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OECDTAX

A MODEL OF TAX POLICY IN THE OECD ECONOMY

by

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I. General features of OECDTAX

This technical working paper presents an applied general equilibrium model called OECDTAX. The model describes the international spillover effects of national tax policies via the world capital market and may be used to illustrate the effects of various forms of international tax coordination. It also shows the effects of tax policies on the labour market in an integrated world economy with structural unemployment. In the empirical applications the model is calibrated to describe the economies of the OECD. Hence the name OECDTAX. The OECDTAX model is an extension of the EUTAX model presented in Sørensen (2001). The extensions include an elaborate modeling of private portfolio composition, the incorporation of a housing market, a distinction between foreign direct investment and foreign portfolio investment, endogenous corporate financial policies, an explicit modeling of the financial sector, and a much more detailed description of the tax system.

The OECDTAX model is static, describing a stationary long-run equilibrium. Variations in endogenous variables may be interpreted as *level* changes in a time path of exogenous steady-state growth. In each national economy firms combine internationally mobile capital with immobile labour to produce a homogeneous internationally traded good. Each country is inhabited by a large number of identical households endowed with a predetermined stock of wealth. A consumer may consume his wealth immediately, or he may accumulate various assets earning a positive rate of return which may be consumed along with the principal at the end of the period. Weighing the return to saving against the disutility of postponing consumption, the utility-maximising consumer chooses to increase his supply of savings as the after-tax real rate of return increases. While *endowments* are exogenous, the supply of *capital* is thus endogenous.

The business sector is divided into a sector of domestic firms with no international operations and a sector of multinational parent companies owning foreign subsidiaries in each of the other countries in the world economy. The product market is competitive, but the labour market is characterized by imperfect competition. Workers are organized in decentralized monopoly trade unions, and each union sets the real wage and the length of the working day for its sector with the purpose of maximising the sum of utilities of its members, subject to the 'right-to-manage' constraint that employers choose the total input of working hours with the purpose of maximising their profits. Union market power leads to some amount of involuntary unemployment as the employed workers' gain from wages above the market-clearing level outweighs the income loss from unemployment. After-tax wages are set as a mark-up over the representative union member's 'outside option' which is the income-equivalent of the expected utility obtainable outside the sector, depending inter alia on after-tax unemployment benefits and on the level of unemployment. Because of rising marginal disutility of work, the working hours set by unions are an increasing function of the after-tax real wage rate.

The world economy is divided into two main regions called the European Union (EU) and the Rest of the World (ROW). Both of the two regions consist of several countries. One country in the ROW region is a tax haven specialized in offering banking services and bank secrecy facilitating international tax evasion. Capital is imperfectly mobile across nations, and the supply of capital to an individual country is an increasing function of the rate of return offered in that country. The OECDTAX model does not explicitly allow for uncertainty, but an incentive for portfolio diversification is generated by modeling the investor's total stock of capital as a CES-aggregate of the capital stock invested in the different countries. With a finite substitution elasticity between different national assets, this specification implies that the investor's aggregate capital stock tends to be more productive - generating a higher net income - if it is spread across countries rather than concentrated in one jurisdiction. The interpretation is that portfolio diversification enables investors to increase their risk-adjusted (certainty-equivalent) income from capital. By parametrically varying the elasticity of substitution between assets invested in different countries, one can vary the degree of capital mobility. In particular, the model is designed to allow for a higher degree of capital mobility within the EU than between the EU and the rest of the world. The model can also account for the possibility that debt instruments issued in the various countries are closer substitutes than shares issued in the different countries.

The government of each country levies indirect taxes on non-durable consumer goods and on housing consumption. It also imposes direct taxes on labour income, unemployment benefits, interest income, corporate profits and the return on shares. In addition, the model includes various withholding taxes and a number of policy variables indicating the extent to which governments engage in international exchange of information to enforce residence-based income taxation. Revenues are spent on public consumption, unemployment benefits and other transfers.

The model relies on simple functional forms to secure analytical tractability and to allow easy identification of the key structural parameters determining the quantitative properties of the model.

Part II of the paper derives the equations describing the household sector, the business sector, the labour market, the capital market, and the government sector. Part III provides a complete summary of all the parameters, variables and equations of the model.

II. Deriving the equations of OECDTAX

In the following, all variables should be understood to refer to a particular country, but country subscripts are left out to avoid notational clutter whenever no misunderstanding is possible.

II.1. Consumption and saving

Each country produces the same homogeneous good which is traded in an integrated international goods market. Output may be used for non-durable consumption C or it may be accumulated as business capital K or as a consumer durable which is interpreted as a stock of owner-occupied housing capital, denoted H. The producer price of output is normalized at unity. Non-durables are subject to a destination-based indirect ad valorem tax rate of t^C, while housing construction is subject to an indirect ad valorem tax t^H (e.g., VAT). In addition, the market value of the housing stock is taxed at the rate τ^H which may include property and wealth tax as well as any income tax on the imputed rental value of owner-occupied housing. To maintain the value of his house until the end of the period, the consumer must incur costs of housing repair at the proportional rate δ^H.

The consumer starts out with a predetermined initial endowment V. He may consume his endowment right away, or he may postpone consumption until the end of the period by investing (part of) the endowment in financial assets S or in housing equity in order to earn a positive return in the form of interest income, shareholder income, or housing services. An endogenous fraction d^H of the acquisition cost of the housing stock is financed by debt which must be repaid with interest i at the end of the period when the house is sold and the consumer consumes all of his wealth. A fraction D^H of the interest expense is deductible against the consumer's marginal personal tax rate m^{rh} on interest income. The consumer also receives after-tax labour income $Wh(1-t)$ (or unemployment benefits), a government lump sum transfer T, and after-tax business profits $\widehat{\pi}$.

With these preliminaries, the budget constraint for an employed worker may be written as

$$\overbrace{\left(1+t^C\right)C}^{\substack{\text{expenses on}\\ \text{non-durables}}} + \overbrace{\left(1+t^H\right)\left[\tau^H+\delta^H+a^H+d^H i\left(1-D^H m^{rh}\right)\right]H}^{\text{expenses on housing}} =$$

$$\overbrace{Wh(1-t)}^{\substack{\text{after-tax}\\ \text{labour income}}} + \overbrace{T}^{\substack{\text{government}\\ \text{transfer}}} + \overbrace{\rho S}^{\substack{\text{after-tax income}\\ \text{from financial}\\ \text{assets}}} + \overbrace{\widehat{\pi}}^{\substack{\text{after-tax}\\ \text{profit}\\ \text{income}}} + \overbrace{V}^{\substack{\text{initial}\\ \text{endowment}}} \tag{1}$$

where W is the hourly real producer wage rate, h is the number of hours worked, t is the effective tax rate on labour income (which may include social security taxes), ρ is the average real *after-tax* return to financial assets, and a^H is the cost of financial distress associated with (excessive) housing debt finance, assumed to be given by

$$a^H = \frac{\left(d^H - \overline{d}^H\right)^{1+\epsilon^H}}{1+\epsilon^H}, \qquad \epsilon^H > 0 \tag{2}$$

Equation (2) reflects the idea that the consumer will suffer increasing marginal costs of financial distress and bankruptcy risk as his housing debt ratio increases above the critical level $\overline{d}^{H}$.

To simplify the consumer's budget constraint, we introduce the definitions

$$S^c = S + \left(1 - d^H\right)\left(1 + t^H\right) H \tag{3}$$

$$PC^c = \left(1 + t^C\right) C + pH \tag{4}$$

$$p = \left(1 + t^H\right)\left[\tau^H + \delta^H + a^H + \left(1 - d^H\right)\rho + d^H i \left(1 - D^H m^{rh}\right)\right] \tag{5}$$

where S^c is comprehensive saving (including investment in housing equity), C^c is comprehensive consumption, P is the general consumer price index, and p is the user cost of housing. Using definitions (3) through (5), we may rewrite the budget constraint (1) as

$$PC^c = Wh\left(1 - t\right) + T + \widehat{\pi} + \rho S^c + V \tag{6}$$

The preferences of the representative consumer are given by the quasi-linear utility function

$$U = \overbrace{C^c}^{\substack{\text{utility}\\ \text{from}\\ \text{consumption}}} - \overbrace{\frac{\left(S^c/P\right)}{1+\varphi}\left(\frac{S^c}{V}\right)^{\varphi}}^{\substack{\text{disutility from}\\ \text{postponing}\\ \text{consumption}}} - \overbrace{\frac{h^{1+\varepsilon}}{1+\varepsilon}}^{\substack{\text{disutility}\\ \text{from}\\ \text{work}}}, \qquad \varphi > 0, \qquad \varepsilon > 0 \tag{7}$$

The second term on the right-hand side of (7) reflects the assumption that the consumer prefers immediate to postponed consumption. The disutility of postponed consumption is seen to increase with the fraction of initial wealth which is saved. This specification implies that the disutility of postponing consumption declines with the level of initial wealth, capturing the idea that wealthier individuals can afford to be more patient. The utility from public consumption does not appear explicitly in (7) since government consumption is kept constant in all experiments with the model.

The utility-generating housing services are assumed to be proportional to the housing stock, with a proportionality factor of unity, and comprehensive consumption is taken to be a Cobb-Douglas aggregate of the consumption of non-durables and the consumption of housing services:

$$C^c = E^{-E} (1 - E)^{E-1} H^E C^{1-E}, \qquad 0 < E < 1 \tag{8}$$

Working hours h are set by trade unions (see section II.4) and are thus taken as given by the individual consumer. The consumer's problem may be solved in stages. In the first stage he optimises comprehensive saving by maximising (7) subject to (6). This yields the savings schedule

$$S^c = \rho^{\frac{1}{\varphi}} \cdot V \tag{9}$$

showing that the elasticity of saving with respect to the after-tax rate of return is given by $1/\varphi$. Substituting (9) into (6), we get the total resources I available to the optimising consumer:

$$PC^c = I = Wh(1-t) + T + \widehat{\pi} + \left(1 + \rho^{\frac{\varphi+1}{\varphi}}\right) V \tag{10}$$

In the second stage the consumer allocates comprehensive consumption across non-durables and housing with the purpose of maximising (8) subject to the constraint $\left(1 + t^C\right) C + pH = I$, implying

$$H = \frac{EI}{p} \tag{11}$$

$$C = \frac{(1-E) I}{1 + t^C} \tag{12}$$

$$P = p^E \left(1 + t^C\right)^{1-E} \tag{13}$$

In the third stage the consumer must choose his housing debt ratio d^H so as to minimise the user cost of housing, since this is a necessary condition for utility maximisation. Using (2) and (5), the first-order condition for the solution to this problem yields

$$d^H = \overline{d}^H + \left[\rho - i\left(1 - D^H m^{rh}\right)\right]^{1/\epsilon^H} \tag{14}$$

An unemployed worker has budget constraints similar to (1), (6) and (10), except that after-tax wage income $WhH(1-t)$ must be replaced by the after-tax rate of unemployment benefit $b^n WhH(1-t)$, where b^n is the net replacement ratio implied by the system of unemployment insurance. Thus the savings, financing and consumption decisions of unemployed individuals are still given by (9) plus (11) through (14).

Having optimised his overall saving and housing investment in this way, the next problem for the consumer is to allocate his financial saving across different asset types.

II.2. Portfolio choice

The consumer's total financial saving equals his comprehensive saving minus his investment in housing equity:

$$S = S^c - \left(1 - d^H\right)\left(1 + t^H\right) H \tag{15}$$

Total financial saving is a CES aggregate of 'institutional saving' S^i capturing pension savings via pension funds, life insurance companies and banks, and 'household saving' S^h representing bank deposits and direct purchases of bonds and shares:

$$S = \left[\Omega^{-\frac{1}{\varpi}} \left(S^i\right)^{\frac{\varpi+1}{\varpi}} + (1-\Omega)^{-\frac{1}{\varpi}} \left(S^h\right)^{\frac{\varpi+1}{\varpi}}\right]^{\frac{\varpi}{\varpi+1}}, \qquad 0 < \Omega < 1 \tag{16}$$

The parameter ϖ is the elasticity of substitution between the two asset types. By definition, the consumer's total net income from financial saving ρS is

$$\rho S = \rho^i \left(1 - c^i\right) S^i + \rho^h S^h, \qquad 0 < c^i < 1 \tag{17}$$

where ρ^h is the net return to household saving, ρ^i is the after-tax return to institutional saving, and c^i is the proportionate intermediation fee charged by the institutional sector to cover the costs of administration and portfolio management (the specification in equation (55) below implies that the rate of return ρ^h is measured net of any intermediation costs).

The consumer allocates his financial wealth across institutional and household saving so as to maximise his total net income from financial saving (17), subject to (16). The latter equation provides a motive for portfolio diversification since it implies that the consumer's total stock of financial wealth is more 'productive' when it is spread across both asset types rather than being concentrated on a single asset. The first-order conditions for the solution to this first stage of the portfolio allocation problem imply that

$$S^i = \left(\frac{\rho^i \left(1 - c^i\right)}{\rho} \right)^{\varpi} \Omega S \tag{18}$$

$$S^h = \left(\frac{\rho^h}{\rho} \right)^{\varpi} \left(1 - \Omega\right) S \tag{19}$$

$$\rho = \left\{ \Omega \left[\rho^i \left(1 - c^i\right) \right]^{\varpi+1} + \left(1 - \Omega\right) \left(\rho^h\right)^{\varpi+1} \right\}^{\frac{1}{\varpi+1}} \tag{20}$$

In subsequent stages of the portfolio optimisation procedure institutional and household savings are allocated across a series of specific asset types issued by different countries. The number of 'normal' countries in the world economy is denoted by n, whereas jurisdiction $n+1$ is a tax haven country attracting household investors but not institutional investors. The first $\overline{n}$ countries in the world represent the EU, while the remaining $n+1-\overline{n}$ jurisdictions make up the rest of the world (ROW). In the specifications given below, the ρ's are after-tax rates of return to the various asset aggregates, the $\widetilde{\rho}$'s are after-tax returns to shares, and the $\widetilde{i}$'s are net interest rates on debt instruments (denoted 'bonds' for convenience). The superscripts s and b indicate 'shares' and 'bonds', respectively, while superscripts u, n, d and f denote 'EU-region', ROW-region', 'domestic', and 'foreign', respectively. A subscript v indicates the country of source from where the income originates, whereas a subscript j refers to the residence country where the investor is domiciled. These country subscripts are included only when necessary to avoid confusion. A share issued by firms in country v is denoted E_v, and a debt instrument (bond) issued in that country is denoted B_v. Recalling that superscript i stands for 'institutional investor' whereas h stands for 'household investor', and remembering that a superscripted S represents a particular asset aggregate, the specification of the various asset aggregates and financial incomes may then be summarized as follows:

Institutional saving: stocks versus bonds

$$S^i = \left[\left(\Upsilon^i\right)^{-\frac{1}{\theta^i}} \left(S^{is}\right)^{\frac{\theta^i+1}{\theta^i}} + \left(1-\Upsilon^i\right)^{-\frac{1}{\theta^i}} \left(S^{ib}\right)^{\frac{\theta^i+1}{\theta^i}} \right]^{\frac{\theta^i}{\theta^i+1}}, \qquad 0 < \Upsilon^i < 1 \tag{21}$$

$$\rho^i S^i = \rho^{is} S^{is} + \rho^{ib} S^{ib} \tag{22}$$

Institutional saving: EU stocks versus ROW stocks

$$S^{is} = \left[\left(\Psi^i\right)^{-\frac{1}{\sigma^i}} \left(S^{isu}\right)^{\frac{\sigma^i+1}{\sigma^i}} + \left(1-\Psi^i\right)^{-\frac{1}{\sigma^i}} \left(S^{isn}\right)^{\frac{\sigma^i+1}{\sigma^i}} \right]^{\frac{\sigma^i}{\sigma^i+1}}, \qquad 0 < \Psi^i < 1 \tag{23}$$

$$\rho^{is} S^{is} = \rho^{isu} S^{isu} + \rho^{isn} S^{isn} \tag{24}$$

Institutional saving: aggregate of EU stocks

$$S^{isu} = \left[\sum_{v=1}^{\overline{n}} \left(\phi_v^i\right)^{-\frac{1}{\omega^i}} \left(E_v^{iu}\right)^{\frac{\omega^i+1}{\omega^i}} \right]^{\frac{\omega^i}{\omega^i+1}}, \qquad \sum_{v=1}^{\overline{n}} \phi_v^i = 1 \tag{25}$$

$$\rho^{isu} S^{isu} = \sum_{v=1}^{\overline{n}} \widetilde{\rho}_v^i E_v^{iu} \tag{26}$$

Institutional saving: aggregate of ROW stocks

$$S^{isn} = \left[\sum_{v=\overline{n}+1}^{n} \left(\Phi_v^i\right)^{-\frac{1}{\zeta^i}} \left(E_v^{in}\right)^{\frac{\zeta^i+1}{\zeta^i}} \right]^{\frac{\zeta^i}{\zeta^i+1}}, \qquad \sum_{v=\overline{n}+1}^{n} \Phi_v^i = 1 \tag{27}$$

$$\rho^{isn} S^{isn} = \sum_{v=\overline{n}+1}^{n} \widetilde{\rho}_v^i E_v^{in} \tag{28}$$

Institutional saving: EU bonds versus ROW bonds

$$S^{ib} = \left[\left(\Lambda^i\right)^{-\frac{1}{\beta^i}} \left(S^{ibu}\right)^{\frac{\beta^i+1}{\beta^i}} + \left(1-\Lambda^i\right)^{-\frac{1}{\beta^i}} \left(S^{ibn}\right)^{\frac{\beta^i+1}{\beta^i}} \right]^{\frac{\beta^i}{\beta^i+1}}, \qquad 0 < \Lambda^i < 1 \tag{29}$$

$$\rho^{ib} S^{ib} = \rho^{ibu} S^{ibu} + \rho^{ibn} S^{ibn} \tag{30}$$

Institutional saving: aggregate of EU bonds

$$S^{ibu} = \left[\sum_{v=1}^{\overline{n}} \left(\upsilon_v^i\right)^{-\frac{1}{\kappa^i}} \left(B_v^{iu}\right)^{\frac{\kappa^i+1}{\kappa^i}} \right]^{\frac{\kappa^i}{\kappa^i+1}}, \qquad \sum_{v=1}^{\overline{n}} \upsilon_v^i = 1 \tag{31}$$

$$\rho^{ibu} S^{ibu} = \sum_{v=1}^{\overline{n}} \widetilde{i}_v^i B_v^{iu} \tag{32}$$

Institutional saving: aggregate of ROW bonds

$$S^{ibn} = \left[\sum_{v=\overline{n}+1}^{n} \left(\digamma_v^i\right)^{-\frac{1}{\gamma^i}} \left(B_v^{in}\right)^{\frac{\gamma^i+1}{\gamma^i}} \right]^{\frac{\gamma^i}{\gamma^i+1}}, \qquad \sum_{v=\overline{n}+1}^{n} \digamma_v^i = 1 \tag{33}$$

$$\rho^{ibn} S^{ibn} = \sum_{v=\overline{n}+1}^{n} \widetilde{i}_v^i B_v^{in} \tag{34}$$

Household saving: stocks versus bonds

$$S^h = \left[\left(\Upsilon^h\right)^{-\frac{1}{\theta^h}} \left(S^{hs}\right)^{\frac{\theta^h+1}{\theta^h}} + \left(1-\Upsilon^h\right)^{-\frac{1}{\theta^h}} \left(S^{hb}\right)^{\frac{\theta^h+1}{\theta^h}} \right]^{\frac{\theta^h}{\theta^h+1}}, \qquad 0 < \Upsilon^h < 1 \tag{35}$$

$$\rho^h S^h = \rho^{hs} S^{hs} + \rho^{hb} S^{hb} \tag{36}$$

Household saving: domestic stocks versus foreign stocks

$$S^{hs} = \left[\Theta^{-\frac{1}{\varrho}} \left(S^{hsd}\right)^{\frac{\varrho+1}{\varrho}} + (1-\Theta)^{-\frac{1}{\varrho}} \left(S^{hsf}\right)^{\frac{\varrho+1}{\varrho}} \right]^{\frac{\varrho}{\varrho+1}}, \qquad 0 < \Theta < 1 \tag{37}$$

$$\rho^{hs} S^{hs} = \rho^{hsd} S^{hsd} + \rho^{hsf} S^{hsf} \tag{38}$$

Household saving: EU stocks versus ROW stocks

$$S^{hsf} = \left[\left(\Psi^h\right)^{-\frac{1}{\sigma^h}} \left(S^{hsu}\right)^{\frac{\sigma^h+1}{\sigma^h}} + \left(1-\Psi^h\right)^{-\frac{1}{\sigma^h}} \left(S^{hsn}\right)^{\frac{\sigma^h+1}{\sigma^h}} \right]^{\frac{\sigma^h}{\sigma^h+1}}, \qquad 0 < \Psi^h < 1 \tag{39}$$

$$\rho^{hsf} S^{hsf} = \rho^{hsu} S^{hsu} + \rho^{hsn} S^{hsn} \tag{40}$$

Household saving: aggregate of EU stocks (held by investor residing in country j)

$$S^{hsu} = \left[\sum_{v=1,\ v\neq j}^{\overline{n}} \left(\phi^h_{vj}\right)^{-\frac{1}{\omega^h}} \left(E^{hu}_{vj}\right)^{\frac{\omega^h+1}{\omega^h}} \right]^{\frac{\omega^h}{\omega^h+1}}, \qquad \sum_{v=1,\ v\neq j}^{\overline{n}} \phi^h_v = 1 \tag{41}$$

$$\rho^{hsu} S^{hsu} = \sum_{v=1,\ v\neq j}^{\overline{n}} \widetilde{\rho}^h_{vj} E^{hu}_{vj} \tag{42}$$

Household saving: aggregate of ROW stocks (held by investor residing in country j)

$$S^{hsn} = \left[\sum_{v=\overline{n}+1,\ v\neq j}^{n} \left(\Phi_{vj}^{h}\right)^{-\frac{1}{\zeta^h}} \left(E_{vj}^{hn}\right)^{\frac{\zeta^h+1}{\zeta^h}} \right]^{\frac{\zeta^h}{\zeta^h+1}}, \qquad \sum_{v=\overline{n}+1,\ v\neq j}^{n} \Phi_{v}^{h} = 1 \tag{43}$$

Household saving: domestic bonds versus foreign bonds

$$S^{hb} = \left[\Delta^{-\frac{1}{\xi}} \left(S^{hbd}\right)^{\frac{\xi+1}{\xi}} + (1-\Delta)^{-\frac{1}{\xi}} \left(S^{hbf}\right)^{\frac{\xi+1}{\xi}} \right]^{\frac{\xi}{\xi+1}}, \qquad 0 < \Delta < 1 \tag{44}$$

$$\rho^{hb} S^{hb} = \rho^{hbd} S^{hbd} + \rho^{hbf} S^{hbf} \tag{45}$$

Household saving: EU bonds versus ROW bonds

$$S^{hbf} = \left[\left(\Lambda^h\right)^{-\frac{1}{\beta^h}} \left(S^{hbu}\right)^{\frac{\beta^h+1}{\beta^h}} + \left(1-\Lambda^h\right)^{-\frac{1}{\beta^h}} \left(S^{hbn}\right)^{\frac{\beta^h+1}{\beta^h}} \right]^{\frac{\beta^h}{\beta^h+1}}, \qquad 0 < \Lambda^h < 1 \tag{46}$$

$$\rho^{hbf} S^{hbf} = \rho^{hbu} S^{hbu} + \rho^{hbn} S^{hbn} \tag{47}$$

Household saving: aggregate of EU bonds (held by investor residing in country j)

$$S^{hbu} = \left[\sum_{v=1,\ v\neq j}^{\overline{n}} \left(\upsilon_{vj}^{h}\right)^{-\frac{1}{\kappa^h}} \left(B_{vj}^{hu}\right)^{\frac{\kappa^h+1}{\kappa^h}} \right]^{\frac{\kappa^h}{\kappa^h+1}}, \qquad \sum_{v=1,\ v\neq j}^{\overline{n}} \upsilon_{vj}^{h} = 1 \tag{48}$$

$$\rho_j^{hbu} S_j^{hbu} = \sum_{v=1,\ v\neq j}^{\overline{n}} \widetilde{i}_{vj}^{h} B_{vj}^{hu} \tag{49}$$

Household saving: aggregate of ROW bonds (held by investor residing in country j)

$$S^{hbn} = \left[\sum_{v=\overline{n}+1,\ v\neq j}^{n+1} \left(\digamma_{vj}^{h}\right)^{-\frac{1}{\gamma^h}} \left(B_{vj}^{hn}\right)^{\frac{\gamma^h+1}{\gamma^h}} \right]^{\frac{\gamma^h}{\gamma^h+1}}, \qquad \sum_{v=\overline{n}+1,\ v\neq j}^{n+1} \digamma_{vj}^{h} = 1 \tag{50}$$

$$\rho_j^{hbn} S_j^{hbn} = \sum_{v=\overline{n}+1,\ v\neq j}^{n+1} \widetilde{i}_{vj}^{h} B_{vj}^{hn} \tag{51}$$

For households as opposed to institutional investors, equations (37) and (44) introduce a separate layer of substitution between domestic and foreign assets. This is motivated by the fact that, for a household investor, the decision to invest abroad rather than at home will often involve a decision to evade domestic tax. This decision - and hence the degree of substitutability of foreign and domestic assets - will be influenced by the household's attitude towards risk and tax fraud and by the information and transactions costs of entering foreign asset markets. By contrast, institutional investors which are monitored by external accountants and regulators are assumed not to engage in tax evasion and to face lower information barriers of entry to foreign asset markets.

