A basic social security competition model

G. Rayp[*] *and B. Vanbergen*[†]

7th April 2006

Abstract

We determine the conditions for social security competition in a standard Dixit-Stiglitz two-region model of international trade in which we allow for endogenous unemployment and governments subject to an Atkinson equity-efficiency trade-off. We show that whether social policies are strategic complements or subsitutes depends on the inequality aversion of the governments and the substitution elasticity of the goods. When trade in goods is the only mechanism of economic integration and the number of varieties is exogenously given, the interaction between the social policies occurs through the regional price indices. Hence, economic integration allows to externalise part of the price increase that higher social allowances imply. As a consequence, in this framework a social planner would opt for lower taxes and benefits.

[*]Ghent University, Faculty of Economics and Business Administration and SHERPPA, Belgium

[†]Ghent University, Faculty of Economics and Business Administration, Belgium

Corresponding author : Glenn Rayp, Ghent University, Faculty of Economics and Business Administration, Hoveniersberg 24, B-9000 Ghent, Belgium

1 Introduction

Every step towards the completion of European integration appears to be met with renewed concern over its potential negative social side-effects, particularly as regards to protection against social risks (unemployment, sickness and invalidity, age, ...) and poverty. In the 1980s and 1990s, governments of different Member States as well as the two EU Commissions headed by Jacques Delors took seriously the menace of 'beggar-thy-neighbour' policies by means of income or social security measures in an integrated market. The EMU may have provided an even greater temptation to do so because other economic policy instruments such as trade policy or monetary policy are kept under tight control. Since the end of the 1990s, one notices indeed the rolling back of the welfare state and cuts in social security contributions in core EU-member states such as Germany, the Netherlands and France. The fear of lower social protection levels and harsher labour conditions in a more integrated European Union, are often cited as an explanation of the opposition against further economic integration in Europe ([17]).

An intuitively appealing way to understand social protection competition is to consider it as a particular form of a "race to the bottom" tax competition. Whereas Tiebout ([16]) regarded tax competition as an incentive for government efficiency that is welfare increasing, the more recent literature (reviewed in ([18]) and in ([3])) stressed the suboptimally low taxation of mobile production factors that results from tax competition. This applies also for recent contributions that link tax competition and unemployment protection, like Lejour and Verbon ([10]) and Leite-Montero et al. ([9]).

However, in a new economic geography approach, Krugman and Baldwin ([2]), and Südekum and Pflüger ([12]) showed that a "race to the bottom" is unlikely to occur in a core-periphery pattern of economic activity and that a core region can even raise its taxes to the amount of the agglomeration rent. Baldwin et al. ([1]) confirm that agglomeration tends to increase national tax autonomy, assuming that the mobile production factor is agglomerated *ab initio*, but add that agglomeration mechanisms tend to increase tax competition when the mobile production factor is initially dispersed (see ([1]). Regarding social protection

in the EU, this might imply that we should expect more competition from increasing market integration between core (old) member states and less between existing and new member states. This on the condition that we can extend the results on tax competition from the new economic geography literature to social security competition.

In this contribution, we study whether and under which conditions this is possible. In doing so, we take account of three specific and to some extent new features.

First, we focus on increased trade in goods instead of factor mobility as the mechanism of economic integration that may affect social security. In most EU countries, the tax base consists primarily of immobile production factors, labour in the first place. Mobile production factors such as capital are largely exempted from taxation, either because of tax competition or because of economic efficiency reasons. E.g. Lindert ([11]) argues that the difference between the welfare state in Europe and the US is not matched by differences in economic efficiency because the structure of taxation in Europe is less distortionary, considering the greater share of labour taxation and consumption taxes in the European government revenue.

Since labour in Europe is still immobile to a large extent, this means that neither social security revenues nor the expenditures might come under pressure from the removal of barriers to factor mobility. However, we must remain careful in concluding from this observation that national social protection is not affected by policy competition pressures, precisely because increased market integration implies in addition to the removal of barriers to factor mobility lower trade costs and more product market competition that obviously affect factor rewards and hence taxation and social security policy. For instance, in a perfect competition Heckscher-Ohlin world, factor prices would equalize completely.

