 to 25 years old) and hence children receive bequests at the age of 60.

If there were no further constraints, solving the dynamic programming problem for a given household would be easy and indeed we would be able to derive closed form consumption and leisure demands. However, we shall assume that the household is not allowed to supply labour after the retirement age, n_r. One may think of this as reducing the shadow wage just sufficiently that the household wishes to supply zero labour in its last few periods. Since the shadow wage is not obtainable in closed form, neither are the associated consumption and leisure demands, however. We must therefore solve the household's programme numerically. More details are provided in Appendix B.

3.2 Firm Behaviour

We suppose that the economy contains two domestic industries labelled 1 and 3 which produce non-tradeable and tradeable goods respectively in a perfectly competitive manner. Each sector is made up of exactly similar firms which possess a constant returns-to-scale CES production function which depends on capital,[9] K_t, and labour, L_t. Scaling up variables, the production function for the industry as a whole is:

$$F_i(K_t, L_t) \equiv \bar{\epsilon}_i \left[\epsilon_{i0} K_t^{1-(1/\epsilon_i)} + (1-\epsilon_{i0}) L_t^{1-(1/\epsilon_i)} \right]^{1/[1-(1/\epsilon_i)]} \qquad i = 1,3 \qquad (9)$$

In each period, producers decide on cost minimising intensities of labour given the current stock of capital. They alter the stock of capital through investment so as to maximize the value of firms' equity. Optimal investment involves balancing the costs of new capital (acquisition and installation costs) against the higher future revenues made possible by a larger capital stock. Adjustment costs are assumed to take the form:

$$CK(I_t, K_{t-1}) \equiv \frac{\xi}{2} \frac{[I_t/K_{t-1} - \kappa]^2}{I_t/K_{t-1}} \qquad (10)$$

With convex adjustment costs of this kind, the capital stock will follow a smooth transition path. In equilibrium, it must be the case that dividends and capital gains equal the required return:

$$(1-\tau_d)D_t + (1-\tau_g)(V_{t+1} - VN_t - V_t) = (1-\tau_r)r_{t+1}V_t \qquad (11)$$

where V is the equity value of the firm, D is dividends, VN, the proceeds from share issues, and τ_d, τ_r, and τ_g are the tax rates on dividend and interest income, and the accrual–equivalent capital gains tax rate, respectively.

Ruling out bubbles, we can write this as

$$V_t = \sum_{v=t}^{\infty} \frac{\left[\frac{1-\tau_d}{1-\tau_g} D_v - VN_v\right]}{\prod_{s=t+1}^{v} [1 + (1-\tau_r) r_s / (1-\tau_g)]}. \qquad (12)$$

[9] Capital is, in fact, a composite good made up of fixed shares of the domestic and imported goods.

To solve the firms' programming problems, we must make assumptions concerning their financial behaviour. In particular, we shall suppose (i) that firms pay dividends equal to a constant fraction of after–tax profits net of depreciation; (ii) that they issue debt to maintain a constant debt–capital ratio; and (iii) that they issue new shares as the marginal source of finance. This financial behaviour is consistent with the assumptions behind the "old view" of capital taxation. Adjustment costs are assumed to be quadratic in the ratio of investment (I) to the capital stock (K) (see equation (10)) and internal to the firm. Such behaviour gives rise to a "q" investment function.

3.3 The Government

The government performs various functions in the model including exhaustive expenditure on goods, the operation of a system of transfers, the levying of taxes and the issuance of debt. Our approach also implicitly assumes that the government owns the firms and consequently receives their profits in the form of dividends. The government faces an intertemporal budget constraint which, for given public expenditures G_t and tax receipts T_t, can be written as:

$$\sum_{t=0}^{\infty} \frac{T_t}{\prod_{s=2}^{t}(1+r_s)} = \sum_{t=1}^{\infty} \frac{G_t}{\prod_{s=2}^{t}(1+r_s)} + B_1^G \tag{13}$$

The fact that government expenditure on goods does not contribute to households' utility or to firms' production means that any cut in public expenditure allows an uncompensated tax cut and therefore increased welfare. The model is therefore inappropriate for studying such questions as the optimal design of expenditure programs. The level of government debt, B^G, primarily affects the distribution of wealth across different generations. Since we do not incorporate a social welfare function capable of evaluating such distributions, the model is ill-equipped to study questions of optimal debt levels. We therefore concentrate on policies that can improve social welfare for given levels of public expenditure and given steady state debt.

3.4 Open Economy Aspects of the Model

Our model departs in several respects from the commonly-adopted 'small country' assumption. In describing industrial economies, it appears quite unrealistic to assume that they can sell unlimited quantities of their exports at constant prices. In modeling international capital flows, the assumption that interest rates are independent of the level of debt is hard to justify. The stylised facts of international capital markets suggest that the supply of world savings is imperfectly elastic for all but the smallest countries.

We, therefore, adopt the following three assumptions. First, demand for the export good (which is also consumed by domestic households and used as an input to capital by firms) is assumed to equal a constant elasticity function, $X_3 = X_0 P_3^{\omega}$, where X_3 and P_3 are export quantities and their foreign currency prices respectively. Second, the net stock supply of savings from the rest of the world depends positively on the gross interest rate according to the equation: $W_{ROW} = \overline{K}\ \mathrm{sign}(r_t - \overline{r})(|r_t - \overline{r}|)^{\omega^*}$. When $\overline{K} = \infty$, the interest rate is internationally given and the small country assumption holds for capital markets. (If $\omega = \infty$, the same is true of the goods market.) When $\overline{K} = 0$, the autarky case, the interest rate adjusts to give current account equilibrium with constant capital flows between the domestic economy and the rest of the world. Third, the imported good, which is consumed by households and used by firms in their constant coefficient production of capital, has a price, P_2, which is exogenously fixed in terms of foreign currency.

3.5 Parametrisation

In studies like this, it is very important to choose parameter values with care. In Appendix B, we describe at length the steps we took to ensure that our chosen parameters were consistent with past macro- and micro-econometric research on the Finnish economy. Table 1 summarises the utility and production function parameters. We detail in the Appendix how we determined other crucial aspects of the parametrisation including (i) the age-profile of the population, (ii) productivity levels

Table 1: BASELINE PARAMETRISATION

Utility Function Parameters

Parameter	Symbol	Value
Subjective discount rate	δ	0.025
Elasticity of intertemporal substitution	α	0.90
Consumption-leisure elasticity of substitution	ρ	1.10
Tradable substitution elasticity	ρ_1	1.20
Intra-tradable substitution elasticity	ρ_2	0.80
Leisure preference parameter	α_L	0.25
Bequest preference parameter	α_B	0.50
Maximum life-span (assuming adult life begins at 20)	T	75.0

Industry Parameters

Production elasticity (nontraded)	ϵ_1	0.71
Production elasticity (traded)	ϵ_3	0.92
Adjustment cost parameter	κ	0.05
Adjustment cost parameter	ξ	20
Depreciation rate	d	0.75
Capital–output ratio	K/X	3.00

Note: δ and α_L are determined by the model calibration.

over the life-cycle, and (iii) the dependence of government expenditures on demographic developments.

4 SIMULATIONS

4.1 Economic Effects of the Demographic Shock

4.1.1 The Nature of the Fertility Shock

As mentioned in the Introduction, the demographic shock experienced by Finland is somewhat greater than the OECD average. Indeed, by 2020, the ratio of those over 65 to those aged 15 to 64 in Finland is projected by the OECD to be the highest for any member country.[10] In this subsection, we explore the economic implications of this shock.

In simulating the model, we adopt the simplifying assumption that net immigration is zero. In fact, emigration has affected the age profile of the Finnish population at various points in time. In particular, in the 1960s and the latter part of the 1970s there was significant emigration to Sweden.[11] On the other hand, there has been very little immigration and Finland has one of the smallest populations of foreigners in relative terms of any European country. Treating emigration explicitly would complicate our projections considerably so it is preferable to assume net immigration is zero.

In our model simulations, we also suppose throughout that agents live for eighty five years. Of course, actual mortality rates are falling in Finland as in other OECD countries. In the present study, however, we wished to focus on the effects of Finland's post-war fertility shock. A justification for adopting this approach is that the prospective rise in old-age dependency ratios that is preoccupying Finnish policy-makers stems more from the fertility shock than from the secular rise in life expectancy.

[10]See OECD (1992).
[11]Leppänen and Romppanen (1990).

Figure 3 illustrates the demographic shock that we analyse in our model. The figure shows different age groups as fractions of the total population at different dates. We suppose that, initially, the economy is on a steady state growth path with the population expanding at a constant rate of 0.5% and with technological change expanding effective labour endowments by an additional 1.5%. From 1940 onwards, we suppose that new cohorts (of 0 to 4 year-olds) are, for dates up to 1990, equal in number to those actually observed, and, for dates from 1990 to 2025, equal to population projections supplied to us by VATT. From 2025 onwards, we assume that births are such as to bring the population age profile smoothly back towards a pattern of steady-state growth with a constant rate of increase of 0.5%.

Though our approach abstracts from immigration and from realistically complicated mortality rates, it nevertheless generates old-age dependency ratios close to those implied by population projections which relax these assumptions. For example, OECD (1992) reports old-age dependency rates for Finland in 1990, 2010 and 2040 of 20%, 25% and 39%. Our approach yields ratios of 24%, 27%, and 40% for these years. Lastly, note the important point that the demographic shock depicted in Figure 3 is not a simple 'baby boom', i.e., a temporary increase in the birth rate, which subsequently affects the size of older age groups, and eventually dies out. Instead, it is a baby boom followed by an even larger 'baby bust', and then a recovery to original rates of fertility. The fact that the shock comprises two opposite perturbations to fertility rates complicates the economic effects as we shall see below.