In each successive stage of the process of portfolio optimisation, the institutional or household investor chooses a mix of assets within a particular asset aggregate so as to maximise the total after-tax return to that aggregate. The outcome of this optimisation yields asset demand functions and a set of average net returns to asset aggregates of a form quite similar to equations (18) through (20) above. All of these asset demand functions and net returns are summarized in section III under the heading 'Portfolio choice'.

II.3. The taxation of portfolio investment

In specifying the after-tax returns to stocks and bonds for portfolio investors, we must describe the rules regarding the taxation of shareholder income and interest income. Many OECD countries relieve the double taxation of dividends arising under a so-called classical corporate tax system where distributed corporate profits are subject to corporate tax as well as income tax at the level of the investor. Roughly speaking, OECD governments have applied two different methods for alleviating the double taxation of dividends. Some countries do so by simply applying a separate personal tax rate to dividends which is lower than the ordinary marginal personal income tax rate. Other countries use a system of dividend tax credits where shareholders are granted a credit against their personal tax for part or all of the corporate tax on the profits underlying the dividend. Under the latter so-called imputation system, the imputation rate $\widehat{u}_v$ reflects the amount of pre-paid corporation tax which is credited to the shareholder. Under a system of full imputation where the double taxation of dividends is fully alleviated, the imputation rate $\widehat{u}_v$ is equal to the corporate tax rate τ_v^d on distributed profits, whereas a system of partial imputation is characterized by $\widehat{u}_v < \tau_v^d$. If a household investor residing in country v with a personal tax rate on dividends equal to m_v^{dh} receives one unit of dividend net of corporation tax, his dividend income is 'grossed-up' by the amount $1/(1-\widehat{u}_v)$ and subject to an amount of dividend tax $m_v^{dh}/(1-\widehat{u}_v)$. To arrive at the shareholder's net tax liability, the dividend tax bill is then reduced by an imputation credit (dividend tax credit) $\widehat{u}_v/(1-\widehat{u}_v)$ intended to compensate for the underlying corporation tax already paid by the company. Hence the net personal tax rate on the net dividend paid out by the corporation is $\left(m_v^{dh}-\widehat{u}_v\right)/(1-\widehat{u}_v)$. We introduce a dummy variable D_{vj}^I which is unity when the source country v grants imputation credits to shareholders in residence country j. In a country without an imputation system we obviously have $D_{vj}^I = 0$ for all v and j. Normally imputation countries only grant credits to their own residents, implying $D_{vj}^I = 0$ for $v \neq j$, but some countries with imputation systems have agreed to extend their credits to some foreign residents via bilateral tax treaties.

With this notation we may specify the residence country tax rate z_{vj}^h on shareholder income from source country v accruing to a household shareholder in residence country j as

$$z_{vj}^h = p_v^d \left[\left(1 - D_{vj}^I\right) m_j^{dh} + D_{vj}^I \left(\frac{m_j^{dh} - \widehat{u}_v}{1 - \widehat{u}_v} \right) \right] + \left(1 - p_v^d\right) m_j^{ch}, \qquad 0 < p_v^d < 1, \qquad \forall\, v, j \tag{52}$$

where p_v^d is the exogenous fraction of the total return on shares which takes the form of dividends (so that $1 - p_v^d$ is the fraction of the total return taking the form of capital gains), and m_j^{ch} is the effective marginal personal tax rate on *accrued* capital gains on shares. In reality, capital gains to household investors are normally taxed only upon realization, and short term 'speculative' gains are often taxed at a different (higher) rate than gains realized after a longer holding period. Moreover, when calculating the taxable increase in the value of the share, a few countries allow the acquisition price of the share to be indexed by the rate of inflation to prevent taxation of purely nominal gains. Suppose that residence country j applies a statutory tax rate τ_j^{chs} to taxable gains realized by a household investor within the first n_j^s years after the acquisition of the shares, and another statutory tax rate τ_j^{chl} to taxable gains realized after that time. Consider a shareholder who has scored a unit real capital gain on his shares right after having acquired them, and suppose that he realizes a fraction a_j^{cs} of his gain every year within the first n_j^s years, and a fraction a_j^{cl} of the remaining gain every year after that time. Finally, let $\widetilde{i}_{jj}^h$ denote the after-tax *real* discount rate applied by the household investor (to be specified in equation (55.b) below), let $\widetilde{p}$ be the rate of inflation, and let D_j^{cp} be a dummy equal to unity when country j allows indexation of the basis (acquisition price) of shares, and zero otherwise. The so-called accruals-equivalent tax rate may then be found in the following manner as the hypothetical tax on accrued capital gains which is equal in present value to the stream of realizations-based taxes actually paid:

$$m_j^{ch} = \tau_j^{chs} \left[a_j^{cs} + \frac{a_j^{cs}\left(1-a_j^{cs}\right)\left(1+\widetilde{p}-D_j^{cp}\widetilde{p}\right)}{\left(1+\widetilde{i}_{jj}^h\right)\left(1+\widetilde{p}\right)} \right.$$

$$\left. + \frac{a_j^{cs}\left(1-a_j^{cs}\right)^2\left(1+\widetilde{p}-D_j^{cp}\widetilde{p}\right)^2}{\left[\left(1+\widetilde{i}_{jj}^h\right)\left(1+\widetilde{p}\right)\right]^2} + \ldots.. + \frac{a_j^{cs}\left(1-a_j^{cs}\right)^{n_j^s-1}\left(1+\widetilde{p}-D_j^{cp}\widetilde{p}\right)^{n_j^s-1}}{\left[\left(1+\widetilde{i}_{jj}^h\right)\left(1+\widetilde{p}\right)\right]^{n_j^s-1}} \right]$$

$$+\tau_j^{chl}\frac{\left(1-a_j^{cs}\right)^{n_j^s}\left(1+\widetilde{p}-D_j^{cp}\widetilde{p}\right)^{n_j^s}}{\left[\left(1+\widetilde{i}_{jj}^h\right)\left(1+\widetilde{p}\right)\right]^{n_j^s}} \left[a_j^{cl} + \frac{a_j^{cl}\left(1-a_j^{cl}\right)\left(1+\widetilde{p}-D_j^{cp}\widetilde{p}\right)}{\left(1+\widetilde{i}_{jj}^h\right)\left(1+\widetilde{p}\right)} \right.$$

$$\left. + \frac{a_j^{cl}\left(1-a_j^{cl}\right)^2\left(1+\widetilde{p}-D_j^{cp}\widetilde{p}\right)^2}{\left[\left(1+\widetilde{i}_{jj}^h\right)\left(1+\widetilde{p}\right)\right]^2} + \ldots\ldots \right] \Longleftrightarrow$$

$$m_j^{ch} = \left(1+\widetilde{i}_{jj}^h\right)\left\{\frac{\tau_j^{chs}a_j^{cs}}{a_j^{cs}+\widetilde{i}_{jj}^h+\frac{D_j^{cp}\widetilde{p}\left(1-a_j^{cs}\right)}{1+\widetilde{p}}}+\right.$$

$$\left.\left(\frac{\left(1-a_j^{cs}\right)\left(1-\frac{D_j^{cp}\widetilde{p}}{1+\widetilde{p}}\right)}{1+\widetilde{i}_{jj}^h}\right)^{n_j^s}\left[\frac{\tau_j^{chl}a_j^{cl}}{a_j^{cl}+\widetilde{i}_{jj}^h+\frac{D_j^{cp}\widetilde{p}\left(1-a_j^{cl}\right)}{1+\widetilde{p}}}-\frac{\tau_j^{chs}a_j^{cs}}{a_j^{cs}+\widetilde{i}_{jj}^h+\frac{D_j^{cp}\widetilde{p}\left(1-a_j^{cs}\right)}{1+\widetilde{p}}}\right]\right\} \tag{53}$$

Accounting for the possibility that residence countries may not always be able to enforce their tax claims, and assuming that cross-border investment in shares (as opposed to domestic investment) involves an additional information and transaction cost equal to a fraction c^s of the pre-tax return, we may now specify the after-tax return to a household investor in residence country j on shares issued in source country v as

$$\widetilde{\rho}_{vj}^h = \widehat{\rho}_v^m\left[1-D_{vj}^{hs}z_{vj}^h-\left(1-D_{vj}^{hs}\right)p_v^d\tau_{vj}^{sw}-c_j^s\right], \qquad 0 \leq D_{vj}^{hs} \leq 1, \qquad v \neq j \tag{54.a}$$

$$\widetilde{\rho}_{jj}^h = \rho_j^{hsd} = \widehat{\rho}_j\left[1-D_{jj}^{hs}z_{jj}^h-\left(1-D_{jj}^{hs}\right)p_j^d\tau_{jj}^{sw}\right] \tag{54.b}$$

where $\widehat{\rho}_v^m$ and $\widehat{\rho}_j$ are the rates of return on shares before imposition of tax at the investor level. The variable D_{vj}^{hs} measures the proportion of shareholder income from source country v which is reported to (and hence taxed by) the tax authorities in residence country j. In the case of foreign investment ($v \neq j$) and no effective international exchange of information, we may have $D_{vj}^{hs} = 0$ in which case the investor will only have to pay the withholding tax rate τ_{vj}^{sw} on his dividend. If the income is reported to the home country tax authorities, the investor will get a credit for the withholding tax against his home country tax. In the case of domestic investment ($v = j$) the tax authorities will often be able to monitor the shareholder's income, at least if companies are obliged to report their dividend payments to the tax authorities. In that case we have $D_{jj}^{hs} = 1$. Again, the shareholder will normally be granted a credit against his personal income tax for any domestic withholding tax τ_{jj}^{sw}on dividends. As we shall explain in section II.10, a household investor's return on domestic shares will be governed by the return $\widehat{\rho}_j$ obtainable on shares in domestic corporations with no foreign operations, as indicated in (54.b). The return obtainable on foreign shares is governed by the return $\widehat{\rho}_v^m$ on internationally traded shares issued by multinational corporations, as shown in (54.a).

The net return on foreign bonds (including bank deposits) for a household investor is specified as

$$\widetilde{i}_{vj}^h = i_v (1-c) \left[1 - D_{vj}^{hb} m_j^{rh} - \left(1 - D_{vj}^{hb}\right) \tau_{vj}^{bw} - c_j^b\right], \qquad 0 \leq D_{vj}^{hb} \leq 1, \qquad v \neq j \quad (55.a)$$

while the net return on domestic bonds is

$$\widetilde{i}_{jj}^h = i_j (1-c) \left[1 - D_{jj}^{hb} m_j^{rh} - \left(1 - D_{jj}^{hb}\right) \tau_{jj}^{bw}\right] \quad (55.b)$$

The parameter c is the exogenous intermediation fee charged on household investments in debt instruments, reflecting inter alia the bank spread between deposit and lending rates. When the household investor invests abroad, he faces an additional information and transaction cost captured by the parameter c_j^b in equation (55.a). m_j^{rh} is the effective personal tax rate on interest income in residence country j, τ_{vj}^{bw} is the withholding tax rate on interest paid from source country v to residence country j, and D_{vj}^{hb} is the proportion of interest income reported to the residence country tax authorities. If there is an automatic reporting system for domestic interest paid to domestic residents, we have $D_{jj}^{hb} = 1$, but for foreign source interest income ($v \neq j$) the lack of effective international information exchange will typically imply $D_{vj}^{hb} < 1$. Note that the intermediation fee c is assumed to be the same across countries due to the existence of an integrated international market for banking services.

We now turn to institutional investors, assuming that in so far as the returns to institutional saving are subject to residence country tax (which will typically not be the case for pension saving), the tax rates are those set by the residence country of the household savers who have supplied the funds. This seems a reasonable approximation, given that households typically channel their pension savings via institutions located in their home country. We introduce a dummy variable D_j^{is} which is unity if the residence country j imposes tax on income from shares accruing to institutional investors, and zero otherwise. We thus assume that any residence country tax can be fully enforced, since institutional investors are typically public companies subject to external auditing. For institutional savings undertaken by savers in residence country j, the after-tax return to shares issued by source country v is therefore given by

$$\widetilde{\rho}^{i}_{vj} = \widehat{\rho}^{m}_{v} \left[1 - D^{is}_{j} z^{i}_{vj} - \left(1 - D^{is}_{j}\right) p^{d}_{v} \tau^{sw}_{vj} - c^{s}_{j}\right], \qquad v \neq j \tag{56.a}$$

$$\widetilde{\rho}^{i}_{jj} = \widehat{\rho}^{m}_{j} \left[1 - D^{is}_{j} z^{i}_{jj} - \left(1 - D^{is}_{j}\right) p^{d}_{j} \tau^{sw}_{jj}\right] \tag{56.b}$$

where z^{i}_{vj} is the effective residence country tax rate on shareholder income from source country v accruing to an institutional investor in residence country j. By analogy to (52), this tax rate is specified as

$$z^{i}_{vj} = p^{d}_{v} \left[\left(1 - D^{I}_{vj}\right) m^{di}_{j} + D^{I}_{vj} \left(\frac{m^{di}_{j} - \widehat{u}_{v}}{1 - \widehat{u}_{v}}\right)\right] + \left(1 - p^{d}_{v}\right) m^{ci}_{j} \tag{57}$$

where m^{di}_{j} is the institutional investor's tax rate on dividend income, and m^{ci}_{j} is his effective tax rate on accrued capital gains on shares. In some cases (e.g. in Denmark) institutional investors are subject to accruals-based capital gains taxation, whether or not the gains have been realized. We introduce a dummy D^{cia}_{j} which is unity in case of accruals-based taxation and zero otherwise, and we denote the institutional investor's tax rate on accrued capital gains by τ^{cia}_{j}. When capital gains are taxed at the time of realization, we use the notation τ^{cis}_{j} and τ^{cil}_{j} to indicate the institutional investor's statutory tax rates on realized short term gains and long term gains, respectively. Noting that $\widetilde{i}^{i}_{jj}$ is the institutional investor's real after-tax discount rate, and calculating the accruals-equivalent realizations-based capital gains tax rate in the same manner as we did for household investors, we find that

$$m^{ci}_{j} = D^{cia}_{j} \tau^{cia}_{j} + \left(1 - D^{cia}_{j}\right) \left(1 + \widetilde{i}^{i}_{jj}\right) \left\{ \frac{\tau^{cis}_{j} a^{cs}_{j}}{a^{cs}_{j} + \widetilde{i}^{i}_{jj} + \frac{D^{cp}_{j} \widetilde{p}\left(1 - a^{cs}_{j}\right)}{1 + \widetilde{p}}} + \right.$$

$$\left(\frac{\left(1-a_j^{cs}\right)\left(1-\frac{D_j^{cp}\widetilde{p}}{1+\widetilde{p}}\right)}{1+\widetilde{i}_{jj}^i}\right)^{n_j^s}\left[\frac{\tau_j^{cil}a_j^{cl}}{a_j^{cl}+\widetilde{i}_{jj}^i+\frac{D_j^{cp}\widetilde{p}\left(1-a_j^{cl}\right)}{1+\widetilde{p}}}-\frac{\tau_j^{cis}a_j^{cs}}{a_j^{cs}+\widetilde{i}_{jj}^i+\frac{D_j^{cp}\widetilde{p}\left(1-a_j^{cs}\right)}{1+\widetilde{p}}}\right]\Bigg\} \tag{58}$$

The after-tax rate of return on bonds issued by source country v and held by an institutional investor in residence country j is

$$\widetilde{i}_{vj}^i = i_v\left[1-D_j^{ib}m_j^{ri}-\left(1-D_j^{ib}\right)\tau_{vj}^{bw}-c_j^b\right], \qquad v\neq j \tag{59.a}$$

$$\widetilde{i}_{jj}^i = i_j\left[1-D_j^{ib}m_j^{ri}-\left(1-D_j^{ib}\right)\tau_{jj}^{bw}\right] \tag{59.b}$$

where i_v is the pre-tax interest rate in country v, D_j^{ib} is a dummy for residence-based taxation of the interest income of institutional investors, m_j^{ri} is the effective residence country tax rate on interest income accruing to an institutional investor, and τ_{vj}^{bw} is the withholding tax rate on interest paid out from source country v to residence country j, for which the investor will normally receive a credit if he is subject to a residence-based tax.

II.4. The business sector

Each country is endowed with a predetermined stock $\overline{A}_j$ of a fixed factor which I will refer to as 'intangible assets' and which may be thought of as human capital, technological and management know-how, etc. An exogenous fraction s_j^m of these assets is allocated to a sector of multinational corporations which are headquartered in country j and which own foreign subsidiaries in all the other countries in the world economy. The remaining fraction of the country's intangible assets is allocated to domestic corporations with no foreign operations. In the following, the superscript m will refer to the multinational sector, while variables with no such superscript will refer to the sector of domestic corporations. If the stock of intangibles held by the latter sector is A, and the intangible asset stock held by the multinational sector is A^m, we thus have

$$\overline{A}_j = A_j + A_j^m, \qquad A_j^m = s_j^m\overline{A}_j, \qquad 0<s_j^m<1 \tag{60}$$

II.4.1. Domestic corporations

In the sector of domestic corporations the output Y of the representative competitive firm is given by the Cobb-Douglas production function

$$Y = A^{1-\alpha-\beta} L^{\alpha} K^{\beta}, \qquad 0 < \alpha < 1, \qquad 0 < \beta < 1 \tag{61}$$

where L is effective labour input, and K is the capital stock invested in domestic corporations. The after-tax economic profit Π of a domestic corporation is

$$\Pi = Y - WL - \left[\widehat{\rho}\,(1-d) + di + a^d + \delta\right] K - \tau \widehat{\Pi} \tag{62}$$

where $\widehat{\rho}$ is the cost of equity finance, d is the domestic corporation's debt-asset ratio, a^d is the cost of financial distress associated with (excessive) debt finance (measured per unit of capital), δ is the true rate of economic depreciation, τ is the average corporate income tax rate (which is a weighted average of the tax rates on distributed and retained profits; see (65) below), and $\widehat{\Pi}$ is taxable corporate income. If $\widetilde{\delta}$ is the rate of depreciation for tax purposes, and α^d is the share of interest payments which is allowed to be deducted against taxable corporate income, we have

$$\widehat{\Pi} = Y - WL - \left(\alpha^d di + a^d + \widetilde{\delta}\right) K \tag{63}$$

The variable a^d measures the costs of financial distress, including potential bankruptcy costs. We may think of these costs as the value of the output and sales volume which is lost as financial distress diverts the attention of managers from production and marketing to the monitoring of short term cash flows. In that case there is an implicit tax deduction for such costs, as assumed in (63). The costs of financial distress are specified as

$$a^d = \frac{\left(d - \overline{d}\right)^{1+\epsilon^d}}{1+\epsilon^d}, \qquad \epsilon^d > 0, \qquad 0 < \overline{d} < 1 \tag{64}$$

As demonstrated below, profit maximisation will imply that $d > \overline{d}$ in the normal case where $\widehat{\rho} > i\left(1 - \alpha^d \tau\right)$. This in turn will ensure that $\partial a^d / \partial d > 0$. In the firm's optimum the costs of financial distress will thus increase with the debt-asset ratio, in accordance with conventional theory.

Historically, a few OECD countries have operated a so-called 'split rate' corporate tax system where the corporate income tax rate on distributed profits τ^d differs from the tax rate on retained profits τ^r. If $\widehat{g}$ is the fraction of taxable profits which is paid out as dividends (the pay-out ratio), the average corporate income tax rate may be written as

$$\tau = \widehat{g}\tau^d + (1 - \widehat{g})\,\tau^r \tag{65}$$

For later purposes, we also introduce the variable r to denote the domestic corporation's marginal cost of finance (which will be found to govern investment):

$$r = \widehat{\rho}\,(1 - d) + di\left(1 - \alpha^d \tau\right) + a^d\,(1 - \tau) \tag{66}$$

In (63) we have expressed depreciation for tax purposes as a fraction $\widetilde{\delta}$ of the true book value of the capital stock, K. We therefore need to derive the relationship between $\widetilde{\delta}$ and the statutory depreciation rate $\widehat{\delta}$ which is applied to the value of the capital stock recorded in the firm's tax accounts. For this purpose, and treating time t as a continous variable for convenience, we note that the present value $\widehat{A}$ of the depreciation allowed in the tax account on a unit of capital purchased at time zero will be

$$\widehat{D} = \widehat{\delta} \int_0^\infty e^{-\left(\widehat{\delta}+r\right)t} dt = \frac{\widehat{\delta}}{\widehat{\delta} + r}$$

whereas the present value D^* of the true economic depreciation on the extra unit of capital is

$$D^* = \delta \int_0^\infty e^{-(\delta+r)t} dt = \frac{\delta}{\delta + r}$$

Using these expressions, we find that

$$\frac{\widetilde{\delta}}{\delta} = \frac{\widehat{D}}{D^*} = \frac{\widehat{\delta}\,(\delta + r)}{\delta\left(\widehat{\delta} + r\right)} \qquad \Longleftrightarrow \qquad \widetilde{\delta} = \frac{\widehat{\delta}\,(\delta + r)}{\widehat{\delta} + r} \tag{67}$$

The competitive domestic corporation chooses L, K, and d to maximise Π subject to (61), (63) and (64). The first-order conditions for the solution to the firm's problem can be shown to imply that

$$\alpha\left(Y/L\right) = W \tag{68}$$

$$\beta\left(Y/K\right) = \frac{r + \delta - \tau\widetilde{\delta}}{1-\tau} \tag{69}$$

$$d = \overline{d} + \left[\frac{\widehat{\rho} - i\left(1-\alpha^{d}\tau\right)}{1-\tau}\right]^{1/\epsilon^{d}} \tag{70}$$

Equations (68) and (69) are standard marginal productivity conditions determining factor demands. Equation (70) shows that the optimal debt ratio increases with the difference between the cost of equity finance $\widehat{\rho}$ and the cost of debt finance $i\left(1-\alpha^{d}\tau\right)$.

