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# Dundee Discussion Papers in Economics

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Aggregate Scale Economies, Market  
Integration, and Optimal Welfare State Policy

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# Aggregate Scale Economies, Market Integration, and Optimal Welfare State Policy

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## Abstract

Using a two-sector-two-country model with aggregate scale economies and unionisation, we show that optimal welfare state policy entails positive levels of unemployment benefits under free-trade and capital mobility. In this setting, economic integration does not reduce the revenue raising capacity of governments and thus does not lead to a race-to-the-bottom in social standards. Instead, trade and capital flows interact with welfare state policies in increasing welfare even when each government acts independently (non-cooperatively) in determining its optimal welfare payment. Cooperation is shown to improve upon non-cooperative outcomes by raising both the generosity of the welfare state and aggregate welfare.

**Keywords:** circular causation; international trade; capital mobility; optimal policy; welfare state

**JEL Classification:** E6, F1, F4, H3, J5

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## 1. INTRODUCTION

Large-scale public provision of social insurance and progressive systems of redistributive taxation are increasingly perceived as being incompatible with economic globalisation. Two main arguments define the emerging conventional wisdom. First, in an environment characterised by deep trade integration, the distortionary effects of welfare state policies and the taxation necessary to finance them are thought to adversely affect a country's economic performance vis-à-vis its competitors.<sup>1</sup> Second, the credible threat of exit of increasingly mobile capital and firms allegedly leads to a shrinking of the tax base and to pressures to shift the burden of taxation on to less mobile factors such as labour. As a result, globalisation purportedly reduces governments' ability to finance social policies by weakening their control over *both* the volume *and* structure of tax revenue, thus entailing a danger of a 'race-to-the-bottom' in social and labour standards as countries compete with each other to attract and/or retain industry.

In general, however, there does not seem to be compelling evidence that the increased extent of goods and capital market integration during the last decades has contributed systematically to the retrenchment of mature welfare states and/or to a substantial reduction of overall tax burdens<sup>2</sup>, and some recent empirical studies find a positive relationship between openness and the size of the welfare state (e.g., Rodrik, 1998). Nevertheless, the arguments at the core of the conventional wisdom are not fundamentally disputed even by more complex analyses of the relationship between globalisation and the welfare state such as, for example, the '*compensation hypothesis*' (Garrett, 1998; Garrett and Mitchell, 1999; Rodrik, 1997, 1998).<sup>3</sup>

In this paper we contend that circumstances can exist in which welfare states and high degrees of economic integration are perfectly compatible, and argue that the roots of these circumstances lie in the imperfectly competitive nature of goods and factor markets. Our argument relies on the well-known principle that in a second-best world – which is, after all,

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<sup>1</sup> This is the 'distortionary argument' for welfare state retrenchment in a global economy as developed, for instance, in Alesina and Perotti (1997).

<sup>2</sup> Although labour income taxes as a proportion of government revenue have grown faster than capital taxation (which has tended to fall after the mid-1990s), overall tax burdens in advanced industrial economies have not significantly reduced. Moreover, despite wide cross-country diversity in spending levels, social expenditure in OECD countries (except Norway) has increased up until the mid-1990s; in the European Union, subsequent reforms have generally been limited to a restructuring of expenditure with modest declines in some areas and stability or even a slow growth in others (for evidence see: European Commission, 2002; Garrett and Mitchell, 2001; Bretschger and Hettich, 2002).

<sup>3</sup> This hypothesis explains the continued expansion of the welfare state as a response to the rising demands for social insurance resulting from the increasing exposure to external risk and economic dislocations caused by growing international openness.

at the very core of the rationale behind the existence of the welfare state – economic policy can be welfare improving. This principle has been addressed at both the microeconomic and macroeconomic levels.

At the microeconomic level, within market structures which enable producers to set their price above marginal cost, the level of provision of a differentiated good (determined by the equilibrium number of firms resulting from free entry and exit) has been shown to be sub-optimal. This is because the marginal utility of consumption will, in such equilibrium, exceed the marginal cost of production. A social planner who maximises consumer surplus subject to the zero profit condition can, in such circumstances, use distortion-free lump-sum transfers from consumers to producers to subsidise a welfare-improving entry, hence raising the provision of varieties.<sup>4</sup>

This type of policy effectiveness in the face of market imperfections has also emerged in studies of sub-optimal general macroeconomic equilibrium. A seminal paper by Hart (1982) shows that in the presence of imperfect competition in both goods and labour markets, the equilibrium level of activity will be too low and there will be unemployment. In this context, a simple balanced budget fiscal intervention will have desirable typical Keynesian effects. Building on Hart's work, a succession of studies – notably Blanchard and Kiyotaki (1987), Mankiw (1988) and Startz (1989) – have strengthened the proposition that some exogenous stimulation of demand, either through fiscal expansion or via income redistribution, can be welfare improving when there are some market imperfections in the economy. In the case of imperfectly competitive goods markets, while the marginal benefit of consumption exceeds the marginal cost of production, individual consumers per se will not (due to a free riding incentive) take any initiative to improve upon this sub-optimal situation by raising their expenditure autonomously. This reluctance by private agents then gives a strong incentive for a (redistributive or expansionary) fiscal intervention by the government.

The policy effectiveness channel in our analysis is, in spirit, similar to that outlined above, but is also reinforced by the existence of aggregate economies of scale stemming from vertical linkages between sectors.<sup>5</sup> We embed these features within a standard two-country model with trade and capital mobility. Each country is characterised by: **(i)** vertical linkages between two production sectors that are populated by endogenously determined masses of

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<sup>4</sup> See Dixit and Stiglitz (1977). Anderson *et al.* (1992) explain the origins of this result in Chamberlin's work on the trade off between production efficiency and benefits of diversity.

<sup>5</sup> Inter-industry connections are an important source of external returns to scale in manufacturing – see Bartelsman, *et al.* (1994) for evidence – and they have been extensively acknowledged by the theoretical literature, e.g. Ethier (1982), Matsuyama (1995) and Venables (1996).

monopolistically competitive firms; **(ii)** a unionised labour market; and **(iii)** a welfare state policy in the form of unemployment benefits financed via proportional factor income taxation. The intersectoral linkages give rise to aggregate scale economies, with productivity in the downstream sector increasing in the mass of varieties produced in the upstream sector. In this context, an expansionary welfare state policy contributes to the correction of the sub-optimal production of intermediate varieties, thus leading to an increase in aggregate efficiency.

We obtain the optimal unemployment benefit rate for different degrees of economic integration under non-cooperative and cooperative policy regimes. We find that the welfare state complements, rather than conflicts with, globalisation forces in improving economic performance and raising welfare.<sup>6</sup> In particular, **(i)** the optimal policy entails a positive unemployment benefit rate in all regimes; **(ii)** the optimal unemployment benefit rate (together with employment and welfare) increases with economic integration; and **(iii)** the cooperative solution entails higher unemployment benefits (and higher employment and welfare) than the non-cooperative solutions. Thus, contrary to the conventional wisdom, the opening up to trade and capital mobility and competition between governments do not lead to a race-to-the-bottom in social policies and to the ultimate disappearance of the welfare state. The basic mechanism at the core of these results can be explained as follows. The increase in the demand for final goods, which is triggered by the immediate expansionary impact of the welfare policy, induces a deepening of the division of labour in the intermediate sector. The latter leads to a rise in aggregate efficiency, real income and welfare. The strength of this cumulative process is positively related to the extent of vertical linkages between sectors.<sup>7</sup>

The rest of the paper is organised as follows. Section 2 outlines the model and derives the optimal policy under autarky. Section 3 extends the autarky results to the two-country case, derives the Nash non-cooperative equilibrium solutions under free-trade without and with capital mobility, and compares them to that obtained under full cooperation. Section 4 concludes the paper.

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<sup>6</sup> These results go against those of Alesina and Perotti (1997), but are consistent with the positive empirical relationship between social spending and competitiveness found by De Grauwe and Polan (2003).