4.1.2 The Dynamics of Savings and Capital

Figures 4 to 7 show the time paths followed by different economic variables when the fertility shock described above occurs unexpectedly in 1940. After that date, agents are assumed to know future demographic developments and the government's policy response with perfect foresight. In Figures 4 to 6, economic variables are shown as percentage deviations from the initial steady-state growth path. The simulations depicted are conducted under different assumptions about the authorities' policy response to the shock. In the 'baseline' policy case on which we shall initially concentrate, the authorities absorb the fiscal impact of the shock by adjusting lump-sum tax rates. Adjustments in lump sum taxes in our model are equivalent to changes in the basic allowance in a standard non-linear income tax system. Hence, one may regard our baseline financing policy as one of absorbing the costs of pension benefits through adjustments in allowances.

Focussing, then, on the case of lump-sum tax financing (shown as solid lines in Figures 4 to 7), one may note that, following the demographic shock, the economy initially exhibits a slight contraction in activity during the period 1940 to 1965. This is followed by a major increase in labour supply, capital formation and output in the decades between 1965 and 2010. Finally, between 2010 and 2090, activity again contracts quite substantially. The main factor behind the sequence of contraction and expansion is inward and outward movements in the economy's production possibility frontier as supplies of labour and capital fluctuate in line with changes in the working-age population and aggregate savings. From Figures 4 and 5, one may note that labour supply peaks earlier that capital (in 1980 rather than in 1995), with output peaking in between (in 1985). Such dynamics are very much what one would expect to observe in an overlapping generations economy following a temporary rise in fertility.

As one may see from Figure 6, factor prices react in an intuitively reasonable manner, given the shock involved. Real wages vary negatively with labour supply, hitting a low in 1985 and then rising to a peak in 2020. Interest rates are high in 1985 when capital is in relatively short supply but fall significantly and remain below trend throughout the period 1990 to 2030 in which capital is relatively abundant. Other relative price movements are similarly intuitive. The exchange rate (expressed as the domestic price of a unit of foreign currency) varies positively with domestic output. This reflects the fact that the domestic currency must weaken when output is high to induce foreigners to purchase more Finnish exports. The magnitude of the required devaluation in the domestic currency is considerable with the real exchange rate increasing by almost 40% in 2005 compared with its trend level.

Figure 7 shows the impact of the shock on fiscal variables. The plots show different components of the government budget expressed as percentages of total output. Again, the baseline simulation with marginal government financing coming from lump sum taxes is shown as a solid line. Social security expenditure rises steeply in the period 2000 to 2025 from 10% to 16% of GDP. Other government expenditures show a sharp decline in the period 1970 to 1990. This mainly reflects a reduction in education expenditure.

Lump sum taxes are the marginal source of additional government revenue in the baseline simulation and adjust endogenously to balance the budget. As one may see from Figure 7, lump sum taxes vary inversely with the level of real output. In 1980, they are 0.6% of GDP above trend. By 2005, they have fallen to 0.7% of GDP below trend. From 2005 to 2035, a combination of higher social security spending and a contraction in real activity lead to a rise in lump sum taxes of 1.1% of GDP after which they gradually decline again towards the trend level.

It is striking that although the changes in lump sum taxes are non-negligible, they certainly do not constitute a fiscal crisis of the kind suggested by some studies. The OECD, for example, has argued that, under unchanged welfare policies, Finland's public debt will increase from 80% of GDP in 1995 to 280% in 2030.[12]

4.1.3 The Welfare of Different Generations

Figure 8 shows the utility levels of representative households from different cohorts plotted against years of birth. Since the demographic shock occurs in 1940, all generations which die after 1940 are affected including those who have only one five year period of life remaining. The utility levels are shown in money metric form. The money metric welfare measure gives the percentage change in each households' total lifetime endowment discounted to the start of the working life that would be enough to compensate them for the demographic shock. The calculations presume that relative prices are those that hold along the original steady state growth path and hence the utility changes represent equivalent variation welfare measures.

A notable feature of Figure 8 is the fall in welfare for households born at the height of the baby boom. These generations suffer doubly. When they are working there is

[12]See OECD (1995).

relatively little capital per capita so labour productivity is lower than trend. When they retire, there is an abundance of capital but relatively few workers to employ it, so returns to savings are lower than trend levels. The households which enjoy the highest welfare are those born in the year 1980. They work with the relatively large capital stock comprising the savings of the baby boomers. When they come to retire, there is a large number of young workers available to use their own savings as capital and hence to bid up the return on savings. Surprising perhaps is the magnitude of the fall in welfare of generations born in the years 2010 to 2020. The baby bust that affected the generation before them means they have relatively little capital to work with.

4.2 Different Policy Responses

4.2.1 A Replacement Rate Cut

Now, consider different possible policy responses to the demographic shock. Recall that in the baseline simulation discussed at length above, lump sum taxes (i.e., income tax allowances) are adjusted to balance the government budget. Three different means by which the authorities might finance the increase in social security expenditures are (i) to reduce pension benefit levels by cutting the replacement rate, (ii) to raise the retirement age, or (iii) to raise contribution rates. We shall assume that these changes in pension rules are implemented for a period of 75 years, starting in the year 1990.

First, suppose that, in the period 1990 to 2065, the replacement rate is adjusted down so as to balance the social security budget. (Lump sum taxes are still used to balance the government budget as a whole.) Relative to the lump-sum financing case, such a policy lowers the cost of labour to firms and boosts their demand for capital. As one may see from Figures 4 and 7, the greatest impact is in the years around 2030 when social security expenditures would otherwise be extremely high. Output is slightly higher (see Figure 5), especially in the period 2030 to 2080 and the policy improves welfare, again especially for later generations. The generations which suffer a reduction in welfare are only marginally worse off. The broadly positive welfare effects follow from the fact that cutting back pension provision reduces the labour market distortions introduced by pension contributions and encourages higher savings. Both effects tend to increase welfare although the positive impact is negligible for generations born prior to 1980.

4.2.2 A Retirement Age Increase

Next, consider a policy of increasing the retirement age from 60 to 65 for those retiring in the years 1990 to 2065. The official retirement age in Finland is 65 but the comparatively small cuts in benefits for those who retire early mean that there is a strong incentive for early retiremnt. In our baseline simulation, we therefore presume that the retirement age is 60.

Raising the retirement age significantly increases total labour supply in the years between 1990 and 2055. In much of this period, the increase exceeds 4%. The rise would be even larger if it were not for the fact (i) that labour productivity declines as individuals approach retirement and (ii) that positive population growth implies older cohorts a relatively small share of the total workforce. Generations whose retirement age is affected (those born between 1915 and 1990) save less, so, in the period 1965 to 2000, capital is between 2% and 4% lower than in the lump sum financing case.

From 1990 onwards, however, the rise in labour supply lowers real wages and raises the marginal product of capital. Investment is strongly stimulated so that by 2010, capital significantly exceeds the levels achieved in the baseline case. Indeed by 2060, capital is 8% higher than in the baseline.

Again, one may see the effects of this policy on the welfare of different generations in Figure 8. Without exception, all generations benefit from a rise in the retirement age. The generation that benefits most compared to the baseline simulation is the one born in 2010. The explanation if that the large build up in capital boosts labour productivity when they are young workers.

4.2.3 A Contribution Rate Rise

The last policy response we consider is a rise in contribution rates, holding benefit levels constant. To be precise, contribution rates are adjusted to balance the social security budget while lump sum taxes are again used to balance the over all government budget.

The main effect of this policy is to discourage labour supply in the period of high social security expenditure between 2000 and 2030. The reason for this effect is that the Finnish pension system bases pension entitlements on a relatively short averaging period towards the end of the working life. In years outside the averaging period, increased pension contributions are equivalent to distortionary, dead–weight wage taxes in their effect on labour supply. The magnitude of the impact on aggregate labour supply is considerable. Around 2025, labour supply is 6% less than in the baseline simulation.

Lower labour supply feeds through into lower output and consumption. By 2025, output is 4% down on the baseline simulation level, while consumption declines by a similar amount. Price effects are muted although there is some slight appreciation in the exchange rate compared to the baseline simulation levels when output is at its lowest. The impact of this policy on welfare is minor for generations born prior to 1970. However, for generations born after 1990, the welfare losses are substantial, representing around 0.8% of lifetime endowment compared to the lump sum financing case in some cases.

4.3 Sensitivity Analysis

To assess the sensitivity of our results to changes in the parameters, we ran a series of additional simulations in which all except one given parameter were at their baseline levels. In particular, we experimented by simulating the model with intertemporal elasticity of substitution, α set to 1.2 instead of the baseline level of 0.9, and the intratemporal elasticity of substitution between consumption and leisure, ρ, set to 1.4 rather than the baseline value, 1.1.

Changing parameters in this way made relatively little difference to the dynamic path followed by the economy after the fertility shocks. (The differences in the dynamic paths were far less, for example, than the differences we found under different assumptions about financing.) Higher intertemporal elasticity of substitution leads to a slightly lower wages, higher interest rate and lower capital stock than in the baseline in the period following the relative boom around 1990. Changing the intratemporal elasticity of substitution, i.e., the elasticity between consumption and leisure, makes negligible difference to any variable.

