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## Tax reform, welfare and intergenerational redistribution

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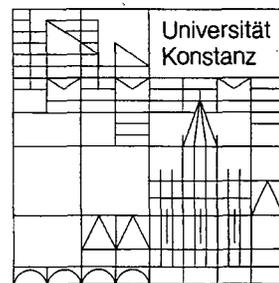
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**Sonderforschungsbereich 178  
„Internationalisierung der Wirtschaft“**

Diskussionsbeiträge



Juristische  
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# TAX REFORM, WELFARE, AND INTER- GENERATIONAL REDISTRIBUTION

- AN INTERTEMPORAL SIMULATION APPROACH

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*Abstract.* This paper analyses the effects of cuts in the marginal tax rates on income from labour and capital on the macroeconomy and on the intergenerational distribution of welfare in a small open economy. For this purpose we set up a computable general equilibrium model incorporating overlapping generations, imperfect competition in the labour market, accumulation of housing and business capital, and a public pension system. We find that a revenue-neutral cut in the marginal labour tax rate yields a Pareto-improvement, whereas a fall in the capital income tax rate tends to benefit the current older generations as well as future generations at the expense of generations entering the economy in the years around the time of the reform. However, by pre-announcing the cut in the capital income tax rate, the welfare losses for the young generations can be almost eliminated.

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## 1. Introduction.

The last few years have witnessed a growing public concern about the distribution of welfare across different generations. This concern is motivated by a number of developments which are likely to have a significant impact on intergenerational distribution: increasing stocks of public debt in many countries; a projected degradation of the natural environment due to past and present economic activities; an aging population imposing increasing strain on existing social security systems; and recent experience with highly volatile prices of assets which are unevenly distributed across generations. In several OECD countries, the wave of tax reforms in the 1980's and early 1990's seems to have contributed to the fluctuations in asset prices, including the prices of owner-occupied houses and other real estate.

Against this background, this paper presents a computable general equilibrium (CGE) model which is designed so as to be able to highlight the intergenerational redistribution effects of various fiscal policies. The model is used to illustrate the effects of tax reforms involving cuts in the marginal tax rates on income from labour and capital, and to illuminate the differences between the effects of anticipated and unanticipated tax reforms. Our main findings are that a revenue-neutral cut in marginal tax rates on labour income seems capable of generating a Pareto-improvement, whereas a cut in the tax rate on capital income tends to benefit the middle-aged and the old generations as well as future generations at the expense of the current young generations, even though the negative impact on the latter can be almost neutralized by announcing the capital income tax cut well in advance.

Our analytical framework is an open economy version of the overlapping generations (OLG) model with finite horizons ad modum Blanchard (1985). Compared to existing CGE models based on an intertemporal approach<sup>1</sup>, our model contains three extensions. First, we explicitly incorporate investment in owner-occupied housing as part of the consumer's overall optimiza-

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<sup>1</sup>See, for example, Bovenberg and Goulder (1990 and 1993), Goulder and Summers (1989), Jorgenson and Yun (1986a and 1986b), Persson and Svensson (1987) and Söderlind (1990).

tion problem. Second, to allow for a life-cycle motive for private saving, we extend the Blanchard model by distinguishing between workers and pensioners, assuming that individuals have to retire from the labour market at some exogenous age dictated by the social security system<sup>2</sup>. Third, we embed in our OLG framework an element of imperfect competition in the labour market, along the lines originally suggested by Blanchard and Kiyotaki (1987). Each household is assumed to possess a specific skill, and the total supply of labour with this skill is completely monopolized by a union. This craft union dictates a wage rate with the objective of maximizing the welfare of the representative union member, subject to the labour demand schedule of employers. The resulting equilibrium wage level turns out to imply a certain amount of underemployment, i.e. the model produces a form of "classical" unemployment<sup>3</sup>.

The paper is structured as follows. Section 2 describes the major building blocks of the model. In section 3 we explain how the model and the instruments of tax policy have been calibrated to provide a stylized picture of the Danish economy around 1990. As a background to our welfare analysis, section 4 then presents some simulated macroeconomic effects of two tax reform experiments, while section 5 analyses the effects of these reforms on the level and intergenerational distribution of consumer welfare. Finally, section 6 sums up and points out some topics for future research.

## 2. Model structure<sup>4</sup>.

The model presented below solves for a full intertemporal equilibrium in which a private sector endowed with forward-looking rational expectations maximizes intertemporal objective functions. Since the model is determi-

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<sup>2</sup>This extension makes it possible to study the effects of a social security reform involving a change in the official retirement age; see Nielsen (1993).

<sup>3</sup>Our model is most closely related to the recent inspiring contribution by Bovenberg (1993). In contrast to Bovenberg, we do not allow for foreign ownership of part of the domestic physical capital stock; on the other hand, we extend his analysis by incorporating a household durable (housing), a life cycle motive for saving, imperfect competition in the labour market, and imported intermediate inputs.

<sup>4</sup>The model is in a constant state of development. Jensen et alia (1993) provide a more detailed overview of the current version of the model on which this paper is based.

nistic, agents essentially have perfect foresight, except for situations where unanticipated shocks such as unforeseen policy changes hit the economy.

There is no monetary sector in the model. The domestic market for interest-bearing financial assets is perfectly integrated with the global capital market. This means that domestic investment is not constrained to equal domestic savings. Exchange rates are assumed to be fixed (vis-à-vis important trading partners), and the taxation of interest income is based on the residence principle, so the domestic rate of interest before tax is tied to the exogenous foreign pre-tax interest rate<sup>5</sup>.

While financial capital is perfectly mobile, labour is assumed to be completely immobile internationally. In between these extremes, physical capital is imperfectly mobile, since firms have to incur installation costs in order to build up or scale down their stocks of physical assets, implying that physical capital cannot be instantaneously relocated across borders.

All variables are measured in units of a foreign tradable good which is used as a numeraire throughout. Finally, the model is specified in discrete time.

### *2.1. The production sector*

The production sector comprises two separate industries: a "manufacturing" sector producing a tradable good, and a "construction" sector producing a non-tradable good (housing units). Gross output in both sectors is a CES-function of an imported intermediate input and of a Cobb-Douglas aggregate of capital and labour, with the CD-aggregate representing domestic value-added. Factor input demands are derived from intertemporal optimization by competitive firms. Output from the manufacturing sector is used for domestic private and public consumption, for exports, and for physical investment in both production sectors. Domestic manufacturing output is an imperfect substitute for imported non-durable goods, so its relative price - henceforth denoted the terms of trade - is determined en-

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<sup>5</sup>These assumptions approximate the situation in Denmark, where there are no restrictions on international flows of financial capital, where the exchange rate is fixed vis-à-vis the partners in the European Monetary System, and where the level of interest rates tends to follow the German level very closely.

dogenously. Output from the construction sector consists of new housing units serving to meet the demand for housing from domestic residents.

Output in both sectors is produced by a large number of identical firms assumed to be organized as joint stock companies. Business investment is financed by an (exogenous) combination of debt and equity, with equity finance taking the form of retained profits<sup>6</sup>. In the process of installing new capital goods, firms incur installation costs which are modelled as a subtraction from marketable net output. Assuming that firms strive to maximize the market value of their outstanding shares and that shares are perfect substitutes for bonds in household portfolios, we obtain business investment demand schedules which embody a version of Tobin's "Q-theory" according to which changes in the market value of the (marginal unit of the) capital stock relative to its replacement value cause a gradual adjustment of the capital stock to a new steady state level.