<sup>7</sup> Alternative mechanisms are examined by van der Ploeg (2003) who shows that conditional unemployment benefits may spur job creation, and by Acemoglu and Shimer (2000) who find that unemployment insurance can improve allocative efficiency by enabling workers to pursue riskier and more productive options.

## 2. THE MODEL: AUTARKY

There are two monopolistically competitive sectors ( $x$  and  $y$ ) in the economy, each supplying horizontally differentiated goods with internal increasing returns to scale. Sector  $y$  produces only a final consumption good, while the output of sector  $x$  is used both as an intermediate input in sector  $y$  and as a final consumption good by consumers. The vertical linkages between the two sectors give rise to aggregate scale economies. The deep division of labour and the complex inter-industry linkages typical of industrial economies are known to result in high degrees of specialisation and, to some extent, in some sector specificity of factors of production.<sup>8</sup> We therefore assume that labour is used directly only in sector  $x$ , while sector  $y$  employs it only indirectly via the use of intermediates as inputs.<sup>9</sup> We also assume that the labour market is unionised. Consistent with the observed tendency in European labour markets towards segmentation in union coverage and decentralisation in collective bargaining (Boeri *et al*, 2001), we assume that wages are set by decentralised (firm-level) monopoly unions. The government, whose role in the economy is limited to income redistribution, is a provider of welfare protection in the form of unemployment benefits financed via proportional factor income taxation. The real unemployment benefits payment is chosen optimally by the government before the other agents in the economy (consumers, unions and firms) optimise their objective functions taking the fiscal policy instruments (tax and unemployment benefit rates) as given.<sup>10</sup>

### 2.1. Final consumers

The preferences of the representative consumer are characterised by the utility function

$$U = \left( \frac{X_c}{\mu} \right)^\mu \left( \frac{Y_c}{1-\mu} \right)^{1-\mu} + (1-\xi)\tilde{V}, \quad (1)$$

where  $0 < \mu < 1$ ,  $X_c$  and  $Y_c$  are the consumption of the goods produced by sectors  $x$  and  $y$  respectively, and  $\tilde{V}$  is the utility of leisure. The individual is endowed with one unit of labour and supplies it inelastically in the labour market;  $\xi = 1$  if the individual is employed and  $\xi = 0$  otherwise. Following Blanchard and Giavazzi (2003), we assume that higher aggregate unemployment “*makes it more painful to be unemployed*” and thus reduces the

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<sup>8</sup> Whilst technological advances in the early phases of industrialisation led to an increase in intersectoral labour mobility, starting from the 1920s the growing complementarity between skills and technology generally led to an increase in sector specificity of labour (Hiscox, 2002).

<sup>9</sup> Relaxing this assumption would not alter the qualitative nature of the results of the paper.

<sup>10</sup> Given that, as we shall see, all agents in the economy are insignificantly *small* individually to interact strategically, no strategic complication arises in terms of the sequence of the moves.

utility of leisure. Hence, we let  $\tilde{V} = f(u)$  where  $u$  denotes the rate of unemployment in the economy, with  $f(0) > 0$  and  $f' < 0$ . Clearly,  $f(0) - f(1)$  ought to be sufficiently large so as to yield a plausible equilibrium solution for  $u$  within the positive unit interval. More specifically, we shall use  $\tilde{V} = e^{\eta \ell} - 1$ , where  $\ell = 1 - u$  is the aggregate employment rate and  $\eta$  is a positive parameter.

Optimisation of (1) subject to the budget constraint yields the demand functions

$$X_c = \mu \frac{M}{P_x}, \quad (2)$$

$$Y_c = (1 - \mu) \frac{M}{P_y}, \quad (3)$$

where  $P_x$  and  $P_y$  are the prices of the two goods and  $M$  is nominal disposable income to be defined later.

We assume that both differentiated goods are aggregated into CES baskets given by

$$X = \left( \int_{i \in N_x} x_i^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}, \quad (4)$$

$$Y = \left( \int_{j \in N_y} y_j^{\frac{\delta-1}{\delta}} dj \right)^{\frac{\delta}{\delta-1}}, \quad (5)$$

where  $x_i$  ( $y_i$ ) is the quantity of a typical variety of the good,  $N_x$  ( $N_y$ ) is the mass of available varieties and  $\sigma > 1$  ( $\delta > 1$ ) is the elasticity of substitution between varieties produced in sector  $x$  ( $y$ ). The industry price indices dual to (4) and (5) are, respectively,

$$P_x = \left( \int_{i \in N_x} p_{x_i}^{1-\sigma} di \right)^{\frac{1}{1-\sigma}}, \quad (6)$$

$$P_y = \left( \int_{j \in N_y} p_{y_j}^{1-\delta} dj \right)^{\frac{1}{1-\delta}}, \quad (7)$$

where  $p_{x_i}$  ( $p_{y_j}$ ) is the price of a typical variety produced in sector  $x$  ( $y$ ).



## 2.2. Producers

There are two sector specific primary inputs in the economy: labour ( $L$ ) and capital ( $K$ ). These are respectively used in sector  $x$  and sector  $y$  and have rates of return denoted by  $w$  and  $r$ .

Each sector is populated by a mass of identical firms, each firm producing a variety of the horizontally differentiated product according to an increasing returns to scale technology. Sector  $x$  uses labour as both fixed and variable input. The total labour demand of a typical firm in this sector is  $l_i = \alpha x_i + \beta$  where  $x_i$  is the firm's output and  $l_i$  is its labour requirement;  $\alpha > 0$  and  $\beta > 0$  are constant parameters which are assumed to be the same across firms and respectively measure the inverse of labour productivity and fixed input requirement. In sector  $y$ , each firm uses a fixed input requirement  $\phi$  of capital and, as variable input, a composite basket of the intermediate varieties produced in sector  $x$  assembled according to the CES aggregator in (4). For any given mass of intermediate varieties, the variable input requirement of a typical firm in sector  $y$  exhibits constant returns to scale  $X_j = \lambda y_j$ .  $\lambda > 0$  is a constant parameter and its inverse measures the degree of vertical linkages between the two sectors. Thus, labour is not used directly in sector  $y$  but is embodied in  $X$ . Also, the CES nature of the latter implies that there are increasing returns to the range of available varieties, since the productivity of the intermediate basket in sector  $y$  is increasing in the mass of varieties in sector  $x$ .

The profit function of a typical firm in sectors  $x$  and  $y$  is, respectively,

$$\pi_{x_i} = p_{x_i} x_i - w_i (\alpha x_i + \beta), \quad (8)$$

$$\pi_{y_j} = p_{y_j} y_j - (P_x \lambda y_j + r \phi). \quad (9)$$

## 2.3. Factor markets

The market for capital is perfectly competitive with  $r$  adjusting to satisfy the resource constraint

$$N_y \phi = \bar{K}, \quad (10)$$

where  $\bar{K}$  is the economy's endowment of capital.

The labour market is unionised. While wages are set by decentralised firm-level monopoly unions, employment is determined by firms. Given the symmetry between firms, in sector  $x$  there is a mass  $N_x$  of identical unions. Denoting by  $\bar{L}$  the aggregate labour force,

a typical union  $i$  will have a mass of members  $\bar{l}_i$  and will embrace the workers of, and set the wage rate for, firm  $i$  in sector  $x$ . Unionisation implies that involuntary unemployment persists in equilibrium and that each union will have some unemployed members<sup>11</sup> – i.e.,  $l_i < \bar{l}_i$  where  $l_i$  is the union's employed members. Each union maximises the expected real income of its typical member subject to its labour demand. Hence, union  $i$ 's objective function is

$$U_i = \frac{l_i}{\bar{l}_i} \frac{(1-t)w_i}{P} + \frac{\bar{l}_i - l_i}{\bar{l}_i} b, \quad (11)$$

where

$$P = P_x^\mu P_y^{1-\mu} \quad (12)$$

is the consumer price index,  $t$  is the labour income tax rate and  $b$  is the real lump-sum benefit received by an unemployed worker. We assume that unemployment benefit payments are not taxed, i.e., they are net transfers.

