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INTERNATIONAL SPILLOVER EFFECTS
OF SECTORAL TAX DIFFERENTIATION IN
UNIONIZED ECONOMIES

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Abstract

The European Union has recently proposed sectoral tax differentiation as a policy to fight unemployment. The member countries are allowed to reduce the VAT rates on goods and services that are particularly labor intensive and price elastic. The paper provides a theoretical analysis of the effects of such tax reforms, with particular emphasis on the international repercussions of the policies. To that end we develop a two-country and two-sector model with monopolistic competition in the goods market and wage bargaining in the labor market. Policy externalities operate through the endogenously determined terms of trade. We examine how national and supranational commodity tax policies affect sectoral and total employment and characterize optimal commodity taxes with and without international policy cooperation. Some rough estimates of the welfare gains from policy coordination are also presented, using a calibrated version of the model.

Keywords: Economic integration, imperfect competition, wage determination, policy cooperation

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1. Introduction

The European Union has imposed restrictions on the use of value added taxes (VAT) in the member states. According to these restrictions, member states may apply at most two VAT rates below the standard rate for certain goods and services. In 1999, these rules were supplemented with a new directive that extended the range of services that could be subject to reduced tax rates. The motivation for this amendment was explicitly focused on employment objectives: "…the problem of unemployment is so serious that those member states wishing to do so should be allowed to experiment with the operation and impact, in terms of job creation, of a reduction in the VAT on labour-intensive services which are not currently listed…"(Council directive 1999/85/EC). Member states can apply the reduced rates as a three year experiment, beginning on January 1, 2000. The services concerned must satisfy several requirements, including labor-intensive production and high price elasticity ("…there must be a close link between the lower prices resulting from the rate reduction and the foreseeable increase in demand and employment").

In this paper we analyze the international repercussions of sectoral tax differentiation in an economic union. To that end we develop a two-country and two-sector general equilibrium model of international trade. The two sectors are referred to as *tradable* and *non-tradable*, respectively. We think of the tradable sector as a sector producing goods whereas the non-tradable sector produces services. The model features monopolistic competition in the markets for goods and services and a labor market with union-firm bargaining over wages. Unemployment prevails in general equilibrium. The source of international policy spillovers is the endogenously determined terms of trade. Goods and services may be taxed at different VAT rates. To the extent that services are more labor intensive and more price elastic than goods, employment objectives may suggest lower VAT rates for services. We examine how reduced VAT rates in one sector in one country affects sectoral and total employment at home and abroad. We also characterize optimal sectoral tax differentiation with and without international policy cooperation.

The paper is primarily related to two strands of recent contributions.[1] One strand has explored the case for policy coordination among economies with integrated product markets. Andersen and Sørensen (1995) as well as Andersen, Rasmusen and Sørensen (1996) analyze optimal fiscal policies with and without international cooperation. The main result is that uncoordinated fiscal

[1] There are also some connections to the literature that has examined how product market integration affects wage bargaining and employment in unionized economies. The papers by Andersen and Sørensen (1992), Driffill and van der Ploeg (1993, 1995), Danthine and Hunt (1994), Huizinga (1993), Sørensen (1994) and Naylor (1998) belong to this category.

policy is too expansionary. Similar results were obtained – in models without labor market distortions – in earlier contributions by van der Ploeg (1987), Turnovsky (1988) and Devereux (1991). This literature ignored sectoral tax differentiation.

The other branch of recent related contributions is the literature on commodity tax competition under destination and origin principles. These contributions include Lockwood (1993, 1998) as well as Keen and Lahiri (1998). The focus of this literature is to compare Nash equilibria under the two principles. The models applied have been diverse and so are the results. Suffice it here to note that the tax competition equilibrium is not generally invariant to a change from a destination to an origin principle.

The previous models employed in the VAT competition literature have assumed competitive labor markets and thus been inappropriate for dealing with employment issues. The present paper attempts to fill some of this gap by providing an analysis where unemployment emerges as an equilibrium outcome. We show that a reduction in the tax rate on services in one country probably will reduce unemployment in that country but it may also increase unemployment in the other country. Increased employment in one country may thus come at the expense of reduced employment in other countries, the reason being the endogenous terms of trade response to national tax policies. We also show that the non-cooperative policy equilibrium entails too low taxes on services relative to the outcome under international policy cooperation.

We proceed by presenting the model in the next section of the paper. Section 3 examines the relationships between trade costs and policy spillovers with regard to employment. Section 4 is devoted to a positive analysis of international repercussions of differentiated VAT and the implications for optimal taxation with and without policy cooperation. Section 5 concludes.

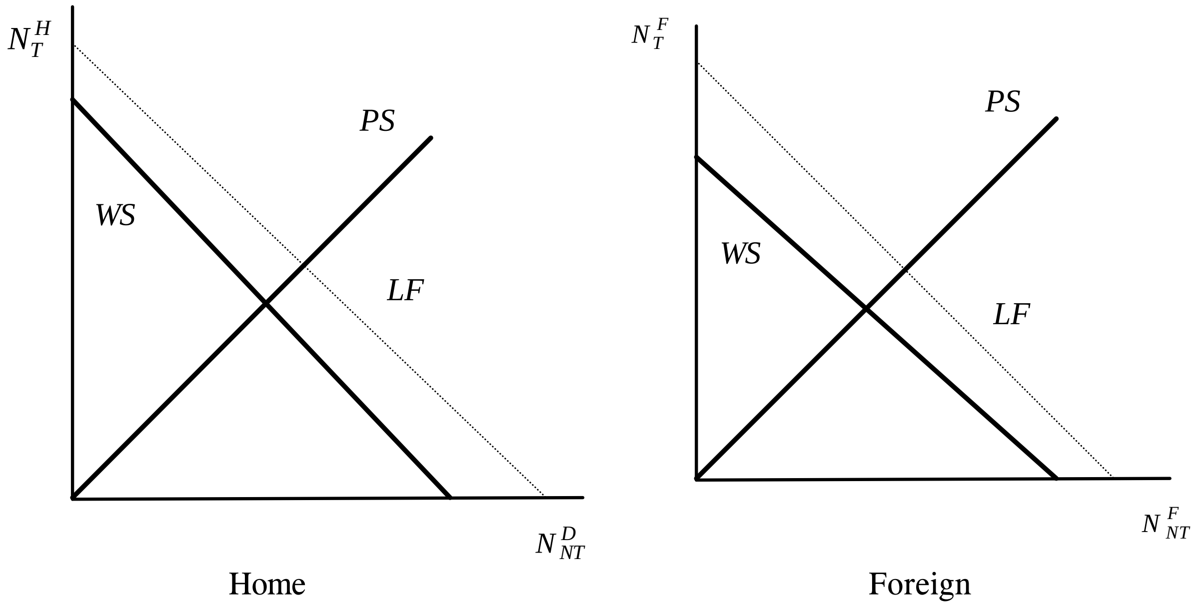
2. The Model

2.1 Brief Outline

We begin with a brief overview of the main ingredients of the model by means of Figure 1. There are two countries, Home (*H*) and Foreign (*F*). In each country there are two sectors, a tradable (*T*) and a non-tradable (*NT*) sector. The tradable sector is thought of as a producing goods, whereas the non-tradable sector produces services. Tradables as well as non-tradables are produced in many varieties. Total employment in the tradable sector is denoted N_T^j, whereas total employment in the non-tradable sector is denoted N_{NT}^j, $j=H, F$. Labor is the only factor of production.