The solution to the firm's intertemporal optimization problem also yields demand schedules for imported intermediate inputs and for aggregate labour input. We abstract from any possible costs of adjusting the level of employment, assuming that firms can costlessly hire and fire labour. The total labour force is assumed to be divided into a large number (say  $m$ ) of different categories, each representing a specific skill. The different labour skills are imperfect substitutes in the production technology of the firm, and aggregate labour input  $L$  at time  $t$  is defined by the following CES aggregate

$$L_t = (m^{1/(1-E)}) \left( \sum_{i=1}^m (n_t^i)^{(E-1)/E} \right)^{E/(E-1)}, \quad E > 1 \quad (1)$$

where  $n^i$  is aggregate demand for labour with skill  $i$ , and  $E$  is the (constant) elasticity of substitution between any two different skills of labour. The minimum cost allocation of a given amount of total labour input  $L$  among the different skill categories can be shown to yield the following optimal

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<sup>6</sup>We thus abstract from new share issues as a marginal source of finance, since new issues are quantitatively unimportant in Denmark.

demand for labour of skill  $i$ ,

$$n_t^i = \left( \frac{w_t^i}{W_t} \right)^{-E} \frac{L_t}{m} \quad \forall i; \quad W_t = \left( \frac{1}{m} \sum_{i=1}^m (w_t^i)^{(1-E)} \right)^{1/(1-E)} \quad (2)$$

where  $w^i$  is the wage rate of labour of skill  $i$ , and  $W$  is an index of the general wage level. The firm optimizes its labour demand by first optimizing the level of aggregate labour input in accordance with the standard marginal productivity condition (taking  $W$  as the price of "aggregate" labour), and then allocating this aggregate labour input across the different skills in accordance with the cost-minimization rule (2).

## 2.2. The household sector

The household sector comprises an infinite number of overlapping generations which are divided into workers and pensioners. The relative size of the two groups is determined by an exogenous retirement age (dictated by the social security system) indicating when an individual changes status from worker to pensioner. The explicit incorporation of a retirement period serves to introduce a life-cycle motive for saving in the model. Despite our distinction between young and old, we retain Blanchard's (1985) simplifying assumption that the probability to survive into the next period is age-independent<sup>7</sup>. Hence the expected remaining lifetime of each generation is the same. We also assume that the birth rate and the death probability are identical, implying a stationary population.

An individual household derives utility from a consumption aggregate  $c$  (to be explained below) and incurs disutility  $f(n^*)$  from its individual work effort  $n^*$ <sup>8</sup>. The household strives to maximize its expected discounted lifetime utility which at time  $t$  is equal to

$$U_t = \sum_{s=t}^{\infty} \left( \frac{1-\rho}{1+\theta} \right)^{(s-t)} \frac{1}{1-\nu} (c_s - f(n_s^*))^{(1-\nu)} \quad (3)$$

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<sup>7</sup>This simplifies our aggregation procedure considerably. An example of a Blanchard-type model with age-independent mortality is provided by Jensen and Nielsen (1993).

<sup>8</sup>In the following, we do not index consumers according to their skill levels, since this will turn out to be superfluous, due to a symmetry assumption introduced in the next section.

where  $\rho$  is the death probability,  $\theta$  is the time preference rate, and  $\nu$  is the intertemporal elasticity of substitution.

In the absence of an operative bequest motive, each consumer engages in a deal with a competitive life insurance company which agrees to pay a return on the sum of the consumer's financial and housing wealth on the condition that it may take over this wealth when the consumer dies. When the premium paid by insurance companies equals  $1/(1 - \rho)$  times the stock of wealth of those consumers who survive into the next period, profits in the insurance industry will be zero. Hence, with  $r$  denoting the interest rate, and  $t^r$  indicating the capital income tax rate, the dynamic budget identity facing the individual consumer in period  $t$  will be

$$(a_t + P_t^h h_t) = \left( \frac{1 + r_t(1 - t_t^r)}{1 - \rho} \right) (a_{t-1} + P_{t-1}^h h_{t-1}) + y_t - c_t \quad (4)$$

where  $a$  is the stock of financial wealth,  $P^h$  is the price of housing units,  $h$  is the physical housing stock (so  $P^h h$  is the value of the consumer's housing stock), and  $y$  is non-capital income. In specifying  $y$ , we have to distinguish between the non-capital income earned by a worker,  $y^w$ , and non-capital income accruing to a pensioner,  $y^p$ :

$$y_t^w = (1 - t_t^l)[w_t n_t^* + v_t(N - n_t^*)] + t_t^l d_t + \tau_t \quad (5)$$

$$y_t^p = b_t + \tau_t \quad (6)$$

Equation (5) defines non-capital income for individuals belonging to the labour force. The first term on the RHS is labour income,  $wn^*$ , while the second term represents unemployment benefits, as given by the benefit rate,  $v$ , times the difference between the exogenous "maximum" individual labour supply,  $N$ , and the actual amount of hours worked. Both of these income components, net of deductions  $d$ , are taxed at the rate  $t^l$ . Households also receive a lump-sum transfer,  $\tau$ , which is the same across all generations. Equation (6) includes the pension benefit,  $b$ , which is provided to pensioners on top of the general transfer. Note that neither  $\tau$  nor  $b$  is subject to taxation. Note also that employment,  $n^*$ , is exogenous to the individual consumer, since it is determined by the wage setting behaviour of unions.

Maximization of expected lifetime utility (3), subject to (4) through (6) plus the wellknown "no-Ponzi-game" condition, can be shown to yield the following individual consumption function

$$x_t = \frac{1 + r_t(1 - t_t^r)}{\Delta(1 - \rho)} [a_{t-1} + P_{t-1}^h h_{t-1} + H_{t-1}], \quad x_t \equiv P_t(c_t - f(n_t^*)) \quad (7)$$

where  $P$  is a general consumer price index (so that  $x$  is the value of total consumption net of the psychic costs of work effort), and  $H$  is the consumer's stock of human capital, defined as the present value of future non-capital income. Equation (7) thus says that "net" consumption during any period is determined by the consumer's total human and non-human wealth at the beginning of the period. The propensity to consume out of wealth depends on the proportionality factor  $\Delta$  which in turn can be shown to be a function of the after-tax interest rate, the time preference rate, the death probability, the intertemporal substitution elasticity, and the expected evolution of the consumer price index.

Once the consumer has optimized the time path of his total consumption in accordance with (7), he further optimizes the allocation of total consumption in each period between consumption of durables services and non-durables and between foreign and domestic non-durables. The validity of this three-stage optimization procedure is guaranteed by our assumption of homothetic sub-utility functions. More specifically, we have assumed that total consumption  $c$  consists of a Cobb-Douglas aggregate of non-durables and the services of durables (housing), and that non-durables consist of a CES aggregate of foreign and domestic goods.

With individual consumption of the different goods being determined in this way, it is possible to derive aggregate consumption functions (including an aggregate demand for new housing), given our assumptions about the overlapping generations structure, including the assumptions of a constant death rate and a constant retirement age.

### *2.3. The labour market*

The labour market is assumed to be unionized, with the number of unions being equal to the number of specific labour skills, and workers being or-

ganized according to their skilltype. While the labour market is thus characterized by monopolistic supply, there are no employers' associations, so the demand side is competitive. Unions may therefore dictate their wage rates to employers, subject to the labour demand curves for each individual skill. By choosing a wage rate, the union implicitly determines the overall level of employment for its members, and this amount of total employment is equally shared among all members<sup>9</sup>.