#### 2.4. Government budget constraint and aggregate income

The government, whose role in the economy is limited to income redistribution, is a provider of welfare protection in the form of unemployment benefits financed via proportional factor income taxation. Noting that  $\int_{i \in N_x} \bar{l}_i di = \bar{L} \geq L = \int_{i \in N_x} l_i di$ , the government budget constraint is

given by

$$\int_{i \in N_x} Pb(\bar{l}_i - l_i) di = \int_{i \in N_x} t w_i l_i di + q r \bar{K}. \quad (13)$$

The right-hand-side of equation (13) is the total tax revenue extracted from the primary factors, where  $q$  is the capital income tax rate, and the left-hand-side of the equation gives the total unemployment benefit bill.

Aggregate income of consumers,  $M$ , is determined by total disposable incomes of primary factors and the transfers from the public to private sector

$$M = \int_{i \in N_x} \left[ (1-t) w_i l_i + Pb(\bar{l}_i - l_i) \right] di + (1-q) r \bar{K}. \quad (14)$$

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<sup>11</sup> We follow the literature in assuming that unemployed workers from other unions cannot be employed in a given union's firm before the latter's unemployed members are hired.

## 2.5. General Equilibrium

Given the assumed preferences and technologies, the total expenditure on the varieties of the good produced in sector  $x$  is given by  $E_x = \mu M + N_y P_x \lambda y$ , where the two terms on the right-hand-side are the total expenditures by the country's consumers and by firms in sector  $y$ , respectively. The total expenditure on the varieties of the good produced in sector  $y$  is instead given by  $E_y = (1 - \mu)M$ . Using these, the demand functions for the variety facing a typical firm in sectors  $x$  and  $y$  are, respectively

$$x_i = \frac{E_x}{P_x} \left( \frac{p_{x_i}}{P_x} \right)^{-\sigma}, \quad (15)$$

$$y_j = \frac{E_y}{P_y} \left( \frac{p_{y_j}}{P_y} \right)^{-\delta}. \quad (16)$$

Firms in both sectors set their prices by maximising their profits – given by (8) and (9) – subject to their demand – in (15) and (16) – and taking the total expenditures and input prices as given. The first order condition for this maximisation can be used to obtain the firms' optimal price rules in sectors  $x$  and  $y$  respectively

$$p_{x_i} = \frac{\alpha \sigma}{\sigma - 1} w_i, \quad (17)$$

$$p_{y_j} = \frac{\lambda \delta}{\delta - 1} P_x. \quad (18)$$

For simplicity, we will use the normalisation  $\alpha = (\sigma - 1) / \sigma$  and replace (17) with  $p_{x_i} = w_i$ . We shall, however, keep (18) intact in order to examine the effect of a rise in the extent of vertical integration captured by a reduction in  $\lambda$ .

The mass of firms in each sector is endogenously determined via free entry and exit and the market clearing process. Hence, at the free-entry equilibrium, all firms in both sectors will break even. Substituting (17) and (18) into (8) and (9) respectively and setting the resulting equations equal to zero, we obtain the equilibrium output scale of a typical firm in sector  $x$  and  $y$

$$x_i = \beta \sigma, \quad (19)$$

$$y_j = \frac{\phi(\delta-1)}{\lambda} \left( \frac{r}{P_x} \right). \quad (20)$$

Hence, in the symmetric equilibrium, while in sector  $x$  the optimal output scale of firms is constant, in sector  $y$  the vertical linkages imply that it depends on the relative price of the two inputs used in the sector. In particular, *ceteris paribus*, the equilibrium output scale in sector  $y$  increases with the depth of the division of labour in sector  $x$  (i.e., it is increasing in  $N_x$  through its effect on  $P_x$ ). Moreover, this effect is larger the larger is the degree of intersectoral linkages ( $1/\lambda$ ).

The wage rate paid by each firm in sector  $x$  is determined by the monopoly union covering its workers. A typical union takes  $P$ ,  $b$  and  $t$  as given and chooses its wage rate  $w_i$  to maximise its objective function in (11) subject to the firm's labour demand (i.e.,  $l_i = \alpha x_i + \beta$ ) as well as (15) and (17). The wage setting equation resulting from this optimisation is

$$\frac{w_i}{P} = \frac{b}{(1-t) \left( 1 - \frac{1}{\varepsilon_i} \right)}, \quad (21)$$

where  $\varepsilon_i$  denotes the wage elasticity of labour demand facing the union and is an inverse measure of unions' monopoly power. It is straightforward to show that  $\varepsilon_i = \sigma - 1$ .

The optimal (real) wage set by the union is positively related to both labour income tax rate and real unemployment benefit since: **(i)** a *ceteris paribus* increase in  $t$  reduces the after tax wage; and **(ii)** a higher unemployment benefit rate  $b$  reduces the utility difference between being employed and unemployed. The wage rate is also negatively related to  $\varepsilon$  since an increase in the latter reduces the rent extracting ability of the union.

Given the assumed symmetry between firms in each sector, we drop the subscripts  $i$  and  $j$  from the equations and, adopting good  $Y$  as numeraire, we set  $P_y = 1$ .

For any given values of the policy instruments,  $t$ ,  $q$  and  $b$ , a general equilibrium is attained when all private agents optimise their objective functions and goods and capital markets clear. In addition, since the general equilibrium also requires the government budget constraint to hold, one of the policy instruments will have to be left to adjust in order to ensure that the tax revenue equals the unemployment benefit bill. For simplicity, we shall assume in the rest of the analysis that the government sets identical tax rates for the income

of the two primary inputs and let  $q=t$ . The solution of the model will therefore determine the endogenous variables – i.e.  $N_x, N_y, x, y, p_x, p_y, P_x, P, r, w, L, M, E_x, E_y$  – and the policy instrument that is left to vary to balance the budget – i.e. either  $t$  or  $b$ .

## 2.6. Optimal unemployment benefit and the role of vertical linkages

The government maximises aggregate welfare to determine the optimal unemployment benefit rate  $b$  allowing the tax rate  $t$  to adjust so as to balance its budget. The government's objective function is given by the aggregate indirect utility which can be obtained from (1), i.e.,

