

# Wage Subsidies and International Trade: When Does Policy Coordination Pay?

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**Abstract** National labour market institutions interact across national boundaries when product markets are global. Labour market policies can thus entail spill-overs, which suggest that there are benefits from international policy coordination. This paper studies the effects of wage subsidies in an international duopoly model with unionized labour markets. The authors document both positive and negative spill-over effects and discuss the benefits and costs from international policy coordination both for the case of symmetric and asymmetric labour market institutions. The results suggest that institutional differences could sign responsible for the slow speed at which labour market policy coordination has progressed so far.

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## 1 Introduction

National labour markets interact across national boundaries when product markets are global. Labour market policies can then have spill-over effects, which suggests that there are benefits from international policy coordination. Surprisingly, the academic literature has widely neglected the benefits (and potential costs) of coordinating national labour market policies.<sup>1</sup> Our paper contributes to fill this gap. We study the effects of wage subsidies in an international duopoly model with unionised labour markets and discuss the costs and benefits from policy coordination both for the case of symmetric and asymmetric labour market institutions.

In the international policy arena, attempts have been made to coordinate policy making in many areas such as monetary policy, competition policy or product standards. Labour market policies, in contrast, remain mostly in national hands. The European Union (EU) is both a prime candidate for coordinative action and an example for the slow progress labour market policy coordination has made so far. In fact, the Amsterdam Treaty of 1997 asks all member states to treat employment ‘as a matter of common concern and [to] coordinate their action’ (European Union, 1997). Against this background the European Employment Strategy (EES) provides a mechanism to coordinate employment policies among member states. In its practical implementation, the EES follows an open method of coordination under which member states mutually agree on common policy targets but national governments design and implement appropriate policies to reach these targets.<sup>2</sup> The interpretation of labour market policy coordination within the EU remains therefore much weaker than in other policy areas.<sup>3</sup> Still, van Vliet and Koster (2011) argue that this soft way of EU coordination has led to a general shift from passive to active labour market policies.

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<sup>1</sup> In fact, there does exist a growing literature on the interaction of national labour institutions in a global world economy (see Davis, 1998; Helpman and Itskhoki, 2010, for two prominent examples). However, this strand of the literature generally assumes that national labour market institutions are exogenously given and does not consider the issue of international policy coordination. In contrast, we focus on optimal labour market policies that are set by welfare maximising governments.

<sup>2</sup> For a more detailed discussion of the open method of coordination see Heidenreich and Bischoff (2008).

<sup>3</sup> One exception is the ‘European Globalisation Adjustment Fund’ that finances active labour market policies for workers who have been made redundant as a result of the globalisation process.

Our analysis focuses on a specific active labour market intervention, namely wage subsidies. Such subsidies are an increasingly popular policy tool in many industrialised countries.<sup>4</sup> We construct a simple and highly tractable two-country trade model where product markets are linked through costly intra-industry trade.<sup>5</sup> Each country hosts one firm that produces a horizontally differentiated good. In our model setup, imperfections in both the labour and the product market provide a rationale for subsidising wages. Labour markets are unionised and thus the prevailing wage rate is above its market-clearing level. In addition, governments pay unemployment benefits that increase the outside option of unions in the wage bargain. Finally, high entry barriers lead to imperfect competition in the product market and thus to inefficiently low levels of production and employment. Wage subsidies respond to these market imperfections by driving a wedge between the wage received by workers and the labour costs paid by firms. Such a policy reduces production costs and fosters labour demand without creating working poverty (Orszag and Snower, 2003).

Even though rigid labour market institutions lead to inefficiently high unemployment, they are often politically infeasible to relax quickly (Saint-Paul, 2000). Since these institutions have emerged over years of bargaining between interest groups and governments, they can usually be changed only gradually and with considerable delay. To make our analysis especially relevant to policy makers, we therefore take the imperfections in the labour (and product) markets as given and examine the best policy response with these imperfections in place. In our model policymaker set wage subsidies so as to maximise welfare (subject to a budget constraint). Governments can either set wage subsidies unilaterally or coordinate their policies to maximise joint welfare. For most parts of the paper we consider a

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<sup>4</sup> Wage subsidies have been implemented in a number of countries, e.g. in Germany (Kombi-Lohn), Great Britain (Working Families Tax Credit) and the United States (Earned Income Tax Credit, EITC). It has been argued that, whereas traditional unemployment benefit systems increase the moral hazard problem and may prolong unemployment spells (see, e.g., Krueger and Mueller, 2010, for recent evidence), active labour market policies may be able to increase job-search incentives of the unemployed (see, e.g., Layard et al., 2005).

<sup>5</sup> Intra-industry trade accounts for a large and growing share of trade among industrialised countries, which are the focus of our analysis. Our basic model setup goes back to the work of Brander (1981). He shows in an international duopoly model that firms' incentives to capture foreign monopoly rents can explain intra-industry trade in identical products.

specific (and particularly popular) form of policy coordination where governments harmonise their policies and choose a common subsidy level. We then relax this assumption and allow for cooperating governments to agree on country-specific subsidy policies.

Even in our simple model wage subsidies paid to domestic producers have a wide range of effects – in both the domestic and the foreign country. First, wage subsidies increase domestic wages and employment but decrease them abroad. Second, wage subsidies increase profits of the domestic firm but decrease profits abroad. Third, wage subsidies reduce consumer prices and thus increase consumer surplus at home and abroad. The relative strength of these effects is determined by the degree of product differentiation. If, for instance, the two firms produce close substitutes, wage subsidies will have a stronger (negative) spill-over effect on foreign employment, wages and profits.

National governments ignore the spill-over effects of wage subsidies when they decide unilaterally about the optimal subsidy levels. With symmetric labour markets international policy coordination then always increases welfare in both countries. With asymmetric labour markets, however, cross-border policy harmonisation entails costs. In particular, cooperating governments restrict their capability to account for the national features of their countries' institutions. Even more, with asymmetric labour market institutions costs and benefits of policy harmonisation are unevenly distributed among trading partners. In fact, a common subsidy level can benefit one country at the expense of the other. Policy harmonisation can hence be difficult to enforce politically – even if it increases aggregate welfare. Our analysis thus provides a rationale for why labour market policies are still mostly in national hands although cooperation might be beneficial from a bird's eye perspective.

As an extension, we analyse the optimal cooperative policy and allow cooperating governments to choose country-specific subsidy levels. Since policy-makers then have two instruments at hand, aggregate welfare must be at least as high as if a common subsidy level were chosen. Nevertheless, a country on its own might still prefer the (globally sub-optimal) harmonisation policy. So even if policy cooperation could indeed be designed optimally in the real world, countries can still disagree about which policy to implement.

**Related Literature.** The academic literature has discussed strategic interactions between governments and the resulting benefits from coordination with respect to a wide range of policy issues such as capital taxation, environmental regulations, and labour standards – but has widely neglected labour market policies.

As an exception, Franzese and Hays (2006) provide evidence for the European Union that an increase in expenditure on labour market training programmes in one country decreases spending by its neighbours. They argue (without a formal model) that their results could be explained by agglomeration effects along European border regions. For instance, effective training policies in the French border region to Belgium may attract Belgian workers and could enhance the pool of workers available for both Belgian and French employers. Labour market training then entails positive externalities and provides incentives for (neighbouring) countries to free-ride on them. In contrast, policy spill-overs in our model arise through product market linkages and thus even in the absence of cross-border labour movements.<sup>6</sup> Moreover, we demonstrate that the existence of spill-over effects does not necessarily justify (any form of) policy coordination, let alone make coordination politically enforceable.

More closely related to our work is a recent paper by Felbermayr et al. (2012a). The authors study endogenous unemployment benefits (rather than wage subsidies as we do) in a two-country asymmetric trade model with heterogeneous firms and search frictions on the labor market. They show that more open economies can spill over a larger fraction of the costs associated with higher unemployment benefits to their trading partner and thus tend to have more generous unemployment benefits. In their setting, non-cooperatively set unemployment benefits are inefficiently high. In related work, Felbermayr et al. (2012b) provide empirical evidence from a panel of OECD countries that foreign labour market institutions matter for domestic labour market outcomes. In particular, they find a strong positive correlation between unemployment rates of countries. In the theoretical part of their paper, they explain their finding with an income effect: Rigid labour market institutions at home increase domestic unemployment. Higher unemployment reduces domestic

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<sup>6</sup> Beyond doubt, in case of the European Union the free movement of labour can induce further spill-over effects not captured in our model. However, even within the EU labour mobility is still comparably low (see Zaiceva and Zimmermann, 2008).

income and, thus, domestic spending on foreign goods. This drives up foreign unemployment. Empirical support for spill-over effects of labor market institutions is also provided by Boulhol (2008).

More generally, our work is related to the strategic trade literature as pioneered by Brander and Spencer (1984) and Brander and Spencer (1985).<sup>7</sup> It is worth noting that in these models wage subsidies will have effects similar to a general production subsidy to domestic firms if labour is the only input in production. More recently, models of international oligopoly have also been used to analyse the choice of the international commodity tax base (see, e.g., Haufler et al., 2005 and Haufler and Pflüger, 2007). A negative commodity tax collected under the origin principle (where taxes are collected in the country of production) will effectively be identical to a wage subsidy if labour is the only production factor. In fact, both wage subsidies and commodity taxes drive a wedge between the wage rate and the labour costs faced by firms.

Despite these strong analogies between wage subsidies on the one hand and production subsidies and commodity taxes on the other hand, our analysis differs in three important aspects from the classical strategic trade literature. First, we analyse wage subsidies in an international duopoly model with unionised labour markets along the lines of Naylor (1998).<sup>8</sup> Since labour market imperfections are the prime motive for active labour market policies, the question at hand can only be tackled by modelling them explicitly. Second, in our model both wages and employment are endogenous and labour income enters the welfare function that is maximised by governments. The strategic trade literature, in contrast, typically abstracts from labour income effects and considers changes in profit income and government revenues only.<sup>9</sup> Third, we consider cross-country differences in national labour market institutions, namely differences in the generosity of national unemployment

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<sup>7</sup> The basic structure of the underlying ‘reciprocal dumping model’ is described in Brander (1981).

<sup>8</sup> Naylor (1998) does not study government interventions. Recently, Moriconi and Sato (2009) have analysed the effects of commodity taxation in a model with downward wage rigidity. However, their work assumes perfect competition in the product market and abstracts from cross-country differences in the labour market.