As section II.6 will make clear, it will be useful to disaggregate the input of labour for purposes of modeling the labour market. I therefore assume that aggregate labour input L is a CES aggregate of the inputs of $\overline{s}$ different types of specific labour skills L^{q}, each earning a wage rate W^{q}, and with a substitution elasticity λ between the different skill types:

$$L = \overline{s}^{\left(\frac{\lambda}{1-\lambda}\right)}\left[\sum_{q=1}^{\overline{s}}\left(L^{q}\right)^{\frac{\lambda-1}{\lambda}}\right]^{\frac{\lambda}{\lambda-1}}, \qquad \lambda > 1 \tag{71}$$

Having optimised its total labour input L in accordance with (68), the firm chooses the input of each particular skill type so as to minimise its total wage bill

$$WL = \sum_{q=1}^{\overline{s}} W^{q}L^{q}$$

subject to (70), yielding the labour demand functions

$$L^q = \left(\frac{W^q}{W}\right)^{-\lambda} \frac{L}{\overline{s}}, \qquad q = 1, ..., \overline{s} \tag{72}$$

and the average wage cost

$$W = \left[\frac{1}{\overline{s}} \sum_{q=1}^{\overline{s}} (W^q)^{1-\lambda}\right]^{\frac{1}{1-\lambda}}$$

Finally, we find from (62), (68) and (69) that the after-tax profits earned in domestic corporations will be

$$\Pi = (1-\tau)(1-\alpha-\beta) Y \tag{73}$$

II.4.2. Multinational corporations

Multinational companies distinguish themselves from domestic corporations by owning subsidiaries operating abroad. I assume that each parent company headquartered in the domestic country j owns one subsidiary in each foreign country v. In the following, the superscript m always refers to the domestic parent company, while superscript F refers to a foreign subsidiary. The production function of the parent company is

$$Y_j^m = \left(A_j^m\right)^{1-\alpha_j-\beta_j} \left(L_j^m\right)^{\alpha_j} \left(K_j^m\right)^{\beta_j} \tag{74}$$

The parent company may transfer part of its output as an input Q_{vj} used in the production process of the foreign subsidiary in country v. The true cost of the input is equal to the producer price of output which is unity, but the parent may choose to charge a transfer price $p_{vj}^Q \neq 1$ to the subsidiary with the purpose of shifting taxable profits between the parent and the subsidiary. If the transfer price deviates from the true input price, the multinational is assumed to incur organizational costs a_{vj}^Q arising from distorted pricing of intracompany transactions. The parent company's after-tax economic profits from *domestic* sources are thus given by

$$\Pi_j^m = \left(1-\tau_j^m\right)\left[Y_j^m - W_j L_j^m + \sum_{v=1,\ v\neq j}^{n}\left(p_{vj}^Q - 1 - a_{vj}^Q\right)Q_{vj} - a_j^{dm} K_j^m\right]$$

$$-\left[\widehat{\rho}_j^m\left(1-d_j^m\right) + d_j^m i_j + \delta_j - \tau_j^m\left(\alpha_j^d d_j^m i_j + \widetilde{\delta}_j^m\right)\right]K_j^m \tag{75}$$

The organizational costs of distorted transfer prices are assumed to be

$$a_{vj}^Q = \frac{\left(p_{vj}^Q - 1\right)^{1+\epsilon_j^Q}}{1+\epsilon_j^Q} \qquad \text{for } \tau_{vj}^F \geq \tau_j^m \tag{76.a}$$

and

$$a_{vj}^Q = \frac{\left(1 - p_{vj}^Q\right)^{1+\epsilon_j^Q}}{1+\epsilon_j^Q} \qquad \text{for } \tau_{vj}^F < \tau_j^m \tag{76.b}$$

As we shall see, the multinational will have an incentive to set $p_{vj}^Q > 1$ when $\tau_{vj}^F > \tau_j^m$ and to choose $p_{vj}^Q < 1$ when $\tau_{vj}^F < \tau_j^m$ in order to shift taxable profits from high-tax to low-tax jurisdictions. Thus the specifications in (76) ensure that the costs of deviating from the 'correct' transfer price will always be positive. Note that government regulation of transfer prices may raise the costs of deviating from the correct transfer price by raising the value of the parameter ϵ_j^Q.

By analogy to (66), the multinational parent's marginal cost of finance can be shown to consist of the costs of financial distress plus a weighted average of the costs of equity and debt finance, i.e.

$$r_j^m = \widehat{\rho}_j^m\left(1-d_j^m\right) + d_j^m i_j\left(1-\alpha_j^d\tau_j^m\right) + a_j^{dm}\left(1-\tau_j^m\right) \tag{77}$$

The fact that $\widehat{\rho}_j^m$ and i_j carry the country subscript j reflects the assumption that the country-specific risk characteristics of the multinational's equity and of the debt associated with its domestic operations are the risks attached to the parent company's home country.

As a parallel to (64), the parent's costs of financial distress per unit of capital are given by

$$a_j^{dm} = \frac{\left(d_j^m - \overline{d}_j^m\right)^{1+\epsilon_j^d}}{1+\epsilon_j^d} \tag{78}$$

and analogously to (67), the relation between depreciation for tax purposes and true economic depreciation is

$$\widetilde{\delta}_j^m = \frac{\widehat{\delta}_j\left(\delta_j + r_j^m\right)}{\widehat{\delta}_j + r_j^m} \tag{79}$$

Consider next the foreign subsidiaries of the multinational. For a foreign subsidiary owned by a parent in country j and operating in country v, output Y_{vj}^F is given by the Cobb-Douglas technology

$$Y_{vj}^F = \left(s_j\overline{Q}_v\right)^{1-\varsigma_v-\alpha_v^F-\beta_v^F}\left(Q_{vj}\right)^{\varsigma_v}\left(L_{vj}^F\right)^{\alpha_v^F}\left(K_{vj}^F\right)^{\beta_v^F}, \qquad 0<\varsigma_v+\alpha_v^F+\beta_v^F<1 \tag{80}$$

The exogenous variable $\overline{Q}_v$ is a fixed public input which is an indicator of the extent to which the infrastructure of the host country v promotes the effective local utilization of the specific assets of foreign multinationals. We assume that a foreign multinational headquartered in country j benefits from this local input in proportion to the size of the home country j, measured by that country's share of world population, s_j. Because $\overline{Q}_v$ is a public input, the pure (after-tax) profits arising from the exploitation of this fixed factor accrue to the owners of the domestic parent company, forming part of total household income in the parent company's home country j.

If τ_{vj}^F is the multinational company's total average tax rate on profits generated by a foreign subsidiary in country v, the parent's after-tax economic profits from this subsidiary (Π_{vj}^F) are equal to

$$\Pi_{vj}^F = \left(1-\tau_{vj}^F\right)\left(Y_{vj}^F - W_vL_{vj}^m - p_{vj}^QQ_{vj} - a_{vj}^{dF}K_{vj}^F\right)$$

$$-\left[\widehat{\rho}_j^m\left(1-d_{vj}^F\right)+d_{vj}^F i_v+\delta_v-\tau_{vj}^F\left(\alpha_v^d d_{vj}^F i_v+\widetilde{\delta}_{vj}^F\right)\right]K_{vj}^F \tag{81}$$

Equation (81) assumes that the subsidiary is 100 percent owned by the parent which thus provides the subsidiary with all of its equity at an opportunity cost equal to the cost of equity $\widehat{\rho}_j^m$ in the parent's home country j. In addition, the subsidiary finances a fraction d_{vj}^F of its capital stock by issuing debt in the foreign host country v. For later purposes, we specify the subsidiary's marginal cost of finance as

$$r_{vj}^F=\widehat{\rho}_j^m\left(1-d_{vj}^F\right)+d_{vj}^F i_v\left(1-\alpha_v^d\tau_{vj}^F\right)+a_{vj}^{dF}\left(1-\tau_{vj}^F\right) \tag{82}$$

and the subsidiary's cost of financial distress is

$$a_{vj}^{dF}=\frac{\left(d_{vj}^F-\overline{d}_v^m\right)^{1+\epsilon_v^d}}{1+\epsilon_v^d} \tag{83}$$

The international tax rules described in section II.5 below imply that the total tax rate on distributed foreign source profits τ_{vj}^d may deviate from the total tax rate τ_{vj}^r on profits which are retained abroad. Assuming that a fraction $\widehat{g}_j^F$ of taxable foreign source profits is distributed to the parent company, we thus have

$$\tau_{vj}^F=\widehat{g}_j^F\tau_{vj}^d+\left(1-\widehat{g}_j^F\right)\tau_{vj}^r \tag{84}$$

where τ_{vj}^d and τ_{vj}^r include taxes paid by the parent as well as the subsidiary. The taxable profits in the foreign subsidiary in source country v are

$$\widehat{\Pi}_{vj}^F\equiv Y_{vj}^F-W_vL_{vj}^m-p_{vj}^QQ_{vj}-\left(\alpha_v^d d_{vj}^F i_v+a_{vj}^{dF}+\widetilde{\delta}_{vj}^F\right)K_{vj}^F \tag{85.a}$$

where the rate of depreciation for tax purposes is given by an expression similar to (67) and (79):

$$\widetilde{\delta}_{vj}^F=\frac{\widehat{\delta}_v\left(\delta_v+r_{vj}^F\right)}{\widehat{\delta}_v+r_{vj}^F} \tag{86}$$

The parent company's taxable profits from *domestic* sources are

$$\widehat{\Pi}_j^m \equiv Y_j^m - W_j L_j^m - \left(\alpha_j^d d_j^m i_j + a_j^{dm} + \widetilde{\delta}_j^m\right) K_j^m + \sum_{v=1,\ v\neq j}^{n} \left(p_{vj}^Q - 1 - a_{vj}^Q\right) Q_{vj} \qquad (85.b)$$

Recall that any domestic taxes paid by the parent company on its foreign source income are included in the variables τ_{vj}^F specified earlier. If the parent distributes a fraction $\widehat{g}_j^m$ of its total taxable profits (including taxable foreign-source income) as dividends, its effective corporate tax rate on domestic source income will be

$$\tau_j^m = \widehat{g}_j^m \tau_j^d + \left(1 - \widehat{g}_j^m\right) \tau_j^r \qquad (87)$$

The multinational chooses L_j^m, K_j^m, d_j^m, Q_{vj}, p_{vj}^Q, L_{vj}^F, K_{vj}^F, and d_{vj}^F so as to maximise its global after-tax economic profits

$$\Pi_j^{gm} = \Pi_j^m + \sum_{v=1,\ v\neq j}^{n} \Pi_{vj}^F$$

and the first-order conditions can be shown to imply that

$$Q_{vj} = \frac{\left(1 - \tau_{vj}^F\right) \varsigma_v Y_{vj}^F}{\left(\tau_j^m - \tau_{vj}^F\right) p_{vj}^Q + \left(1 - \tau_j^m\right) \left(1 + a_{vj}^Q\right)} \qquad (88)$$

$$\alpha_j \left(Y_j^m / L_j^m\right) = W_j \qquad (89)$$

$$\beta_j \left(Y_j^m / K_j^m\right) = \frac{r_j^m + \delta_j - \tau_j^m \widetilde{\delta}_j^m}{1 - \tau_j^m} \qquad (90)$$

$$d_j^m = \overline{d}_j + \left[\frac{\widehat{\rho}_j^m - i_j \left(1 - \alpha_j^d \tau_j^m\right)}{1 - \tau_j^m}\right]^{1/\epsilon_j^d} \qquad (91)$$

$$p_{vj}^{Q} = 1 + \left(\frac{\tau_{vj}^{F} - \tau_{j}^{m}}{1 - \tau_{j}^{m}} \right)^{1/\epsilon_{j}^{Q}} \qquad \text{for} \quad \tau_{vj}^{F} \geq \tau_{j}^{m} \tag{92.a}$$

$$p_{vj}^{Q} = 1 - \left(\frac{\tau_{j}^{m} - \tau_{vj}^{F}}{1 - \tau_{j}^{m}} \right)^{1/\epsilon_{j}^{Q}} \qquad \text{for} \quad \tau_{vj}^{F} < \tau_{j}^{m} \tag{92.b}$$

$$\alpha_{v}^{F} \left(Y_{vj}^{F} / L_{vj}^{F} \right) = W_{v} \tag{93}$$

$$\beta_{v}^{F} \left(Y_{vj}^{F} / K_{vj}^{F} \right) = \frac{r_{vj}^{F} + \delta_{v} - \tau_{vj}^{F} \widetilde{\delta}_{vj}^{F}}{1 - \tau_{vj}^{F}} \tag{94}$$

$$d_{vj}^{F} = \overline{d}_{v} + \left[\frac{\widehat{\rho}_{j}^{m} - i_{v} \left(1 - \alpha_{v}^{d} \tau_{vj}^{F} \right)}{1 - \tau_{vj}^{F}} \right]^{1/\epsilon_{v}^{d}} \tag{95}$$

Like domestic corporations, multinationals must allocate their labour input across the $\overline{s}$ different skill types to mimise their total wage bill, once they have optimised their aggregate labour demand in accordance with (89) and (93). In parallel to (72), this yields the labour demand schedules

$$L_{j}^{qm} = \left(\frac{W_{j}^{q}}{W_{j}} \right)^{-\lambda_{j}} \frac{L_{j}^{m}}{\overline{s}}, \qquad q = 1, ..., \overline{s}_{j} \tag{95}$$

$$L_{vj}^{qF} = \left(\frac{W_{v}^{q}}{W_{v}} \right)^{-\lambda_{v}} \frac{L_{vj}^{F}}{\overline{s}}, \qquad q = 1, ..., \overline{s}_{v} \tag{96}$$

II.5. The taxation of income from foreign direct investment

In equation (84), we specified the corporate tax rate on income from foreign direct investment as

$$\tau_{vj}^{F}=\widehat{g}_{j}^{F}\tau_{vj}^{d}+\left(1-\widehat{g}_{j}^{F}\right)\tau_{vj}^{r} \tag{97}$$

Even if the home country of the parent company imposes corporate tax on the parent's income from foreign subsidiaries, such home country tax is usually deferred until the time the income is repatriated, whereas profits which are retained abroad will normally only be subject to ordinary corporation tax in the foreign host country. However, when retention of (after-tax) profits abroad generates a capital gain on the shares held by the parent company, the parent may have to pay a residence-based corporate capital gains tax (denoted by τ_{j}^{cm}) to the home country. Hence we have

$$\tau_{vj}^{r}=\tau_{v}^{r}+\left(1-\tau_{v}^{r}\right)\tau_{j}^{cm} \tag{98}$$

In specifying the effective capital gains tax rate τ_{j}^{cm} we assume that a parent company does not acquire shares in a foreign subsidiary for the purpose of scoring a short term capital gain. Specifically, we assume that the parent company realizes a fraction a_{j}^{cm} of its capital gain per year, but only *after* expiry of the first period n_{j}^{sm} in which a gain is defined and taxed as a 'speculative' gain. In our previous equation (53), such behaviour would correspond to $a_{j}^{cs}=0$. Following the procedure used to derive (53), and using a dummy D_{j}^{cm} to allow for the possibility that the basis value of the shares owned by parent companies may be indexed, the parent's effective tax rate on accrued capital gains on shares in the foreign subsidiary is then found to be

$$\tau_{j}^{cm}=\frac{\tau_{j}^{sml}a_{j}^{cm}\left(1-\frac{D_{j}^{cm}\widetilde{p}}{1+\widetilde{p}}\right)^{n_{j}^{sm}}}{\left[1+i_{j}\left(1-\alpha_{j}^{d}\tau_{j}^{m}\right)\right]^{n_{j}^{sm}-1}\left[a_{j}^{cm}+i_{j}\left(1-\alpha_{j}^{d}\tau_{j}^{m}\right)+\frac{D_{j}^{cm}\widetilde{p}\left(1-a_{j}^{cm}\right)}{1+\widetilde{p}}\right]} \tag{99}$$

The tax rate on distributed foreign source profits τ_{vj}^{d} will depend on the method of international double tax relief which is written into the domestic tax law or into the bilateral tax treaties of the parent company's home country. Under the pure *exemption* method foreign source income is simply exempt from home country tax, so the tax paid on distributed foreign source profits will consist of the foreign host country corporate tax rate on distributed profits $\left(\tau_{v}^{d}\right)$ plus any source country withholding tax

$\left(\tau_{vj}^{wF}\right)$ on dividends from foreign direct investment, i.e., $\tau_{vj}^{d} = \tau_{v}^{d} + \tau_{vj}^{wF}\left(1-\tau_{v}^{d}\right)$. However, some residence countries only exempt a fraction (denoted D_{j}^{ee}) of the net dividend from foreign sources, thus imposing an amount of domestic corporation tax equal to $\tau_{j}^{m}\left(1-D_{j}^{ee}\right)\left(1-\tau_{v}^{d}\right)\left(1-\tau_{vj}^{wF}\right)$ on the non-exempt fraction.

On top of this, some countries with an imputation system impose a so-called equalization tax on the parent company when it distributes dividends received from foreign subsidiaries to its domestic shareholders. The purpose of this equalization tax is to offset the dividend tax credit received by the domestic shareholder in view of the fact that the corporation tax paid on the underlying profits has accrued to the foreign rather than the domestic government. In practice the tax code contains ordering rules specifying when the dividends paid by the parent company are considered to originate from foreign sources. These rules imply that the equalization tax imposed on the parent company will depend inter alia on the relative importance of its foreign-source and its domestic-source income. This relative importance will vary from company to company, but we assume that, on average, a fraction $\widehat{g}_{j}^{m}$ of the after-tax foreign-source dividends are paid out to domestic shareholders (equal to the parent company's average pay-out ratio). If the imputation rate is $\widehat{u}_{j}$, if the foreign source income is fully exempted from domestic corporation tax, and if we denote the total tax rate on repatriated profits under the exemption method by τ_{vj}^{de}, the parent company must then pay an equalization tax equal to $\widehat{g}_{j}^{m}\left(1-\tau_{vj}^{de}\right)\widehat{u}_{j}/\left(1-\widehat{u}_{j}\right)$ per unit of after-tax dividend received from the foreign subsidiary, corresponding to the dividend tax credit granted to shareholders when the foreign source income is distributed. If the foreign source income is only partially exempt from domestic corporate tax, the domestic tax already paid on the foreign income is subtracted from the equalization tax bill. Using a dummy D_{j}^{E} which is unity when the residence country applies an equalization tax, the total effective tax rate on repatriated foreign-source income under the exemption method may then be written as follows:

$$\tau_{vj}^{de} = \overbrace{\tau_{v}^{d}}^{\substack{\text{foreign}\\ \text{corporation}\\ \text{tax}}} + \overbrace{\tau_{vj}^{wF}\left(1-\tau_{v}^{d}\right)}^{\substack{\text{foreign}\\ \text{withholding}\\ \text{tax}}} + \overbrace{\tau_{j}^{m}\left(1-D_{j}^{ee}\right)\left(1-\tau_{v}^{d}\right)\left(1-\tau_{vj}^{wF}\right)}^{\substack{\text{ordinary domestic}\\ \text{corporation tax}}}$$

$$+D_j^E \overbrace{\left\{ \underbrace{\frac{\widehat{u}_j \widehat{g}_j^m \left(1-\tau_{vj}^{de}\right)}{1-\widehat{u}_j}}_{\substack{\text{imputation credits attached} \\ \text{to foreign-source dividends}}} - \tau_j^m \left(1-D_j^{ee}\right)\left(1-\tau_v^d\right)\left(1-\tau_{vj}^{wF}\right) \right\}}^{\text{domestic equalization tax}} \Longleftrightarrow$$

$$\tau_{vj}^{de} = \frac{\tau_v^d + \tau_{vj}^{wF}\left(1-\tau_v^d\right) + \tau_j^m\left(1-D_j^E\right)\left(1-D_j^{ee}\right)\left(1-\tau_v^d\right)\left(1-\tau_{vj}^{wF}\right) + D_j^E\left(\frac{\widehat{u}_j\widehat{g}_j^m}{1-\widehat{u}_j}\right)}{1+D_j^E\left(\frac{\widehat{u}_j\widehat{g}_j^m}{1-\widehat{u}_j}\right)} \tag{100}$$

As an alternative to exemption, the home country may impose domestic tax on 'grossed-up' foreign source dividends but grant a *credit* for foreign taxes paid against the domestic tax liability. Normally the amount of credit is limited to the total amount of domestic tax liable on the foreign source income. This limitation means that the credit method is equivalent to the exemption method whenever the sum of foreign corporation and withholding taxes exceeds the ordinary domestic coporation tax on the pre-tax foreign income. Again, imputation countries may in addition impose an equalization tax to recover the difference between the dividend tax credit granted to shareholders when the foreign-source income net of the total tax τ_{vj}^{dcs} is distributed, $\left(\frac{\widehat{u}_j\widehat{g}_j^m}{1-\widehat{u}_j}\right)\left(1-\tau_{vj}^{dcs}\right)$, and the net *domestic* corporate tax which has been paid on foreign income, denoted $\widetilde{T}_{vj}^{sF} \equiv \tau_j^m - \left[\tau_v^d + \left(1-\tau_v^d\right)\tau_{vj}^{wF}\right]$. Under this so-called system of credit by source the total tax rate on repatriated foreign income is therefore equal to

$$\tau_{vj}^{dcs} = \tau_j^m + D_j^E\left[\frac{\widehat{u}_j\widehat{g}_j^m\left(1-\tau_{vj}^{dcs}\right)}{1-\widehat{u}_j} - \widetilde{T}_{vj}^{sF}\right] \Longleftrightarrow$$

$$\tau_{vj}^{dcs} = \frac{\tau_j^m + D_j^E\left[\frac{\widehat{u}_j\widehat{g}_j^m}{1-\widehat{u}_j} - \widetilde{T}_{vj}^{sF}\right]}{1+D_j^E\left(\frac{\widehat{u}_j\widehat{g}_j^m}{1-\widehat{u}_j}\right)} \quad \text{for} \quad \widetilde{T}_{vj}^{sF} \equiv \tau_j^m - \left[\tau_v^d + \left(1-\tau_v^d\right)\tau_{vj}^{wF}\right] \geq 0 \tag{101.a}$$

$$\tau_{vj}^{dcs} = \tau_{vj}^{de} \quad \text{for} \quad \widetilde{T}_{vj}^{sF} < 0 \tag{101.b}$$

The relations in (101) describe the method of 'credit by source' where the limitation on the foreign tax credit is applied to each foreign source country separately. However, some countries like Japan and the United States only apply the limit on the foreign tax credit if the total foreign tax on total foreign source income exceeds the domestic tax liability on aggregate foreign income. Under this method of 'worldwide credit' the total tax rate τ_{vj}^{dcw}on repatriated foreign profits is given as

$$\tau_{vj}^{dcw} = \frac{\tau_j^m + D_j^E \left[\frac{\widehat{u}_j \widehat{g}_j^m}{1-\widehat{u}_j} - \widetilde{T}_{vj}^{sF}\right]}{1 + D_j^E \left(\frac{\widehat{u}_j \widehat{g}_j^m}{1-\widehat{u}_j}\right)} \quad \text{for} \quad \widetilde{T}_j^F \equiv \sum_{v=1,\ v \neq j}^{n} \widetilde{T}_{vj}^{sF} \widehat{g}_j^F \widehat{\Pi}_{vj}^F \geq 0 \tag{102.a}$$

$$\tau_{vj}^{dcw} = \tau_{vj}^{de} \quad \text{for} \quad \widetilde{T}_j^F < 0 \tag{102.b}$$

The specifications (101) and (102) assume that the parent's home country accepts the definition of taxable profits applied in foreign source countries. In practice, home countries using the credit method sometimes calculate the limitation on the foreign tax credit by applying the domestic tax rate to the foreign source profits calculated on the basis of *domestic* rules for defining the foreign tax base. For simplicity, the OECDTAX model ignores this complication.