In Figure 1, the dashed and negatively sloped 45-degree lines denoted *LF* represent the labor force constraints in the countries. In an economy with full employment, the feasible employment combinations would coincide with the labor force constraint. With imperfect labor markets, the feasible employment combinations are located to the left of the labor force constraint, as illustrated in Figure 1 by the *WS*-lines. These lines are derived from wage setting behavior; hence the label *WS*. The position of a *WS*-line is determined by labor and product market characteristics within a country. An increase in wage pressure, caused by, say, higher unemployment benefits or more powerful unions, produces a downward shift of the *WS*-line. The slope of a *WS*-line is determined by parameters of the model that capture sectoral differences in the market power of firms and unions. A reallocation of employment across sectors has no effect on total employment if the slope is equal to minus unity; otherwise a reallocation does affect total employment.

Figure 1. Wage Setting and Price Setting in Open Economies.



The positively sloped lines, denoted *PS*, capture relative demand for tradables and non-tradables. The *PS*-lines incorporate the firms' price setting decisions – hence the label *PS* – but *not* wage-setting decisions. They are derived from two relationships, namely the demand for tradables and non-tradables as increasing functions of aggregate real income. By substituting out real income from these relationships we obtain a *PS*-equation for each of the countries. An important feature of the model is that *PS* in general depends on the terms of trade, i.e., the relative price of domestic tradables in terms of foreign tradables. For a given relative price, equilibrium obtains when the *PS*-line intersects with the *WS*-line. In general "world" equilibrium with balanced trade, the relative price is determined simultaneously with the other variables in the two economies.

Policy spillovers operate through the terms of trade. Domestic policies affect the terms of trade through the effects on wage setting (*WS*) and/or relative demand (*PS*) at home. For example, an increase in wage pressure in Home has a "direct" effect on *WS* – involving a shift towards the origin in Home – and "indirect" effects on the *PS*-lines in both countries through the terms of trade.

Moreover, a domestic reduction in the tax on tradables has a direct effect on *PS* in Home, raising the demand for tradables and inducing a reallocation of employment towards the tradable sector. The increased supply of tradables in Home relative to the supply of tradables in Foreign causes a decline in the price of domestic relative to foreign tradables. This will induce further reallocations of workers towards the tradable sector in Home, whereas the foreign country experience a reallocation of workers towards their non-tradable sector. These sectoral reallocations affect total employment in each country if the market power of firms or unions differ across sectors. Total employment increases if there is reallocation of workers towards the sector where the firms have less monopoly power and unions are weaker.

This completes the brief overview of the model. We proceed to the details. The model characterization below pertains to Home; analogous descriptions hold for Foreign.

2.2 Consumers

We normalize the number of individuals in each country to unity. There is no labor mobility between countries. Individual i consumes traded (C_{iT}^{H}) and non-traded (C_{iNT}^{H}) goods and has a utility function given as:

$$\Lambda_i = \left(\frac{C_{iT}^{H}}{\alpha}\right)^{\alpha}\left(\frac{C_{iNT}^{H}}{1-\alpha}\right)^{1-\alpha}, \qquad 0 < \alpha < 1. \tag{1}$$

Labor is supplied inelastically without loss of utility. Both tradables and non-tradables appear in many varieties and the sub-utility functions for the different varieties are given as:

$$C_{iT}^{H}=\left(\sum_{s=1}^{K_T} C_{is}^{\frac{m-1}{m}}\right)^{\frac{m}{m-1}},$$

(2) $$\mu, \sigma > 1.$$

$$C_{iNT}^{H}=\left(\sum_{\ell=1}^{K_{NT}^{H}} C_{i\ell}^{\frac{s-1}{s}}\right)^{\frac{s}{s-1}},$$

There are K_T varieties of tradables; K_T^H of these are produced in Home and $K_T - K_T^H$ in Foreign. The number of varieties of non-tradables in Home is given by K_{NT}^H. The number of varieties produced in each of the countries is exogenous. The parameter μ (σ) is the elasticity of substitution between any two tradable (non-tradable) goods.

The individual receives unemployment benefits, *B*, if he is unemployed and labor income, W_i, if he is employed in one of the sectors. Profits are distributed equally to all individuals as dividends, π. The individual's income is thus given as $I_i = W_i + \pi$ if he is employed and as $I_i = B + \pi$ if he is unemployed. The budget constraint takes the form:

(3) $$I_i = \sum_{h=1}^{K_T^H} \tilde{P}_h^H C_{ih}^H + \sum_{f=K_T^H}^{K_T} \tilde{P}_f^H C_{if}^H + \sum_{\ell=1}^{K_{NT}^H} \tilde{P}_\ell^H C_{i\ell}^H .$$

The consumer (producer) price of tradables produced in Home is denoted $\tilde{P}_h^H$ (P_h^H), whereas $\tilde{P}_f^H$ (P_f^H) is the domestic consumer (producer) price of tradables produced in Foreign. $\tilde{P}_\ell^H$ (P_ℓ^H) is the consumer (producer) price of non-tradables in Home. C_{ih}^H, C_{if}^H , and $C_{i\ell}^H$ are the domestic consumer's demand for domestically produced tradables, foreign produced tradables, and non-tradables. Destination-based value added taxes, denoted t_T^j and t_{NT}^j for *j=H, F*, create a wedge between consumer and producer prices, i.e., $\tilde{P}_h^H = P_h^H(1+t_T^H)$, $\tilde{P}_f^H = P_f^H(1+t_T^H)$, and $\tilde{P}_\ell^H = P_\ell^H(1+t_{NT}^H)$. All our results are independent of whether value added taxes are destination-based or origin-based.[2] Moreover, value added taxes and payroll taxes are equivalent in our model so all results can be obtained by sectoral differentiation of payroll taxes.

The individual demand for the specific goods is derived by maximizing the utility function given by (1) and (2), subject to the budget constraint in (3). From this maximization we derive the aggregate *domestic* demand function pertaining to a specific firm. This takes the form

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[2] This appears to be at variance with the analysis in Lockwood (1993), where a switch from the destination principle to the origin principle does affect the equilibrium outcome in the case of non-uniform commodity taxation. However, Lockwood considers VAT-differences across varieties of tradables, a policy not considered in our paper.

$$(4) \qquad C_h^H = a\left(\frac{\tilde{P}_h^H}{\tilde{P}_T^H}\right)^{-m} \frac{I^H}{\tilde{P}_T^H}, \qquad h=1,\ldots,K_T^H,$$

for a firm that produces tradables in Home. I^H is the aggregate domestic income whereas $\tilde{P}_T^H$ is the general price index on tradables relevant for domestic consumers:

$$(5) \qquad \tilde{P}_T^H = \left[\sum_{s=1}^{K_T} \left(\tilde{P}_s^H\right)^{1-m}\right]^{\frac{1}{1-m}} = \left[K_T^H \left(\tilde{P}_h^H\right)^{1-m} + \left(K_T - K_T^H\right)\left(\tilde{P}_f^H\right)^{1-m}\right]^{\frac{1}{1-m}}.$$

Some of the prices in the price index are set by foreign firms. The expression in the rightmost bracket is derived by assuming symmetric conditions for firms within each country.

A firm in Home producing tradables faces also *foreign* demand for its product. With equal preferences in the two countries, the *aggregate* demand relevant for such firm is given by:

$$(6) \qquad C_h = C_h^H + C_h^F = a\left[\left(\frac{\tilde{P}_h^H}{\tilde{P}_T^H}\right)^{-m} \frac{I^H}{\tilde{P}_T^H} + \left(\frac{\tilde{P}_h^F}{\tilde{P}_T^F}\right)^{-m} \frac{I^F}{\tilde{P}_T^F}\right], \qquad h=1,\ldots,K_T^H.$$

$\tilde{P}_h^F$ is the price of tradable *h* produced in Home facing consumers in Foreign, and $\tilde{P}_T^F$ is the general price index on tradables relevant for foreign consumers. I^F is the aggregate income level in Foreign.

