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Abstract

This paper sets up a general oligopolistic equilibrium model with two countries that differ in the centralization of union wage setting. Being interested in the consequences of openness, we show that, in the short-run, trade increases welfare and employment in both locations, and it raises income of capital owners as well as workers. In the long run, capital outflows from the country with the more centralized wage setting generate winners and losers and make the two countries more dissimilar in terms of unemployment of welfare. Decentralization of wage setting can successfully prevent capital outflow and the export of jobs.

JEL codes: F12, F16, J51, L13
Keywords: General oligopolistic equilibrium, Union wage setting, Asymmetric labor market institutions, Trade liberalization, Capital mobility, Decentralization in union wage setting

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1 Introduction

Since Calmfors and Driffill (1988) have published their seminal work on a hump-shaped relationship between the degree of centralization in collective bargaining and aggregate unemployment, it has been a broadly accepted fact in the science community that sector-level unions are more successful in securing economic rents for their members than more centralized as well as more decentralized ones, with adverse macroeconomic consequences. However, even though the 'hump-shape hypothesis' seems to be well suited for explaining why continental European countries have suffered from significantly higher unemployment rates than Scandinavian or Anglo-Saxon ones over the last two decades, empirical research does not provide strong supportive evidence for this hypothesis (see, for instance, Nickell, 1997; Flanagan, 1999, 2003). In the years following the publication by Calmfors and Driffill (1988), economists have therefore searched for a rationale that can explain the lack of supportive evidence, and openness to international trade features prominently on the list of possible arguments. While there seems to be broad agreement among economists that differences in union wage-setting institutions are in general less important in open economies (see, for instance, Bean, Danthine, Bernholz, and Malinvaud, 1990; Danthine and Hunt, 1994),[1] we still know surprisingly little about how different forms of openness, such as international trade or capital mobility, contribute to this result.

Filling the gap and providing a more comprehensive picture about how different forms of openness affect the macroeconomic consequences of differing wage-setting institutions is the purpose of this paper. To tackle this issue, we set up a general oligopolistic equilibrium (GOLE) model along the lines of Neary (2003, 2009), with a unit mass of sectors and a small (endogenous) number of firms in each industry. Enriching this framework with a simple textbook model of monopoly unions – in which unions set wages first and firms adjust employment afterwards – gives an analytically tractable general equilibrium version of a unionized oligopoly model with pure economic rents and involuntary unemployment in equilibrium (see, for instance, Egger and Etzel, 2012).[2] We embed this extended GOLE framework into a two-country model, in which the two economies are symmetric in all respects, except for their wage-setting institutions. To capture the institutional differences, we assume that one country is populated by firm-level unions, while the other country is populated by sector-level unions.[3]

[1] It is noteworthy that this insight does not necessarily extend to other labor market institutions. For instance, Brecher (1974) and Davis (1998) point out that in an otherwise standard two-country, two-sector, two-factor Heckscher-Ohlin model, in which one country introduces a binding minimum wage, factor price equalization in the opening economy leads to an increase in unemployment in the country that suffers from the labor market friction. This suggests that the adverse employment effects of minimum wages may become even more pronounced in an open economy.

[2] A similar model has been proposed by Bastos and Kreickemeier (2009) and Kreickemeier and Meland (2011). However, assuming that only part of the industries are unionized, these models generate full employment and are thus not equipped to study the relationship between the degree of centralization in union wage setting and economy-wide unemployment.

[3] We do not discuss economy-wide agreements as as a third alternative, because agreements at the highest level of centralization have become an exception in the 21^{st} century (see OECD, 2004).

In a first step of our analysis, we study the two economies under autarky and reproduce a key finding of Calmfors and Driffill (1988): Sector-level unions set higher wages than firm-level ones, causing higher unemployment and lower welfare in the closed economy. Equipped with this insight, we then study how opening up for trade changes the outcome in the two economies. Thereby, we distinguish two possible scenarios of openness. In the first one, we assume that product markets are fully integrated, while capital markets remain segmented. Since this captures the idea that capital (firm) owners do not immediately adjust their investment decisions after a globalization shock, we refer to this scenario as the *short run*. In this short-run scenario, trade raises competition in the product market and lowers the ability of unions to set excessive wages for 'insiders'. This generates an employment and welfare stimulus in both economies and thus raises the magnitude of economic rents that can be distributed between capital owners and workers. Since unions set lower wages in the open economy, the share of rents attributed to capital owners increases and this group is thus unambiguously better off than in the closed economy. However, also the group of workers benefits from product market integration, because the negative consequences of falling wages are counteracted and dominated by the employment stimulus and a ceteris paribus reduction in the price level resulting from stronger product market competition in the open economy.

Regarding the role of country-specific wage-setting institutions in the open relative to the closed economy, our model reproduces a well known result from previous research. Product market integration lowers the wage gap between the two economies, arising from differences in the prevailing wage-setting institutions, and this reduces the differential in unemployment and welfare ceteris paribus. However, there is also a counteracting effect. Fiercer competition in the global market magnifies the employment and welfare differences associated with a given wage gap, because production shifts towards the country that offers the lower production costs in the open economy. There are hence two counteracting effects in our model and it is not clearcut in general whether differences in the degree of centralization in union wage-setting lose part of their impact on the macroeconomic performance of countries in response to product market integration. Nonetheless, our model establishes the common result that product market integration lowers differences in unemployment and welfare, when focusing on empirically plausible parameter domains. For instance, if those who are unemployed receive a compensation which is less than 2/3 of the going wage rate, the common result is reproduced provided that at least two firms are active in either country and each industry.

In the *long run*, capital is internationally mobile and searches for the most profitable investment opportunities in the global economy. This generates capital flows from the country that hosts sector-level unions to the country that hosts firm-level unions, and these flows continue until the return to capital investment, i.e. the profit of the firm, is equalized between the two locations. Abstracting from extra costs of investing abroad, this *no arbitrage* condition is reached if wages are equalized in the two locations. However, one should not be tempted

to conclude from the observation of factor price equalization that differences in the degree of union wage setting lose their impact on macroeconomic variables. On the contrary, the outflow of capital lowers employment and welfare in the country that hosts the sector-level union and raises these two macroeconomic performance measures in the country of capital inflow. This points to an important conclusion: It is not openness *per se* that helps explaining the lack of empirical evidence for the hump-shape hypothesis put forward by Calmfors and Driffill (1988). Rather, it is the integration of product markets as a specific form of openness that provides a rationale for the missing evidence, while other forms of openness, as for instance capital market integration, do not provide such a rationale. Aside from its implications on aggregate employment and welfare, we also analyze how capital mobility influences the groups of capital owners and workers specifically. Intuitively, the additional investment opportunities increase the real income of capital owners in the country that hosts sector-level unions, while workers lose in this economy since capital outflow is associated with an export of jobs in our setting. Things are different in the country that hosts the firm-level union. Due to capital inflow, firms headquartered in this country lose their competitive advantage vis-á-vis foreign producers, and hence the capital owners running these firms are worse off than in the short run. Finally, workers in the country that attracts foreign capital are definitely better off than in the short run, because the establishment of new local firms implies additional domestic jobs.

In a final step of our analysis, we investigate to what extent the common trend among OECD countries to implement less centralized forms of collective bargaining and to move towards firm-level agreements (see OECD, 2004) can be successful in securing domestic jobs and thus guarantee gains from trade for domestic workers also in the long run. The message from our analysis is clear: Decentralization can be successful if it occurs early, because in this case it can prevent the capital outflow. If decentralization is a response to the export of jobs, its implications are less promising. Decentralization – be it politically enforced or voluntarily imposed by unions – may be ineffective in stopping an already existing capital outflow and reversing the foreign investment decision of firms. Furthermore, it is worth noting that in an open economy, decentralization not only affects the domestic labor market but also generates negative spillovers on foreign workers due to labor market linkages arising from integrated product and capital markets. To be more specific, a movement from sector-level to firm-level wage setting reduces the relative competitiveness of foreign producers and thus their employment in the short run. Furthermore, if decentralization is successful in preventing capital outflow and job exports, it additionally generates long-run losses in terms of foreign employment.

Our paper is of course not the first one that studies the role of unions in open economies, and some of our results have already been established in previous work. For instance, the argument that opening up to trade lowers the ability of unions to set excessive wages can already be found in Huizinga (1993) and Sørensen (1993). Naylor (1998, 1999) broadens our understanding of the consequences of product market integration by looking at marginal reductions in trade

costs. While these studies were concerned with partial equilibrium effects on union wage setting in one particular industry, Bastos and Kreickemeier (2009) have pointed to the role of general equilibrium feedback effects. In their GOLE model with a partially unionized labor market, the competitive wage rises in the open economy and this counteracts the ceteris paribus decline of union wages in a partial equilibrium environment. As a consequence, union wages may actually increase in response to a country's movement from autarky to free trade when general equilibrium feedback effects are accounted for. While all of these studies have contributed significantly to our understanding of the role of labor unions in the context of product market integration, they do not provide insights on how differences in wage-setting institutions shape the outcome in open economies.

The first study that has addressed differences in the degree of centralization in collective bargaining in the context of international trade is Bean, Danthine, Bernholz, and Malinvaud (1990). In an open economy version of the model proposed by Calmfors and Driffill (1988), these authors show that differences in unemployment rates between countries with differing degrees of centralization in collective bargaining decline when product markets become more integrated. Relying on insights from a similar setting, Danthine and Hunt (1994) therefore conclude that the hump shape in the relationship between the degree of centralization in collective bargaining and unemployment flattens in an open economy.[4] Sørensen (1994) looks at the role of centralization in union wage-setting from a different angle and investigates how differences in wage-setting institutions affect the pattern of specialization in a two-sector trade model. The degree of centralization in collective bargaining also features prominently in a literature that broaches the role of central bank independence and its interaction with non-atomistic wage setters in determining key macroeconomic variables, such as unemployment or inflation (see, for instance, Cukierman and Lippi, 1999; Soskice and Iversen, 2000). Daniels, Nourzad, and VanHoose (2006) extend the discussion to an open economy model that allows for international trade flows. However, none of the existing studies in these two strands of the literature addresses the differential impact of product and capital market integration, which is in the center of this paper's interest.

Since capital market integration is associated with job relocation in our setting, our analysis is also related to a sizable literature on the interaction between union wage setting and multinational activity. To the best of our knowledge, this interaction has first been broached by Mezzetti and Dinopoulos (1991), who point out that the threat to shift production abroad improves a firm's bargaining position and reduces the negotiated wage. Zhao (1995) and Eckel and Egger (2009) argue that this threat point argument provides an incentive to set up a foreign production facility from which the firm can import in the case of disagreement with the union. Leahy and Montagna (2000) look explicitly on the role of centralization in union wage setting for

[4]It is worth noting that in Danthine and Hunt (1994) the impact of product market integration on the role of wage-setting institutions is unique, because they consider a model with perfectly competitive producers and inter-industry trade, implying that product market integration does not expose firms of a given industry to stronger foreign competition in the product market.

the investment incentives of multinational firms and investigate under which conditions inward foreign direct investment is welfare improving. Lommerud, Meland, and Sørgard (2003) show that a fall in trade costs may render multinational activity more attractive in the presence of unions, which indicates that the interaction between different forms of globalization may be complicated when collective bargaining leads to rent sharing between firms and workers. While there are many other studies that emphasize specific aspects in the interaction between multinational firms and wage-setting institutions – including work by Bughin and Vannini (1995); Skaksen and Sørensen (2001); Lommerud, Straume, and Sørgard (2006) – there is no contribution that looks explicitly on the differential impact of product market and capital market integration for the macroeconomic consequences of different wage-setting institutions.[5]

The remainder of the paper is organized as follows. Section 2 introduces the theoretical framework and studies the differences between firm-level and sector-level wage setting in a closed economy. In Section 3, we consider two open economies that are fully symmetric in all respects, except for the prevailing degree of centralization in union wage setting, and study how the movement from the closed to an open economy affects aggregate employment and welfare as well as the real income of capital owners and workers. We distinguish between two scenarios of openness: the short run, in which product markets are fully integrated, while investment decisions are given and capital thus remains immobile; and the long run, in which both product and capital markets are fully integrated. In Section 4, we investigate whether decentralization in the country that hosts sector-level unions can be successful in preventing capital outflow and the export of domestic jobs. The last section concludes with a brief summary of the most important results.

2 The closed economy

We start our formal analysis with a detailed model description and a characterization of the autarky equilibrium.