$$U = \frac{M}{P} + \tilde{V}(\bar{L} - L). \quad (22)$$

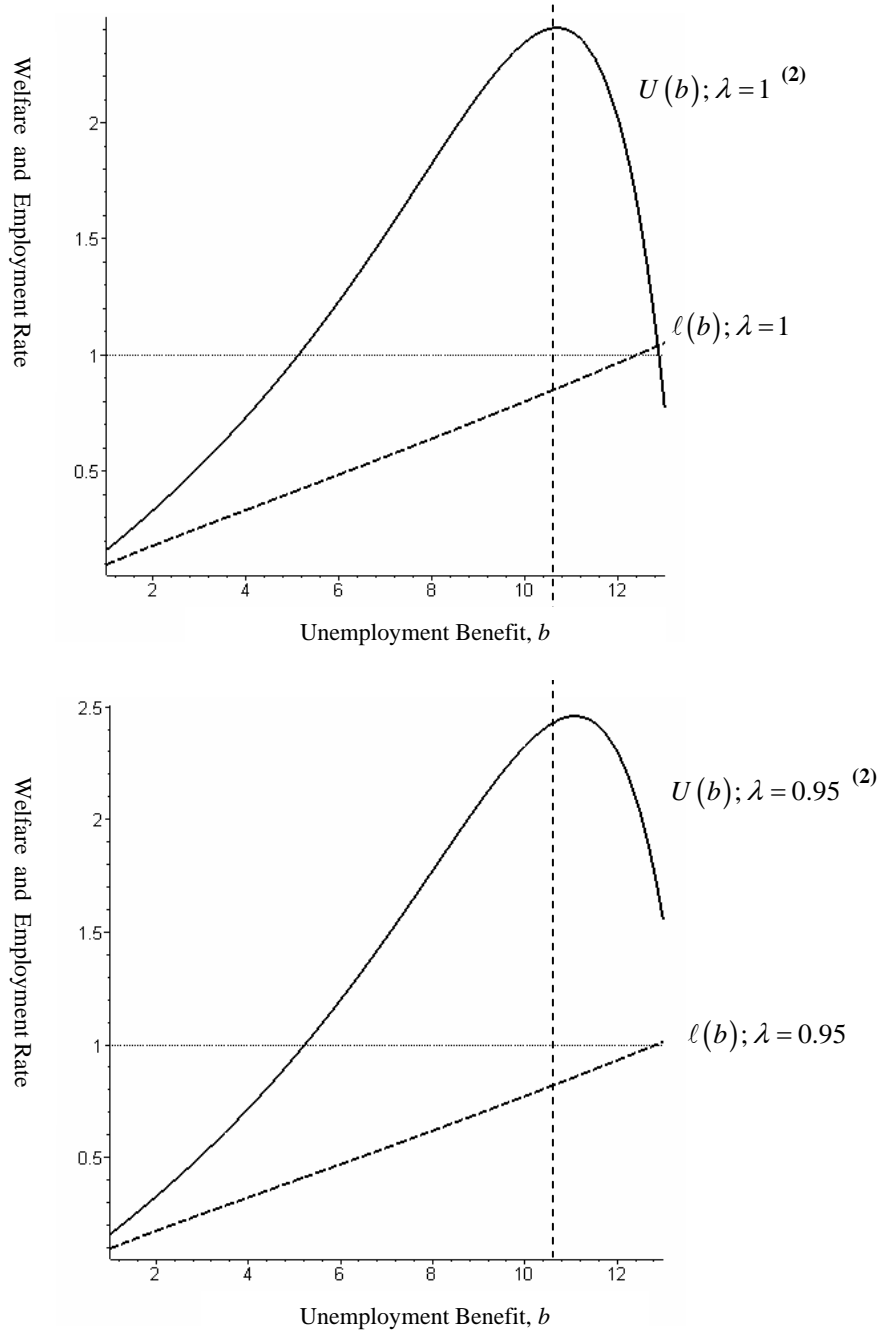
where  $\tilde{V} = e^{\eta\left(\frac{L}{\bar{L}}\right)} - 1$ . The function in (22) is maximised subject to the government budget constraints and all other equations determining  $N_x, N_y, x, y, p_x, p_y, P_x, P, r, w, L, M, E_x, E_y$  and  $t$  in terms of  $b$ . This is equivalent to first solving the model and determining these variables in terms of  $b$  and then substituting the resulting expressions in (22) to obtain the welfare function as  $U(b)$ . Given the analytical complexity of the model, we resort to numerical simulations. Figure 1 below plots the aggregate welfare function and the function determining the aggregate employment rate,  $U(b)$  and  $L/\bar{L} = \ell(b)$ , for two different values of the vertical linkages parameter  $\lambda$ . As the figure suggests, aggregate employment is positively related to the real unemployment benefit rate and the optimal policy entails a positive  $b$ . Recalling that  $\lambda$  is an inverse measure of the degree of vertical linkages between sectors, it is also clear that the optimal unemployment benefit rate and the associated level of aggregate employment and welfare are higher the stronger are the intersectoral linkages.

The concavity of  $U(b)$  reflects the trade-off that the government faces as a result of an increase in unemployment benefit. This trade-off rests on the fact that, a rise in  $b$  leads to an increase in aggregate employment and in real income. On the one hand, the higher income generates an incentive to raise  $b$ . On the other hand, the higher employment reduces the utility of leisure, hence making a lower unemployment benefit rate more desirable.

The fact that real income and employment are increasing in  $b$  may seem counterintuitive and is at odds with the conventional wisdom. Central to this outcome is the existence of complementarities – stemming from monopolistic competition and intersectoral linkages – which result in a sub-optimal provision of intermediate varieties.

**Figure 1. Equilibrium in the Autarky Case<sup>(1)</sup>**  
**Optimal Unemployment Benefit and the Role of Vertical Integration**

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- (1) Parameter values used in the numerical simulation are given in the note to Table A3 in the Appendix. A reduction in  $\lambda$  is equivalent to a rise in the productivity of  $X$  and hence to a higher degree of vertical integration.
- (2)  $U(b)$  is aggregate welfare, measured here by the aggregate indirect utility, evaluated at the general equilibrium solution. The plot of  $U$  depicts per capita welfare (i.e. as ratio of  $\bar{L}$ ) scaled by 0.1 to enable comparison with  $\ell = L/\bar{L}$ .

The *expansionary* nature of the welfare policy reduces the extent of this *sub-optimality*. To see the intuition behind this, let us sketch the complex adjustment process that follows an

exogenous change in  $b$ . For any given  $N_x$  (the mass of firms in sector  $x$ ), an increase in  $b$  will initially prompt unions to demand higher nominal wages. This will have two main effects. First, as firms in sector  $x$  mark-up their prices, the increase in wages is transferred into a higher price for each variety and thus leads to an increase in  $P_x$  – the price index in the industry. By triggering a substitution of  $Y$  for  $X$  by consumers and a reduction in demand for intermediates by firms in sector  $y$ , this effect will lower the demand for  $X$  – which, due to the vertical linkages, is however partially dampened by the higher demand for  $Y$  by consumers. Second, the increase in the benefit rate and the subsequent rise in the wage rate lead together to a higher aggregate nominal income that stimulates consumers’ demand for both  $X$  and  $Y$ . Note that, via the vertical linkages in production, the higher consumption of  $Y$  enhances the direct increase in the demand for  $X$ . It is straightforward to show that the *immediate* impact of a rise in  $b$  (i.e., before the mass of firms, employment levels and other prices adjust) is a net increase in the demand for good  $X$  that triggers new entry of firms into sector  $x$ . The expansion of  $N_x$  reduces  $P_x$  which, other things equal, stimulates both final and intermediate demand for good  $X$  and thus leads to further entry into the sector. A rise in unemployment benefit, therefore, ultimately generates a positive pecuniary externality via an overall expansion of product variety in sector  $x$  which, by reducing  $P_x$ , will lead to: **(i)** a higher productivity of the intermediate goods that will reduce the cost of production in sector  $y$ ; **(ii)** a lower consumer price index that will foster the demand for final goods via a real income effect; and **(iii)** a substitution of  $X$  for  $Y$  by consumers that will further stimulate the demand for  $X$ . The combined effects of these forces will give rise to a cumulative process of entry of new firms into the intermediate industry, higher aggregate efficiency<sup>12</sup>, employment and real income. This virtuous circle clearly generates an incentive for the government to increase its unemployment benefit. In doing so, however, it faces a trade-off in that the higher employment reduces the aggregate utility of leisure.

It is straightforward to verify that the virtuous circle discussed above is stronger the higher is the extent of intersectoral linkages, i.e., the stronger are the aggregate returns to scale. In fact, the smaller is  $\lambda$ , the greater will be: **(i)** the increase in the demand for intermediates following the rise in final goods demand; **(ii)** the entry of new firms in sector  $x$ ; **(iii)** the ensuing aggregate productivity *gains*; and **(iv)** the increase in employment and real income. Hence, as is illustrated in Figure 1 above and in Table A3 in the Appendix, the

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<sup>12</sup> In De Grauwe and Polan (2003), social expenditure affects workers’ productivity by entering directly as an argument in the production function of the private sector. Here, instead, the effects of government policy on aggregate efficiency emerges endogenously.

optimal unemployment benefit rate is higher and the tax rate on primary factors' incomes is lower (due to a higher tax base) at smaller values of  $\lambda$ . Note also that, despite the higher employment, the overall size of the welfare state (i.e., the total unemployment benefit bill) is larger at smaller values of  $\lambda$ , i.e., the increase in  $b$  dominates the fall in unemployment.