Each union sets its wage rate with the aim of maximizing the expected lifetime utility of its representative member. Individual union members take the resulting wage rate and employment level and the resulting stock of human capital as given, and on this basis they optimize their individual consumption and housing decisions.

All unions have the same size. This assumption eliminates aggregation problems by allowing for symmetric equilibria. Furthermore, each union has a negligible influence on the aggregate wage level and a similar negligible influence on the aggregate employment level. This simplifies the dynamic effects considerably, since it eliminates any effects of the individual union's wage claim on aggregate investment and hence on the future path of the general level of real wages.

Formally, the problem for the union for workers with skill  $i$  is to maximize expected lifetime utility (3) with respect to the (time path of the) wage rate, subject to the consumer's dynamic budget constraint (given by (4) through (6)), and subject to the labour demand curve (2) for workers of skill  $i$ . Technically, the union performs this optimization on the assumption that its members will choose the optimum level and composition of consumption for any given wage rate which the union might set. The solution to the union's problem can be shown to imply a wage-employment relationship of the form

$$f'(n_t) = (1 - t_t^l) \left[ \left( \frac{E - 1}{E} \right) \left( \frac{w_t^i}{P_t} \right) - \frac{v_t}{P_t} \right] \quad (8)$$

Equation (8) could be interpreted as a "pseudo" labour supply curve, determining the supply of labour with skill  $i$  as an implicit function of the

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<sup>9</sup>Rather than distinguishing between employed and unemployed workers, we make this assumption of work sharing to reduce aggregation problems.

marginal disposable real wage rate for that type of labour and of the after-tax rate of unemployment benefit. In implementing the model, we have chosen to specify the disutility of labour as

$$f(n_t) = \frac{n_t^{1+\gamma}}{(1+\gamma)\zeta} \quad (9)$$

Because this disutility-of-labour function is assumed to be identical for all workers regardless of their skill level, it follows from (8) and (9) that the equilibrium wage rate and the equilibrium level of employment will be the same across all unions. This is why we previously found it unnecessary to index individual consumers according to their skill level.

The wage rate chosen by the representative union can be shown to imply a level of employment below potential "full" employment. Thus, if the individual worker were not restricted by his union to supply only his proportional share of the total number of working hours, he would in fact like to work more at the going wage rate<sup>10</sup>. On the other hand, for any given average level of wages and prices in the economy, workers with a particular skill will be better off by forming a union and exploiting their collective monopoly power rather than acting atomistically as individual competitive suppliers of labour. However, when workers of all skill categories react in this way, i.e. by forming small monopoly unions in an uncoordinated manner, the average wage level is driven above the Pareto-efficient marketclearing level which would prevail under competitive labour market conditions.

### 3. Calibration of the model.

The remaining relationships in the model mainly take the form of accounting identities and will not be elaborated here. The various tax instruments and other policy instruments available to the government are indicated in the lower part of table 1. The tax rates stated in the table provide a rough estimate of the effective tax rates on different types of income in the personal and corporate income tax system in Denmark before the recently enacted tax reform.

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<sup>10</sup>The potential free-rider problems arising from this fact are bypassed by our assumption that union membership is compulsory.

The upper part of table 1 reports the values assigned to the behavioral parameters and exogenous variables in the model. In calibrating the model, we have chosen parameter values which in our judgement appear "plausible" and which generate an initial steady state of the model corresponding roughly to a set of benchmark data for the Danish economy around 1990. We have adopted a liberal interpretation of the parameter  $1/\rho$ , considering it as an index of the length of the planning horizon (the degree of "farsightedness") of consumers. Assuming a value of  $\rho = .04$  implies a horizon of 25 years. Another liberal interpretation applies to our calibration of the retirement age,  $a^r$ . It has been set to 30 years (after entrance of the labour market); the combination of the chosen values for  $\rho$  and  $a^r$  produces relative proportions of workers and pensioners corresponding closely to actual proportions in Denmark.

Table 2 shows the initial steady state implied by the model, given the parameter values stated in table 1, and compares the figures calculated by the model to our estimate of the corresponding actual annual figures for the Danish economy in 1990. The model is seen to replicate the empirical numbers reasonably well, the main exception being that our model seems to overestimate the value of firms and of the housing stock.

#### **4. Simulation results.**

In June 1993, the Danish parliament enacted a major tax reform to take effect from 1994. The most important element in the reform is an across-the-board cut of roughly 8-9 percentage points in effective marginal tax rates on labour income, financed mostly by various measures to broaden the income tax base. The reform will also imply a reduction of typically 7 percentage points in the marginal tax rate on capital income (which mainly consists of interest and imputed rent on owner-occupied housing).

Against this background, we found it to be of some interest to simulate the effects of a 10 percentage point reduction of the marginal labour income tax rate, financed by a cut in the deduction  $d$  from the labour income tax base. For comparison, we also simulate the effects of a 10 percentage point cut in the capital income tax rate (which reduces the "tax value" of interest deductions by a similar amount).

Table 1. Parameterization of the model

Exogenous variables and parameters		
$E$	Elasticity of substitution between different labour skills	9.000
$\nu$	Intertemporal elasticity of substitution in consumption	0.450
$\epsilon$	Numerical elasticity of exports w.r.t. the real exchange rate	2.500
$\kappa$	Parameter in export relation	23.000
$\tau$	Real rate of interest	0.050
$\theta$	Rate of time preference	0.010
$\rho$	Probability of death	0.040
$\beta$	Share of housing consumption in total private consumption	0.170
$\delta^h$	Rate of economic depreciation of the housing stock	0.025
$\varepsilon$	Numerical elast. of subst. between domestic and foreign non-durables	2.000
$\varpi$	Weight parameter in CES utility function for non-durables	0.750
$\varphi$	Elasticity of marginal disutility of work	5.000
$\zeta$	Scale parameter concerning disutility of work	$260 \cdot 10^6$
$\alpha$	Profit share in manufacturing sector	0.275
$\alpha^b$	Profit share in construction sector	0.250
$g$	Target debt ratio in manufacturing sector	0.600
$g^b$	Target debt ratio in construction sector	0.600
$\delta$	Rate of economic depreciation of capital stock in manufacturing sector	0.070
$\delta^b$	Rate of economic depreciation of capital stock in construction sector	0.120
$\pi$	Elasticity of investment installation costs in manufacturing sector	1.000
$\chi$	Elasticity of investment installation costs in construction sector	1.000
$\Omega$	Scale parameter in installation cost function in manufacturing sector	0.100
$\iota$	Scale parameter in installation cost function in construction sector	2.570
$mM$	Labour force	25.000
$a^r$	Retirement age	30.000
$b$	Transfer to pensioners	5.600
$b^f$	Transfer to foreigners in percent of GDP	0.015
$\eta$	Elasticity parameter in CES production function	0.667
$\phi$	Weight parameter in CES production function	0.900
Policy variables		
$\hat{g}$	Ratio of public consumption to domestic output	0.300
$B$	Stock of public debt	14.500
$b$	Rate of unemployment benefit	0.200
$d$	Deduction from the labour income tax base	7.000
$\hat{\delta}$	Rate of depreciation for tax purposes in manufacturing sector	0.180
$\hat{\delta}^b$	Rate of depreciation for tax purposes in construction sector	0.250
$r^h$	Rate of taxable imputed rent from owner occupied housing	0.025
$t^l$	Marginal personal tax rate on labour income	0.600
$t^r$	Marginal personal tax rate on capital income	0.500
$t^d$	Marginal personal tax rate on dividends	0.380
$t^g$	Marginal effective personal tax rate on accrued capital gains on shares	0.060
$t^{bc}$	Corporate income tax rate	0.340
$t^a$	Payroll tax rate	0.025
$t^f$	Ad valorem VAT rate	0.250
$t^p$	Ad valorem excise duties rate	0.200
$S$	Adjustment parameter in lump sum subsidy to households	0.041