2.1 Assumptions

We consider an economy that is populated by L workers, each of them supplying one unit of labor, and K capital owners, each of them supplying one unit of capital. Capital is required as a fixed input for starting up and operating firms, while labor is used as a variable input in

[5]By looking at the role of union wage setting in open economies, our model also contributes to a meanwhile large and rapidly growing literature that is more generally interested in the role of labor market imperfections in an international trade context. Prominent early examples to this literature include Brecher (1974), Davidson, Martin, and Matusz (1988), Matusz (1996), Davis (1998), and Davidson, Martin, and Matusz (1999). In the last few years, the attention in the literature has shifted towards the role of firm heterogeneity, pointing to the self-selection of the most productive firms into exporting as a key factor for explaining empirical patterns of the labor market (see, for instance, Davidson, Matusz, and Shevchenko, 2008; Egger and Kreickemeier, 2009, 2012; Helpman, Itskhoki, and Redding, 2010; Davis and Harrigan, 2011). For an excellent review of recent work in this field, see McLaren, Harrison, and McMillan (2011).

the production process. Product markets are modeled along the lines of Neary (2003, 2009), who provides a workhorse for studying oligopolistic competition in a general equilibrium environment. Regarding the remuneration of the two factors, we assume that capital owners are entrepreneurs and thus receive firm profits as a return on their capital input. There is no imperfection in the capital market and free entry of firms. On the contrary, there is imperfection in the labor market due to union wage-setting. The remainder of this subsection provides a detailed description of preferences, technology, competition, and labor market institutions.

Preferences and consumer demand

We assume that preferences are described by an additively separable utility function over a continuum of different goods z, with the sub-utility for each of these goods being quadratic. The utility function of consumer c is given by

$$U_c[\{x_c(z)\}] = \int_0^1 a x_c(z) - \frac{1}{2} b x_c(z)^2 dz, \tag{1}$$

and his/her budget constraint equals

$$\int_0^1 p(z) x_c(z) dz \leq I_c, \tag{2}$$

where $p(z)$ denotes the price of good z, and I_c is income of consumer c. Provided that the budget constraint is binding, the solution to the consumer's utility maximization problem, gives his/her inverse demand function for good z:

$$p(z) = \frac{1}{\lambda_c}[a - b x_c(z)], \tag{3}$$

where λ_c is the consumer's marginal utility of income, which is a function of the first and second (uncentered) moments of prices,

$$\mu \equiv \int_0^1 p(z) dz \quad \text{and} \quad \sigma \equiv \int_0^1 p(z)^2 dz, \tag{4}$$

respectively, as well as income, I_c. Rearranging the consumer's budget constraint, we can calculate

$$\lambda_c = \frac{a\mu - b I_c}{\sigma}. \tag{5}$$

To determine economy-wide consumer demand, $X(z)$, we aggregate x_c over all consumers. This gives

$$p(z) = \frac{1}{\lambda}[A - b X(z)], \tag{6}$$

where $A \equiv (K + L)a$, $\lambda \equiv \sum_c \lambda_c = (A\mu - bI)/\sigma$, and $I \equiv \sum_c I_c$. This captures a nice property of consumer preferences in this model: Since preferences are quasi-homothetic, there exists

a positive representative consumer, so that maximizing this consumer's utility subject to the economy-wide budget constraint gives aggregate demand for consumer goods. The representative consumer also has a normative interpretation in our setting and his/her preferences can therefore be used as a measure of social welfare. As extensively discussed in Neary (2009), ignoring constants, we can calculate $\tilde{U} = -\lambda^2\sigma$ as a monotonically transformed measure of the representative consumer's indirect utility. And we can refer to changes in $\tilde{U}$ when being interested in economy-wide welfare effects.

Technology, production, and competition

In each sector, an endogenous number of firms, $n(z)$, produces a homogeneous sector-specific output. Firm number, $n(z)$, is finite and firms therefore take into account their impact on price $p(z)$, when setting quantities in Cournot competition. However, in view of a continuum of industries, firms rationally ignore their impact on economy-wide variables, such as λ or I. Regarding production, we assume that firms in all industries employ the same technology. They invest one unit of capital as a fixed input and must hire one unit of labor for each unit of output they want to produce. Denoting output of firm j in industry z by $y_j(z)$, considering product market clearing, i.e. $\sum_{k=1}^{n(z)} y_k(z) = X(z)$, and accounting for demand function (6), we can write firm-level profits as follows:

$$\Pi_j(z) \equiv \lambda\pi_j(z) = \left[A - b\sum_{k=1}^{n(z)} y_k(z) - \lambda w_j(z)\right] y_j(z). \tag{7}$$

As explained in Neary (2009), $\lambda\pi_j(z)$ can be interpreted as real profits *at the margin*, and changes in this variable do not exert direct welfare implications. However, such changes are still instructive as they indicate adjustments of the competitive environment in the product market. Throughout our analysis we focus on the case of a positive supply of all firms and, therefore, restrict our attention to parameter configurations that lead to $A > \lambda w_j(z)$ for all j and z.

Labor market institutions

We assume that wages are unilaterally set by unions before firms set their employment level, produce and sell their products to consumers.[6] Unions maximize an objective function $V = (w - \bar{w})\ell$, where ℓ is the number of employed union members, which, in the case of a *closed shop*, equals the employment level of all firms in which the respective union is active (see Booth, 1995), w is the union wage, and $\bar{w} \equiv \beta\tilde{w}$ is unemployment compensation, which is a constant share $\beta \in (0, 1)$ of a country's economy-wide average wage, $\tilde{w}$.[7] For that reason, there is no

[6] Limiting union activity to wage setting, we ignore other important aspects of their activities and may therefore end up with a too negative picture of their welfare consequences (see, for instance, Donado and Wälde, 2012). However, this should not be a particular problem for our analysis, because the main purpose of this paper is shedding light on the differential impact of union wage-setting in the closed and the open economy.

[7] In the background, there is a proportional tax on both sources of labor income, wages and unemployment

difference from the perspective of unions between setting gross or net wages, while choosing gross notation helps saving on parameters in the subsequent analysis. Furthermore, while wage w and unemployment compensation $\bar{w}$ are nominal variables, the outcome of the union's maximization problem would of course be unaffected if both of these variables were divided by a common deflator, such as the consumer price index or λ^{-1}.

It is well established in the labor market literature that the wage-setting behavior of unions crucially depends on the degree of centralization in the wage-setting process. The literature distinguishes three possible degrees of centralization: the firm level, the sector level, and the country level. According to OECD (2004) the degree of centralization has continuously declined over the last decades, rendering firm-level and sector-level wage-setting predominant in most industrialized countries.[8] We therefore focus on these two forms of union wage-setting in the subsequent analysis and investigate, in particular, how differences in the degree of centralization affect the labor and product market outcomes in our model. When being organized at the sector-level (index s), unions take into account the impact of their wage claims on sector-wide employment. However, setting a uniform wage for all firms in the industry, they do not care how a given sector-wide employment is distributed across firms in the respective industry. This is captured by setting $\ell = \sum_{k=1}^{n(z)} l_k(z)$. Things are different in the case of firm-level unions (index f) who are only interested in the consequences of their wage claims for their firm's employment level. This is captured by setting $\ell = l_j(z)$ and allowing for firm-specific wage rates.[9] In summary, we can express the objectives of sector-level and firm-level unions in the following way:

$$V^s(z) = \big[w^s(z) - \bar{w}\big] \sum_{k=1}^{n(z)} l_k(z), \qquad V_j^f(z) = \big[w_j(z) - \bar{w}\big] l_j(z). \tag{8}$$

This completes our discussion of the basic model ingredients, and we are now equipped to solve for the autarky equilibrium.

benefits, which provides the revenues for financing unemployment compensation. This income tax has the attractive feature of being a lump-sum instrument, which allows for redistributing resources towards those who do not have a job, without affecting the maximization problems of capital owners, firms, and unions in our model. In this respect, the choice of the tax instrument is in the spirit of Davidson and Matusz (2006) and, in the context of this paper, it allows us to highlight the role of wage-setting institutions in isolation from tax policy.

[8]For instance, firm-level wage setting can be found in Japan, Canada, U.K., or the U.S., while sector-level wage setting is typical for central and northern European countries, such as Austria, Germany, the Netherlands or Sweden.

[9]Of course, the observation that unions are only interested in firm-level employment does not mean that firm-level unions disregard the impact of higher wage claims on the competitors' employment levels. Since firms set quantities in oligopolistic competition after the unions have chosen w, a higher wage claim reduces competitiveness of the own firm and thus leads to output and employment adjustments of the firm's competitors in the subsequent Cournot competition.

2.2 The autarky equilibrium

The equilibrium outcome is characterized by the solution to a three-stage game in which capital owners decide on firm entry at stage one, unions enter and set wages at stage two, while firms choose employment and compete in quantities at stage three. We solve this three stage game through backward induction.

Output competition at Stage 3:
Under Cournot competition, firms set their output to maximize profits (7) subject to $y_j(z) \geq 0$. The (interior) solution to this maximization problem is given by the first-order condition, which can be reformulated to

$$y_j(z) = \frac{A - b\sum_{k \neq j} y_k(z) - \lambda w_j(z)}{2b}. \tag{9}$$

Sector-level unions set a uniform industry-wide wage and since the profit-maximization problem is the same for all firms in this industry, we have $w_k(z) = w(z)$ and thus $y_k(z) = y(z)$ for all $k = 1, ..., n(z)$. Things are different if unions are organized at the firm-level. In this case, union wage claims are only binding for workers of a specific firm. However, since firms have perfect foresight, producer j rationally anticipates symmetry of all competitors, implying $w_k(z) = w_{-j}(z)$ and thus $y_k(z) = y_{-j}(z)$ for all $k \neq j$.[10] In view of these insights, we can reformulate Eq. (9) in the following way:

$$y(z) = \frac{A - \lambda w(z)}{b(n(z)+1)}, \qquad y_j(z) = \frac{A + (n(z)-1)\lambda w_{-j}(z) - n(z)\lambda w_j(z)}{b(n(z)+1)}. \tag{10}$$

Wage setting at Stage 2:
In view of our technology assumptions, we have $l_j(z) = y_j(z)$. Substituting the latter into union objectives (8), accounting for (10), and maximizing the resulting expressions for $w(z)$ and $w_j(z)$, respectively, gives the first-order conditions

$$\frac{dV^s(z)}{dw(z)} = \frac{A - 2\lambda w(z) + \lambda \bar{w}}{b(n(z)+1)} = 0, \quad \frac{dV_j^f(z)}{dw_j(z)} = \frac{A + (n(z)-1)\lambda w_{-j}(z) - 2n(z)\lambda w_j + n(z)\lambda \bar{w}}{b(n(z)+1)} = 0.$$

Due to symmetry of all firms and unions in industry z, we can now set $w_j(z) = w_{-j}(z) = w(z)$. Solving for wages, therefore gives

$$\lambda w^s(z) = \frac{A + \lambda \bar{w}}{2}, \qquad \lambda w^f(z) = \frac{A + n(z)\lambda \bar{w}}{n(z)+1} \tag{11}$$

[10] We use subscript $-j$ for referring to all firms differing from j.

in the case of sector-level and firm-level unions, respectively. According to (11), wage setting of sector-level unions does not depend on the competitive environment in the product market, while firm-level unions set lower wages in response to stronger product market competition as captured by a higher n. This result is well known from a large literature analyzing wage setting in unionized oligopoly. However, it refers to a partial equilibrium outcome as we have treated unemployment benefits as exogenous so far. In general equilibrium, the average wage, $\tilde{w}$, and thus the level of unemployment benefits, $\bar{w} = \beta\tilde{w}$, are endogenously determined. And the equilibrium outcome of these two variables as well as the equilibrium number of firms that are active in industry z, $n(z)$, depend on how capital owners allocate K on the unit mass of industries.