### 3. INTERNATIONAL OPENNESS

The aim of this section is to shed light on the effects of international economic integration on the optimal unemployment benefit policy described above. To this end, we extend the model to a standard symmetric two-country setting. We assume that the two economies (Home and Foreign, denoted by H and F respectively) are identical in every respect (tastes, technologies, institutional features and factor endowments). Hence, the model developed in Section 2 applies symmetrically to the foreign country – whose variables will be denoted with an asterisk superscript. The equations for the two country model are given in Tables A1 and A2 in the Appendix.

To start with, we shall focus on the effects of free-trade in goods and assume that both primary factors of production are internationally immobile. Given the absence of trade barriers, the CES aggregators and the price indices of the two differentiated goods will be defined over the varieties produced in, and will be common to, both countries. It follows that a major implication of free-trade is that the increasing returns to the range of available varieties of input  $X$  are fully 'international', i.e., the external economies of scale that characterise the economy are not country specific. Thus, productivity in sector  $y$  in both countries is increasing in  $(N_x + N_x^*)$ , where  $N_x^*$  is the mass of varieties of good  $X$  produced in the foreign country.

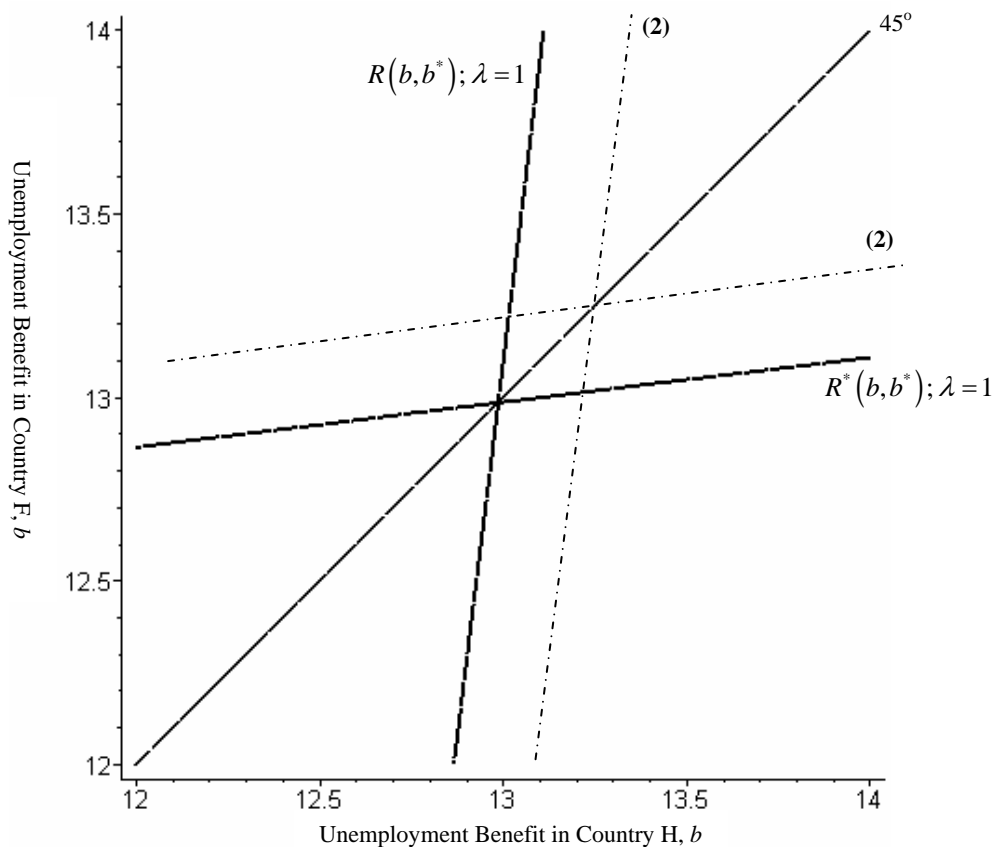
#### 3.1. Optimal non-cooperative policy under free-trade and no capital mobility

We model the optimal non-cooperative policy as the outcome of a Nash game between governments. Hence, each government chooses its unemployment benefit rate to maximise the aggregate welfare of their residents given by (22), allowing the income tax rate to adjust to balance its budget and taking the unemployment benefit rate set by the other government as given. Clearly, as in the autarky case, the maximisation of (22) is carried out subject to the governments' budget constraints and all other equations determining the endogenous variables for H and F in terms of  $b$  and  $b^*$ .



The Nash equilibrium is depicted in Figure 2 below by the intersection of the two governments' reaction functions and consists of positive and – given that the two countries are identical in every respect – symmetric unemployment benefit rates. The fact that the two reaction functions are upward sloping reflects the positive spill-over effects that an increase in unemployment benefit in one country has on the other country's welfare. A unilateral increase in unemployment benefit in one country leads to an increase in the mass of intermediate varieties produced there and thus to a higher aggregate efficiency. However, given that – due to the free tradability of the good – the returns to scale are fully international, the expansion in the intermediate product range in one country generates a positive pecuniary externality for its trading partner who will enjoy higher real income and whose government, as a result, will find it optimal to raise its unemployment benefit rate too.

**Figure 2. Non-Cooperative Nash Equilibrium in the Two-Country Case<sup>(1)</sup>  
Reaction Functions with Free-trade and No Capital Mobility**



- (1) Parameter values used in the numerical simulation are given in the note to Table A3 in the Appendix.
- (2) The broken lines show the shift in the reaction functions as a result of an increase in the degree of vertical integration. See the relevant column in Table A3 in the Appendix for the effect of a rise in the extent of vertical integration captured by a reduction in  $\lambda$ .

As is clear from Table A3 in the Appendix, the Nash equilibrium unemployment benefit rates are higher than in the autarkic regime. Furthermore, the tax rate is lower and employment, real income, and aggregate welfare are higher. Hence, due to positive inter-country spillovers that result from free-trade, a departure from autarky makes it optimal for governments to increase the generosity and the real size of their welfare state,  $b(\bar{L} - L)$ , despite the lower tax rates and the lower unemployment. Essentially, the positive efficiency effects of international trade reinforce, and are reinforced by, the efficiency gains due to aggregate increasing returns that are triggered by the policy.

Again, as in the autarkic case, when intersectoral linkages are stronger, the Nash equilibrium unemployment benefits are higher and, consistently, so are the level of employment in sector  $x$ , aggregate real income, and welfare (see Table A3 for a numerical comparison). This is because at lower values of  $\lambda$ , stronger aggregate scale economies imply that the expansionary effects of welfare state expenditure generate larger efficiency gains which, under free-trade, result in greater *international* pecuniary externalities.