<sup>9</sup> If labour is an input in production, its wage is usually tied down in the numeraire good sector. With perfectly competitive factor markets, and thus with full employment, labour income is then by assumption not affected by policy.

benefits. Such differences turn out to be crucial for the costs and benefits from policy coordination.

The remainder of the paper is organised as follows. The basic model setting is presented in the next section. Sections 3.1 and 3.2 analyse the optimal responses of firms and trade unions, respectively, to given subsidy policies. Section 4 derives and compares the optimal welfare maximising subsidy levels under both policy competition and coordination. The section also distinguishes between symmetric and asymmetric labour market institutions. Section 5 discusses extensions of our benchmark model. Finally, Section 6 offers some concluding remarks.

## 2 The Model

There are two countries, Home (H) and Foreign (F), where variables referring to the latter are marked by an asterisk (\*). Each country is endowed with a continuum of immobile consumers of unit measure 1. Utility of consumers is a quasilinear function of a numeraire good  $m$  and the two differentiated products  $X$  and  $Y$ .<sup>10</sup>

$$U(x, y, m) = a(x + y) - \frac{1}{2}(x^2 + y^2 + 2exy) + m, \quad (1)$$

$$U^*(x^*, y^*, m^*) = a(x^* + y^*) - \frac{1}{2}((x^*)^2 + (y^*)^2 + 2ex^*y^*) + m^*, \quad (2)$$

where  $x$  and  $y$  denote consumption of good  $X$  and  $Y$ , respectively. The parameter  $a$  determines the substitution pattern between the two differentiated products and the numeraire: an increase in  $a$  boosts demand for the differentiated varieties relative to the numeraire. The parameter  $e \in [0, 1]$  is an inverse measure of the degree of product differentiation between  $X$  and  $Y$ . The higher  $e$  is, the closer substitutes the

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<sup>10</sup> Quasi-linear preferences give rise to linear demand functions and are thus widely used in international duopoly models with unionised labour markets (see, e.g., Naylor, 1998). The downside of quasi-linear preferences is that all income effects are swept up by the numeraire good. Therefore, demand for the differentiated products is independent of aggregate income (see Equations 6 and 7). A relevant path for further research is thus the integration of the model into a framework of General Oligopolistic Equilibrium as proposed by Neary (2002, 2003). In such a framework, wage subsidies could also affect aggregate employment through changes in net labour income (and not only by reducing labour costs).

two varieties are. As  $e$  approaches 1, varieties become perfect substitutes, while they are completely unrelated for  $e = 0$ . Production of the differentiated goods  $X$  and  $Y$  is country-specific. Good  $X$  is produced by firm 1, which is located in Home, while good  $Y$  is produced by the foreign-based firm 2.

Each consumer supplies inelastically one unit of labour to the differentiated good sector,<sup>11</sup> is endowed with  $Z$  units of the numeraire good (which describes the individual endowment of non-labour assets), and may also receive an identical share of profit income.<sup>12</sup> Since a country-specific trade union raises wages above the market clearing wage in each country, labour markets do not clear and workers can either be employed or unemployed. Employed workers (marked with the subscript  $EM$ ) earn a wage  $w$ , while unemployed workers ( $UN$ ) receive unemployment benefits of size  $b$ . Denoting profits by  $\Pi$  and also allowing for the possibility of lump-sum taxes  $h$ , the per-capita income of a type  $i$  worker ( $i = EM, UN$ ) can be written as:

$$I_{EM} = w + \Pi + Z - h, \quad I_{UN} = b + \Pi + Z - h, \quad (3)$$

$$I_{EM}^* = w^* + \Pi^* + Z^* - h^*, \quad I_{UN}^* = b^* + \Pi^* + Z^* - h^*. \quad (4)$$

Consumers spend their income on consumption of the differentiated varieties  $x$  and  $y$  and the numeraire good  $m$ . The budget constraint of a type  $i$  worker in Home and Foreign can then be written as:

$$I_i = p_x x + p_y y + m_i, \quad I_i^* = p_x^* x^* + p_y^* y^* + m_i^*, \quad (5)$$

where  $p_x$  and  $p_y$  are the prices of good  $X$  and  $Y$  at home.

Utility maximisation yields the following linear demand functions for the differentiated goods:

$$p_x = a - (x + ey), \quad p_y = a - (ex + y), \quad (6)$$

$$p_x^* = a - (x^* + ey^*), \quad p_y^* = a - (ex^* + y^*). \quad (7)$$

<sup>11</sup> As in e.g. Moriconi and Sato (2009) we assume that the numeraire is not produced using labor. Alternatively, one may think of workers being tied to the differentiated good sector due to e.g. sector-specific human capital.

<sup>12</sup> We thus assume that workers own firms. The assumption ensures that national welfare, defined as the (indirect) utility of the average worker, also includes profit income (see Equations 12 and 13).



On the supply side, the two firms are assumed to compete as Cournot duopolists in segmented markets. Firms incur symmetric trading costs of  $t$  per unit of exports. Trading costs are exogenously given and should reflect a wide range of costs, including, for instance, transportation expenditures or costs of border formalities. Since we focus on trade between industrialised countries – and in particular on intra-EU trade – we assume that the two countries do not impose any revenue-generating tariffs.

In order to produce one unit of the good each firm has to employ one unit of labour. The governments of Home and Foreign pay a wage subsidy to their domestic firm of size  $s$  and  $s^*$ , respectively, per unit of labour employed.<sup>13</sup> Unit production costs of firm 1 and 2 are thus given by  $w - s$  and  $w^* - s^*$  and profits of the two firms read:

$$\Pi = (p_x - w + s)x + (p_x^* - w + s - t)x^*, \quad (8)$$

$$\Pi^* = (p_y^* - w^* + s^*)y^* + (p_y - w^* + s^* - t)y. \quad (9)$$

Firms choose their level of production for the two markets so as to maximise profits. In doing so, they take the output choices of their competitors as given.

Following Naylor (1998), wage rates in both countries are set by a country-specific monopoly union that represents all the workers employed by the respective firm. Unions maximise insider rents  $\Omega$  taking the unemployment benefit received by an unemployed worker as the outside option:

$$\Omega = (w - b)L, \quad \Omega^* = (w^* - b^*)L^*, \quad (10)$$

where  $L = x + x^*$  and  $L^* = y + y^*$  are the employment levels of firm 1 and 2, respectively. We assume that unions do not collude but set the optimal wage rate taking the other union's wage demand as given. Firms retain their right-to-manage and can choose their respective employment levels.

Governments in the two countries finance wage subsidies  $sL$  and unemployment benefits  $(1 - L)b$  by levying a lump-sum tax  $h$  on its population. The respective budget constraints therefore read:

$$h = sL + b(1 - L), \quad h^* = s^*L^* + b^*(1 - L^*). \quad (11)$$

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<sup>13</sup> As the model features only one factor of production, wage subsidies are identical to production subsidies.

Policy makers take the imperfections in the labour (and product) markets as given and implement the best policy response with these imperfections in place. In particular, due to political constraints policy makers take the country-specific levels of unemployment benefits ( $b$  and  $b^*$ ) as given and set wage subsidies in order to maximise welfare<sup>14</sup> subject to the budget constraint.<sup>15</sup> It is important to note that in our simple model framework, unemployment benefits are purely distortionary and do not fulfill any economic purpose (so that the first-best solution is  $b = 0$ ).<sup>16</sup>

National welfare  $W$  is defined as the weighted average of (indirect) utilities of employed and unemployed workers, respectively:

$$\begin{aligned} W &= LU(x, y, m_{EM}) + (1 - L)U(x, y, m_{UN}) \\ &= \frac{x^2 + y^2}{2} + exy + \Pi + Lw + (1 - L)b - h + Z, \end{aligned} \quad (12)$$

$$\begin{aligned} W^* &= L^*U^*(x^*, y^*, m_{EM}^*) + (1 - L^*)U^*(x^*, y^*, m_{UN}^*) \\ &= \frac{(x^*)^2 + (y^*)^2}{2} + ex^*y^* + \Pi^* + L^*w^* + (1 - L^*)b^* - h^* + Z^*. \end{aligned} \quad (13)$$

Notice that welfare can also be interpreted as the expected utility of a worker before her employment status is determined. Welfare increases with consumer surplus (as given by the first two terms in Equations 12 and 13) and with the net income received by an average worker. Governments can either set wage subsidies unilaterally (taking the policy of the trading partner as given) or coordinate their policies to maximise joint welfare. We first assume that cooperating governments

<sup>14</sup> In the extended working paper version (Braun and Spielmann, 2010), we additionally analyse governments that target employment rather than welfare. We demonstrate that under an employment target governments only account for a subset of the subsidy effects identified in Section 4. In particular, governments do not account for the positive effect of wage subsidies on consumer surplus and thus set subsidy levels that are too low from a welfare perspective.

<sup>15</sup> As it turns out, welfare in the model depends on the difference between subsidy level and unemployment benefit. Governments thus implicitly choose the optimal difference  $s - b$  taking  $b$  as given. If, instead, governments could choose both  $s$  and  $b$ , the equilibrium values of  $s$  and  $b$  would be indeterminate because the optimal  $s - b$  could be reached by an infinite number of combinations of  $s$  and  $b$ .

<sup>16</sup> This is due to the fact that agents are risk-neutral and all income effects fall on the numeraire good, so that individuals have constant marginal utility of consumption.

harmonise wage subsidies to a common level. In Section 5, however, we then relax this assumption and discuss an optimal cooperation policy.

We consider a game of perfect information with the following timing of events:

1. The two governments set (non-cooperatively or cooperatively) the level of wage subsidies in the two countries.
2. Each union chooses a wage rate.
3. Each firm chooses its output (and thus employment) levels for the two product markets (home and abroad).

The game is solved by backward induction starting with the last stage of the decision making process.

### 3 Production and Wage Bargaining Stages

Before we derive the welfare maximising subsidies under the different policy regimes, we first describe the production and bargaining stage in detail and discuss the optimal behaviour of firms and unions for given subsidy levels.