Capital allocation and firm entry at Stage 1:
Capital owners make the investment decision to maximize their profit income. Substituting wage rates (11) into output functions (10) and noting further that $\Pi_j = by_j^2$, we can calculate firm-level profits

$$\Pi^s(z) = \frac{1}{b}\left(\frac{A-\lambda\bar{w}}{2b\left(n(z)+1\right)}\right)^2, \qquad \Pi^f(z) = \frac{1}{b}\left(\frac{n(z)\left(A-\lambda\bar{w}\right)}{\left(n(z)+1\right)^2}\right)^2, \tag{12}$$

where firm indices have been neglected because all firms in an industry are symmetric. Differentiating (12) with respect to $n(z)$, we see that real profit income at the margin shrinks in the number of competitors. Hence, income maximization of capital owners requires an equal number of firms in all industries and thus an allocation of K according to the no arbitrage condition $\Pi(z) = \Pi$ for all z. With a unit mass of industries, we therefore get $n = K$, and since in equilibrium industries are symmetric in all respects, we can omit sector indices from now on. Furthermore, in view of the *ex-post* symmetry of sectors, we can set $\bar{w} = \beta w$. Equipped with this insight, we can now solve for equilibrium wages, employment and profits in the symmetric autarky equilibrium. This gives

$$W^s \equiv \lambda w^s = \frac{A}{2-\beta}, \qquad W^f \equiv \lambda w^f = \frac{A}{1+n(1-\beta)}. \tag{13}$$

It is easily confirmed that $n > 1$ implies $W^s > W^f$, so that our model reproduces the textbook result that sector-level unions set higher wages than firm-level unions (see Calmfors and Driffill, 1988, for supportive empirical evidence). Of course, when interpreting the two expressions in (13) we must keep in mind that W^s and W^f are real wages at the margin, and differences in these two variables therefore do not have a direct welfare implication. However, looking at these variables is still instructive as they capture the strength of labor market imperfection. To be more specific, substituting (13) into (10) and accounting for the symmetry of industries, we can

calculate firm-level output and employment under the two labor market regimes:

$$y^s = l^s = \frac{A(1-\beta)}{b(n+1)(2-\beta)}, \qquad y^f = l^f = \frac{nA(1-\beta)}{b(n+1)[1+n(1-\beta)]}. \tag{14}$$

Higher wage claims of sector-level unions lead to higher production costs and lower firm-level output and employment than in the case of firm-level unions. With firms and industries being symmetric in equilibrium, economy-wide employment can be calculated by plugging (14) into nl. Denoting the unemployment rate by u and focussing on parameter configurations for which not all workers find a job in equilibrium, total employment under the two labor market regimes is given by

$$(1-u^s)L = \frac{nA(1-\beta)}{b(n+1)(2-\beta)}, \qquad (1-u^f)L = \frac{n^2A(1-\beta)}{b(n+1)[1+n(1-\beta)]}. \tag{15}$$

From (15) we can conclude that in an interior equilibrium with involuntary unemployment, i.e. $u > 0$, labor supply is a non-binding constraint and thus aggregate employment independent of labor endowment L (see Brecher, 1974, for a similar result). Furthermore, sector-level unions generate a stronger labor market imperfection leading to higher unemployment than in the case of firm-level unions i.e. $u^s > u^f$. With prices being the same in all industries, it follows from (4) and (5) that $\tilde{U} = -A + b\lambda I/P$, where λI is total real income at the margin and $P = \lambda p$ is the consumer price index. Noting further that a binding budget constraint requires that aggregate revenues, $Pny = P(1-u)L$, equal aggregate income, λI, we can safely conclude that $\lambda I/P = (1-u)L$. Hence, $u^s > u^f$ implies that welfare is lower with sector-level than with firm-level unions: $\tilde{U}^s < \tilde{U}^f$. Summing up, (15) captures the well known result that in a closed economy sector-level unions are more detrimental for the economic performance of a country than firm-level unions (see Calmfors and Driffill, 1988).

In a final step, we now analyze how different degrees of centralization in union wage setting affect the two income groups, capital owners and workers, in our model. Welfare of an income group can be measured by the indirect utility of this group's representative agent, which, assuming identical preferences of workers and capital owners, can be expressed as an increasing function of total real group-specific income. In view of (13) and (15), we can determine economy-wide labor income, $\Phi \equiv (1-u)LW$:[11]

$$\Phi^s = \frac{nA^2(1-\beta)}{b(n+1)(2-\beta)^2}, \qquad \Phi^f = \frac{n^2A^2(1-\beta)}{b(n+1)\left[1+n(1-\beta)\right]^2}. \tag{16}$$

In a similar vein, we can combine $\Pi = by^2$ with (14) to calculate economy-wide profit income

[11] With unemployment benefits being financed by a tax on labor income, total gross wage income equals total net wage income in our model, implying that taxation *per se* does not affect the distribution of income between firm owners and workers in our setting.

$\Psi = n\Pi$:

$$\Psi^s = \frac{nA^2(1-\beta)^2}{b(n+1)^2(2-\beta)^2}, \qquad \Psi^f = \frac{n^3A^2(1-\beta)^2}{b(n+1)^2[1+n(1-\beta)]^2}. \tag{17}$$

Since, by definition, economy-wide labor and profit income must add up to total income, i.e. $\Phi + \Psi = \lambda I$, we can write $\Phi = \phi\lambda I$ and $\Psi = \psi\lambda I$, where ϕ and ψ denote the income shares attributed to workers and capital owners, respectively. For the two wage-setting institutions, we can thus calculate

$$\phi^s = \frac{n+1}{n+2-\beta}, \qquad \psi^s = \frac{1-\beta}{n+2-\beta}, \tag{18}$$

$$\phi^f = \frac{n+1}{(n+1)+n(1-\beta)}, \qquad \psi^f = \frac{n(1-\beta)}{(n+1)+n(1-\beta)}, \tag{19}$$

where $\phi^s > \phi^f$ and $\psi^s < \psi^f$, provided that $n > 1$. Noting further that a binding budget constraint implies that total income must equal total revenues, $\lambda I = Pny$, we can calculate total real labor and capital income, $\Phi/P = \phi(1-u)L$ and $\Psi/P = \psi(1-u)L$, respectively. Using (15), (18) and (19), we obtain

$$\left(\frac{\Phi}{P}\right)^s = \frac{nA(1-\beta)}{b\left[n+2-\beta\right](2-\beta)}, \qquad \left(\frac{\Phi}{P}\right)^f = \frac{n^2A(1-\beta)}{b\left[(n+1)+n(1-\beta)\right]\left[1+n(1-\beta)\right]}, \tag{20}$$

$$\left(\frac{\Psi}{P}\right)^s = \frac{nA(1-\beta)^2}{b(n+1)\left[n+2-\beta\right](2-\beta)}, \left(\frac{\Psi}{P}\right)^f = \frac{n^3A(1-\beta)^2}{b(n+1)\left[(n+1)+n(1-\beta)\right]\left[1+n(1-\beta)\right]}. \tag{21}$$

From inspection of (21), it is immediate that capital owners are better off with wage setting at the firm instead of the sector level. This is intuitive, as we know from above that both total economic rents, $(1-u)L$, as well as the share of rents attributed to capital owners, ψ, are larger with wage-setting at the firm-level. Furthermore, from (20) we can infer that, despite our finding of $\phi^s > \phi^f$, workers are also better off under firm-level wage setting, i.e. $(\Phi/P)^f > (\Phi/P)^s$. However, this does not mean that *all* workers necessarily prefer firm-level to sector-level unions. As formally shown in the Appendix, real *net* wages under sector- and firm-level bargaining are given by

$$\omega^s \equiv \frac{nA(1-\beta)\phi^s}{bL(n+1)(2-\beta)\beta + nA(1-\beta)^2}, \quad \omega^f \equiv \frac{n^2A(1-\beta)\phi^f}{bL(n+1)\left[1+n(1-\beta)\right]\beta + n^2A(1-\beta)^2}, \tag{22}$$

respectively. There are two counteracting effects of a higher degree of centralization in union wage setting on the size of real net wages. On the one hand, it can be inferred from our previous discussion that gross real wages, W/P, are proportional to rent-sharing parameter ϕ and thus higher under sector-level bargaining. On the other hand, sector-level bargaining leads to a lower employment rate, $1-u$, so that a higher income tax is needed to finance unemployment compensation, and this lowers disposable income of those who have a job ceteris paribus. The

tax effect is less pronounced if replacement ratio β is small, implying that, if unemployment compensation is not too generous, those who have a job (as well as those who are unemployed) in both scenarios are better off with sector-level than with firm-level bargaining. This completes the discussion of the closed economy.

3 The open economy

Let us now consider trade between two countries, $i = 1, 2$, whose economies are of the type analyzed in Section 2. We abstract from international shipment costs and assume that product markets are fully integrated, so that consumers in both countries pay the same price. Labor is internationally immobile, and we distinguish two scenarios with respect to capital mobility. In the first one, we assume that the capital investment decision is given and thus firm allocation the same as in the closed economy. We refer to this scenario as the short run because it captures the idea that de-investment of capital takes time. In the long run, capital is fully mobile and invested where it generates the highest return, which may be at home or abroad. Of course, the outflow of capital must be distinguished from actual movements of capital owners, who are assumed to stay in their home country and repatriate profits when capital is invested abroad. This implies that the number of consumers within an economy remains unaffected by adjustments in the investment decision of capital owners, which simplifies welfare comparisons in the subsequent analysis enormously. Regarding labor market institutions, we assume that the two economies differ in the degree of centralization in union wage setting. To be more specific, we assume that country 1 is populated by sector-level unions, while country 2 is populated by firm-level ones. This implies that in the closed economy the labor market friction is more severe in country 1 than in country 2 and that country 1 ends up with lower employment and welfare as well as with lower income of both capital owners and workers under autarky.

To characterize the open economy equilibrium, we can follow the analysis in Section 2 step by step. For studying product market competition, we first need to sum up consumer demand in the two economies. This gives the indirect demand function

$$p^t(z) = \frac{1}{\bar{\lambda}} \left[2A - b\bar{x}^t(z) \right], \tag{23}$$

where superscript t is introduced for referring to $\underline{t}$rade variables and, $\bar{\lambda} \equiv \lambda_1 + \lambda_2$ denotes the world representative consumer's marginal utility of income. Applying the product market clearing condition, firm j's profits are given by

$$\Pi_j^t(z) \equiv \bar{\lambda}\pi_j^t(z) = \left(2A - b \sum_{k=1}^{n^t(z)} y_k(z) - \bar{\lambda} w_j(z) \right) y_j(z), \tag{24}$$

where $n^t(z)$ is the total number of domestic and foreign firms: $n^t(z) = n(z) + n^*(z)$, with the

asterisk indicating the foreign country variable. Solving the firm's profit maximization problem, we can calculate j's optimal output

$$y_j(z) = \frac{2A + n^*(z)\bar{\lambda}w^*(z) + (n(z)-1)\,\bar{\lambda}w(z) - (n(z)+n^*(z))\,\bar{\lambda}w_j(z)}{b\,(n(z)+n^*(z)+1)} \tag{25}$$

as a function of the own as well as the domestic and foreign competitors' wage rates, $w_j(z)$, $w(z)$, and $w^*(z)$, respectively.

To solve for the unions' wage setting problem, we can substitute (25) into the union objectives in (8) and maximize the resulting expressions for the respective union wage rates. As formally shown in the Appendix, this gives a system of two equations that characterize the optimal wage choices for a given capital allocation:

$$\begin{aligned}\bar{\lambda}w_1(z) = {} & \frac{2A\,[2\,(n_1(z)+n_2(z))+1] + n_2(z)\,(n_1(z)+n_2(z))\,\bar{\lambda}\bar{w}_2}{3n_1(z)n_2(z)+2n_2(z)^2+4n_1(z)+4n_2(z)+2} \\ & + \frac{(n_2(z)+1)\,[2n_1(z)+n_2(z)+1]\,\bar{\lambda}\bar{w}_1}{3n_1(z)n_2(z)+2n_2(z)^2+4n_1(z)+4n_2(z)+2},\end{aligned} \tag{26}$$

$$\begin{aligned}\bar{\lambda}w_2(z) = {} & \frac{2A\,[n_1(z)+2n_2(z)+2] + n_1(z)\,(n_2(z)+1)\,\bar{\lambda}\bar{w}_1}{3n_1(z)n_2(z)+2n_2(z)^2+4n_1(z)+4n_2(z)+2} \\ & + \frac{2\,(n_2(z)+1)\,(n_1(z)+n_2(z))\,\bar{\lambda}\bar{w}_2}{3n_1(z)n_2(z)+2n_2(z)^2+4n_1(z)+4n_2(z)+2}.\end{aligned} \tag{27}$$

Regarding capital allocation at Stage 1, we distinguish between a short-run perspective, in which firm numbers are determined by the investment decisions of the closed economy, and a long-run perspective, in which investment decisions are adjusted to maximize the income of capital owners in the open economy. We start with an analysis of the short-run equilibrium.

A short-run trade equilibrium

Since the capital allocation in the short run is the same as under autarky, we have $n_1(z) = n_2(z) = n(z)$. Accounting for $\bar{w}_i = \beta w_i$, we can therefore simplify wage rates (26) and (27) in the following way:

$$W_1^{sr} \equiv \left(\bar{\lambda}w_1\right)^{sr} = \frac{2A\,[(2n+1)+2n(1-\beta)]}{(n+1)(1-\beta)\,[(3n+1)+2n(1-\beta)]+(2n+1)}, \tag{28}$$

$$W_2^{sr} \equiv \left(\bar{\lambda}w_2\right)^{sr} = \frac{2A\,[(2n+1)+(n+1)(1-\beta)]}{(n+1)(1-\beta)\,[(3n+1)+2n(1-\beta)]+(2n+1)}, \tag{29}$$

where superscript 'sr' refers to the short run. Substituting (28) and (29) into Eq. (25) yields

short-run equilibrium output levels

$$y_1^{sr} = \frac{2A(n+1)(1-\beta)\left[(2n+1)+2n(1-\beta)\right]}{b(2n+1)\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}}, \tag{30}$$

$$y_2^{sr} = \frac{4nA(1-\beta)\left[(2n+1)+(n+1)(1-\beta)\right]}{b(2n+1)\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}}. \tag{31}$$

And, in view of symmetry of all producers in country i, we thus obtain total employment levels by substituting $l_i = y_i$ into $(1-u_i)L = nl_i$. This gives

$$(1-u_1^{sr})L = \frac{2nA(n+1)(1-\beta)\left[(2n+1)+2n(1-\beta)\right]}{b(2n+1)\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}}, \tag{32}$$

$$(1-u_2^{sr})L = \frac{4n^2A(1-\beta)\left[(2n+1)+(n+1)(1-\beta)\right]}{b(2n+1)\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}}. \tag{33}$$

As formally shown in the Appendix, we can infer from contrasting (15) with (32) and (33) that product market integration provides an employment stimulus relative to the closed economy. And this stimulus is essential for gains from trade in our model. Since prices are identical in all industries, consumers equally distribute their income on the unit mass of industrial goods. In this case, a pari passu increase in the employment of all firms allows for a proportional increase in the consumption of all products in the open economy, implying that welfare unambiguously goes up. Put differently, similar to the closed economy country-level aggregate employment is equal to total real income in this economy, which is an adequate welfare measure in our setting. Since product market integration raises employment in both countries relative to the closed economy, welfare must be higher in the open economy than under autarky.