### 3.2. Effects of capital mobility

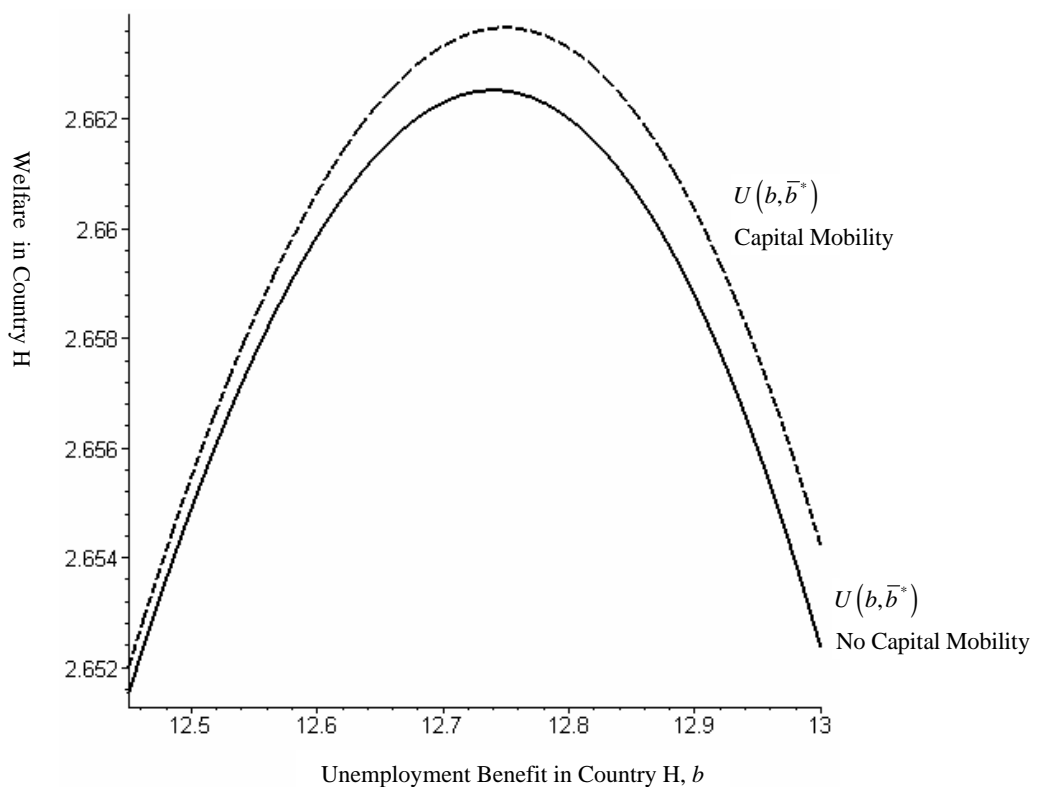
With capital mobility, the stock of capital available to a country can exceed or fall short of its endowment  $\bar{K}$  as capital can now flow in or out of the country. We use the source principle as the tax rule, so that the income generated by an inflow of capital is taxed before it is repatriated. We also assume that the capital flow between the two countries responds to differences in the net of tax return on this factor. The modified equations of the model are given in Table A2 in the Appendix.

A comparison of the Home country's aggregate welfare function under no capital mobility with that derived under capital mobility is illustrated in Figure 3 which plots, for a given  $b^*$ , the Home country's welfare function against its unemployment benefit rate  $b$ . It is clear that capital mobility leads to a shift in the Home welfare function such that, for any given  $b^*$ , a higher optimal value of  $b$  is obtained which also corresponds to a higher level of aggregate welfare.

The basic intuition behind this result is that a unilateral increase in the generosity of unemployment protection in the Home country results, through the virtuous circle outlined above, in a lower tax rate. The latter leads to an incipient *inflow* of capital, thus generating a unilateral incentive for the Home government to raise  $b$  beyond the case without capital mobility. In the  $(b, b^*)$  space, this implies an outward (upward) shift of the Home (Foreign)

reaction function. As a result, compared to the case without capital mobility, the Nash non-cooperative solution under capital mobility entails higher (but identical, given the symmetry between countries) unemployment benefit rates. Given the virtuous circle triggered by the policy, it is not surprising that capital mobility also implies a higher level of employment and aggregate welfare – as can be seen from the numerical comparisons provided in Table A3 in the Appendix. Again, as in the previous cases, the virtuous circle of entry, higher efficiency and higher aggregate employment and income triggered by the policy is more enhanced the stronger are vertical linkages and aggregate scale economies.

**Figure 3. Non-Cooperative Nash Equilibrium in the Two-Country Case<sup>(1)</sup>**  
**The shift in welfare function and optimal  $b$  due to capital mobility**



(1) Parameter values used in the numerical simulation are given in the note to Table A3 in the Appendix. We have used  $\bar{b}^*=11$ . Note that the above graph is based on the  $K>0$  case (i.e. capital flows from country F to country H). To enable comparison,  $U$  is scaled as in Figure 1 – see note (2) therein.

In sum, the welfare policy creates a positive externality even in the presence of capital mobility. Note that although governments' choice variables are not the capital tax rates, this can be thought of as a 'fiscal' competition case (defined as non-cooperative policy setting by independent governments), to the extent that each government's policy (optimal choice of

unemployment benefits financed by adjusting the capital tax rates) influences the allocation of mobile capital amongst different jurisdictions<sup>13</sup>. These results then clearly suggest that capital mobility does not hinder the sustainability of welfare states and that a race-to-the-bottom in social standards does not necessarily emerge as a result of the competition between countries for internationally mobile factors of production<sup>14</sup>. In fact, whilst due to the symmetric nature of the model the Nash equilibrium is characterised by the same inter-country distribution of the mobile factor as before barriers to capital mobility were removed, both countries are in all respects *better off* as a result of allowing for capital mobility in spite, and indeed because of, a higher unemployment benefit entitlement<sup>15</sup> (see Table A3 for a numerical comparison of the two cases).

### 3.3. The cooperative solution

Finally, we analyse the cooperative equilibrium solution. The latter is obtained when the two governments agree to set  $t=t^*$  and  $b=b^*$  at the outset and choose the latter to maximise their joint welfare function subject to the relevant constraints determining the endogenous variables in terms of  $b$ . Note that, given the symmetry between countries, the cooperative equilibrium is not affected by capital mobility.

Figure 4 plots the joint welfare function against the common unemployment benefit rate. It is clear from this figure and the numerical results provided in Table A3 in the Appendix that the cooperative solution entails a higher optimal unemployment benefit rate than the Nash equilibrium both without and with capital mobility. The reason for this is that in the non-cooperative regimes each government does not take account of the fact that a rise in its own unemployment benefit rate will be matched by a rise in the other government's rate. In other words, in the non-cooperative case each government fails to internalise that the positive externality of the policy implies that after a raise in  $b$  ( $b^*$ ) the optimal response for the government of F (H) is to raise  $b^*$  ( $b$ ). Cooperation gets round this omission. It is worth noting again that, as in all cases considered before, the optimal policy implies a higher  $b$  (and a higher employment and welfare) the stronger are the vertical linkages between sectors.

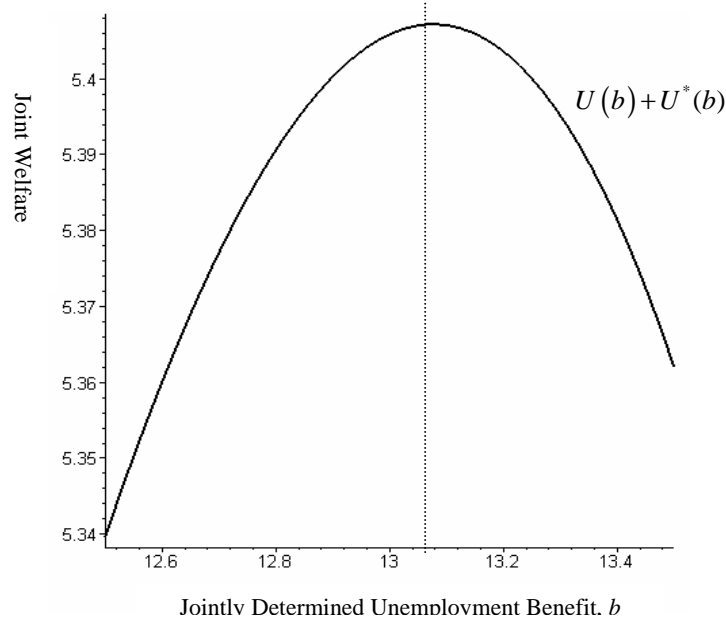
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<sup>13</sup> This definition of tax competition is taken from Wilson and Wildasin (2004).

<sup>14</sup> Recall that the reduction in tax rates in this context results from an *expansion* of the tax base due to a rise in employment and real returns to the factors and not from a desire to attract capital as in the tax competition case.

<sup>15</sup> Note that, despite the higher  $b$ , the total unemployment benefit bill falls as a result of capital mobility. This is due to the much higher level of employment compared to the non-capital mobility case.

**Figure 4. Cooperative Equilibrium in the Two-Country Case <sup>(1)</sup>**



- (1) Parameter values used in the numerical simulation are given in the note to Table A3 in the Appendix. To enable comparison,  $U$  is scaled as in Figure 1 – see note (2) therein.