Analogous derivations yield the demand relevant for a firm that produces non-tradables as $C_\ell^H = (1-a)\left(\tilde{P}_\ell^H / \tilde{P}_{NT}^H\right)^{-s} \times \left(I^H / \tilde{P}_{NT}^H\right)$, $\ell = 1,\ldots,K_{NT}^H$. By assuming $s > m$, we can capture the notion that service producing firms face a more price-elastic demand function. (Recall that this is one of the arguments advanced for sectoral tax differentiation within the EU.)

The general consumer price index in Home, denoted $\tilde{P}^H$, is obtained as a weighted geometric average of the price of tradables, $\tilde{P}_T^H$, and the price of non-tradables, $\tilde{P}_{NT}^H$, i.e., $\tilde{P}^H = \left(\tilde{P}_T^H\right)^{\alpha}\left(\tilde{P}_{NT}^H\right)^{1-\alpha}$.

2.3 Firms

In each country there are a large number of firms that produce tradables and non-tradables. Only one firm produces a particular variety. Labor is the only factor of production, the production technology is linear and all productivity parameters are normalized to unity.[3] Exports involve "iceberg" transport costs implying that a fraction of goods shipped abroad evaporates during transit. Markets are segmented because of transport costs, and hence prices for identical products can differ across countries. Firms set prices to maximize profits, taking wages as given. The objective function for a representative domestic firm in the tradable sector can be written as:

$$(7) \quad \Pi_h = P_h^H C_h^H + P_h^F C_h^F - W_h\left(C_h^F + C_h^H\right) - F^D P_h^F C_h^F = P_h^H C_h^H + P_h^F C_h^F / \tau^H - W_h\left(C_h^F + C_h^H\right).$$

W_h is the nominal wage and F^H captures the transport cost, where $F^H \in [0,1)$ and $\tau^H \equiv 1/(1-F^H)$. $F^H = 0$ implies $\tau^H = 1$. The product markets are completely integrated when $t^j = 1$, $j=H, F$.

The following price setting rules are obtained for domestic and foreign markets:

$$(8) \qquad P_h^H = \kappa_T W_h,$$

$$(9) \qquad P_h^F = \tau^H P_h^H = \tau^H \kappa_T W_h.$$

$\kappa_T \equiv \mu/(\mu-1)$ is the usual markup factor. The optimal price in the foreign market is, in general, higher than the domestic price due to transport costs. Once prices are set we obtain output and employment from the relevant demand functions. By aggregating over the domestic firms and using the relationships between consumer and producer prices we obtain the following aggregate labor demand schedule for the domestic tradable sector:

$$(10) \qquad N_T^H = \frac{\alpha K_T^H I^H}{P_h^H (1+t_T^H)} \left[\left(\frac{P_h^H}{P_T^H} \right)^{1-\mu} + \frac{I^F (1+t_T^H)}{I^H (1+t_T^F)} \left(\frac{P_h^H}{P_T^F} \right)^{1-\mu} \left(\tau^H\right)^{-\mu} \right],$$

where $P_T^H = \tilde{P}_T^H/(1+t_T^H)$ and $P_T^F = \tilde{P}_T^F/(1+t_T^F)$ are producer price indexes. Aggregate demand for labor in the tradable sector depends on the relative price of domestic goods in the home

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[3] By taking labor as the sole factor of production, we cannot explicitly examine whether the effects of tax differentiation depend on differences in the labor intensity of production; cf. the citation from the European Commission above. Our simplification is without loss of generality, however. Suppose that the labor intensity is higher in the non-tradable than in the tradable sector. This would imply that the wage-elasticity of labor demand would be higher among firms producing non-tradables. This dimension is, however, already captured by the assumption that the price-elasticity of demand is higher for non-tradables than for tradables, i.e., $s > m$.

market, P_h^H / P_T^H, as well as the relative price of domestic goods in the foreign market, P_h^H / P_T^F. It also depends on the aggregate real income in Home and Foreign.

It will be convenient to define the *terms of trade* as the relative price of domestic tradables in terms of foreign tradables, i.e., $p \equiv P_h^H / P_f^F$. By using the expressions for the price indexes for tradables in Home and Foreign we can rewrite (10) and obtain

$$(10') \quad N_T^H = \frac{aI^H}{P_h^H(1+t_T^H)}\left[\left[1+k_T^{-1}\left(t^F\right)^{1-m} p^{m-1}\right]^{-1} + \frac{I^F(1+t_T^H)}{I^H(1+t_T^F)}\left[\left(t^H\right)^{1-m} + k_T^{-1} p^{m-1}\right]^{-1}\left(t^H\right)^{-m}\right],$$

where $k_T \equiv K_T^H / (K_T - K_T^H)$. A rise in p, i.e., a real appreciation experienced by Home, reduces labor demand in the tradable sector. In general equilibrium we also need to consider adjustments in real incomes, something that we do in the subsequent analysis.

Analogous reasoning can be used to derive pricing rules for firms in the non-tradable sector as $P_\ell^H = \kappa_{NT} W_\ell$, where $\kappa_{NT} \equiv \sigma / (\sigma - 1)$. In a symmetric equilibrium, the demand for labor in the non-tradable sector is given by $N_{NT}^H = (1-\alpha) I^H / \tilde{P}_\ell^H$.

2.4 Wage Determination and the Labor Market

There is one union in each firm and each union cares about the utility of its members. The indirect utility function for the worker is given as $\Lambda_i^* = I_i / \tilde{P}^H$, where I_i is the state-dependent income. The time horizon is infinite and workers are concerned with their expected lifetime utility, recognizing the possibility of transitions across sectors and labour force states. (See Appendix A for details on the labor market structure.) Let V_h denote the expected lifetime utility of a worker employed in a particular firm h in the tradable sector, V_ℓ the expected lifetime utility of a worker employed in a firm ℓ in the non-tradable sector, and V_u the expected lifetime utility of an unemployed worker. The nominal wage is set in decentralized union-firm negotiations, taking the general price and wage levels as given. Wages are chosen according to Nash bargains where the objectives are of the form:

$$\max_{W_h} \Omega_h = \left[n_h(W_h)\left(V_h(W_h) - V_u\right)\right]^{\lambda_T^H}\left[\Pi_h(W_h) / \tilde{P}^H\right]^{1-\lambda_T^H},$$

$$\max_{W_\ell} \Omega_\ell = \left[n_\ell(W_\ell)\left(V_\ell(W_\ell) - V_u\right)\right]^{\lambda_{NT}^H}\left[\Pi_\ell(W_\ell) / \tilde{P}^H\right]^{1-\lambda_{NT}^H}.$$

The union's contribution to the Nash bargain is given by its "rent", i.e., $n_h(V_h - V_u)$ for the tradable sector, and $n_\ell(V_\ell - V_u)$ for the non-tradable sector, with employment at the firm level denoted n_h and n_ℓ. The parameters λ_T^H and λ_{NT}^H measure the relative bargaining power of the unions relative to the firms, with $\lambda_i^H \in (0,1]$, for *i=T, NT*. The wage bargains recognize that the firms unilaterally determine employment once wages are set. The real wages in Home implied by the bargains are:

(11) $$\frac{W_h}{\tilde{P}^H} = \left(\frac{\lambda_T^H + \mu - 1}{\mu - 1}\right)\bar{V}^H, \qquad h = 1,\ldots,K_T^H,$$

(12) $$\frac{W_\ell}{\tilde{P}^H} = \left(\frac{\lambda_{NT}^H + \sigma - 1}{\sigma - 1}\right)\bar{V}^H, \qquad \ell = 1,\ldots,K_{NT}^H.$$