A third method for international double tax relief which is rarely used is the method of *deduction* under which the home country imposes tax on foreign source dividends after deduction of foreign tax. The domestic corporate tax burden (excluding equalization tax) on the foreign source income will then be $\tau_j^m \left(1 - \tau_v^d\right) \left(1 - \tau_{vj}^{wF}\right)$. In principle, if τ_{vj}^{dd} is the total tax rate on repatriated profits under the deduction method, any equalization tax must equal the difference between the imputation credit granted to shareholders, $\left(\frac{\widehat{g}_j^m \widehat{u}_j}{1-\widehat{u}_j}\right) \left(1 - \tau_{vj}^{dd}\right)$, and the domestic corporate tax $\tau_j^m \left(1 - \tau_v^d\right) \left(1 - \tau_{vj}^{wF}\right)$ already paid on the foreign profits. However, it can be shown that this amount of equalization tax is always non-positive. Hence we may ignore any equalization tax under a deduction system, so the effective corporate-level tax rate on distributed foreign source profits becomes

$$\tau_{vj}^{dd} = \tau_v^d + \left(1 - \tau_v^d\right) \tau_{vj}^{wF} + \tau_j^m \left(1 - \tau_v^d\right) \left(1 - \tau_{vj}^{wF}\right) \tag{103}$$

Let us now introduce the dummy variables

$D_{vj}^{e} = 1$ if residence country j grants exemption vis á vis source country v; $D_{vj}^{e} = 0$ otherwise

$D_{vj}^{cs} = 1$ if residence country j grants credit by source vis á vis source country v; $D_{vj}^{cs} = 0$ otherwise

$D_{vj}^{cw} = 1$ if residence country j grants worldwide credit vis á vis source country v; $D_{j}^{cw} = 0$ otherwise

$D_{vj}^{d} = 1$ if residence country j applies the deduction method vis á vis source country v; $D_{vj}^{d} = 0$ otherwise

Using this notation along with (100) through (103), we may now specify the effective corporate tax rate on repatriated foreign direct investment income as follows:

$$\tau_{vj}^{d} = D_{vj}^{e}\tau_{vj}^{de} + +D_{vj}^{d}\tau_{vj}^{dd} + D_{vj}^{cs}\tau_{vj}^{dcs} + D_{vj}^{cw}\tau_{vj}^{dcw}, \qquad v \neq j \tag{104}$$

II.6. Dividend payout ratios

We may also use the above notation to specify the fraction of taxable profits which is taxed as dividends. In the derivations above, we have used p^{d} to denote the fraction of the *true* return to equity ($\widehat{\rho}$ and $\widehat{\rho}^{m}$) which is subject to dividend tax, while $\widehat{g}$ and $\widehat{g}^{m}$ denoted the fraction of *taxable* profits which is taxed as dividends. By definition, the ratio of these two magnitudes must equal the ratio between the true return to equity and taxable profits. For multinational companies we therefore have the identity

$$\widehat{g}_{j}^{m} =$$

$$\frac{p_{j}^{d}\widehat{\rho}_{j}^{m}\left[K_{j}^{m}\left(1-d_{j}^{m}\right)+\sum_{v=1,\ v\neq j}^{n}K_{vj}^{F}\left(1-d_{vj}^{F}\right)\right]}{\widehat{\Pi}_{j}^{m}+\sum_{v=1,\ v\neq j}^{n}\left\{\left(1-\tau_{v}^{d}\right)\left(1-\tau_{vj}^{wF}\right)\left[D_{vj}^{e}\left(1-D_{j}^{ee}\right)+D_{vj}^{d}\right]+D_{vj}^{cs}+D_{vj}^{cw}\right\}\widehat{g}_{j}^{F}\widehat{\Pi}_{vj}^{F}} \tag{105}$$

where the numerator is the distributed part of the true return to the total equity invested in the multinational, and the denominator is that part of the multinational's global profits which is taxable in the home country.

For domestic corporations we have the simpler identity

$$\widehat{g}_j = \frac{p_j^d \widehat{\rho}_j K_j (1 - d_j)}{\widehat{\Pi}_j} \qquad (106)$$

In the OECDTAX model p_j^d is treated as an exogenous variable common to domestic corporations and domestically-based multinationals, while $\widehat{g}_j^m$ and $\widehat{g}_j$ are determined endogenously via the two equations above.

II.7. Wage setting, working hours and unemployment

While the output market is perfectly competitive, the labour market is characterized by imperfect competition. Labour of each skill type is organized in a monopoly craft union setting the wage rate and working hours for its skill type. If a worker fails to find employment within the union to which he initially belongs, he may seek a job elsewhere in the domestic economy. In that case he will remain unemployed with probability $f(u)$, where u is the average economywide unemployment rate, and $0 < f(u) < 1$ for $0 < u < 1$ reflects the assumption of some labour mobility across skill types.

In setting wages and work hours, the union for workers of skill type q maximises its members' expected consumer surplus from work, U^{uq}. This is a weighted average of the consumer surplus from work within the union, $\frac{W^q h^q (1-t)}{P} - \frac{(h^q)^{1+\varepsilon}}{1+\varepsilon}$, and the average expected surplus $\overline{U}$ obtainable elsewhere in the labour market, with the weight being determined by the unemployment rate u^q for the skill type in question:

$$U^{uq} = (1 - u^q) \left[\frac{W^q h^q (1-t)}{P} - \frac{(h^q)^{1+\varepsilon}}{1+\varepsilon} \right] + u^q \overline{U} \qquad (107)$$

Since employers have the right to manage, the union must account for their labour demand curves. If L^a is aggregate labour demand and N is the total labour force, and if the initial allocation of workers across skill types is symmetric, it follows from (72), (95) and (96) and the definition of unemployment that the union for workers of skill type q faces the constraint

$$h^q (1 - u^q) \overbrace{\frac{N}{\overline{s}}}^{\text{members of union } q} = \overbrace{\left(\frac{W^q}{W}\right)^{-\lambda} \frac{L^a}{\overline{s}}}^{\text{demand for work hours of type } q} \qquad (108)$$

where the aggregate demand for labour input in country j is the sum of the demand emanating from domestic corporations and multinationals, including foreign-owned subsidiaries operating in the country:

$$L_j^a = L_j + L_j^m + \sum_{v=1,\ v \neq j}^{n} L_{jv}^F \tag{109}$$

Since there are many skill types, each union takes aggregate employment, the general wage and price level and the outside option $\overline{U}$ as given when maximising (107) with respect to W^q and h^q, subject to (108). The first-order conditions for the solution to the union's problem can be shown to imply that

$$\frac{(h^q)^{1+\varepsilon}}{1+\varepsilon} = \frac{\overline{U}}{\varepsilon} \tag{110}$$

$$\frac{W^q h^q (1-t)}{P} = \left(\frac{\lambda}{\lambda - 1}\right)\left(\frac{1+\varepsilon}{\varepsilon}\right)\overline{U} \tag{111}$$

From (111) we see that the union sets the after-tax real income of its members as a mark-up over the value of the outside option. The mark-up is higher the lower the substitution elasticity λ between skill types, i.e. the lower the wage elasticity of demand for the individual skill type. Using variables without q-superscripts to denote economywide averages, we may specify the outside option as

$$\overline{U} = [1 - f(u)]\left[\frac{Wh(1-t)}{P} - \frac{h^{1+\varepsilon}}{1+\varepsilon}\right] + f(u)\left[\frac{b^n Wh(1-t)}{P}\right], \qquad 0 < b^n < 1 \tag{112}$$

where $f(u)$ is the probability that the worker remains unemployed when seeking a job outside his original trade, and the last term on the right-hand side is the real net rate of unemployment benefit, with b^n denoting the average net replacement ratio. Since the value for $\overline{U}$ in (112) is the same for all unions, it follows from (110) through (112) that they will all set the same wage rates and working hours. Setting $W^q = W$ and $h^q = h$ and assuming that $f(u)$ takes the constant-elasticity form $f(u) = u^\eta$, we then find from (110) through (112) that

$$h = \left[\left(\frac{\lambda - 1}{\lambda} \right) \frac{W(1-t)}{P} \right]^{1/\varepsilon} \tag{113}$$

$$u = \left\{ \frac{1+\varepsilon}{\lambda\left[(1-b^n)(1+\varepsilon)-1\right]+1} \right\}^{1/\eta}, \qquad \eta > 0 \tag{114}$$

Note that the limiting case of perfect competition in the labour market may be obtained by letting the substitution elasticity λ tend to infinity, since unions will then lose their monopoly power. In that case we see from (114) that the rate of involuntary unemployment goes to zero. We also see from (113) that, compared to the competitive benchmark where $\lambda \to \infty$, unions use their monopoly power to restrict the supply of working hours, implying that employed workers are rationed in their labour supply.

Finally we observe that if μ is the ratio of the tax rate on benefit income to the tax rate on wage income, and if b is the *gross* replacement rate (the ratio of the pre-tax benefit rate to the pre-tax wage rate), we have

$$b^n = \frac{b(1-\mu t)}{1-t} \tag{115}$$

II.8. The tax haven

Country $n+1$ is a tax haven specializing in issuing debt instruments (e.g. bank deposits) to foreign household investors. The foreign deposits received by the tax haven (measured per inhabitant) are denoted B^{n+1}. By definition, the volume of these deposits is

$$s_{n+1}B^{n+1} = \sum_{j=1}^{n} s_j B^{hn}_{n+1,j} \tag{116}$$

where s_j denotes country j's share of total world population, and $B^{hn}_{n+1,j}$ is the volume of deposits placed in jurisdiction $n+1$ by a household investor residing in country j. The deposits received by the tax haven are not invested locally; instead they are reinvested in the international bond market with the purpose of maximising the tax haven intermediator's total income

$$i_{n+1}B^{n+1} = \sum_{v=1}^{n} i_v \left(1 - \tau_{v,n+1}^{bw}\right) B_v^{n+1} \tag{117}$$

subject to the usual CES transformation curve

$$B^{n+1} = \left[\sum_{v=1}^{n} \chi_v^{-\frac{1}{\psi}} \left(B_v^{n+1}\right)^{\frac{\psi+1}{\psi}}\right]^{\frac{\psi}{\psi+1}}, \qquad \sum_{v=1}^{n} \chi_v = 1 \tag{118}$$

where B_v^{n+1} is the tax haven intermediator's holdings of bonds issued in country v, and where (117) assumes that he can reinvest his deposits without incurring any intermediation charge. The solution to the tax haven intermediator's portfolio allocation problem implies

$$B_v^{n+1} = \left[\frac{i_v \left(1 - \tau_{v,n+1}^{bw}\right)}{i_{n+1}}\right]^{\psi} \chi_v \cdot B^{n+1}, \qquad v = 1, ..., n \tag{119}$$

$$i_{n+1} = \left[\sum_{v=1}^{n} \chi_v \left[i_v \left(1 - \tau_{v,n+1}^{bw}\right)\right]^{\psi+1}\right]^{\frac{1}{\psi+1}} \tag{120}$$

Of course, for the tax haven to fully live up to its name, the variables D_{vj}^{hb} and τ_{vj}^{bw} in equation (55) must both assume a value of zero for $v = n+1$; i.e., the tax haven neither engages in international information exchange nor imposes any withholding tax.

When the tax haven intermediator maximises his total portfolio income given in (117), he will also maximise his total (per-capita) profit from intermediation which is

$$\pi_{n+1}^{f} = c \cdot i_{n+1}B^{n+1} \tag{121}$$

Note that (121) also represents the per-capita GDP of the tax haven.

II.9. The on-shore financial sector

Part of household income consists of the profits generated by the intermediation fees charged by the financial sector. The per-capita profits generated in the domestic institutional sector are $c^i\rho^i S^i$. In addition, we must account for the earnings of banks operating 'on shore', i.e. outside the tax haven jurisdiction. The total 'on-shore' bank profits generated by debt issued in country v are

$$y_v^f = ci_v \left[\overbrace{d_v^h \left(1+t_v^H\right) H_v}^{\substack{\text{supply of} \\ \text{mortgage bonds}}} + \overbrace{d_v k_v + d_v^m k_v^m + \sum_{j=1,\ j\neq v}^{n} d_{vj}^F k_{vj}^F}^{\substack{\text{supply of} \\ \text{corporate bonds}}} + \overbrace{B_v^g}^{\substack{\text{supply of} \\ \text{government} \\ \text{bonds}}} \right.$$

$$\left. - \overbrace{\left(s_{n+1}/s_v\right) B_v^{n+1}}^{\substack{\text{debt intermediated} \\ \text{by off-shore banks}}} - \overbrace{\sum_{j=1}^{n} \left(\frac{s_j}{s_v}\right) \left[D_v^u B_{vj}^{iu} + \left(1-D_v^u\right) B_{vj}^{in}\right]}^{\substack{\text{debt intermediated by} \\ \text{institutional investors}}} \right] \tag{122}$$

where B^g is the stock of government debt per capita, and D_v^u is a dummy which is equal to unity if country v is an EU member state, and zero otherwise. Since banks can operate outside their home country, only a part of the total bank profits y_v^f generated in country v accrues to banks owned by that country's residents. We assume that domestically-owned banks in country j earn an exogenous fraction $\overline{f}_j$ of the total on-shore bank profits generated by debt issues in that country, and a fraction f_j of the on-shore bank profits generated by debt issues in other countries. Hence the total per-capita profits earned by the financial sector in country j is given by

$$\pi_j^f = \overbrace{c_j^i \rho_j^i S_j^i}^{\substack{\text{profits earned} \\ \text{by domestic} \\ \text{institutional sector}}} + \overbrace{\overline{f}_j \cdot y_j^f + f_j \cdot \sum_{v=1,\ v\neq j}^{n} \left(\frac{s_v}{s_j}\right) y_v^f}^{\substack{\text{profits earned by} \\ \text{domestic banking sector}}}, \quad j = 1, ..., n \tag{123}$$

where the parameters must satisfy the following restrictions:

$$0 < \overline{f}_j \leq 1, \qquad 0 \leq f_j < 1 \tag{123.a}$$

$$\sum_{j=1,\ j\neq v}^{n} f_j = 1 - \overline{f}_v, \qquad v = 1, 2, ..., n \tag{123.b}$$

Equation (123.b) simply says that the fraction of the bank profits generated in country v which does not accrue to domestic banks must accrue to foreign banks. Since the $\overline{f}_v$'s are exogenous, (123.b) uniquely determines all the f_j's. It can be shown that an increase in $\overline{f}_j$ will also increase f_j, so the choice of the vector of $\overline{f}$'s will determine the cross-country distribution of global bank profits. Thus the OECDTAX model accounts for the fact that financial sector income is more important for some countries than for others.

In addition to the income earned by debt intermediation, the domestic banking sector also earns income by offering intermediation and payments services to domestic portfolio investors wishing to invest part of their wealth abroad. Specifically, we assume that the transaction cost parameters c^b and c^s appearing in (54), (55), (56) and (59) reflect charges for banking services offered to household portfolio investors. Thus the total charges by banks in country j for the administration of the foreign portfolio investment of domestic investors amount to

$$\pi_j^{tr} = c_j^b \sum_{v=1,\ v\neq j}^{n+1} i_v (1-c)\left[D_v^u B_{vj}^{hu} + (1-D_v^u) B_{vj}^{hn}\right] + c_j^b \sum_{v=1,\ v\neq j}^{n} i_v \left[D_v^u B_{vj}^{iu} + (1-D_v^u) B_{vj}^{in}\right]$$

$$+c_j^s \sum_{v=1,\ v\neq j}^{n} \widehat{\rho}_v^m \left[D_v^u \left(E_{vj}^{hu} + E_{vj}^{iu}\right) + (1-D_v^u)\left(E_{vj}^{hn} + E_{vj}^{in}\right)\right] \tag{123.c}$$

II.10. Household profit income

The pre-existing stock of intangible assets is owned by households. The pure profits accruing to this fixed factor are therefore included in the total after-tax profit income per capita ($\widehat{\pi}$) which enters the consumer's budget constraint. We will now account for the various components of $\widehat{\pi}$. If y_j is the output produced by domestic corporations divided by the number of inhabitants in country j, it follows from (73) that the after-tax profit per capita generated by domestic corporations (π) is

$$\pi_j = (1 - \tau_j)\left(1 - \alpha_j - \beta_j\right) y_j \tag{124}$$

From the relevant first-order conditions we also find that the parent company of the domestic multinational earns an after-tax per-capita profit equal to

$$\pi_j^m = \left(1 - \tau_j^m\right)\left[\left(1 - \alpha_j - \beta_j\right) y_j^m + \sum_{v=1,\ v \neq j}^{n} \left(p_{vj}^Q - 1 - a_{vj}^Q\right) q_{vj}\right] \tag{125}$$

where $y_j^m \equiv Y_j^m / N_j$ and $q_{vj} \equiv Q_{vj}/N_j$. Furthermore, the solution to the multinational's optimization problem can be shown to imply that the total net profit per capita earned from the foreign subsidiaries of the domestic multinational is

$$\widehat{\pi}_j^F = \sum_{v=1,\ v \neq j}^{n} \left(1 - \tau_{vj}^F\right)\left[\left(1 - \alpha_v^F - \beta_v^F\right)(s_v/s_j)\, y_{vj}^F - p_{vj}^Q q_{vj}\right] \tag{126}$$

where $y_{vj}^F \equiv Y_{vj}^F / N_v$ is the output of the foreign subsidiary measured per inhabitant in the foreign *host* country. Finally, the consumer receives profit income from the domestic financial sector which is taxed at the rate τ^f, leaving a net per-capita profit of $\widehat{\pi}^f$:

$$\widehat{\pi}_j^f = \left(1 - \tau_j^f\right)\left(\pi_j^f + \pi_j^{tr}\right) \tag{127}$$

The consumer's total net profit income then becomes

$$\widehat{\pi}_j = \pi_j + \pi_j^m + \widehat{\pi}_j^F + \widehat{\pi}_j^f \tag{128}$$

II.11. Capital market equilibrium

We turn now to the equilibrium conditions for the national capital markets. Since assets invested in different countries are imperfect substitutes, there is a separate capital market for each country, although national markets are linked by capital mobility.

It is convenient to introduce the notation k to indicate a business capital stock measured per inhabitant in the source country where the capital is invested. The condition for equilibrium in the bond market of EU country v may then be written in per-capita form as

$$s_v \left[\overbrace{d_v^H \left(1 + t_v^H\right) H_v}^{\substack{\text{supply of} \\ \text{mortgage bonds}}} + \overbrace{d_v k_v + d_v^m k_v^m + \sum_{j=1,\ j \neq v}^{n} d_{vj}^F k_{vj}^F}^{\text{supply of corporate bonds}} + \overbrace{B_v^g}^{\substack{\text{supply of} \\ \text{government} \\ \text{bonds}}} \right]$$

$$= s_{n+1} B_v^{n+1} + s_v S_v^{hbd} + \sum_{j=1,\ j \neq v}^{n} s_j B_{vj}^{hu} + \sum_{j=1}^{n} s_j B_{vj}^{iu}, \qquad v = 1, ..., \overline{n} \tag{129}$$

The left-hand side of (129) measures the sum of the supply of mortgage bonds, corporate bonds and government bonds, while the right-hand side gives the demand for country v bonds emanating from the tax haven intermediator and from domestic and foreign household and institutional investors.

In a similar way we may write the equilibrium condition for the bond market in ROW country v as

$$s_v \left[d_v^H \left(1 + t_v^H\right) H + d_v k_v + d_v^m k_v^m + \sum_{j=1,\ j \neq v}^{n} d_{vj}^F k_{vj}^F + B_v^g \right]$$

$$= s_{n+1} B_v^{n+1} + s_v S_v^{hbd} + \sum_{j=1,\ j \neq v}^{n} s_j B_{vj}^{hn} + \sum_{j=1}^{n} s_j B_{vj}^{in}, \qquad v = \overline{n} + 1, ..., n \tag{130}$$

Consider next the conditions for stock market equilibrium. As already mentioned, shares issued by domestic corporations are not traded in the official stock exchange and are held only by domestic household investors. Households may also hold shares in domestic and foreign multinationals. Institutional investors only hold listed shares issued by domestic and foreign multinational companies. Whereas shares issued in different countries are imperfect substitutes, I assume that shares issued by companies operating in the same national economy are perfect substitutes in the eyes of household investors. This means that shares issued by domestically-based multinationals can never yield a lower after-tax return to household investors than shares issued by unquoted domestic corporations in an equilibrium where household investors hold both types of shares in their portfolio (which we realistically assume to be the case). This means that the cost of equity for domestic multinationals ($\widehat{\rho}_v^m$) is linked to the cost of equity for domestic unquoted corporations ($\widehat{\rho}_v$) by the following arbitrage condition, where we use the notation introduced in section II.3:

$$\widehat{\rho}_j^m = \widehat{\rho}_j \left(\frac{1 - D_{jj}^{hs} z_{jj}^h - \left(1 - D_{jj}^{hs}\right) p_j^d \tau_{jj}^{sw}}{1 - D_{jj}^{hs} z_j^{hm} - \left(1 - D_{jj}^{hs}\right) p_j^d \tau_{jj}^{sw}} \right) \tag{131}$$

The variable z_j^{hm} in (131) denotes the tax rate on shareholder income from domestic multinationals. This tax rate may differ from the tax rate z_{jj}^h on shareholder income from domestic corporations (given in (52)) because countries with imputation systems which exempt foreign source income from domestic corporation tax do not always grant imputation credits when dividends are paid out of foreign source income (since in this case the company may not have paid domestic corporation tax on the underlying profits if there is no equalization tax). In such a tax regime we shall assume that the fraction α_j^{mI} of dividends from the parent company which does *not* attract domestic dividend tax credits is given as follows:

$$\alpha_j^{mI} = \frac{\widehat{g}_j^F \sum_{v=1,\ v \neq j}^n D_{vj}^e \left(s_v / s_j\right) \left(1 - \tau_{vj}^d\right) \widetilde{\pi}_{vj}^F}{\left(1 - \tau_j^m\right) \widetilde{\pi}_j^m + \widehat{g}_j^F \sum_{v=1,\ v \neq j}^n \left(s_v / s_j\right) \left(1 - \tau_{vj}^d\right) \widetilde{\pi}_{vj}^F} \tag{132}$$

The numerator in (132) is the amount of repatriated foreign source income which has been exempted from domestic corporation tax, and the denominator is the total amount of profits which is potentially available for distribution to the parent company's shareholders.

We introduce a dummy D_j^{IF} which is unity for imputation countries which do not grant imputation credits when dividends are paid out of foreign source income, and zero otherwise. Remembering that D^I is a dummy for imputation systems, the tax rate on shareholder income from domestic multinationals is then given by

$$z_j^{hm} = p_j^d \left\{ \left(1 - D_{jj}^I\right) m_j^{dh} + D_{jj}^I \left(1 - D_j^{IF}\right) \left(\frac{m_j^{dh} - \widehat{u}_j}{1 - \widehat{u}_j} \right) \right.$$

$$+D_{jj}^{I}D_{j}^{IF}\left[\alpha_{j}^{mI}m_{j}^{dh}+\left(1-\alpha_{j}^{mI}\right)\left(\frac{m_{j}^{dh}-\widehat{u}_{j}}{1-\widehat{u}_{j}}\right)\right]\Bigg\}+\left(1-p_{j}^{d}\right)\left(1-m_{j}^{ch}\right) \qquad (133)$$

The arbitrage condition (131) is one condition for equilibrium in the domestic stock market. The other equilibrium condition is that the total supply of shares issued by domestic firms equals the demand for such shares emanating from domestic and foreign household and institutional investors. Thus we may write the condition for equilibrium in the stock market of EU country v as

$$s_{v}\left[\overbrace{\left(1-d_{v}\right)k_{v}}^{\substack{\text{shares issued by}\\ \text{domestic corporations}}}+\overbrace{\left(1-d_{v}^{m}\right)k_{v}^{m}+\sum_{j=1,\ j\neq v}^{n}\left(1-d_{jv}^{F}\right)\left(s_{j}/s_{v}\right)k_{jv}^{F}}^{\text{shares issued by domestic multinationals}}\right]$$

$$=s_{v}S_{v}^{hsd}+\sum_{j=1}^{n}s_{j}E_{vj}^{iu}+\sum_{j=1,\ j\neq v}^{n}s_{j}E_{vj}^{hu}, \qquad v\in\left(1,........,\overline{n}\right) \qquad (134)$$

By analogy, the stock market equilibrium condition for ROW country v is

$$s_{v}\left[\left(1-d_{v}\right)k_{v}+\left(1-d_{v}^{m}\right)k_{v}^{m}+\sum_{j=1,\ j\neq v}^{n}\left(1-d_{jv}^{F}\right)\left(s_{j}/s_{v}\right)k_{jv}^{F}\right]$$

$$=s_{v}S_{v}^{hsd}+\sum_{j=1}^{n}s_{j}E_{vj}^{in}+\sum_{j=1,\ j\neq v}^{n}s_{j}E_{vj}^{hn}, \qquad v\in\left(\overline{n}+1,........,n\right) \qquad (135)$$

II.12. The public budget

To close the model we need to specify the government budget constraint. This is an exercise in bookkeeping. We start out calculating the various components of public revenue. For convenience, we introduce a dummy variable D_{j}^{u} which is unity for all EU countries and zero for ROW countries:

$$D_{j}^{u}=1 \quad \text{for} \quad j=1,.....,\overline{n}; \qquad D_{j}^{u}=0 \quad \text{for} \quad j=\overline{n}+1,.....,n+1$$

Measured on a per-capita basis, the revenue from indirect taxes, including property taxes and the VAT on the construction of new housing $\delta^H H$ (or on the repair of the existing housing stock) will be

$$R_j^i = t_j^C C_j + t_j^H \delta_j^H H_j + \tau_j^H \left(1 + t_j^H\right) H_j \tag{138}$$

The last term in (138) reflects the fact that, in a long run housing market equilibrium, the market value of existing property will exceed the production cost by a factor $\left(1 + t^H\right)$, due to the existence of the indirect tax t^H on maintenance and repair and on the construction of new housing.