Second, we endogenize the social risk in such a way the government cannot restore the fist best equilibrium. This aspect seems somewhat neglected in other contributions. A social risk such as unemployment emerges from a labour market distortion, like wage bargaining between employers and trade unions instead of a competitive labour market. Yet, it is not always clear why a benevolent

government, or the median voter, that can anticipate on the behaviour of the private economic agents, do not try to restore the first best equilibrium, e.g. by deciding to a sufficiently low unemployment benefit (of which the bargained wage is a mark-up) in order to restore full employment. We also identify the social risk to be insured as an unemployment risk, but consider it as the result of an efficiency wage mechanism, such that the government is compelled to a second best policy and must compensate one market distortion (unemployment) by another (granting benefits for which it has to raise taxes that creates additional distortions in the economy).

Third, we assume a benevolent government of which the objective can be represented by an Atkinson abbreviated welfare function. This framework has the advantage to take explicitly account of the government's preferences, in particular between equity and efficiency (represented by the inequality aversion parameter), such that we can show the effect of the government's preferences on social protection competition.

In the next section we present our model, derive and discuss the most important results. In final section we draw some conclusions and try to formulate questions for further research

2 Theoretical Framework

Our economy consists of two regions: the north and the south. Both regions are symmetric in terms of tastes and openness to trade. This means that both regions have isomorphic expressions (southern variables are marked by a '$\star$'). Each region is endowed with a fixed number of immobile labourers, denoted by L_S ($L_S^\star$). These workers can either be employed in manufacturing and earn a wage w ($w^\star$) or be unemployed and obtain a social security allowance b ($b^\star$) from the government. This is the only source of inequality at the regional level. Goods are produced in an increasing returns to scale sector using a fixed capital input and a variable labour input. The technological differences between the regions are captured in different labour productivities and in divergent fixed input requirements. The final goods are subject to iceberg trade costs when exported: in order to have one unit exported to the other region, the firm has to send τ units ($\tau > 1$) becasue a fraction $\tau - 1$ melts away during transport.

2.1 The product markets

The market structure is Dixit-Stiglitz monopolistic competitive. The supply side is modelled as a sector with increasing returns to scale within varieties and no economies of scope across varieties. At the same time we assume that there are so many firms that they don't care about the individual behaviour of other firms. The only thing that strategically matters for the firms is the global production of the market. The demand side is represented by a consumer whose preferences exhibit varietas delectat. The utility of a consumer j consuming a quantity $c_{i,j}$ of variety i is given by[1]:

$$U_j = \left(\int_0^{n+n^\star} c_{i,j}^{\frac{\sigma-1}{\sigma}} di\right)^{\frac{\sigma}{\sigma-1}} \tag{1}$$

The elasticity of substitution σ is identical for all goods and is assumed to be greater than 1. n ($n^\star$) is the exogenously given number of varieties produced in the north (the south).

[1] We will only give the northern expressions as the southern ones are isomorphic.

Standard utility maximization and aggregating the individual demand of all consumers lead to the following result for the northern market demand of a variety i:

$$c_i = (\frac{p_i}{P})^{-\sigma}\frac{E}{P} \tag{2}$$

In this expression E stands for the total northern income. The price index P is given by:

$$P = (\int_0^{n+n^\star} p_i^{1-\sigma} di)^{\frac{1}{1-\sigma}} \tag{3}$$

The demand for a good i is a negative function of its relative price and a positive function of the northern real demand.

The goods are produced according to an increasing returns to scale production using a fixed amount of capital R and a variable amount of labour l_i. The production function of a firm is given by:

$$x_i = a(w_i)l_i \tag{4}$$

For ease of calculation we assume that the reward to capital is equal to unity. Note that the productiviy parameter $a(w)$ depends on the wage (see section (2.2)).

