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WAGE FORMATION BY MAJORITY VOTING AND THE INCENTIVE EFFECTS OF PENSIONS AND TAXATION*

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ABSTRACT: The incentive effects of taxation and social security are studied using a centralized monopoly union framework for bargaining. Wages are set in a nation-wide trade union by majority voting, based on lifetime utility considerations. Workers have identical preferences but are in different phases of the lifecycle. Households determine their consumption and saving by maximising lifetime utility. We compare median voter wage-setting and its dependence on pensions and taxation with market-clearing wage-setting, using a dynamic computable general equilibrium model with an overlapping generations structure. Usually the voting outcome has higher wages and lower employment than the market-clearing outcome. The difference is bigger when the incentives to work are stronger in the market equilibrium, and gets smaller when the incentives are weaker. When e.g. the benefits of a PAYG type pension system are increased, the voting equilibrium wage level gets closer to the market equilibrium wage, and may even fall below it. The voting-equilibrium level of employment in fact increases with the PAYG benefits, whereas the market-equilibrium employment decreases.

JEL Classification: D58, E24, H55
KEY WORDS: wage bargaining, majority voting, overlapping generations, pensions and taxes

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TIIVISTELMÄ: Eläkejärjestelmä ja verotus vaikuttavat sekä säästämiseen että halukkuuteen tehdä työtä. Nämä vaikutukset riippuvat mm. työmarkkinoiden toiminnasta. Tutkimuksessa näitä kannustinvaikutuksia tarkastellaan numeerisen limittäisten sukupolvien simulointimallin avulla. Ammattiliittojen oletetaan päättävän palkoista enemmistöpäätöksillä. Jäsenet perustavat päätöksensä arvioituihin elinkaarihyötyihin, eli ottavat huomioon palkkojen vaikutukset paitsi nykyisiin myös tuleviin hintoihin, työllisyyteen, eläkkeisiin ja veroihin. Ammattiliittojen määräämät palkat ovat simulointitulosten mukaan yleensä korkeampia kuin taloudessa, jossa työvoiman kysyntä ja tarjonta tasapainottuvat palkkojen joustamisen kautta. Tämä ero on sitä pienempi mitä vähemmän eläkejärjestelmä ja verotus kannustavat työntekoon. Jos esimerkiksi jakojärjestelmällä rahoitettavia eläkkeitä korotetaan, tämä palkkojen ero pienenee, ja ammattiliittojen asettama palkkataso voi jopa asettua markkinatasapainopalkkaa alemmaksi. Markkinatasapainomallissa korkea eläketaso pienentää työllisyyttä, mutta ammattiliittomallissa työllisyys lisääntyy eläketason kohotessa. Kummassakin tapauksessa kotitalouksien hyvinvointi kuitenkin pitkällä aikavälillä vähenee eläketason kasvaessa.

AVAINSANAT: monopoliliitto, enemmistöpäätökset, limittäiset sukupolvet, eläkkeet ja verotus

YHTEENVETO

Dynaamisissa yleisen tasapainon numeerisissa simulointimalleissa työmarkkinoiden oletetaan yleensä tasapainottuvan. Tässä tutkimuksessa käytetään ammattiliitoihin perustuvaa mallintamista, ja vertaillaan eläkkeiden ja verotuksen vaikutuksia näissä kahdessa vaihtoehtoisessa kuvaustavassa.

Ammattiliittojen toimintaa mallitettaessa keskeinen kysymys on: Miten ammattiliittojen toiminta heijastelee liittojen jäsenten tavoitteita? Erityistä painoa tämä kysymys saa Auerbach - Kotlikoff -tyyppisissä simulointimalleissa, joiden perusidea on tutkia politiikkavaikutuksia lähtien liikkeelle kotitalouksien optimointikäyttäytymisestä. Ammattiliittojen jäsenet ovat samoja henkilöitä, jotka tekevät päätöksiä myös kotitalouksissa. Mediaaniäänestäjämalli on tästä lähtökohdasta luonteva valinta: ammattiliiton toiminnassa vaikuttavat samat preferenssit kuin kotitalouksienkin päätöksissä.

Äänestysmalleissa ammattiliiton oletetaan tekevän palkkapäätöksensä demokraattisesti, jäsenten enemmistön tahdon mukaisesti. Koska päätettäväksi oletetaan vain yksi asia, palkkataso, voidaan soveltaa mediaaniäänestäjätarkastelua. FOG-mallin kaltaiset numeeriset simulointimallit soveltuvat lähes suoraan mediaaniäänestäjämallin käyttöön. Mallissa on eri-ikäisiä työntekijöitä. Vaikka he ovat muuten identtisiä, he ovat eri vaiheissa elinkaartaan, ja täten heillä on mm. eri määrä varallisuutta tai velkaa, erilainen kertynyt eläkeoikeus, ja eri määrä elinvuosia edessään. Nämä seikat vaikuttavat, kun he ammattiliiton jäseninä pohtivat itsensä kannalta parasta palkkatasoa. Työllisyyden määräytyminen on täsmennettävä myös yksittäisen kotitalouden tasolla. Jos ammattiliitto asettaa palkat ja yritykset päättävät työllisyyden, täytyy kotitalouksien ottaa työllisyys annettuna. Mallissa käytetään yksinkertaista mekanismia: kaikki työikäiset työskentelevät yhtä paljon.

Taloudessa oletetaan olevan yksi, kaikki työikäiset kattava ammattiliitto. Sen jäsenyys oletetaan pakolliseksi. Liitto on ns. monopoliliitto: se asettaa palkat täysin, työnantajilla ei ole asiaan mitään sanomista. Varsinaista palkoista päättämistä ammattiliiton sisällä ei täsmennetä. Oletetaan vain, että palkoista tehdään sellainen päätös, että jäsenten enemmistö ei halua sitä korkeampaa palkkatasoa, mutta ei myöskään matalampaa.

FOG-mallin työmarkkinaversiolla tehdyt simuloinnit osoittavat, että jakojärjestelmätyyppisellä eläkejärjestelmällä on mielenkiintoinen vaikutus palkkatasoon: mitä korkeampia eläkkeet ovat suhteessa palkkoihin, sitä matalammaksi muodostuu palkkataso. Eläkkeillä on siis palkanmuodostusta hillitsevä vaikutus. Tämä vaikutus on lisäksi niin merkittävä, että vaikka korkeampaan eläketasoon liittyvät korkemmat eläkemaksut, niin työvoimakustannukset (työyksikköä kohden) ovat kuitenkin matalammat korkeampien eläkkeiden tapauksessa. Koska työvoiman kysyntä määrää työllisyyden, ja riippuu käänteisesti työvoimakustannuksista, liittyy korkeaan eläketasoon myös korkea työllisyys. Kotitalouksien hyvinvointi kuitenkin on sitä matalampi mitä korkeampia ovat eläkkeet.

Ammattiliittoihin perustuva palkanmuodostus johtaa yleensä korkeampaan palkkatasoon kuin tasapainottuvien työmarkkinoiden malli. Tämä palkkaero on sitä pienempi mitä vähemmän eläkejärjestelmä ja verotus kannustavat työntekoon.

SUMMARY

The incentive effects of taxation and social security may be quite different when wages are set by bargaining between trade unions and employers than when they are set by perfectly competitive labour markets. We study these issues using a centralized monopoly union framework for bargaining. Wages are set in a nation-wide trade union by majority voting. Voting takes place each period, and members base their voting on lifetime utility considerations. Workers are identical in preferences but differ in age and are thus in different phases of the lifecycle. Employment is determined by firms' demand for labour. Households take employment as given, and determine their consumption and saving by maximising lifetime utility. We compare median voter wage-setting and its dependence on pensions and taxation with market-clearing wage-setting, using a dynamic computable general equilibrium model with overlapping generations structure.

Intertemporal CGE models usually assume that labour markets clear: wages adjust to equate supply of and demand for labour. We propose a wage-setting model based on trade-union approach, in an ordinary overlapping-generations framework.

In principle, the median voter approach is almost directly applicable to a numerical OLG model of the Auerbach-Kotlikoff type. Workers differ in age, and their gains and losses from higher wages differ also, because the length of remaining working years, wealth, accumulated pension rights etc. differ. The median voter approach has the advantage that it defines exactly the target of the trade union. No additional assumptions are needed, the relevant information is included in the households' utility function. The approach also defines the dynamic aspects of the trade union's decision: the horizon is that of the median voter member. Only one feature must be added to the model: the rule stating how employment is divided to households. In this paper employment is divided equally to all households.

We assume that there is one nation-wide trade union. It is a monopoly union: it sets wages alone, the employers have no say. Employment is determined by the firms. Trade union membership is compulsory. In each period the members decide the wage of that period. The voting procedure is not specified, we simply assume that the outcome is such that the majority of members do not want to change it.

Each member base her/his voting on lifetime utility considerations. When comparing the wage alternatives for the current period, they calculate the optimal consumption and leisure combinations for all the periods of their remaining lifetime, within their budget constraint during their remaining lifetime, aggregate period utilities in their lifetime utility function and choose the wage that yields the highest lifetime utility. In these calculations they take into account all the general equilibrium effects, for which they have perfect foresight.

The results show important differences between the two types of wage formation. Usually the voting outcome has higher wages and lower employment than the market-clearing outcome. The difference is bigger when the incentives to work and save are stronger in the market equilibrium, and gets smaller when the incentives are weaker. When e.g. the benefits of a PAYG type pension system are increased, the voting equilibrium wage level gets closer to the market equilibrium wage, and may even fall below it. The voting-equilibrium level of employment in fact increases with the PAYG benefits, whereas the market-equilibrium employment decreases.

1. INTRODUCTION

The functioning of labour markets has an important influence on the incentive effects of taxation. This is rather self-evident for the supply of labour and employment. One striking result is theoretically well-established: tax progression is good for employment if wages are set by bargaining, but bad for employment if wages adjust to clear the supply of and demand for labour (see e.g. Koskela and Vilmunen, 1996). However, we still lack systematic results concerning taxation and social security.