#### 3.1 Production Stage

Each firm maximises profits by choosing the quantity of goods produced for the domestic and the foreign market. Throughout the paper we assume the parameter  $a$  to be large enough relative to trading costs  $t$  for two-way intra-industry trade to occur in equilibrium. By solving the first-order conditions, we obtain:

$$x = \frac{a - w + s}{2} - \frac{ey}{2}, \quad x^* = \frac{a - w + s - t}{2} - \frac{ey^*}{2}, \quad (14)$$

$$y = \frac{a - w^* + s^* - t}{2} - \frac{ex}{2}, \quad y^* = \frac{a - w^* + s^*}{2} - \frac{ex^*}{2}. \quad (15)$$

Equations (14) and (15) are the output reaction functions of the respective firm given the output choices of its competitor, the firm-specific union wage, and the

wage subsidy paid by the government. Solving the system of equation yields the optimal production quantities:

$$x = \frac{(2-e)a - 2(w-s) + e(w^* - s^*) + et}{4 - e^2}, \quad (16)$$

$$x^* = \frac{(2-e)a - 2(w-s) + e(w^* - s^*) - 2t}{4 - e^2}, \quad (17)$$

$$y = \frac{(2-e)a - 2(w^* - s^*) + e(w-s) - 2t}{4 - e^2}, \quad (18)$$

$$y^* = \frac{(2-e)a - 2(w^* - s^*) + e(w-s) + et}{4 - e^2}. \quad (19)$$

Given the linear production technology, total employment of firm 1 and 2, respectively, can then be written as:

$$L = x + x^* = \frac{(2-e)(2a-t) - 4(w-s) + 2e(w^* - s^*)}{4 - e^2}, \quad (20)$$

$$L^* = y + y^* = \frac{(2-e)(2a-t) - 4(w^* - s^*) + 2e(w-s)}{4 - e^2}. \quad (21)$$

Employment is therefore decreasing in a firm's own net production costs but increasing in the production costs of its competitor.

### 3.2 Wage Bargaining Stage

When setting the wage rate, each trade union faces a trade off between wages and employment. The first-order conditions for optimal wage-setting read:

$$w = \frac{\varepsilon_w}{\varepsilon_w - 1} b, \quad w^* = \frac{\varepsilon_w^*}{\varepsilon_w^* - 1} b^*, \quad (22)$$

where  $\varepsilon_w \equiv -\frac{\partial L}{\partial w} \frac{w}{L}$  and  $\varepsilon_w^* \equiv -\frac{\partial L^*}{\partial w^*} \frac{w^*}{L^*}$  are the relevant wage elasticities of labour demand. The wage is thus set as a mark-up over unemployment benefits, where the mark-up depends on the elasticity of labour demand. The more inelastic labour demand is, the higher the wage rate chosen by a union is. Using the expressions

for employment in (20) and (21), we obtain the following first order conditions:

$$w = \frac{b}{2} + \frac{(2-e)(2a-t) + 4s + 2e(w^* - s^*)}{8}, \quad (23)$$

$$w^* = \frac{b^*}{2} + \frac{(2-e)(2a-t) + 4s^* + 2e(w - s)}{8}. \quad (24)$$

Equations (23) and (24) can be interpreted as the optimal response of each union to the wage set by the competing union and the subsidies paid by each government. Solving the system of equations yields:

$$w = \frac{8b + 2eb^* + \frac{1}{2}(4+e)(2-e)(2a-t) + (8-e^2)s - 2es^*}{16-e^2}, \quad (25)$$

$$w^* = \frac{8b^* + 2eb + \frac{1}{2}(4+e)(2-e)(2a-t) + (8-e^2)s^* - 2es}{16-e^2}. \quad (26)$$

The domestic wage rate thus increases in both the domestic and the foreign unemployment benefits as well as in the subsidy paid by the domestic government. In contrast, domestic wages decrease in the subsidy paid to the foreign firm. The latter finding is due to the fact that foreign wage subsidies, by decreasing production and thus employment of the domestic firm, increase the wage elasticity of labour demand. Domestic subsidies, in contrast, increase the domestic wage by increasing employment and thus by reducing the (domestic) labour demand elasticity.

#### 4 Non-cooperative vs. Harmonized Wage Subsidies

At the first stage of the model, governments choose the welfare-maximising subsidy levels taking into account the optimal response of unions and firms. Governments can either set their own (national) wage subsidies unilaterally to maximise national welfare or they can choose to cooperate and maximise joint welfare. Cooperating governments are assumed to harmonise their subsidy policies. We first analyse the case of symmetric labour markets and then allow for cross-country differences in the unemployment benefit systems.<sup>17</sup> As an extension, Section 5 considers *optimal* cooperative wage subsidies.

<sup>17</sup> Cross-country differences in unemployment benefits are not only widespread in reality (OECD, 2011), they also serve well to illustrate the general problems associated with policy harmonisation in

#### 4.1 Symmetric Labour Markets

In the case of symmetric labour markets both countries pay the same level of unemployment benefits  $b = b^*$  per unemployed worker. Given the symmetry of the model, in this subsection we shall only present equations for Home. Analogous equations exist for Foreign as well.

In our model utility is derived from the consumption of the differentiated goods  $X, Y$  and the numeraire good  $m$ . The latter in turn depends on income net off taxes and net off consumption expenditures for  $X$  and  $Y$ . Before proceeding, it is useful to reformulate the social welfare function in (12) in the following way:

$$\begin{aligned}
 W &= \underbrace{1/2(x^2 + y^2) + exy}_{\text{Consumer Surplus}} + \underbrace{\Pi + (x + x^*)w + (1 - x - x^*)b + Z}_{\text{Gross Income}} \\
 &\quad - \underbrace{s(x + x^*) - b(1 - x - x^*)}_{\text{Taxes}} \\
 &= \underbrace{1/2(x^2 + y^2) + exy}_{\text{Consumer Surplus (CS)}} + \underbrace{\overbrace{(x + x^*)w}^{LI} - \overbrace{(x + x^*)s}^{GS}}_{\text{Net Income}} + Z \\
 &\equiv CS + \Pi + LI - GS + Z. \tag{27}
 \end{aligned}$$

Welfare thus increases with consumer surplus ( $CS$ ), producer surplus ( $\Pi$ ) and labour income of the employed ( $LI$ ), but decreases with government spending on wage subsidies ( $GS$ ). Note that government spending on unemployment benefits,  $(1 - x - x^*)b$ , cancels out, because it increases both the lump-sum tax and the income received by the average worker in equal amounts.

**Decomposing the Effects of Wage Subsidies.** Before calculating the optimal subsidy levels with and without policy cooperation, we consider the various effects a wage subsidy has on welfare at home and abroad. Differentiating welfare in Home with respect to the domestic subsidy  $s$  yields:

$$\frac{\partial W}{\partial s} = \frac{\partial CS}{\partial s} + \frac{\partial \Pi}{\partial s} + \frac{\partial LI}{\partial s} - \frac{\partial GS}{\partial s}. \tag{28}$$

the presence of idiosyncratic institutional features. An interesting extension could consider the case where one country has a unionised and the other a perfectly competitive labour market.

Taking a closer look at the different elements of Equation (28), we first of all see that a higher wage subsidy increases domestic consumer surplus by reducing market prices and alleviating the under-provision problem created by product market imperfections:

$$\begin{aligned} \frac{\partial CS}{\partial s} &= x \left( \frac{\partial x}{\partial s} + e \frac{\partial y}{\partial s} \right) + y \left( \frac{\partial y}{\partial s} + e \frac{\partial x}{\partial s} \right) \\ &= \frac{(16 - 6e^2)x + (12e - 2e^3)y}{64 - 20e^2 + e^4} > 0. \end{aligned} \quad (29)$$

Notice that the positive effect of an increase in  $s$  on consumer surplus increases with  $x$  and  $y$ . A consumer gains more from a given reduction in prices the higher her consumption level is.

Secondly, higher domestic wage subsidies increase the profit level of the domestic firm:

$$\frac{\partial \Pi}{\partial s} = \frac{4(8 - e^2)(x + x^*)}{64 - 20e^2 + e^4} > 0. \quad (30)$$

Wage subsidies drive a wedge between the wage rate and per-unit labour costs and thus reduce marginal production costs. The firm benefits more from a given reduction in its marginal costs, when production  $x + x^*$  is large.

Thirdly, wage subsidies also increase total labour income, as given by the product of wages and employment:

$$\begin{aligned} \frac{\partial LI}{\partial s} &= (x + x^*) \frac{\partial w}{\partial s} + w \frac{\partial (x + x^*)}{\partial s} \\ &= \frac{(x + x^*)(8 - e^2)}{16 - e^2} + \frac{4w(8 - e^2)}{64 - 20e^2 + e^4} > 0. \end{aligned} \quad (31)$$

In particular, firms respond to lower labour costs by expanding production and thus employment. Moreover, higher levels of employment induce unions to demand higher wages (which somewhat dampens the positive employment effect). The effect of  $s$  on labour income increases with both the level of employment and the wage rate. The positive wage effect will apply to a larger number of workers if employment is already high. Likewise, a given increase in employment will have larger income effects if wages are high.

Taken together, wage subsidies do not only increase employment but also boost consumer surplus, profits and wages. The welfare costs for the home economy come in terms of higher government spending on wage subsidies (recall that spending on unemployment benefits cancels out in (27)):

$$\begin{aligned}\frac{\partial GS}{\partial s} &= s \frac{\partial(x+x^*)}{\partial s} + (x+x^*) \\ &= \frac{4s(8-e^2)}{64-20e^2+e^4} + (x+x^*) > 0.\end{aligned}\quad (32)$$

The first term on the right-hand side of Equation (32) represents additional expenditures for those workers that would have been unemployed without the marginal increase in  $s$ . Moreover, the state also has to pay higher subsidies for those already employed. This effect, reflected by the second term on the right-hand side, is usually referred to as the deadweight effect of wage subsidies. The costs of further increases in  $s$  therefore depend positively on the actual level of employment. Higher government spending increases lump-sum taxes and thus reduces disposable income available for the consumption of the numeraire good.

Beside the effect a wage subsidy has on the domestic economy, it also affects welfare of the trading partner abroad. The effect of foreign wage subsidies on welfare in Home can again be broken down into four parts:

$$\frac{\partial W}{\partial s^*} = \frac{\partial CS}{\partial s^*} + \frac{\partial \Pi}{\partial s^*} + \frac{\partial LI}{\partial s^*} - \frac{\partial GS}{\partial s^*}.\quad (33)$$

Combining these four effects we identify two spill-over effects that a foreign wage subsidy has on the home economy: First, the foreign wage subsidy decreases the marginal cost of the foreign supplier and thus increases foreign production. This, in turn, reduces the price level of  $X$  and  $Y$  in Home. We therefore observe a *positive consumer surplus spill-over*:

$$\frac{\partial CS}{\partial s^*} = \frac{(12e-2e^3)x + (16-6e^2)y}{64-20e^2+e^4} > 0.\quad (34)$$

When product markets are linked through trade, consumers thus benefit from wage subsidies paid to the foreign firm.