The increasing returns to scale assumption together with occam's razor make the connection between firm and variety bijective. Profit maximization gives us the price of a variety. This price is a fixed mark-up of the unit labour costs, as a function of the 'perceived' elasticity of demand:

$$p_{i,N} = (\frac{\sigma}{\sigma-1})\frac{w_i}{a(w_i)}, \qquad p_{i,S} = (\frac{\sigma}{\sigma-1})\frac{w_i}{a(w_i)}\tau \tag{5}$$

Firms find it optimal to engage in mill pricing as the trade costs are fully shifted towards the foreign consumer. The price of the variety i produced in the north but sold in the south, $p_{i,S}$ is τ times bigger than the price of the variety i produced in the north and sold in the north.

We follow Grossman and Helpman ([6]) and set total nominal spending $E^w = E + E^\star$ equal to 1. This can be considered as representative for a policy of strict

control of money supply. This assumption combined with the expressions for the prices (5) and the demand (2) relates n and $n^\star$:

$$nR + n^\star R^\star = \frac{1}{\sigma} \tag{6}$$

To determine the amount of labour a single firm needs in equilibrium we use the long-run monopolistic competitive zero-profit condition. This amount depends inversely on the wage paid to the workers:

$$l_i = \frac{\sigma - 1}{w_i} R \tag{7}$$

This equation (7) together with the production function (4) gives the equilibrium output for a northern variety in function of the wage:

$$x_i = \frac{\sigma - 1}{w_i} R a(w_i) \tag{8}$$

2.2 The labour markets

We assume that the net productivity of workers is a positive function of the net wage rate they receive. This negative incentive effect of low wages leads to firms paying wages in excess of market clearing, introducing unemployment in the model. Stiglitz ([14]) gives five main reasons for the occurence of efficiency wages.

We follow the simple effort model of Summers ([15]). The effort that a worker delivers, is a positive function of the difference between the net wage and a reference wage:

$$a(w_i) = (w_i(1 - z) - w_R)^\beta, \tag{9}$$

with z the tax rate on labour income. The strength of the productivity enhancing effects of high wages is measured by the parameter β, lying between 0 and 1. In our set-up only the reference wage is region specific.

The traditional approach in choosing the reference wage in efficiency wage models consists in taking the immediate alternative for the worker who may be fired

when caught shirking. Hence, the reference wage is often put equal to the unemployment benefit or the weighted average of the wage and the unemployment benefit. However, Danthine and Kuman ([4]) argue that this definition of the external wage reference does not allow to explain why wage rigidity generates unemployment, since it is correlated with labour demand (or can be put by the government at a sufficiently low level such that the labour market clears). Hence, we propose a definition of the reference wage that it is independent from the actual market wage or unemployment allowance[2].

Fehr and Falk ([5]) indicate that also other mechanisms besides dismissal incite workers to work harder, in particular reciprocity-based voluntary cooperation (i.e. the gift exchange argument in [8]). Reciprocity implies that, if the employee (i.e. the agent) perceives the actions of the employer (i.e. the principal) as kind (hostile), he will value the employer's payoff positively (negatively). Experiments indicate that employees respond to higher wage offers, combined with higher expected effort, with higher effective effort ([5]). Taking this into account, the reference wage is the wage that would apply if all the workers behaved selfishly, i.e. the market-clearing wage at which the workers provide the basic effort. This definition of the outside option avoids the contradiction of a government able to do the first-best chooses for second-best options. The purely redistributing government is no longer able to remedy any unemployment occurence simply by setting the unemployment benefit low enough to ensure that everybody is willing to work.

There is no unemployment in a perfect competitive labour market. This also encompasses no taxation as the government doens't need to provide unemployment risk ensurances. As a consequence, the (northern) reference wage is determined using the full employment condition:

$$w_R = \frac{n(\sigma - 1)R}{L_S}, \tag{10}$$

where L_S stands for the northern labour supply.

The wage is determined by maximizing the profit of a firm. Simple calculus shows that a firm should find the wage for which the elasticity of effort equals

[2]We are indebted to Wim Meeusen, University of Antwerp, for this idea.

unity, i.e. the Solow condition ([13]):

$$\frac{w_i \frac{\partial a(w_i)}{\partial w_i}}{a(w_i)} = 1 \tag{11}$$

Using the expression (9) for the effort parameter, equation (11) solves to:

$$w_i = w = \frac{w_R}{(1-z)(1-\beta)} = \frac{n(\sigma-1)R}{L_S(1-z)(1-\beta)} \tag{12}$$

The net labour income is independent of the tax rate and is only determined by the reference wage w_R and the effort parameter β. As the taxation needed to pay for the social security benefits don't affect the effort delivered by labourers, any tax rise is fully passed through in price increases.