In addition, we can determine the relative importance of wage-setting institutions for the two macroeconomic performance measures in the open as compared to the closed economy by looking at the sign of $\Delta u^{sr} - \Delta u$, with $\Delta u^{sr} \equiv u_1^{sr} - u_2^{sr}$ and $\Delta u \equiv u^s - u^f$. It is formally shown in the Appendix that the sign of $\Delta u^{sr} - \Delta u$ is equivalent to the sign of $-1+(1-\beta)(n^2-1)$, which in general can be positive or negative. However, noting that even in countries with generous unemployment compensation schemes, those who do not find a job receive a compensation that is smaller than 2/3 of the going wage rate,[12] i.e. $\beta < 2/3$, we can conclude that $n \geq 2$ is sufficient for $\Delta u^s < \Delta u$ when focusing on empirically relevant parameter domains. In this case, our model reproduces the well known result that product market integration reduces the impact that differences in the degree of centralization exert on key macroeconomic variables, such as unemployment and welfare (see Danthine and Hunt, 1994).

The following proposition summarizes the main insights from the analysis above.

[12]For instance, gross replacement rates are smaller than 2/3 for all OECD countries. This is also true for standard measures of net replacement rates. Only if social assistance and housing benefits are added, net replacement rates are larger than 2/3 for some of the OECD countries. (Source: http://www.oecd.org/dataoecd/60/8/49971171.xlsx)

Proposition 1 *Product market integration increases total employment and aggregate welfare in both countries, irrespective of the degree of centralization in the wage-setting process. Furthermore, provided that $\beta < 2/3$ and $n \geq 2$, differences in the the degree of centralization in the union wage-setting are less important for unemployment and welfare in the short-run open economy than under autarky.*

Proof. Analysis in the text and derivation details in the Appendix. ■

In a next step, we are interested in the group-specific effects of product market integration. Substituting W_i from (28) and (29) as well as $(1-u_i)L$ from (32) and (33) into $\Phi_i = (1-u_i)LW_i$ we can determine economy-wide labor income at the margin in the two economies:

$$\Phi_1^{sr} = \frac{4nA^2(n+1)(1-\beta)\left[(2n+1)+2n(1-\beta)\right]^2}{b(2n+1)\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}^2}, \tag{34}$$

$$\Phi_2^{sr} = \frac{8n^2A^2(1-\beta)\left[(2n+1)+(n+1)(1-\beta)\right]^2}{b(2n+1)\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}^2}. \tag{35}$$

In a similar vein, we can substitute y_i from (30) and (31) into $\Psi_i = n\Pi_i = bny_i^2$ to economy-wide profit income at the margin in the two economies:

$$\Psi_1^{sr} = \frac{4nA^2(n+1)^2(1-\beta)^2\left[(2n+1)+2n(1-\beta)\right]^2}{b(2n+1)^2\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}^2}, \tag{36}$$

$$\Psi_2^{sr} = \frac{16n^3A^2(1-\beta)^2\left[(2n+1)+(n+1)(1-\beta)\right]^2}{b(2n+1)^2\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}^2}. \tag{37}$$

Noting from the discussion of the closed economy that $\Phi_i + \Psi_i = \bar{\lambda}I_i$ and $P(1-u_i)L = \bar{\lambda}I_i$, we can furthermore compute

$$\phi_1^{sr} = \frac{2n+1}{(2n+1)+(n+1)(1-\beta)}, \qquad \psi_1^{sr} = \frac{(n+1)(1-\beta)}{(2n+1)+(n+1)(1-\beta)}, \tag{38}$$

$$\phi_2^{sr} = \frac{2n+1}{(2n+1)+2n(1-\beta)}, \qquad \psi_2^{sr} = \frac{2n(1-\beta)}{(2n+1)+2n(1-\beta)}. \tag{39}$$

Contrasting (38) and (39) with their counterparts in the closed economy, we see that trade improves the relative position of firm owners and lowers the share of total rents that is attributed to workers. This is not surprising, as we know from above that trade reduces union wage claims. While the reduction of wages ceteris paribus lowers welfare of those workers who already had a job prior to product market integration, it does not mean that workers lose on average. The reason is that prices fall and employment expands in response to the trade shock, and this generates two counteracting positive welfare effects for workers. To shed light on which of the opposing effects dominates, we can substitute (32) and (33) together with (38) and (39) into $\Phi_i/P = \phi_i(1-u_i)L$, which allows us to calculate total real wage income (and thus welfare) of

workers:

$$\left(\frac{\Phi_1}{P}\right)^{sr} = \frac{2nA(n+1)(1-\beta)\left[(2n+1)+2n(1-\beta)\right]}{b\left[(2n+1)+(n+1)(1-\beta)\right]\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}} \quad (40)$$

$$\left(\frac{\Phi_2}{P}\right)^{sr} = \frac{4n^2A(1-\beta)\left[(2n+1)+(n+1)(1-\beta)\right]}{b\left[(2n+1)+2n(1-\beta)\right]\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}}. \quad (41)$$

In the Appendix, we show that a comparison of (40) and (41) with the respective expressions in (20) makes clear that group-specific welfare of workers is unambiguously higher in the open than in the closed economy.

To determine total real profit income (and thus welfare) of capital owners, in the open economy, we substitute (32) and (33) together with (38) and (39) into $\Psi_i/P = \psi_i(1-u_i)L$, which yields

$$\left(\frac{\Psi_1}{P}\right)^{sr} = \frac{2nA(n+1)^2(1-\beta)^2\left[(2n+1)+2n(1-\beta)\right]}{b(2n+1)\left[(2n+1)+(n+1)(1-\beta)\right]\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}}, \quad (42)$$

$$\left(\frac{\Psi_2}{P}\right)^{sr} = \frac{8n^3A(1-\beta)^2\left[(2n+1)+(n+1)(1-\beta)\right]}{b(2n+1)\left[(2n+1)+2n(1-\beta)\right]\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}}. \quad (43)$$

Since we know from our analysis above that product market integration raises both the size of total economic rents, $(1-u_i)L$, as well as the share of these rents attributed to capital owners, ψ_i, it is immediate that capital owners must be unambiguously better off in the open than in the closed economy.

The following proposition summarizes the short-run effects of product market integration on group-specific welfare of capital owners and workers.

Proposition 2 *Product market integration increases real income and thus welfare of capital owners as well as workers in both countries, irrespective of the degree of centralization in the wage-setting process.*

Proof. Analysis in the text and derivation details in the Appendix. ■

Since both workers and capital owners are better off in the open economy, one may be tempted to conclude that both income groups should welcome efforts of policy makers to further deepen economic integration. However this conclusion would be short-sighted for at least two reasons. On the one hand, while workers as a group benefit from trade liberalization due to an expansion in aggregate employment, this is not true for each individual worker. In particular, those who already had a job in the closed economy may experience an income loss due to wage moderation of unions in the open economy and thus may oppose further economic integration. On the other hand, globalization in the 21^{st} century is more than just the shipment of goods across borders. In the last few decades the increasing ability of firms to shift production to low-cost destinations has become a major concern of workers in the industrialized world. Hence,

it is important to shed further light on this facet of globalization for getting a better understanding about why workers are often not enthusiastic about openness. Studying the consequences of capital mobility and the associated relocation of jobs is the purpose of the following subsection.

A long-run trade equilibrium

In the long run, capital owners adjust their investment decisions in order to maximize profit income. Abstracting from extra costs of foreign investment, we can conclude that an interior equilibrium with full diversification requires $\Pi_1(z) = \Pi_2(z) \equiv \Pi^t(z)$ and $\Pi^t(z) = \Pi^t$ for all z. In view of linear demand, the two no arbitrage conditions imply that firm-level output must be the same in both countries and all industries and thus $w_i(z) \equiv w$ for all z and $i = 1, 2$, according to (25). In the Appendix we show that a unique full diversification equilibrium exists and in this equilibrium firm allocation is symmetric across industries, i.e. $n_i(z) = n_i$ for all z, and given by $n_1 = 1$ and $n_2 = 2n - 1$. This outcome is intuitive, as we know from the analysis of the short-run scenario that, with an equal number of firms in either country, production costs are higher in country 1 than country 2, i.e. $(\bar{\lambda}w_1)^{sr} > (\bar{\lambda}w_2)^{sr}$. And due to this production cost differences, there is an incentive for capital owners to de-invest in country 1 and to set up a new production facility in country 2. As a consequence, capital flows from country 1 to country 2, and this flow continues until profit income is equalized, i.e. until union wage-setting generates the same outcome in the two economies, irrespective of the prevailing differences in the degree of centralization in union wage-setting. This requires $n_1 = 1$, because in this case the sector-level union in country 1 degenerates to a firm-level union.[13]

With the equilibrium firm allocation at hand, we can now calculate employment, welfare and group-specific income in the long-run open economy equilibrium. Setting $\bar{\lambda}w_i = \bar{\lambda}w$, $n_1 = 1$, and $n_2 = 2n - 1$, we rewrite (26) and (27) in the following way:

$$W^{lr} \equiv (\bar{\lambda}w)^{lr} = \frac{2A}{1 + 2n(1 - \beta)}, \tag{44}$$

where superscript 'lr' refers to the long-run open economy equilibrium. Substituting the latter into (25) gives firm-level employment and output in the long-run trade equilibrium:

$$y^{lr} = \frac{4nA(1 - \beta)}{b(2n + 1)\left[1 + 2n(1 - \beta)\right]}. \tag{45}$$

Comparing the output levels from the short-run equilibrium in (30) and (31) with (45), we can show that $y_1^{sr} < y^{lr} < y_2^{sr}$. This ranking is intuitive. On the one hand, firms in country 1 lose their competitive disadvantage in the long run and thus experience an output increase. On the

[13] One might speculate that an outcome with $n_1 = 2n - 1$ and $n_2 = 1$ is an alternative candidate for a long-run equilibrium firm allocation. However, this is not true. While $n_2 = 1$ indeed implies that unions in country 2 set sector-wide wages that are binding for all workers employed in domestic production of the respective industry, there remains an asymmetry in union coverage in the two economies, and hence the outcome of wage setting in the two countries would not be the same in this case.

other hand, firms in country 2 lose their competitive advantage relative to foreign producers and thus experience an output reduction.

To determine aggregate employment in country i, we can add up firm-level employment (output) over all firms that are active in country i. In view of (45), this gives

$$\left(1-u_1^{lr}\right)L=\frac{4nA(1-\beta)}{b(2n+1)\left[1+2n(1-\beta)\right]},\qquad \left(1-u_2^{lr}\right)L=\frac{4n(2n-1)A(1-\beta)}{b(2n+1)\left[1+2n(1-\beta)\right]}. \tag{46}$$

Comparing (46) with the aggregate employment levels of the short-run open economy equilibrium in (32) and (33), we see that capital flows towards the country with more decentralized wage setting lower employment in country 1 and raise employment in country 2. From inspection of Eq. (15), we can further note that if unemployment compensation is not too generous and the number of competitors not too small the negative employment effect triggered by capital outflow in country 1 may be strong enough to reverse the positive short-run effect of product market integration. The higher is n, the more capital flows from country 1 to country 2, and the stronger is the negative employment effect in country 1. The higher is β, the smaller is firm-level employment and the smaller is ceteris paribus the number of domestic jobs replaced by foreign ones in the case of capital outflow.