Second, wage subsidies paid to the foreign firm have a *negative net income effect* on Home, which is, however, only present for  $e > 0$ . In that case the two producers are competitors and national subsidy policies affect global patterns of production, of employment and of wages. In contrast, for  $e = 0$  firms are monopolists in their own market segments. Subsidies paid to the foreign firm then do not affect the production decision of the domestic firm (and vice versa). Consequently, profits, employment and wages and thus income in the home country are also not affected by foreign wage subsidies.

The income spill-over effect can be decomposed in three parts. First, a wage subsidy in Foreign shifts rents to the foreign firm and as a result profit income in Home decreases:

$$\frac{\partial \Pi}{\partial s^*} = \frac{-8e(x+x^*)}{64-20e^2+e^4} < 0. \quad (35)$$

Second, a wage subsidy paid in Foreign reduces labour income in Home. This is due to both a fall in employment and in wages. By differentiating employment in Home with respect to  $s^*$ , and taking also into account the wage responses by the trade unions, we arrive at:

$$\frac{\partial(x+x^*)}{\partial s^*} = -\frac{2e}{4-e^2} - \frac{4}{4-e^2} \frac{\partial w}{\partial s^*} + \frac{2e}{4-e^2} \frac{\partial w^*}{\partial s^*} \quad (36)$$

$$= -\frac{2e}{4-e^2} \left( 1 - \frac{12-e^2}{16-e^2} \right) < 0. \quad (37)$$

A wage subsidy in Foreign improves the competitiveness of the foreign firm and has a direct negative effect on employment in the home country (first term on the right-hand side of (36)). In unionised labour markets this effect is mitigated as unions at home and abroad adjust their wage demands accordingly. More specifically, Home's union moderates its wage demands (second term on the right-hand side of (36)) while the foreign union sets a higher wage rate (third term). Overall, the negative direct effect prevails and subsidies therefore have a negative effect on the level of employment of the trading partner. As shown, wages in Home also

decrease and so does labour income:

$$\begin{aligned}\frac{\partial LI}{\partial s^*} &= (x+x^*) \frac{\partial w}{\partial s^*} + w \frac{\partial(x+x^*)}{\partial s^*} \\ &= \frac{-2e(x+x^*)}{16-e^2} - \frac{8ew}{64-20e^2+e^4} < 0.\end{aligned}\quad (38)$$

Note that the effects of foreign wage subsidies on both domestic employment and domestic wages ( $\frac{\partial(x+x^*)}{\partial s^*}$  and  $\frac{\partial w}{\partial s^*}$ ) decrease with  $e$  and are thus larger (in absolute terms) when the two goods are close substitutes in consumption.

Finally, the negative effect of foreign wage subsidies on domestic employment also implies that government expenditures on wage subsidies decline. This reduces the tax burden for consumers and hence has a positive effect on home income:

$$\frac{\partial GS}{\partial s^*} = s \frac{\partial(x+x^*)}{\partial s^*} = -\frac{8es}{64-20e^2+e^4} < 0.\quad (39)$$

Nevertheless, by reducing both profit and labour income, a wage subsidy in Foreign reduces *net* income in Home and thus decreases (*ceteris paribus*) the consumption level of the numeraire good.<sup>18</sup>

Summarising these policy spill-overs we arrive at:

**Proposition 1** *A foreign wage subsidy has two spill-over effects on welfare in Home. First, there is a positive effect on consumer surplus in Home and, second, there is a negative effect on net income in Home. The negative effect on net income is only present for  $e > 0$  and operates through both a reduction in profit and in labour income.*

**Harmonisation vs. Policy Competition.** Having discussed the various effects of wage subsidies on welfare at home and abroad, we now calculate and compare

<sup>18</sup> Evaluating  $\frac{\partial LI}{\partial s^*} + \frac{\partial \Pi}{\partial s^*} - \frac{\partial GS}{\partial s^*}$  at the symmetric equilibrium  $s = s^*$ , we obtain  $\frac{-8e((6-e^2)(2a-t) - (4-(2+e)e)(b-s))}{(4-e)^2(2+e)^2(2-e)(4+e)}$ . The effect of  $s^*$  on net income in Home will be negative if  $(6-e^2)(2a-t) - (4-(2+e)e)(b-s) > 0$ . Furthermore, output of the domestic firm in the symmetric equilibrium is given by  $\frac{2(2a-t)-4(b-s)}{(4-e)(2-e)}$ . It is easily verified that nonnegative output levels then imply a negative effect of  $s^*$  on net income in Home.

the optimal subsidies with and without policy cooperation. Consider first the case of non-cooperative policy making. Each government decides independently about the level of subsidies taking the choice of the other country as given. The first-order condition of the government in Home then reads

$$\frac{\partial W}{\partial s} = \frac{\partial CS}{\partial s} + \frac{\partial \Pi}{\partial s} + \frac{\partial LI}{\partial s} - \frac{\partial GS}{\partial s} = 0 \quad (40)$$

From this we calculate optimal government response functions, given the trading partner's policy choice. A discussion of these reaction functions is relegated to Appendix A.1. The optimal non-cooperative subsidy level in the Nash equilibrium,  $s_{noncoop}$ , is then given by<sup>19</sup>

$$s_{noncoop} = b + 2a\phi - t\gamma \quad (41)$$

with  $\phi = \frac{40+6e-e^2(11+e-e^2)}{2(6+e)(4+e-e^2)} \geq \gamma = \frac{96-24e-(3-e)e^2(4-2e-e^2)}{4(2-e)(6+e)(4+e-e^2)} > 0$ .<sup>20</sup>

The optimal wage subsidy increases one for one with domestic unemployment benefits. In fact, from a welfare perspective, unemployment benefits act as a negative wage subsidy in the model. The optimally chosen levels of output, and thus consumer surplus and profit levels, depend only on the difference between domestic subsidies and unemployment benefits (but not on their absolute levels).<sup>21</sup> Intuitively, wage subsidies decrease domestic labour costs, while unemployment

<sup>19</sup> With just one firm being present in each market, product market imperfections are severe in our model. This is one reason for why governments have a large incentive to subsidise wages. As a result, the optimal wage subsidy in (41) has the unrealistic feature of being larger than the equilibrium wage itself (which equals  $b + \frac{(64-24e^2+2e^4)2a-(48+4e-e^2(3-e)(4+e))t}{4(6+e)(4+e-e^2)}$ ). When calculating the equilibrium solution, we implicitly assume that governments pay wage subsidies only for 'productive workers' who are hired to produce output actually sold into the market. Thus, by assumption, firms cannot hire workers and just stockpile their production (otherwise governments would not pay such high subsidies in the first place). While the fact that  $s$  is larger than  $w$  in equilibrium is clearly an undesirable model feature, it does not invalidate the message of the paper. One possible remedy to the problem is to increase the social costs of wage subsidies, e.g., by requiring them to be financed through distortionary taxes.

<sup>20</sup> We show in the extended working paper version (Braun and Spielmann, 2010) that the second-order conditions for a maximum are fulfilled and that the equilibrium is stable. Equilibrium wage, price and output levels associated with (41) can also be found in Braun and Spielmann (2010).

<sup>21</sup> We show this formally in Appendix A.2.

benefits, by improving the bargaining position of unions, increase wages. Since wage subsidies and unemployment benefits in Foreign have an analogous effect on foreign production, and output levels are strategic substitutes, domestic production not only increases with  $s - b$  but also decreases with  $s^* - b^*$ . Moreover, total non-profit income net off lump-sum taxes  $w(x + x^*) - s(x + x^*)$ , and thus the remaining part of the welfare function, is also a function of  $s - b$ .<sup>22</sup> Unemployment benefits increase the wage rate (and thus the after-tax labour income) but decrease employment. An increase in  $s$ , in contrast, exactly pulls into the opposite direction by increasing employment but lowering the wage rate net off taxes. The domestic government then effectively chooses the optimal level of  $s - b$  taking the unemployment benefit as given. This result also implies that the distortionary effect of unemployment benefits can be fully offset by wage subsidies.

Even for  $b = 0$ , the optimal wage subsidy is positive, as imperfections in the product market (duopolistic competition) and labour market (monopoly union) leads to an under-provision of the differentiated good and thus to a suboptimally low level of employment. According to (41), the optimal wage subsidy increases with  $a$ , but decreases with  $t$ . An increase in  $a$  shifts the demand function for the differentiated goods outward and *ceteris paribus* increases production and thus employment. Even though wage subsidies are then relatively expensive, they are also more effective in raising consumer surplus and income. Likewise, closer economic integration between the two countries (a lower  $t$ ) increases competitive pressures in the two markets and thus total production of the domestic firm (i.e.  $\frac{\partial x + x^*}{\partial t} < 0$ ). The marginal effect of wage subsidies on profit and labour income is then again larger but marginal costs of subsidising wages increase as well. In contrast to an increase in  $a$ , closer economic integration has an ambiguous effect on  $\frac{\partial CS}{\partial s}$ . While protection of the domestic market and, hence, domestic sales  $x$  decline when trade barriers are dismantled, exports into the home market  $y$  increase. Consumers then gain less from a given reduction in  $p_x$  but more from a reduction in  $p_y$ .<sup>23</sup>

<sup>22</sup> Using Equation (25),  $w - s$  can be written as  $\frac{(4+e)(2-e)(2a-t)-16(s-b)-4e(s^*-b^*)}{2(16-e^2)}$ .

<sup>23</sup> The formal derivatives of the marginal effects of wage subsidies on consumer surplus, profits, labour income, and government spending with respect to  $a$  and  $t$  are provided in Appendix A.3.

The spill-overs described before provide a rationale for policy coordination. Since governments do not take costs and benefits for the foreign country into consideration, the non-cooperative solution in (41) is generally not optimal from a global point of view. We thus compare the non-cooperative solution to a cooperative equilibrium. Motivated by the literature on tax competition, we first assume that governments agree to harmonise the level of wage subsidies across countries. This approach seems natural if countries are fully symmetric. It will, however, entail costs if countries differ in terms of their labour market institutions. As an extension, we thus also consider an optimal cooperation policy (see Section 5).