The wage is set as a constant markup on $\bar{V}^H$, which is the per period value of unemployment adjusted for dividends.[4] The markups capture the market power of the unions relative to the firms and are increasing in λ_T^H and λ_{NT}^H and decreasing in σ and μ. Note that a rise in σ or μ increases the elasticity of labor demand and profits with respect to wages. By symmetry, wages are set equal across bargaining units within each sector in equilibrium, i.e., $W_h = W_T^H$ and $W_\ell = W_{NT}^H$. From eqs. (11) and (12) we obtain the relative wage as $Z^H \equiv W_{NT}^H / W_T^H$. Since all workers face the same opportunities the relative wage takes the form:

(13) $$Z^H = \frac{(\mu - 1)(\lambda_{NT}^H + \sigma - 1)}{(\sigma - 1)(\lambda_T^H + \mu - 1)}.$$

The relative wage is thus fixed by preference parameters and the measure of union bargaining power. The value of unemployment net of dividends is, under our assumption of no discounting, obtained as a weighted average of the utilities in the different states; the weights are given by the employment rates, N_T^H and N_{NT}^H, and the unemployment rate, U^H:

(14) $$\bar{V}^H = N_T^H \frac{W_T^H}{\tilde{P}^H} + N_{NT}^H \frac{W_{NT}^H}{\tilde{P}^H} + U^H \frac{B^H}{\tilde{P}^H}.$$

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[4] $\bar{V}^H \equiv rV_u - \pi / \tilde{P}^H$, where *r* is the discount rate (see Appendix A for details).

The wage equations in (11) and (12) can be expressed as an equilibrium relationship between employment in the two sectors by eliminating $\bar{V}^H$ by means of (14) and by using the labour force identity, i.e., $1 = N_T^H + N_{NT}^H + U^H$. The resulting employment relationship takes the form:

(15) $$N_T^H = \psi^H - \left(\frac{Z^H - b^H}{1 - b^H}\right) N_{NT}^H,$$

where $\psi^H < 1$ is a constant.[5] The parameter b^H is the fixed replacement rate with unemployment benefits indexed to the average wage in the tradable sector, i.e., $B^H = b^H W_T^H$; no results would change if benefits instead were indexed to the wage in the non-tradable sector. The inequalities $b^H < Z^H$ and $b^H < 1$ must hold as participation constraints. As (15) reveals, there is a tradeoff between employment in the two sectors; indeed, this is the *WS*-line for Home as illustrated in Figure 1. The relative wage, Z^H, plays a crucial role for this tradeoff. An increase in employment in the non-tradable sector is exactly offset by a decrease in employment in the tradable sector if the relative wage is unity, i.e., $Z^H = 1$. However, an expansion of non-tradable employment is not completely offset by a decline in employment in the tradable sector if $Z^H < 1$, and it is more than offset if $Z^H > 1$. A rise in the market power of unions or firms, or a higher replacement rate, produces a shift to the left of the *WS*-line by reducing ψ^H.

To understand the employment tradeoff, consider an exogenous increase in the demand for labor in the non-tradable sector and assume $Z^H < 1$. Notice that $Z^H < 1$ would indeed hold under the assumption that labor demand is relatively more wage-elastic in the non-tradable sector, i.e., $s > m$ (absent differences in union bargaining power). The rise in labor demand raises wages and thus crowds out employment in the tradable sector. A wage premium for workers in the tradable sector, $Z^H < 1$, moderates the wage increase since the relative probability of finding a job in the high-wage sector has decreased. The rise in employment in the non-tradable sector is in this case not completely offset by lower employment in the tradable sector.

2.5 General Equilibrium

General equilibrium with a balanced government budget implies balanced trade. The trade balance expression can be written as:

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[5] $\psi^H \equiv 1 - \left[\lambda_T^H / (\lambda_T^H + \mu - 1)\right](1 - b^H)^{-1}$.

(16) $$TB = K_T^H P_h^F C_h^F - \left(K_T - K_T^H\right) P_f^H C_f^H \, ,$$

where the first term represents the value of exports and the second term the value of imports. From the individuals' utility maximization we obtain the aggregate domestic demand for tradables produced in Foreign as well as foreigners' aggregate demand for tradables produced in Home. By making use of the price indexes for tradables relevant for domestic and foreign consumers, we obtain the trade balance condition (*TB*=0) as:

(17) $$\frac{I^F}{I^H} = \left(\frac{1+t_T^F}{1+t_T^H}\right) \frac{1+k_T^{-1}\left(t^H\right)^{m-1} p^{m-1}}{1+k_T\left(t^F\right)^{m-1} p^{1-m}} \equiv \left(\frac{1+t_T^F}{1+t_T^H}\right) f(p; t^H, t^F) \, .$$

Straightforward calculations yield the following partial derivatives: $f_p(.) > 0$, $f_{\tau^H}(.) > 0$ and $f_{\tau^F}(.) < 0$. A rise in p – a real appreciation experienced by Home – induces a trade deficit, which has to be offset by an increase in foreign income relative to domestic income so as to maintain external balance. A rise in transport costs in Home, τ^H, also worsens the trade balance, which requires an offsetting rise in foreign relative income. Analogous arguments hold for changes in transport costs in Foreign.

We have now derived the relationships needed to characterize the general equilibrium. It will be convenient to make use of the equations for the *WS*- and *PS*-lines. To that end we first represent the equilibrium in each country by the following equations:

(18) $$N_T^j = y^j - \left(\frac{Z^j - b^j}{1-b^j}\right) N_{NT}^j \qquad j=H, F$$

(19) $$N_T^j = \frac{\alpha I^j}{\kappa_T W_T^j \left(1+t_T^j\right)} \Gamma^j\left(p; \tau^h, \tau^F\right) \qquad j=H, F$$

(20) $$N_{NT}^j = \frac{(1-\alpha) I^j}{\kappa_{NT} W_{NT}^j \left(1+t_{NT}^j\right)} \qquad j=H, F$$

(21) $$Z^j = \frac{(m-1)\left(l_{NT}^j + s - 1\right)}{(s-1)\left(l_T^j + m - 1\right)} \qquad j=H, F$$

where

(22) $$\Gamma^H(.) \equiv \frac{k_T + \left(t^F\right)^{1-m}\left(t^H\right)^{-1} p^{m-1}}{k_T + \left(t^F\right)^{1-m} p^{m-1}},$$

and

(23) $$\Gamma^F(.) \equiv \frac{k_T^{-1} + \left(t^H\right)^{1-m}\left(t^F\right)^{-1} p^{1-m}}{k_T^{-1} + \left(t^H\right)^{1-m} p^{1-m}}.$$

Eq. (18) reproduces (15) and represents the tradeoff between employment in the two sectors, i.e., the *WS*-line. Eqs. (19) and (20) represent the aggregate demand for labor in the two sectors for each country. To derive (19) for Home we use eq. $(10')$ and the trade balance condition (17). The aggregate demand relationship for the tradable sector thus incorporates the trade balance condition through $\Gamma^H(.)$. Notice that $\Gamma^j(.) \leq 1$ as $t^j \geq 1$, *j=H,F*. We have the following partial derivatives: $\Gamma_p^H(.) \leq 0$, $\Gamma_{t^H}^H(.) < 0$, $\Gamma_{t^F}^H(.) > 0$, $\Gamma_p^F(.) \geq 0$, $\Gamma_{t^H}^F(.) > 0$, and $\Gamma_{t^F}^D(.) < 0$.

$\Gamma^H(.)$ captures domestic and foreign demand for tradables produced in Home relative to what the demand for tradables would be in Home if it were a *closed* economy (in which case domestic consumers could buy only home-produced tradables). $\Gamma^H(.)$ is smaller than unity if domestic firms face transport costs, i.e., $\Gamma^H(.) < 1$ as $t^H > 1$. The labor demand is thus generally smaller in an open economy than it would be in a closed economy, given wages and total income. To understand this feature of the model, notice that the opening of the domestic economy to trade has two effects on sales and thereby labor demand. First, the exposure of domestic firms to foreign competition results in some loss in demand as domestic consumers substitute goods produced in Foreign for goods produced in Home. Second, the access to a foreign market implies some gain in demand as foreign consumers substitute goods produced in Home for goods produced in Foreign. Foreign consumers have to spend part of their income to cover transport costs, which implies that the net effect on demand is negative.