Wage bargaining models seldom incorporate overlapping generations. An exception is Huizinga (1990), who uses a bargaining approach in an overlapping generations framework. He considers efficient bargaining, where both wages and employment are agreed upon, and the union utility is the sum of the utilities of the members.

That the median voter approach in trade unions is a suitable one is not new. Blair and Crawford (1984) give a critical assessment of some applications in the 1970s. They stress that the conditions for the existence of a voting equilibrium are extremely stringent in models with choice spaces of dimensionality two or larger. Layard, Nickell and Jackman state as one of their stylized conclusions that 'Union democracy means that unions maximize the welfare of the median member' (Layard et al., 1991, p. 86). Applications are scarce, though. A recent one is Renström and Roszbach (1995), regarding employee share ownership in an economy with one monopoly union for each firm. In their analysis union members differ in exogenous stock endowments. There are several applications of majority voting to taxation, from the 1970s onwards, and to pensions, see e.g. Lassila and Valkonen (1995).

Hawtrey (1990) combines trade unions and capital formation in an overlapping generations framework, modifying the Solow-Swan growth model. Workers live and work for two periods, and positive population growth ensures that the median voter belongs to the younger generation. There is no retirement and thus no pension system. Capital is owned by a separate group of people, capitalists. Hawtrey stresses the dynamic interaction between the union's decisions and capital formation.

Intertemporal CGE models usually assume that labour markets clear: wages adjust to equate supply of and demand for labour. A notable exception is Jensen et al. (1996). Their model includes a Blanchard - Kiyotaki (1987) type labour market, and a household sector where the probability of death is independent of age. We propose a wage-setting model based also on trade-union bargaining approach, but now in an ordinary overlapping-generations framework.

In principle, the median voter approach is almost directly applicable to a numerical OLG model of the Auerbach-Kotlikoff (1987) type. Workers differ in age, and their gains and losses from higher wages differ also, because the length of remaining working years, wealth, accumulated pension rights etc. differ. The median voter approach has the advantage of exactly defining the target of the trade union. No additional assumptions are needed, the relevant information is included in the households' utility function. The approach also defines the dynamic aspects of the trade union's decision: the horizon is that of the median voter member.

Only one feature needs to be added to the model: the rule stating how employment is divided among households. There are at least two obvious candidates. One is to divide employment equally among all households, the other is to leave some households entirely unemployed,

and divide total employment among a smaller group. In this paper we use the first option because of its simplicity.

The structure of the paper is as follows. In section 2 the behaviour of individuals, both as members of trade unions and as households, is described. The median voter approach is specified more fully in section 3. Section 4 discusses the features of the voting equilibrium. The incentive effects of PAYG pensions in the voting equilibrium are compared to those with labour-market clearing in section 5. Incentives and taxation are discussed in section 6, and concluding remarks are presented in section 7.

2. THE MODEL

2.1. Households

The economy has overlapping generations of households, each maximising lifetime utility U with respect to consumption. The maximisation problem is

$$\max_c U = \sum_{t=1}^{T} \frac{1}{1-\frac{1}{\gamma}} \frac{u_t^{1-\frac{1}{\gamma}}}{(1+\delta)^{t-1}} \tag{1}$$

where the periodic utility function

$$u_t = (c_t^{1-\frac{1}{\rho}} + \alpha_0 l_t^{1-\frac{1}{\rho}})^{\frac{1}{1-\frac{1}{\rho}}} \tag{2}$$

is subject to the budget constraint (3) that discounted lifetime wage income, pensions z and transfers E equal discounted consumption expenditure:

$$\sum_{t=1}^{T_w}(1-l_t)w_t(1-\tau_t^w)R_t + \sum_{t=T_w+1}^{T} z_t(1-\tau_t^w)R_t + \sum_{t=1}^{T} E_t R_t - \sum_{t=1}^{T} c_t P_t^C(1+\tau_t^c)R_t = 0 \tag{3}$$

where c is consumption, l is leisure, and of the constant parameters γ is the elasticity of intertemporal substitution, δ is the rate of time preference and ρ is the elasticity of substitution between consumption and leisure. The household lives T periods and works the first T^W periods. Labour incomes are taxed with a rate τ^w and the VAT rate is τ^c. P^C denotes consumer prices (see equation A 21 in Appendix 2). Incomes and expenditures are discounted with an exogenous interest rate r.

$$R_t = \prod_{s=1}^{t-1} \frac{1}{1+r_s} \tag{4}$$

Leisure l is determined by total employment L^T (see Appendix 2), which is divided equally among all working-age households, whose number is N^w, according to equation (5). Utility maximization is also subject to the rules of the pension system, described in section 5.1. The transfers are taken as given by the households.

$$1 - l_t = L_t^T / N_t^w \tag{5}$$

As a reference, we shall also look at competitive labour markets without trade unions. There the supply of and demand for labour balance, and households do not take leisure as given but instead maximise U with respect to both consumption c and leisure l.

2.2 The trade union

We assume that there is one nation-wide trade union. It is a monopoly union, i.e. it sets wages independently and employers have no say in the outcome. Employment is determined by firms. Trade union membership is compulsory. This is to avoid problems of whether or not it is advantageous for all workers to be members.

In each period the members decide the wage of that period. The voting procedure is not specified, we simply assume that the outcome is such that the majority of members do not want to change it.

Each member bases her/his voting on lifetime utility considerations. When comparing the wage alternatives for the current period, they calculate their combinations of leisure and optimal consumption, and the resulting period utilities, for all the periods of their remaining lifetime, subject to their budget constraint during their remaining lifetime, aggregate period utilities in their lifetime utility function and choose the wage that yields the highest lifetime utility. In these calculations they take into account all the general equilibrium effects, of which they have perfect foresight.

Formally, the median voter maximises the utility of the rest of his life, with respect to the wage in the period in which he is the median voter. We denote both the age group and the period by m in the following formulas.

$$\max_{w_m} U = \sum_{t=m}^{T} \frac{1}{1-\frac{1}{\gamma}} \frac{u_t^{1-\frac{1}{\gamma}}}{(1+\delta)^{t-1}} \tag{6}$$

subject to the budget constraint

$$W_{m-1} + \sum_{m}^{T_w}(1-l_t)w_t(1-\tau_t^w)\frac{R_t}{R_m} + \sum_{T_w+1}^{T} z_t(1-\tau_t^w)\frac{R_t}{R_m} + \sum_{m}^{T} E_t\frac{R_t}{R_m} - \sum_{m}^{T} c_t P_t^C(1+\tau_t^c)\frac{R_t}{R_m} = 0 \tag{7}$$

and subject to the rules of the pension system which determine z. Financial wealth at the end of period t is W_t. A crucial difference from the household's optimisation problem is that the median voter does not take employment, prices and taxes as given, but considers them endogenous as described in section 3.1.

2.3 The rest of the economy

The rest of the economy is described in more detail in Appendix 2, but its main features are as follows

- a forward-looking value-maximizing firm sector, which chooses the optimal path of investment, use of labour and intermediate goods and produces the domestic good which can be exported and which is an imperfect substitute for the imported good

- a government sector, which collects taxes and produces public services which are provided free of charge and are not taken into account in individual utility considerations

- a pension institution, which pays the pensions and collects contributions from the employers. The employers' contribution rate is endogenous and balances the fund's budget each period (see section 5.1)

- the rest of the world, with which goods can be traded and capital interchanged. The domestic interest rate is equal to the world interest rate.

3. MAJORITY VOTING WAGE SETTING

The median voter tries to find a wage rate that maximises his lifetime utility. Thus we may write the overall condition for optimal wage setting as follows.

$$
\begin{aligned}
\frac{dU}{dw_m} = {} & \Sigma_m^T\left(\frac{u_t^{-\gamma^{-1}}}{(1+\delta)^{t-1}}\frac{\partial u_t}{\partial c_t} - \Omega P_t^C(1+\tau^c)\frac{R_t}{R_m}\right)\frac{dc_t}{dw_m} + \\
& \left(\Sigma_m^T \frac{u_t^{-\gamma^{-1}}}{(1+\delta)^{t-1}}\frac{\partial u_t}{\partial l_t} - \Omega\Sigma_m^{T_w} w_t(1-\tau^w)\frac{R_t}{R_m}\right)\frac{dl_t}{dw_m} + \\
& \Omega\frac{dW_{m-1}}{dw_m} + \\
& \Omega\Sigma_m^{T_w}(1-l_t)(1-\tau^w)\frac{R_t}{R_m}\frac{dw_t}{dw_m} + \\
& \Omega\Sigma_{T_w}^{T}(1-\tau^w)\frac{R_t}{R_m}\frac{dz_t}{dw_m} - \\
& \Omega\Sigma_{t=m}^{T} c_t(1+\tau^c)\frac{R_t}{R_m}\frac{dP_t^C}{dw_m} - \\
& \Omega\left(\Sigma_{t=m}^{T} c_t P_t^C \frac{R_t}{R_m}\frac{d\tau_t^c}{dw_m} + \Sigma_{t=m}^{T}\frac{R_t}{R_m}\frac{dE_t}{dw_m}\right) = 0
\end{aligned}
\tag{8}
$$

The median voter considers what will happen if he increases the wage marginally. He feels the effects through seven channels, corresponding to the rows of the formula above (the term Ω is the Lagrange multiplier of the budget constraint). First, consumption changes in every period of his remaining lifetime. This is the result of his reoptimization as a consumer, and by the envelope theorem we know that the magnitude of this effect is zero. Second, employment, and thus leisure, changes. Third, the value of his financial wealth changes, as the stock market re-evaluates the future streams of dividends. Fourth, wages change. The change in the initial period is decided by the median voter, but he must also consider what median voters in future periods will do. Fifth, the pension benefits that he will get in the future will change. Sixth, consumption prices change. Seventh, consumption taxes or transfers change to balance the budget. The total effect determines the median voter's attitude towards an increase in the wage.