Cooperating governments set the common subsidy level  $s$  so as to maximise aggregate welfare  $W + W^* = (CS + CS^*) + (\Pi + \Pi^*) + (LI + LI^*) - (GS + GS^*) + (Z + Z^*)$ . Solving the resulting first-order condition then yields the common welfare-maximising subsidy level under policy harmonisation

$$s_{coop1} = b + \frac{(6 - e^2)(2a - t)}{4(1 + e)}, \quad (42)$$

where the subscript *coop1* indicates that we consider cooperation with just one instrument (namely the common harmonised wage subsidy) at hand.<sup>24</sup>

The difference between the optimal subsidy under policy cooperation and non-cooperation is given by

$$s_{coop1} - s_{noncoop} = \frac{(4 - e)^2(1 - e)(2 + e)^2((2 - e)2a - 3t)}{4(2 - e)(1 + e)(6 + e)(4 + e - e^2)} \quad (43)$$

and the welfare gain from policy harmonisation can be written as:

$$\begin{aligned} & (W_{coop1} + W_{coop1}^*) - (W_{noncoop} + W_{noncoop}^*) = \\ & \frac{(4 - e)^2(1 - e)^2(2 + e)^2((2 - e)2a - 3t)^2}{2(2 - e)^2(1 + e)(6 + e)^2(4 + e - e^2)^2}. \end{aligned} \quad (44)$$

By inspecting the differences in (43) and (44), we arrive at

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<sup>24</sup> The second-order condition for a maximum is fulfilled, see Braun and Spielmann (2010) for details. The equilibrium wages, prices and output levels associated with (42) can also be found in the extended working paper version

**Proposition 2** *If governments maximise social welfare and countries are symmetric, the optimal subsidy level under policy harmonisation will be strictly higher than under non-cooperation for  $e = [0, 1[$  and identical for  $e = 1$ . Furthermore, the difference between the subsidy level with and without policy cooperation and the welfare gain from cooperation are both strictly decreasing in  $e$ .*

The proof of Proposition 2 is relegated to the Appendix.

Intuitively, Proposition 2 can be explained as follows: While the positive spill-over effect on consumer surplus calls for a higher cooperative subsidy, the negative income spill-over pulls into the opposite direction. As long as the two goods are not fully homogeneous, the positive spill-over effect on consumer surplus dominates and cooperating governments choose a higher subsidy level than non-cooperating governments do. In fact, the gap between the subsidy levels in the cooperative and the non-cooperative equilibrium increases with the degree of product differentiation. To grasp the intuition behind the result, it is useful to reconsider the extreme case of  $e = 0$ . Recall that the two firms are then monopolies in their market segments and a wage subsidy paid to one firm does not affect production of the other. Employment and wages in Home are also not affected by wage subsidies in Foreign. The negative income spill-over effect then ceases to exist and cooperating governments are left with the positive spill-over effect on consumer surplus:

$$\begin{aligned} \left. \frac{\partial W}{\partial s^*} \right|_{e=0} &= \left. \frac{\partial CS}{\partial s^*} \right|_{e=0} + \left. \frac{\partial \Pi}{\partial s^*} \right|_{e=0} + \left. \frac{\partial LI}{\partial s^*} \right|_{e=0} - \left. \frac{\partial GS}{\partial s^*} \right|_{e=0} \\ &= \left. \frac{\partial CS}{\partial s^*} \right|_{e=0} > 0. \end{aligned} \quad (45)$$

Consequently, cooperating governments have an incentive to agree on a relatively large wage subsidy (compared to the non-cooperative solution). Naturally, large differences between  $s_{coop1}$  and  $s_{noncoop}$  also imply large welfare gains from policy harmonisation.

## 4.2 Asymmetric Labour Market Institutions

Differences in national institutions are often seen as the main culprit why cooperation, though theoretically appealing, rarely works in practice. In this section we

thus allow for asymmetric labour market institutions, namely for cross-country differences in the level of unemployment benefits, and discuss how these asymmetries alter our results derived before. Without loss of generality, we assume that  $b > b^*$ . This may, for instance, replicate institutional differences in the unemployment benefits system across EU member states such as Austria and the UK. In general, the generosity of unemployment benefits in OECD countries differ widely (see OECD, 2011).

We find that policy harmonisation will face two problems if countries differ in the generosity of their unemployment benefits: First, policy harmonisation reduces the capability of governments to adopt their policies to country-specific institutions. And second, even if policy harmonisation still increases *aggregate* welfare, it can run into fierce political opposition because benefits and costs are unevenly distributed between cooperating countries. Surprisingly, a harmonisation of wage subsidies, in fact, increases cross-country differences in welfare levels.

We first derive the non-cooperative equilibrium. Governments set wage subsidies to maximise national welfare taking the subsidy choice of the trading partner as given. To simplify expressions, we choose a specific value of  $e$  and assume that the two products are completely unrelated (i.e.  $e = 0$ ). The results presented in the following are, in a qualitative sense, not affected by the specific choice of  $e$  as long as  $e$  is smaller than one (and thus potential gains from cooperation exist).<sup>25</sup> The general expressions (for  $e \in [0, 1]$ ) are in Appendix A.4. As we show there, the exact parameter value of  $e$  only determines the responsiveness of the optimal wage subsidies under the different policy regimes to changes in  $a$  and  $t$ . This, in turn, will affect the exact parameter values of  $b - b^*$ , for which countries will prefer policy harmonization over non-cooperation, but will affect none of the general insights presented in this section.

For  $e = 0$ , the non-cooperative subsidy levels are given by:

$$s_{noncoop} = b + \frac{5}{3}a - \frac{1}{2}t, \quad s_{noncoop}^* = b^* + \frac{5}{3}a - \frac{1}{2}t. \quad (46)$$

The optimal subsidy set by each government thus increases with the respective domestic level of unemployment benefits but is unrelated to the benefits paid by

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<sup>25</sup> For  $e = 1$  the cooperative and the non-cooperative solution are again identical in welfare terms.

the trading partner. As in the case of symmetric labour markets, subsidies increase in  $a$  but decrease in  $t$ .

The one-to-one relation between subsidies and unemployment benefits imply that both countries choose the same difference  $s - b = s^* - b^*$ . Welfare in turn depends only on this difference but not on the absolute levels of  $s$  and  $b$ . Therefore, the non-cooperative equilibrium levels of welfare are independent of the country-specific and exogenously given unemployment benefits:

$$W_{noncoop} - Z = W_{noncoop}^* - Z^* = \frac{8a^2}{9} - \frac{5at}{6} + \frac{3t^2}{8}. \quad (47)$$

Wage subsidies allow each government to fully offset the welfare effects of unemployment benefits. Apart from the exogenous endowment of non-labour assets, welfare levels in the two countries are thus exactly identical in the non-cooperative equilibrium. Clearly, this result should not be taken too literally since it hinges on a number of assumptions, and in particular on the capability of governments to raise non-distortionary (lump-sum) taxes. In fact, for  $b > b^*$  Home is a high-wage, high-tax country while both taxes and wages are relatively low in Foreign. The results in (46) and (47) mainly serve as a benchmark scenario, to which we now compare welfare under policy harmonisation.

If governments agree to harmonise their labour market policies, they choose a common subsidy level  $s = s^*$  to maximise joint welfare. The resulting optimal subsidy level for  $e = 0$  reads:

$$s_{coop1} = \frac{b + b^*}{2} + \frac{3(2a - t)}{2}. \quad (48)$$

When comparing subsidy levels with and without policy coordination, two main differences are striking. First, a harmonisation of wage subsidies has the distinctive disadvantage that labour market policies can no longer be targeted to the benefit system of each country. In fact, the common subsidy depends on the cross-country average of the two unemployment benefit levels. Second, with policy coordination the two governments account for spill-over effects of wage subsidies. Since the overall spill-over effect on welfare is positive, the common subsidy level under cooperation is strictly higher than the *average* of the two non-cooperative subsidy



levels.<sup>26</sup> It is the interplay of these two forces – the cost of not being able to tailor the wage subsidy to the characteristics of the domestic labour market and the general benefit of internalising the spill-over effects of wage subsidies – that is at the heart of any cost and benefit analysis of policy harmonisation in the presence of asymmetric labour markets.

If cooperating governments choose a common subsidy level, wage subsidies paid in one country not only reflect domestic but also foreign labour market institutions. Therefore, cross-country differences in the unemployment benefit systems are no longer inconsequential for domestic welfare. In equilibrium, welfare levels are given by:

$$W_{coop1} - Z = a^2 + \frac{a(b - b^* - 4t)}{4} - \frac{(b - b^* - 2t)(b - b^* + 14t)}{64}, \quad (49)$$

$$W_{coop1}^* - Z^* = a^2 + \frac{a(b^* - b - 4t)}{4} - \frac{(b^* - b - 2t)(b^* - b + 14t)}{64}. \quad (50)$$

Inspecting the expressions (49) and (50) and comparing them to the results derived for the case of non-cooperating governments, we arrive at

**Proposition 3** *i. Policy harmonisation increases (decreases) joint welfare of the two countries iff  $b - b^* < (>) \frac{2(4a-3t)}{3}$ . Furthermore, the aggregate welfare gain from cooperation is strictly decreasing in  $b - b^*$ .*

*ii. Policy harmonisation increases (decreases) welfare in Home iff  $b - b^* < (>) \frac{2\lambda(4a-3t)}{3}$  with  $\lambda = \sqrt{10} + 3 > 1$ . For sufficiently small (large) differences between  $b$  and  $b^*$ ,  $W_{coop1} - W_{noncoop}$  is increasing (decreasing) in  $b - b^*$ .*

*iii. Policy harmonisation increases (decreases) welfare in Foreign iff  $b - b^* < (>) \frac{2\lambda^*(4a-3t)}{3}$  with  $\lambda^* = \sqrt{10} - 3 < 1$ . Moreover,  $W_{coop1}^* - W_{noncoop}^*$  is strictly decreasing in  $b - b^*$ .*

<sup>26</sup> Subtracting  $1/2(s_{noncoop} + s_{noncoop}^*)$  from  $s_{coop1}$  gives  $4/3a - t$ . Given our assumption of positive intra-industry trade and the fact that  $x$  and  $y$  equal  $(4a - 3t)/6 > 0$  in the non-cooperative equilibrium, the common subsidy level under cooperation is higher than the average of the two non-cooperative subsidy levels.