Table 2. The initial steady state

	Ratio to GDP at producer prices	
	Steady state of the model	Empirical estimate
Tangible wealth	4.434	3.304
Value of the housing stock	2.214	1.550
Financial wealth	2.220	1.784
Business equity	0.726	0.600
Business debt	1.302	1.000
Public debt	0.604	0.595
Net foreign asset position	-0.411	-0.411
Private consumption (of non durable goods)	0.466	0.454
Public spending	0.300	0.310
Business investment	0.154	0.133
Housing investment	0.044	0.032
Domestic demand	0.964	0.929
Exports	0.360	0.419
Imports	0.325	0.348
Trade balance	0.035	0.071
Net interest payments	-0.020	-0.049
Net transfers	-0.015	-0.010
Current account	0.000	0.012
Public receipts:		
Personal labour income taxes	0.338	0.326
Social security contributions	0.018	0.022
Corporation taxes	0.015	0.019
Capital income taxes	-0.042	-0.013
Commodity taxes	0.221	0.214
Tax on imputed rent	0.028	0.023
Total receipts	0.578	0.591
Public Expenditures:		
Public spending	0.300	0.310
Net interest payments	0.030	0.038
Unemployment benefits	0.052	0.046
Transfers to pensioners	0.069	0.096
Other transfers to residents	0.112	0.107
Net transfers to the rest of the world	0.015	0.010
Total expenditures	0.578	0.607
Unemployment (percent of labour force)	9.4	9.5
Unemployment compensation (percent of wage rate)	69.1	68.0

In both policy experiments, we assume that any net changes in government revenue are matched by offsetting adjustments in the general government lump sum transfer so that the stock of public debt is kept constant. This assumption is made to isolate the incentive effects of changes in marginal tax rates from the macroeconomic effects stemming from changes in the stock of government debt.

In the labour tax cut experiment, the associated cut in the deduction from the labour income tax base has been chosen such that the initial revenue loss from the tax cut has been fully recouped after a period of about five years, given the behavioral general equilibrium response to the tax cut. If we had assumed a larger initial reduction of personal deductions, the labour tax reform experiment would have implied considerable long term revenue gains for the government, and a concomitant significant increase in government transfers (and consequently in human wealth) the effects of which would have tended to blur the effects of the lower marginal tax rate<sup>11</sup>.

We report our simulation results by portraying the dynamic trajectories. In the figures presented below, the new steady state values are indicated by the horizontal dotted lines, with the initial pre-reform steady state values of all variables being normalized at unity. The simulated effects are plotted over an interval of 50 years, with the observations being spaced one year apart<sup>12</sup>. The solid curves in our diagrams indicate the effects of unantici-

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<sup>11</sup>Interestingly, the so-called capital income tax in Denmark actually yields a **negative** net revenue, because much of private sector interest income benefits from special tax concessions, whereas all interest expenses are fully deductible from taxable income. A cut in the capital income tax rate therefore tends to be revenue-increasing, but in the short run our model implies that this effect will be more than offset by the negative revenue effect of the initial recession generated by the capital income tax cut. This short term revenue loss is assumed to be made up by a cut in the lump sum transfer.

<sup>12</sup>As an exception, we have omitted the observation for the first year immediately after the reforms, illustrating only the total movement from year zero (the time of reform or announcement) to year two. Our motive for doing so is that, given the dating conventions in our discrete-time model, the price of owner-occupied dwellings cannot adjust to announced or actual changes in the tax code until a year after the announcement or implementation. For this reason, we consider the simulated first-year response in the model to be less plausible than the effects calculated by the model for the first two years as a whole. At any rate, because our model abstracts from "Keynesian" short term effects, we put more emphasis on the predicted medium to long term effects than

pated policy changes, whereas the "starred" curves represent the effects of tax reforms which are announced five years before they are implemented.

#### *4.1. A surprise cut in the marginal labour income tax rate*

Consider first the effects of an unanticipated cut in the marginal tax rate on labour income, illustrated by the solid curves in figures 1 through 8. The lower marginal tax rate induces unions to "buy" more employment and less leisure on behalf of their members through lower wage claims. This dampening effect on the pre-tax wage rate feeds through into domestic prices; however, the wage effect outweighs the price effect, implying a fall in the real product wage. This makes it profitable for firms to increase employment. Despite the fall in pre-tax wage rates, the stock of human capital goes up, due to improved employment prospects, and this stimulates private consumption, including housing demand. Business investment also responds positively, because improved profitability and the prospect of higher current and future demand are capitalized in higher stock market values. Since the fall in pre-tax wage rates improves international competitiveness, a further expansionary impulse emanates from stronger export demand. Overall, the surprise cut in the marginal labour income tax rate exerts an expansionary effect on aggregate supply and demand and hence leads to an increase in GDP. While employment adjusts relatively quickly towards its new steady state level (predicted to be almost four percent higher than the initial level), the costs of capital stock adjustment in the manufacturing and construction sectors imply that business and housing investment display more drawn-out dynamics, including some overshooting of the new steady state level. As capacity in the construction sector increases, it becomes possible to expand the output of new housing units, even with the price of houses displaying a minor fall.

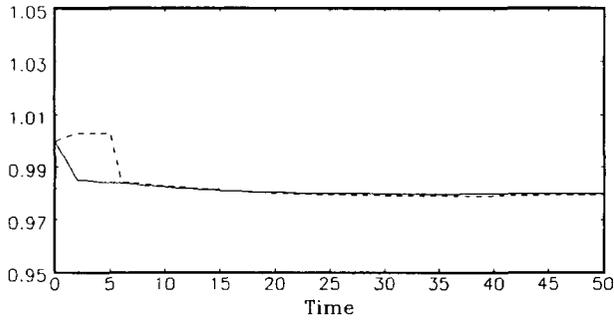
The model also calculates the effects on the various components of wealth. It turns out that the cut in the marginal labour income tax rate induces a three percent increase in steady state private non-human wealth. The net foreign asset position is also improved in the very long run, but net foreign assets decline in the medium term, due to a medium-run deterioration of the

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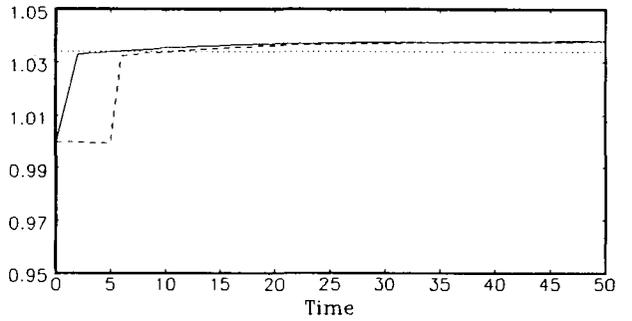
on the very short term effects.