The changes in initial wealth, due to revaluation of firms' share price, are important in our simulations. When wages are increased, this comes as a surprise to the stock market and share prices immediately fall. The effects depend on the distribution of ownership of these shares. A part of the shares is owned by foreign citizens; the bigger this part is the less the median voter has to worry about the wealth effect. The domestically owned shares are assumed to be distributed equally among all households. Besides shares, the households' financial wealth consists of firms' and government's bonds.

An important question is also what happens to taxation, in response to wage setting by trade unions. The government's budget must be balanced eventually. If a large share of public outlays is salaries, and the budget is balanced each period by e.g. transfers or VAT, then the voting outcome may be very near, or even below, the market wage. This is so because an increase in wages increases public outlays so much that the following cut in transfers leaves workers worse off than initially without the wage increase. In our simulations the government's budget is balanced by increased borrowing in the first period and by transfers thereafter.

The effects on current and future employment are obviously very important in the wage-setting considerations. The decisions of the future median voters are considered in section 4.2. The assumption that firms determine employment after the wages are set means that employees are not on their notional labour supply curve, and that wages and labour input are negatively correlated. Recently, Oswald and Walker (1993) provide empirical evidence that this seems to hold for unionized workers, whereas for non-union workers the correlation seems to be positive, implying that they may be on their labour supply curve.

The pension effects are dealt with in section 5.

Unemployment is only indirectly present in the model: households would like to work more at the wage rate determined by the trade union, but are restricted by the demand for labour by firms. There are no unemployed people in the model, however, as employment is divided equally among working-age households. The critique by Lucas (1987, section 5) applies: macromodels can tell us something about employment and wages, but have very little to say about unemployment, which as a concept deals with disruptions in, or difficulties in forming, employer - employee relationships.

In the wage-bargaining literature dealing with local bargaining only the labour demand effects are usually included. Of the effects in this study, the pension effects should also be taken into account under local bargaining, as wages and pensions are connected also at the individual level, and not only at the economy-wide level. Wealth effects could be ignored by local bargainers, unless their holdings are in the firms they work. The effects on the behaviour of future local bargainers, however, should be taken into account, especially if labour is immobile between sectors. Each local bargainer probably thinks that the effects of his own decision on prices, taxes and interest rates are too small to be taken into account. These general equilibrium effects are more relevant with highly centralized wage bargaining. Including the general equilibrium effects means that the whole model constrains the maximization problem of the median member of the union. Perhaps he is able to solve it analytically; otherwise he must do what the researcher does, and find the optimum by trial and error.

4. WHY IS THERE A VOTING EQUILIBRIUM?

4.1 Market-wage equilibria and fixed-wage equilibria

When the model described above is used to study e.g. the effects of tax policies, it is usually assumed that there is full equilibrium, i.e. goods, financial and labour markets clear in each period, with all expectations fulfilled (see e.g. Auerbach and Kotlikoff, 1987 and Broer and Lassila, 1997).

Here we try to illustrate how the outcome of the economy changes when wages no longer clear the labour market, but are instead set by the trade union, employment is determined by firms' labour demand, and total employment is distributed equally among all households whose members are of working age. We call this equilibrium a fixed-wage equilibrium, to separate it from the full equilibrium, later referred to as the market-wage equilibrium. Notice that there is a stationary fixed-wage equilibrium for any wage rate the trade union cares to set, irrespective of whether it is set by majority voting or in some other way. The voting equilibrium is just one special case of fixed-wage equilibria. We consider only steady states[1].

The numeraire of the model is the imported good: its price is unity. The higher the wage level, compared to the numeraire, in the fixed-wage model, the less labour will be used as a production factor. Output is smaller. Domestically produced goods are more expensive relative to foreign goods. This induces substitution away from domestically produced goods, so the import content of consumer goods, investment goods and intermediate goods increases. The increase in the terms of trade decreases exports. Imports decline also, because the level of output, investment and consumption declines as higher wages imply lower employment. The decline in imports is smaller, however, than in exports. This is only consistent in equilibrium if foreign debt service costs are smaller, so net foreign debt is lower the higher the wage rate is. Although the capital-labour ratio is higher the higher wages are, the capital stock also declines with the level of output when wages are set to a higher level. It is not clear what happens to aggregate household wealth as both capital stock and net foreign debt decline, although usually it declines as well.

4.2 Voting equilibrium

When the workers of some period decide the wage of that period, they try to take into account what future workers will decide and how future wage decisions depend on the current wage decision. This forms an infinite forward linkage, as the future decision makers will also consider the effects of their wage decisions on the decisions of the worker generations to come still further in time, and so on. The current median voter thus faces an enormous mental task, and it is likely that he is unable to form a coherent and credible view of the consequences of every possible current wage choice.

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[1] Notice that market-wage and fixed-wage equilibria can be found using only a steady-state model, but to find the voting equilibrium among the fixed-wage equilibria one needs a dynamic model (see Appendix 1).

The question is: Are there any circumstances under which the median voter can confidently predict the consequences on future wages of a particular choice for the current wage? Assume that there is: what kind of situation could that be? The median worker may think as follows: "I must make a decision, and I may as well start from some assumption concerning the path of future wages. I'll make an optimal decision of the current wage, conditional on that path. Will the median voter of the next period decide the exact wage I have assumed? He will do that only under four conditions. One, he must reason like I do. He probably does, because he is just as rational as I am. Two, he must have the same assumption concerning wages from his time onwards. Three, the wage level I assumed he would set must be optimal for him, conditional on the assumed wage path during his future. Four, he must think that next median voter also fulfills these conditions. If these conditions are met for all the median voters to come, all that remains is to correctly assume the path of future wages." Whether the path is found also depends on the history of the economy, but the thinking process itself leads us to consider the concept of 'voting equilibrium'. That is what we define in this section and use throughout the rest of the paper.

Let w_1^e be the wage set by majority voting in period 1, given the future path of wages w_2 ,w_3 , ... By definition, the change in the (remaining) lifetime utility resulting from an increase in wages from w_1^e to $w_1^e + \varepsilon$ is not positive for the majority of working-age persons. Also, the utility from decreasing the wage to $w_1^e - \varepsilon$ is non-positive for the majority, for all ε.

The voting equilibrium path of wages is the sequence w_1^e, w_2^e, ..., where each wage is such that the majority of workers wants neither to increase it nor to decrease it, given the correctly anticipated future wages. Considering all time points simultaneously, this equilibrium is analogous to a Nash equilibrium in noncooperative games: workers of any one period do not want to change their decision, if workers of some other period do not change their decision. If one takes the time structure into account, each median voter acts as a Stackelberg leader vis a vis the future median voters.

4.3 Why there is a voting equilibrium

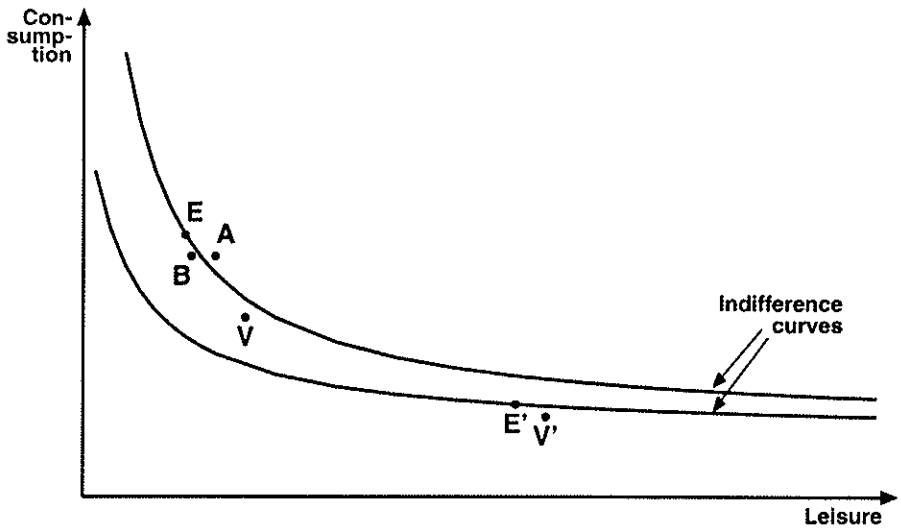
As noted earlier, there is a fixed-wage equilibrium for any wage rate the trade union wishes to set. In this section we try to give a heuristic explanation of why there is a voting-wage equilibrium among the fixed-wage equilibria, that is, what prevents the median voter from setting the wage level infinitely high or low.

If in any steady state fixed-wage equilibrium we increase the wage for one period, the dynamic simulation shows the following pattern for the median worker. In the first period leisure increases as the demand for labour decreases, and this increases the utility of the worker. It is the dominant utility effect during the worker's remaining lifetime. During the following working periods leisure is also greater than it would have otherwise been, because the capital stock was adjusted downwards during the first period, and it is not immeadiately raised to the original level because of adjustment costs, although wages have returned to the original level. These leisure effects after the first period are small compared to the first period effect. The total effect of a temporary wage increase and a longer-lasting decline in employment is a fall in discounted wage income during the remaining lifetime. The counterpart of the positive leisure effects on utility is the decline in consumption, which follows from the reduction in lifetime wage income. This consumption decline is smoothed over all periods of the remaining

lifetime. The total effect on lifetime utility is the weighted sum of the leisure and consumption effects.

The pattern is illustrated in Figure 1. Point E is the initial consumption-leisure combination. When the wage is increased for one period, the combination moves to point A, with more leisure and less consumption[2]. The second period combination is B, where leisure approaches the original amount (but does not reach it) and consumption remains lower. The points of future periods are not shown: they are near B, but leisure gets closer and closer to the initial amount. The combinations after retirement are not shown either.