To determine country-specific welfare, we must look at total real income $\bar{\lambda}I_i/P$. Noting that total labor income equals $\Phi_i=(1-u_i)LW$, while total capital income is $\Psi_i=nby^2$, we can calculate:

$$\left(\frac{\bar{\lambda}I_1}{P}\right)^{lr}=\frac{4nA(1-\beta)}{b(2n+1)\left[1+2n(1-\beta)\right]}\,\frac{(2n+1)+2n^2(1-\beta)}{(2n+1)+2n(1-\beta)}, \tag{47}$$

$$\left(\frac{\bar{\lambda}I_2}{P}\right)^{lr}=\frac{4nA(1-\beta)}{b(2n+1)\left[1+2n(1-\beta)\right]}\,\frac{(2n-1)(2n+1)+2n^2(1-\beta)}{(2n+1)+2n(1-\beta)}. \tag{48}$$

according to (44)-(46).[14] Noting from the analysis above that under autarky as well as in the short run open economy aggregate income is equal to total employment, $\bar{\lambda}I_i/P_i=(1-u_i)L$, we can infer the welfare effects of capital relocation from a comparison of (15), (32), (33), (47) and (48). As formally shown in the Appendix, the inflow of capital unambiguously raises welfare in country 2, whereas capital outflow has negative welfare consequences in country 1. However, this does not mean that country 1 is worse off in the long-run open economy equilibrium than under autarky. On the contrary, provided that capital owners repatriate their profits from their foreign production activity, welfare losses associated with capital outflow are unambiguously lower than the welfare gains from product market integration in the short run.

Regarding the impact of the degree in union wage-setting on the relative macroeconomic

[14]Total income of country 1 is given by $\left(\bar{\lambda}I_1\right)^{lr}=\Phi_1^{lr}\left[1+2n^2(1-\beta)/(2n+1)\right]$, while total income of country 2 is given by $\left(\bar{\lambda}I_2\right)^{lr}=\Phi_2^{lr}\left[1+2n^2(1-\beta)/(4n^2-1)\right]$. Furthermore, the value of total *domestic* output equals $n_i\left(Py\right)^{lr}=\Phi_i^{lr}\left[1+2n(1-\beta)/(2n+1)\right]$. Putting together and substituting for y^{lr} and n_i^{lr}, we can calculate $\left(\bar{\lambda}I_1/P\right)^{lr}$, $\left(\bar{\lambda}I_2/P\right)^{lr}$ in Eqs. (47) and (48), respectively.

performance in the two economies, we show in the Appendix that capital outflow raises both the employment as well as the welfare differential between the two economies, and this effect is strong enough to render the respective differentials larger than under autarky. Hence, the finding in Bean, Danthine, Bernholz, and Malinvaud (1990) and Danthine and Hunt (1994) that in an open economy differences in wage-setting institutions are less important for the economic performance of countries does no longer hold – at least in our setting – if one accounts for international capital mobility as an important feature of open economies. All other things equal, the surge of international capital flows over the last few decades may therefore lead to a revitalization of the hump-shape relationship between the degree of centralization in union wage-setting and unemployment as identified by Calmfors and Driffill (1988) for the closed economy.

The following proposition summarizes the impact of capital mobility on aggregate employment and welfare as well as their differentials between the two economies.

Proposition 3 *In the long run, capital inflows increase aggregate employment and welfare in country 2, while capital outflows reduce employment and welfare in country 1. Furthermore, welfare is definitely higher in the long-run open economy equilibrium than under autarky, while the ranking of employment in the two scenarios is not clearcut in general. Finally, in the long run open economy, the employment and welfare differentials between the two economies are even more pronounced than under autarky.*

Proof. Analysis in the text and derivation details in the Appendix. ■

Being not only interested in aggregate but also in group-specific effects, we additionally determine real income of workers and entrepreneurs. Looking first at the group of workers, we can calculate[15]

$$\left(\frac{\Phi_1}{P}\right)^{lr} = \frac{4nA(1-\beta)}{b[1+2n(1-\beta)][(2n+1)+2n(1-\beta)]}, \tag{49}$$

$$\left(\frac{\Phi_2}{P}\right)^{lr} = \frac{4n(2n-1)A(1-\beta)}{b[1+2n(1-\beta)][(2n+1)+2n(1-\beta)]}. \tag{50}$$

Comparing (49) with total real wage income of workers in the short-run open economy, we find that capital outflow harms workers in country 1. However, this does not mean that workers also lose relative to autarky. Contrasting (49) with the respective expression for the closed economy in (20), we find that welfare losses of workers due to capital outflow do not necessarily dominate the short-run welfare stimulus this group experiences from product market integration. To be more specific, we find that workers are the more likely better off in the long-run open economy equilibrium than under autarky, the more generous is unemployment compensation and the weaker is product market competition. Furthermore, due to capital inflow and the

[15]From Footnote 14, we know that $(\Phi_i/P)^{lr} = n_i y^{lr}\left[1+2n(1-\beta)/(2n+1)\right]^{-1}$. Substituting (45) and $n_1 = 1$, $n_2 = 2n-1$, then gives (49) and (50), respectively.

establishment of new local jobs, workers in country 2 are unambiguously better off in the long-run open economy equilibrium than in the short run or under autarky.

In a final step, we look at total real capital income. In the absence of extra costs for foreign investment, profit income must be the same in the two economies, and it is given by[16]

$$\left(\frac{\Psi}{P}\right)^{lr} = \frac{8n^3A(1-\beta)^2}{b(2n+1)[(2n+1)+2n(1-\beta)][1+2n(1-\beta)]}. \tag{51}$$

Intuitively, capital mobility improves investment opportunities of capital owners in country 1, who are therefore unambiguously better off in the long-run open economy equilibrium than in the short run or under autarky. Things are different for capital owners in country 2. The inflow of capital reduces the competitive advantage of country 2 firms relative to country 1 firms, with negative consequences for the market position of country 2 firms. As a consequence, capital owners in country 2 lose relative to the short-run open economy equilibrium, while they are still better off than under autarky.

Proposition 4 *In the long run, better investment opportunities reinforce the short-run stimulus of trade on total real capital income in country* 1*. Capital outflow lowers welfare of workers in country* 1 *relative to the short-run open economy equilibrium, but these losses need not be high enough to destroy all benefits from product market integration. Capital inflow lowers income of capital owners in country* 2*, but does not entirely destroy this group's benefits from product market integration. Finally, capital inflow reinforces the short-run gains of workers in country* 2*.*

Proof. Analysis in the text and derivation details in the Appendix. ■

4 Decentralization in union wage setting

In view of our insights from the previous section that workers in the country that hosts sector-level unions are hurt in the long run due to capital outflow, we now analyze how a shift from sector-level to firm-level wage setting in country 1 affects the capital allocation in our model. Decentralization in union wage setting not only refers to a common trend within OECD countries over the last few decades, but also captures a possible form of policy intervention that aims at banning those factors which render capital outflow attractive. That this is a relevant policy option can be inferred from the observation that in the aftermath of the Eurozone crisis, the European Council has suggested to "review the wage setting arrangements, and, where necessary,

[16]Substituting (45) into $\Psi = nby^2$ and $P = 2(A - bny)$, we can calculate

$$\Psi = \frac{8n^3A(1-\beta)^2}{b(2n+1)\left[1+2n(1-\beta)\right]\left[2n+1+2n(1-\beta)\right]}, \qquad P = \frac{2A\left[2n+1+2n(1-\beta)\right]}{(2n+1)\left[1+2n(1-\beta)\right]}.$$

Substituting these two expressions into Ψ/P, gives (51).

the degree of centralization in the bargaining process, [. . .], while maintaining the autonomy of the social partners in the collective bargaining process" (European Council, 2011) as one promising instrument to stabilize the system.

But can decentralization be a successful reform? To answer this question, it is worth noting that with firm-level wage setting everywhere, the real wage at the margin is the same in both locations and given by (44), while firm-level output is determined by (45). This outcome does not depend on where capital is invested. In view of this invariance result, we have to impose an additional assumption that allows us to determine capital allocation in the case of indifference. A plausible solution to this problem can be derived from the observation that in the case of indifference capital owners will refuse to adjust their investment decisions if de-investment would involve just infinitesimally small costs. However, this implies that if decentralization in union wage setting occurs after a long-run equilibrium with firm allocation $n_1 = 1$ and $n_2 = 2n - 1$ has been established (*ex-post* decentralization, in short), it is ineffective and leaves all long-run equilibrium variables unchanged. On the contrary, if decentralization occurs prior to the capital outflow (*ex-ante* decentralization, in short) it is fully effective and bans the long-run incentives for de-investment in country 1.[17]

Since *ex-post* decentralization does not alter the long-run equilibrium outlined in Section 3, we focus on the impact of *ex-ante* decentralization in the subsequent analysis. Noting that wage claims and output after the reform are given by (44) and (45), respectively, we can calculate aggregate employment materializing under firm-level union wage-setting in both economies (and symmetric firm allocation $n_1 = n_2 = n$). This gives:

$$(1 - u^r)L = \frac{4n^2A(1-\beta)}{b(2n+1)[1+2n(1-\beta)]}, \tag{52}$$

where superscript r indicates post-reform (or post-decentralization) variables. With output per firm increasing and the number of active firms remaining constant, total employment in country 1 is higher than in the short-run open economy equilibrium. Hence, the decentralization in union wage-setting is not only successful in abolishing the incentives for capital outflow, but it also provides an additional short-run stimulus for domestic employment, because it lowers union wage claims and thus the competitive disadvantage of domestic firms in the international market. Of course, this increase in the competitiveness of domestic firms generates negative spillovers on the foreign labor market. Since firms in country 2 lose their competitive advantage vis-á-vis the producers in country 1, they choose lower output and therefore employ less workers than in the (pre-decentralization) short-run open economy equilibrium. In contrast to the long-run open economy equilibrium studied in Section 3, there is furthermore no capital inflow that

[17] In the subsequent analysis, we disregard other policy measures that may be used to alter investment decisions in a country's favor, such as subsidies. While it is clear that governments have an incentive to use tax instruments strategically in our setting, considering them would not provide any novel insights relative to Haufler and Wooton (2010); Ferrett and Wooton (2010), and this is the reason why we ignore them.

compensates for the decline in production triggered by the improvement in the competitiveness of country 1 firms, and hence aggregate employment in country 2 unambiguously falls in response to decentralization in the wage setting of country 1 unions. With welfare being directly linked to aggregate employment in this paper, it is immediate that the positive employment effects in country 1 are associated with welfare gains, while the employment reduction in country 2 is accompanied by welfare losses.

Equipped with these insights, we now take a closer look at the group-specific welfare effects of *ex-ante* decentralization in the wage-setting of country 1. Welfare of workers is determined by total real labor income $(\Phi/P)^r$, while welfare of capital owners is determined by total real profits $(\Psi/P)^r$. To calculate these variables, we can first determine total real labor income and total real profit income *at the margin*, $\Phi^r = W^r(1-u^r)L$ and $\Psi^r = nb(y^r)^2$, respectively. Substituting (44), (45), and (52), we obtain

$$\Phi^r = \frac{8n^2A^2(1-\beta)}{b(2n+1)[1+2n(1-\beta)]^2}, \qquad \Psi^r = \frac{16n^3A^2(1-\beta)^2}{b(2n+1)^2[1+2n(1-\beta)]^2}. \tag{53}$$

Similar to the analysis in Sections 2 and 3, it is also useful to calculate the share of economic rents that accrues to workers and capital owners, $\phi = \Phi^r/(\lambda I)^r$ and $\psi = \Psi^r/(\lambda I)^r$, respectively. Noting that $(\lambda I)^r = \Psi^r + \Phi^r$ must hold by definition, we can calculate

$$\phi^r = \frac{2n+1}{(2n+1)+2n(1-\beta)}, \qquad \psi^r = \frac{2n(1-\beta)}{(2n+1)+2n(1-\beta)}, \tag{54}$$

respectively. Contrasting (54) with the respective findings in (38) and (39) gives the following rankings $\phi_1 > \phi_2 = \phi^r$ and $\psi_1 < \psi_2 = \psi^r$. We can therefore conclude that decentralization attributes a larger share of rents to capital owners in country 1, while leaving rent-sharing in country 2 unaffected. To put it differently, the spillover effects identified above alter the total size of economic rents in country 2, but not the way these rents are distributed between capital owners and workers there.

Total real income of workers can now be calculated by substituting (52) and (54) into $(\Phi/P)^r = \phi^r(1-u^r)L$, which gives

$$\left(\frac{\Phi}{P}\right)^r = \frac{4n^2A(1-\beta)}{b[1+2n(1-\beta)][(2n+1)+2n(1-\beta)]}. \tag{55}$$

From a comparison of (55) with (40), we can conclude that it is not clearcut in general whether workers in country 1 gain or lose due to ex-ante decentralization relative to the short-run open economy equilibrium. As formally shown in the Appendix, the outcome depends on the competitive environment in the product market as well as the generosity of unemployment compensation. If unemployment benefits are small and competition sufficiently strong, workers in country 1 are worse off after the decentralization in the wage-setting of local unions. However, this does not

mean that workers should oppose the reform. Decentralization in union wage setting, while generating short-run losses, may still be to the benefit of workers, because it helps avoiding the capital outflow and thus the even more disastrous long-run outcome in (49).

Things are different in country 2, where workers face double losses from *ex-ante* decentralization in the wage setting of country 1. On the one hand, they lose because firms in country 2 experience a fall in their competitiveness relative to producers in country 1 and therefore hire less workers in the short run (see above). On the other hand, they also lose because the reform abolishes the incentives for capital relocation and thus destroys the long-run gains of workers in country 2 due to import of jobs. One final remark is in order here. While workers in both countries lose from *ex-ante* decentralization, one should not be tempted to conclude that globalization – by increasing the pressure to decentralize wage setting – lowers the welfare of workers. On the contrary, product market integration generates huge short-run benefits for workers in our setting and these benefits (while smaller) do still exist after the change in wage-setting institutions.