A second aspect of the results we explored was the importance of age-dependent government expenditure. Recall that in the baseline version of the model, government spending on a range of items, most notably education and health, is assumed to vary according to the age profile of the population. When we simulated the model using the baseline parametrisation but removing any sensitivity of health and education spending to age, we found that total government spending was lower in 1955 to 1975 and mostly higher thereafter. The reason is quite simply that in the early period the baby boom produces a rise in education spending while later on, education spending falls with the baby bust and health expenditure rises as the proportion of old people in the population goes up.

The magnitude of the effect is quite large in that government expenditure as a percentage of GDP is 4% higher in the forty years after 1990. While lump sum taxes are slightly reduced, other taxes rise significantly as a proportion of GDP. The effect on total output is actually very small and the additional demand from the government is offset partly by a fall in consumption and a contraction in exports. The exchange rate appreciates and wages are slighly lower in the period of higher government expenditure.

5 CONCLUSION

In this paper, we describe a flexible but quite complex overlapping generations model of the Finnish economy. This model generalizes past work in that it allows for non-stationary population and technological change but represents a realistic open economy with variable terms of trade and an imperfectly elastic supply of foreign savings. Even for a small industrial economy like Finland, trade elasticities are likely to be finite. The limited degree of international capital market diversification studied by Feldstein and Horioka (1980) and others suggests that one should likewise assume a finite savings supply for Finland despite the size of the Finnish economiy.

We apply this model in studying the effects of demographic change and pension reform in the Finnish economy. Since the Second World War, Finland has experienced an unusually severe demographic shock with a substantial rise in fertility being followed by a sharp drop. The implication is a very marked ageing in the population in the years 2010 to 2050 as baby-boomers retire and the working population is unusually small. The ratio of retired people to those of working-age is projected to be the highest of any OECD country by 2020.

Simulations of our model suggest that the demographic shock will have substantial implications for real variables such as output, labour supply and investment. These will fluctuate with lower than trend levels of activity in the period up to the year 2000, followed by relative boom in the years 2000 to 2030, and ending with a contraction relative to trend in the thirty years after 2030. These developments largely reflect fluctuations in the working-age population implied by the demographic shock. As one might suspect, therefore, per capita welfare will be affected much less than aggregate output. Welfare calculations suggest that the maximum impact of the shock on the utility of individual households is less than 1% of their lifetime endowment.

A major concern of policy-makers has been the fiscal pressures that the shock may induce both (i) by boosting aggregate pension benefit expenditures, and (ii) by increasing age-sensitive government spending such as health care. Our model simulations suggest these concerns are somewhat exaggerated. Nevertheless, different approaches to financing the increase in social security expenditures can have significantly different outcomes. Approaches to financing that we consider include cutbacks in benefit entitlements, a rise in the retirement age and an increase in pension contributions. The best policies consist either of cutting benefits or of increasing the retirement age. The worst policy (by some way) is that of increasing contributions while holding benefit entitlements fixed. For some generations, the difference between the best and the worst policy is equivalent to a 2% change in their lifetime endowment, a substantial effect indeed.

6 APPENDIX A: THE MODEL

In this appendix, we supply more details of our overlapping generations model. We discuss the utility and profit maximization problems facing households and firms respectively.

6.1 Household Sector

This Appendix provides a derivation of the principal behavioural equations of the model. The dynamic programme of each individual household may be stated compactly as that of choosing consumption, leisure and bequests, $c_{j1}, c_{j2}, \ldots, c_{jn}$, for $j = 1, 2, 3$; $l_1, l_2, \ldots, l_n$, and b_n, to maximize:

$$U \equiv \frac{1}{1-1/\alpha}\sum_{t=1}^{n}\frac{1}{(1+\delta)^{t-1}}u_t^{1-1/\alpha} + \frac{\alpha_B}{1-1/\alpha}\frac{b_n^{1-1/\alpha}}{(1+\delta)^n}, \tag{14}$$

$$\text{where to } u_t \equiv [c_t^{1-1/\rho} + \alpha_L l_t^{1-1/\rho}]^{1/[1-1/\rho]} \tag{15}$$

$$c_t \equiv [c_{1t}^{1-1/\rho_1} + \alpha_T c_{0t}^{1-1/\rho_1}]^{1/[1-1/\rho_1]} \tag{16}$$

$$c_{0t} \equiv [c_{2t}^{1-1/\rho_2} + \alpha_X c_{3t}^{1-1/\rho_2}]^{1/[1-1/\rho_2]} \quad . \tag{17}$$

subject to the retirement constraints:

$$l_t = 1 \qquad t = n_r, \ldots, 11. \tag{18}$$

and the lifetime wealth constraint:

$$\frac{b_n}{\prod_{s=2}^{n}[1+(1-\tau_r)r_s]} + \sum_{t=1}^{n}\frac{(1+\tau_v)p_t c_t}{\prod_{s=2}^{t}[1+(1-\tau_r)r_s]} = \tag{19}$$

$$\sum_{t=1}^{n}\frac{(1-\tau_x-\tau_w)w_t e_t(1-l_t)+z_t}{\prod_{s=2}^{t}[1+(1-\tau_r)r_s]} + \gamma_{ac}\sum_{v=n_r}^{n}\frac{\bar{n}\bar{w}^{\lambda}w_t^{1-\lambda}}{\prod_{s=2}^{t}[1+(1-\tau_r)r_s]} + \sum_{t=1}^{n}\frac{b_{rt}}{\prod_{s=2}^{t}[1+(1-\tau_r)r_s]}$$

Here, the right hand side is the sum of human, pension and bequest wealth, and the price indices p_t^u and p_t are defined as:

$$p_t^u = [p_t^{1-\rho} + \alpha_L^{\rho}((1-\tau_w-\tau_x)w_t e_t + \mu_t)^{1-\rho}]^{\frac{1}{1-\rho}} \tag{20}$$

$$p_t = [((1+\tau_v)p_{1t})^{1-\rho_1} + \alpha_T^{\rho_1} p_{0t}^{1-\rho_1}]^{\frac{1}{1-\rho_1}} \tag{21}$$

$$p_{0t} = [((1+\tau_v)p_{2t})^{1-\rho_2} + \alpha_X^{\rho_2} p_{3t}^{1-\rho_2}]^{\frac{1}{1-\rho_2}} \tag{22}$$

Here, the homothetic specification of the subutility function makes it possible to interpret the normalised expenditure function as a price index p_t^u of total consumption, where μ_t in equation (20) is the Lagrange multiplier associated with retirement.

If the levels of full consumption, u, and retirement Lagrange multiplier μ_t are known, then it is easy to obtain optimal consumption and leisure in closed form as:

$$c_t = (p_t^u)^\rho u_t/(p_t)^\rho \tag{23}$$

$$l_t = (p_t^u)^\rho u_t/((1-\tau_w-\tau_x)w_t e_t+\mu_t)^\rho \tag{24}$$

To find optimal full consumption and bequests requires the solution of an intertemporal maximisation problem which has first order conditions:

$$u_t = \Omega^{-\alpha}\left[\frac{\prod_{s=2}^{t}[1+(1-\tau_r)r_s]}{(1+\delta)^{t-1}}\right]^\alpha (p_t^u)^{-\alpha} \tag{25}$$

$$\frac{1}{(1+\delta)^{n-1}}\alpha_B\, b_n^{-\frac{1}{\alpha}} = \Omega\prod_{s=2}^{n}[1+(1-\tau_r)r_s] \tag{26}$$

where Ω is the Lagrange multiplier associated with the intertemporal wealth constraint.

Further steps to obtain expressions for full consumption and bequest can be summarised as follows. We modify the intertemporal wealth constraint so as to comprise full consumption and full time endowments. Substituting the first order condition for full consumption into the modified intertemporal wealth constraint gives rise to a useful expression for Ω. Inserting this (i.e., Ω) into the first order conditions yields desired expressions for full consumption and bequest. However, forcing cohorts to retire at certain periods cannot be defined analytically. We therefore follow the simple approach of assuming that retirement takes place at a fixed age.

6.2 Firm Sector

The economy we examine has two production sectors producing goods nontraded and tradeable using capital K and labour L inputs. Each industry consists of identical firms with C.E.S. production functions of the form:

$$F_t(K_t\,,\,L_t) \;\equiv\; \bar{\epsilon}\left[\epsilon_0 K_t^{1-\frac{1}{\epsilon}} \;+\; (1-\epsilon_0)L_t^{1-\frac{1}{\epsilon}}\right]^{\frac{1}{(1-\frac{1}{\epsilon})}} \tag{27}$$

Firms face convex costs of adjusting their capital inputs:

$$CK(I_t\,,\,K_t) \;\equiv\; \frac{\xi}{2}\frac{[I_t/K_t-\kappa]^2}{I_t/K_t} \tag{28}$$

where I stands for investment at period t. κ and ξ are parameters.

We postulate that managers of firms maximise the equity value of the firm (V). This equity value can be expressed as the discounted value of after–tax dividends D net of share issues VN:

$$V_t = \sum_{s=t}^{\infty}\frac{\left[\frac{1-\tau_d}{1-\tau_g}D_s - VN_s\right]}{\prod_{v=t+1}^{s}[1+(1-\tau_r)r_v/(1-\tau_g)]}, \tag{29}$$

subject to capital accumulation

$$K_{s+1} = (1-d)K_s - I_s. \tag{30}$$

In the above equations, τ_d is the dividend tax rate, τ_g is the capital gains tax rate, d denotes the rate of capital depreciation, r is the interest rate, τ_r represents the tax rate applied to interest income.