- iv. With policy coordination welfare net of the exogenous endowment of non-labor assets is strictly larger in Home than in Foreign, i.e.  $W_{coop1} - Z > W_{coop1}^* - Z^*$ .

The proof of Proposition 3 is relegated to the Appendix.

The proposition demonstrates that even with cross-country differences in labour market institutions harmonising subsidies can raise joint welfare of the two countries – as long as the institutions in place are not too different. The aggregate welfare gain successively decreases and eventually turns negative as cross-country differences in labour market institutions become more important. However, this may not be the case for each country on its own. In fact, cross-country differences in the benefit systems strictly diminish the welfare gain from policy harmonisation for Foreign (that pays the relatively low unemployment benefit level of  $b^* < b$ ). In contrast, for Home the gain from coordination even increases with  $b - b^*$  provided that the difference does not exceed a certain threshold level. Moreover, in the cooperative equilibrium welfare in Home, the country with a more generous unemployment benefit system, strictly exceeds welfare in Foreign. Harmonising wage subsidies therefore does not equalise welfare across countries but even drives a wedge between welfare levels in Home and in Foreign.

To clarify these results, consider the country-specific differences between the subsidy paid with and without policy cooperation:

$$s_{coop1} - s_{noncoop} = \frac{4a - 3t}{3} - \frac{b - b^*}{2}, \quad (51)$$

$$s_{coop1}^* - s_{noncoop}^* = \frac{4a - 3t}{3} + \frac{b - b^*}{2}. \quad (52)$$

If countries do not engage in policy competition but choose a common subsidy level, they will target the average unemployment benefit  $(b + b^*)/2$  rather than their country-specific benefit levels  $b$  and  $b^*$ . The average is too low relative to the generous benefits in Home but too high relative to the meager benefits in Foreign (i.e.  $b > (b + b^*)/2 > b^*$ ). It then follows that an increase in  $b - b^*$  decreases  $s_{coop1} - s_{noncoop}$  but increases  $s_{coop1}^* - s_{noncoop}^*$ . Since on average the common subsidy level is higher than the non-cooperative choices, larger cross-country differences push the harmonised subsidy closer to  $s_{noncoop}$  (as long as  $b - b^*$  is not

getting too large) but further away from  $s_{noncoop}^*$ . As the non-cooperative subsidy levels represent the best response of a country to the subsidy set by its trading partner, the gain from policy harmonisation then increases in Home but decreases in Foreign. Moreover, given the positive spill-over effect associated with wage subsidies, Home does not only benefit from  $s_{coop1}$  approaching  $s_{noncoop}$  but also from the increase in  $s_{coop1}^*$  relative to  $s_{noncoop}^*$ . Only for large differences between  $b$  and  $b^*$ , when  $s_{coop1}$  already falls short of  $s_{noncoop}$ , further increases in  $b - b^*$  push  $s_{coop1}$  away from  $s_{noncoop}$  and eventually decrease Home's benefits from policy harmonisation.

Foreign, in contrast, is punished twice by increases in  $b - b^*$ . Not only does its own wage subsidy diverges more and more from  $s_{noncoop}^*$ , it also benefits less and less from Home paying a higher subsidy under harmonisation than under non-cooperation. For large  $b - b^*$  Foreign even suffers from  $s_{coop1}$  falling short of  $s_{noncoop}$ .<sup>27</sup>

The differential effect on welfare in Home and Foreign induces a potential enforceability problem associated with policy cooperation under labour market asymmetries. According to Proposition 3 there exists a range of parameter values,  $\frac{2\lambda(4a-3t)}{3} < b - b^* < \frac{2(4a-3t)}{3}$ , for which policy harmonisation increases joint welfare of the two countries but decreases welfare in Foreign. The low-benefit country then has an incentive to blockade any policy initiative to harmonise labour market policies. Our analysis thus provides a rationale for why labour market policies are still mostly in national hands even though policy harmonisation might be beneficial from a bird's eye perspective.

## 5 Optimal Policy Cooperation

So far, we have interpreted policy cooperation as a harmonisation of wage subsidies. In fact, the public debate about international policy coordination often focuses on the question of whether national policies should be leveled across national

<sup>27</sup> While an increase in  $b - b^*$  diminishes the aggregate gains from cooperation for Foreign, firm profits are positively affected. Foreign firms benefit both from relatively high wage subsidies (compared to the low unemployment benefits) and the comparably low subsidies paid to their competitors.

borders. However, policy harmonisation reduces the capability of governments to adapt their policies to country-specific institutions as governments are left with only one policy instrument at hand. An optimal cooperative policy, in contrast, allows subsidy levels to differ across countries. With asymmetric labour market institutions, aggregate welfare must be higher if policy makers have two rather than one instruments at their disposition. However, as we illustrate in the following, the high-benefit country might nevertheless prefer a harmonisation policy.

Optimal policy cooperation between Home and Foreign requires that country-specific subsidy levels  $s$  and  $s^*$  are chosen to maximise aggregate welfare  $W + W^*$ . To simplify expressions – and to facilitate comparison with the results derived in Section 4.2 – we again focus on the case of unrelated products (i.e.  $e = 0$ ). Expressions for general parameter values of  $e$  are in the Appendix A.4. We also continue to assume that Home pays higher unemployment benefits than Foreign, i.e.,  $b > b^*$ . Solving the first-order conditions yields the optimal cooperative subsidy levels (marked with the subscript *coop2* for a cooperation strategy with two instruments):<sup>28</sup>

$$s_{coop2} = b + \frac{3(2a - t)}{2}, \quad s_{coop2}^* = b^* + \frac{3(2a - t)}{2}. \quad (53)$$

The optimal cooperative solution combines the benefits of both policy competition and subsidy harmonisation. On the one hand, with two instruments at hand governments target country-specific institutions (as they do under policy competition) and national wage subsidies depend on local unemployment benefits only. On the other hand, cooperating governments account for the spill-over effects of wage subsidies. In fact, the average of  $s_{coop2}$  and  $s_{coop2}^*$  exactly equals the optimal harmonised subsidy level  $s_{coop1}$ .

The optimal subsidies in (53) increase one to one with national unemployment benefits. Therefore, the difference between  $s$  and  $b$  is identical in Home and Foreign and welfare levels coincide as well:

$$W_{coop2} - Z = W_{coop2}^* - Z^* = a^2 - at + \frac{7t^2}{16}. \quad (54)$$

<sup>28</sup> The second-order condition for a maximum are fulfilled as  $\frac{\partial^2(W+W^*)}{\partial^2 s} = \frac{\partial^2(W+W^*)}{\partial^2 s^*} = -\frac{1}{8}$ .

Policy cooperation with two instruments at hand always increases *aggregate* welfare  $W + W^*$  relative to both the equilibrium with policy competition and policy harmonisation. Since welfare levels in Home and Foreign are identical, as they are under policy competition, it furthermore follows that each country on its own also prefers optimal policy cooperation to policy competition. The high-benefit country, however, might still lobby for policy harmonisation, as we demonstrate in

**Proposition 4** *i. Optimal policy cooperation decreases (increases) welfare in Home relative to the equilibrium under policy harmonisation iff  $b - b^* < (>)4(4a - 3t)$ .*

*ii. Optimal policy cooperation increases welfare in Foreign relative to the equilibrium under policy harmonisation.*

The proof of Proposition 4 is relegated to the Appendix.

Even though policy-makers give up a policy instrument by harmonising subsidy levels, Home will be best off with policy harmonisation if cross-country differences are sufficiently small. Foreign, in contrast, is always better off when cooperating countries do not coordinate on a common subsidy but choose country-specific subsidy levels.

The reason is as follows. If countries have to choose a common subsidy level, they will target the average unemployment benefit  $(b + b^*)/2$ . The harmonised subsidy level is thus lower in the high-benefit country but higher in the low-benefit country (relative to the optimal cooperative and country-specific subsidies). Positive spill-over effects imply that Home benefits from higher subsidy levels paid in Foreign. In addition, for sufficiently small differences in the unemployment benefit systems, the difference between  $s_{coop1}$  and  $s_{noncoop}$  is smaller (in absolute terms) than the difference between  $s_{coop2}$  and  $s_{noncoop}$ . Subtracting the two terms yields:

$$|s_{coop2} - s_{noncoop}| - |s_{coop1} - s_{noncoop}| = \left| \frac{4a - 3t}{3} \right| - \left| \frac{4a - 3t}{3} - \frac{b - b^*}{2} \right|. \quad (55)$$

For  $b - b^* < 4(4a - 3t)/3$ , the harmonised subsidy  $s_{coop1}$  is closer to Home's optimal unilateral choice  $s_{noncoop}$  than is the optimal cooperative subsidy  $s_{coop2}$ .

Since the non-cooperative subsidy represents the best response of a country to the subsidy set by its trading partner, this is again in the interest of Home.

From the perspective of Foreign, in contrast, policy harmonisation only carries disadvantages relative to the optimal cooperative policy. Not only does Home pay relatively low wage subsidies. Policy harmonisation also pushes the subsidy level further away from Foreign's non-cooperative choice than optimal policy coordination does:

$$\begin{aligned} |s_{coop2}^* - s_{noncoop}^*| - |s_{coop1}^* - s_{noncoop}^*| &= \left| \frac{4a - 3t}{3} \right| - \left| \frac{4a - 3t}{3} + \frac{b - b^*}{2} \right| \\ &= -\frac{b - b^*}{2} < 0. \end{aligned} \quad (56)$$

It then follows that Foreign strictly prefers optimal policy cooperation over policy harmonisation.

To sum up: The optimal cooperative policy accounts for the spill-over effects of national wage subsidies while allowing policy-makers to target country-specific labour market institutions. Aggregate welfare thus increases unambiguously compared to both policy competition and policy harmonisation. But even if policy cooperation could indeed be designed optimally in the real world, countries can still disagree about which policy to implement. In fact, the high-benefit country may prefer the (globally suboptimal) harmonisation policy that chooses a common subsidy level for both countries.