## 10 PERCENT CUT IN MARGINAL LABOUR INCOME TAX RATE

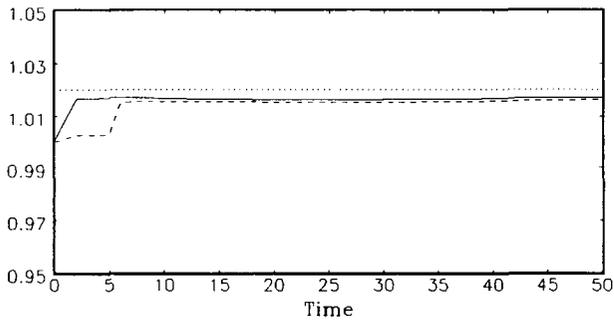
(1) Wage rate (W)



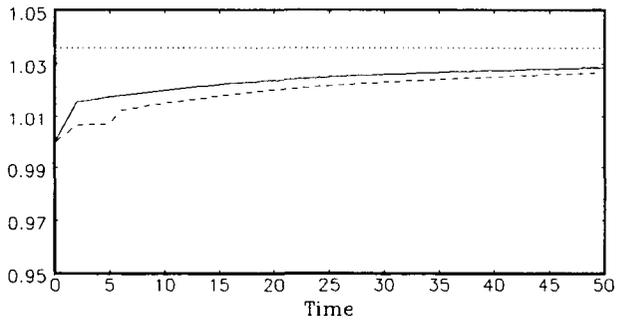
(2) Employment (L)



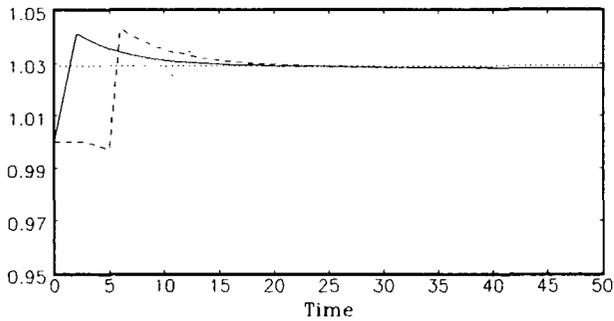
(3) GDP at producer prices



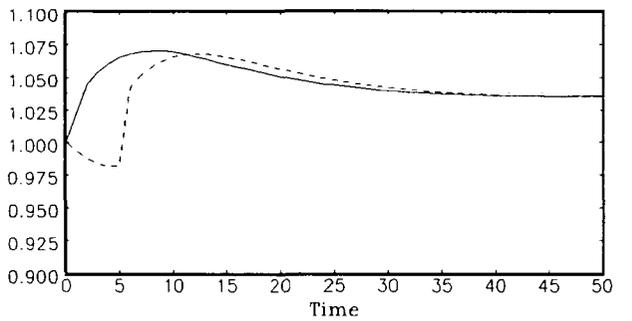
(4) Private consumption (C)



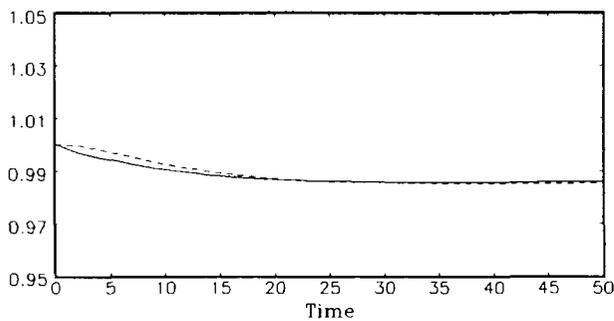
(5) Manufacturing investment (I)



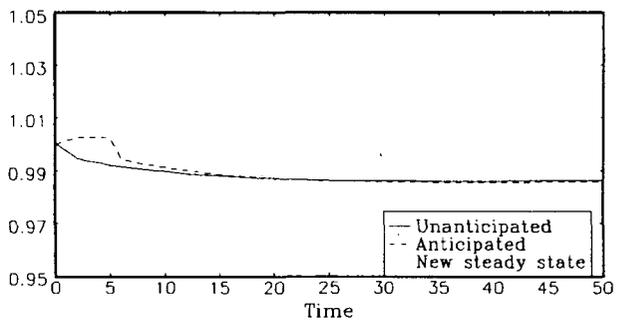
(6) Housing investment (J)



(7) Price of housing units (Ph)



(8) Terms of trade (q)



— Unanticipated  
 - - Anticipated  
 ··· New steady state

current account generated by the expansion of domestic economic activity.

#### *4.2. An anticipated cut in the marginal labour income tax rate*

Consider next the effects of a 10 percentage point cut in the marginal labour income tax rate which is (credibly) announced in period 0 but implemented only five years later. For most of the variables displayed in figures 1 through 8, we see from the starred curves that the announcement itself will have only minor consequences. At the time of announcement, forward-looking consumers anticipate a future increase in their human wealth. This generates an increase in consumption demand which tends to raise the domestic price level. Since the tax cut appears with a delay of five years, there is no immediate wage fall. Instead, the short run increase in domestic prices feeds into higher nominal wages, inducing firms to substitute some imported materials for labour and generating a slight fall in employment during the announcement period. Nevertheless, despite the fall in employment, there is a small increase in GDP measured in units of the foreign numeraire good, due to the compensating extra import of materials, and because of the improved terms of trade.

While the above announcement effects are quantitatively insignificant, the effects of the announcement on the housing market are somewhat larger. Following the announcement of the future labour tax cut, rational consumers anticipate a future cost-induced fall in the price of newly produced housing units, and this induces them to postpone part of their housing consumption, leading to a fall in housing investment until the time of implementation of the tax cut. Business firms also foresee a future cost-induced reduction of the price of new capital goods and therefore choose to postpone a minor part of their investment, as witnessed by figure 5.

After the implementation of the announced tax cut, the adjustment of the economy corresponds quite closely to the adjustment following a surprise tax cut, and in the new steady state the effects of the anticipated and the unanticipated policy change will of course be the same.

It should be clear from the analysis above that the beneficial expansionary effects of a cut in the marginal tax rate on labour income depend crucially on the predicted fall in nominal pre-tax wage rates. In general,

the effect of a lower marginal tax rate on wage claims is ambiguous in the standard textbook monopoly union model, due to offsetting income and substitution effects, but given the specification of the present model, we find that union wage claims will be moderated. However, the empirical basis for this prediction remains somewhat shaky. While some empirical studies (e.g. Bean, Layard and Nickell (1986), and Hansen (1990)) have indeed found a significant positive effect of direct taxes on the pre-tax wage rate, other scholars (e.g. Calmfors, ed. (1990)) have had difficulties identifying such an effect.

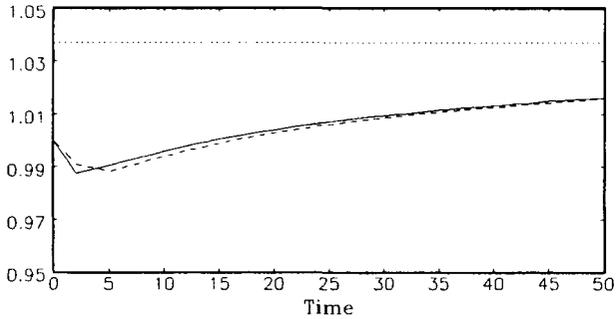
#### *4.3. A surprise cut in the marginal capital income tax rate*

Figures 9-16 display the effects of a cut in the capital income tax rate  $t^r$  which applies to interest income (negative as well as positive) and to imputed rent on owner-occupied houses, in accordance with Danish tax rules. To understand why an unanticipated fall in the capital income tax rate induces a recession in the short term, notice that the substitution effects, the wealth effects and the intergenerational redistribution effects of this policy change all tend to reduce aggregate demand on impact: first, the higher after-tax interest rate induces consumers to substitute future consumption for some present consumption. Second, with a higher net interest rate, future incomes are capitalized at a higher discount rate. On impact, this causes a fall in human wealth as well as a fall in the market value of firms which exerts a depressing short-term effect on private consumption and investment. Third, because taxable imputed rent is significantly below the market real interest rate, the lower tax rate on capital income raises the user-cost of owner-occupied houses, adding a further negative influence on housing demand to the general fall in consumption. Fourth, as we shall see in section 5.3, the cut in the capital income tax rate tends to redistribute lifetime wealth away from generations born in the first years after the tax reform towards most of the generations alive at the time of reform. When new relatively poorer generations enter the economy during the first years following the reform, the resulting change in the composition of the population tends to reduce aggregate per-capita consumption.