To derive the equations for relative labor demand we use (19) and (20) to obtain:

(24) $$N_T^j / N_{NT}^j = A\theta^j Z^j \Gamma^j\left(p; \tau^H, \tau^F\right), \qquad j=H, F.$$

$A \equiv \alpha\kappa_{NT} / (1-\alpha)\kappa_T$ is a constant and $\theta^j \equiv \left(1+t_{NT}^j\right) / \left(1+t_T^j\right)$ captures *relative* tax pressure, i.e., the tax pressure in the non-tradable sector relative to the tradable sector. Eq. (24) is the positively sloped *PS*-schedule, as illustrated in Figure 1 above. The employment levels in the two domestic and the two foreign sectors, conditional on p, are thus obtained from eqs. (18) and (24). We note that taxes only affect sectoral and total employment through the *relative* tax pressure. The fact that *total* tax pressure does not matter for employment outcomes is essentially driven by two features of the model, namely the iso-elastic utility functions and the fixed replacement rates.[6]

It remains to determine the terms of trade, i.e., the relative price between domestic and foreign tradables. This is obtained by making use of two relationships: (i) the demand for foreign tradables relative to the demand for domestic tradables, and (ii) the supply of foreign tradables relative to the supply of domestic tradables. To obtain the relative demand schedule we use the two equations in (19) together with the trade balance condition (17), recognizing that prices are set as markups on wages. The resulting relationship gives the demand for foreign tradables relative to domestic tradables as a function of the terms of trade and trade costs, i.e.,

$$\frac{N_T^F}{N_T^H} = \frac{\Gamma^F(p;t^H,t^F)}{\Gamma^H(p;t^H,t^F)} f(p;t^H,t^F)\,p\,, \tag{25}$$

where the right-hand side is increasing in p. A rise in p, i.e., a rise in domestic relative prices, increases the demand for foreign tradables relative to domestic tradables.

To obtain the relative supply schedule we use eqs. (18) and (24) to solve for N_T^H and N_T^F as functions of p. The outcome is the following relationship:

$$\frac{N_T^F}{N_T^H} = \frac{\psi^F}{\psi^H} \cdot \frac{1+(Z^H-b^H)[A\theta^H Z^H \Gamma^H(p)]^{-1}(1-b^H)^{-1}}{1+(Z^F-b^F)[A\theta^F Z^F \Gamma^F(p)]^{-1}(1-b^F)^{-1}}\,, \tag{26}$$

where the right-hand side is non-decreasing in p. Eqs. (25) and (26) are illustrated in Figure 2. It is easily verified that the slope of (25) is steeper than the slope of (26), the reason being that (26) incorporates wage adjustments to changes in the terms of trade, whereas eq. (25) is a demand-side relationship that holds conditional on wages.[7]

By equating relative demand and relative supply, i.e., eqs. (25) and (26), we obtain:

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[6] Many models of equilibrium unemployment have the property that labor and commodity taxes are completely borne by labor if unemployment benefits are indexed to after-tax real wages; see, for example, Pissarides (1998).

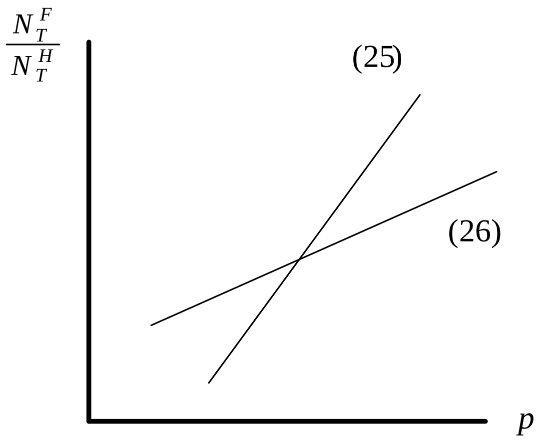
[7] The relative supply schedule is horizontal if product markets are completely integrated, i.e., if $\tau^j = 1$, j=*H*, *F*.

$$(27) \qquad Q \equiv f(p;t^H,t^F)p - \frac{\psi^F}{\psi^H} \cdot \frac{\Gamma^H(p;\tau^H,\tau^F) + (Z^H - b^H)[A\theta^H Z^H]^{-1}(1-b^H)^{-1}}{\Gamma^F(p;\tau^H,\tau^F) + (Z^F - b^F)[A\theta^F Z^F]^{-1}(1-b^F)^{-1}} = 0.$$

Eq. (27) implicitly determines *p*; note that $Q_p > 0$ holds. Eq. (27) together with eqs. (18) and (24) determine sectoral employment in each of the two countries along with the real exchange rate. Total employment is given as $N^j_{TOT} = N^j_T + N^j_{NT}$, *j=H,F.*

This completes the description of the model. We now turn to an investigation of the effects of market integration and the nature of policy spillovers.

Figure 2. The Determination of the Terms of Trade.



3. Market Integration and Spillover Effects on Employment

We note from eqs. (18), (24) and (27) that international policy spillovers on employment work through $\Gamma^H(.)$ and $\Gamma^F(.)$, which involve the trade balance condition. Changes in the terms of trade will in general affect employment in both countries, so policies in one country that affect *p* will thereby also influence employment in the other country.

How does increased market integration, i.e., a reduction in trade costs, affect these spillover effects? From (22) and (23) we can conclude that there will be *no* spillover effects on employment if (i) transport costs are infinitely high or if (ii) transport costs are zero. More specifically we have:

Proposition 1. (i) Infinitely high transport costs: $t^H \to \infty$ implies $\Gamma^H \to 1$; analogously, $t^F \to \infty$ implies $\Gamma^F \to 1$. (ii) Zero transport costs: $t^H = 1$ implies $\Gamma^H = 1$; analogously, $t^F = 1$ implies $\Gamma^F = 1$.

The fact that spillover effects on employment are absent when transport costs are infinitely high is obvious since there will be no trade in this case. To understand the second and less obvious part of the proposition, note that balanced trade implies that any decline in imports has to be matched by a corresponding decline in exports. A decline in *p* causes an increase in the domestic consumers' demand for domestic tradables and a reduction in the imports of tradables. External balance requires an offsetting fall in the foreign demand for domestic goods through a decline in foreign income relative to domestic income, as revealed by eq. (17). The resulting substitution of domestic demand for foreign demand has no effect on domestic labor demand when $\tau^H = 1$, since this implies that the prices of domestic tradables are the same at home and abroad. The purchasing power of foreign income in terms of domestically produced goods is thus the same as the purchasing power of domestic income and the reallocation of spending patterns have no real effects. With positive transport costs, however, a reallocation of spending induced by a decline in *p* does matter for domestic labor demand. The purchasing power of foreign income in terms of domestic tradables is lower than that of domestic income, which implies that the demand for domestic labor increases when domestic demand is substituted for foreign demand.[8]

The result that spillover effects on employment vanish as markets become completely integrated does not imply absence of policy externalities with respect to social welfare. Changes in the terms of trade affect welfare directly even if there is no effect on employment. This implies, as discussed in the next section, that policy externalities prevail even if markets are completely integrated.

From here on we will, unless stated otherwise, present results that hold for strictly positive transport costs.[9]

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[8] Holmlund and Kolm (2000) examine the effects of environmental tax reforms in a model of a small open economy with the same labor market structure as the one adopted here. Since they assume zero trade costs, there will be no employment effects arising from changes in the terms of trade.