The labourers' remuneration is independent of firm-specific parameters. As a consequence all northern firms behave identically. They charge the same prices, sell the same quantities, etc[3].

When firms pay the optimal wage, the workers respond in delivering the following effort:

$$a(w) = (\frac{w_R \beta}{1-\beta})^{\beta} \tag{13}$$

Based on the expressions for the labour needed by an individual firm (7), the wage (12) and the reference wage (10), it is easy to determine the percentage unemployed people $u(z)$:

$$u(z) = \beta + z(1-\beta) \tag{14}$$

The higher the tax rate becomes, the higher the unemployment rate becomes. Expression (14) also leads to an alternative interpretation of the effort parameter β: the unemployment rate and the effort parameter β are equal in the absence of any taxation.

2.3 The redistribution policy of the government

In the previous sections we showed that all the variables in the model depend on the workers' wage level. This, in its turn, is a function of the tax rate, which is

[3]This symmetry clarifies the notation for the prices ($p_{i,N} \rightarrow p_{NN}$, $p_{i,S} \rightarrow p_{NS}$) and the sold quantities ($x_i \rightarrow x_N$).

fixed by the government. Consequently, commodity prices and demand as well the demand for labour ultimately depend on the transfer and income policy of the government. Yet, it does not imply that the government can influence economic activity in an entirely arbitrary manner, because she has to take into account the country's position with respect to the rest of the world, i.e. its competitiveness through the price indices P and $P^{\star}$. Because the price indices depend on the prices of the home and foreign goods, all the variables in the model are determined in the end by the home and foreign government policies.

To take into account the different attitudes a government can have towards supporting the unemployed, we use the Atkinson abbreviated social welfare function ([7]):

$$SW = \frac{\mu^{1-e}(1-I)^{1-e}}{1-e} = \frac{(y_d)^{1-e}}{1-e}, \tag{15}$$

with μ the mean income of the residents of a region and $I = 1 - \frac{y_d}{\mu}$, the Atkinson index of relative inequality. e represents the inequality aversion with $I \to 0$ if $e \to 0$ and $I \to \frac{b}{P\mu}$ if $e \to \infty$. Hence, a rising e implies that more weight is attached to transfers to the lowest incomes and less weight to the top of the distribution. In the expression for the inequality index I, y_d stands for the equally distributed equivalent income or, otherwise stated, the level of income per head which if equally distributed would give the same level of social welfare as the current distribution. In our discrete case, the e.d.e. income y_d can be written as the sum of the individual incomes y_j, weighted at the fraction of people having that income y_j:

$$\begin{aligned} y_d &= (\sum_{j=1}^{n} y_j^{1-e} f(y_j)^{\frac{1}{1-e}} \\ y_d &= [(1-u(z))(\frac{w(1-z)}{P})^{1-e} + u(z)(\frac{b}{P})^{1-e}]^{\frac{1}{1-e}} \end{aligned} \tag{16}$$

Our model doesn't include any savings. As a consequence, the government can't spend more on unemployment benefits as she collects through taxes. Hence, the social welfare function maximization problem is constrained with a social security balance:

$$(L_S - nl)b = znlw \tag{17}$$

Substituting the expressions for the wage (7), the demanded labour (12) and the reference wage (10) in the above expression (17), results in the tax rate z in function of the unemployment benefit b:

$$z = \frac{\beta b}{w_R - (1-\beta)b} \tag{18}$$

Deriving the tax rate with respect to the unemployment benefit,

$$\frac{\partial z}{\partial b} = \frac{\beta w_R}{(w_R - (1-\beta)b)^2} > 0 \tag{19}$$

shows that a higher unemployment benefit leads to higher tax rates.