## 6 Conclusion

Wage subsidies are an increasingly popular policy tool to foster labour demand and fight unemployment without creating working poverty. When product markets are global, however, such labour market policies entail important spill-over effects. In this paper, we analyse the effects of wage subsidies in an international duopoly model with unionised labour markets and discuss the costs and benefits from international policy coordination both for the case of symmetric and asymmetric labour market institutions.

We find that wage subsidies paid in one country have several effects – both for the domestic country but also for the trading partner. First, wage subsidies

affect the global patterns of wages and employment, increasing labour income at home while decreasing it abroad. Second, wage subsidies increase profits of the domestic firm at the expense of the foreign competitor. Third, consumers at home and abroad benefit from wages subsidies as they reduce marginal production cost and thus consumer prices. The relative strength of these effects depends crucially on the degree of product differentiation.

Given the spill-over effects identified in our analysis, there is room for coordinating labour market policies internationally. In fact, coordinative action has been discussed in the policy arena, especially within the European Union, but little progress has been made in its implementation. We show that policy harmonisation can run into severe problems when national labour market institutions differ, as they do in practice. Not only does harmonisation reduce the capability of governments to adopt their policies to country-specific institutions. The benefits and costs are also unevenly distributed between cooperating countries. International policy harmonisation may then be difficult to enforce politically, even if it increases *aggregate* welfare. Thus, in practice, the harmonisation of labour market policies seems realistic only for countries with sufficiently similar labour market institutions, a result that also may help to explain the slow speed at which coordination within the European Union has progressed so far.

An optimal cooperative policy that allows subsidy levels to differ across countries does not restrict the capability of cooperating governments to account for country-specific institutions. It thus overcomes the key problem associated with policy harmonisation. Though theoretically appealing, an optimal cooperative policy might be very difficult to implement in reality since it requires cross-country coordination on more than just one instrument. And even if policy cooperation could indeed be designed optimally, countries can still disagree about which cooperation policy to implement. In fact, our analysis suggests that a subset of countries could lobby for policy harmonisation although a common subsidy does not maximise overall welfare.

Our model setup is highly analytically tractable and thus allows us to precisely identify the forces at work. At the downside, the model is inevitably stylized. It thus lends itself to a number of extensions. In particular, we have abstracted from labour and capital mobility. While in the past labour mobility within the European Union, a prime candidate for policy coordination, has indeed been rather

low, this may change as the European unification process proceeds. Since labour market policies could arguably also affect migration decisions, a model with mobile workers may detect additional spill-overs not captured in our simple framework. Likewise, labour market policies might also affect the location decision of firms. Moreover, labour market policy harmonization will not only entail costs in the face of cross-country differences in institutions but also in the face of asymmetric economic shocks, a fact not captured by our static and deterministic model. Finally, wage subsidies are generally regarded as a mean to fight unemployment among low-skilled workers. Hence, allowing for heterogeneous labour could enrich the predictions of the model. We consider these extensions as promising paths for future research.

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## A Appendix

### A.1 Policy Reaction Functions under Symmetry

If governments choose the level of wage subsidies non-cooperatively, the reaction function  $s(s^*)$  for Home will read:

$$s(s^*) = \frac{(4+e)(2-e)(6+e)(4+(1-e)e)b}{192-84e^2+7e^4} - \frac{e(32-8e^2+e^4)s^*}{192-84e^2+7e^4} + \frac{(4+e)(2-e)(40+6e-e^2(11+(1-e)e))a}{192-84e^2+7e^4} - \frac{(384-(2-e)e^2(36+4e-e^2(5+e)))t}{4(192-84e^2+7e^4)}. \quad (57)$$

Note that for the relevant parameter range of  $e$  (i.e., for  $0 \leq e \leq 1$ ),  $\frac{\partial s}{\partial s^*} \leq 0$ . Hence, an increase in the subsidy level of the trading partner reduces the optimal subsidy level at home. This is due to the fact that, for  $e \neq 0$ , an increase in the foreign subsidy level reduces the output level of the domestic firm (i.e.,  $\frac{\partial x}{\partial s^*} < 0$  and  $\frac{\partial x^*}{\partial s^*} < 0$ ), which, in turn, reduces the marginal benefit of domestic subsidies in increasing consumer surplus, domestic profit and labour income (see Equations (29), (30) and (31)). In contrast, an increase in the foreign subsidy level also increases the exports of the foreign firm to Home (i.e.,  $\frac{\partial y}{\partial s^*} > 0$ ), which, in turn, increases the marginal benefit of domestic subsidies in increasing consumer surplus. Overall, however, an increase in the foreign subsidy decreases the effectiveness of the domestic subsidy in increasing domestic welfare.

### A.2 Production as a Function of (s-b)

By plugging the wages set by the unions into the corresponding output expressions for the domestic firm, we obtain

$$x = \frac{4(4+e)(2-e)a + (16+20e-e^3)t + (32-4e^2)(s-b) - 8e(s^*-b^*)}{2(64-20e^2+e^4)},$$

$$x^* = \frac{4(4+e)(2-e)a - (4+e)(12-e^2)t + (32-4e^2)(s-b) - 8e(s^*-b^*)}{2(64-20e^2+e^4)}.$$

The optimally chosen levels of output thus depend only on the difference between domestic subsidies  $s$  and unemployment benefits  $b$ . Analogous expressions exist for the firm located in Foreign.

### A.3 The Effect of $a$ and $t$ on the Marginal Effects of Wage Subsidies

Differentiating the marginal effects of wage subsidies on consumer surplus, profits, labour income, and government spending, with respect to  $a$  and  $t$  yields:

$$\begin{aligned}\frac{\partial CS}{\partial s \partial a} &= \frac{4(1+e)}{(4-e)^2(2+e)^2} > 0, \\ \frac{\partial \Pi}{\partial s \partial a} &= \frac{16(8-e^2)}{(8+2e-e^2)^2(8-2e-e^2)} > 0, \\ \frac{\partial LI}{\partial s \partial a} &= \frac{8(8-e^2)}{(4-e)^2(8+6e+e^2)} > 0, \\ \frac{\partial GS}{\partial s \partial a} &= \frac{4}{8+2e-e^2} > 0, \\ \frac{\partial \Pi}{\partial s \partial t} &= \frac{-8(8-e^2)}{(8+2e-e^2)^2(8-2e-e^2)} < 0, \\ \frac{\partial LI}{\partial s \partial t} &= \frac{-4(8-e^2)}{(4-e)^2(8+6e+e^2)} < 0, \\ \frac{\partial GS}{\partial s \partial t} &= \frac{-2}{8+2e-e^2} > 0, \\ \frac{\partial CS}{\partial s \partial t} &= \frac{32-40e-e^2(20-6e-(3-e)e^2)}{(4-e)^2(4+e)(4-e^2)^2},\end{aligned}$$

where the last expression is positive (negative) for a sufficiently small (large)  $e$ .

### A.4 Welfare and Subsidy Levels for General Parameter Values of $e$

For asymmetric labour market institutions, we have derived subsidy and welfare levels under non-cooperation, policy harmonization and optimal policy cooperation only for a specific parameter value of  $e$  (namely, for  $e = 0$ ). This section presents the expressions for general parameter values of  $e$ . We show that the results presented

in the main body of the text are, in a qualitative sense, not affected by the specific choice of  $e$ .

The optimal non-cooperative subsidy levels in the Nash equilibrium,  $s_{noncoop}$  and  $s_{noncoop}^*$ , are given by

$$s_{noncoop} = b + 2a\phi - t\gamma, \quad s_{noncoop}^* = b^* + 2a\phi - t\gamma \quad (58)$$

with  $\phi = \frac{40+6e-e^2(11+e-e^2)}{2(6+e)(4+e-e^2)} \geq \gamma = \frac{96-24e-(3-e)e^2(4-2e-e^2)}{4(2-e)(6+e)(4+e-e^2)} > 0$ . Just as for  $e = 0$ , the optimal subsidy levels thus increase one for one with the domestic level of unemployment benefits. They also increase in  $a$  but decrease in  $t$ . The parameter  $e$  determines the responsiveness of the optimal wage subsidies to changes in  $a$  and  $t$ . As for the specific case of  $e = 0$ , the non-cooperative equilibrium levels of welfare are, also in the general case, independent of the country-specific unemployment benefits:

$$\begin{aligned} W_{noncoop} - Z &= W_{noncoop}^* - Z^* \\ &= \frac{8(8-e^2)(8-e(2e-1))a^2}{(6+e)^2(4+e-e^2)^2} \\ &\quad - \frac{(960-288e-436e^2+124e^3+43e^4-10e^5-e^6)at}{(2-e)(6+e)^2(4+e-e^2)^2} \\ &\quad + \frac{(1728-192e-724e^2+112e^3+67e^4-10e^5-e^6)t^2}{2(2-e)^2(6+e)^2(4+e-e^2)^2}. \end{aligned} \quad (59)$$

The optimal subsidy level under policy harmonization,  $s_{coop1}$ , is given by

$$s_{coop1} = \frac{b+b^*}{2} + \frac{(6-e^2)(2a-t)}{4(1+e)}. \quad (60)$$

Just as for  $e = 0$ , the optimal subsidy under policy harmonization thus targets the cross-country average of the two unemployment benefit levels. The parameter  $e$  again determines the responsiveness of the optimal wage subsidies to changes in  $a$  and  $t$ . As for the specific case of  $e = 0$ , domestic welfare under policy

harmonization depends on cross-country differences in unemployment benefits:

$$W_{coop1} - Z = \frac{a^2}{1+e} + \frac{a(2(1-e)(b-b^*) - (2-e)(4+e)t)}{(2-e)(1+e)(4+e)} - \frac{4(b-b^*)^2(1-e^2) + 12(b-b^*)(1-e)(4+e)t}{4(2-e)^2(1+e)(4+e)^2} + \frac{(4+e^2)(7-2e)t^2}{4(2-e)^2(1+e)(4+e)^2}, \quad (61)$$

$$W_{coop1}^* - Z^* = \frac{a^2}{1+e} + \frac{a(2(1-e)(b^*-b) - (2-e)(4+e)t)}{(2-e)(1+e)(4+e)} - \frac{4(b^*-b)^2(1-e^2) + 12(b^*-b)(1-e)(4+e)t}{4(2-e)^2(1+e)(4+e)^2} + \frac{(4+e^2)(7-2e)t^2}{4(2-e)^2(1+e)(4+e)^2}. \quad (62)$$

Given (59), (61), (62), it can be verified that all the results of Proposition 3, derived for  $e = 0$ , also hold for general parameter values of  $e$ . The parameter  $e$  only determines the exact cut-off points of  $b - b^*$ , until which Home and Foreign prefer policy harmonization over non-cooperation. The exact cut-off points can be obtained from the authors upon request. The proof for the general case proceeds just as the proof for the specific case of  $e = 0$  (see Appendix A.6).