[9] Holmlund and Kolm (1999) includes an analysis of how transport costs affect employment and real wages in the present model.

4. National and Supranational Tax Policies

4.1 Employment Effects of Tax Differentiation

We now turn to the employment effects of commodity taxation. The national policy is represented by the *relative* tax in Home, i.e., $\theta^H \equiv \left(1+t^H_{NT}\right)/\left(1+t^H_T\right)$; recall that the *total* tax pressure has no effects on sectoral or total employment. The analysis of foreign policies is analogous and therefore omitted. We also examine the consequences of supranational (global) policies, i.e., simultaneous changes of domestic and foreign policies. The government's budget is always balanced.[10]

Consider first a *domestic* policy that changes the tax on non-tradables relative to the tax on tradables. By making use of eqs. (18), (24) and (27), we can conclude:

Proposition 2. An increase in domestic relative tax pressure (q^H) increases N^H_T/N^H_{NT}, but reduces p and N^F_T/N^F_{NT}. The effect on N^H_{TOT} is positive (negative) if $Z^H > 1 (Z^H < 1)$; analogously, the effect on N^F_{TOT} is negative (positive) if $Z^F > 1 (Z^F < 1)$.

To understand the effects on employment, consider first the direct effect in Home. A rise in q^H due to, for example, a reduction in t^H_T implies lower consumer prices of tradables, which result in expanding employment. The resulting decline in unemployment increases domestic wage demands, which leads to higher wages and prices and falling employment in the non-tradable sector; the economy thus moves along its *WS*-schedule as employment is reallocated towards the tradable sector. This process also implies that the supply of domestic tradables increases relative to the supply of foreign tradables, which has to be accompanied by a real depreciation, i.e., a decline in *p*. This decline in *p* reduces the relative demand for tradables in Foreign; there is a further upward shift of the domestic *PS*-schedule whereas the foreign *PS*-schedule shifts downwards. The resulting increase in foreign unemployment leads to wage moderation and thereby to rising employment in the foreign non-tradable sector.

The effects on *total* employment of the shifts of relative demand in both countries depend on sectoral relative wages. Total employment is not affected so long as wages are equal across sectors, i.e., $Z^H = Z^F = 1$. Total employment increases if employment is allocated towards a sector with less wage pressure, and vice versa. With the demand for services (non-tradables) being more price

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[10] The government's budget restriction is given as: $t^H_{NT}P^H_\ell C^H_{NT} + t^H_T(P^H_h C^H_h + P^H_f C^H_f) = (1- N_{NT} - N_T)bW_T$. A balanced budget can always be achieved through adjustment of t^H_T or t^H_{NT}.

elastic, and hence tradable-sector workers are likely to have a wage premium, one would expect that a rise in q^H causes a decline of employment in Home and an increase in Foreign. A tax *cut* on domestic services would thus lead to an increase in total domestic employment, but the increase may come at the expense of employment abroad.

The effects of a *global* tax policy $(\theta^H = \theta^F = \theta)$ is more difficult to characterize. The effect on *p* is ambiguous, as it is generally unclear how the relative supply of domestic vs foreign tradables is affected, i.e., we cannot determine whether (26) in Figure 2 shifts up or down. The effect on *p* is zero in a symmetric world, in which case the relative supply of domestic vs foreign tradables is unaffected by the policy. In the symmetric case we can conclude that there will be a reallocation of employment towards the tradable sector in both countries; absent effects on *p*, we are left with only the *direct* effects of the policy. Lower taxes on services would thus increase total employment in both countries as long as the demand for services is more price elastic. Summarizing the results for the symmetric case we have:

Proposition 3. A global increase in relative tax pressure $(\theta^H = \theta^F = \theta)$ has no effect on *p* in a symmetric world. The policy increases N_T^H / N_{NT}^H and N_T^F / N_{NT}^F. The effects on N_{TOT}^H and N_{TOT}^F are positive (negative) if $Z^H = Z^F > 1$ $(Z^H = Z^F < 1)$.

4.2 Tax Competition vs Tax Coordination

We proceed to a characterization of non-cooperative and cooperative tax policies. The social welfare function is taken to be utilitarian and is obtained through summation of the individual indirect utility functions. Welfare for Home is then given as:

(28) $$SW^H = N_T^H \frac{W_T^H}{\tilde{P}^H} + N_{NT}^H \frac{W_{NT}^H}{\tilde{P}^H} + \left(1 - N_T^H - N_{NT}^H\right) \frac{B^H}{\tilde{P}^H} + \frac{\Pi_T^H}{\tilde{P}^H} + \frac{\Pi_{NT}^H}{\tilde{P}^H}.$$

Π_T^H and Π_{NT}^H are aggregate nominal profits in the two sectors, distributed to individuals as dividends. By using the expression for profits and the government budget restriction, we can write social welfare as $SW^H = (P_h^H C_T^H + P_h^H C_T^F + P_\ell^H C_{NT}^H) / P^H$, which corresponds to the real value of the domestic aggregate production. Moreover, by using the trade balance condition we obtain:

(28') $$SW^H = \frac{I^H}{\tilde{P}^H} - \frac{P_h^F C_T^F F^H}{\tilde{P}^H}.$$

The first term is the real income that captures the real value of aggregate domestic consumption, whereas the second term represents the waste due to transport costs. For obvious reasons there will be no waste when $F^H = 0$ and hence $\tau^H = 1$.

No transport costs

We first consider *uncoordinated* optimal tax policies in the limiting case with zero domestic transport costs, i.e., $t^H = 1$. We also assume $t^F = 1$, although this is not crucial as long as we focus on optimal policy in Home. Only the relative tax pressure influences social welfare and the relevant policy instrument is therefore q^H.[11] The specific tax rates follow residually from the optimal relative tax pressure and the government's budget constraint. The optimal relative tax pressure in Home, taking policy in Foreign as given, is given by

$$(29) \qquad q^H = \left(\frac{k_T}{k_{NT} Z^H}\right)\left(\frac{Z^H - b^H}{1 - b^H}\right)\left(\frac{1 + h^H r^H}{1 - h^H r^H a(1-a)^{-1}}\right),$$

where $h^H \equiv \partial \ln p / \partial \ln q^H < 0$ and $r^H \equiv 1/(1 + k_T p^{1-m})$. Observe that $Z^H > b^H$, and notice that $1 + h^H r^H > 0$ must hold so as to guarantee a solution with $q^H > 0$ and thus $1 + t_{NT}^H > 0$, an inequality that is required in order to have positive labor costs.[12] It follows that $\Phi^H \equiv \left[1 + h^H r^H\right] / \left[1 - h^H r^H a(1-a)^{-1}\right] < 1$.

Consider the components of the three parentheses on the right-hand-side of (29) and recall that $q^H < 1$ means that non-tradables should be taxed at a lower rate than tradables. The two first factors would be present also in a closed economy, whereas the third is a feature of the open economy environment. The factor in the first parenthesis captures the incentive to restore efficiency in the output mix. If the service sector is more price elastic, implying $s > m$ and thus $k_{NT} < k_T$, the price of tradables tends to be too high (and consumption too low) compared to the price (and consumption) of services. This calls for *higher* taxes on services and lower taxes on tradables, so as to induce an increase in the production of tradables.

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[11] See Appendix B for details on the maximization of social welfare.

[12] It can be shown that the inequality is always satisfied for the case considered here (zero transport costs). Our subsequent numerical simulations, involving also positive transport costs, have never indicated pathological cases.

The factor in the second parenthesis of (29) suggests, by contrast, that the service sector should be taxed at a *lower* rate if $s > m$. The reason is that $s > m$ implies $Z^H < 1$ absent sectoral differences in the bargaining power of unions (cf. eq. (13)). The more price elastic the demand for the product is, the more wage elastic is the demand for labor and the lower the bargained wage. From proposition (2) we know that a lower tax rate on services increases aggregate employment when $Z^H < 1$.