Figure 1. Median voter's utility



The points A and B are not stationary equilibrium points. If it pays for the median voter to increase the wage in period 1, the economy starts to adjust to higher wages, and the new stationary equilibrium may be e.g. point V (for voting equilibrium), which is on a lower indifference curve. Thus although the initial median voter benefits from moving away from point A, the future median voters are worse off than they would have been in the initial equilibrium E.

Basically, thus, the trade union trades consumption for leisure when it increases the wage level above the initial fixed-wage equilibrium level. More leisure is paid for in the form of reduced consumption. The crucial issue then is how these two items affect the utility of the household. The normal assumption is that both goods have declining marginal utility. That is also the case in our model. Additional leisure is more appreciated the less leisure there is, in relation to consumption, to begin with. If there is quite a lot of leisure to begin with, the utility of the household is not much increased by having more leisure. Thus, if the initial

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[2] The indifference curves refer to periodic utilities during the median voter's working periods. The figure is too static to fully illustrate the dynamic choices of the median voter.

equilibrium had been point E' instead of E in figure 1, the median voter's utility would have increased much less from a wage increase, or perhaps even decreased. This gives one explanation for the existence of the voting equilibrium. When we move from one fixed-wage equilibrium to another with a higher wage, we move both to the right in figure 1 and to a lower indifference curve, and this increases leisure in relation to consumption. Thus it is likely that we will find an initial wage level where, if the wage is still marginally increased for one period, more leisure exactly compensates for the decline in consumption for the median voter: this initial wage is the voting equilibrium wage. Above it the median voter would like to lower the wage and below it to increase it.

4.4 Who is the median voter?

Union members are identical in all respects, except that they are in different phases of their life-cycles. Among other things, that means that they have different numbers of periods ahead, and they have accumulated different amounts of financial wealth. In our simulations both these features cause the young cohorts to prefer higher wages to the older cohorts. Thus the endogenously determined median voter is the median-age worker.

A reassuring feature is that, qualitatively, the utility changes from a temporary wage increase are similar in all cohorts although quantitatively they differ. This means that the qualitative properties of the voting equilibrium in comparison to market-wage equilibrium are probably robust to the age of the median voter, although quantitative results could be more sensitive. If, however, the median voter changes as a result of a change in an exogenous or policy variable, the effects may become volatile. This does not happen in the simulations of this paper.

4.5 Sensitivity analysis

Steady-state sensitivity analysis concerning the relations between market-wage and voting-wage equilibria, with respect to households' behavioural parameters, firms' production function parameters and other parameters describing the economy, does not point towards any great sensitivity (see Table 1). In all cases considered, the voting-wage equilibrium had higher wages, lower labour input, lower consumption levels, a lower capital stock, lower output and higher export prices than the market-wage equilibrium. It is likely, however, that there exist parameter values where the voting-wage would be below the market-wage[3], and most of the relations stated above would reverse. High values of the capital - labour substitution elasticity would probably produce that situation. Of course, in such a case the trade union would have to force people to work more than they would like to at the going wage and prices.

The trade-off of the union is, briefly, more leisure and higher wages today and more leisure tomorrow versus less consumption now and in the future. The crucial parameters are those that affect this trade-off strongly. The elasticity of substitution between capital and labour is obvious: the higher the elasticity, the easier it is for the firm to reduce labour demand after a

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[3] Hawtrey (1990, p. 90) concludes that in his model this situation is the prevailing one, as it is often wise for the union not to use its power to increase wages. The model is different but the trade union faces an analogous trade-off between higher wages today and an increased capital stock tomorrow.

temporary wage increase, and thus workers lose more income and consumption. The price elasticity of exports is important: with a high elasticity, the wage increase would hit exports badly and thus reduce output and labour demand. The price elasticity of imports works in a similar fashion: a high elasticity implies that domestic production is greatly reduced after the wage increase affects prices, as the imported good is used more in the consumption, investment and intermediate good. The reduction in production means less employment and less labour income. The ownership of firms' shares is also important: the more foreigners own the shares, the less the median voter gives weight to the negative share value effects of wage increases. On the household side, the intratemporal elasticity of substitution is important. If the elasticity is high, the households are more willing to sacrifice consumption to get more leisure, and the median voter, having the same preferences, drives the wage level higher.

5. PENSIONS AND WAGE FORMATION

5.1 PAYG pension system

By replacing the labour-market equilibrium assumption with majority-voting wage setting behaviour, we could use the simulation model to analyse e.g. pension policies in a similar fashion as in e.g. Broer and Lassila (1997). The dynamic calculations are, however, very difficult with the median voter approach. We can gain some insight of the way the wage formation assumptions affect the incentive effects of pensions and taxation by doing some simulated exercises with the stationary market-wage and voting-wage equilibria.

When we compare voting equilibrium to market equilibrium, we do not want the employment division rule to affect the comparisons. Thus we adjust the model so that in the market equilibrium steady states all workers wish to have an equal amount of leisure, irrespective of their age. To achieve this, two conditions must be met. One, the price of leisure must be constant, so that there is no intertemporal substitution concerning leisure. Two, the real net interest rate faced by the households must equal the rate of time preference, so that there is no intertemporal substitution concerning consumption, because that would also be reflected in leisure. The latter is straightforward, we set $r = \delta$. Condition one is slightly more complicated, because the price of leisure also includes, besides the net wage rate, the present value of the future pension right that comes from working. What is required is that the PAYG pension right accrues steadily in time and yields interest, so that the present value of future pensions accruing from each period, discounted to that period, is constant. With these features, the market-wage equilibrium is a special case of fixed-wage equilibria.

For the person who started working in period 1 the pension z in period t is

$$z_t = \frac{1}{T_W} \sum_{s=1}^{T_W} \theta(1 - l_s) w_s \frac{R_t}{R_s} \left(\frac{w_t}{w_s}\right)^{\lambda} \quad , \quad T_W < t \leq T \tag{9}$$

The parameter θ expresses the pension replacement rate and λ is the indexation parameter of pensions to current wages. We consider only the limit cases when $\lambda = 0$, representing no indexation, and $\lambda = 1$, representing full indexation. From (9), the discounted pension right that accrues from marginal work during period s is the following:

$$\sum_{t=T_W+1}^{T} \frac{R_s}{R_t} \frac{dz_t}{d(-l_s)} = \frac{1}{T_W} \sum_{t=T_W+1}^{T} \frac{R_s}{R_t} \theta w_s \frac{R_t}{R_s} \left(\frac{w_t}{w_s}\right)^{\lambda} = \frac{1}{T_W} \sum_{t=T_W+1}^{T} \theta w_s \left(\frac{w_t}{w_s}\right)^{\lambda}, \; 1 \leq s \leq T_W \tag{10}$$

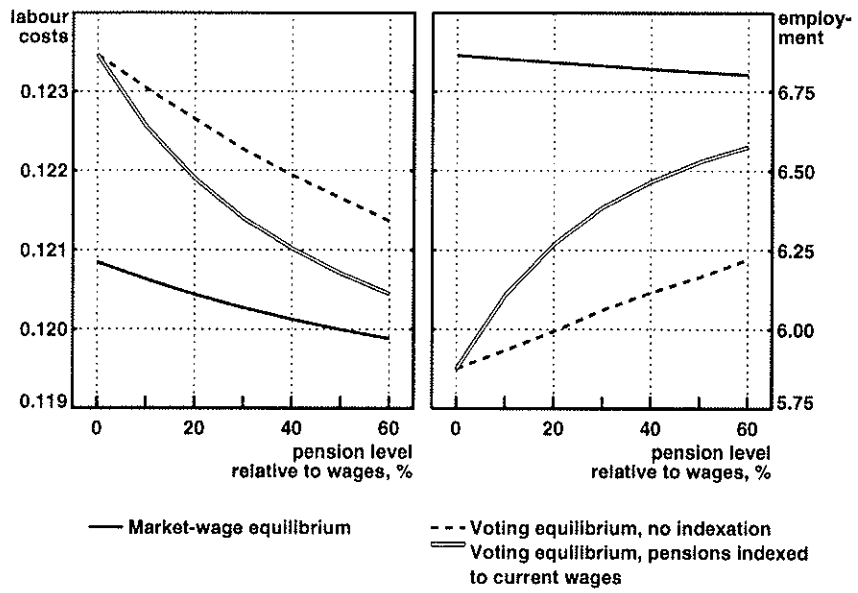
which is constant and independent from s in an equilibrium where $w_s = w_t = w$ for all s and t. The employers' contribution rate is determined by the pension institute's budget constraint. That is obtained by aggregating pensions and contributions over cohorts i.

$$\sum_{i=T_{W+1}}^{T} z_{i,t} - \tau_t^z \sum_{i=1}^{T_W} (1 - l_{i,t}) w_t = 0 \qquad (11)$$

5.2 PAYG pensions and the median voter's decision

Figure 2 shows the pattern between the market equilibrium labour cost (wage rate + employers' pension contribution) and the voting equilibrium labour cost, when the pension benefit level, as a percentage of wage income, is increased. The curves show that the higher the PAYG pensions, the lower are work incentives and wages. Actually, wages decline more rapidly when the pension level is increased, but as contributions rise, labour costs decline rather slowly. The voting equilibrium wages approach the market-equilibrium wages when pension levels are higher, and can in fact fall below them for sufficiently high pensions (this requires that households work more than they would like to at the prevailing wages and prices, so the union must force them to work). The second part of the figure shows the corresponding employment levels (see also Table 2).

Figure 2. Pensions, labour costs and employment



In the market-wage equilibria, the increase in pension level decreases the work incentives of households. This is entirely a consequence of missing funding. The pension rule (equation 9) itself has no distortive effect: rational households take the accruing pension rights into account, in the way shown in equation (10), when they make labour supply decisions. If there were funding, exactly matching the accruing pension rights, and no indexing to current wages ($\lambda = 0$), the system would be actuarially fair, and the market-wage equilibria would be

identical in all economically meaningful respects. Household wealth would be lower if pension rights were excluded, but the pension fund would match that exactly. Gross wages and the contribution rate would vary, but labour costs would be constant. Net labour incomes would differ in timing in households' lifecycles, but their discounted amount would be the same. But since no funds are collected, the interest income from funds is missing and a corresponding amount must be collected from current wages. This part of the employers' contribution rate is pure tax, and it distorts the labour supply decision.