To round off the analysis in this section, we finally calculate group-specific welfare of capital owners. Substituting (52) and (54) into $(\Psi/P)^r = \psi^r(1-u^r)L$, we obtain

$$\left(\frac{\Psi}{P}\right)^r = \frac{8n^3A(1-\beta)^2}{b(2n+1)[1+2n(1-\beta)][(2n+1)+2n(1-\beta)]}. \tag{56}$$

which replicates the outcome for the long-run open economy equilibrium in (51). We can therefore infer the impact of *ex-ante* decentralization on welfare of capital owners from the respective discussion in Section 3. Capital owners in country 1 are better off after the change in the local wage setting institutions than in the short run open economy equilibrium or under autarky. Capital owners in country 2 lose relative to the (pre-decentralization) short run open economy equilibrium but are still better off than in the closed economy.

The following proposition summarizes the main insights from the analysis above.

Proposition 5 *For the effectiveness of decentralization in union wage-setting, the timing is important. If decentralization occurs after the capital outflow, it is not successful in restoring the initial capital allocation. However, if decentralization occurs early, it can prevent the capital outflow with positive consequences for domestic employment and welfare, and possibly the real income of workers. This success comes at the cost of negative spillovers on country* 2*, where employment, welfare, and real labor income shrink in response to decentralization in the wage-setting of country* 1 *unions. At least in the long run, capital owners are not affected by the decentralization in country* 1*, because they can always enforce the outcome of firm-level wage-setting by relocating their investment accordingly.*

Proof. Analysis in the text and derivation details in the Appendix. ■

The general recommendation from our analysis for policy makers who aim at securing domestic jobs in an open economy is clear. Act early to prevent capital outflow, because it may

be difficult (if not impossible) to reverse the investment decisions of domestic capital owners once they have set up their production facilities abroad. The costs of responding late to new challenges in an open economy may be even more significant if agglomeration effects are at work. In this case, a government that aims at persuading domestic capital owners to invest at home instead of abroad may have to pay the full agglomeration rent – in addition to the direct costs of de-investment in the foreign country – when these capital owners have already closed their domestic plants because of the strong local wage-setting institutions.

5 Concluding remarks

This paper presents a general oligopolistic equilibrium model with unionized labor markets and two countries that differ in the degree of centralization in union wage setting. In this framework, we investigate how openness alters the way in which the degree of centralization in union wage setting affects key macroeconomic variables, such as welfare and unemployment. Thereby we distinguish two forms of openness: a short-run scenario, in which product markets are fully integrated, while capital markets remain segmented; and a long-run scenario, in which both product and capital markets are integrated. In the short run, product market integration has the expected effects. It lowers the scope of unions to set excessive wages, with positive effects on welfare and economy-wide employment in both economies. Furthermore, the results from our analysis are consistent with findings from previous research that differences in the degree of centralization in union wage-setting are less important for unemployment and welfare in open economies. We also shed light on group-specific effects of openness and show that even though product market integration alters the way economic rents are distributed in the society, the overall increase in production generates benefits for both income groups in our model: capital owners and workers.

However, our analysis also makes clear that these optimistic conclusions regarding the consequences of openness refer to a short-run perspective. When capital becomes internationally mobile it searches for the best investment opportunities worldwide and therefore moves to the country with less centralized wage setting and lower labor costs. The capital outflow reduces welfare and employment in the country with the higher degree of centralization in union wage-setting and alters the distribution of income in this economy significantly. While workers are worse off due to an export of jobs, capital owners benefit from having access to better investment opportunities. Things are exactly the opposite in the country with the more decentralized level of wage-setting. Due to an inflow of capital this country experiences a welfare gain and an employment expansion. Furthermore, while workers benefit from an inflow of capital and the establishment of new local jobs, capital owners are worse off, because their firms lose their competitive advantage in the product market. Our results also indicate that in the long run, openness does not reduce the impact the degree of centralization exerts on macroeconomic per-

formance measures, but instead widens the gap in unemployment and welfare between the two economies.

To round off the discussion in this paper, we have looked at the consequences of decentralization of wage-setting in the country with the more severe labor market imperfection. The results from this analysis make clear that such a reform can be successful in preventing capital outflow when it occurs early, i.e before the relocation of capital starts. Early attempts to decentralize union wage-setting can indeed be essential for securing benefits of product market integration in the long run and for rendering globalization a success story for all income groups. On the contrary, if decentralization starts after capital owners have adjusted their investment decisions in the long run, the reform is less promising and may fail to restore the initial capital allocation. In this case, long-run losses of some income groups may be unavoidable, rendering strong and persistent opposition by the respective income groups a real threat to globalization.

While we hope that this paper broadens the understanding of how different wage-setting institutions shape the outcome in open economies, it is clear that the analysis builds on many simplifying assumptions which are attractive from the perspective of analytical tractability, but at the same time limit the ability of our model to inform policy makers on how to solve real world problems. One restrictive feature of our analysis is the assumption of identical unemployment compensation schemes. Since we know that OECD countries systematically differ in this respect, it may be a worthwhile task for future research to consider more explicitly the interaction between union wage-setting institutions and unemployment compensation schemes for determining unemployment and welfare in open economies. Another restrictive assumption in our model is the immobility of workers. While it is evident that capital and product markets are more integrated than labor markets, the increasing mobility of workers has also been an important aspect of globalization in the last few decades. Whereas a detailed discussion on how migration alters the insights from our analysis is beyond the scope of this paper, it is worth noting that the higher probability of getting a job abroad may be a key rationale for emigration in our setting. Hence, if migration were possible, workers would follow capital in the long run, and this points to differences in the degree of centralization in union wage setting as a so far unexplored source of agglomerative tendencies in industrialized countries, with production and factors shifting to those locations that offer the least restrictive labor market institutions.

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Appendix

Derivation of Eq. (22) and the ranking of ω^s, ω^f

A balanced budget of the government requires

$$t^\eta(1-u^\eta)LW^\eta = (1-t^\eta)\,u^\eta L\beta W^\eta, \tag{57}$$

where t^η is the proportional income tax rate under labor market regime $\eta = s, f$. Solving (57) for t^η, we can calculate $1-t^\eta = (1-u^\eta)/\left[1-u^\eta(1-\beta)\right]$. Substituting u^η from (15), therefore implies

$$1-t^s = \frac{nA(1-\beta)}{bL(n+1)(2-\beta)\beta + nA(1-\beta)^2}, \tag{58}$$

$$1-t^f = \frac{n^2A(1-\beta)}{bL(n+1)\left[1+n(1-\beta)\right]\beta + n^2A(1-\beta)^2}. \tag{59}$$

Furthermore, we can combine $(1-u^\eta)L(W/P)^\eta = (\Phi/P)^\eta$ with the insight that $(\Phi/P)^\eta = \phi^\eta(1-u^\eta)L$, to see that real gross income of an employed production worker, $(W/P)^\eta$, equals ϕ^η, while real net income of this worker equals $\omega^\eta \equiv (1-t^\eta)\phi^\eta$. Substituting $1-t^\eta$ from above, then gives ω^s and ω^f in (22).

With respect to the ranking of ω^s and ω^f, we can note from (18), (19), and (22) that $\omega^s >, =, < \omega^f$ is equivalent to $\rho(\beta) >, =, < 0$, with

$$\rho(\beta) \equiv (n-1)\left\{n^2A(1-\beta)^3 - \beta bL(n+1)\left[1+\beta n(2-\beta)\right]\right\}. \tag{60}$$

It is easily shown that $\rho(0) > 0$, $\rho(1) < 1$ and $\rho'(\beta) < 0$, which confirms the respective statement in the main text.[18] *QED*

Derivation of Eq. (25)

Maximizing profits (24) for $y_j(z)$, gives the first-order condition $d\Pi_j^t(z)/dy_j = 0$. Solving the latter for y_j, gives the best-reply function $2by_j(z) = 2A - b\sum_{k\neq j} y_k(z) - \bar{\lambda}w_j(z)$. We can now note two things: first, a structurally identical best-response function can be calculated for any other producer $k \neq j$; second, due to perfect foresight, firm j rationally anticipates that all competitors of country $i = 1, 2$ choose the same output in equilibrium. Introducing an asterisk for indicating foreign variables, we can thus rewrite the best response function of firm j in the

[18] Of course, an interior equilibrium requires $u^\eta > 0$ and, in view of $u^f < u^s$, we can conclude from inspection of (15) that $n^2A(1-\beta) < bL(n+1)\left[1+n(1-\beta)\right]$ is sufficient for positive unemployment rates in both countries. However, this parameter restriction does not influence our findings regarding the ranking of ω^s and ω^f.

following way:

$$y_j(z) = \frac{2A - b\,(n(z)-1)\,y(z) - bn^*(z)y^*(z) - \bar{\lambda}w_j(z)}{2b}, \tag{61}$$

where $y(z)$, $y^*(z)$ refers to the common output of domestic and foreign competitors, respectively. Accounting for the symmetry assumption of domestic and foreign competitors in the first order-conditions of the respective producers, we can furthermore calculate

$$y(z) = \frac{2A - bn^*(z)y^*(z) - by_j(z) - \bar{\lambda}w(z)}{n(z)b} \tag{62}$$

$$y^*(z) = \frac{2A - b\,(n(z)-1)\,y(z) - by_j(z) - \bar{\lambda}w^*(z)}{(n^*(z)+1)\,b}, \tag{63}$$

where $\bar{\lambda}w(z)$ and $\bar{\lambda}w^*(z)$ refer to the common wage rates of domestic and foreign competitors of firm j, respectively. We can now solve system (62) and (63) for $y(z)$ and $y^*(z)$. This gives

$$y(z) = \frac{2A - by_j(z) + n^*(z)\bar{\lambda}w^*(z) - (n^*(z)+1)\,\bar{\lambda}w(z)}{(n(z)+n^*(z))\,b}, \tag{64}$$

$$y^*(z) = \frac{2A - by_j(z) + (n(z)-1)\,\bar{\lambda}w(z) - n(z)\bar{\lambda}w^*(z)}{(n(z)+n^*(z))\,b}. \tag{65}$$

Substituting (64) and (65) into (61), finally gives (25). *QED*

Derivation of Eqs. (26) and (27)

Since sector-level unions choose a uniform wage rate for all employees in the respective sector, we can set $w_{1j}(z) = w_1(z)$ in (25) to determine industry-wide employment in country 1: $\sum_{j=1}^{n(z)} l_{1j}(z) = ny_1(z)$. Substituting the latter into the union objective of sector-level union in (8), gives

$$V_1 = \frac{[w_1(z) - \bar{w}_1]\,n_1(z)\,\left[2A + n_2(z)\bar{\lambda}w_2(z) - (n_2(z)+1)\,\bar{\lambda}w_1(z)\right]}{b\,(n_1(z)+n_2(z)+1)}.$$

Maximizing V_1 for $w_1(z)$ gives the first-order condition $dV_1/w_1(z) = 0$, which can be reformulated to

$$\bar{\lambda}w_1(z) = \frac{2A + n_2(z)\bar{\lambda}w_2(z) + (n_2(z)+1)\,\bar{\lambda}\bar{w}_1}{2\,(n_2(z)+1)}. \tag{66}$$

In a similar vein, we can substitute (25) together with $l_{2j}(z) = y_{2j}(z)$ into the objective function of firm-level unions in (8), which gives

$$V_{2j}(z) = \frac{[w_{2j}(z) - \bar{w}_2]\,\left[2A + n_1(z)\bar{\lambda}w_1(z) + (n_2(z)-1)\,\bar{\lambda}w_2(z) - (n_2(z)+n_1(z))\,\bar{\lambda}w_{2j}(z)\right]}{b\,(n_1(z)+n_2(z)+1)}.$$

Maximizing this objective for $w_2 j(z)$ gives the first-order condition $dV_{2j}/dw_{2j} = 0$. Rearranging terms and noting that $w_{2j}(z) = w_2(z)$ must hold due to ex-post symmetry we can calculate

$$\bar{\lambda} w_2(z) = \frac{2A + n_1(z)\bar{\lambda} w_1(z) + (n_1(z) + n_2(z))\,\bar{\lambda}\bar{w}_2}{2n_1(z) + n_2(z) + 1}. \tag{67}$$

Eqs. (66) and (67) constitute a system of two equations, which jointly determine wage rates $\bar{\lambda} w_1(z)$ and $\bar{\lambda} w_2(z)$ in (26) and (27). *QED*

The impact of product market integration on economy-wide employment

Using (15) and (32), we can show that the sign of $\Delta_1^u \equiv (1-u_1^{sr})L-(1-u^s)L$ is equivalent to the sign of $\bar{\gamma}_1^u \equiv (2n+1)(2n^2+2n+1)+(1-\beta)(n+1)(2n^2+5n+1)+(1-\beta)^2 2n(n+1)$ and thus positive. In a similar way, we can infer from (15) and (33) that the sign of $\Delta_2^u \equiv (1-u_2^{sr})L-(1-u^f)L$ is equivalent to the sign of $\bar{\gamma}_2^u \equiv (2n+1)(2n+3)+(1-\beta)(n+1)(2n^2+3n+3)+(1-\beta)^2 2n(n+1)$, and hence is also positive. Putting together, we can thus conclude that product market integration stimulates employment in both locations. *QED*

The impact of product market integration on rent sharing

Looking first at country 1, we can infer from a comparison of (18) and (39) that

$$\Delta_1^{\psi} \equiv \psi_1^{sr} - \psi^s = \frac{n^2(1-\beta)}{[(2n+1)+(n+1)(1-\beta)][(n+1)+(1-\beta)]} > 0, \tag{68}$$

while for country 2, we get

$$\Delta_2^{\psi} \equiv \psi_2^{sr} - \psi^f = \frac{n(1-\beta)}{[(2n+1)+2n(1-\beta)][(n+1)+n(1-\beta)]} > 0. \tag{69}$$

Hence, we see that capital owners in both countries are able to extract a larger share of economic rents in the short-run open economy equilibrium than under autarky.