2.3.1 Are the unemployment benefits strategic substitutes or complements?

We maximize the social welfare function with respect to the unemployment benefit b. The first order condition can be written as:

$$u(z)b^{1-e}(\frac{\partial u(z)}{\partial b}\frac{b}{u(z)}\frac{1}{1-e}(1-(\frac{w_R}{(1-\beta)b})^{1-e})+1) - (\frac{1}{P})^{1-e}\frac{b}{P}\frac{\partial P}{\partial b} = 0 \tag{20}$$

It is intuitively easy to understand that $\frac{\partial P}{\partial b} > 0$. After all, higher unemployment benefits in the north imply higher northern tax rates (see (19)) and these, in turn cause an increase in the northern wage level (see (12)). Higher northern prices are the result. Ceteris paribus, the price index rises[4]. Based upon this result, we derive the condition for which an internal solution for the unemployment benefit exists, provided that $e > 1$:

$$\begin{aligned}(\frac{\partial u(z)}{\partial b}\frac{b}{u(z)}\frac{1}{1-e}(1-(\frac{w_R}{(1-\beta)b})^{1-e})+1) &> 0 \\ &\Leftrightarrow \\ (\frac{w_R}{(1-\beta)b})^{1-e}(\frac{w_R}{(1-\beta)b}^{e-1}-1) &< (e-1)(\frac{w_R}{(1-\beta)b}-1)\end{aligned} \tag{21}$$

The last inequality, obtained after substituting the constraint (19) and the unemployment (14), indicates the range of e-values ($e > 1$) for which an internal solution occurs. For values of e smaller than 1, the inequality sign is reversed in condition (21).

[4]This is formally proven in the appendix.

The Benthamite government is characterized by an inequality aversion e equal to 0. In this case the social welfare function can be, based on the social security budget constraint (17) and the wage expression (12), be written as $\frac{w_R}{P}$. Deriving this expression with respect to the northern unemployment benefit b, results in

$$\frac{\partial SW}{\partial b}|_{e=0} = -w_R \frac{1}{P^2} \frac{\partial P}{\partial b} < 0 \tag{22}$$

We conclude that the utilitarian government chooses the corner solution of having no social security. This result shouldn't be surprising as higher taxes and unemployment benefits decrease the real income of the region through an increased price index.

The extreme opposite of the Benthamite government is a government that only cares for the income of the poorest, the unemployed. The Rawslian objective consists of maximizing the real income of the unemployed $\frac{b}{P}$. The first order condition (20) becomes

$$\frac{b}{P} \frac{\partial P}{\partial b} = 1, \tag{23}$$

or otherwise stated the elasticity of the price index with respect to the unemployment benefit should be unity. It's clear from this statement that an unemployment benefit equal to 0 can't be optimal. The equilibrium unemployment benefit b should be larger than 0. Apparently governments with a larger equity-efficiency trade-off parameter will extend their social security system.

We are not only interested in the effect from the social perspective of a government on the social welfare generosity but also and more importantly in the interplay between the government decisions of different regions.

We use the implict function theorem on the first order condition (20) to obtain the sign of the derivative of the northern unemployment benefit b with respect to the southern unemployment benefit $b^\star$ in the optimum:

$$\frac{db}{db^\star} = -\frac{\frac{\partial FOC}{\partial b^\star}}{\frac{\partial FOC}{\partial b}} \tag{24}$$

We start with determining the sign of the derivative of the FOC with respect to the southern unemployment benefit. The first term of expression (20) is

independent of $b^\star$ when optimizing. As a consequence, we only have to determine the sign of the derivative of the second part with respect to $b^\star$:

$$-\frac{\partial}{\partial b^\star}((\frac{1}{P})^{1-e}\frac{b}{P}\frac{\partial P}{\partial b}) = (1-e)(\frac{1}{P})^{-e}\frac{1}{P^2}\frac{\partial P}{\partial b^\star}\frac{b}{P}\frac{\partial P}{\partial b} - (\frac{1}{P})^{1-e}\frac{\partial}{\partial b^\star}(\frac{b}{P}\frac{\partial P}{\partial b}) \quad (25)$$