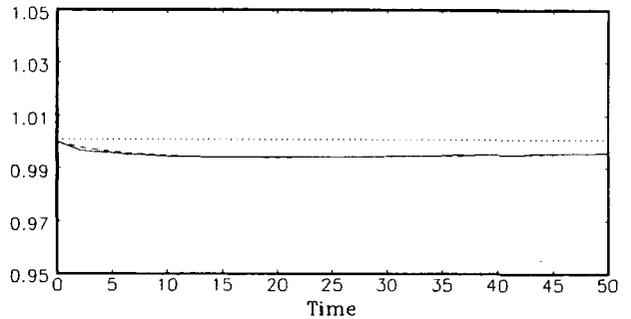
The reduction in total demand lowers the overall demand for labour, in-

## 10 PERCENT CUT IN MARGINAL CAPITAL INCOME TAX RATE

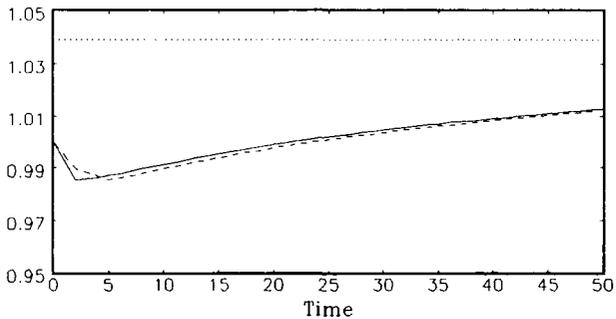
(9) Wage rate (W)



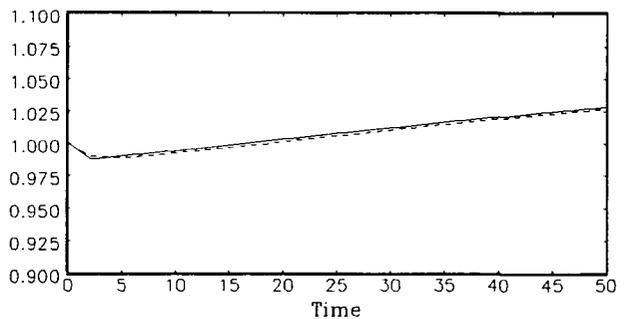
(10) Employment (L)



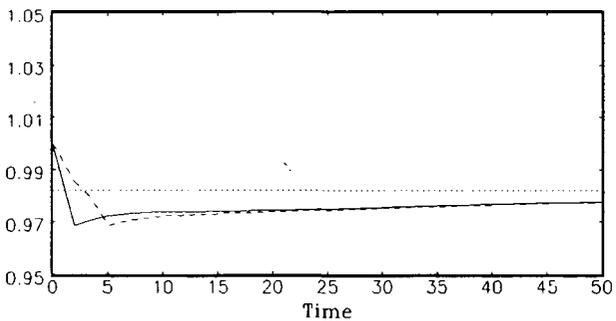
(11) GDP at producer prices



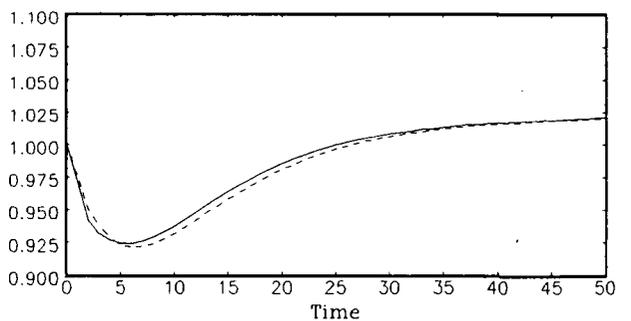
(12) Private consumption (C)



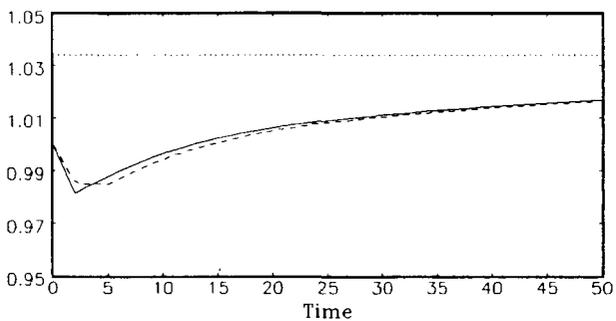
(13) Manufacturing investment (I)



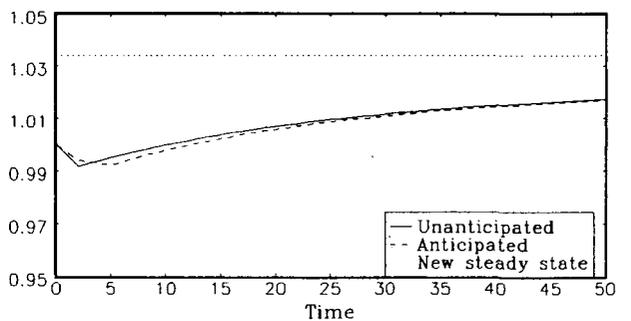
(14) Housing investment (J)



(15) Price of housing units (Ph)



(16) Terms of trade (q)



— Unanticipated  
 - - Anticipated  
 ···· New steady state

ducing unions to renounce on nominal wages. The resulting fall in the marginal costs of production is passed on to lower domestic prices, generating an increase in exports due to improved competitiveness. Over time, consumer demand for non-durables and durables (housing) also regains strength, because non-human wealth gradually increases due to higher savings. Eventually consumption rises above the pre-reform level and continues to increase monotonically (but slowly) during the transition to the new steady state. As a result of the permanent rise in savings, the model predicts a rather dramatic increase in net foreign assets in the very long run.

In summary, the capital income tax cut will raise the level of wealth and consumption by a substantial amount in the long run, but in contrast to a cut in the marginal labour income tax rate, the capital income tax cut will cause economic activity to fall below the prereform level for a rather long transitional period.

#### *4.4. An anticipated fall in the marginal capital income tax rate*

As figures 9-16 make clear, the contractionary short run impact will only be slightly modified if policy makers choose to announce the capital income tax cut some (five) years in advance. Anticipating a higher after-tax interest rate and a higher user-cost of housing a few years ahead, consumers register an immediate fall in wealth and immediately reduce their demand for non-durables and durables. Furthermore, foreseeing a future desire to reduce the capital stock, firms start to scale down their investment level right away so as to save on (convex) adjustment costs. On top of this, business investment is discouraged by the fall in consumer demand following the announcement. Thus, the qualitative responses of the economy to unanticipated and anticipated cuts in the capital income tax rate are very much the same. By pre-announcement of the tax cut, the initial recession will be slightly dampened, but it will also be slightly prolonged, as illustrated by the figures. Despite these modest effects of pre-announcement, the welfare gains from the reduced intertemporal distortion will nevertheless be more evenly distributed across generations if the capital income tax cut is announced well in advance, as we shall demonstrate below.