In order to obtain an explicit expression for $D_s - VN_s$, we use a series of definitions. The first is the cash flow identity that equates sources and uses of funds:

$$R_s + BN_s + VN_s = r_s B_{s-1} + D_s + IE_s + T_s \tag{31}$$

This identity states that firms use earnings before taxes and interest payments R and funds from borrowing BN and share issues VN to pay interest payments $r_s B_{s-1}$ to bondholders on accumulated debt B_{s-1}, dividends D_s to shareholders, investment expending IE_s and taxes to government T_s. The second expression defines R_s earnings before taxes and interest payments:

$$R_s = [p_s F(K_s, L_s)] - (1-\tau_L)w_s L_s] \tag{32}$$

where w_s is the wage rate and τ_L is the employer contribution rate. The third definition is dividend rule

$$D_s = \bar{a}[(1-\tau_c)(R_s + r_s B_{s-1}) + \tau_c A_s - dP_{Ks}K_s] \tag{33}$$

This definition states that firms pay dividends equal to a constant fraction, $\bar{a}$, of after–tax profits and interest payments net of economic depreciation. Here, τ_c stands for the corporation tax rate and A is the value of currently allowable capital depreciation allowances. The fourth definition is given by

$$B_{s-1} = \bar{b}P_{Ks-1}K_s \tag{34}$$

It states that firms maintain debt as a fraction, $\bar{b}$, of the value of their capital $P_{s-1}K_s$ with P_K the replacement price of capital goods. The rule defines firms' borrowing policy

$$BN_t = \bar{b}[P_{Kt}K_t - P_{Kt-1}K_{t-1}] \tag{35}$$

The value of investment expenditure IE_s is defined as:

$$IE_s = (1-\tau_k)P_{Ks}I_t \tag{36}$$

where τ_k is the investment tax credit rate. Finally, we define firms' corporation tax liabilities as:

$$T_t = \tau_c[R_t - r_t B_{t-1}] - \tau_c A_t \tag{37}$$

Using these definitions one can find the following expression for the market (equity) value of the firm:

$$V_t = \sum_{s=t}^{\infty} \{(1-\omega)(1-\tau_c)[R_s - r_s\bar{b}P_{Kt}K_{t-1}] - \bar{b}[P_{Ks}K_s - P_{Ks}K_{s-1}]$$
$$+\omega[(1-d)P_{Ks}K_s - P_{Ks-1}K_s] + (1-\tau_k-(1-\omega)A_s^N)P_{Ks}I_s\}\,\Gamma(s) + A_t^E \tag{38}$$

where $(1-\omega) = \bar{a}\frac{1-\tau_d}{1-\tau_g} - \bar{a} + 1$ and $\Gamma(s) = \prod_{v=t+1}^{s}[1+(1-\tau_r)r_v/(1-\tau_g)]$ is the discounting operator. To obtain the above expression we made two assumptions: (1) The present value of depreciation allowances can be split into the present value of allowances on current A_t^E and future investments A^N. (2) Adjustment costs to investing are internal to firms and thus subtracted from production to obtain net product level.

Hence we write the Lagrangian as:

$$\begin{aligned}\mathcal{L}_t &= \sum_{s=t}^{\infty}\Big\{(1-\omega)(1-\tau_c)[R_s - r_s\bar{b}P_{Ks-1}K_s] - \bar{b}[P_{Ks}K_s - P_{Ks-1}K_s] \\ &\quad +\omega[(1-d)P_{Ks}K_s - P_{Ks-1}K_s] + (1-\tau_k-(1-\omega)A^N)P_{Ks}I_s\Big\}\Gamma(s) + A_t^E \\ &\quad -\sum_{s=t}^{\infty} q_s[K_{s+1}-(1-d)K_s - I_s]\Gamma(s)\end{aligned} \tag{39}$$

The first order conditions for optimal labour input, investment in period s are given by $\partial\mathcal{L}_s/\partial L_s = 0$, $\partial\mathcal{L}_s/\partial I_s = 0$ and $\partial\mathcal{L}_s/\partial K_s = 0$, or

$$\frac{\partial F_t(K_t, L_t)}{\partial L_s} = (1-\tau_L)w_t \tag{40}$$

$$(1-\tau_k-(1-\omega)A^N)P_{Kt} + (1-\omega)(1-\tau_c)P_s\left(CK + CK'\frac{I_s}{K_s}\right) = q_s \tag{41}$$

$$\begin{aligned}&\Big\{(1-\omega)(1-\tau_c)\left[\frac{\partial R_{s+1}}{\partial K_s} + P_{s+1}CK'\left(\frac{I_s}{K_s}\right)^2\right] - (1-\omega)(1-\tau_c)r_{s+1}\bar{b}P_s \\ &\quad +(\bar{b}-\omega)[(1-d)P_{Ks+1} - P_{Ks}]\Big\}\Gamma(s+1)q_s = \Gamma(s) - (1-d)q_{s+1}\Gamma(s+1).\end{aligned} \tag{42}$$

7 APPENDIX B: PARAMETRISATION

Section 2 of the paper describes the rules of the Finnish pension system. This Appendix summarizes research aimed at establishing suitable values for all the other parameters of the model. These include:

1. **Utility function parameters.** These describe the degree to which households are willing to substitute between different forms of consumption when prices change and the extent to which they discount future versus with current utility.

2. **Production function parameters.** These reflect the technological possibilities available to firms both in altering their long-run balance of inputs in response to factor price changes and in the depreciation and adjustment cost rates that govern their investment decisions.

3. **Tax rates.** Tax rates on household income, goods and corporations are important. The welfare effects of changes in tax rates depend non-linearly on the initial level of total marginal tax rates.

4. **Government Expenditure.** Gauging the impact of population changes across generations requires careful treatment of government expenditures since important components of such expenditures like education or health care affect different age groups to substantially differing degrees.

5. **Lifetime Wage Income profiles.** The emphasis in our models on intertemporal effects means that the pattern of wages over the lifetime may affect results quite substantially.

6. **Parameters of the Foreign Sector.** The results of our analyses are likely to depend significantly both on the elasticity of foreign demand for Finnish exports and the elasticity of world savings supply.

The following sections and subsections deal in turn with the items in the above list.

7.1 Utility Function Parameters

The most important parameters are the elasticity of intertemporal substitution, α, the subjective rate of discount, δ, and the elasticity of substitution between consumption and leisure, ρ. Information on these parameters may be obtained from the various published econometric investigations of Finnish data (described below). To supplement this information, however, we carry out our own Euler equations estimations using annual Finnish macroeconomic data from 1960 to 1990. Our methodology follows that of Mankiw, Rotemberg, and Summers (1985). As in their study, we employ not just an Euler equation based on the first order condition for consumption decisions, but also an intertemporal first order condition in leisure consumption, and an intra-period first order condition linking marginal utilities of consumption and leisure. The equations employed in our estimations are then:

$$\frac{\partial u_{t+1}/\partial C_{t+1}}{\partial u_t/\partial C_t}\frac{P_t(1+r_t)}{P_{t+1}(1+\delta)} - 1 = \eta_{1,t} \quad (43)$$

$$\frac{\partial u_{t+1}/\partial L_{t+1}}{\partial u_t/\partial L_t}\frac{W_t(1+r_t)}{W_{t+1}(1+\delta)} - 1 = \eta_{2,t} \quad (44)$$

$$\frac{\partial u_t/\partial C_t}{\partial u_t/\partial L_t}\frac{W_t}{P_t} - 1 = \eta_{3,t} \quad (45)$$

As expectational errors, $\eta_{1,t}$ and $\eta_{2,t}$, should be orthogonal to any variables dated t or earlier. $\eta_{3,t}$ may be interpreted as a measurement error. Hence, all these error terms are unconditionally orthogonal to t-dated instruments. We apply Generalized Method of Moments (GMM) to these equations using a Newey-West weighting matrix in the GMM quadratic form.[13]

The results of our estimations were: (i) Subjective rate of discount (δ) 0.05 ; (ii) Leisure-consumption expenditure share parameter (α_0) 3.62 ; (iii) Consumption-leisure elasticity of substitution (ρ) 0.52 ; (iv) Intertemporal elasticity of substitution

[13]The data employed was as follows. Consumption (C_t) - final consumption expenditure of resident households on nondurable goods: food, beverages and tobacco, clothing and footwear, and gross rent, fuel and power. (Source: OECD. *National Accounts*). Leisure (L_t) - for this we take per capita income divided by the wage rate. Interest Rate (r_t) - yield of long-term government bond. (Source: OECD. *Historical Statistics*). Instruments - a constant and a de-meaned version of the per capita real consumption proxy.

(α) 0.66. Despite the short-comings of these estimates, they provide a useful supplement to evidence drawn from the various studies in the literature. We would expect our estimates to give a reasonable idea of the true underlying values although aggregation and other errors-in-variables problems probably bias the elasticities towards zero.

7.1.1 Intertemporal Substitution Elasticity and Discount Rates

We now turn to the evidence on utility function parameters provided by past empirical studies. Kostiainen and Starck (1990) estimate utility function parameters for a representative agent using aggregate quarterly Finnish data. They obtain values for α of between 0.2 and 0.3. Arguing that identification is otherwise difficult, they fix the subjective discount rate, δ in their estimations to 0.01.