The impact of product market integration on the employment and welfare differential between the two economies

In the closed economy the employment differential between the two countries is given by $\Delta u \equiv (1-u^f)L-(1-u^s)L = (u^s-u^f)L$:

$$\Delta u = \frac{n(n-1)A(1-\beta)}{b(n+1)(2-\beta)\,[1+n(1-\beta)]}, \tag{70}$$

according to (15). Furthermore, accounting for (32) and (33), we can compute the respective differential in the short-run open economy:

$$\Delta u^{sr} = \frac{2n(n-1)A(1-\beta)}{b\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}}. \tag{71}$$

Combining (70) and (71), it is straightforward to show that the sign of $\Delta u - \Delta u^{sr}$ is equivalent to $\delta_u^{sr} \equiv -1+(1-\beta)(n^2-1)$. Hence, $\Delta u - \Delta u^{sr}$ is positive if $\beta < 2/3$ and $n \geq 2$. Finally, noting that aggregate employment equals total real income in the two economies and and that total real income is a suitable welfare measure in our model, we can conclude that product market integration lowers the employment and welfare differential between the two economies. *QED*

The impact of product market integration on real labor income

Looking first at country 1, we can note that total real labor income (and thus the welfare of workers) in the short-run open economy is higher than, equal to, or smaller than in the closed economy if $\Delta_1^{\Phi} \equiv (\Phi_1/P)^{sr} - (\Phi/P)^{s} >, =, < 0$. In view of (20) and (40), we can furthermore show that the sign of Δ_1^{Φ} is equivalent to the sign of $\gamma_1(n,\beta) \equiv 4n^3+6n^2+4n+1+(1-\beta)\left(2n^2+7n+2\right)(n+1)-(1-\beta)^2\left(3n^2-6n-1\right)(n+1)-2(1-\beta)^3 n\,(n-1)\,(n+1)$. Noting that $\gamma_1(n,\beta) > 0$ holds for any possible combination of $n \geq 1$ and $\beta \in (0,1)$, we can conclude that trade increases real income and welfare of workers in country 1. Looking at country 2, we can note that total labor income in the open economy is higher than, equal to, or lower than under autarky if $\Delta_2^{\Phi} \equiv (\Phi/P)^{sr} - (\Phi/P)^{s} >, =, < 0$. In view of (20) and (41), we can furthermore show that the sign of Δ_2^{Φ} is equivalent to the sign of $\gamma_2(n,\beta) \equiv (2n+1)(2n+3)+(1-\beta)[(n+1)^2(2n+1)+(2n+1)^2+1]+2(1-\beta)^2 n(n^2+n+2)$. Noting that $\gamma_2(n,\beta) > 0$ holds for any $n \geq 1$ and $\beta \in (0,1)$, we can thus safely conclude that product market integration increases real income and welfare of workers in country 2. *QED*

The allocation of capital in a long-run open economy equilibrium

It is the aim of this proof to show that there exists a unique full diversification equilibrium, in which both countries produce all goods.[19] Throughout the proof, we ignore the integer problem and assume that long-run adjustments of investment decisions do not generate costs. The capital allocation problem in the open economy has two dimensions. On the one hand, within an industry capital owners have to decide in which country they invest and, one the other hand, capital owners must determine the industry in which they set up a firm. Accordingly, we can conclude that in any full diversification equilibrium the following two *no arbitrage* conditions must hold: (i) $\Pi_i(z) = \Pi^t(z)$ for $i = 1,2$, implying that capital owners cannot further increase their income by choosing a different country for their investment in industry z; (ii) $\Pi^t(z) = \Pi^t$

[19] We do not study the existence of specialization equilibria, in which at least one country ceases production in a subset of industries.

for all z, implying that capital owners cannot increase their income by choosing a different industry for their investment.

We first look at no arbitrage condition (i). Recollecting from the main text that linear consumer demand implies $\Pi_i(z) = by_i(z)^2$, we can conclude that in a full diversification equilibrium $y_1(z) = y_2(z)$ must hold. In view of (64) and (65), we can further note that $y_1(z) = y_2(z)$ is equivalent to $\bar{\lambda}w_1 = \bar{\lambda}w_2$, and from (26) and (27) we can infer that international factor price equalization requires

$$(2A - \bar{\lambda}\bar{w}_1)\,[n_1(z) - 1] = \left(\bar{\lambda}\bar{w}_2 - \bar{\lambda}\bar{w}_1\right)[n_1(z) + n_2(z)]\,[n_2(z) + 2]\,, \tag{72}$$

$$(2A - \bar{\lambda}\bar{w}_2)\,[n_1(z) - 1] = \left(\bar{\lambda}\bar{w}_2 - \bar{\lambda}\bar{w}_1\right)[n_1(z) + n_2(z) + 1]\,[n_2(z) + 1]\,. \tag{73}$$

Recollecting from the main text that sector-level unions set a uniform wage rate for all producers in the respective industry, we can note that $w_j(z) = w(z)$ holds in this case. Combining (25) with (26) and (27) therefore yields

$$\begin{aligned} y_1(z) = {} & \frac{\left(2A - \bar{\lambda}\bar{w}_1\right)\left[2n_1(z)n_2(z) + 2n_2(z)^2 + 2n_1(z) + 3n_2(z) + 1\right]}{b\,[n_1(z) + n_2(z) + 1]\,[3n_1(z)n_2(z) + 2n_2(z)^2 + 4n_1(z) + 4n_2(z) + 2]} \\ & + \frac{\left(\bar{\lambda}\bar{w}_2 - \bar{\lambda}\bar{w}_1\right)[n_1(z) + n_2(z)]\,[n_2(z) + 1]\,n_2(z)}{b\,[n_1(z) + n_2(z) + 1]\,[3n_1(z)n_2(z) + 2n_2(z)^2 + 4n_1(z) + 4n_2(z) + 2]}. \end{aligned} \tag{74}$$

Solving (72) for $2A - \bar{\lambda}\bar{w}_1$, substituting the resulting expression into (74) and recollecting from above that $y_i(z) \equiv y(z)$ for $i = 1, 2$, we can calculate

$$y(z) = \frac{\left(\bar{\lambda}\bar{w}_2 - \bar{\lambda}\bar{w}_1\right)[n_1(z) + n_2(z)]\,[n_2(z) + 1]}{b\,[n_1(z) + n_2(z) + 1]\,[n_1(z) - 1]} \tag{75}$$

and substituting (73) finally gives

$$y(z) = \frac{\left(2A - \bar{\lambda}\bar{w}_2\right)[n_1(z) + n_2(z)]}{b\,[n_1(z) + n_2(z) + 1]^2}. \tag{76}$$

Noting from no arbitrage condition (ii) that $y(z)$ must be the same for all z, i.e. $y(z) = y$, we can infer from Eq. (76) that in a full diversification equilibrium the total number of competitors is the same in all industries z: $2n = n_1(z) + n_2(z) > 1$. According to (72), we can then define the implicit function

$$\zeta\left(n_1(z)\right) \equiv \left[(2A - \bar{\lambda}\bar{w}_1) + 2n\left(\bar{\lambda}\bar{w}_2 - \bar{\lambda}\bar{w}_1\right)\right][n_1(z) - 1] - 2n(2n+1)\left(\bar{\lambda}\bar{w}_2 - \bar{\lambda}\bar{w}_1\right) = 0. \tag{77}$$

Noting that changes in $n_1(z)$ do not affect economy-wide variables $\bar{\lambda}\bar{w}_1$, $\bar{\lambda}\bar{w}_2$, we can conclude from inspection of (77) that $\zeta(\cdot)$ is a monotonic function of $n_1(z)$, so that a solution to $\zeta(\cdot) = 0$, if it exists, must be unique. This implies that if a full diversification equilibrium exists, the number of competitors in the two countries must be the same in all industries, i.e. $n_1(z) = n_1$

and $n_2(z) = 2n - n_1 = n_2$ for all z. However, if industries are symmetric in this respect, it follows from (26), (27) – and the previous insight that diversification requires factor price equalization – that $\bar{\lambda} w_i(z) = \bar{\lambda} w$ for $i = 1, 2$ and all z. This implies $\bar{\lambda}\bar{w}_i = \beta\bar{\lambda} w$ for $i = 1, 2$, and we can therefore calculate

$$W \equiv \bar{\lambda} w = \frac{2A\left(2n_1 + 2n_2 + 1\right)}{(1-\beta)\left(3n_1 n_2 + 2n_2^2 + 2n_1 + 2n_2 + 1\right) + \left(2n_1 + 2n_2 + 1\right)}, \tag{78}$$

$$W \equiv \bar{\lambda} w = \frac{2A\left(n_1 + 2n_2 + 2\right)}{(1-\beta)\left(3n_1 n_2 + 2n_2^2 + 3n_1 + 2n_2\right) + \left(n_1 + 2n_2 + 2\right)}, \tag{79}$$

according to (26) and (27). Accounting for $n_2 = 2n - n_1$, system (78) and (79) establishes an implicit relationship between n_1 and n:

$$\Gamma\left(n_1, n\right) \equiv \left(n_1 - 1\right)\left[2\left(2n_1 + 1\right) + \left(3n_1 + 4\right)\left(2n - n_1\right) + 2\left(2n - n_1\right)^2\right] = 0. \tag{80}$$

It is immediate that $\Gamma\left(n_1, n\right) = 0$ has a unique solution at $n_1 = 1$. Put differently, capital mobility establishes firm allocation $n_1 = 1$ and $n_2 = 2n - 1$ in a long-run open economy equilibrium with diversification. Wages and output corresponding to this firm allocation are given by (44) and (45), according to (25) and system (78), (79).

Taking stock, we have so far shown that firm allocation $n_1(z) = 1$, $n_2(z) = 2n - 1$ is the only candidate for a long-run open economy equilibrium with diversification. However, we have not discussed whether respective firm allocation captures the capital owners' best responses to the investment decisions of their competitors and thus establishes an equilibrium at all. Showing that $n_1(z) = 1$, $n_2(z) = 2n - 1$ characterizes a best-response equilibrium in the investment game is the purpose of the subsequent analysis. Since capital owners foresee that their investment decision influences product market competition and thus union wage setting in the respective industry, we must evaluate $y_i(z)$, $i = 1, 2$ for asymmetric wages $\bar{\lambda} w_1 \neq \bar{\lambda} w_2$. However, since a single capital owner cannot influence the economy-wide average wage, we still have $\bar{\lambda}\bar{w}_i = \bar{\lambda}\bar{w}$ for $i = 1, 2$. Evaluating (26) and (27) at $\bar{\lambda}\bar{w}_i = \bar{\lambda}\bar{w}$, substituting the resulting expression into (25), and accounting for $w_j(z) = w(z)$ we get

$$y_1(z) = \frac{2A - \bar{\lambda}\bar{w}}{b} \frac{2n_1(z)n_2(z) + 2n_2(z)^2 + 2n_1(z) + 3n_2(z) + 1}{\left[n_1(z) + n_2(z) + 1\right]\left[3n_1(z)n_2(z) + 2n_2(z)^2 + 4n_1(z) + 4n_2(z) + 2\right]}, \tag{81}$$

$$y_2(z) = \frac{2A - \bar{\lambda}\bar{w}}{b} \frac{3n_1(z)n_2(z) + n_1^2 + 2n_2(z)^2 + 2n_1(z) + 2n_2(z)}{\left[n_1(z) + n_2(z) + 1\right]\left[3n_1(z)n_2(z) + 2n_2(z)^2 + 4n_1(z) + 4n_2(z) + 2\right]}. \tag{82}$$