The contribution rate effect of the missing fund is also present in the voting equilibria. But there are other effects also. The voter, thinking about the effects of a possible wage increase in the current period, balances in his mind the increase in leisure and the decrease in consumption, the latter being the consequence of a decline in discounted labour incomes. This decline is the sum of the increase in work income he receives in the first period and the decrease in all periods during the rest of his working life. The aggregate effect of these on pensions is negative. The advantage of this fall in pensions, in the form of lower contributions, does not come to the median voter but goes to future workers: there is a generational transfer. The higher the pension level is the higher is this transfer, and selfish workers react to this transfer by resorting to lower wage levels. There is also another generational transfer: a wage increase raises the pension contribution rate and this deteriorates the leisure - consumption trade-off of the median voter. The rise in the contribution rate follows from the fact that the labour income of the median voter falls. The rise is higher if current pensions are indexed to wages. Indexation also further reduces the median voter's own pension, as the current higher wage is replaced by the future wage which remains constant (see equation 8). Both these generational effects work to the disadvantage of the median voter, and are greater the higher is the PAYG benefit rate and the higher is the degree of indexation of pension to current wages

Figure 2 shows that employment increases with the PAYG benefits, if wages are set by majority voting. Firms increase the demand for labour as labour costs decline. The market-wage employment also reflects the distortion effect to households' labour supply, which dominates the labour demand increase by firms.

From the above reasoning, short aggregating periods of the pension rights, at the end of individual's working life, may also contribute to higher employment than aggregating systems based on the whole working history of the worker. The loss of work income in future periods weighs more in the median voter's calculations if those future periods are crucial for the determination of the pension level.

The capital stock is also affected by the pension level. This is not due to saving effects: although household wealth declines and the net foreign asset position deteriorates with higher pension levels, interest rates do not rise because financial capital is assumed to be perfectly mobile internationally. The increase in capital stock in voting equilibria takes place because of output expansion: cheaper labour makes it profitable to produce more, and thus more capital is also needed. There are of course general equilibrium effects: part of the increased profitability goes abroad as the price of the domestically produced good slightly falls in relation to the foreign good, and this in part increases the cost of capital as the capital good price falls less than output price. There is some input substitution towards labour, but this substitution effect is smaller than the effect of the output increase.

Another partial explanation of the convergence of equilibria is illustrated in Figure 1. Point E can be interpreted as a market-wage equilibrium with a low level of pensions, and point E' a similar equilibrium with higher pensions. At E, the incentives in society are such that people work a lot and there is little leisure in the market equilibrium. In this case the trade union can increase the utility of its members by increasing wages, which leads to more leisure and less consumption. The voted wage level will be far higher than the market equilibrium wage. But if the incentive system is such that not much work is done in the market equilibrium, such as at E', the trade union cannot increase the utilities much by acquiring more leisure, and the wage level in the voting equilibrium V' will be closer to the market-equilibrium wage.

Even though employment increases with PAYG, the utility of workers decreases with increasing pension benefits, as compensated variation results in Table 2 show. It is also noticeable that welfare is higher in every market-wage equilibrium than in the corresponding voting-wage equilibrium with the same pension level. Again, this applies to steady state comparisons. Further research should try to establish whether there is a voting-wage equilibrium path, described in section 4.2., leading from the market-wage equilibrium to the steady-state voting-wage equilibrium. If there is, imagine that a nation-wide trade union is established in the market-wage equilibrium. The initial median voter would raise the wage and be better off, and probably would some of his successors. But gradually the capital stock would decline and other changes would occur, and future workers would be worse off than they would have been in the market-wage equilibrium.

6. TAXATION

If the incentives in society are such that people work a lot, there is little leisure in the market equilibrium. In this case the trade union can increase the utility of its members by increasing wages, which leads to more leisure and less consumption. The wage level will be far higher than the market equilibrium wage. But if the incentive system is such that not much work is done in the market equilibrium, the trade union cannot increase the utilities much by acquiring more leisure, and the wage level in the voting equilibrium will be nearer the market-equilibrium wage.

This simple explanation points to a general conclusion about the incentive effects of taxation and social security. Comparing the voting-equilibrium wage level and the market-equilibrium wage level, in the region where the former is higher than the latter, we thus expect to find that they are closer to each other

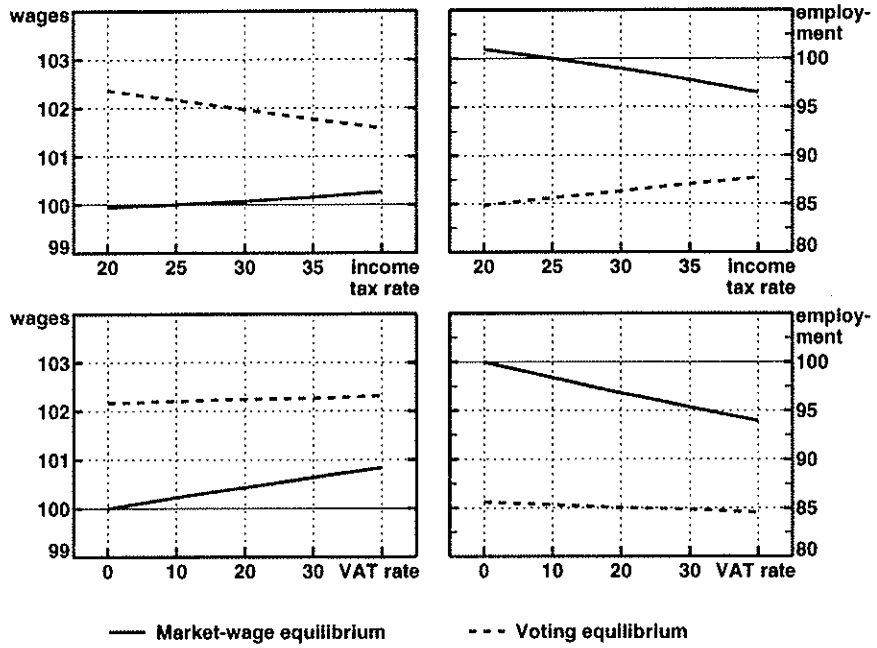
- the higher are labour income taxes, used to finance larger transfers

- the higher are value added taxes, used to finance larger transfers

The simulations (in Table 3) support these conclusions. Furthermore, sensitivity analysis shows that the taxation results are not very sensitive to those parameter values that showed largest effects in Table 1. Still, as is typical with a simulation approach, no generality can be claimed.

The effects of higher taxes, either income or consumption taxes, on the market-wage equilibrium outcomes are explained by the work incentives. The higher the taxes are, the less

Figure 3. Taxes, wages and employment



rewarding is working: with higher income taxes the net wage is lower, with higher consumption taxes the consumption prices are higher. In both cases the higher transfers compensate roughly for the income effects, so only the substitution effect, leisure becoming cheaper in relation to consumption, remains. More leisure is consumed, less work is done.

The voting equilibrium outcomes are not so straightforward. There is also a clear difference between labour taxes and consumption taxes: with the former, higher taxes means lower wages and higher employment, with the latter slightly higher wages and correspondingly lower employment. To understand why, we must go through the median voter's choices in some detail.

The median voter trades consumption for leisure, as noted in section 4.3. The wage increase in the first period leads to lower employment during several periods. The higher the labour income tax rate is, the more unfavourable this trade-off is for the median voter: a small increase in the net wage produces a large reduction in employment, which is affected by the gross wage. Thus the reduction in lifetime gross incomes is bigger. Net incomes also fall substantially and consumption need be reduced accordingly. Thus the median voter tends to settle for lower gross wages if income taxes are higher. Because the higher income tax rate also means higher transfers, we should talk about "the effects of an increase in the marginal tax rate".

Higher consumption taxes do not affect the fall in lifetime incomes resulting from an increase in the wage in the first period. But this fall in income will result in a decline in consumption which is smaller in volume, because the price of consumption is higher with the higher VAT. This makes the overall trade-off between leisure and consumption slightly better for the median voter, and he claims higher wages. Remember that higher consumption tax revenues are paid back to the households in the form of transfers, so this is a "marginal VAT rate effect".

Taxation can, in principle, have similar effects on wage formation as pensions did in section 5.2, as different taxes may be targeted at different phases of the life-cycle. For instance, taxing pensions more heavily than wages may make the median voter assign less weight to future income and thus claim higher current wages. This remains an area of future research. So does progressivity: Simulations (not reported here) show that progressive taxation has similar effects for voting-equilibrium wages and employment in this model to those reported by Koskela and Vilmunen (1996) for most bargaining-type models of wage formation and employment. Increasing progressivity, while keeping the total amount collected by the tax constant, makes the trade union choose lower wages and higher employment. It is not directly possible to compare the effects of progressivity between market-wage equilibria and voting-wage equilibria, because the employment division rule blurs the picture. Progressivity has effects only if there is redistribution between persons, or between periods in a person's life-cycle, which requires differences in period earnings. In market-wage equilibria this leads to a varying supply of labour either between periods or between persons, and the equal division of labour rule that is employed in the voting-wage equilibria causes in itself differences between these two regimes, which intertwine with the effects of progressivity.

7. CONCLUSIONS

We have studied majority-voting wage-setting in an overlapping generations economy, using a numerical simulation model. Wages are set by a nation-wide labour union where all persons in the working-age are members. Employment is determined by firms, and is divided equally among all workers. Households take employment as given, and determine their consumption and saving by maximizing lifetime utility under perfect foresight. Although employment is given and thus leisure also, leisure is an argument in the utility function.