## 5. Welfare analysis.

We now wish to evaluate the effects of the two tax reform experiments on the level and intergenerational distribution of consumer welfare. For this purpose, we employ a dynamic compensating variation measure which is derived as follows: First, we calculate the level of discounted lifetime utility obtained by each generation in the initial steady state equilibrium. For each generation, we then calculate the minimum capitalized value of lifetime "net" consumption expenditure ( $x$ ) which would yield a similar level of lifetime utility, given the after-tax prices and wages prevailing in each period after the tax reform. In this way, we obtain a measure of the stock of wealth which would enable the generation in question to maintain an unchanged level of welfare. To arrive at the net lifetime welfare gain, we then subtract this "compensated" stock of wealth from the actual stock of human plus non-human wealth prevailing right after the (announcement of the) tax reform, given the evolution of the economy after the reform. In order to calculate the post-reform stock of wealth for each generation, we assume that the young generations with negative amounts of net financial wealth do not hold any corporate shares, while generations with positive financial wealth hold the two financial assets (bonds and shares) in the same proportion. Given this assumption, we can allocate the initial capital gains or losses on shares induced by the tax reform across generations.

In the two diagrams below, the percentage welfare gains are measured along the vertical axis, while the different generations are ordered along the horizontal axis, with generations becoming successively younger as we move from left to right. Generation 0 is the generation entering the labour market in the period where the unanticipated tax reform is implemented or the anticipated tax reform is announced; generation  $-50$  is the generation which entered the labour market 50 years before the reform, while generation 30 comprises yet unborn individuals who will start their working careers 30 years after the reform.

### *5.1. Welfare effects of a cut in the marginal tax rate on labour income*

As noted previously, the primary effect of a cut in the marginal labour income tax rate is to reduce the pre-tax nominal wage rates claimed by

unions. Since our unionized labour market produces a level of nominal wages exceeding the level which would prevail in a competitive labour market, one would expect a general wage reduction to be Pareto-improving, at least if assets are not too unevenly distributed across generations.

This expectation is borne out by figure 17 which shows that all generations will gain from a lowering of the marginal tax rate on labour income. Not surprisingly, however, the gains are unevenly distributed. Focusing first on the case of an unanticipated tax reform, individuals who started to work 30 years or more before the reform are no longer active in the labour market and therefore do not benefit directly from the higher after-tax labour incomes generated by the reform. Nevertheless, these retirees enjoy a welfare gain of about 1% from the lower domestic goods prices induced by the lower pre-tax wage rates, and from the gradual increase in lump sum government transfers which results when the tax base expands due to increasing economic activity.

For any generation which is active in the labour market after the unanticipated reduction of the marginal labour income tax rate, the welfare gain exceeds 1%. Moreover, since the level of employment is increasing through time, an individual will have a higher stock of human wealth and hence enjoy a larger welfare gain, the later he is born. The welfare gain to future generations is seen to converge on approximately 3%.

In studying figure 17, the reader may find it difficult to understand why an **anticipated** cut in the labour income tax rate appears to be Pareto-dominated by a **surprise** cut. In general, wouldn't people be better off if they were able to foresee and therefore adjust in advance to a change in the economic environment? This apparent puzzle is resolved when it is recalled that the surprise tax cut is implemented at time 0, whereas the anticipated tax cut is only announced at time 0 but not implemented until period 5. Most of the beneficial expansionary effects of the tax cut are therefore postponed for five years in the case of the pre-announced tax reform. In particular, individuals entering the labour market during the first five years after the announcement will face less favourable labour market conditions than their successors, since after-tax employment income only starts to increase after the tax cut is implemented. Furthermore, pensioners will suffer from

a slight domestic price increase during the five-year announcement period. For generations born later than year 5, the difference between the welfare from anticipated and unanticipated tax reform is gradually reduced with the time of birth as the economy approaches the same steady state after the two policy experiments.

## *5.2. Welfare effects of a cut in the capital income tax rate*

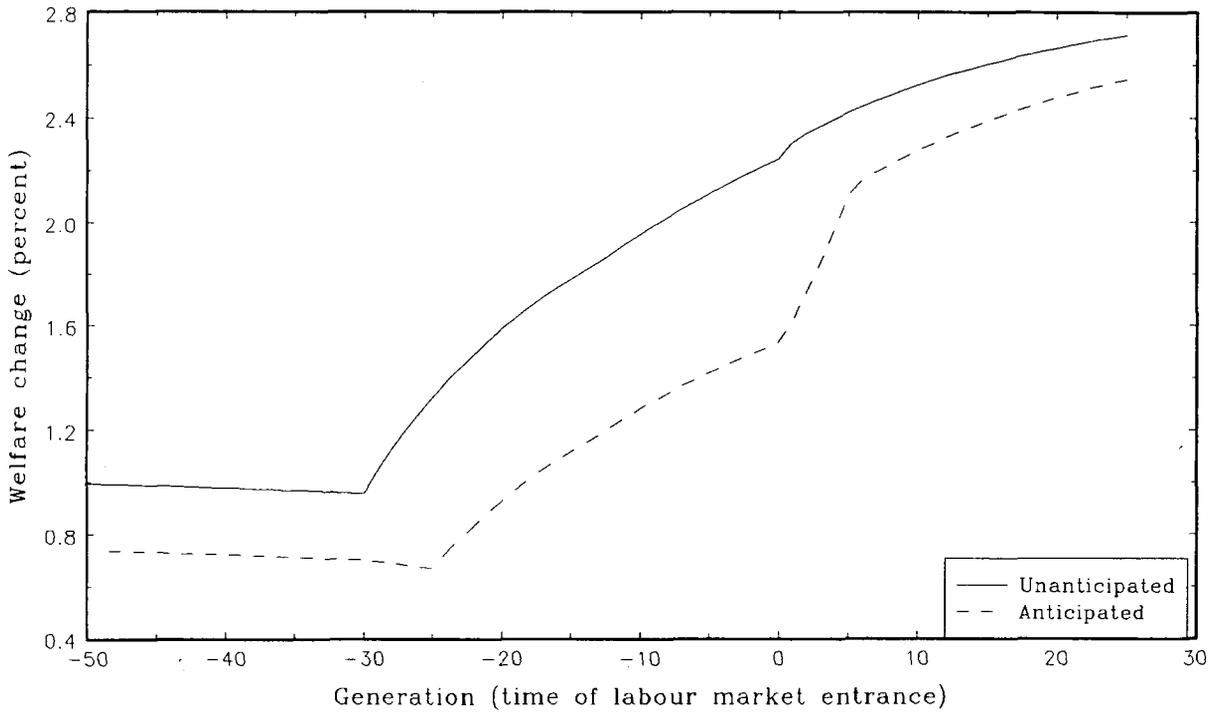
As illustrated in figure 18, the intergenerational distribution effects of a capital income tax cut are quite different from those of a cut in the marginal labour income tax rate. Indeed, in the case of a surprise cut in the tax rate on capital income, generations entering the economy in the years around the reform suffer a **loss** of welfare.

To understand the distribution effects depicted in figure 18, it is useful to consider how the level and composition of wealth evolves over the life cycle of an individual. When a person enters the economy without any inherited wealth, he must incur financial debt in order to acquire a house. In the initial steady state of the model, it takes about 14 years before this "mortgage" debt is repaid. After that time, individuals become net financial creditors and gradually increase their stock of financial assets along with their housing stock. This asset accumulation continues even after the date of retirement (although at a reduced pace), since pensioners are assumed to have the same expected remaining lifetime as workers, and since the after-tax interest rate exceeds the rate of time preference.