Finally, the optimal cooperative wage subsidies,  $s_{coop2}$  and  $s_{coop2}^*$ , for general parameter values of  $e$  are given by:

$$s_{coop2} = b + \frac{(6-e^2)(2a-t)}{4(1+e)}, \quad s_{coop2}^* = b^* + \frac{(6-e^2)(2a-t)}{4(1+e)}. \quad (63)$$

The optimal cooperative wage subsidies thus increase one-for-one with domestic unemployment benefits. They also increase with  $a$  but decrease with  $e$ . As under both non-cooperation and policy harmonization, the parameter  $e$  determines the responsiveness of the optimal wage subsidies to changes in  $a$  and  $t$ . Just as for  $e = 0$ , welfare levels in Home and Foreign also coincide in the general case:

$$W_{coop2} - Z = W_{coop2}^* - Z^* = \frac{a^2}{1+e} - \frac{at}{1+e} + \frac{(7-2e)t^2}{4(2-e)^2(1+e)}. \quad (64)$$

Given (61), (62) and (64), it is easily verified that the results of Proposition 4, derived for  $e = 0$ , also hold for general parameter values of  $e$ . The parameter  $e$  only determines the exact cut-off point of  $b - b^*$ , until which Home prefers policy harmonization over optimal policy cooperation. This cut-off point is given by  $\frac{(4-e)((2-e)2a-3t)}{1+e}$ . As for  $e = 0$ , Foreign is, also in the general case, always better off under the optimal cooperative solution. The proof for the general case proceeds just as the proof for the specific case of  $e = 0$  (see Appendix A.7).

### A.5 Proof of Proposition 2

In the noncooperative equilibrium exports from Home to Foreign and vice versa are given by  $x^* = y = \frac{(8-e^2)((2-e)2a-3t)}{(6+e)(2-e)(4+e-e^2)}$ . For intra-industry trade to occur in equilibrium, trading costs  $t$  thus have to be lower than  $\frac{(2-e)2a}{3}$ . It then follows directly from (43) that  $s_{coop1} - s_{noncoop}$  is positive for  $0 \leq e < 1$  and zero for  $e = 0$ . Moreover, differentiating  $s_{coop1} - s_{noncoop}$  with respect to  $e$  yields:

$$\frac{\partial(s_{coop1} - s_{noncoop})}{\partial e} = \frac{-(4-e)(2+e)(2a(2-e)\kappa_1 - 3t\kappa_2)}{4(2-e)^2(1+e)^2(6+e)^2(4+e-e^2)^2},$$

where  $\kappa_1 = (2-e)(368 + 252e - 66e^2 - 64e^3 + e^4(14e + e^2 - 1))$  and  $\kappa_2 = 544 + 8e - 148e^2 + e^3(94 + 15e - 9e^3)$ . It then follows from  $\kappa_1 \geq \kappa_2$  for  $e \in [0, 1]$  and  $(2-e)2a > 3t$  that  $s_{coop1} - s_{noncoop}$  is strictly decreasing in  $e$ .

Finally, differentiating the welfare gain from cooperation with respect to  $e$  yields:

$$\frac{\partial(W_{coop1} + W_{coop1}^* - W_{noncoop} - W_{noncoop}^*)}{\partial e} = \frac{-(4-e)(1-e)(2+e)(2a(2-e) - 3t)(2a(2-e)\lambda_1 - 3t\lambda_2)}{2(2-e)^3(1+e)^2(6+e)^3(4+e-e^2)^3}$$

with  $\lambda_1 = (2-e)(640 + 512e - 116e^2 - 72e^3 + 31e^4 + 14e^5 - e^6)$  and  $\lambda_2 = 896 + 128e - 272e^2 + 284e^3 + 40e^4 - 61e^5 - 10e^6 + 3e^7$ . It then follows from  $\lambda_1 \geq \lambda_2$  for  $e \in [0, 1]$  and  $(2-e)2a > 3t$  that the welfare gain from cooperation is decreasing in  $e$ .



### A.6 Proof of Proposition 3

In the non-cooperative equilibrium exports from Home to Foreign and vice versa are given by  $x = y = \frac{4a-3t}{6}$ . For our assumption of positive intra-industry trade to hold in equilibrium, trading costs  $t$  thus have to be lower than  $4/3a$ . Recall further that  $b - b^*$  is positive by assumption. We can now consider each part of Proposition 3 in turn:

- i. Calculating the aggregate welfare gain from policy harmonisation  $\Delta(W + W^*) = W_{coop1} + W_{coop1}^* - (W_{noncoop} + W_{noncoop}^*)$  yields:

$$\Delta(W + W^*) = \frac{(8a - 6t)^2 - 9(b - b^*)^2}{288}.$$

Next, observe that

$$\lim_{b-b^* \rightarrow 0} \Delta(W + W^*) = \frac{(8a - 6t)^2}{288} > 0, \quad \lim_{b-b^* \rightarrow \infty} \Delta(W + W^*) = -\infty,$$

and

$$\frac{\partial \Delta(W + W^*)}{\partial (b - b^*)} = \frac{-(b - b^*)}{16} < 0.$$

It then follows that there exist a threshold  $b'$  such that the aggregate welfare gain from policy harmonisation is positive (negative) iff  $b - b^* < (>) b'$ . It is easily verified that the threshold equals  $\frac{2(4a-3t)}{3}$ .

- ii. Calculating Home's welfare gain from policy harmonisation  $\Delta W = W_{coop1} - W_{noncoop}$  yields:

$$\Delta W = \frac{(8a - 6t)^2 - 9(b - b^*)^2 + 36(4a - 3t)(b - b^*)}{576}.$$

Next, observe that

$$\lim_{b-b^* \rightarrow 0} \Delta W = \frac{(8a - 6t)^2}{576} > 0, \quad \lim_{b-b^* \rightarrow \infty} \Delta W = -\infty,$$

and

$$\frac{\partial \Delta W}{\partial (b - b^*)} = \frac{-(b - b^*) + 2(4a - 3t)}{32}, \quad \frac{\partial^2 \Delta W}{\partial^2 (b - b^*)} = -\frac{1}{32}.$$

Home's gain from policy harmonisation is thus strictly positive as  $b - b^*$  approaches zero but negative for large cross-country differences in the unemployment benefit system. We furthermore see that  $W_{coop1} - W_{noncoop}$  first increases in  $b - b^*$ , reaches a maximum at  $b - b^* = 8a - 6t$  and decreases thereafter. It then follows that there exist a threshold  $b''$  such that the welfare gain from policy harmonisation in Home is positive (negative) iff  $b - b^* < (>) b''$ . It is easily verified that the threshold equals  $(\sqrt{10} + 3) \frac{2(4a - 3t)}{3}$ .

- iii. Calculating Foreign's welfare gain from policy harmonisation  $\Delta W^* = W_{coop1}^* - W_{noncoop}^*$  yields:

$$\Delta W^* = \frac{(8a - 6t)^2 - 9(b - b^*)^2 - 36(4a - 3t)(b - b^*)}{576}.$$

Next, observe that

$$\lim_{b - b^* \rightarrow 0} \Delta W^* = \frac{(8a - 6t)^2}{576} > 0, \quad \lim_{b - b^* \rightarrow \infty} \Delta W^* = -\infty,$$

and

$$\frac{\partial \Delta W^*}{\partial (b - b^*)} = \frac{-(b - b^*) - 2(4a - 3t)}{32} < 0.$$

It then follows that there exist a threshold  $b'''$  such that the welfare gain from policy harmonisation in Foreign is positive (negative) iff  $b - b^* < (>) b'''$ . It is easily verified that the threshold equals  $(\sqrt{10} - 3) \frac{2(4a - 3t)}{3}$ .

- iv. Subtracting  $W_{coop1}^* - Z$  from  $W_{coop1} - Z^*$  gives

$$\frac{(b - b^*)(4a - 3t)}{8},$$

which is always positive for  $b > b^*$ .

### A.7 Proof of Proposition 4

Notice first that in the (optimal) cooperative equilibrium exports from Home to Foreign and vice versa are given by  $x = y = \frac{4a-3t}{4}$ . For our assumption of positive intra-industry trade to hold in equilibrium, trading costs  $t$  thus have to be lower than  $4/3a$ . Recall further that  $b - b^*$  is positive by assumption. We now consider each part of Proposition 4 in turn:

i. Calculating  $W_{coop2} - W_{coop1}$  yields:

$$W_{coop2} - W_{coop1} = \frac{(b - b^*)(b - b^* - (16a - 12t))}{64}.$$

Next, observe that

$$\lim_{b-b^* \rightarrow 0} W_{coop2} - W_{coop1} = 0, \quad \lim_{b-b^* \rightarrow \infty} W_{coop2} - W_{coop1} = \infty,$$

and

$$\frac{\partial(W_{coop2} - W_{coop1})}{\partial(b - b^*)} = \frac{b - b^* - (8a - 6t)}{32}, \quad \frac{\partial^2(W_{coop2} - W_{coop1})}{\partial^2(b - b^*)} = \frac{1}{32}.$$

Home's gain from optimal policy cooperation (relative to policy harmonisation) is thus strictly positive for large cross-country differences and converges to zero as  $b - b^*$  approaches zero. We furthermore see that for  $b - b^* < 8a - 6t$   $W_{coop2} - W_{coop1}$  decreases in  $b - b^*$ , then reaches a minimum at  $b - b^* = 8a - 6t$  and increases thereafter. It then follows that there exist a threshold  $b'$  such that  $W_{coop2} - W_{coop1} < (>)0$  iff  $b - b^* < (>)b'$ . It is easily verified that the threshold  $b'$  equals  $4(4a - 3t)$ .

ii. Calculating  $W_{coop2}^* - W_{coop1}^*$  yields:

$$W_{coop2}^* - W_{coop1}^* = \frac{(b - b^*)(b - b^* + (16a - 12t))}{64},$$

which is always positive for  $b - b^* > 0$ .

Please note:

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