The third parenthesis captures the terms of trade effect: an increase in θ^H reduces *p*, which in turn reduces social welfare. Since $\Phi^H < 1$, it follows that the terms of trade effect induces the government to set *lower* taxes in the service sector than would have been chosen if p had been unaffected. By setting lower taxes on services, and higher on tradables, the country can improve its terms of trade.

Eq. (29) gives the optimal relative tax chosen by the domestic government, taking the foreign government's tax policy as given. We can thus view (29) as a reaction function, where θ^H is implicitly defined as a function of θ^F. Notice, however, that θ^F only affects θ^H through $\Phi^H(.)$, since social welfare is only affected by θ^F through *p*. The reaction function for Home can thus be written as:

(30) $$\Psi^H(.) \equiv q^H - \left(\frac{k_T}{k_{NT}Z^H}\right)\left(\frac{Z^H - b^H}{1-b^H}\right)\Phi^H(q^H, q^F) = 0 .$$

The reaction function for the foreign government can be derived in a similar fashion, yielding θ^F as a function of θ^H. The equivalent to (30) in Foreign takes the form:[13]

(31) $$\Psi^F(.) \equiv q^F - \left(\frac{k_T}{k_{NT}Z^F}\right)\left(\frac{Z^F - b^F}{1-b^F}\right)\Phi^F(q^H, q^F) = 0 .$$

The solution of the two reaction functions gives the tax structure that prevails in a Nash equilibrium.

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13 $\Phi^F \equiv \left(\frac{1-h^F r^F}{1+h^F r^F a(1-a)^{-1}}\right)$, $h^F \equiv \partial \ln p / \partial \ln q^F > 0$ and $r^F \equiv 1/\left(1 + k_T p^{m-1}\right)$.

Consider now the case where two symmetric countries *coordinate* their tax policies in order to maximize total welfare. With policy coordination it is recognized that there is no scope for welfare improvements by reducing taxes to influence the real exchange rate. The optimal θ^j is hence given by (29) with $\Phi^j = 1$, *j*=*H*, *F*, and we can conclude:

Proposition 4. The non-tradable sector is taxed too little relative to the tradable sector in a symmetric Nash equilibrium.

It is possible to solve explicitly for the optimal tax structure. The solution is particularly simple when the sectors are symmetric in the "strong" sense that $\mu = \sigma$, $\lambda_T = \lambda_{NT}$ and $\alpha = 0.5$. Uniform taxation would be optimal under policy cooperation as long as $\mu = \sigma$ and $\lambda_T = \lambda_{NT}$. The relative tax pressure in the symmetric Nash equilibrium, θ_N, is obtained as:

(32) $$\theta_N = -\frac{1}{4\mu}\left[1 - (16\mu^2 - 8\mu + 1)^{1/2}\right].$$

It is straightforward to verify that θ_N is increasing in μ. Moreover, we have $\theta_N \in (0.5,1)$ since $\mu \in (1,\infty)$. The lower μ is, the higher (in absolute value) the elasticity $(\P \ln p / \P \ln q^H)$. A low value of m means that the relative demand for tradables produced in Home is not very sensitive to changes in *p*; sizeable changes in *p* are therefore required so as to maintain equilibrium in the market for tradables when taxes are changed.

Transport costs

If transport costs are positive, we have to consider how the tax structure affects the amount of waste, i.e., the second term in (28'). A look at this term reveals that the direct effect of a higher θ^H, given *p*, is to reduce the real value of the waste. The induced reduction in *p* will, however, also affect the real value of the waste. The net effect on the waste of a lower *p* is positive because the export of tradables increases.

The fact that the waste increases with a lower *p* gives an additional incentive for the domestic government to reduce θ^H; recall that the real value of income, i.e., the first term in the welfare measure, falls with a lower *p*. It is hence tempting to believe that governments in a Nash equilibrium will chose too low levels of θ^j also when there are positive transport costs. This may, however, not be the case because there will be a direct cross-country effect from the relative tax pressure when policies are coordinated. In fact, a higher θ^F tends to increase the waste in Home by increasing the volume of exports. This relationship is ignored in a Nash equilibrium but internalized with coordinated policies. In the latter case it is recognized that a lower θ^F also reduces the waste in Home, which implies incentives to lower the relative tax pressure relative to the uncoordinated equilibrium. It is not possible to analytically determine whether or not the relative tax pressure is set too low or too high in a Nash equilibrium.

We have undertaken numerical experiments in order to shed some light on the magnitude of the spillover and welfare effects (see Table 1). The model is calibrated so as to produce an

Table 1. Welfare Effects of Coordinated Tax Policies.

	SW_N	SW_C	θ_N	θ_C	U_N	U_C	Z
$\tau^D = \tau^F = 1$ **1)**	100.00	100.03	0.952	1.000	10.00	10.00	1
$\tau^D = \tau^F = 1.5$ **1)**	100.00	100.00	1.006	1.007	10.00	10.00	1
$\tau^D = \tau^F = 1$ **2)**	100.00	100.12	0.970	1.076	9.89	10.28	0.91
$\tau^D = \tau^F = 1.5$ **2)**	100.00	100.00	1.124	1.137	10.24	10.28	0.91

Notes: SW_N and θ_N represent social welfare and the relative tax pressure in the Nash equilibria. SW_C and θ_C represent the cooperative cases. The superscripts refer to the set of parameter values used: **1)** $\alpha = 1/3$, $s = m = 10.5$, $\lambda_T^H = \lambda_{NT}^H = \lambda_T^F = \lambda_{NT}^F = b^H = b^F = 0.5$, $k_T = 1$; **2)** $\alpha = 1/3$, $\sigma = 25$, $\mu = 5.09$, $\lambda_T^H = \lambda_{NT}^H = \lambda_T^F = \lambda_{NT}^F = b^H = b^F = 0.5$, $k_T = 1$. Social welfare is normalized to 100 in the Nash cases for the two parameter sets and the two trade cost regimes. The two parameter sets generate unemployment rates of 10 percent when there are no transportation costs and the two sectors are equally taxed.

unemployment rate of 10 percent for the case with zero transport costs and symmetric sectors as well as symmetric countries.[14] It turns out that the impact on the terms of trade of changes in θ^j is small in general, which implies that sectoral employment is not substantially affected by the changes working through *p*. With very low values of μ it is possible to obtain some sizeable action in *p*, but the induced effects on relative employment is quite small even in this case. Notice also that non-tradables are taxed too little even in the presence of (large) transport costs, although the difference relative to the cooperative outcome is very small.[15] The welfare gains from coordinated tax policies

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[14] The parameters for the benchmark case with $\tau^j = 1$ are: $\alpha = 1/3, \sigma = \mu = 10.5, k_T = 1$ and $\lambda_T^H = \lambda_{NT}^H = \lambda_T^F = \lambda_{NT}^F = b^H = b^F = 0.5$.

[15] Transport costs are rather extreme in these examples, as $t^j = 1.5$ would imply transport costs corresponding to one third of the value of exports. The empirical studies suggest much smaller costs for freight and insurance (see

appear also to be very small. These basic results are quite robust for alternative plausible parameter values.

5. Concluding Remarks

The European Union has recently proposed sectoral tax differentiation as a policy to fight unemployment. The member countries are allowed to reduce the VAT rates on goods and services that are particularly labor intensive and price elastic. Our paper has provided a theoretical analysis of the effects of such tax reforms, with particular emphasis on the international repercussions of the policies. To that end we have developed a two-country and two-sector model with monopolistic competition in the goods markets and wage bargaining in the labor markets. The terms of trade is endogenously determined in the model and unemployment prevails in general equilibrium.