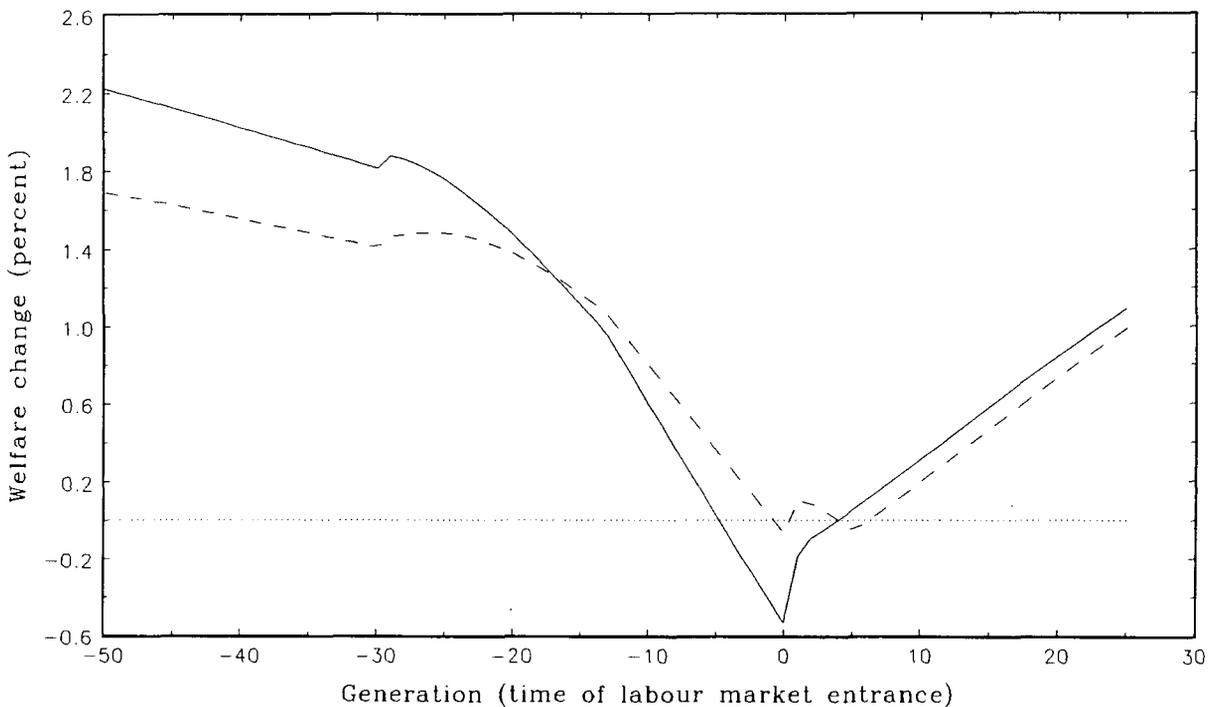
It obviously follows from this pattern of asset accumulation that, in their capacity as asset holders, individuals will suffer less or benefit more from a rise in the after-tax interest rate, the older they are at the time of the capital income tax cut. This is the main reason why the welfare profiles in figure 18 are rising in the leftward direction from time 0. The small "kink" in the curves between generations -30 and -31 is explained by the fact that retirees do not benefit from any increase in leisure due to the initial fall in employment after the reform.

For the youngest generations alive at the time of reform, the combination of a higher net burden of debt service during the early stage of their lives and the loss of human capital generated by the initial post-reform recession

(17) Cross-generational welfare effects of a 10 percent cut in the marginal labour income tax rate (welfare gain in percent of initial wealth).



(18) Cross-generational welfare effects of a 10 percent cut in the marginal capital income tax rate (welfare gain in percent of initial wealth).



is sufficiently strong to cause an outright loss of lifetime welfare, despite the fact that these generations will share in the benefits from a higher net return to financial assets as they grow older and wealthier. For the very same reasons, the generations entering the economy in the first few years after the unanticipated capital income tax cut will likewise suffer a welfare loss. However, as the economy gradually recovers from the initial recession, and as the private sector starts to accumulate assets at a higher pace, individuals born later into the future can look forward to better labour market prospects and to higher lump sum transfers from the government (due to a stronger tax base). Thus, the later a future generation is born, the higher its initial stock of human wealth, and hence the larger its net welfare gain from the higher net return to savings, as witnessed by figure 18.

Comparing the solid and the "starred" welfare profiles in figure 18, we see that preannouncement of the capital income tax cut will ensure that the welfare gains become more equally distributed and that almost no generation will suffer a direct loss. Generations which are net financial debtors (those who have entered the economy 14 years or less before the reform) will obviously benefit from the five-year postponement of the rise in the after-tax interest rate, whereas generations with positive net financial wealth will lose from the postponement. Generations entering the economy during the initial post-reform recession will also receive some compensation for their loss of human capital through the postponement of the rise in the after-tax interest rate on their mortgage debt, although the value of this "compensation" is clearly smaller, the closer to the time of implementation of the tax cut (year 5) they enter the labour market (this is why the starred welfare profile is decreasing from left to right between generations 1 and 5). The reason why generation 0 suffers a direct loss whereas its immediate successors enjoy a net welfare gain is that the former generation acquires its initial housing stock at the high housing prices prevailing immediately before the time of announcement, while successive generations can take advantage of the fall in housing prices induced by the announced capital income tax cut.

## 6. Concluding remarks.

This paper set up a finite-horizon overlapping generations model of a small open economy inhabited by workers and pensioners and incorporating accumulation of a stock of housing capital along with business capital and domestic and foreign financial assets. The model was calibrated to Danish data and institutions and was utilized to simulate the effects of a revenue-neutral 10 percentage point cut in the marginal tax rate on labour income and the effects of a 10 percentage point cut in the marginal tax rate on "capital income" (interest and imputed rent on owner-occupied houses).

Within this framework, the labour income tax cut was found to be Pareto-improving, although the relative welfare gains to young and future generations turned out to be considerably larger than the gains to the older current generations. This intergenerational distribution profile would seem to make a tax reform involving across-the-board cuts in marginal labour income tax rates an attractive policy in a time like the present one where several developments such as growing stocks of public debt, growing environmental problems, and an aging population all tend to imply a redistribution of resources away from the present young and future generations.

A cut in the capital income tax rate was also found to benefit most generations, but the current older generations and generations born long into the future turned out to benefit disproportionately, whereas generations entering the economy in the years around the time of reform were found to suffer a net loss of lifetime welfare. However, we also found that a more equal intergenerational distribution and a "near-Pareto improvement" could be achieved by announcing the capital income tax cut some years in advance. By contrast, we found no benefits from pre-announcing a labour income tax cut, since a postponement of the implementation of a lower marginal tax rate on labour would only postpone the gains to all generations.

The CGE model presented in this paper could be extended in many directions. While we believe that our introduction of imperfect competition in the labour market does represent an improvement compared to the standard competitive labour market set-up in almost all other CGE-models, it is clearly desirable to undertake further refinements of our labour market, involving inter alia an explicit distinction between the employed and the

unemployed. The introduction of wage differentials due to differences in productivity would also enable us to study the effects of public policy on intra-generational as well as intergenerational distribution. Further possible extensions would be the introduction of a tenure choice between rented and owner-occupied housing, and the incorporation of capital market imperfections such as liquidity constraints. These and other extensions are on our research agenda.

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