If there were no trade union, each household would make its own decisions concerning leisure and consumption. Here the trade union makes the leisure-consumption choice for the households. And, its decision affects the terms of the choice, the trade-off that there is between leisure and consumption in each period. The current trade-off is affected by the previous choices, and the current choice will affect the trade-off of the current and future periods. There is a dynamic element: by increasing the wage, the trade-off is better for the union today but worse tomorrow. The combined effect is what counts.

The economy seems to have an equilibrium wage level, which the majority of workers wants neither to increase nor decrease. We compare this voting equilibrium outcome to the full market-clearing outcome where wages adjust to equate the supply of and demand for labour. Usually the voting outcome has higher wages and lower employment than the market-clearing outcome. How big this difference is depends on many features of the economy. The production technology has effects, especially the substitutability between labour and capital. Individual preferences concerning the substitution between leisure and consumption are important; one advantage of the median voter approach is that household preferences directly affect the trade union's decisions. Openness of the economy also affects the wage outcomes: the easier it is to replace domestic products with foreign goods in consumption, investment, intermediate use or in the export markets, the less room the trade union has to operate. Even if the interest rate is not affected by the wage decisions, there is still an openness issue in financial

markets: the more foreigners own domestic shares the less the trade union cares about the adverse share value effects of wage increases.

Pension policies and tax policies have both saving incentive and work incentive effects. Without trade unions these incentives affect household behaviour. With a trade union the work incentives affect its decisions, while saving incentives still operate through households. The central incentive result of this study is that when we compare trade union wage setting with labour markets where wages adjust to equate supply and demand, the difference is bigger when the incentives to work are stronger in the market equilibrium, and gets smaller when the incentives are weaker. When e.g. the benefits of a PAYG type pension system are increased, the voting equilibrium wage level gets closer to the market equilibrium wage, and may even fall below it. Similar results are obtained with respect to labour and consumption taxes.

If wages are set by voting, the resulting employment is higher the higher is the PAYG pension benefit level. The reason is that if the voter claims high current wages, it will lead to lower pensions, and the advantage of lower pension contributions goes to future working generations, not the current median voter. Also, the median voter has to pay higher contributions both because the current wage bill falls and because current pensions may increase due to indexation. Both these generational transfer effects lead the median voter to choose lower wages, which leads to higher employment. This example shows that incentive effects of e.g. pension policies can be drastically different in a unionised economy from the effects in an economy with non-union labour markets.

LITERATURE

Auerbach, A.J. and L.J. Kotlikoff (1987): Dynamic fiscal policy. Cambridge University Press.

Blair, D.H. and D.L. Crawford (1984): Labor Union Objectives and Collective Bargaining. Quarterly Journal of Economics, Vol. XCIX, No. 3, 547 - 566.

Blanchard, O. and N. Kiyotaki (1987): Monopolistic Competition and the Effects of Aggregate Demand. American Economic Review 77, 647 - 666.

Broer, D.P. and J. Lassila, editors (1997): Pension policies and public debt in dynamic CGE models. Physica-Verlag, Heidelberg.

Hawtrey, K. (1990): Dynamic Behaviour of a Unionized Solow-Swan Economy. Economic Record, June, 81 - 92.

Huizinga, F. (1990): An Overlapping Generations Model of Wage Determination. Scandinavian Journal of Economics 92(1), 81 - 98.

Jensen, S.H., S.B. Nielsen, L.H. Pedersen and P.B. Sørensen (1996): Tax policy, housing and the labour market: An intertemporal simulation approach. Economic Modelling, Vol. 13, Issue 3, July, 355 - 382.

Keuschnigg, C. and W. Kohler (1994): Modeling Intertemporal General Equilibrium: An Application to Austrian Commercial Policy. Empirical Economics 19, 131 - 164, and "Appendix", Research Memorandum No. 304, Institute for Advanced Studies, Vienna.

Koskela, Erkki and Jouko Vilmunen (1996): Tax progression is good for employment in popular models of trade union behaviour. Labour Economics 3(1996) 65 - 80.

Lassila, J. and T. Valkonen (1995): Policy credibility in numerical overlapping generations models. ETLA Discussion papers No. 545.

Layard, R., S. Nickell and R. Jackman (1991): Unemployment. Oxford University Press.

Lucas, R.E., Jr (1987): Models of Business Cycles. Basil Blackwell.

Oswald, A. and I. Walker (1993): Labour supply, contract theory and unions. The Institute for Fiscal Studies, Working Paper No. 93/21.

Renström, T.I. and K. Roszbach (1995): Trade unions, employee share ownership and wage setting: A supply-side approach to the share economy. Working paper No. 65, Stockholm School of Economics.

Valkonen, Tarmo (1995): Corporate and Capital Income Tax Reform in a Numerical Overlapping Generations Model: The Case of Finland. ETLA Discussion Papers Nro 543.

Valkonen, Tarmo (1997): Corporate Taxation and Investment Finance in Finland. ETLA Discussion Papers Nro 594.

Table 1. Market-wage and voting equilibria: sensitivity calculations

Parameter	w	L	C	K	F	P^d	A^f	W	CV
basic	102.16	85.59	86.73	86.07	85.88	101.57	1.03	3.36	-3.73
$\gamma = 0.4$	102.20	85.43	86.67	85.92	85.72	101.60	1.84	4.21	-3.80
$\gamma = 0.75$	102.07	85.94	86.81	86.40	86.22	101.50	-0.96	1.27	-3.57
$\rho = 0.375$	100.35	97.39	97.51	97.48	97.45	100.25	-0.61	-0.24	-0.57
$\rho = 0.9$	103.61	77.29	79.04	78.01	77.72	102.61	2.07	6.00	-6.25
$\sigma = 0.6$	102.52	84.74	86.20	85.39	85.14	101.69	0.99	3.47	-3.92
$\sigma = 1.4$	101.85	86.52	87.39	86.86	86.72	101.44	1.06	3.22	-3.45
$\beta = 0.6$	105.51	70.74	73.19	71.77	71.47	103.46	-1.29	4.74	-14.72
$\beta = 0.9$	100.73	94.32	94.73	94.50	94.40	100.60	1.32	1.97	-0.48
$\sigma^E = -5$	105.18	82.91	85.24	84.00	83.56	103.75	-0.17	5.53	-4.03
$\sigma^E = -20$	101.05	86.03	86.70	86.27	86.18	100.76	1.52	2.63	-4.01
s^F=0.5	103.16	79.70	81.21	80.35	80.09	102.29	1.18	4.58	-7.34
Budget rule:									
E	101.32	90.91	91.66	91.22	91.10	100.96	0.78	2.20	-1.40
τ^c	101.32	90.90	91.65	91.21	91.09	100.96	0.78	2.20	-1.41
B^G, τ^c	102.16	85.58	86.72	86.06	85.87	101.57	1.03	3.36	-3.73

Notes: Basic parameter values are: $\gamma = 0.5$, $\rho = 0.75$, $\sigma^E = -10$, $s^F = 0.333$ (see equations 1, 2, A1 and A14. s^F is foreign owners' share of stocks). The figures express ratios of voting equilibrium values to corresponding market-wage equilibrium values. Net foreign assets and total household wealth are expressed in relation to private production, and the figures are percentage point differences between voting and market-wage equilibria. The budget rule tells how the public sector is balanced in the dynamic simulations describing the median voter's calculations. At "E" the budget is balanced by transfers and at τ^c by value-added taxes in all periods, at B^G, τ^c the first period balance is achieved by taking debt, and from then on VAT is used. Compensated variation CV expresses the compensation needed to achieve the same lifetime utility in VW that prevails in corresponding MW. It is expressed as a percentage of discounted lifetime consumption expenditure, and a negative sign implies a welfare loss.

w = wage rate
L = employment
C = total private consumption
K = capital stock
F = production
P^d= terms of trade (price of domestic good)
A^f = net foreign assets
W = total household wealth

Table 2. Market-wage and voting-wage outcomes with different replacement rates θ

a) no indexation ($\lambda = 0$)

Parameter		w	L	C	K	F	P^d	A^f	W	τ^z	CV
$\theta = 0$	*MW*	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000
	VW	1.022	0.856	0.867	0.861	0.859	1.016	1.030	3.355	0.000	-3.730
$\theta = 10$	*MW*	0.939	0.998	0.982	0.998	0.998	0.999	-12.622	-12.818	6.260	-1.310
	VW	0.958	0.864	0.860	0.868	0.867	1.013	-11.899	-9.949	6.260	-5.004
$\theta = 20$	*MW*	0.886	0.997	0.965	0.996	0.996	0.998	-23.809	-24.176	12.516	-2.494
	VW	0.902	0.873	0.855	0.877	0.875	1.011	-23.329	-21.727	12.516	-6.119
$\theta = 30$	*MW*	0.838	0.995	0.951	0.994	0.994	0.997	-33.795	-34.310	18.774	-3.569
	VW	0.852	0.883	0.852	0.886	0.885	1.009	-33.504	-32.242	18.774	-7.068
$\theta = 40$	*MW*	0.795	0.994	0.937	0.992	0.993	0.996	-42.764	-43.409	25.032	-4.551
	VW	0.807	0.891	0.848	0.893	0.892	1.007	-42.617	-41.644	25.032	-7.998
$\theta = 50$	*MW*	0.756	0.992	0.925	0.991	0.991	0.995	-50.864	-51.624	31.290	-5.451
	VW	0.767	0.898	0.845	0.900	0.899	1.005	-50.828	-50.110	31.290	-8.877
$\theta = 60$	*MW*	0.721	0.991	0.915	0.989	0.990	0.994	-58.215	-59.079	37.548	-6.278
	VW	0.730	0.906	0.843	0.907	0.907	1.003	-58.260	-57.801	37.548	-9.636

b) full indexation ($\lambda = 1$)