The revenue from labour income taxes net of unemployment benefits is

$$R_j^L = W_j h_j \left[t_j \left(1 - u_j\right) - u_j b_j^n \left(1 - t_j\right)\right] \tag{139}$$

The revenue from residence-based taxes on interest income - allowing for the fact that withholding taxes are typically creditable against ordinary income tax and for the possible deductibility of mortgage interest payments - is given by

$$R_j^r = D_{jj}^{hb} \left(m_j^{rh} - \tau_{jj}^{bw}\right) i_j \left(1 - c\right) S_j^{hbd} - D_j^H m_j^{rh} i_j d_j^H \left(1 + t_j^H\right) H_j$$

$$+ \sum_{v=1,\ v\neq j}^{n+1} D_{vj}^{hb} i_v \left(1 - c\right) \left(m_j^{rh} - \tau_{vj}^{bw}\right) \left[D_v^u B_{vj}^{hu} + \left(1 - D_v^u\right) B_{vj}^{hn}\right]$$

$$+ \sum_{v=1}^{n} D_j^{ib} i_v \left(m_j^{ri} - \tau_{vj}^{bw}\right) \left[D_v^u B_{vj}^{iu} + \left(1 - D_v^u\right) B_{vj}^{in}\right] \tag{140}$$

In a similar way we can calculate the revenue from residence-based taxes on the return to portfolio investment in shares. We include the revenue from domestic taxation of imputation credits received from abroad, and deduct the imputation credits granted to foreign residents. The net revenue from residence-based taxes on the return to portfolio investment in shares may then be found as follows:

$$R_j^s = D_{jj}^{hs}\left(z_j^{hm} - p_j^d \tau_{jj}^{sw}\right)\widehat{\rho}_j^m\left[S_j^{hsd} - (1-d_j)\,k_j\right] + D_{jj}^{hs}\left(z_{jj}^h - p_j^d \tau_{jj}^{sw}\right)\widehat{\rho}_j\,(1-d_j)\,k_j$$

$$+\left(\sum_{v=1,\ v\neq j}^{n} D_{vj}^{hs}\widehat{\rho}_v^m\left\{p_v^d\left[\left(1-D_{vj}^I\right)m_j^{dh} + D_{vj}^I\left(\frac{m_j^{dh}}{1-\widehat{u}_v}\right) - \tau_{vj}^{sw}\right] + \left(1-p_v^d\right)m_j^{ch}\right\}\right.$$

$$\left.\times\left[D_v^u E_{vj}^{hu} + (1-D_v^u)\,E_{vj}^{hn}\right]\right)$$

$$+D_j^{is}\left(z_{jj}^i - p_j^d \tau_{jj}^{sw}\right)\widehat{\rho}_j^m\left[D_j^u E_{jj}^{iu} + \left(1-D_j^u\right)E_{jj}^{in}\right]$$

$$+\left(\sum_{v=1,\ v\neq j}^{n} D_j^{is}\widehat{\rho}_v^m\left\{p_v^d\left[\left(1-D_{vj}^I\right)m_j^{di} + D_{vj}^I\left(\frac{m_j^{di}}{1-\widehat{u}_v}\right) - \tau_{vj}^{sw}\right] + \left(1-p_v^d\right)m_j^{ci}\right\}\right.$$

$$\left.\times\left[D_v^u E_{vj}^{iu} + (1-D_v^u)\,E_{vj}^{in}\right]\right)$$

$$-p_j^d\widehat{\rho}_j^m \cdot \sum_{v=1,\ v\neq j}^{n} D_{jv}^I\left(\frac{\widehat{u}_j}{1-\widehat{u}_j}\right)\left[D_v^u\left(E_{jv}^{hu} + E_{jv}^{iu}\right) + (1-D_v^u)\left(E_{jv}^{hn} + E_{jv}^{in}\right)\right] \tag{141}$$

Denoting taxable profits per capita by $\widetilde{\pi} \equiv \widehat{\Pi}/N$ and $\widetilde{\pi}^m \equiv \widehat{\Pi}^m/N$, the revenue from the taxation of bank profits and *domestic-source* corporate profits is

$$R_j^\pi = \tau_j^f\left(\pi_j^f + \pi_j^{tr}\right) + \tau_j\widetilde{\pi}_j + \tau_j^m\widetilde{\pi}_j^m + \overbrace{\sum_{v=1,\ v\neq j}^{n}\left[\widehat{g}_v^F\tau_j^d + \left(1-\widehat{g}_v^F\right)\tau_j^r\right]\widetilde{\pi}_{jv}^F}^{\text{domestic corporation tax on inward foreign direct investment}} \tag{142}$$

where $\widetilde{\pi}_{jv}^F \equiv \widehat{\Pi}_{jv}^F/N_j$, and where the average tax rate on income from the financial sector is assumed to be a weighted average of the labour income tax rate and the corporate tax rate, reflecting that part of the income generated in the financial service sector takes the form of labour income:

$$\tau_j^f = \alpha_j t_j + (1 - \alpha_j)\,\tau_j \tag{143}$$

By definition, the revenue from domestic corporation tax on repatriated foreign direct investment income must equal the total tax on this income minus that part which accrues to foreign governments. In addition, residence countries may impose a capital gains tax τ^{cm} on a parent company's gains on shares in a foreign subsidiary. Hence the total per-capita revenue R_j^F from residence-based corporation taxes on foreign direct investment income becomes

$$R_j^F = \sum_{v=1,\ v\neq j}^{n} \left\{ \left[\tau_{vj}^d - \tau_v^d - \tau_{vj}^{wF}\left(1-\tau_v^d\right)\right]\widehat{g}_j^F + \left(1-\widehat{g}_j^F\right)\left(1-\tau_v^r\right)\tau_j^{cm} \right\} \left(\frac{s_v \widetilde{\pi}_{vj}^F}{s_j}\right) \tag{144}$$

Let us finally account for the revenue from source-based withholding taxes. Withholding taxes on interest will generate revenue equal to

$$R_j^{wr} = \tau_{jj}^{bw} i_j (1-c)\, S_j^{hbd}$$

$$+ i_j (1-c) \left\{ \sum_{v=1}^{n} \tau_{jv}^{bw} \left(\frac{s_v}{s_j}\right) \left[D_j^u B_{jv}^{iu} + \left(1-D_j^u\right) B_{jv}^{in}\right] \right\}$$

$$+ i_j (1-c) \left\{ \tau_{j,n+1}^{bw} \left(\frac{s_{n+1}}{s_j}\right) B_j^{n+1} + \sum_{v=1,\ v\neq j}^{n} \tau_{jv}^{bw} \left(\frac{s_v}{s_j}\right) \left[D_j^u B_{jv}^{hu} + \left(1-D_j^u\right) B_{jv}^{hn}\right] \right\} \tag{147}$$

while witholding taxes on dividends on inward portfolio and direct investment will yield the revenue

$$R_j^{wd} = \tau_{jj}^{sw} p_j^d \left\{ \widehat{\rho}_j^m \left[S_j^{hsd} - (1-d_j)\, k_j\right] + \widehat{\rho}_j (1-d_j)\, k_j \right\}$$

$$+\sum_{v=1}^{n}\tau_{jv}^{sw}p_j^d\widehat{\rho}_j^m\left(\frac{s_v}{s_j}\right)\left[D_j^uE_{jv}^{iu}+(1-D_v^u)\,E_{jv}^{in}\right]$$

$$+\sum_{v=1,\ v\neq j}^{n}\tau_{jv}^{sw}p_j^d\widehat{\rho}_j^m\left(\frac{s_v}{s_j}\right)\left[D_j^uE_{jv}^{hu}+\left(1-D_j^u\right)E_{jv}^{hn}\right]+\sum_{v=1,\ v\neq j}^{n}\tau_{jv}^{wF}\widehat{g}_v^F\left(1-\tau_v^d\right)\widetilde{\pi}_{jv}^F \quad (148)$$

Assuming a balanced government budget, remembering that the exogenous stock of government debt per capita is B^g, and denoting government consumption per capita by G, we may now state the government budget constraint as follows:

$$T_j = R_j^i + R_j^L + R_j^r + R_j^s + R_j^{\pi} + R_j^F + R_j^{wr} + R_j^{wd} - i_jB_j^g - G_j \quad (149)$$

II.13. Consumer welfare

For purposes of policy evaluation, it is useful to calculate the average level of welfare for consumers in a given country. Using the utility function (7), the consumer's budget constraint (6), the solution for comprehensive saving (9) and for working hours (113), we find that consumer welfare - measured as an average across employed and unemployed individuals, and disregarding the utility from the constant level of public consumption - may be written as

$$U=\frac{Wh\,(1-t)\left[1-u+ub^n-\left(\frac{\lambda-1}{\lambda(1+\varepsilon)}\right)\right]+T+\widehat{\pi}+V\left[1+\left(\frac{\varphi}{1+\varphi}\right)\rho^{\frac{1+\varphi}{\varphi}}\right]}{P} \quad (150)$$

The population-weighted average level of consumer welfare in the EU (U^u) is given by

$$U^u=\frac{\sum_{j=1}^{\overline{n}}s_jU_j}{\sum_{j=1}^{\overline{n}}s_j} \quad (151)$$

and the population-weigthed average level of welfare in the Nordic countries (U^N) may be calculated as

$$U^N = \frac{\sum_{j=1}^{n} D_j^N s_j U_j}{\sum_{j=1}^{n} D_j^N s_j}, \qquad j = 1, ..., n \tag{152}$$

$$D_j^N = 1 \quad \text{if country } j \text{ is a Nordic country,} \qquad D_j^N = 0 \text{ otherwise}$$

where D_j^N is a dummy variable which is unity for Denmark, Finland, Iceland, Norway and Sweden, and zero for all other countries.

II.14. National income statistics

To facilitate the calibration of the model, it is also useful to calculate the following national income statistics:

Gross domestic product per capita (at market prices):

$$\widehat{y}_j = y_j + y_j^m + \sum_{v=1,\ v\neq j}^{n} \left[y_{jv}^F - p_{jv}^Q \left(\frac{s_v}{s_j} \right) q_{jv} \right] + \overbrace{p_j H_j}^{\substack{\text{imputed value of} \\ \text{housing services}}} + t_j^C C_j \tag{153}$$

Gross national income per capita (at market pricest):

$$\widetilde{y}_j = W_j h_j \left(1 - t_j\right) \left(1 - u_j + u_j b_j^n\right) + T_j + \widehat{\pi}_j + \rho_j P_j \widetilde{S}_j^c + G_j + \delta_j \left(k_j + k_j^m + \sum_{v=1,\ v\neq j}^{n} k_{jv}^F \right)$$

$$+ \delta_j^H H_j + a_j^d k_j + a_j^{dm} k_j^m + \sum_{v=1,\ v\neq j}^{n} a_{vj}^Q q_{vj} + \sum_{v=1,\ v\neq j}^{n} a_{jv}^{dF} k_{jv}^F, \qquad j = 1, ..., n \tag{154}$$

Total domestic capital stock per capita (including the housing stock):

$$\widetilde{k}_j = H_j + k_j + k_j^m + \sum_{v=1,\ v\neq j}^{n} k_{jv}^F \tag{155}$$

Ratio of inward foreign direct investment to total domestic capital stock:

$$\widetilde{k}_j^I = \frac{\sum_{v=1,\ v\neq j}^{n} \left(1 - d_{jv}^F\right) k_{jv}^F}{\widetilde{k}_j} \tag{156}$$

Ratio of outward foreign direct investment to total domestic capital stock:

$$\widetilde{k}_j^O = \frac{\sum_{v=1,\ v\neq j}^{n} \left(s_v/s_j\right) \left(1 - d_{vj}^F\right) k_{vj}^F}{\widetilde{k}_j} \tag{157}$$

Ratio of inward foreign portfolio investment to total domestic capital stock:

$$I_j^{PI} = \frac{\sum_{v=1,\ v\neq j}^{n} \left(s_v/s_j\right) \left[D_j^u \left(B_{jv}^{hu} + B_{jv}^{iu} + E_{jv}^{hu} + E_{jv}^{iu}\right) + \left(1 - D_j^u\right) \left(B_{jv}^{hn} + B_{jv}^{in} + E_{jv}^{hn} + E_{jv}^{in}\right)\right]}{\widetilde{k}_j} \tag{158}$$

Ratio of outward foreign portfolio investment to total domestic capital stock:

$$I_j^{PO} = \frac{\sum_{v=1,\ v\neq j}^{n} \left[D_v^u \left(B_{vj}^{hu} + B_{vj}^{iu} + E_{vj}^{hu} + E_{vj}^{iu}\right) + \left(1 - D_v^u\right) \left(B_{vj}^{hn} + B_{vj}^{in} + E_{vj}^{hn} + E_{vj}^{in}\right)\right]}{\widetilde{k}_j} \tag{159}$$

Ratio of financial sector income to total national income:

$$\widetilde{R}_j^f = \frac{\pi_j^f}{\widetilde{y}_j} \tag{160}$$

Ratio of global on-shore financial sector income to global on-shore GDP:

$$\widetilde{R}^B = \frac{\sum_{j=1}^{n} s_j \pi_j^f}{\sum_{j=1}^{n} s_j \widehat{y}_j} \tag{161}$$

Ratio of institutional saving to total financial saving:

$$\widetilde{R}_j^i = \frac{S_j^i}{S_j} \tag{162}$$

Ratio of residential capital to total capital:

$$\widetilde{R}_j^H = \frac{H_j}{\widetilde{k}_j} \tag{163}$$

Ratio of national income to domestic product:

$$\widetilde{R}_j^y = \frac{\widetilde{y}_j}{\widehat{y}_j} \tag{164}$$

Government interest payments relative to GDP:

$$\widetilde{R}_j^r = \frac{i_j B_j^g}{\widehat{y}_j} \tag{164.a}$$

Weight of shares in household portfolios:

$$\widetilde{R}_j^{hs} = \frac{S_j^{hs}}{S_j^{hs} + S_j^{hb}} \tag{164.b}$$

Weight of shares in institutional investor portfolios:

$$\widetilde{R}_j^{is} = \frac{S_j^{is}}{S_j^{is} + S_j^{ib}} \tag{164.c}$$

Ratio of corporate tax revenue to GDP:

$$\widetilde{R}_j^c = \frac{R_j^\pi + R_j^F - \alpha_j t_j \pi_j^f}{\widehat{y}_j} \tag{165}$$

The last term in the numerator of (165) corrects for the fact that part of the revenue from the taxation of the financial sector represents taxes on labour income.

II.15. Calibration principles

Because of the simultaneity of the model, most endogenous variables depend on all model parameters, but loosely speaking we may think of 'assigning' to certain parameters the task of generating realistic values of certain endogenous variables and ratios like the ones defined in the previous section. When calibrating the model, the endowment parameter $\overline{a}_j \equiv \overline{A}_j/N_j$ in (60) may thus be chosen so as to generate a realistic relative level of GDP per capita; $\overline{q}_j \equiv \overline{Q}_j/N_j$ in (79) may be chosen such that $\widetilde{k}_j^I$ corresponds roughly to the observed ratio of inward FDI to total domestic investment; s_j^m in (60) may be set to ensure that $\widetilde{k}_j^O$ approximates the observed ratio of outward FDI to total domestic investment, and the tax base parameter $\widehat{\delta}_j$ may be chosen so that $\widetilde{R}_j^c$ coincides with the empirically observed ratio of corporate tax revenue to GDP. The transaction cost parameters c_j^b and c_j^s can be calibrated to ensure a realistic degree of home bias in financial investor portfolios. Furthermore, if we set the intermediation fees c and c^i to generate a realistic value of $\widetilde{R}^B$ in (161), the parameters f_j in (123) may then be chosen to produce plausible values of the financial sector income ratio $\widetilde{R}_j^f$ in individual countries. The cost parameters d_j^H and $\overline{d}_j$ in (2) and (64) may naturally be chosen to generate reasonable debt-equity ratios, and the labour market parameters η_j may be set so that the equilibrium unemployment rates coincide with prevailing empirical estimates of structural unemployment rates in individual countries. Finally, we may choose a value of the exogenous endowment variable V_j so as to generate a ratio $\widetilde{y}_j/\widehat{y}_j$ of national income to domestic product corresponding to the one observed in the country's national income statistics.

III. Summarizing the OECDTAX model

Exogenous variables and parameters

Endowments

$\overline{a}$ = endowment of intangible assets per capita

V = initial wealth endowment per capita

$\overline{q}$ = fixed local public input in foreign-owned firms (per inhabitant in host country)

$\overline{f}$ = share of domestic-source bank profits accruing to domestic banks

Technology

α = elasticity of output w.r.t. labour input in domestically-owned firms

β = elasticity of output w.r.t. capital input in domestically-owned firms

α^F = elasticity of output w.r.t. labour input in foreign-owned firms

β^F = elasticity of output w.r.t. capital input in foreign-owned firms

ς = elasticity of output w.r.t. intermediate input in foreign-owned firms

c^b = transaction cost of investing in foreign bonds

c^s = transaction cost of investing in foreign shares

c = share of gross interest charged as bank intermediation fee

c^i = share of gross return charged as intermediation fee by institutional sector

$\overline{d}$ = target debt-asset ratio in domestic corporations

$\overline{d}^m$ = target debt-asset ratio in multinational corporations

$\overline{d}^H$ = target debt-asset ratio in housing sector

δ = rate of true economic depreciation of business capital

δ^H = rate of true economic depreciation of housing capital

ϵ^d = elasticity of marginal cost of financial distress in business sector

ϵ^H = elasticity of marginal cost of financial distress in housing sector

ϵ^Q = elasticity of marginal cost of distorting transfer prices

λ = elasticity of substitution between different labour skills

η = elasticity of unemployment risk w.r.t. unemployment rate

Preferences

a^{cs} = fraction of short-term capital gains realized per year by portfolio investors

a^{cl} = fraction of long-term capital gains realized per year by portfolio investors

a^{cm} = fraction of long-term capital gains realized per year by direct investors

E = budget share of housing consumption

p^d = dividend payout ratio

$\widehat{g}^F$ = fraction of taxable profits repatriated from foreign subsidiary

ε = elasticity of marginal disutility of work ($1/\varepsilon$ = net wage elasticity of individual labour supply)

φ = elasticity of marginal disutility of postponed consumption ($1/\varphi$ = elasticity of saving w.r.t. net return)

ϖ = elasticity of substitution between household saving and institutional saving

θ^z = elasticity of substitution between stocks and bonds, $z = h, i$

β^z = elasticity of substitution between EU bonds and ROW bonds, $z = h, i$

κ^z = elasticity of substitution between different EU bonds, $z = h, i$

γ^z = elasticity of substitution between different ROW bonds, $z = h, i$

σ^z = elasticity of substitution between EU stocks and ROW stocks, $z = h, i$

ω^z = elasticity of substitution between different EU stocks, $z = h, i$

ζ^z = elasticity of substitution between different ROW stocks, $z = h, i$

ϱ = elasticity of substitution between foreign and domestic stocks held by households

ξ = elasticity of substitution between foreign and domestic bonds held by households

ψ = tax haven intermediator's elasticity of substitution between different bonds

Ω = taste for institutional saving

Υ^z = taste for investment in stocks, $z = h, i$

Ψ^z = taste for EU stocks, $z = h, i$

ϕ^z = taste for individual EU stocks, $z = h, i$

Φ^z = taste for individual ROW stocks, $z = h, i$

Λ^z = taste for EU bonds, $z = h, i$

υ^z = taste for individual EU bonds, $z = h, i$

$\digamma^z$ = taste for individual ROW bonds, $z = h, i$

Θ = household investor taste for domestic stocks

Δ = household investor taste for domestic bonds

χ = tax haven intermediator's taste for individual bonds

Scale parameters

n = total number of (non-tax-haven) countries

$\overline{n}$ = number of EU countries

s_j = country j's share of world population

s^m = share of intangible assets allocated to multinational sector

Policy variables

α^d = deductible fraction of corporate interest payments

b = gross replacement ratio

B^g = government debt per capita

D^{cia} = dummy for accruals-based capital gains taxation of institutional investors

D^{cp} = dummy for indexation of capital gains tax base for portfolio investors

D^{cm} = dummy for indexation of capital gains tax base for direct investors

D^{cs} = dummy variable for credit-by-source system

D^{cw} = dummy variable for worldwide-credit system

D^d = dummy variable for deduction system

D^e = dummy variable for exemption system

D^E = dummy variable for equalization tax

D^I = dummy variable for imputation credits

D^{IF} = dummy variable for absence of imputation credits in case of distribution from foreign income sources

D^{ib} = dummy variable for residence-based taxation of institutional investor income from bonds

D^{is} = dummy variable for residence-based taxation of institutional investor income from stocks

D^N = dummy variable for Nordic country status

D^u = dummy variable for EU member status

D^{ee} = fraction of FDI income which is exempted under exemption system

D^H = fraction of interest payments on mortgage debt which is tax-deductible

D^{hb} = fraction of household interest income which is subject to residence country tax

D^{hs} = fraction of household shareholder income which is subject to residence country tax

$\widehat{\delta}$ = rate of depreciation for tax purposes

G = public consumption per capita

m^{dh} = tax rate on dividend income for household investor

m^{rh} = tax rate on interest income for household investor

m^{di} = tax rate on dividend income for institutional investor

m^{ri} = tax rate on interest income for institutional investor

n^{s} = length of 'speculation period' for portfolio investors

n^{sm} = length of 'speculation period' for direct investors

$\widetilde{p}$ = inflation rate

t = effective average direct tax rate on labour income

μ = ratio of effective tax rate on unemployment benefits to effective tax rate on labour income

t^{C} = indirect tax rate on non-durables

t^{H} = indirect tax rate (VAT) on housing

$\widehat{u}$ = imputation rate

τ^{H} = rate of property tax on value of housing stock

τ^{d} = corporate tax rate on distributed profits

τ^{r} = corporate tax rate on retained profits

τ^{chs} = statutory tax rate on realized short-term capital gains on shares held by household investors

τ^{chl} = statutory tax rate on realized long-term capital gains on shares held by household investors

τ^{cis} = statutory tax rate on realized short-term capital gains on shares held by institutional investors

τ^{cil} = statutory tax rate on realized long-term capital gains on shares held by institutional investors

τ^{cia} = statutory tax rate on accrued capital gains on shares held by institutional investors

τ^{sml} = statutory tax rate on realized long-term capital gains on shares held by direct investors

τ^{wF} = withholding tax rate on dividends from foreign subsidiaries

τ^{sw} = withholding tax rate on dividends from portfolio investment

τ^{bw} = withholding tax rate on interest on portfolio investment

Endogenous variables

α^{mI} = ratio of exempted foreign-source dividends to potential parent-company dividends

a^d = cost of financial distress in domestic corporation

a^{dm} = cost of financial distress in multinational parent company

a^{dF} = cost of financial distress in foreign subsidiary

a^H = cost of financial distress associated with mortgage debt

a_{vj}^Q = cost of distorting transfer price charged by parent company in country j to subsidiary in country v

b^n = net replacement ratio

B_{vj}^{hu} = bonds issued by EU country v held by household investor domiciled in country j

B_{vj}^{iu} = bonds issued by EU country v held by institutional investor domiciled in country j

B_{vj}^{hn} = bonds issued by ROW country v held by household investor domiciled in country j

B_{vj}^{in} = bonds issued by ROW country v held by institutional investor domiciled in country j

B^{n+1} = deposits in tax haven

B_v^{n+1} = tax haven intermediator's holding of bonds issued by country v

C = consumption of non-durables

C^c = real comprehensive consumption

d = debt-asset ratio of domestic corporation

d_{vj}^F = debt-asset ratio of subsidiary in country v owned by parent in country j

d^H = ratio of mortgage debt to value of housing stock

d^m = debt ratio of multinational parent company

$\widetilde{\delta}$ = effective rate of depreciation for tax purposes in domestic corporations