As proven in the appendix, the effect of a higher southern unemployment benefit $b^\star$ on the northern price index P is positive. As a result the first term is negative as soon as $e > 1$. Straightforward but cumbersome calculations show that, in case of an inequality aversion parameter smaller than one, this term remains negative as soon as the sum of the inequality aversion parameter and the elasticity of substitution surmounts the value of 2:

$$-\frac{\partial}{\partial b^\star}((\frac{1}{P})^{1-e}\frac{b}{P}\frac{\partial P}{\partial b})|_{e<1} < 0 \qquad \Leftrightarrow \qquad e+\sigma > 2 \quad (26)$$

The sign of the second term is determined by the sign of $\frac{\partial}{\partial b^\star}(\frac{b}{P}\frac{\partial P}{\partial b})$, which is, after some straightforward substitutions, equal to:

$$\frac{\partial}{\partial b^\star}(\frac{b}{P}\frac{\partial P}{\partial b}) \quad = \quad \frac{\beta b w_R}{(w_R-b)(w_R-(1-\beta)b)} \frac{\beta w_R^\star}{(w_R^\star-(1-\beta)b^\star)(w_R^\star-b^\star)} \frac{nK^{1-\sigma}}{(nK^{1-\sigma}+n^\star K^\star \tau^{1-\sigma}(\frac{1-z}{1-z^\star})^{1-\sigma})^2}, \quad (27)$$

with K equal to $\frac{\sigma}{\sigma-1}(\frac{w_R}{1-\beta})^{1-\beta}\beta^\beta$ and $K^\star = \frac{\sigma}{\sigma-1}(\frac{w_{R^\star}}{1-\beta})^{1-\beta}\beta^\beta$. As the only relevant cases are those where the reference wage is larger than the unemployment benefit, this expression is unambigously positive. We conclude that expression (25) is negative as soons as $e > 1$ or for values of e smaller than one, that the market is not too imperfect (σ sufficiently large).

In the optimum we know that the second derivative of the social welfare function with respect to b is negative. Hence, the derivative of the first order condition with respect to the northern unemployment benefit is also negative. This leads to the following result (for $e > 1$ or $e + \sigma > 2$):

$$\frac{db}{db^\star} < 0 \quad (28)$$

When the foreing region opts for less social security, the home region chooses to increase her social welfare program. This effect can be explained by noting that the only interaction between b and $b^\star$ occurs through the price index. As a consequence, lower foreign social security levels are reflected in higher real

incomes for northern inhabitants. This creates the policy space for the home government, that has a relative strong focus on the welfare of the poor, to increase the own unemployment benefits. At the same time, the home government don't have to reckon with the full negative real income effects of their extension of the social security system as part of the burden is shifted on to the foreign region. This region is now faced with reduced purchasing power.

The unemployment benefits don't always have to be strategic substitutes. Strong utilitarian governments facing a severe imperfect economy (low σ-values) will choose to play complementary, provided that an internal solution exists in this region of e-values. This means that cuts in the social security system of the foreign country automatically lead to cuts in the home welfare system.

2.3.2 What will a social planner do?

The social planner maximizes the social welfare of both regions with respect to b and $b^\star$. The symmetric set-up allows us to focus on the maximization with respect to the northern unemployment benefit.

The first order condition of the social planner equals

$$\begin{aligned} \frac{\partial SW(world)}{\partial b} &= \frac{\partial SW(north)}{\partial b} + \frac{1}{1-e}\frac{\partial}{\partial b}\{(1-u^\star)(\frac{w_R^\star}{P^\star(1-\beta)})^{1-e} + u^\star(\frac{b^\star}{P^\star})^{1-e}\} \\ &= \frac{\partial SW(north)}{\partial b} - P^{e-2}\frac{\partial P}{\partial b} \end{aligned} \tag{29}$$

The last equality holds because, in this optimization problem, only the southern price index depends on the northern unemployment benefit. We already showed that $\frac{\partial P}{\partial b}$ is positive. Hence, the last term on the right-hand side is positive. As this first order condition (29) equals zero in the optimum, the social planner has to optimize a larger (northern) social welfare function compared to the problem of the northern government. This constatation together with the negative sign of the second derivative of the northern social welfare with respect to the northern unemployment benefit, leads to the general result that

$$b_{socialplanner} < b_{region}, \qquad \forall e \tag{30}$$

Independent of the efficiency-equity trade-off of the government, a social planner will always choose for lower taxes and lower social security benefits compared to

the regional governments. This can once again be explained as the dominance of the terms-of-trade effect. A social planner will include the negative effects of a higher unemployment benefit on the real income of the other region and as a consequence will opt for lower taxes.