Sullstrom and Riihela (1993) study household survey data for Finland. They deduce nominal consumption paths for different cohorts over the 1966-1990 period (see their Figure 2.a, page 11). Using these consumption profiles, for a given subjective rate of discount, it is possible to get a rough idea of the intertemporal elasticity of substitution. This calculation relies on the fact that with constant elasticities of intertemporal substitution and ignoring leisure, $\log(C_{t+1}/C_t) = \alpha(r - \delta)$. The average real interest rate over this period was 2.2%, while the real consumption growth rates over lifetime for the cohort aged 25 in 1966 was 1.32. For values of δ of -2, 0, and 2%, this implies elasticities of intertemporal substitution, α, of 0.31, 0.60 and 6.44.

The values of α and δ that we fixed upon were $\delta = 0.025$ and $\alpha = 0.90$. δ was decided by the model calibration procedure which selects certain parameters so that aggregate variables equal given data in the initial steady state. The value for δ of 2.5% nevertheless appears sensible. We chose an intertemporal substitution elasticity slightly higher than our estimate since it appears reasonably likely that aggregation effects bias the former downwards.[14]

[14]Uncorrelated measurement error in an independent variable yield a systematic bias towards zero in the parameter estimate in a univariate regression. Aggregation can yield quite complex measurement errors that are not necessarily uncorrelated with regressors, so this argument only

7.1.2 Consumption-Leisure Elasticity

As part of the parametrization of the general equilibrium model GEMFIN, Törmä and Rutherford (1993) estimate static CES utility functions. They use data from 1960 to 1985, employing hours as the time variable with a marginal tax rate of 0.499. The upper level of these functions corresponds to the intra-period allocation between consumption and leisure in our model. Torma and Rutherford obtain values for the equivalent in our model of ρ and α_0 of 1.001 and 0.331. In our model, we set the consumption-leisure elasticity of substitution, ρ, equal to 1.10. Again, this was somewhat higher than our own estimate but was in line with Törmä and Rutherford (1993). Again, we justify a higher elasticity by the fact that the errors in variables involved in aggregation are likely to bias the parameter estimate downwards.

7.1.3 Tradeables Versus Non-Tradeables

Total consumption in our model, C_t, may be regarded as a constant elasticity of substitution composite of tradeables and non-tradeables. To deduce a value for the substitution elasticity, we worked out the cross-price demand elasticities of aggregates of goods which could be regarded as reasonable proxies for tradeables and non-tradeables. Suoniemi (1993) gives the compensated price elasticities for eight categories of consumer goods. As proxies for nontradable goods, we take medical and health care, and recreational services and education, while we use the remaining six spending groups as a proxy for tradable goods. Cross-price elasticities of non-tradable with respect to tradable are then weighted and averaged to calculate the elasticity between tradable and nontradable goods. This yielded a value for the latter of -0.1. The elasticity of substitution, ρ_1, was then set to 1.20, a value which implies a demand elasticity of the order of -0.1.

provides a rough guide as to the direction of bias.

7.2 Production Function Parameters

7.2.1 Substitution Elasticities

Abstracting from adjustment costs, the production functions assumed in our model are CES functions of the form given in (9). Estimates of CES production functions have been carried out on Finnish industry data again as part of the parametrization of the general equilibrium model GEMFIN. Using data from 1960 to 1985, Törmä and Rutherford (1993) regress log output-labour input ratios on real wages for nineteen industries. The slope parameter on real wages in these regressions is an estimate of the substitution elasticity while, for the ith industry, the constant equals $\epsilon_i \log(1/(1-\epsilon_{i0}))$. We take the average of the regression parameter estimates for two groups - ten industries whose output can plausibly be regarded as exportable and nine industries producing non-tradeables - and then invert to obtain the production function parameters. For exportable and non-tradeables industries, $(\epsilon_i, \epsilon_{i0})$ are then $(0.92, 0.63)$ and $(0.71, 0.91)$ respectively.

7.2.2 Adjustment Cost Parameters

Firms are assumed to face convex costs of adjusting their capital inputs as in equation (10). Lacking direct information on adjustment costs in Finnish industry, we set the adjustment parameters, ξ and κ, equal to 20 and 0.05 respectively, values in line with those assumed by Auerbach and Kotlikoff (1987) in their study of the United States economy.

7.2.3 Depreciation Rates and Capital-Output Ratios

Estimates of depreciation rates for Finland may be found in Keese, Salou, and Richardson (1991). For structures, these authors suggest rates of 2.4% in the 1960s and 1970s and 2.5% in the 1980s, while for plant and equipment, they estimate figures of 7.1, in the 1960s and 6.7 in the 1970s and 1980s. These depreciation rates are low for structures compared to the US and Japan, but much higher than in Germany and

Sweden. For plant and machinery, the rates are high by international standards, with only Japan having higher rates out of the ten countries for which Keese et al. supply estimates. In our model, we take the depreciation rate to be 5% per annum which translates into $d = 0.75$ in our parametrisation with five year periods.

Keese, Salou, and Richardson (1991) also give business sector capital output ratios for OECD countries. The Finnish figures are unusual in that there is no upward trend in the 1960 to 1988 period. Although the ratio was slightly higher in the 1980s (at 3.4), in 1960 and in 1988 the ratio was the same (3.2). These ratios were more or less in line with those of other countries in the latter year but the ratios in these other countries had risen considerably in the period since the 1960s. In our model, we assume a capital output ratio of 3.

7.3 Tax Rates

7.3.1 Household Income Taxation

Under the Finnish income tax system, married couples are taxed separately on their earned and unearned income, although the fact of being married affects an individual's allowances. In addition, earned income is subject to a municipal tax that varied between 14.5% and 20.0% and averaged 17.7% in 1993. The municipal tax is levied at flat rates and is assessed on the same base as the state income tax. Members of the State Churches (87% of the population) pay a special church tax. Again, this is assessed on the same base as the income tax and the weighted average rate across the population is 1.3%. Total marginal tax rates on earned income drifted up smoothly from about 29% in 1960 to 50% in the mid-1970s. Since then, they have remained flat, generally just under 50%.

Capital income including interest income, dividends, rents and capital gains are taxed at a flat rate of 25% separately from earned income. Deficits in capital income may be carried forward for up to 10 years. Capital losses may be off-set only against other capital gains and may be carried forward up to 3 years. Savings are also taxed through the net wealth tax levied on net wealth over Fmk 1.1 million. A basic tax of

Fmk 500 is paid plus 0.9% of any amount in excess of the threshold. Married couples have a deduction of Fmk 50,000 which applies to the aggregate property of married couples. Wealth tax is not deductible against income tax.

The gift and inheritance tax is levied at rates that depend on the closeness of the relation with the giver. Gifts of less than Fmk 15,000 every two years are tax exempt. Mortgage interest is deductible from capital income. When it exceeds capital income, 25% of the excess may be deducted from taxes on earned income subject to a ceiling that increases with household size.[15]

7.3.2 Capital and Corporate Taxation

In the past, personal and corporate income taxes were integrated so that the rate paid on distributed corporate income was each individual's marginal income tax rate. Earned and unearned income were effectively included in the same tax base. In 1992, the tax rates for individuals varied from 0 to 63%. The threshold for the highest rate was relatively low at Fmk 275,000. These rates were so high that various forms of capital income had been granted deductions and exemptions. The result was a system that was far from neutral in its impact on different forms of capital income.

This system was replaced as part of a major tax reform implemented in January, 1993.[16] The reform was to some extent the result of tax competition between Finland and its neighbours. Sweden initiated a round of savings tax reductions by reducing its rates to 30% and Norway followed suit, cutting rates to 28%. The 1993 reform in Finland, which was intended to be revenue-neutral, followed a more modest reform in 1989-90 which had somewhat broadened the corporate income tax base and lowered rates.

Under the new system, individual income is classified separately as earned or capital income. Capital income is subject to a flat rate tax of 25% while earned income continues to be subject to a steeply progressive income tax. Capital income is

[15]Fmk 8,000 for an individual, Fmk 16,000 for couples, Fmk 18,000 for couples with a single child, Fmk 20,000 for couples with two or more children.

[16]See Tikka (1993). For a description of the system just prior to the reform, see OECD (1991).

defined here as a broad category including any yield on capital assets including interest income, dividends, rents, capital gains and some agricultural income. Expenses to acquire income are allocated to capital or earned income separately and debt interest deductions are at the flat rate on capital income. Capital income is not subject to municipal or church taxes.

The corporate tax rate is also 25% and an imputation system ensures that there is no double taxation of dividends. The imputation system is relatively recent, having been introduced in 1990. Under the pre-1993 system, corporations paid a state tax of 19% and a municipal tax of 17%, resulting in a total corporate tax rate of 36%.

7.3.3 Goods Taxes

Partly to further harmonization with Europe given its approaching entry into the EC, Finland began preparations to replace its system of turnover taxes with a VAT in 1994.[17] The switch will not be as significant as one might think since the Finnish turnover tax allowed firms to deduct part of the taxes paid at earlier stages of the production process. Nevertheless, limits on these deduction meant that the cascading problems typical of turnover taxes, leading to high effective taxes on goods produced by non-vertically integrated industries, were to some extent present.

The general rate for the new VAT is 22%,[18] the same as that of the turnover tax it replaces. All goods and services are taxable unless specifically excluded. Exclusions are granted for medical and health services, social welfare services, banking, insurance, education, property sales and most significantly perhaps given the scale of this industry in the Finnish economy, agriculture and forestry.

A fair number of industries that were in the past free of turnover taxes are to be included in the base for the new VAT so the sectoral impact may be considerable. A few goods are subject to a lower rate than the standard 22%. Personal transport, accomodation, films, books and medicines are taxed at 12%. The overall impact of

[17]See Viherkenttä (1993) for a fuller discussion of the VAT reform.