The main results in Table A3 in the Appendix may be summarised as follows:  $b^A < b^{NT} < b^{NK} < b^C$ ;  $t^A > t^{NT} > t^{NK} > t^C$ ;  $\ell^A < \ell^{NT} < \ell^{NK} < \ell^C$ ; and  $U^A < U^{NT} < U^{NK} < U^C$ , where the superscripts  $A$ ,  $NT$ ,  $NK$ , and  $C$  denote the solutions respectively obtained under autarkic, Nash with free-trade only, Nash with free-trade and capital mobility, and full cooperation. These results stem from the positive international spillover effects of the policy which imply that: (i) in comparison to the autarkic regime, both the free-trade and the capital mobility regimes entail a higher optimal unemployment benefit payment; and (ii) when deciding on their level of unemployment benefit independently (or non-cooperatively), governments underestimate the extent of the positive policy spillovers, thus setting them below the level that would be optimal from a global welfare point of view.

#### 4. CONCLUSIONS

The conventional wisdom holds that economic globalisation, defined by free-trade and capital mobility, reduces governments' ability to effectively finance social policies and that a shrinking tax base and competition for internationally mobile capital could in fact lead to a race-to-the-bottom in social standards.

In this paper we develop a theoretical two-sector-two-country model with aggregate scale economies and unionisation and find that **(i)** optimal welfare policy entails a positive level of unemployment benefit provision which is higher the higher is the degree of international economic integration (i.e., as we move from autarky to free-trade and to capital mobility) even when each government acts independently (non-cooperatively) in determining its optimal welfare payment; and **(ii)** optimal cooperative governments' behaviour entails a higher level of benefit entitlement and a higher aggregate welfare.

Hence, this model provides a clear example of circumstances in which welfare states and increasing degrees of economic integration are perfectly compatible. Contrary to the conventional wisdom, international trade and capital mobility need not lead to a reduction in the revenue raising capacity of governments and to a race-to-the-bottom in social standards. International openness can instead complement social insurance policies in increasing welfare, thus facilitating the provision of a more generous welfare protection. Our analysis does not counter the importance of institutional factors, as proposed by political scientists, in explaining the compatibility between welfare states and economic openness<sup>16</sup>, but suggests that these factors may not be necessary for reconciling the provision of social insurance with the pressures stemming from economic openness.

At the core of our results lies the imperfectly competitive nature of markets and the well-known principle that in a second-best world economic policy can be welfare improving. In the labour market, unionisation implies that wages are positively related to unemployment benefit and income tax rates. In the goods market, monopolistic competition leads to a suboptimal production of varieties and to the emergence of pecuniary externalities stemming from the links between upstream producers and their customers – i.e., the downstream industry and final consumers. Effectively, government policy contributes to the extraction of the rents associated with these pecuniary externalities, thus alleviating the sub-optimal provision of varieties in a fashion that reinforces and is reinforced by the standard gains from international openness.

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<sup>16</sup> Political scientists argue that the extent to which economic (and political) pressures stemming from globalisation are translated into welfare state retrenchment will typically depend on country-specific political and institutional factors and envisage conditions in which a retrenchment of welfare state may not result (e.g., Garrett, 1998; Swank, 2002).

## References

- Acemoglu, D. and R. Shimer (2000). "Productivity Gains from Unemployment Insurance", *European Economic Review*, 44, 1195-1224.
- Alesina, A. and R. Perotti (1997). "The Welfare State and Competitiveness", *American Economic Review*, 87, 921-39.
- Anderson, S.P., de Palma, A. and , J-F. Thisse (1992). *Discrete Choice Theory of Product Differentiation*, MIT Press. Cambridge, Massachusetts.
- Baldwin R. and P. Krugman (2000). "Agglomeration, Integration and Tax Harmonisation", CEPR Discussion Paper No. 2630.
- Bartelsman, E.J., Caballero, R.J. and R.K. Lyons (1994). "Customer- and Supplier-Driven Externalities", *American Economic Review*, 84, 1075-1084.
- Blanchard, O. and F. Giavazzi (2003), "Macroeconomic Effects of Regulation and Deregulation in Goods and Labour Markets", *Quarterly Journal of Economics*, 118, 879-907.
- Blanchard, O. and N. Kiyotaki (1987). "Monopolistic Competition and the Effects of Aggregate Demand", *American Economic Review*, 77, 647-66.
- Boeri T., A. Gruglavini, and L. Calmfors (2001). *The Role of Unions in the Twenty-First Century*, (Eds.), Oxford University Press.
- Bretschger, L. and Hettich, F. (2002). "Globalisation, Capital Mobility and Tax Competition: Theory and Evidence for OECD Countries", *European Journal of Political Economy*, 18, 695-716.
- De Grauwe, P. and M. Polan (2003). "Globalisation and Social Spending", CESifo Working Paper No. 885.
- Dixit, A.K. and J.E. Stiglitz (1977). "Monopolistic Competition and Optimum Product Diversity", *American Economic Review*, 67, 297-308.
- Ethier, W.J. (1982). "National and International Returns to Scale in the Modern Theory of International Trade", *American Economic Review*, 72, 389-405.
- European Commission (2002). *Public Finances in EMU*, European Economy – Report and Studies, 3.
- Garrett, G. (1998). *Partisan Politics in the Global Economy*, Cambridge University Press, Cambridge.
- Garrett, G. and D. Mitchell (1999). "Globalization and the Welfare State", mimeo, Department of Political Science, Yale University.

- Garrett, G. and D. Mitchell (2001). "Globalisation, Government Spending and Taxation in the OECD", *European Journal of Political Research*, 39, 145-177.
- Hart, O.D. (1982). "A Model of Imperfect Competition with Keynesian Features", *Quarterly Journal of Economics*, 97, 109-138.
- Hiscox, M.J. (2002). *International Trade and Political Conflict: Commerce, Coalitions, and Mobility*, Princeton University Press.
- Mankiw, N.G. (1988). "Imperfect competition and the Keynesian Cross", *Economics Letters*, 26, 7-13.
- Ploeg, F. van der (2003). "Do Social Policies Harm Employment and Growth?", CESifo Working Paper No. 886.
- Rodrik, D. (1997). *Has Globalisation Gone too Far?*, Institute for International Economics, Washington, DC.
- Rodrik, D. (1998). "Why Do More Open Economies Have Bigger Governments", *Journal of Political Economy*, 106, 997-1032.
- Startz, R. (1989). "Monopolistic competition as a foundation for Keynesian macroeconomic models", *Quarterly Journal of Economics*, 104, 737-52.
- Swank, D. (2002). *Global Capital, Political Institutions, and Policy Change in Developed Welfare States*, Cambridge University Press, Cambridge.
- Venables, A.J. (1996). "Equilibrium Location of Vertically Linked Industries", *International Economic Review*, 37, 341-59.
- Wilson, J.D. and D.E. Wildasin (2004). "Capital Tax Competition: Bane or Boon", *Journal of Public Economics*, 88, 1065– 1091.