$\widetilde{\delta}^m$ = effective rate of depreciation for tax purposes in multinational parent company

$\widetilde{\delta}_{vj}^F$ = effective rate of depreciation for tax purposes in foreign subsidiary in country v owned by parent company in country j

E_{vj}^{hu} = shares issued in EU country v held by household investor domiciled in country j

E_{vj}^{iu} = shares issued in EU country v held by institutional investor domiciled in country j

E_{vj}^{hn} = shares issued in ROW country v held by household investor domiciled in country j

E_{vj}^{in} = shares issued in ROW country v held by institutional investor domiciled in country j

f = share of foreign-source bank profits accruing to domestic banks

$\widehat{g}$ = distributed share of taxable profits in domestic corporations

$\widehat{g}^m$ = distributed share of taxable parent company profits

h = working hours

H = housing stock

i = interest rate

$\widetilde{i}_{vj}^h$ = net return on bonds issued in country v to a household investor domiciled in country j

$\widetilde{i}_{vj}^i$ = net return on bonds issued in country v to an institutional investor domiciled in country j

I = total consumer resources

I^{PI} = ratio of inward portfolio investment to total domestic capital stock

I^{PO} = ratio of outward portfolio investment to total domestic capital stock

I^{IB} = ratio of inward portfolio investment to total stock of business capital

I^{OB} = ratio of outward portfolio investment to total stock of business capital

k = capital stock per capita in domestic corporation

k^m = capital stock per capita in multinational parent

k_{vj}^F = capital stock per capita (per foreign inhabitant) held by subsidiary in country v owned by parent in country j

$\widetilde{k}$ = total domestic capital stock per capita

$\widetilde{k}^I$ = ratio of inward FDI to total capital stock

$\widetilde{k}^O$ = ratio of outward FDI to total capital stock

k^B = total stock of business capital per capita

k^{IB} = ratio of inward FDI to total stock of business capital

k^{OB} = ratio of outward FDI to total stock of business capital

ℓ = labour input per capita in domestic corporation

ℓ^m = labour input per capita in multinational parent

ℓ^F_{vj} = labour input per capita (per foreign inhabitant) in subsidiary in country v owned by parent in country j

m^{ch} = effective tax rate on accrued capital gains on shares for household investor

m^{ci} = effective tax rate on accrued capital gains on shares for institutional investor

p = user cost of housing

P = consumer price index

p^Q_{vj} = transfer price charged to subsidiary in country v by parent in country j

π = per-capita net profit from domestic corporation

π^m = per-capita net profit from multinational parent

$\widehat{\pi}^F$ = total net profit per capita from foreign subsidiaries

π^f = per-capita pre-tax profit from financial sector

$\widehat{\pi}^f$ = per-capita net profit from financial sector

π^{tr} = income generated by transactions in foreign securities

$\widehat{\pi}$ = total net profit per capita

π^f_{n+1} = profit earned in tax haven

$\widetilde{\pi}$ = taxable profit per capita in domestic corporation

$\widetilde{\pi}^m$ = taxable profit per capita in multinational parent company

$\widetilde{\pi}^F_{vj}$ = taxable profit per capita (per foreign inhabitant) in foreign subsidiary in country v owned by parent in country j

q_{vj} = input from parent in country j to subsidiary in country v

r = cost of finance for domestic corporation

r^m = cost of finance for multinational parent

r^F_{vj} = cost of finance for foreign subsidiary in country v owned by parent in country j

R^i = per-capita revenue from indirect taxes (including property taxes)

R^L = per-capita revenue from labour income taxes (net of unemployment benefits)

R^r = per-capita revenue from residence-based taxes on interest income

R^s = per-capita revenue from residence-based taxes on portfolio investment in shares

R^π = per-capita revenue from taxes on domestic-source profits

R^F = per-capita revenue from residence-based corporation tax on foreign direct investment income

$\widetilde{R}^B$ = ratio of global on-shore financial sector income to global on-shore GDP

$\widetilde{R}^c$ = ratio of corporate tax revenue to GDP

$\widetilde{R}^f$ = ratio of financial sector income to total national income

$\widetilde{R}^H$ = ratio of residential capital to total capital

$\widetilde{R}^h$ = proportion of interest-bearing household assets held in tax haven jurisdiction

$\widetilde{R}^{hs}$ = weight of shares in household portfolios

$\widetilde{R}^{is}$ = weight of shares in institutional investor portfolios

$\widetilde{R}^i$ = ratio of institutional saving to total financial saving

$\widetilde{R}^P$ = inward profit-shifting relative to GDP

$\widetilde{R}^r$ = government interest payments relative to GDP

$\widetilde{R}^y$ = ratio of national income to domestic product

R^{wd} = per-capita revenue from withholding taxes on dividends

R^{wr} = per-capita revenue from withholding taxes on interest

ρ = net return to financial saving

ρ^h = average net return to household saving

ρ^{hs} = average net return to stocks for household investor

ρ^{hsd} = average net return to domestic stocks for household investor

ρ^{hsf} = average net return to foreign stocks for household investor

ρ^{hsu} = average net return to EU stocks for household investor

ρ^{hsn} = average net return to ROW stocks for household investor

$\widetilde{\rho}^h_{vj}$ = net return to shares issued in foreign country v held by household investor domiciled in country j

ρ^{hb} = average net return to bonds for household investor

ρ^{hbf} = average net return to foreign bonds for household investor

ρ^{hbu} = average net return to EU bonds for household investor

ρ^{hbn} = average net return to ROW bonds for household investor

ρ^i = average net return to institutional saving

ρ^{is} = average net return to stocks for institutional investor

ρ^{isu} = average net return to EU stocks for institutional investor

ρ^{isn} = average net return to ROW stocks for institutional investor

$\widetilde{\rho}^{i}_{vj}$ = net return to stock issued in country v to institutional investor domiciled in country j

ρ^{ib} = average net return to bonds for institutional investor

ρ^{ibu} = average net return to EU bonds for institutional investor

ρ^{ibn} = average net return to ROW bonds for institutional investor

$\widehat{\rho}$ = return on shares in domestic corporations before investor tax

$\widehat{\rho}^{m}$ = return on shares in multinational parent company before investor tax

S = financial saving

$\widetilde{S}^{c}$ = real comprehensive saving

S^{h} = household saving

S^{i} = institutional saving

S^{hb} = household holdings of bonds

S^{hs} = household holdings of stocks

S^{hbd} = household holdings of domestic bonds

S^{hbf} = household holdings of foreign bonds

S^{hbu} = household holdings of EU bonds

S^{hbn} = household holdings of ROW bonds

S^{hsd} = household holdings of domestic stocks

S^{hsf} = household holdings of foreign stocks

S^{hsu} = household holdings of EU stocks

S^{hsn} = household holdings of ROW stocks

S^{ib} = institutional holdings of bonds

S^{is} = institutional holdings of stocks

S^{ibu} = institutional holdings of EU bonds

S^{ibn} = institutional holdings of ROW bonds

S^{isu} = institutional holdings of EU stocks

S^{isn} = institutional holdings of ROW stocks

T = public transfers per capita

$\widetilde{T}^{F}$ = variable determining credit limitation under system of worldwide credit

$\widetilde{T}^{sF}$ = variable determining credit limitation under system of credit by source

τ = average corporate tax rate for domestic corporation

τ^{f} = average tax rate on income from financial sector

τ^m = average corporate tax rate for multinational parent company

τ_{vj}^F = average corporate tax rate on foreign subsidiary in country v owned by parent in country j

τ_{vj}^d = total corporate tax rate on profits repatriated from subsidiary in country v to parent in country j

τ_{vj}^{de} = total corporate tax rate on repatriated FDI income under exemption

τ_{vj}^{dd} = total corporate tax rate on repatriated FDI income under deduction

τ_{vj}^{dcs} = total corporate tax rate on repatriated FDI income under credit by source

τ_{vj}^{dcw} = total corporate tax rate on repatriated FDI income under worldwide credit

τ_{vj}^r = total corporate tax rate on profits retained in subsidiary in country v, owned by parent in country j

τ^{cm} = effective corporate tax rate on accrued capital gains on shares in foreign subsidiaries

u = unemployment rate

U = consumer welfare

U^u = average consumer welfare in the EU

U^N = average consumer welfare in the Nordic countries

X = household holding of shares in domestic multinational company

y = output per capita in domestic corporation

y^m = output per capita in multinational parent company

y_v^f = per-capita on-shore profits generated by debt issues in country v

y_{vj}^F = output per capita (per foreign inhabitant) in subsidiary in country v owned by parent in country j

$\widehat{y}$ = GDP per capita at factor prices

$\widehat{y}^M$ = GDP per capita at market prices

$\widetilde{y}$ = gross national income per capita at factor prices

$\widetilde{y}^M$ = gross national income per capita at market prices

z_{vj}^i = effective tax rate on income from shares held by institutional investor

z_{vj}^h = effective tax rate on income from shares held by household investor

z^{hm} = effective tax rate on income from shares in domestic multinationals held by household investor

W = wage rate before tax

Equations of the OECDTAX model

Consumption behaviour

Total consumer resources:

$$I_j = W_j h_j \left(1 - t_j\right) \left(1 - u_j + b_j^n u_j\right) + T_j + \widehat{\pi}_j + \left(1 + \rho_j^{\frac{\varphi_j + 1}{\varphi_j}}\right) V_j \tag{A.1}$$

User cost of housing:

$$p_j = \left(1 + t_j^H\right) \left[\tau_j^H + \delta_j^H + a_j^H + \left(1 - d_j^H\right) \rho_j + d_j^H i_j \left(1 - D_j^H m_j^{rh}\right)\right] \tag{A.2}$$

Cost of financial distress associated with mortgage debt:

$$a_j^H = \frac{\left(d_j^H - \overline{d}_j^H\right)^{1+\epsilon_j^H}}{1 + \epsilon_j^H} \tag{A.3}$$

Optimal housing debt ratio:

$$d_j^H = \overline{d}_j^H + \left[\rho_j - i_j \left(1 - D_j^H m_j^{rh}\right)\right]^{1/\epsilon_j^H} \tag{A.4}$$

Housing investment:

$$H_j = \frac{E_j I_j}{p_j}, \qquad 0 < E_j < 1 \tag{A.5}$$

Consumption of non-durables:

$$C_j = \frac{\left(1 - E_j\right) I_j}{1 + t_j^C} \tag{A.6}$$

Consumer price index:

$$P_j = p_j^{E_j} \left(1 + t_j^C\right)^{1-E_j} \tag{A.7}$$

Real comprehensive consumption:

$$C_j^c = E_j^{-E_j} \left(1 - E_j\right)^{E_j - 1} H_j^{E_j} C_j^{1-E_j} \tag{A.8}$$

Real comprehensive saving:

$$\widetilde{S}_j^c = \frac{\rho_j^{\frac{1}{\varphi_j}} V_j}{P_j} \tag{A.9}$$

Financial saving:

$$S_j = \rho_j^{\frac{1}{\varphi_j}} V_j - \left(1 - d_j^H\right) \left(1 + t_j^H\right) H_j \tag{A.10}$$

Portfolio choice

Institutional saving:

$$S_j^i = \left(\frac{\rho_j^i \left(1 - c_j^i\right)}{\rho_j} \right)^{\varpi_j} \Omega_j S_j, \qquad 0 < \Omega_j < 1 \tag{A.11}$$

Household saving:

$$S_j^h = \left(\frac{\rho_j^h}{\rho_j} \right)^{\varpi_j} \left(1 - \Omega_j\right) S_j \tag{A.12}$$

Net return to financial saving:

$$\rho_j = \left\{ \Omega_j \left[\rho_j^i \left(1 - c_j^i\right)\right]^{\varpi_j + 1} + \left(1 - \Omega_j\right) \left(\rho_j^h\right)^{\varpi_j + 1} \right\}^{\frac{1}{\varpi_j + 1}} \tag{A.13}$$

Institutional holdings of stocks:

$$S_j^{is} = \left(\frac{\rho_j^{is}}{\rho_j^i}\right)^{\theta_j^i} \Upsilon_j^i \cdot S_j^i, \qquad 0 < \Upsilon_j^i < 1 \tag{A.14}$$

Institutional holdings of bonds:

$$S_j^{ib} = \left(\frac{\rho_j^{ib}}{\rho_j^i}\right)^{\theta_j^i} \left(1 - \Upsilon_j^i\right) S_j^i \tag{A.15}$$

Average net return to institutional saving:

$$\rho_j^i = \left[\Upsilon_j^i \left(\rho_j^{is}\right)^{\theta_j^i + 1} + \left(1 - \Upsilon_j^i\right) \left(\rho_j^{ib}\right)^{\theta_j^i + 1} \right]^{\frac{1}{\theta_j^i + 1}} \tag{A.16}$$

Institutional holdings of EU stocks:

$$S_j^{isu} = \left(\frac{\rho_j^{isu}}{\rho_j^{is}}\right)^{\sigma_j^i} \Psi_j^i \cdot S_j^{is}, \qquad 0 < \Psi_j^i < 1 \tag{A.17}$$

Institutional holdings of ROW stocks:

$$S_j^{isn} = \left(\frac{\rho_j^{isn}}{\rho_j^{is}}\right)^{\sigma_j^i} \left(1 - \Psi_j^i\right) \cdot S_j^{is} \tag{A.18}$$

Average net return to stocks for institutional investors:

$$\rho_j^{is} = \left[\Psi_j^i \left(\rho_j^{isu}\right)^{\sigma_j^i+1} + \left(1-\Psi_j^i\right)\left(\rho_j^{isn}\right)^{\sigma_j^i+1}\right]^{\frac{1}{\sigma_j^i+1}} \tag{A.19}$$

Institutional holdings of stocks issued by EU country v:

$$E_{vj}^{iu} = \left(\frac{\widetilde{\rho}_{vj}^i}{\rho_j^{isu}}\right)^{\omega_j^i} \phi_{vj}^i \cdot S_j^{isu}, \qquad \sum_{v=1}^{\overline{n}} \phi_{vj}^i = 1, \qquad v = 1, ..., \overline{n}; \qquad j = 1, ..., n \tag{A.20}$$

Institutional holdings of stocks issued by ROW country v:

$$E_{vj}^{in} = \left(\frac{\widetilde{\rho}_{vj}^i}{\rho_j^{isn}}\right)^{\zeta_j^i} \Phi_{vj}^i \cdot S_j^{isn}, \qquad \sum_{v=\overline{n}+1}^{n} \Phi_{vj}^i = 1, \qquad v = \overline{n}+1, ..., n; \qquad j = 1, ..., n \tag{A.21}$$

An institutional investor's after-tax return to stock issued in foreign country v:

$$\begin{aligned} \widetilde{\rho}_{vj}^i &= \widehat{\rho}_v^m \left[1 - D_j^{is} z_{vj}^i - \left(1-D_j^{is}\right) p_v^d \tau_{vj}^{sw} - c_j^s\right], \\ v &= 1, ..., n; \qquad j = 1, ..., n; \qquad v \neq j \end{aligned} \tag{A.22.a}$$

An institutional investor's after-tax return to domestic stocks:

$$\widetilde{\rho}_{jj}^i = \widehat{\rho}_j^m \left[1 - D_j^{is} z_{jj}^i - \left(1-D_j^{is}\right) p_j^d \tau_{jj}^{sw}\right] \tag{A.22.b}$$

An institutional investor's effective tax rate on income from shares:

$$\begin{aligned} z_{vj}^i &= p_v^d \left[\left(1-D_{vj}^I\right) m_j^{di} + D_{vj}^I \left(\frac{m_j^{di} - \widehat{u}_v}{1-\widehat{u}_v}\right)\right] + \left(1-p_v^d\right) m_j^{ci}, \\ v &= 1, ..., n; \qquad j = 1, ..., n \end{aligned} \tag{A.23}$$

An institutional investor's effective tax rate on accrued capital gains on shares:

$$m_j^{ci} = D_j^{cia}\tau_j^{cia} + \left(1 - D_j^{cia}\right)\left(1 + \widetilde{i}_{jj}^i\right)\left\{\frac{\tau_j^{cis}a_j^{cs}}{a_j^{cs} + \widetilde{i}_{jj}^i + \frac{D_j^{cp}\widetilde{p}\left(1-a_j^{cs}\right)}{1+\widetilde{p}}} + \right.$$

$$\left.\left(\frac{\left(1 - a_j^{cs}\right)\left(1 - \frac{D_j^{cp}\widetilde{p}}{1+\widetilde{p}}\right)}{1 + \widetilde{i}_{jj}^i}\right)^{n_j^s}\left[\frac{\tau_j^{cil}a_j^{cl}}{a_j^{cl} + \widetilde{i}_{jj}^i + \frac{D_j^{cp}\widetilde{p}\left(1-a_j^{cl}\right)}{1+\widetilde{p}}} - \frac{\tau_j^{cis}a_j^{cs}}{a_j^{cs} + \widetilde{i}_{jj}^i + \frac{D_j^{cp}\widetilde{p}\left(1-a_j^{cs}\right)}{1+\widetilde{p}}}\right]\right\} \quad \text{(A.23.a)}$$

Average net return to EU stocks for an institutional investor:

$$\rho_j^{isu} = \left[\sum_{v=1}^{\overline{n}} \phi_{vj}^i \left(\widetilde{\rho}_{vj}^i\right)^{\omega_j^i+1}\right]^{\frac{1}{\omega_j^i+1}} \quad \text{(A.24)}$$

Average net return to ROW stocks for an institutional investor:

$$\rho_j^{isn} = \left[\sum_{v=\overline{n}+1}^{n} \Phi_{vj}^i \left(\widetilde{\rho}_{vj}^i\right)^{\zeta_j^i+1}\right]^{\frac{1}{\zeta_j^i+1}} \quad \text{(A.25)}$$

Institutional holdings of EU bonds:

$$S_j^{ibu} = \left(\frac{\rho_j^{ibu}}{\rho_j^{ib}}\right)^{\beta_j^i}\Lambda_j^i \cdot S_j^{ib}, \qquad 0 < \Lambda_j^i < 1 \quad \text{(A.26)}$$

Institutional holdings of ROW bonds:

$$S_j^{ibn} = \left(\frac{\rho_j^{ibn}}{\rho_j^{ib}}\right)^{\beta_j^i}\left(1 - \Lambda_j^i\right) \cdot S_j^{ib} \quad \text{(A.27)}$$

Average return to bonds for an institutional investor:

$$\rho_j^{ib} = \left[\Lambda_j^i \left(\rho_j^{ibu}\right)^{\beta_j^i+1} + \left(1-\Lambda_j^i\right)\left(\rho_j^{ibn}\right)^{\beta_j^i+1}\right]^{\frac{1}{\beta_j^i+1}} \tag{A.28}$$

Institutional holdings of bonds issued by EU country v:

$$B_{vj}^{iu} = \left(\frac{\widetilde{i}_{vj}^i}{\rho_j^{ibu}}\right)^{\kappa_j^i} \upsilon_{vj}^i \cdot S_j^{ibu}, \qquad \sum_{v=1}^{\overline{n}} \upsilon_{vj}^i = 1, \qquad v = 1, \ldots.., \overline{n}; \qquad j = 1, \ldots..., n \tag{A.29}$$

Institutional holdings of bonds issued by ROW country v:

$$B_{vj}^{in} = \left(\frac{\widetilde{i}_{vj}^i}{\rho_j^{ibn}}\right)^{\gamma_j^i} F_{vj}^i \cdot S_j^{ibn}, \qquad \sum_{v=\overline{n}+1}^{n} F_{vj}^i = 1, \qquad v = \overline{n}+1, \ldots.., n; \qquad j = 1, \ldots..., n \tag{A.30}$$

Average net return to EU bonds for an institutional investor:

$$\rho_j^{ibu} = \left[\sum_{v=1}^{\overline{n}} \upsilon_{vj}^i \left(\widetilde{i}_{vj}^i\right)^{\kappa_j^i+1}\right]^{\frac{1}{\kappa_j^i+1}} \tag{A.31}$$

Average net return to ROW bonds for an institutional investor:

$$\rho_j^{ibn} = \left[\sum_{v=\overline{n}+1}^{n} F_{vj}^i \left(\widetilde{i}_{vj}^i\right)^{\gamma_j^i+1}\right]^{\frac{1}{\gamma_j^i+1}} \tag{A.32}$$

An institutional investor's after-tax return to bonds issued in foreign country v:

$$\widetilde{i}_{vj}^i = i_v \left[1 - D_j^{ib} m_j^{ri} - \left(1 - D_j^{ib}\right)\tau_{vj}^{bw} - c_j^b\right], \qquad v = 1, \ldots.., n; \quad j = 1, \ldots..., n; \qquad v \neq j \tag{A.33.a}$$

An institutional investor's after-tax return to domestic bonds:

$$\widetilde{i}^{i}_{jj} = i_j \left[1 - D^{ib}_j m^{ri}_j - \left(1 - D^{ib}_j\right) \tau^{bw}_{jj}\right] \tag{A.33.b}$$

Household holdings of stocks:

$$S^{hs}_j = \left(\frac{\rho^{hs}_j}{\rho^h_j}\right)^{\theta^h_j} \Upsilon^h_j \cdot S^h_j, \qquad 0 < \Upsilon^h_j < 1 \tag{A.34}$$

Household holdings of bonds:

$$S^{hb}_j = \left(\frac{\rho^{hb}_j}{\rho^h_j}\right)^{\theta^h_j} \left(1 - \Upsilon^h_j\right) \cdot S^h_j \tag{A.35}$$

Average return to household saving:

$$\rho^h_j = \left[\Upsilon^h_j \left(\rho^{hs}_j\right)^{\theta^h_j + 1} + \left(1 - \Upsilon^h_j\right) \left(\rho^{hb}_j\right)^{\theta^h_j + 1}\right]^{\frac{1}{\theta^h_j + 1}} \tag{A.36}$$

Household holdings of domestic stocks:

$$S^{hsd}_j = \left(\frac{\rho^{hsd}_j}{\rho^{hs}_j}\right)^{\varrho_j} \Theta_j \cdot S^{hs}_j, \qquad 0 < \Theta_j < 1 \tag{A.37}$$

Household holdings of foreign stocks:

$$S^{hsf}_j = \left(\frac{\rho^{hsf}_j}{\rho^{hs}_j}\right)^{\varrho_j} \left(1 - \Theta_j\right) \cdot S^{hs}_j \tag{A.38}$$

Average return to stocks for a household investor:

$$\rho_j^{hs} = \left[\Theta_j \left(\rho_j^{hsd}\right)^{\varrho_j+1} + (1-\Theta_j)\left(\rho_j^{hsf}\right)^{\varrho_j+1}\right]^{\frac{1}{\varrho_j+1}} \tag{A.39}$$

A household investor's after-tax return to domestic stocks:

$$\rho_j^{hsd} = \widehat{\rho}_j \left[1 - D_{jj}^{hs} z_{jj}^h - \left(1 - D_{jj}^{hs}\right) p_j^d \tau_{jj}^{sw}\right] \tag{A.40}$$

A household investor's after-tax return to foreign stocks:

$$\rho_j^{hsf} = \left[\Psi_j^h \left(\rho_j^{hsu}\right)^{\sigma_j^h+1} + \left(1-\Psi_j^h\right)\left(\rho_j^{hsn}\right)^{\sigma_j^h+1}\right]^{\frac{1}{\sigma_j^h+1}} \tag{A.42}$$

Household holdings of EU stocks:

$$S_j^{hsu} = \left(\frac{\rho_j^{hsu}}{\rho_j^{hsf}}\right)^{\sigma_j^h} \Psi_j^h \cdot S_j^{hsf}, \qquad 0 < \Psi_j^h < 1 \tag{A.43}$$

Household holdings of ROW stocks:

$$S_j^{hsn} = \left(\frac{\rho_j^{hsn}}{\rho_j^{hsf}}\right)^{\sigma_j^h} \left(1-\Psi_j^h\right) \cdot S_j^{hsf} \tag{A.44}$$