[18]Though high by international standards, this may be compared with the rates of 25% in Denmark and Sweden.

the reform is intended to be revenue neutral, with the effect of the wider tax base being offset by the greater deductions available for tax paid higher up the production process.

Excise taxes are fairly important in Finland, contributing 14% of total state tax revenue in 1990.[19] The major items subject to excise taxes are tobacco, beer, alcoholic beverages, fuels and some foods.

7.4 Government Expenditures

7.4.1 Social Expenditures

Social expenditure as a percentage of GDP is somewhat less in Finland than in other Nordic countries and roughly in line with the levels in France and West Germany.[20] Sickness insurance and unemployment benefit schemes reached their current levels of provision only recently, with significant extensions of the system being introduced as late as the 1970s and 1980s.[21] Social expenditure as a percentage of GDP rose from 7% in 1960 to over 22% in the mid-1980s.

The ratio of total government expenditures to GDP increased from 26 per cent in 1960 to more than 46 per cent in 1990. The trend increase in the ratio over this period implied a value of 1.40 for the income elasticity of demand for public goods. This is consistent with Wagner's Law, the proposition that the public sector will expand in relation to the economy as a whole due to the high positive income elasticity of the demand for government services.

Other factors such as industrialisation, modernisation and urbanisation, also play important roles in determining the growth of public expenditures. In Table 2, we report estimated elasticities of public expenditure and its components with respect to on GDP. We also report elasticities obtained from regression equations that include

[19]See Ministry of Finance (1992) p. 70.
[20]See Parkkinen (1989).
[21]See Andersson, Kosonen, and Vartiainen (1993).

Table 2: Income elasticities of various government expenditure catogories

	Single variable case		Multi variable case	
Variable	Elasticity	t-ratios	Elasticity	t-ratios
Health expenditure	1.52	(6.51)	2.15	(4.47)
Education expenditure	0.66	(2.83)	0.28	(0.74)
Social services	1.23	(4.03)	0.28	(0.58)
Transfer expenditure	1.14	(6.95)	0.46	(1.80)
Public consumption	1.07	(4.25)	0.77	(1.69)
Current expenditure	1.17	(7.76)	0.69	(2.91)
Total expenditure	1.05	(6.60)	0.40	(2.11)

proxies for the additional factors listed above. The proxies include the unemployment rate, ratio of unproductive part of population to total population, deficit finance of government spending, and ratio of urban population to total population.

In the simple model without the extra explanatory variables, elasticities with respect to GDP of different government expenditures are in the range 0.7 to 1.5. When we include additional explanatory variables, we generally obtain lower values for income elasticity, although the health expenditure elasticity is, in fact, even higher. A study by the OECD (see OECD (1989)) estimates income elasticities of public consumption and public transfers comparable to ours. For example, they estimate income elasticities of public consumption and transfers to be 1.14 and 0.87.

7.4.2 Projecting Social Expenditures

In assessing the impact of population shocks on intergenerational distribution, it is important to take account of the implied dynamics of government expenditures. Households at different points in the life-cycle benefit to differing degrees from different categories of expenditure and so demographic shocks imply complicated but predictable fluctuations in government spending. For a study of the impacts on government expenditures on a group of major countries (although not including Finland), see Heller, Hemming, and Kohnert (1986).

The approach we take in preparing our projections is as follows:

1. Assume a trend GDP growth rate over the period (1.5% per annum) and use the elasticities given in Table 2 to calculate time paths for expenditure categories under the assumption of unchanged population.
2. Use the 1990 cross-sectional pattern of government expenditures by age to work out what additional expenditure growth should occur given that the population follows the forecast path described in Section 4.1.1 above.

According to our calculations, health expenditure will increase very substantially. Education and social spending will also be affected in proportional terms although the starting base is somewhat lower than for health expenditures.

7.5 Labour Income Profiles

The lifetime profile of wages for a given individual reflects several factors including aggregate productivity and GDP developments, increases in the individual's own productivity due to increases in experience, and seniority premia given by firms to older workers as part of implicit labour market contracts. We shall abstract from the last of these factors and assume that an individual's real wage reflects only his or her marginal productivity.

The age-wage-income profiles employed in the model were based on profiles calculated by VATT staff on the basis of Statistics Finland data from 1977 to 1991 on income distribution and employment. The method used is similar to that employed by Pehkonen and Viren (1992), and consists of regressing wage income on non-linear functions of age multiplied by GDP levels.

7.6 Export Demand and Savings Supply Elasticities

The structure of Finnish output has changed markedly since the 1960s. While the proportion of manufacturing output in value added has stayed flat at around 28%, the share of agricultural and forestry has declined from 21% to 8%. Nevertheless, the latter still makes up quite a large share of Finnish exports. Together with the fact that Finland is a small, quite open economy, the high proportion of its exports made up of primary products suggests that the price elasticity of demand for Finnish exports will be very high. Savings supply elasticities are also likely to be large. The recent surge in borrowing abroad by Finnish corporations after the relaxation of constraints in such activities underlines this point.

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Figure 1: Income Testing of Benefits