## APPENDIX

**Table A1. Equations of the two-country model without capital mobility <sup>(1)</sup>**

(a1) Sector $x$ price index	$P_x = \left( N_x p_x^{1-\sigma} + N_x^* p_x^{*1-\sigma} \right)^{\frac{1}{1-\sigma}} = P_x^*$
(a2) Sector $y$ price index	$P_y = \left( N_y p_y^{1-\delta} + N_y^* p_y^{*1-\delta} \right)^{\frac{1}{1-\delta}} = P_y^*; \quad P_y = P_y^* = 1, Y \text{ used as numeraire}$
(a3) $y$ mark up	$p_y = \left( \frac{\lambda \delta}{\delta - 1} \right) P_x, \text{ and } p_y^* = \left( \frac{\lambda \delta}{\delta - 1} \right) P_x$
(a4) $y$ supply	$y = \frac{\phi}{\lambda} (\delta - 1) \left( \frac{r}{P_x} \right), \text{ and } y^* = \frac{\phi}{\lambda} (\delta - 1) \left( \frac{r^*}{P_x} \right)$
(a5) $y$ demand	$y = (E_y + E_y^*) P_y^{\delta-1} p_y^{-\delta}, \text{ and } y^* = (E_y + E_y^*) P_y^{*\delta-1} p_y^{-\delta}$
(a6) Definition of $E_y$	$E_y = (1 - \mu) M, \text{ and } E_y^* = (1 - \mu) M^*$
(a7) $x$ mark up <sup>(2)</sup>	$p_x = w, \text{ and } p_x^* = w^*$
(a8) $x$ supply <sup>(2)</sup>	$x = \beta \sigma, \text{ and } x^* = \beta \sigma$
(a9) $x$ demand	$x = (E_x + E_x^*) P_x^{\sigma-1} p_x^{-\sigma}, \text{ and } x^* = (E_x + E_x^*) P_x^{*\sigma-1} p_x^{*-\sigma}$
(a10) Definition of $E_x$	$E_x = \mu M + N_y P_x \lambda y, \text{ and } E_x^* = \mu M^* + N_y^* P_x \lambda y$
(a11) Capital Market Restriction	$\phi N_y = \bar{K}, \text{ and } \phi N_y^* = \bar{K}$
(a12) Demand for Labour <sup>(2)</sup>	$L = \beta \sigma N_x, \text{ and } L^* = \beta \sigma N_x^*$
(a13) Wage Set by Unions	$\frac{w}{P} = \frac{b}{(1-t) \left( 1 - \frac{1}{\sigma-1} \right)}, \text{ and } \frac{w^*}{P^*} = \frac{b^*}{(1-t^*) \left( 1 - \frac{1}{\sigma-1} \right)}$
(a14) Consumer Price Index	$P = P_x^\mu P_y^{1-\mu}, \text{ and } P^* = P_x^{*\mu} P_y^{*1-\mu}$
(a15) Government Budget Constraint	$b(\bar{L} - L) = \frac{t(wL + r\bar{K})}{P}, \text{ and } b^*(\bar{L} - L^*) = \frac{t^*(w^*L^* + r^*\bar{K})}{P^*}$
(a16) Components of Income	$M = (1-t)(wL + r\bar{K}) + Pb(\bar{L} - L), \text{ and } M^* = (1-t^*)(w^*L^* + r^*\bar{K}) + P^*b^*(\bar{L} - L^*)$
(a17) $x$ Market Clearing Condition	$E_x + E_x^* = N_x p_x x + N_x^* p_x^* x^*$
(a18) $y$ Market Clearing Condition	$E_y + E_y^* = N_y p_y y + N_y^* p_y^* y^*$
(a19) Balance of Payments	$\left( N_y p_y y - E_y \right) + \left( N_x p_x x - E_x \right) = 0, \text{ and } \left( N_y^* p_y^* y^* - E_y^* \right) + \left( N_x^* p_x^* x^* - E_x^* \right) = 0$

<sup>(1)</sup> Foreign country's variables are denoted by an asterisk superscript. Note that not all the equations are needed for solving the model: (a17) can be obtained from (a1) and (a9); (a18) can be obtained from (a2) and (a5); and (a19) can be obtained from (a3), (a4), (a6), (a7), (a8), (a10), (a11), (a12) and (a16).

<sup>(2)</sup> Recall that in these equations we have imposed the normalisation  $\alpha = (\sigma - 1) / \sigma$ , where  $\alpha$  is the inverse of labour productivity.

**Table A2. Modifications to allow for capital mobility in the two-country model <sup>(1)</sup>**

(11') Capital Market Restriction	$\phi N_y = \bar{K} + K$ , and $\phi N_y^* = \bar{K} - K$
(15') Government Budget Constraint	$b(\bar{L} - L) = \frac{t(wL + r(\bar{K} + K))}{P}$ , and $b^*(\bar{L} - L^*) = \frac{t^*(w^*L^* + r^*(\bar{K} - K))}{P^*}$
(16') Components of Income	$M = (1-t)(wL + r\bar{K}) + Pb(\bar{L} - L)$ , and $M^* = (1-t^*)(w^*L^* + r^*(\bar{K} - K)) + (1-t^*)rK + P^*b^*(\bar{L} - L^*)$
(19') Balance of Payments	$(N_y p_y y - E_y) + (N_x p_x x - E_x) - (1-t)rK = 0$ , and $(N_y^* p_y^* y^* - E_y^*) + (N_x^* p_x^* x^* - E_x^*) + (1-t)rK = 0$

<sup>(1)</sup> Note that capital flow is denoted by  $K$ , with  $K > 0$  when the flow is from country F to country H. In the above, income equations are based on the convention that the Home country is the net importer of capital, i.e.  $K > 0$ . When  $K < 0$ , these are given by  $M = (1-t)(wL + r(\bar{K} + K)) + Pb(\bar{L} - L) - (1-t)rK$  and  $M^* = (1-t^*)(w^*L^* + r^*(\bar{K} - K)) + P^*b^*(\bar{L} - L^*)$ . In principle, the capital flow between country F and country H is determined by the relative net returns, e.g.  $\frac{K}{\kappa} = \frac{(1-t)r - (1-t^*)r^*}{(1-t)r + (1-t^*)r^*}$ , where  $K > 0$  when the flow is from F to H and  $\kappa \in (0, \infty)$  determines the degree of substitution,  $\kappa \rightarrow 0$  and  $\kappa \rightarrow \infty$  reflecting the extreme cases of zero and perfect substitution. However, given that in this model  $K \in [-\bar{K}, +\bar{K}]$ , we have normalised the capital flow equation as  $\frac{K}{\bar{K}} = \frac{(1-t)r - (1-t^*)r^*}{(1-t)r + (1-t^*)r^*}$  in order to remain consistent with the capital market restriction. Clearly,  $K=0$  when  $(1-t^*)r^* = (1-t)r$  while the extreme cases of very large tax rate in F or H, i.e.  $t/t^* \rightarrow 0$  or  $t^*/t \rightarrow 0$ , leads to  $K \rightarrow \bar{K}$  or  $K \rightarrow -\bar{K}$ .

**Table A3. Comparing Solutions for Different Symmetric Equilibria <sup>(1)</sup>**

	Autarky Equilibrium		Two-Country Nash Non-cooperative Equilibrium (no capital mobility)		Two-Country Nash Non-cooperative Equilibrium (capital mobility)		Two-Country Cooperative Equilibrium	
	1	0.95	1	0.95	1	0.95	1	0.95
$\lambda$	1	0.95	1	0.95	1	0.95	1	0.95
Optimal $b$	10.6800	11.0900	12.9865	13.4855	12.9886	13.4875	13.0800	13.8100
$t$	0.1111	0.1099	0.1090	0.1077	0.1089	0.1076	0.1040	0.1027
$\ell = L/\bar{L}$	0.8562	0.8577	0.8588	0.8604	0.8590	0.8605	0.8652	0.8667
$w/P$	15.0186	15.5733	18.2187	18.8917	18.2193	18.8923	18.2456	18.9191
$r/P$	0.0968	0.1005	0.1178	0.1223	0.1178	0.1224	0.1188	0.1234
$(M/P)/\bar{L}$	13.826	14.363	16.824	17.478	16.827	17.481	16.974	17.631
$b(\bar{L} - L)/\bar{L}$	1.536	1.578	1.834	1.883	1.832	1.881	1.763	1.810
$U/\bar{L}$	24.082	24.588	27.027	27.647	27.027	27.648	27.038	27.651

<sup>(1)</sup> Parameter values used are  $\mu = 0.3, \eta = 5, \delta = 10, \sigma = 6, \beta = 10^{-10}\bar{K}, \phi = 10^{-3}\bar{K}, \bar{L} = 10^{-1}\bar{K}$ . Optimal  $b$  refers to the welfare maximising value of benefit payment. These results are robust to plausible changes in parameter values. All analytical solutions and calibrations are done in Maple and the work files are available on request from the authors.