Parameter		w	L	C	K	F	P^d	A^f	W	τ^z	CV
$\theta = 0$	*MW*	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000
	VW	1.022	0.856	0.867	0.861	0.859	1.016	1.030	-5.941	0.000	-3.730
$\theta = 10$	*MW*	0.939	0.998	0.982	0.998	0.998	0.999	-12.622	28.270	6.260	-1.310
	VW	0.954	0.890	0.884	0.893	0.892	1.010	-11.964	25.004	6.260	-3.846
$\theta = 20$	*MW*	0.886	0.997	0.965	0.996	0.996	0.998	-23.809	47.177	12.516	-2.494
	VW	0.896	0.913	0.891	0.915	0.914	1.006	-23.393	45.211	12.516	-4.516
$\theta = 30$	*MW*	0.838	0.995	0.951	0.994	0.994	0.997	-33.795	60.711	18.774	-3.569
	VW	0.846	0.930	0.894	0.931	0.931	1.003	-33.538	59.458	18.774	-5.404
$\theta = 40$	*MW*	0.795	0.994	0.937	0.992	0.993	0.996	-42.764	70.878	25.032	-4.551
	VW	0.801	0.942	0.893	0.942	0.942	1.001	-42.612	70.033	25.032	-6.388
$\theta = 50$	*MW*	0.756	0.992	0.925	0.991	0.991	0.995	-50.864	78.795	31.290	-5.451
	VW	0.761	0.951	0.890	0.951	0.951	0.999	-50.782	78.213	31.290	-7.364
$\theta = 60$	*MW*	0.721	0.991	0.915	0.989	0.990	0.994	-58.215	85.135	37.548	-6.278
	VW	0.725	0.958	0.887	0.957	0.957	0.998	-58.180	84.723	37.548	-8.315

Notes: The figures express ratios of market wage (*MW*) and voting equilibrium (*VW*) values to market-wage equilibrium base values (top row). Net foreign assets and household wealth are expressed in relation to private production, and the figures are percentage point differences between voting and market-wage equilibria and the base values. *CV* expresses the welfare loss compared to the base case. τ^z is the employer's pension contribution rate. For the other variables see Table 1.

Table 3. Market-wage and voting-wage outcomes with different taxes

a) labour taxes (τ^w)

Parameter		w	L	C	K	F	P^d	A^f	W	E	CV
$\tau^w = 20$	*MW*	1.000	1.010	1.015	1.009	1.009	1.000	4.655	4.598	-6.080	0.420
	VW	1.024	0.849	0.866	0.854	0.852	1.017	5.940	8.480	-6.062	-3.480
$\tau^w = 25$	*MW*	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000
	VW	1.022	0.856	0.867	0.861	0.859	1.016	1.030	3.355	0.000	-3.729
$\tau^w = 30$	*MW*	1.001	0.989	0.984	0.990	0.990	1.000	-4.660	-4.586	6.150	-0.465
	VW	1.020	0.863	0.868	0.867	0.865	1.014	-3.864	-1.744	6.136	-4.019
$\tau^w = 35$	*MW*	1.002	0.978	0.967	0.978	0.978	1.001	-9.327	-9.160	12.372	-0.987
	VW	1.018	0.871	0.870	0.875	0.873	1.013	-8.746	-6.845	12.349	-4.283
$\tau^w = 40$	*MW*	1.003	0.965	0.949	0.965	0.965	1.002	-14.003	-13.720	18.666	-1.583
	VW	1.016	0.877	0.870	0.881	0.880	1.011	-13.611	-11.912	18.638	-4.611

b) VAT (τ^c)

Parameter		w	L	C	K	F	P^d	A^f	W	E	CV
$\tau^c = 0$	*MW*	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000
	VW	1.022	0.856	0.867	0.861	0.859	1.016	1.030	3.355	0.000	-3.729
$\tau^c = 10$	*MW*	1.002	0.984	0.984	0.984	0.984	1.002	-0.427	-0.191	10.000	-0.035
	VW	1.022	0.853	0.864	0.858	0.856	1.016	0.606	2.970	10.000	-3.923
$\tau^c = 20$	*MW*	1.004	0.968	0.969	0.969	0.969	1.003	-0.831	-0.367	20.000	-0.167
	VW	1.022	0.850	0.861	0.855	0.853	1.016	0.191	2.600	20.000	-4.143
$\tau^c = 30$	*MW*	1.006	0.953	0.955	0.955	0.954	1.005	-1.214	-0.531	30.000	-0.376
	VW	1.023	0.849	0.859	0.854	0.852	1.016	-0.228	2.202	30.000	-4.284
$\tau^c = 40$	*MW*	1.008	0.939	0.942	0.941	0.941	1.006	-1.580	-0.684	40.000	-0.645
	VW	1.023	0.845	0.855	0.850	0.848	1.017	-0.629	1.853	40.000	-4.524

Notes: The figures express ratios of market wage (*MW*) and voting equilibrium (*VW*) values to market-wage equilibrium base values (second row in (a), top row in (b)). Net foreign assets and total household wealth are expressed in relation to private production, and the figures are percentage point differences between voting and market-wage equilibria and the base values. Transfers E are expressed as a percentage of total consumption expenditure (excluding VAT). For the other variables see Table 1.

Table 4. Sensitivity of pension and tax effects to key parameter values

a) $\beta = 0.6$

Parameter		w	L	C	K	F	P^d	A^f	W	E
$\beta = 0.6$	*MW*	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000	0.000
	VW	1.055	0.707	0.732	0.718	0.715	1.035	-1.293	4.743	0.000
$\tau^w = 40$	*MW*	1.003	0.967	0.953	0.968	0.968	1.002	-10.278	-9.917	18.661
	VW	1.035	0.792	0.796	0.800	0.798	1.022	-11.198	-7.374	18.611
$\tau^c = 40$	*MW*	1.009	0.944	0.947	0.946	0.946	1.006	-1.440	-0.473	40.000
	VW	1.050	0.728	0.750	0.738	0.735	1.032	-1.944	3.569	40.000
$\theta = 60$,	*MW*	0.722	0.992	0.916	0.990	0.991	0.996	-41.963	-42.658	0.000
$\lambda = 0$	*VW*	0.749	0.788	0.745	0.795	0.793	1.019	-43.992	-40.730	0.000
$\theta = 60$,	*MW*	0.722	0.992	0.916	0.990	0.991	0.996	-41.963	-42.658	0.000
$\lambda = 1$	*VW*	0.729	0.933	0.867	0.934	0.933	1.002	-42.340	-41.982	0.000

b) $\rho = 0.375$

Parameter		w	L	C	K	F	P^d	A^f	W	E
$\rho = 0.375$	*MW*	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000	0.000
	VW	1.004	0.974	0.975	0.975	0.974	1.003	-0.607	-0.236	0.000
$\tau^w = 40$	*MW*	0.998	0.994	0.975	0.993	0.994	0.999	-14.426	-14.591	18.505
	VW	1.000	0.979	0.961	0.979	0.979	1.000	-14.773	-14.729	18.511
$\tau^c = 40$	*MW*	1.002	0.988	0.989	0.988	0.988	1.001	0.116	0.298	40.000
	VW	1.004	0.974	0.976	0.975	0.975	1.003	-0.250	0.126	40.000
$\theta = 60$,	*MW*	0.720	1.002	0.923	0.999	1.000	0.993	-58.010	-59.034	0.000
$\lambda = 0$	*VW*	0.721	0.988	0.911	0.986	0.987	0.994	-58.407	-59.241	0.000
$\theta = 60$,	*MW*	0.720	1.002	0.923	0.999	1.000	0.993	-58.010	-59.034	0.000
$\lambda = 1$	*VW*	0.720	0.999	0.921	0.996	0.997	0.993	-58.106	-59.087	0.000

c) $\sigma^E = -5$

Parameter		w	L	C	K	F	P^d	A^f	W	E
$\sigma^E = -5$	*MW*	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000	0.000
	VW	1.052	1.026	0.852	0.840	0.836	1.038	-0.168	5.532	0.000
$\tau^w = 40$	*MW*	1.005	1.003	0.950	0.966	0.965	1.004	-14.523	-13.949	18.667
	VW	1.037	1.019	0.860	0.866	0.863	1.027	-15.097	-10.983	18.633
$\tau^c = 40$	*MW*	1.017	1.008	0.945	0.943	0.941	1.012	-2.063	-0.242	40.000
	VW	1.052	1.026	0.847	0.837	0.832	1.038	-1.874	3.894	40.000
$\theta = 60$,	*MW*	0.716	0.992	0.911	0.987	0.989	0.989	-58.875	-60.619	0.000
$\lambda = 0$	*VW*	0.740	1.009	0.819	0.879	0.877	1.013	-60.758	-58.784	0.000
$\theta = 60$,	*MW*	0.716	0.992	0.911	0.987	0.989	0.989	-58.875	-60.619	0.000
$\lambda = 1$	*VW*	0.721	0.996	0.890	0.962	0.963	0.994	-59.221	-60.143	0.000

Notes: The figures express ratios of market wage (*MW*) and voting equilibrium (*VW*) values to market-wage equilibrium base values (top row). Net foreign assets and total household wealth are expressed in relation to private production, and the figures are percentage point differences between voting and market-wage equilibria and the base values. Transfers E are expressed as a percentage of total consumption expenditure (excluding VAT). For the other variables see Table 1.

Appendix 1: How to find the voting equilibrium wage level

The voting equilibrium path is found by trial and error. Starting from a stationary fixed-wage equilibrium, we increase the first-period wage slightly, find the new dynamic solution to the economy, calculate the compensated variations and see whether the majority gains or loses. If the majority gains, we calculate a new fixed-wage equilibrium with a higher wage and repeat the dynamic exercise and calculate the compensated variations. After some initial wage level the majority usually looses from a wage increase; then we have passed the voting equilibrium point. The exact point when the gains become losses also depends on the size of the first-period wage increase. Ideally we would like to make an infinitesimal change to the wage.