Figure 2: Average Large Employer's Contributions

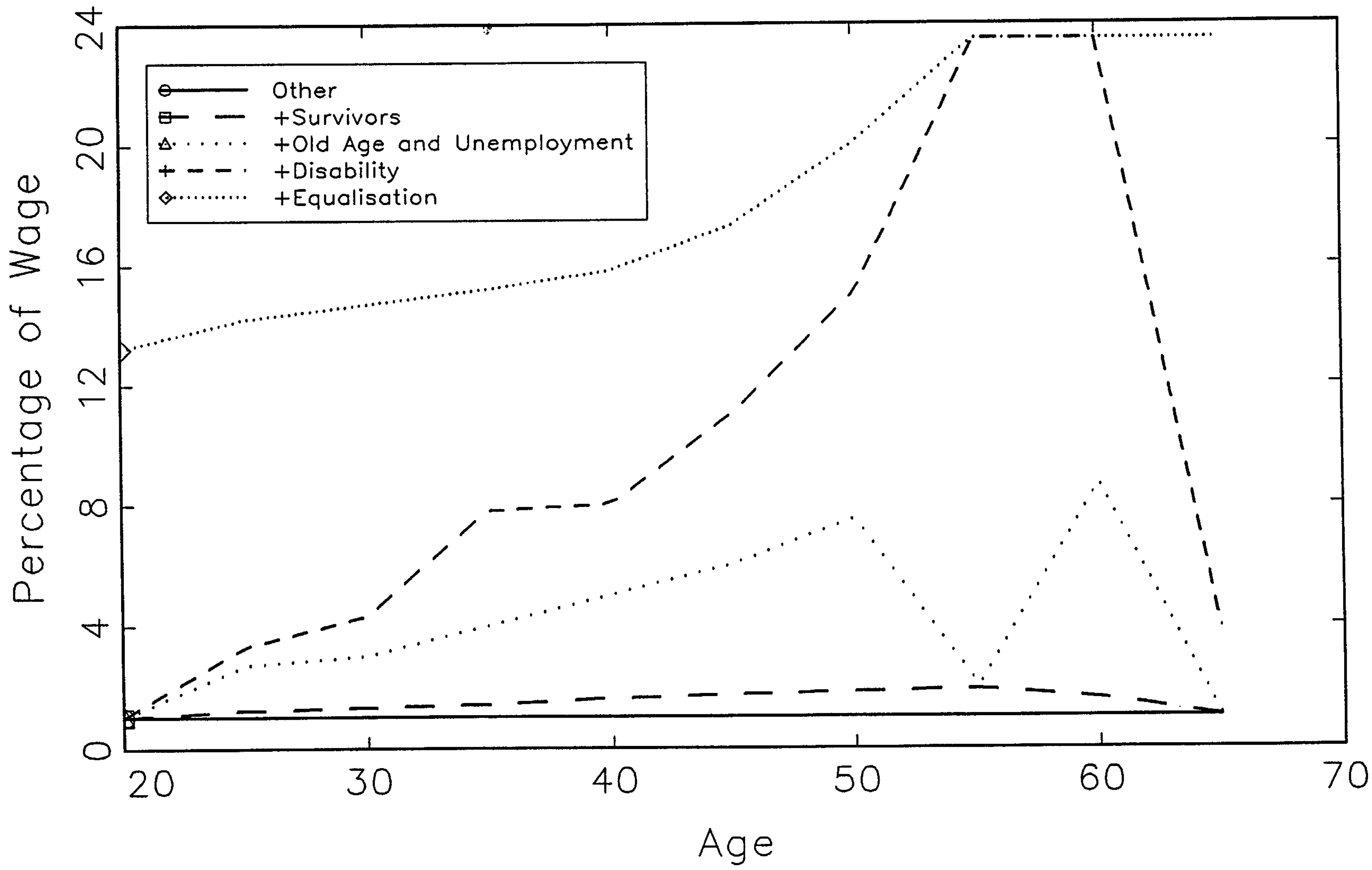

Figure 3: FERTILITY SHOCKS

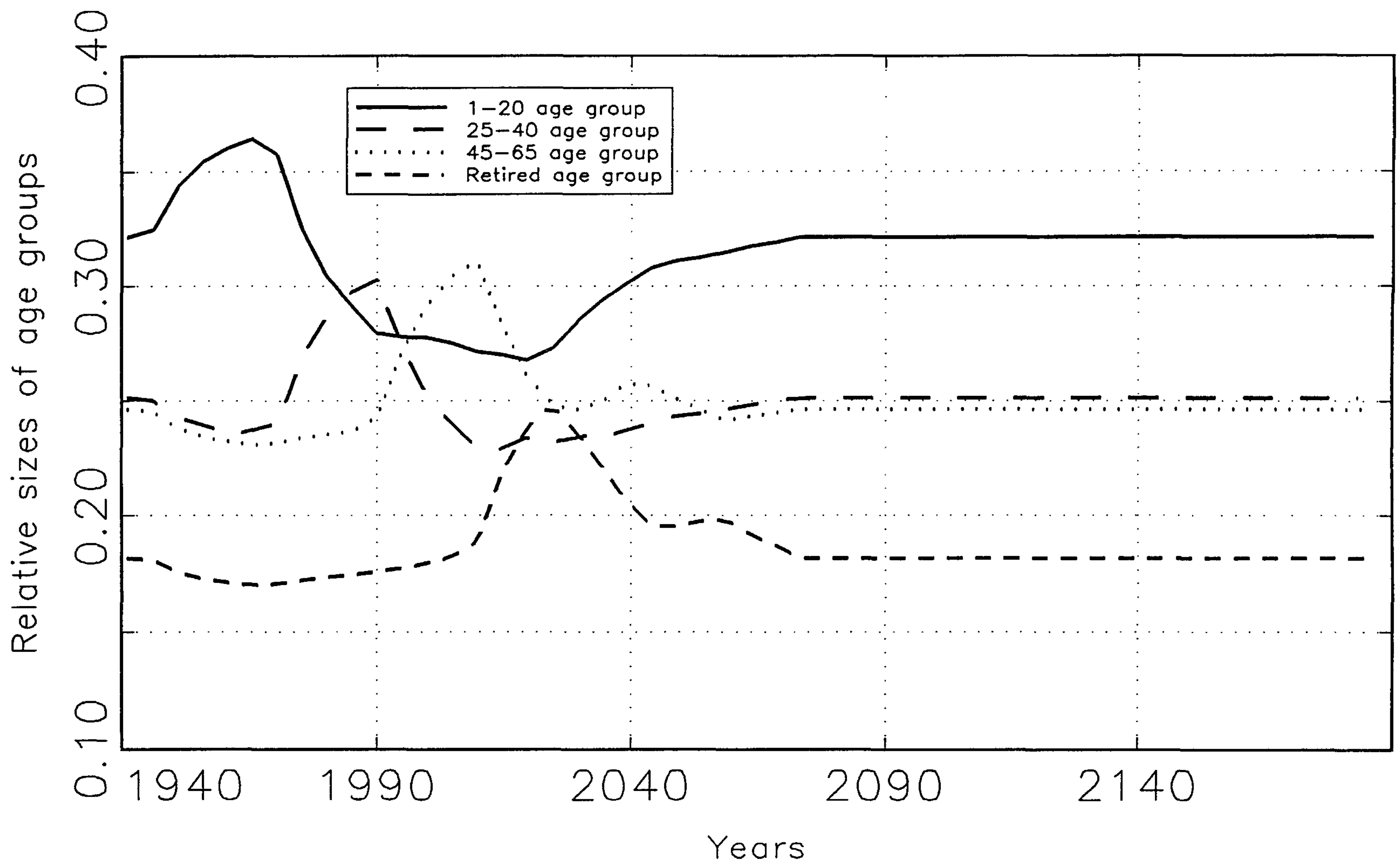

Figure 4: CAPITAL ACCUMULATION EFFECTS.

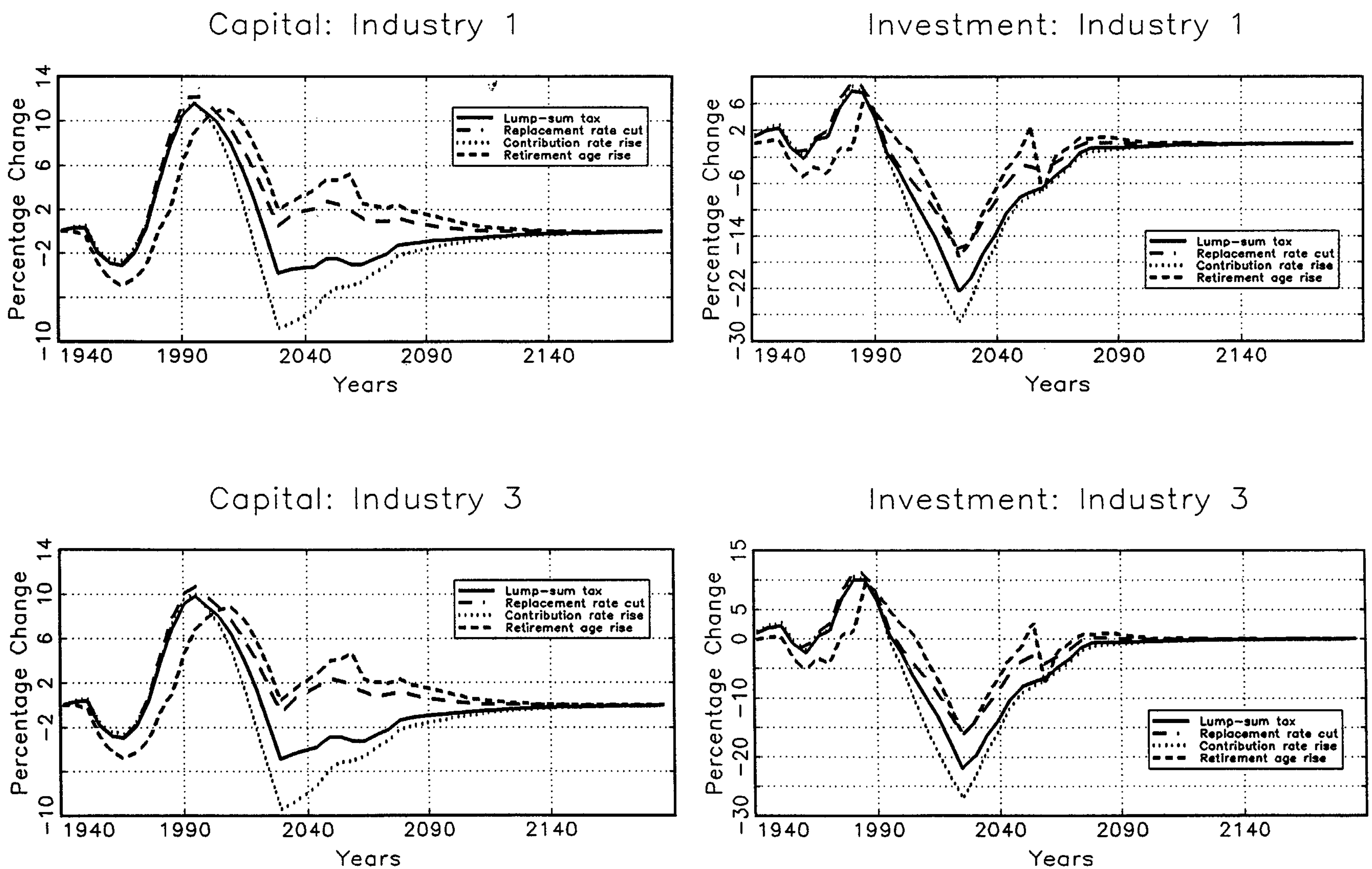

Figure 5: MACROECONOMIC EFFECTS.