Household holdings of stocks issued by EU country v:

$$E_{vj}^{hu} = \left(\frac{\widetilde{\rho}_{vj}^h}{\rho_j^{hsu}}\right)^{\omega_j^h} \phi_{vj}^h \cdot S_j^{hsu}, \tag{A.45}$$

$$\sum_{v=1,\ v\neq j}^{\overline{n}} \phi_{vj}^h = 1, \quad v = 1, \ldots.., \overline{n}; \quad j = 1, \ldots..., n; \quad j \neq v$$

Household holdings of stocks issued by ROW country v:

$$E_{vj}^{hn} = \left(\frac{\widetilde{\rho}_{vj}^{h}}{\rho_{j}^{hsn}} \right)^{\zeta_j^h} \Phi_{vj}^{h} \cdot S_{j}^{hsn}, \tag{A.46}$$

$$\sum_{v=\overline{n}+1,\ v\neq j}^{n} \Phi_{vj}^{h} = 1, \quad v = \overline{n}+1, \ldots\ldots, n; \quad j = 1, \ldots\ldots, n; \quad j \neq v$$

A household investor's average net return to EU stocks:

$$\rho_{j}^{hsu} = \left[\sum_{v=1,\ v\neq j}^{\overline{n}} \phi_{vj}^{h} \left(\widetilde{\rho}_{vj}^{h} \right)^{\omega_j^h+1} \right]^{\frac{1}{\omega_j^h+1}} \tag{A.47}$$

A household investor's average net return to ROW stocks:

$$\rho_{j}^{hsn} = \left[\sum_{v=\overline{n}+1,\ v\neq j}^{n} \Phi_{vj}^{h} \left(\widetilde{\rho}_{vj}^{h} \right)^{\zeta_j^h+1} \right]^{\frac{1}{\zeta_j^h+1}} \tag{A.48}$$

A household investor's after-tax return to shares issued in foreign country v:

$$\widetilde{\rho}_{vj}^{h} = \widehat{\rho}_{v}^{m} \left[1 - D_{vj}^{hs} z_{vj}^{h} - \left(1 - D_{vj}^{hs}\right) p_{v}^{d} \tau_{vj}^{sw} - c_{j}^{s} \right], \tag{A.49}$$

$$v = 1, \ldots\ldots, n; \qquad j = 1, \ldots\ldots, n; \qquad v \neq j$$

A household investor's average effective tax rate on income from shares:

$$z_{vj}^{h} = p_{v}^{d} \left[\left(1 - D_{vj}^{I}\right) m_{j}^{dh} + D_{vj}^{I} \left(\frac{m_{j}^{dh} - \widehat{u}_{v}}{1 - \widehat{u}_{v}} \right) \right] + \left(1 - p_{v}^{d}\right) m_{j}^{ch}, \qquad 0 < p_{v}^{d} < 1, \quad \forall\ v, j \tag{A.50}$$

A household investor's effective tax rate on accrued capital gains on shares:

$$m_j^{ch} = \left(1+\widetilde{i}_{jj}^h\right)\left\{\frac{\tau_j^{chs}a_j^{cs}}{a_j^{cs}+\widetilde{i}_{jj}^h+\frac{D_j^{cp}\widetilde{p}\left(1-a_j^{cs}\right)}{1+\widetilde{p}}}+\right.$$

$$\left.\left(\frac{\left(1-a_j^{cs}\right)\left(1-\frac{D_j^{cp}\widetilde{p}}{1+\widetilde{p}}\right)}{1+\widetilde{i}_{jj}^h}\right)^{n_j^s}\left[\frac{\tau_j^{chl}a_j^{cl}}{a_j^{cl}+\widetilde{i}_{jj}^h+\frac{D_j^{cp}\widetilde{p}\left(1-a_j^{cl}\right)}{1+\widetilde{p}}}-\frac{\tau_j^{chs}a_j^{cs}}{a_j^{cs}+\widetilde{i}_{jj}^h+\frac{D_j^{cp}\widetilde{p}\left(1-a_j^{cs}\right)}{1+\widetilde{p}}}\right]\right\} \tag{A.50.a}$$

Household holdings of domestic bonds:

$$S_j^{hbd} = \left(\frac{\widetilde{i}_{jj}^h}{\rho_j^{hb}}\right)^{\xi_j}\Delta_j\cdot S_j^{hb}, \qquad 0<\Delta_j<1 \tag{A.51}$$

Household holdings of foreign bonds:

$$S_j^{hbf} = \left(\frac{\rho_j^{hbf}}{\rho_j^{hb}}\right)^{\xi_j}(1-\Delta_j)\cdot S_j^{hb} \tag{A.52}$$

Average net return to bonds for a household investor:

$$\rho_j^{hb} = \left[\Delta_j\left(\widetilde{i}_{jj}^h\right)^{\xi_j+1}+(1-\Delta_j)\left(\rho_j^{hbf}\right)^{\xi_j+1}\right]^{\frac{1}{\xi_j+1}} \tag{A.53}$$

Household holdings of EU bonds:

$$S_j^{hbu} = \left(\frac{\rho_j^{hbu}}{\rho_j^{hbf}}\right)^{\beta_j^h}\Lambda_j^h\cdot S_j^{hbf}, \qquad 0<\Lambda_j^h<1 \tag{A.54}$$

Household holdings of ROW bonds:

$$S_j^{hbn} = \left(\frac{\rho_j^{hbn}}{\rho_j^{hbf}}\right)^{\beta_j^h} \left(1 - \Lambda_j^h\right) \cdot S_j^{hbf} \tag{A.55}$$

Average net return to foreign bonds for a household investor:

$$\rho_j^{hbf} = \left[\Lambda_j^h \left(\rho_j^{hbu}\right)^{\beta_j^h+1} + \left(1 - \Lambda_j^h\right) \left(\rho_j^{hbn}\right)^{\beta_j^h+1}\right]^{\frac{1}{\beta_j^h+1}} \tag{A.56}$$

Household holdings of bonds issued by EU country v:

$$\begin{aligned} B_{vj}^{hu} &= \left(\frac{\widetilde{i}_{vj}^h}{\rho_j^{hbu}}\right)^{\kappa_j^h} \upsilon_{vj}^h \cdot S_j^{hbu}, \qquad (A.57) \\ \sum_{v=1,\ v\neq j}^{\overline{n}} \upsilon_{vj}^h &= 1, \quad v = 1, ..., \overline{n}; \quad j = 1, ..., n; \quad j \neq v \end{aligned}$$

Household holdings of bonds issued by ROW country v:

$$\begin{aligned} B_{vj}^{hn} &= \left(\frac{\widetilde{i}_{vj}^h}{\rho_j^{hbn}}\right)^{\gamma_j^h} F_{vj}^h \cdot S_j^{hbn}, \qquad (A.58) \\ \sum_{v=\overline{n}+1,\ v\neq j}^{n+1} F_{vj}^h &= 1, \quad v = \overline{n}+1, ..., n+1; \quad j = 1, ..., n; \quad j \neq v \end{aligned}$$

Average net return on EU bonds for a household investor:

$$\rho_j^{hbu} = \left[\sum_{v=1,\ v\neq j}^{\overline{n}} \upsilon_{vj}^h \left(\widetilde{i}_{vj}^h\right)^{\kappa_j^h+1}\right]^{\frac{1}{\kappa_j^h+1}} \tag{A.59}$$

Average net return on ROW bonds for a household investor:

$$\rho_j^{hbn} = \left[\sum_{v=\overline{n}+1,\ v\neq j}^{n+1} F_{vj}^{h} \left(\widetilde{i}_{vj}^{h} \right)^{\gamma_j^h+1} \right]^{\frac{1}{\gamma_j^h+1}} \tag{A.60}$$

Net return to a household investor on bonds issued in foreign country v:

$$\widetilde{i}_{vj}^{h} = i_v \left(1-c\right) \left[1 - D_{vj}^{hb} m_j^{rh} - \left(1 - D_{vj}^{hb}\right) \tau_{vj}^{bw} - c_j^b\right] \tag{A.61.a}$$

$$v = 1, \ldots\ldots, n+1; \qquad j = 1, \ldots\ldots, n; \qquad v \neq j$$

A household investor's net return on domestic bonds:

$$\widetilde{i}_{jj}^{h} = i_j \left(1-c\right) \left[1 - D_{jj}^{hb} m_j^{rh} - \left(1 - D_{jj}^{hb}\right) \tau_{jj}^{bw}\right] \tag{A.61.b}$$

Deposits in tax haven:

$$B^{n+1} = \frac{1}{s_{n+1}} \sum_{j=1}^{n} s_j B_{n+1,j}^{hn} \tag{A.62}$$

Tax haven intermediator's holdings of bonds issued by country v:

$$B_v^{n+1} = \left[\frac{i_v \left(1 - \tau_{v,n+1}^{bw}\right)}{i_{n+1}} \right]^{\psi} \chi_v \cdot B^{n+1}, \qquad \sum_{v=1}^{n} \chi_v = 1, \qquad v = 1, \ldots\ldots\ldots\ldots, n \tag{A.63}$$

Interest on deposits in tax haven:

$$i_{n+1} = \left[\sum_{v=1}^{n} \chi_v \left[i_v \left(1 - \tau_{v,n+1}^{bw}\right)\right]^{\psi+1} \right]^{\frac{1}{\psi+1}} \tag{A.64}$$

The business sector and the labour market

Unemployment:

$$u_j = \left\{ \frac{1+\varepsilon_j}{\lambda_j \left[\left(1-b_j^n\right)\left(1+\varepsilon_j\right) - 1 \right] + 1} \right\}^{1/\eta_j} \tag{A.65}$$

Net replacement ratio:

$$b_j^n = \frac{b_j \left(1-\mu_j t_j\right)}{1-t_j} \tag{A.66}$$

Per-capita output in domestic corporations:

$$y_j = \left[\left(1-s_j^m\right) \overline{a}_j \right]^{1-\alpha_j-\beta_j} \ell_j^{\alpha_j} k_j^{\beta_j} \tag{A.67}$$

Cost of financial distress for domestic corporation:

$$a_j^d = \frac{\left(d_j - \overline{d}_j\right)^{1+\epsilon_j^d}}{1+\epsilon_j^d} \tag{A.68}$$

Average corporate tax rate for domestic corporations:

$$\tau_j = \widehat{g}_j \tau_j^d + \left(1-\widehat{g}_j\right) \tau_j^r \tag{A.69}$$

Taxable profits per capita in domestic corporations:

$$\widetilde{\pi}_j = y_j - W_j \ell_j - \left(\alpha_j^d d_j i_j + a_j^d + \widetilde{\delta}_j \right) k_j \tag{A.70}$$

Cost of finance in domestic corporations:

$$r_j = \widehat{\rho}_j \left(1 - d_j\right) + d_j i_j \left(1 - \alpha_j^d \tau_j\right) + a_j^d \left(1 - \tau_j\right) \tag{A.71}$$

Per-capita demand for labour in domestic corporations:

$$\ell_j = \frac{\alpha_j y_j}{W_j} \tag{A.72}$$

Per-capita demand for capital in domestic corporations:

$$k_j = \frac{\beta_j y_j \left(1 - \tau_j\right)}{r_j + \delta_j - \tau_j \widetilde{\delta}_j} \tag{A.73}$$

Effective rate of depreciation for tax purposes in domestic corporations:

$$\widetilde{\delta}_j = \frac{\widehat{\delta}_j \left(\delta_j + r_j\right)}{\widehat{\delta}_j + r_j} \tag{A.74}$$

Optimal debt ratio in domestic corporation:

$$d_j = \overline{d}_j + \left[\frac{\widehat{\rho}_j - i_j \left(1 - \alpha_j^d \tau_j\right)}{1 - \tau_j}\right]^{1/\epsilon_j^d} \tag{A.75}$$

Distributed share of taxable profits in domestic corporation:

$$\widehat{g}_j = \frac{p_j^d \widehat{\rho}_j k_j \left(1 - d_j\right)}{\widetilde{\pi}_j} \tag{A.76}$$

Output per capita in multinational parent company:

$$y_j^m = \left(s_j^m \overline{a}_j\right)^{1 - \alpha_j - \beta_j} \left(\ell_j^m\right)^{\alpha_j} \left(k_j^m\right)^{\beta_j} \tag{A.77}$$

Cost of financial distress for multinational parent:

$$a_j^{dm} = \frac{\left(d_j^m - \overline{d}_j^m\right)^{1+\epsilon_j^d}}{1+\epsilon_j^d} \tag{A.78}$$

Cost of distorted transfer prices:

$$a_{vj}^Q = \frac{\left(p_{vj}^Q - 1\right)^{1+\epsilon_j^Q}}{1+\epsilon_j^Q} \qquad \text{for } \tau_{vj}^F \geq \tau_j^m, \quad v \neq j \tag{A.83.a}$$

$$a_{vj}^Q = \frac{\left(1 - p_{vj}^Q\right)^{1+\epsilon_j^Q}}{1+\epsilon_j^Q} \qquad \text{for } \tau_{vj}^F < \tau_j^m, \quad v \neq j \tag{A.83.b}$$

Average corporate tax rate for multinational parent:

$$\tau_j^m = \widehat{g}_j^m \tau_j^d + \left(1 - \widehat{g}_j^m\right) \tau_j^r \tag{A.84}$$

Distributed share of parent company taxable profits:

$$\widehat{g}_j^m = \frac{p_j^d \widehat{\rho}_j^m \left[k_j^m \left(1 - d_j^m\right) + \sum_{v=1,\ v\neq j}^n \left(s_v/s_j\right) k_{vj}^F \left(1 - d_{vj}^F\right)\right]}{\widetilde{\pi}_j^m + \sum_{v=1,\ v\neq j}^n \left\{\left(1-\tau_v^d\right)\left(1-\tau_{vj}^{wF}\right)\left[D_{vj}^e\left(1-D_j^{ee}\right) + D_{vj}^d\right] + D_{vj}^{cs} + D_{vj}^{cw}\right\} \widehat{g}_j^F \left(\frac{s_v}{s_j}\right) \widetilde{\pi}_{vj}^F} \tag{A.85}$$

Cost of finance for multinational parent:

$$r_j^m = \widehat{\rho}_j^m \left(1 - d_j^m\right) + d_j^m i_j \left(1 - \alpha_j^d \tau_j^m\right) + a_j^{dm} \left(1 - \tau_j^m\right) \tag{A.86}$$

Output per capita in foreign subsidiary:

$$\begin{aligned} y_{vj}^F &= (s_j \overline{q}_v)^{1-\varsigma_v-\alpha_v^F-\beta_v^F} \left[\left(\frac{s_j}{s_v} \right) q_{vj} \right]^{\varsigma_v} \left(\ell_{vj}^F \right)^{\alpha_v^F} \left(k_{vj}^F \right)^{\beta_v^F}, \\ v &= 1, \ldots.., n; \qquad j = 1, \ldots.., n; \qquad v \neq j \end{aligned} \tag{A.87}$$

Cost of financial distress for foreign subsidiary:

$$\begin{aligned} a_{vj}^{dF} &= \frac{\left(d_{vj}^F - \overline{d}_v^m \right)^{1+\epsilon_v^d}}{1+\epsilon_v^d}, \\ v &= 1, \ldots.., n; \qquad j = 1, \ldots.., n; \qquad v \neq j \end{aligned} \tag{A.88}$$

Cost of finance for foreign subsidiary:

$$\begin{aligned} r_{vj}^F &= \widehat{\rho}_j^m \left(1 - d_{vj}^F \right) + d_{vj}^F i_v \left(1 - \alpha_v^d \tau_{vj}^F \right) + a_{vj}^{dF} \left(1 - \tau_{vj}^F \right), \\ v &= 1, \ldots.., n; \qquad j = 1, \ldots.., n; \qquad v \neq j \end{aligned} \tag{A.89}$$

Average corporate tax rate on foreign subsidiary:

$$\begin{aligned} \tau_{vj}^F &= \widehat{g}_j^F \tau_{vj}^d + \left(1 - \widehat{g}_j^F \right) \tau_{vj}^r, \\ v &= 1, \ldots.., n; \qquad j = 1, \ldots.., n; \qquad v \neq j \end{aligned} \tag{A.90}$$

Taxable profits per capita in foreign subsidiary:

$$\begin{aligned} \widetilde{\pi}_{vj}^F &\equiv y_{vj}^F - W_v \ell_{vj}^F - p_{vj}^Q q_{vj} \left(\frac{s_j}{s_v} \right) - \left(\alpha_v^d d_{vj}^F i_v + a_{vj}^{dF} + \widetilde{\delta}_{vj}^F \right) k_{vj}^F, \\ v &= 1, \ldots.., n; \qquad j = 1, \ldots.., n; \qquad v \neq j \end{aligned} \tag{A.91}$$

Parent company's taxable per-capita profits from domestic sources:

$$\widetilde{\pi}_j^m = y_j^m - W_j \ell_j^m - \left(\alpha_j^d d_j^m i_j + a_j^{dm} + \widetilde{\delta}_j^m\right) k_j^m + \sum_{v=1,\ v\neq j}^{n} \left(p_{vj}^Q - 1 - a_{vj}^Q\right) q_{vj} \tag{A.92}$$

Optimal level of intermediate input:

$$q_{vj} = \frac{\left(1-\tau_{vj}^F\right) \varsigma_v \left(s_v/s_j\right) y_{vj}^F}{\left(\tau_j^m - \tau_{vj}^F\right) p_{vj}^Q + \left(1-\tau_j^m\right)\left(1+a_{vj}^Q\right)} \tag{A.93}$$

$$v = 1, \ldots.., n; \qquad j = 1, \ldots.., n; \qquad v \neq j$$

Demand for labour in multinational parent:

$$\ell_j^m = \frac{\alpha_j y_j^m}{W_j} \tag{A.94}$$

Demand for capital in multinational parent:

$$k_j^m = \frac{\beta_j y_j^m \left(1-\tau_j^m\right)}{r_j^m + \delta_j - \tau_j^m \widetilde{\delta}_j^m} \tag{A.95}$$

Effective rate of depreciation for tax purposes in multinational parent:

$$\widetilde{\delta}_j^m = \frac{\widehat{\delta}_j \left(\delta_j + r_j^m\right)}{\widehat{\delta}_j + r_j^m} \tag{A.96}$$

Optimal debt ratio in multinational parent:

$$d_j^m = \overline{d}_j^m + \left[\frac{\widehat{\rho}_j^m - i_j\left(1-\alpha_j^d \tau_j^m\right)}{1-\tau_j^m}\right]^{1/\epsilon_j^d} \tag{A.97}$$

Optimal transfer price:

$$p_{vj}^{Q} = 1 + \left(\frac{\tau_{vj}^{F} - \tau_{j}^{m}}{1 - \tau_{j}^{m}} \right)^{1/\epsilon_j^Q} \qquad \text{for} \quad \tau_{vj}^{F} \geq \tau_{j}^{m} \tag{A.98.a}$$

$$p_{vj}^{Q} = 1 - \left(\frac{\tau_{j}^{m} - \tau_{vj}^{F}}{1 - \tau_{j}^{m}} \right)^{1/\epsilon_j^Q} \qquad \text{for} \quad \tau_{vj}^{F} < \tau_{j}^{m} \tag{A.98.b}$$

$$v = 1, ..., n; \qquad j = 1, ..., n; \qquad v \neq j$$

Demand for labour in foreign subsidiary:

$$\ell_{vj}^{F} = \frac{\alpha_v^F y_{vj}^F}{W_v} \tag{A.99}$$

$$v = 1, ..., n; \qquad j = 1, ..., n; \qquad v \neq j$$

Demand for capital in foreign subsidiary:

$$k_{vj}^{F} = \frac{\beta_v^F y_{vj}^F \left(1 - \tau_{vj}^F\right)}{r_{vj}^F + \delta_v - \tau_{vj}^F \widetilde{\delta}_{vj}^F} \tag{A.100}$$

$$v = 1, ..., n; \qquad j = 1, ..., n; \qquad v \neq j$$

Effective rate of depreciation for tax purposes in foreign subsidiary:

$$\widetilde{\delta}_{vj}^{F} = \frac{\widehat{\delta}_v \left(\delta_v + r_{vj}^F\right)}{\widehat{\delta}_v + r_{vj}^F} \tag{A.101}$$

$$v = 1, ..., n; \qquad j = 1, ..., n; \qquad v \neq j$$

Optimal debt ratio in foreign subsidiary:

$$d_{vj}^{F} = \overline{d}_{v}^{m} + \left[\frac{\widehat{\rho}_{j}^{m} - i_{v}\left(1 - \alpha_{v}^{d}\tau_{vj}^{F}\right)}{1 - \tau_{vj}^{F}} \right]^{1/\epsilon_{v}^{d}} \tag{A.102}$$

$$v = 1, ..., n; \qquad j = 1, ..., n; \qquad v \neq j$$

Corporate tax rate on repatriated income from foreign direct investment:

$$\tau_{vj}^{d} = D_{vj}^{e}\tau_{vj}^{de} + D_{vj}^{d}\tau_{vj}^{dd} + D_{vj}^{cs}\tau_{vj}^{dcs} + D_{vj}^{cw}\tau_{vj}^{dcw}, \qquad v \neq j \tag{A.103}$$

Corporate tax rate on repatriated FDI income under exemption:

$$\tau_{vj}^{de} = \frac{\tau_{v}^{d} + \tau_{vj}^{wF}\left(1 - \tau_{v}^{d}\right) + \tau_{j}^{m}\left(1 - D_{j}^{E}\right)\left(1 - D_{j}^{ee}\right)\left(1 - \tau_{v}^{d}\right)\left(1 - \tau_{vj}^{wF}\right) + D_{j}^{E}\left(\frac{\widehat{u}_{j}\widehat{g}_{j}^{m}}{1 - \widehat{u}_{j}}\right)}{1 + D_{j}^{E}\left(\frac{\widehat{u}_{j}\widehat{g}_{j}^{m}}{1 - \widehat{u}_{j}}\right)}, \tag{A.103.a}$$

$$v \neq j$$

Corporate tax rate on repatriated FDI income under deduction:

$$\tau_{vj}^{dd} = \tau_{v}^{d} + \left(1 - \tau_{v}^{d}\right)\tau_{vj}^{wF} + \tau_{j}^{m}\left(1 - \tau_{v}^{d}\right)\left(1 - \tau_{vj}^{wF}\right), \qquad v \neq j \tag{A.103.b}$$

Corporate tax rate on repatriated FDI income under credit by source:

$$\tau_{vj}^{dcs} = \frac{\tau_j^m + D_j^E \left[\frac{\widehat{u}_j \widehat{g}_j^m}{1-\widehat{u}_j} - \widetilde{T}_{vj}^{sF}\right]}{1 + D_j^E \left(\frac{\widehat{u}_j \widehat{g}_j^m}{1-\widehat{u}_j}\right)} \quad \text{for} \quad \widetilde{T}_{vj}^{sF} \geq 0, \qquad v \neq j \tag{A.104.a}$$

$$\tau_{vj}^{dcs} = \tau_{vj}^{de} \quad \text{for} \quad \widetilde{T}_{vj}^{sF} < 0, \qquad v \neq j \tag{A.104.b}$$

Auxiliary variable determining credit limitation under system of credit by source:

$$\widetilde{T}_{vj}^{sF} \equiv \tau_j^m - \left[\tau_v^d + \left(1 - \tau_v^d\right) \tau_{vj}^{wF}\right], \qquad v \neq j \tag{A.105}$$

Corporate tax rate on repatriated FDI income under worldwide credit:

$$\tau_{vj}^{dcw} = \frac{\tau_j^m + D_j^E \left[\frac{\widehat{u}_j \widehat{g}_j^m}{1-\widehat{u}_j} - \widetilde{T}_{vj}^{sF}\right]}{1 + D_j^E \left(\frac{\widehat{u}_j \widehat{g}_j^m}{1-\widehat{u}_j}\right)} \quad \text{for} \quad \widetilde{T}_j^F \geq 0;, \qquad v \neq j \tag{A.106.a}$$

$$\tau_{vj}^{dcw} = \tau_{vj}^{de} \quad \text{for} \quad \widetilde{T}_j^F < 0, \qquad v \neq j \tag{A.106.b}$$

Auxiliary variable determining credit limitation under system of worldwide credit:

$$\widetilde{T}_j^F \equiv \sum_{v=1,\ v \neq j}^{n} \widetilde{T}_{vj}^{sF} \widehat{g}_j^F \left(s_v / s_j\right) \widetilde{\pi}_{vj}^F \tag{A.107}$$