We have found that a reduction in the tax rate on more price elastic goods in one country (Home) most likely reduces unemployment in that country, but probably raises unemployment in the other country (Foreign). The reason is that the policy induces a reallocation of workers in Home towards the sector where unions and firms have less market power – the service sector – whereas the reallocation has the opposite direction in Foreign. The reallocation of workers in Foreign is driven by changes in the terms of trade: the decline in the supply of tradables produced in Home causes a terms of trade improvement for Home but a terms of trade deterioration for Foreign. Increased employment in one country may thus come at the expense of reduced employment in other countries. However, a coordinated reduction in the tax rate on relatively price elastic goods will reduce unemployment in both countries, at least as long as the countries are symmetric (in which case there will be no effect on the terms of trade).

We have also explored the welfare implications of national and supranational tax policies and found that each country, acting on its own, tends to set the tax rate on services too low relative to what a coordinated policy would imply. The reason is that each country attempts to use tax differentiation as a means to improve its terms of trade. This also implies that the employment objectives pursued under non-cooperative policies will be too ambitious relative to the cooperative welfare maximum.

Rauch 1999). The total costs of trade across country borders should, however, also include other elements, such as differences in culture, language, lack of direct contact etc. These other elements are not easily estimated.

Although the presence of policy externalities provides a case for policy coordination, our numerical calibrations suggest that the gains from coordinated tax policies are small. Of course, these simulations are mainly illustrative, and the model is fairly specific, but they do give pause to proposals to impose supranational restrictions on sectoral differentiation of value added taxes.

Our analysis has taken the number of firms in each country as exogenously fixed. An interesting but nontrivial extension would be to allow for free entry and an endogenous determination of the number of product varieties. We also believe that our framework can be used to shed light on issues in trade policy. Indeed, our measure of waste due to trade can be reinterpreted as export taxes and it is possible to derive optimal export taxes (or subsidies) with and without policy cooperation. These and other extensions are left for future work.

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Appendix A

The Labour Market[16]

The indirect utility function for the worker is given as $\Lambda_i^* = I_i / \tilde{P}^H$. Define V_h, V_h^* as the expected lifetime utility of a worker employed in a particular firm h, and an arbitrary firm, in the tradable sector; V_ℓ, V_ℓ^* as the expected lifetime utility of a worker employed in a particular firm, and an arbitrary firm, in the non-tradable sector; and V_u as the expected lifetime utility of an unemployed individual. Assuming an infinite time horizon we can write the value functions as:[17]

(A1)
$$
\begin{aligned}
rV_h &= \frac{W_h + p}{\tilde{P}^H} + q_T\left(V_u - V_h\right), \\
rV_\ell &= \frac{W_\ell + p}{\tilde{P}^H} + q_{NT}\left(V_u - V_\ell\right), \\
rV_u &= \frac{B + p}{\tilde{P}^H} + a_T\left(V_h^* - V_u\right) + a_{NT}\left(V_\ell^* - V_u\right).
\end{aligned}
$$

r is the discount rate and q_i is the exogenous probability that a worker is separated from his job in sector i, i=T, NT. The probability of leaving unemployment for employment in sector i is denoted a_i. The workers have no sector-specific skills and move between firms through a spell of unemployment. On-the-job search and job-to-job mobility are ruled out by assumption.

From (A1) we can derive expressions for the utility differences between employment and unemployment:

(A2)
$$
\begin{aligned}
V_h - V_u &= \frac{1}{q_T + r}\left(\frac{W_h + \pi}{\tilde{P}^H} - rV_u\right), \\
V_\ell - V_u &= \frac{1}{q_{NT} + r}\left(\frac{W_\ell + \pi}{\tilde{P}^H} - rV_u\right)
\end{aligned}
$$

rV_u is common for all workers since their labour market histories are irrelevant for the job-finding probabilities. Flow equilibrium requires equality between the inflow and outflow of workers to and from a sector. This implies $q_T N_T^H = a_T U^H$ for the tradable sector and $q_{NT} N_{NT}^H = a_{NT} U^H$ for the non-tradable sector. Wages are set equal across bargaining units in each sector in a symmetric

[16] The model of the labour market draws on Holmlund (1997) and Kolm (1998).

[17] The value functions in (A1) are consistent with a continuous time formulation where q_i and a_i are interpreted as transition rates.

equilibrium, i.e., $W_h = W_T^H$ and $W_\ell = W_{NT}^H$. In a symmetric equilibrium, outside opportunities are given by a probability-weighted average of the utilities in the different states. For simplicity, we focus on the case when the discount rate approaches zero. Using the flow equilibrium constraints as well as the labour force identity, $1 = N_T^H + N_{NT}^H + U^H$, we can write the flow value of unemployment, net of dividends, as:

$$\text{(A3)} \qquad \overline{V}^H \equiv rV_u - \pi / \tilde{P}^H = N_T^H \frac{W_T^H}{\tilde{P}^H} + N_{NT}^H \frac{W_{NT}^H}{\tilde{P}^H} + U^H \frac{B^H}{\tilde{P}^H}.$$

Note that non-labor income, $\pi / \tilde{P}^H$, does not affect the utility difference between employment and unemployment since it is state independent.

Appendix B

Maximization of Social Welfare

Social welfare is given as

$$\text{(B1)} \qquad SW^H = \frac{I^H}{\tilde{P}^H} - \frac{P_h^F C_T^F F^H}{\tilde{P}^H},$$

where the general consumer price index is: $\tilde{P}^H = \left(\tilde{P}_T^H\right)^{\alpha}\left(\tilde{P}_{NT}^H\right)^{1-\alpha}$. By substituting the sectoral consumer prices, $\tilde{P}_T^H$ and $\tilde{P}_{NT}^H$, into this index and making use of the price-setting rules as well as eqs. (20) and (21), we can write the consumer price index as

$$\text{(B2)} \qquad \tilde{P}^H = I^H \cdot \left(d^H \left(q^H\right)^a N_{NT}^H \left(q^H\right) \left[1 + k_T^{-1}\left(p\left(q^H, q^F\right)\right)^{m-1}\left(t^F\right)^{1-m}\right]^{a/(m-1)} \right)^{-1},$$

where $d^H \equiv \left(Z^H\right)^a \left(K_T^H\right)^{\frac{a}{m-1}} \left(K_{NT}^H\right)^{\frac{1-a}{s-1}} k_T^{-a} k_{NT}^{a} (1-a)^{-1}$. With zero domestic transport costs ($F^H = 0$), the social welfare function thus takes the form:

$$\text{(B3)} \qquad SW^H = d^H \left(q^H\right)^a N_{NT}^H \left(q^H\right) \left[1 + k_T^{-1}\left(p\left(q^H, q^F\right)\right)^{m-1}\left(t^F\right)^{1-m}\right]^{a/(m-1)}.$$

$N_{NT}^{H}\left(\theta^{H}\right)$ can be derived from (18)-(23) and is given as

(B4) $$N_{NT}^{H}\left(\theta^{H}\right)=\frac{\psi^{H}}{A\theta^{H}Z^{H}+(Z^{H}-b^{H})(1-b^{H})^{-1}},$$

where $\psi^{H}\equiv 1-\left[\lambda_{T}^{H}/(\lambda_{T}^{H}+\mu-1)\right](1-b^{H})^{-1}$. The terms of trade is obtained as a function of relative tax pressure, $p=p(\theta^{H},\theta^{F})$, by means of eq. (27). Domestic social welfare is hence affected by θ^{H} directly as well as through p. However, recall that p does not appear as an argument in N_{NT}^{H} when $\tau^{H}=1$. However, when $\tau^{H}>1$, we have $N_{NT}^{H}=N_{NT}^{H}\left(\theta^{H},p\left(\theta^{H},\theta^{F}\right)\right)$.