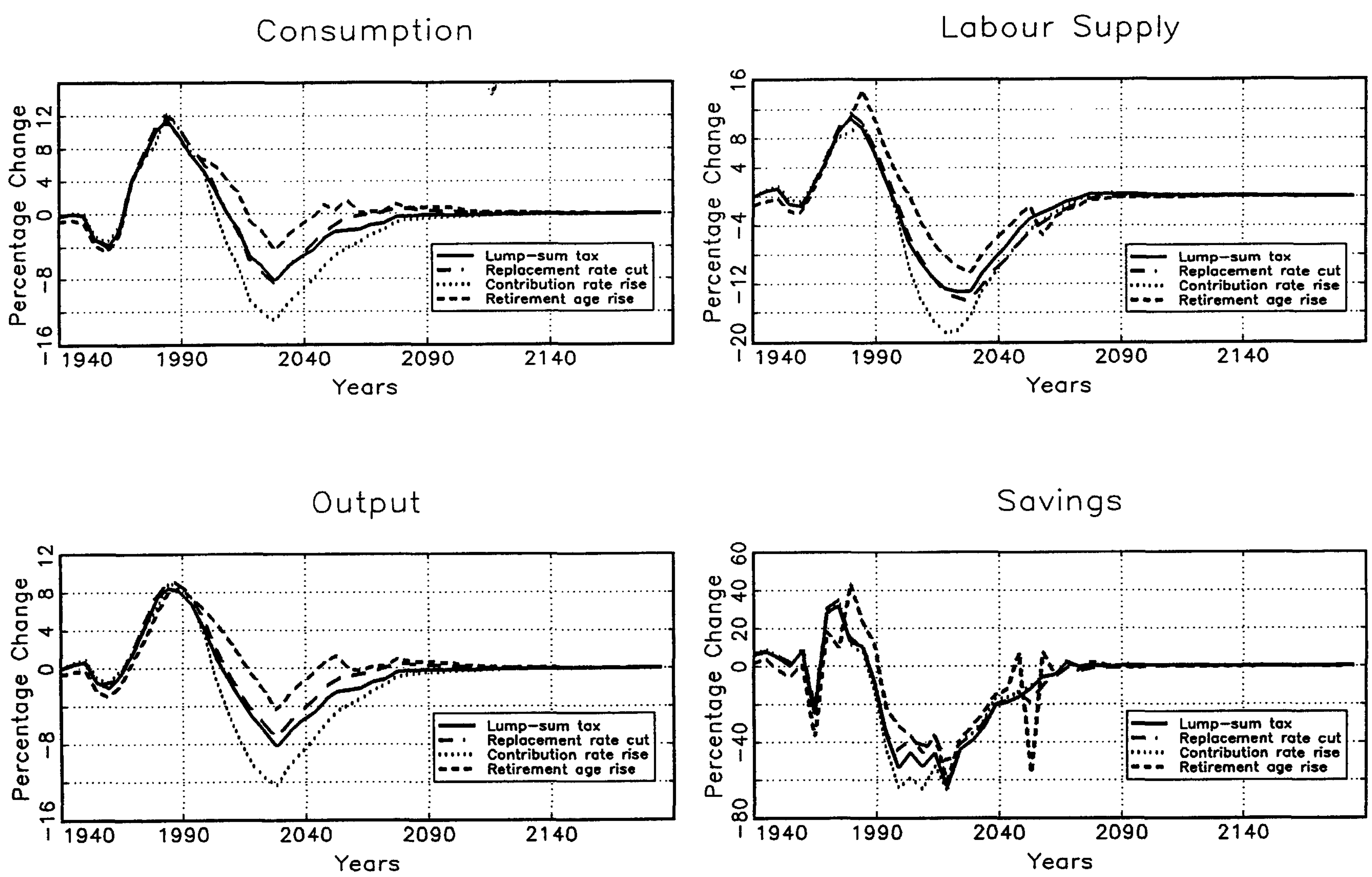

Figure 6: PRICE EFFECTS.

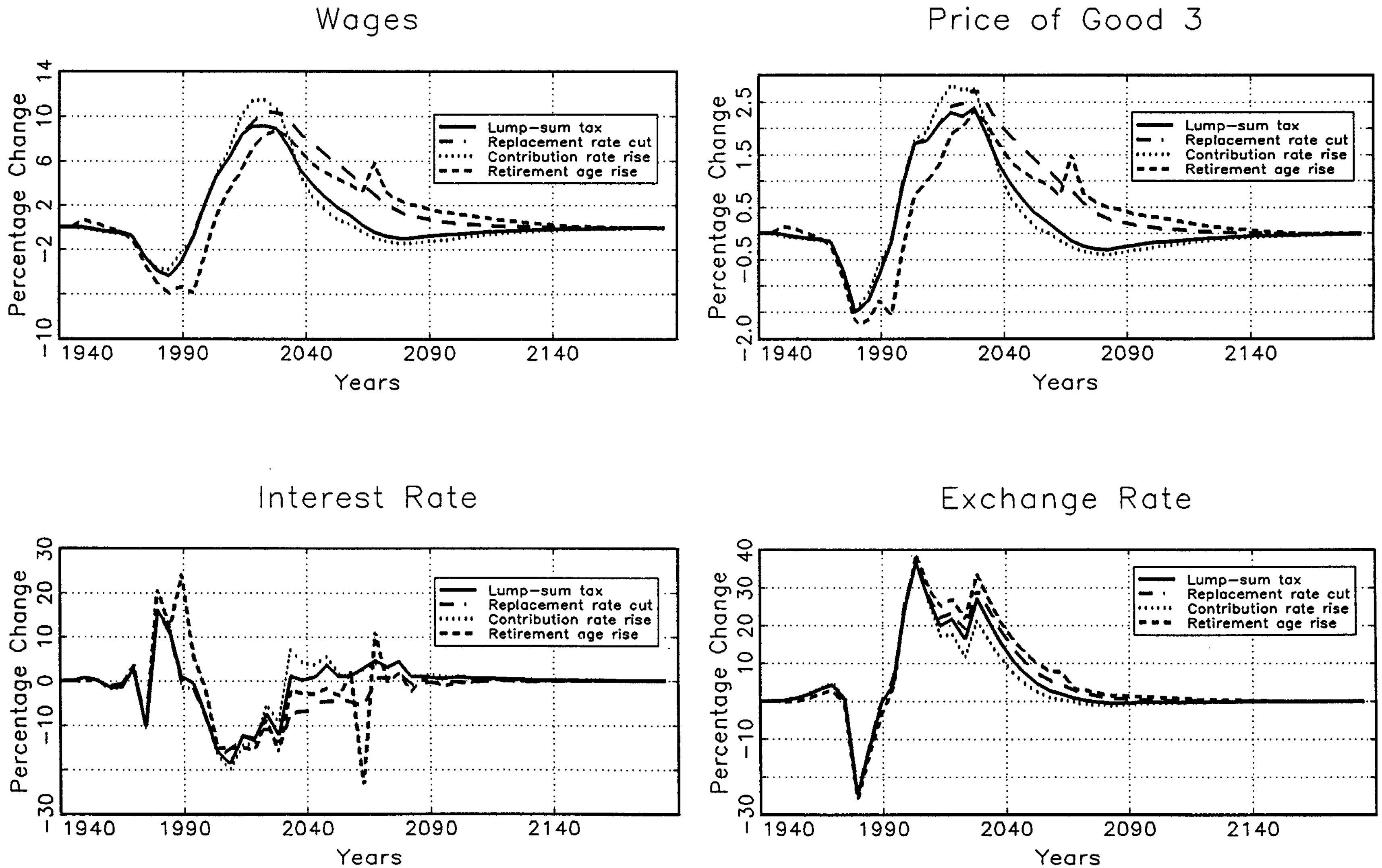

Figure 7: REVENUE AND EXPENDITURE EFFECTS.

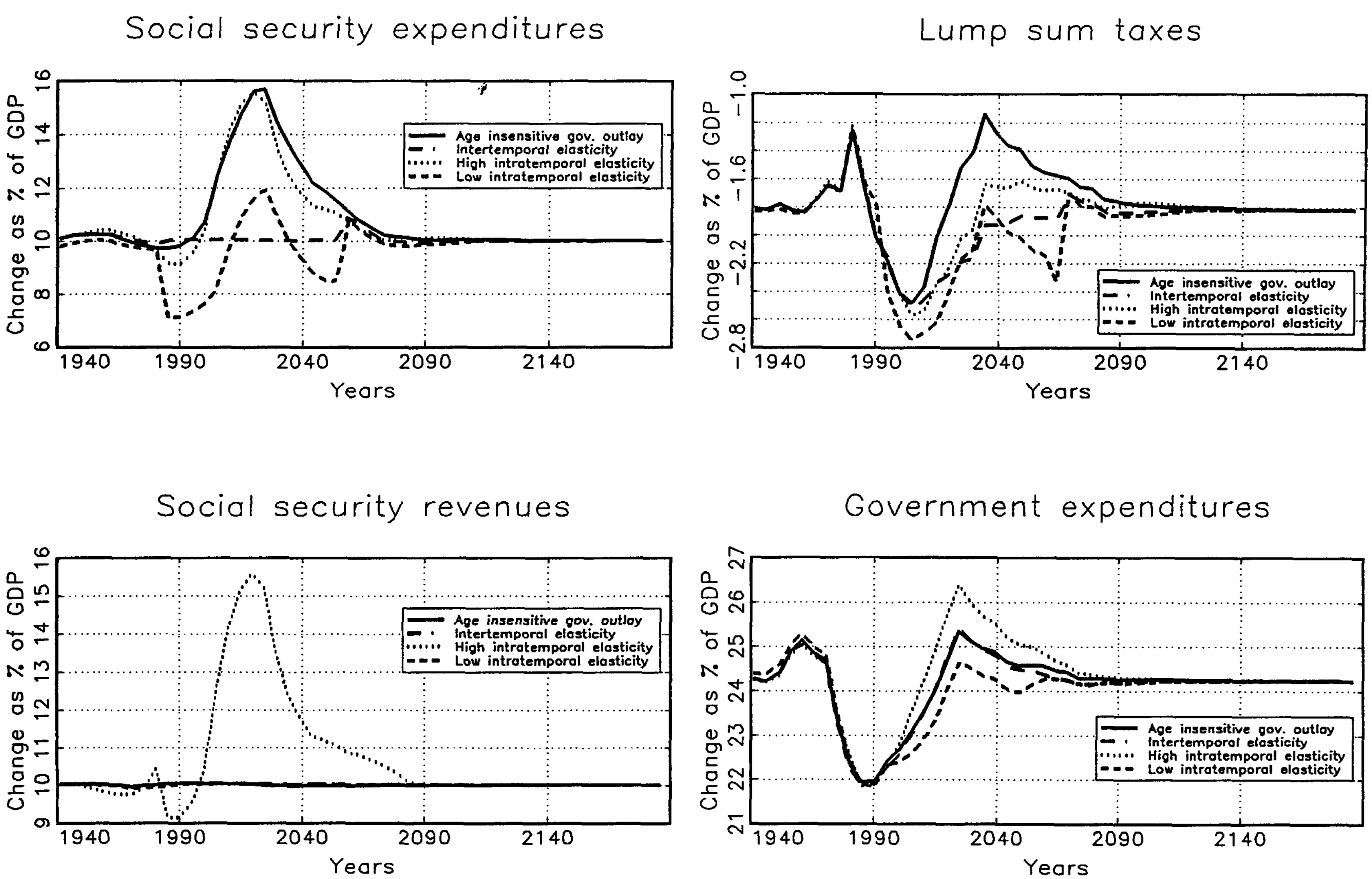

Figure 8: EQUIVALENT VARIATIONS