3 Conclusion

In this paper, we determine the conditions for social security competition in a standard Dixit-Stiglitz two-region model of international trade in which we allow for endogenous unemployment and where governments maximise social welfare facing an equity-efficiency trade-off. We show that social policies can be strategic complements or substitutes depending on the inequality aversion of the governments and the substitution elasticity of the goods. Our results are however strongly determined by the kind and scope of international economic interaction that is possible in this framework. When trade in goods is the only mechanism of economic integration and the number of varieties is exogenously given, the interaction between the social policies occurs through the regional price indices. Hence, economic integration allows to externalise part of the price increase that higher social allowances imply, which explains why sufficiently inequality averse governments might raise social allowances when these are lowered abroad. In the same vain, governments would opt for more social protection in an internationally integrated economy compared to autarky, as they can externalise part of the negative price index effect. We find however that for an inequality aversion below 1 and low product substitution elasticity, social policies become strategic complements, which is more in line with the results of the tax competition literature. Notwithstanding, a social planner would opt for lower taxes and benefits in this framework.

In future research we will try to deal with the limitations of the actual model. First we will check the robustness of our results by assessing numerically the probability of an interior solution for the welfare maximalization problem of the government when the inequality aversion is below 1. Second we will try to reformulate the model according to the Thisse and Ottaviano approach to monopolistic competition and check to what extent results converge. Next, since the conclusions in this model are rather tied to the exogenous character of n and n* and the absence of factor mobility, we will try to extend the model allowing endogenous determination of the number of product varieties, e.g. by a vertical integration mechanism. It will then become time to subject the model to some empirical scrutiny.

Appendix

The price index (3) can be written as:

$$P = (np_{NN} + n^{\star}p_{SN})^{\frac{1}{1-\sigma}} \tag{31}$$

Based on the expressions for the wage (12) and the effort (13), we rewrite the prices (5) as:

$$p_{NN} = \frac{K}{1-z} \qquad with \qquad K = \frac{\sigma}{\sigma-1}(\frac{w_R}{1-\beta})^{1-\beta}\beta^{\beta} > 0 \tag{32}$$

$$p_{SN} = \frac{K^{\star}}{1-z^{\star}} \qquad with \qquad K^{\star} = \frac{\sigma}{\sigma-1}(\frac{w_R^{\star}}{1-\beta})^{1-\beta}\beta^{\beta} > 0 \tag{33}$$

After substituting these prices in the price index and rearranging, we get:

$$P = \frac{1}{1-z}(nK^{1-\sigma} + n^{\star}(K^{\star}\tau\frac{1-z}{1-z^{\star}})^{1-\sigma})^{\frac{1}{1-\sigma}} \tag{34}$$

The derivative of the northern price index with respect to the northern tax rate is

$$\begin{aligned}\frac{\partial P}{\partial z} = & \frac{1}{(1-z)^2}(nK^{1-\sigma} + n^{\star}(K^{\star}\tau\frac{1-z}{1-z^{\star}})^{1-\sigma})^{\frac{1}{1-\sigma}} \\ & [1 - \frac{n^{\star}(\tau K^{\star}\frac{1-z}{1-z^{\star}})^{1-\sigma}}{(nK^{1-\sigma} + n^{\star}(K^{\star}\tau\frac{1-z}{1-z^{\star}})^{1-\sigma})}]\end{aligned} \tag{35}$$

This is clearly positive. Because $\frac{\partial z}{\partial b}$ is also positive (see (19)), we conclude that

$$\frac{\partial P}{\partial b} > 0 \tag{36}$$

In a similar way, one can prove:

$$\frac{\partial P}{\partial b^{\star}} > 0 \qquad \frac{\partial P^{\star}}{\partial b} > 0 \qquad \frac{\partial P^{\star}}{\partial b^{\star}} > 0 \tag{37}$$

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