Total corporate tax rate on profits retained in foreign subsidiary:

$$\tau_{vj}^r = \tau_v^r + \left(1 - \tau_v^r\right) \tau_j^{cm} \tag{A.107.a}$$

$$v = 1, ..., n; \qquad j = 1, ..., n; \qquad v \neq j$$

Effective corporate tax rate on accrued capital gains on shares:

$$\tau_j^{cm} = \frac{\tau_j^{sml} a_j^{cm} \left(1 - \frac{D_j^{cm}\widetilde{p}}{1+\widetilde{p}}\right)^{n_j^{sm}}}{\left[1 + i_j \left(1 - \alpha_j^d \tau_j^m\right)\right]^{n_j^{sm}-1} \left[a_j^{cm} + i_j \left(1 - \alpha_j^d \tau_j^m\right) + \frac{D_j^{cm}\widetilde{p}\left(1-a_j^{cm}\right)}{1+\widetilde{p}}\right]} \tag{A.107.b}$$

Working hours:

$$h_j = \left[\left(\frac{\lambda_j - 1}{\lambda_j}\right) \frac{W_j \left(1 - t_j\right)}{P_j}\right]^{1/\varepsilon_j} \tag{A.108}$$

Labour market equilibrium:

$$h_j \left(1 - u_j\right) = \ell_j + \ell_j^m + \sum_{v=1,\ v \neq j}^{n} \ell_{jv}^F \tag{A.109}$$

Profit income

Per-capita net profit from domestic corporations:

$$\pi_j = \left(1 - \tau_j\right) \left(1 - \alpha_j - \beta_j\right) y_j \tag{A.110}$$

Per-capita net profit in multinational parent:

$$\pi_j^m = \left(1 - \tau_j^m\right) \left[\left(1 - \alpha_j - \beta_j\right) y_j^m + \sum_{v=1,\ v \neq j}^{n} \left(p_{vj}^Q - 1 - a_{vj}^Q\right) q_{vj}\right] \tag{A.111}$$

Per-capita net profit from foreign subsidiaries:

$$\widehat{\pi}_j^F = \sum_{v=1,\ v \neq j}^{n} \left(1 - \tau_{vj}^F\right) \left[\left(1 - \alpha_v^F - \beta_v^F\right) \left(s_v / s_j\right) y_{vj}^F - p_{vj}^Q q_{vj}\right] \tag{A.112}$$

Per-capita on-shore bank profits generated by debt issues in country v :

$$y_v^f = ci_v \left[d_v^h \left(1 + t_v^H\right) H_v + d_v k_v + d_v^m k_v^m + \sum_{j=1,\ j\neq v}^{n} d_{vj}^F k_{vj}^F + B_v^g \right.$$

$$\left. - \left(s_{n+1}/s_v\right) B_v^{n+1} - \sum_{j=1}^{n} \left(\frac{s_j}{s_v}\right) \left[D_v^u B_{vj}^{iu} + \left(1 - D_v^u\right) B_{vj}^{in}\right] \right] \qquad \text{(A112.a)}$$

Per-capita pre-tax profit from debt intermediation in the financial sector:

$$\pi_j^f = c_j^i \rho_j^i S_j^i + \overline{f}_j \cdot y_j^f + f_j \cdot \sum_{v=1,\ v\neq j}^{n} \left(\frac{s_v}{s_j}\right) y_v^f, \qquad 0 < \overline{f}_j \leq 1, \qquad j = 1, ..., n \qquad \text{(A.112.b)}$$

Share of foreign-source bank profits accruing to domestic banks:

$$\sum_{j=1,\ j\neq v}^{n} f_j = 1 - \overline{f}_v, \qquad 0 \leq f_j < 1 \qquad v = 1, 2, ..., n \qquad \text{(A.112.c)}$$

Per-capita net profit from financial sector:

$$\widehat{\pi}_j^f = \left(1 - \tau_j^f\right)\left(\pi_j^f + \pi_j^{tr}\right) \qquad \text{(A.113)}$$

Average tax rate on income from financial sector:

$$\tau_j^f = \alpha_j t_j + \left(1 - \alpha_j\right) \tau_j \qquad \text{(A.114)}$$

Bank income generated by intermediation of foreign portfolio investment:

$$\pi_j^{tr} = c_j^b \sum_{v=1,\ v\neq j}^{n+1} i_v \left(1-c\right) \left[D_v^u B_{vj}^{hu} + \left(1-D_v^u\right) B_{vj}^{hn}\right] + c_j^b \sum_{v=1,\ v\neq j}^{n} i_v \left[D_v^u B_{vj}^{iu} + \left(1-D_v^u\right) B_{vj}^{in}\right]$$

$$+c_j^s \sum_{v=1,\ v\neq j}^{n} \widehat{\rho}_v^m \left[D_v^u \left(E_{vj}^{hu} + E_{vj}^{iu}\right) + \left(1-D_v^u\right)\left(E_{vj}^{hn} + E_{vj}^{in}\right)\right] \tag{A.114.a}$$

Total net profit per capita:

$$\widehat{\pi}_j = \pi_j + \pi_j^m + \widehat{\pi}_j^F + \widehat{\pi}_j^f \tag{A.115}$$

Profit (GDP) earned in tax haven:

$$\pi_{n+1}^f = c \cdot i_{n+1} B^{n+1} \tag{A.116}$$

The public sector

Dummy variable for EU membership:

$$D_j^u = 1 \quad \text{for} \quad j = 1, ..., \overline{n}; \qquad D_j^u = 0 \quad \text{for} \quad j = \overline{n}+1, ..., n+1 \tag{A.117}$$

Per-capita revenue from indirect taxes, including property taxes:

$$R_j^i = t_j^C C_j + t_j^H \delta_j^H H_j + \tau_j^H \left(1 + t_j^H\right) H_j \tag{A.118}$$

Per-capita revenue from labour income taxes net of unemployment benefits:

$$R_j^L = W_j h_j \left[t_j \left(1-u_j\right) - u_j b_j^n \left(1-t_j\right)\right] \tag{A.119}$$

Per-capita revenue from residence-based taxes on interest income:

$$R_j^r = D_{jj}^{hb}\left(m_j^{rh} - \tau_{jj}^{bw}\right) i_j\,(1-c)\,S_j^{hbd} - D_j^H m_j^{rh} i_j d_j^H \left(1+t_j^H\right) H_j$$

$$+ \sum_{v=1,\ v\neq j}^{n+1} D_{vj}^{hb} i_v\,(1-c)\left(m_j^{rh} - \tau_{vj}^{bw}\right)\left[D_v^u B_{vj}^{hu} + \left(1-D_v^u\right) B_{vj}^{hn}\right]$$

$$+\sum_{v=1}^{n} D_j^{ib} i_v\left(m_j^{ri} - \tau_{vj}^{bw}\right)\left[D_v^u B_{vj}^{iu} + \left(1-D_v^u\right) B_{vj}^{in}\right] \tag{A.120}$$

Domestic household shares in domestic multinationals:

$$X_j \equiv S_j^{hsd} - \left(1-d_j\right) k_j \tag{A.121}$$

Per-capita revenue from residence-based taxes on portfolio investment in shares:

$$R_j^s = D_{jj}^{hs}\left[\left(z_j^{hm} - p_j^d \tau_{jj}^{sw}\right)\widehat{\rho}_j^m X_j + \left(z_{jj}^h - p_j^d \tau_{jj}^{sw}\right)\widehat{\rho}_j\left(1-d_j\right) k_j\right]$$

$$+\left(\sum_{v=1,\ v\neq j}^{n} D_{vj}^{hs}\widehat{\rho}_v^m \left\{p_v^d\left[\left(1-D_{vj}^I\right) m_j^{dh} + D_{vj}^I\left(\frac{m_j^{dh}}{1-\widehat{u}_v}\right) - \tau_{vj}^{sw}\right] + \left(1-p_v^d\right) m_j^{ch}\right\}\right.$$

$$\left.\times\left[D_v^u E_{vj}^{hu} + \left(1-D_v^u\right) E_{vj}^{hn}\right]\right)$$

$$+D_j^{is}\left(z_{jj}^i - p_j^d \tau_{jj}^{sw}\right)\widehat{\rho}_j^m\left[D_j^u E_{jj}^{iu} + \left(1-D_j^u\right) E_{jj}^{in}\right]$$

$$+\left(\sum_{v=1,\ v\neq j}^{n} D_j^{is}\widehat{\rho}_v^m \left\{p_v^d\left[\left(1-D_{vj}^I\right) m_j^{di} + D_{vj}^I\left(\frac{m_j^{di}}{1-\widehat{u}_v}\right) - \tau_{vj}^{sw}\right] + \left(1-p_v^d\right) m_j^{ci}\right\}\right.$$

$$\times \left[D_v^u E_{vj}^{iu} + (1 - D_v^u) E_{vj}^{in}\right]\Big)$$

$$-p_j^d \widehat{\rho}_j^m \cdot \sum_{v=1,\ v\neq j}^{n} D_{jv}^I \left(\frac{\widehat{u}_j}{1-\widehat{u}_j}\right) \left[D_j^u \left(E_{jv}^{hu} + E_{jv}^{iu}\right) + \left(1 - D_j^u\right)\left(E_{jv}^{hn} + E_{jv}^{in}\right)\right] \qquad \text{(A.123)}$$

Per-capita revenue from corporate taxes on domestic-source profits:

$$R_j^{\pi} = \tau_j^f \left(\pi_j^f + \pi_j^{tr}\right) + \tau_j \widetilde{\pi}_j + \tau_j^m \widetilde{\pi}_j^m + \sum_{v=1,\ v\neq j}^{n} \left[\widehat{g}_v^F \tau_j^d + \left(1 - \widehat{g}_v^F\right)\tau_j^r\right] \widetilde{\pi}_{jv}^F \qquad \text{(A.124)}$$

Per-capita revenue from residence-based corporation tax on foreign direct investment income:

$$R_j^F = \sum_{v=1,\ v\neq j}^{n} \left\{\left[\tau_{vj}^d - \tau_v^d - \tau_{vj}^{wF}\left(1-\tau_v^d\right)\right]\widehat{g}_j^F + \left(1 - \widehat{g}_j^F\right)\left(1-\tau_v^r\right)\tau_j^{cm}\right\}\left(\frac{s_v \widetilde{\pi}_{vj}^F}{s_j}\right) \qquad \text{(A.125)}$$

Per-capita revenue from withholding taxes on interest:

$$R_j^{wr} = \tau_{jj}^{bw} i_j (1-c) S_j^{hbd}$$

$$+ i_j (1-c) \left\{\sum_{v=1}^{n} \tau_{jv}^{bw}\left(\frac{s_v}{s_j}\right)\left[D_j^u B_{jv}^{iu} + \left(1 - D_j^u\right) B_{jv}^{in}\right]\right\}$$

$$+ i_j (1-c) \left\{\tau_{j,n+1}^{bw}\left(\frac{s_{n+1}}{s_j}\right) B_j^{n+1} + \sum_{v=1,\ v\neq j}^{n} \tau_{jv}^{bw}\left(\frac{s_v}{s_j}\right)\left[D_j^u B_{jv}^{hu} + \left(1 - D_j^u\right) B_{jv}^{hn}\right]\right\} \qquad \text{(A.128)}$$

Per-capita revenue from witholding taxes on dividends:

$$R_j^{wd} = \tau_{jj}^{sw} p_j^d \left[\widehat{\rho}_j^m X_j + \widehat{\rho}_j \left(1 - d_j\right) k_j \right] + \sum_{v=1}^{n} \tau_{jv}^{sw} p_j^d \widehat{\rho}_j^m \left(\frac{s_v}{s_j} \right) \left[D_j^u E_{jv}^{iu} + \left(1 - D_j^u\right) E_{jv}^{in} \right]$$

$$+ \sum_{v=1,\ v \neq j}^{n} \tau_{jv}^{sw} p_j^d \widehat{\rho}_j^m \left(\frac{s_v}{s_j} \right) \left[D_j^u E_{jv}^{hu} + \left(1 - D_j^u\right) E_{jv}^{hn} \right] + \sum_{v=1,\ v \neq j}^{n} \tau_{jv}^{wF} \widehat{g}_v^F \left(1 - \tau_v^d\right) \widetilde{\pi}_{jv}^F \tag{A.129}$$

Transfer per capita:

$$T_j = R_j^i + R_j^L + R_j^r + R_j^s + R_j^\pi + R_j^F + R_j^{wr} + R_j^{wd} - i_j B_j^g - G_j \tag{A.130}$$

Capital market equilibrium

Equilibrium in bond market of EU country v:

$$s_v \left[d_v^H \left(1 + t_v^H\right) H_v + d_v k_v + d_v^m k_v^m + B_v^g + \sum_{j=1,\ j \neq v}^{n} d_{vj}^F k_{vj}^F \right]$$

$$= s_{n+1} B_v^{n+1} + s_v S_v^{hbd} + \sum_{j=1,\ j \neq v}^{n} s_j B_{vj}^{hu} + \sum_{j=1}^{n} s_j B_{vj}^{iu}, \qquad v = 1, \ldots\ldots.., \overline{n} \tag{A.131}$$

Equilibrium in bond market of ROW country v:

$$s_v \left[d_v^H \left(1 + t_v^H\right) H + d_v k_v + d_v^m k_v^m + B_v^g + \sum_{j=1,\ j \neq v}^{n} d_{vj}^F k_{vj}^F \right]$$

$$= s_{n+1} B_v^{n+1} + s_v S_v^{hbd} + \sum_{j=1,\ j \neq v}^{n} s_j B_{vj}^{hn} + \sum_{j=1}^{n} s_j B_{vj}^{in}, \qquad v = \overline{n} + 1, \ldots\ldots.., n \tag{A.132}$$

Arbitrage condition for domestic stock market:

$$\widehat{\rho}_v^m = \widehat{\rho}_v \left(\frac{1 - D_{jj}^{hs} z_{jj}^h - \left(1 - D_{jj}^{hs}\right) p_j^d \tau_{jj}^{sw}}{1 - D_{jj}^{hs} z_j^{hm} - \left(1 - D_{jj}^{hs}\right) p_j^d \tau_{jj}^{sw}} \right), \qquad v \in (1, ..., n) \tag{A.133}$$

Effective tax rate on shareholder income from domestic multinationals:

$$z_j^{hm} = p_j^d \left\{ \left(1 - D_{jj}^I\right) m_j^{dh} + D_{jj}^I \left(1 - D_j^{IF}\right) \left(\frac{m_j^{dh} - \widehat{u}_j}{1 - \widehat{u}_j} \right) \right.$$

$$\left. + D_{jj}^I D_j^{IF} \left[\alpha_j^{mI} m_j^{dh} + \left(1 - \alpha_j^{mI}\right) \left(\frac{m_j^{dh} - \widehat{u}_j}{1 - \widehat{u}_j} \right) \right] \right\} + \left(1 - p_j^d\right) m_j^{ch} \tag{A.133.a}$$

Ratio of exempted foreign-source dividends to potential parent-company dividends

$$\alpha_j^{mI} = \frac{\widehat{g}_j^F \sum_{v=1,\ v \neq j}^n D_{vj}^e \left(s_v / s_j\right) \left(1 - \tau_{vj}^d\right) \widetilde{\pi}_{vj}^F}{\left(1 - \tau_j^m\right) \widetilde{\pi}_j^m + \widehat{g}_j^F \sum_{v=1,\ v \neq j}^n \left(s_v / s_j\right) \left(1 - \tau_{vj}^d\right) \widetilde{\pi}_{vj}^F} \tag{A.133.b}$$

Equilibrium in market for shares issued by EU country v:

$$s_v \left[\left(1 - d_v\right) k_v + \left(1 - d_v^m\right) k_v^m + \sum_{j=1,\ j \neq v}^n \left(1 - d_{jv}^F\right) \left(s_j / s_v\right) k_{jv}^F \right]$$

$$= s_v S_v^{hsd} + \sum_{j=1}^n s_j E_{vj}^{iu} + \sum_{j=1,\ j \neq v}^n s_j E_{vj}^{hu}, \qquad v \in (1, ..., \overline{n}) \tag{A.134.a}$$

Equilibrium in market for shares issued by ROW country v:

$$s_v \left[\left(1 - d_v\right) k_v + \left(1 - d_v^m\right) k_v^m + \sum_{j=1,\ j \neq v}^n \left(1 - d_{jv}^F\right) \left(s_j / s_v\right) k_{jv}^F \right]$$

$$= s_v S_v^{hsd} + \sum_{j=1}^{n} s_j E_{vj}^{in} + \sum_{j=1,\ j\neq v}^{n} s_j E_{vj}^{hn}, \qquad v \in (\overline{n}+1, ..., n) \tag{A.135.a}$$

Consumer welfare:

$$U_j = \frac{W_j h_j (1-t_j) \left[1 - u_j + u_j b_j^n - \left(\frac{\lambda_j - 1}{\lambda_j (1+\varepsilon_j)}\right)\right] + T_j + \widehat{\pi}_j + V_j \left[1 + \left(\frac{\varphi_j}{1+\varphi_j}\right) \rho_j^{\frac{1+\varphi_j}{\varphi_j}}\right]}{P_j} \tag{A.136}$$

Gross domestic product per capita at market prices:

$$\widehat{y}_j^M = y_j + y_j^m + \sum_{v=1,\ v\neq j}^{n} \left[y_{jv}^F - p_{jv}^Q \left(\frac{s_v}{s_j}\right) q_{jv} \right] + p_j H_j + t_j^C C_j \tag{A.137}$$

Gross domestic product per capita at factor prices:

$$\widehat{y}_j = \widehat{y}_j^M - R_j^i \tag{A.137.a}$$

Gross national income per capita at market prices:

$$\widetilde{y}_j^M = W_j h_j (1-t_j) \left(1 - u_j + u_j b_j^n\right) + T_j + \widehat{\pi}_j + \rho_j P_j \widetilde{S}_j^c + G_j + \delta_j \left(k_j + k_j^m + \sum_{v=1,\ v\neq j}^{n} k_{jv}^F \right)$$

$$+ \delta_j^H H_j + a_j^d k_j + a_j^{dm} k_j^m + \sum_{v=1,\ v\neq j}^{n} a_{vj}^Q q_{vj} + \sum_{v=1,\ v\neq j}^{n} a_{jv}^{dF} k_{jv}^F, \qquad j = 1, ..., n \tag{A.138}$$

Gross national income per capita at factor prices:

$$\widetilde{y}_j = \widetilde{y}_j^M - R_j^i \tag{A.138.a}$$

Total domestic capital stock per capita (including the housing stock):

$$\widetilde{k}_j = H_j + k_j + k_j^m + \sum_{v=1,\ v\neq j}^{n} k_{jv}^F \tag{A.138.b}$$

Ratio of inward foreign direct investment to total domestic capital stock:

$$\widetilde{k}_j^I = \frac{\sum_{v=1,\ v\neq j}^{n} \left(1 - d_{jv}^F\right) k_{jv}^F}{\widetilde{k}_j} \tag{A.139}$$

Ratio of outward foreign direct investment to total domestic capital stock:

$$\widetilde{k}_j^O = \frac{\sum_{v=1,\ v\neq j}^{n} (s_v/s_j) \left(1 - d_{vj}^F\right) k_{vj}^F}{\widetilde{k}_j} \tag{A.140}$$

Ratio of inward foreign portfolio investment to total domestic capital stock:

$$I_j^{PI} = \frac{\sum_{v=1,\ v\neq j}^{n} (s_v/s_j) \left[D_j^u \left(B_{jv}^{hu} + B_{jv}^{iu} + E_{jv}^{hu} + E_{jv}^{iu}\right) + \left(1 - D_j^u\right) \left(B_{jv}^{hn} + B_{jv}^{in} + E_{jv}^{hn} + E_{jv}^{in}\right)\right]}{\widetilde{k}_j} \tag{A.140.a}$$

Ratio of outward foreign portfolio investment to total domestic capital stock:

$$I_j^{PO} = \frac{\sum_{v=1,\ v\neq j}^{n} \left[D_v^u \left(B_{vj}^{hu} + B_{vj}^{iu} + E_{vj}^{hu} + E_{vj}^{iu}\right) + (1 - D_v^u) \left(B_{vj}^{hn} + B_{vj}^{in} + E_{vj}^{hn} + E_{vj}^{in}\right)\right]}{\widetilde{k}_j} \tag{A.140.b}$$

Ratio of financial sector income to total national income:

$$\widetilde{R}_j^f = \frac{\pi_j^f}{\widetilde{y}_j}, \qquad j = 1, ..., n \tag{A.140.c}$$

Ratio of global on-shore financial sector income to global on-shore GDP:

$$\widetilde{R}^B = \frac{\sum_{j=1}^n s_j \pi_j^f}{\sum_{j=1}^n s_j \widehat{y}_j} \tag{A.140.d}$$

Ratio of institutional saving to total financial saving:

$$\widetilde{R}_j^i = \frac{S_j^i}{S_j} \tag{A.140.e}$$

Ratio of residential capital to total capital:

$$\widetilde{R}_j^H = \frac{H_j}{\widetilde{k}_j} \tag{A.140.f}$$

Government interest payments relative to GDP

$$\widetilde{R}_j^r = \frac{i_j B_j^g}{\widehat{y}_j} \tag{A.140.g}$$

Weight of shares in household portfolios:

$$\widetilde{R}_j^{hs} = \frac{S_j^{hs}}{S_j^{hs} + S_j^{hb}} \tag{A.140.h}$$

Weight of shares in institutional investor portfolios:

$$\widetilde{R}_j^{is} = \frac{S_j^{is}}{S_j^{is} + S_j^{ib}} \tag{A.140.i}$$

Inward profit-shifting relative to GDP:

$$\widetilde{R}_j^{P} = \frac{\sum_{v=1,\ v \neq j}^{n} \left(p_{vj}^{Q} - 1 - a_{vj}^{Q} \right) q_{vj}}{\widehat{y}_j} \tag{A.140.j}$$

Proportion of interest-bearing household assets held in tax haven jurisdiction:

$$\widetilde{R}_j^{h} = \frac{B_{n+1}^{hn}}{\sum_{v=1}^{n+1} \left[D_v^u B_{vj}^{hu} + \left(1 - D_v^u\right) B_{vj}^{hn} \right]} \tag{A.140.k}$$

Ratio of corporate tax revenue to GDP:

$$\widetilde{R}_j^{c} = \frac{R_j^{\pi} + R_j^{F} - \alpha_j t_j \pi_j^{f}}{\widehat{y}_j} \tag{A.141}$$

Ratio of national income to domestic product:

$$R_j^{y} = \frac{\widetilde{y}_j}{\widehat{y}_j} \tag{A.142}$$

Total domestic business capital stock per capita:

$$k_j^{B} = \widetilde{k}_j - H_j \tag{A.142.a}$$

Ratio of inward FDI to total stock of busines capital:

$$k_j^{IB} = \frac{\widetilde{k}_j^{I}}{1 - \widetilde{R}_j^{H}} \tag{A.142.b}$$

Ratio of outward FDI to total stock of domestic business capital:

$$k_j^{OB} = \frac{\widetilde{k}_j^O}{1 - \widetilde{R}_j^H} \tag{A.142.c}$$

Ratio of inward portfolio investment to total stock of business capital:

$$I_j^{IB} = \frac{I_j^{PI}}{1 - \widetilde{R}_j^H} \tag{A.142.d}$$

Ratio of outward portfolio investment to total domestic stock of business capital:

$$I_j^{OB} = \frac{I_j^{PO}}{1 - \widetilde{R}_j^H} \tag{A.142.e}$$

Average consumer welfare in the EU:

$$U^u = \frac{\sum_{j=1}^{\overline{n}} s_j U_j}{\sum_{j=1}^{\overline{n}} s_j} \tag{A.143}$$

Average consumer welfare in the Nordic countries:

$$U^N = \frac{\sum_{j=1}^{n} D_j^N s_j U_j}{\sum_{j=1}^{n} D_j^N s_j}, \qquad j = 1, ..., n \tag{A.144}$$

$D_j^N = 1$ if country j is a Nordic country, $\quad D_j^N = 0$ otherwise

Reference

Sørensen, Peter Birch (2001): "Tax Coordination in the European Union: What Are the Issues?" Forthcoming in Swedish Economic Policy Review.