Figure 4 describes the outcome of a series of wage increase trials. Wages in the initial fixed-wage equilibrium are in the horizontal axis. They are related to the market-wage equilibrium outcome. The gains decline smoothly, and after wages are about three percent over the market-wage equilibrium level, the median voter suffers from a one-period wage increase.

Figure 4. Relative gain from 0.5 percent one-period wage increase in age group 35-40

Compensated variation as a percentage of discounted consumption expenditure during remaining lifetime.

At present, I have no other proof for the existence of a voting equilibrium except that it can be found in practice by the procedure described above. Uniqueness or its absence is probably very difficult to prove, as little is known about it even with market clearing instead of voting. However, nothing has pointed towards multiple equilibria in the experiments.

Appendix 2: The model

Firms

A representative small firm produces the domestic good using capital inherited from the previous period, intermediate goods and labour. Infinite horizon decisions of investment, employment and use of intermediate goods are made to maximise the firm's market value. The firm takes the prices, demand of production and supply of factors at given prices, and production technology and taxation as given. Intermediate and capital goods are costs minimising CES composites of domestic and imported goods. Investments are financed by retained earnings and debt.

The formulation of the production structure follows Keuschnigg and Kohler (1994). The structure applied in this study is essentially a one-sector version of a model intended for multisector use. The structure can be described as follows:

$$F_t = A\left\{\varepsilon K_{t-1}^{1/(1-\beta)} + (1-\varepsilon)L_t^{1/(1-\beta)}\right\}^{\frac{\beta}{\beta-1}} \qquad (A1)$$

$$G(I_t, K_{t-1}) = \xi\frac{I_t^2}{K_{t-1}} \qquad (A2)$$

$$Y_t = \frac{F(K_{t-1},L_t)-G(I_t,K_{t-1})}{1-\zeta} \qquad (A3)$$

The value-added production function F is a CES function of capital and labour. In the process of installing new capital some production is lost due to investment adjustment costs G. These installation costs depend positively on investments and negatively on the amount of capital. The use of the composite intermediate good is determined as a fixed proportion ζ of gross production Y.

Domestic households consider bonds and firms' shares as perfect substitutes in their portfolios. The arbitrage condition between (after-tax[2]) returns on bonds and shares is:

$$r_{t-1}V_{t-1} = D_t + V_t - V_{t-1} \qquad (A4)$$

where the left-hand side describes the invested amount yielding the domestic interest rate. On the right-hand side, the first term is the dividend income and the second term the capital gain.

The arbitrage condition can be transformed to a form where the market value of the shares equals the present value of expected future dividends:

$$V_t = \sum_{s=t+1}^{\infty} D_s \prod_{v=t+1}^{s} \frac{1}{1+r_v} \qquad (A5)$$

[2] All corporate and capital income tax rates in the model have been set to zero and removed from the equations. Valkonen (1995, 1997) has used the same model for tax reform analysis.

The dividends are a residual from the firm's cash flow identity:

$$D_t = P_t^F(F_t - G_t) - (1+\tau_t^z)w_t L_t - r_{t-1}B_{t-1}^f - P_t^K I_t + B_t^f - B_{t-1}^f \qquad (A6)$$

where the dividend in period t is determined by profits before depreciation minus investment expenditure plus any increase in corporate debt. Corporate debt is preferred when financing investments, but its use is limited to a fixed ratio of the replacement value of corporate capital.

The firm chooses the optimal path of investment, use of labour and intermediate goods to maximise the current period dividend and the firm's value at the end of the period. If there are no unexpected shocks, there is no need to revise the optimal plan and it will be followed forever. Capital depreciates at a constant annual rate of d. The constraints of the maximisation are the initial capital stock and an equation describing its dynamics:

$$K_t = K_{t-1}(1-d) + I_t \qquad (A7)$$

Three of the four first order conditions of the constrained optimisation are used as model equations. The first implies that investments should be carried out until the marginal benefit from an additional unit of investment equals the marginal cost. The marginal cost includes the price of a unit of capital plus the installation cost. The condition can be transformed to a q-theory investment equation (A 8). The optimality condition of capital says that capital should be installed until the return of an additional unit is large enough to cover the expenses of carrying the capital to the next period. These expenses include interest, depreciation and the change in the replacement price of capital. This condition is transformed to an equation (A 9) describing the path of the shadow value of the capital. In a steady state this marginal productivity condition of capital can be written as (A 10). The terms within the brackets are the depreciation rate d and the interest cost of the capital stock. The two terms to the right of the brackets are based on adjustment costs linked to replacement investments.

$$I_t = \frac{(q_t - P_t^K)K_{t-1}}{2\xi p_t^F} \qquad (A8)$$

$$q_t = (P_{t+1}^F(F_K - G_K) + q_{t+1}(1-d))\frac{1}{1+r_t} \qquad (A9)$$

$$F_K - G_K = \frac{P^K}{P^F}[d+r] + r\xi d + \xi d^2 \qquad (A10)$$

The third condition says that the marginal benefit of an extra unit of labour should cover wage costs plus the employer's pension contribution:

$$P_t^F F_L = (1+\tau_t^z)w_t \qquad (A11)$$

The fourth condition is a transversality condition ensuring that the discounted shadow value of capital goes to zero as time approaches infinity.

The market value of the firm is linked to the shadow value of the capital in the leveraged firm as follows:

$$V_t = K_t q_t - B_t^f \qquad (A12)$$

where B_t^f is the firm's debt. This link has been derived using the homogeneity of production and capital installation technologies. The value of the firm jumps whenever unexpected news about the firm's future profitability enters the market. Domestic households own a part $(1 - s^F)$ of the firms. When the value of the firms jumps, and changes the households' wealth, they reoptimise their life-cycle plans immediately.

The numerical values of the firm parameters applied in this study are the following: $\beta = 0.7, \varepsilon = 0.36, \xi = 6, \zeta = 0.1, d = 0.5, s^F = 0.333$. The household parameter values are: $\gamma = 0.5, \rho = 0.75, \delta = 0.01, \alpha_0 = 0.8$.

Government sector

The government collects income taxes from wages and from pensions Z, and consumption taxes, and uses the proceeds to pay interest on outstanding debt and to employ civil servants to produce public services. These services are provided free of charge and are not taken into account in individual utility considerations.

$$E_t + L_t^G w_t (1 + \tau_t^z) + r_{t-1} B_{t-1}^G = (L_t w_t + Z_t)\tau_t^w + C_t P_t^C \tau^c \qquad (A13)$$

In the steady states, transfers are used to balance revenues and expenditures of the government every period. The share of public employment is 0.25 of the total employment in steady states. In dynamic simulations describing the median voter's calculations public employment is held constant throughout, the government holds all tax rates constant in the first period, and runs a deficit, and in the following periods balances the budget and freezes the public debt using transfers. Public debt in steady states equals zero.

Foreign sector

The model imitates a small open economy, where the export share of total demand is large. The amount exported depends on the price elasticity of foreign demand:

$$X_t = x\left(\frac{P_t^d}{P_t^M}\right)^{\sigma^E} \qquad (A14)$$

A large negative value for the elasticity implies that a small country has to adjust to the price level of international markets. The basic parameter values are: $x = 0.6, \sigma^E = -10$.

The imported good is used in consumption, investments and as an intermediate good in production. Its price is determined in the international markets. It is an imperfect substitute for the home-made good. The demand conditions are described with a CES structure.

Markets

The model includes four markets, which balance every period. The two labour markets specifications have been described in the text. Total employment equals the sum of private employment and public employment (equation A 15). In the domestic good markets, firms are the sole supplier. The product is used by other firms as a part of the composite intermediate and investment goods, by households as a part of the composite consumption good and by foreign agents. The demand of domestic agents is determined by a cost minimising CES structure. The equilibrium condition which determines the price of the domestic good is equation A 16. Domestic demand for the fixed-price imported good is also determined by minimising costs of the composite goods (the price of the imported good serves as a numeraire in the model). The perfectly elastic supply adjusts to demand in these markets (equation A 17). The fourth market is the capital market. In this market, savings and investment are balanced. The arbitrage condition of domestic households ensures that they are ex ante indifferent between investing their savings in bonds and in firms' shares. Total savings are a sum of domestic savings and foreign portfolio investments. Equation A 18 describes the parallel stock equilibrium.

$$L_t^T = L_t + L^G \qquad (A15)$$

$$Y_t = \zeta Y_t \, v_t^d + I_t \, i_t^d + C_t \, c_t^d + X_t \qquad (A16)$$

$$M_t = \zeta Y_t \, v_t^M + I_t \, i_t^M + C_t \, c^M t \qquad (A17)$$

$$W_t = V_t + B_t^f + B_t^G + A_t^f \qquad (A18)$$

where the unit demands are

$$v_t^M = \left(\frac{mP_t^C}{P_t^M}\right)^{\sigma^M} = i_t^M = c_t^M, \quad v_t^d = \left(\frac{(1-m)P_t^C}{P_t^d}\right)^{\sigma^M} = i_t^d = c_t^d \qquad (A19)$$

The price of the domestic good P^d is endogenous and the price of the imported good serves as the numeraire in the model. Other prices are linked to them according to the following equations. The model facilitates the use of different share parameters m and price elasticities σ to consumption, investment and intermediate goods, but in this study we use the common values $m = 0.3$ and $\sigma^M = 0.99$ to all goods, which explains equations (A19) and (A 22). P^H is the price of the intermediate good.

$$P_t^F = (P_t^d - \zeta P_t^H)/(1-\zeta) \qquad (A20)$$

$$P_t^C = \left[m^{\sigma^M} (P_t^M)^{1-\sigma^M} + (1-m)^{\sigma^M} (P_t^d)^{1-\sigma^M} \right]^{1/(1-\sigma^M)} \qquad (A21)$$

$$P_t^C = P_t^K = P_t^H \qquad (A22)$$

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