Differentiating $y_i(z)$ by $n_i(z)$ and evaluating the resulting expression at $n_1(z) = 1, n_2(z) = 2n - 1$, further implies

$$\frac{\partial y_1(z)}{\partial n_1(z)} = -\frac{2A - \bar{\lambda}\bar{w}}{b} \frac{12n^2}{\left(2n+1\right)^3\left(4n+1\right)}, \quad \frac{\partial y_2(z)}{\partial n_2(z)} = -\frac{2A - \bar{\lambda}\bar{w}}{b} \frac{2n-1}{\left(2n+1\right)^3}. \tag{83}$$

It is straightforward that $dy_i(z)/dn_i(z) < 0$ and thus $d\Pi_i(z)/dn_i(z) < 0$. This implies that a capital owner cannot benefit from adjusting his/her investment if $n_1 = 1$ and $n_2 = 2n-1$, which confirms that a unique full diversification equilibrium exists and completes the proof. *QED*

The impact of trade and capital mobility on aggregate employment

Let us first look at country 1. The employment effects of capital outflow are determined by the sign of $\bar{\Delta}_1^u \equiv u_1^{sr} - u_1^{lr}$, which in view of (32) and (46) is equal to the sign of $\bar{\gamma}_1^u(n,\beta) \equiv -(n-1)\big[(2n+1)+2(n+1)(2n+1)(1-\beta)+4n(n+1)(1-\beta)^2\big]$. Since $\bar{\gamma}_1(n,\beta) \leq 0$ holds for all $n \geq 1$ and $\beta \in (0,1)$, aggregate employment in country 1 must be lower in the long run than in the short-run open economy. Furthermore, to see whether capital mobility reverses the positive employment stimulus from product market integration, we have to look at $\tilde{\Delta}_1^u \equiv u_1^s - u_1^{lr}$. From (15) and (46), it follows that the sign of $\tilde{\Delta}_1^u$ is equivalent to the sign of $\tilde{\gamma}_1^u(n,\beta) \equiv (2n+3) - 2(1-\beta)\big(2n^2-n-2\big)$. It is obvious that $\tilde{\gamma}_1^u(n,1) = 2n+3 > 0$, while $\tilde{\gamma}_1^u(n,0) = -4n^2+4n+7$, where $\tilde{\gamma}_1^u(0,0) = 7$ and $\lim_{n\to\infty}\tilde{\gamma}_1^u(n,0) < 0$ imply that the sign of $\tilde{\gamma}_1^u(n,0)$ is ambiguous. In addition, we can show that $\tilde{\gamma}_1^u(1,\beta) = 7-2\beta > 0$. Accounting for the properties of $\tilde{\gamma}_1^u(n,\beta)$, we can therefore conclude that openness may have negative long-run employment effects in country 1 if n is sufficiently large, while β is sufficiently small. Turning to country 2, we can note that capital provides an employment stimulus if $\bar{\Delta}_2^u \equiv u_2^{sr} - u_2^{lr} \geq 0$. Noting that, in view of (33) and (46), the sign of Δ_2^u is equivalent to the sign of $\bar{\gamma}_2^u(n,\beta) \equiv (n-1)\big[(2n+1)+(1-\beta)(2n^2+4n+1)+2n(n+1)(1-\beta)^2\big]$ and thus positive for any $n > 1$ and $\beta \in (0,1)$, we can safely conclude that capital inflow reinforces the employment stimulus from product market integration. *QED*

The impact of trade and capital mobility on aggregate welfare

Let us first look at country 1. The welfare implications of capital outflow can be inferred from the sign of $\bar{\Delta}_1^U \equiv \big(\bar{\lambda}I_1/P\big)^{lr} - \big(\bar{\lambda}I_1/P\big)^{sr}$. Noting from our previous analysis that $(\lambda I_1/P)^{sr} = (1-u_1^{sr})\,L$, it follows from (32) and (47) that the sign of $\bar{\Delta}_1^U$ is equivalent to the sign of $\bar{\gamma}_1^U(n,\beta) \equiv -(n-1)\big[(2n+1)^2+2(1-\beta)(2n+1)(2n^2+2n+1)+4(1-\beta)^2n(n+1)^2\big]$. Since $\bar{\gamma}_1(n,\beta) < 0$ holds for any $n > 1$ and $\beta \in (0,1)$, it is clear that capital outflow lowers welfare relative to the short-run open economy. To see, whether this detrimental effect can be strong enough to reverse the positive welfare implications of product market integration, we have to determine the sign of $\tilde{\Delta}_1^U \equiv \big(\bar{\lambda}I_1/P\big)^{lr} - \big(\bar{\lambda}I/P\big)^{s}$. Noting that $\big(\bar{\lambda}I/P\big)^{s} = (1-u^s)L$, we can infer from (15) and (47) that $\tilde{\Delta}_1^U$ must be positive because $\tilde{\gamma}_1^U(n,\beta) \equiv (2n+1)(2n+3)+4(1-\beta)(n+1)^2+4(1-\beta)^2n^2 > 0$ holds for any $n > 1$ and $\beta \in (0,1)$. Therefore, we can safely conclude that welfare in country 1 is higher in the long run open economy equilibrium than under autarky. To determine the welfare effects of capital inflow in country 2, we can evaluate $\bar{\Delta}_2^U \equiv \big(\bar{\lambda}I_2/P\big)^{lr} - \big(\bar{\lambda}I_2/P\big)^{sr}$. Noting that $(\lambda I_2/P)^{sr} = (1-u_2^{sr})\,L$ and accounting for (33) and (48), we can show that the sign of $\bar{\Delta}_2^U$ is equivalent to the sign of

$\bar{\gamma}_2^U(n,\beta) \equiv (n-1)\big[(2n+1)^2 + (1-\beta)(4n^3+10n^2+6n+1) + 2(1-\beta)^2 n(n^2+3n+1)\big]$. Since $\bar{\gamma}_2^U(n,\beta)$ is positive for any $n > 1$, $\beta \in (0,1)$, we can thus safely conclude that capital inflow amplifies the positive short-run welfare gains from product market integration. *QED*

The impact of trade and capital mobility on the employment and welfare differential

In the closed economy, the employment differential between the two countries is given by (70). In the long-run open economy, the respective differential is given by $\Delta u^{lr} \equiv (1-u_2^{lr})L - (1-u_1^{lr})L$:

$$\Delta u^{lr} \equiv \frac{8n(n-1)A(1-\beta)}{b(2n+1)\left[1+2n(1-\beta)\right]}, \tag{84}$$

according to (46). Combining (70) and (84), we can show that the sign of $\Delta u - \Delta u^{lr}$ is equivalent to the sign of $\delta_u^{lr} \equiv -(6n+3) - 2(1-\beta)(4n^2+7n+2) - (1-\beta)^2 8n(n+1)$, which is negative. In a similar vein, we can compare (71) and (84) to see that the sign of $\Delta u^{sr} - \Delta u^{lr}$ is equivalent to the sign of $\tilde{\delta}_u^{lr} \equiv -(7n+3) - 2(1-\beta)(n+1)(5n+2) - (1-\beta)^2 8n(n+1)$ and thus negative.

Let us now turn to the welfare differential. Accounting for (47) and (48), we can show that the real income differential between the two countries in the long-run open economy equilibrium is given by $\Delta\tilde{U}^{lr} \equiv (\bar{\lambda}I_2/P)^{lr} - (\bar{\lambda}I_1/P)^{lr}$:

$$\Delta\tilde{U}^{lr} \equiv \frac{8n(n-1)A(1-\beta)}{b[1+2n(1-\beta)][(2n+1)+2n(1-\beta)]}. \tag{85}$$

Noting further that $\Delta\tilde{U} \equiv (\bar{\lambda}I/P)^f - (\bar{\lambda}I/P)^s = \Delta u$ holds in the closed economy, we can infer from comparing (70) with (85) that the sign of $\Delta\tilde{U} - \Delta\tilde{U}^{lr}$ is equivalent to the sign of $\delta_U^{lr} \equiv -(6n+7) - 4(1-\beta)(n^2+3n+2) - (1-\beta)^2 4n(n+2)$ and thus negative. Finally, noting that $\Delta\tilde{U}^{sr} \equiv (\bar{\lambda}I_2/P)^{sr} - (\bar{\lambda}I_1/P)^{sr} = \Delta u^{sr}$, it follows from (71) and (85) that the sign of $\Delta\tilde{U}^{sr} - \Delta\tilde{U}^{lr}$ is equivalent to the sign of $\tilde{\delta}_U^{lr} \equiv -(6n+3) - 4(1-\beta)(2n^2+3n+2) - 4(1-\beta)^2 n(n+2)$ and thus negative. Putting together, we can therefore conclude that both the employment differential and the welfare differential are more pronounced in the long-run open economy equilibrium than in the short run or under autarky. *QED*

The impact of trade and capital mobility on total real labor income

For country 1, we can infer the impact of capital outflow on total real labor income from the sign of $\bar{\Delta}_1^{\Phi} \equiv (\Phi_1/P)^{lr} - (\Phi_1/P)^{sr}$. In view of (40) and (49), we can conclude that $\bar{\gamma}_1^{\Phi}(n,\beta) \equiv -(n-1)\big[(2n+1)^2 + 4(1-\beta)(n+1)(2n^2+3n+1) + 2(1-\beta)^2(n+1)(8n^2+7n+1) + 4(1-\beta)^3(n+1)n\big] < 0$ implies $\bar{\Delta}_1^{\Phi} < 0$, so that capital outflow reduces total real labor income in country 1 relative to the short-run open economy equilibrium. To see whether this income loss is strong enough to reverse the positive real income stimulus from product market integration, we have to determine the sign of $\tilde{\Delta}_1^{\Phi} \equiv (\Phi_1/P)^{lr} - (\Phi/P)^s$. In view of (20) and (49) we can conclude that the sign

of $\tilde{\Delta}_1^{\Phi}$ is equivalent to the sign of $\tilde{\gamma}_1^{\Phi}(n,\beta) \equiv (2n+3) - 4(1-\beta)(n^2-2) - 4(1-\beta)^2(n^2-1)$. It is easily confirmed that $\tilde{\gamma}_1^{\Phi}(n,1) = 2n+3 > 0$, while $\tilde{\gamma}_1^{\Phi}(n,0) = 15 + 2n - 8n^2$, where $\tilde{\gamma}_1^{\Phi}(0,0) = 15 > 0$ and $\lim_{n\to\infty} \tilde{\gamma}_1^{\Phi}(n,0) < 0$ imply that the sign of $\tilde{\gamma}_1^{\Phi}(n,0)$ is ambiguous. Accounting for the properties of $\tilde{\gamma}_1^{\Phi}(n,\beta)$, we can therefore conclude that openness may generate long-run welfare losses of workers if n is sufficiently large, while β is sufficiently small. Turning to country 2, we can infer the impact of capital inflow on total real labor income by determining the sign of $\bar{\Delta}_2^{\Phi} \equiv (\Phi_2/P)^{lr} - (\Phi_2/P)^{sr}$. Accounting for (41) and (50), we can conclude that $\bar{\gamma}_2^{\Phi}(n,\beta) \equiv (n-1)\big[(2n+1)^2 + (1-\beta)\left(2n^2+4n+1\right) + 2(1-\beta)^2 n(n+1)\big] > 0$ implies $\bar{\Delta}_2^{\Phi} > 0$, so that capital inflow amplifies the positive welfare implications for workers triggered by product market integration. *QED*

The impact of trade and capital mobility on total real capital income

Let us first look at country 1, where we can infer the impact of capital inflow on total real capital income from determining the sign of $\bar{\Delta}_1^{\Psi} \equiv (\Psi_1/P)^{lr} - (\Psi_1/P)^{sr}$. Accounting for (42) and (51), we can show that the sign of $\bar{\Delta}_1^{\Psi}$ is equivalent to the sign of $\bar{\gamma}_1^{\Psi}(n,\beta) \equiv (n-1)\big[(2n+1)^2(3n+1) + 2(1-\beta)n(n+1)(2n+1)(4n+3) + 4(1-\beta)^2 n^2(n+1)(3n+2)\big]$, which is positive for any $n > 1$ and $\beta \in (0,1)$. Hence, we can safely conclude that capital outflow reinforces the positive short-run impact of product market integration on total real capital income. Turning to country 2, we can infer the impact of capital inflow on total real income of domestic capital owners from the sign of $\bar{\Delta}_2^{\Psi} \equiv (\Psi_2/P)^{lr} - (\Psi_2/P)^{sr}$, which, in view of (43) and (51), is equivalent to the sign of $\bar{\gamma}_2^{\Psi} \equiv -(1-\beta)n(n-1)$ and thus negative. This implies that capital inflow lowers total real income of capital owners in country 2 relative to the short-run open economy equilibrium. To see whether this negative impact is strong enough to reverse the short-run benefits of this income group from product market integration, we can look at the sign of $\tilde{\Delta}_2^{\Psi} \equiv (\Psi_2/P)^{lr} - (\Psi_2/P)^{f}$. Accounting for (21) and (51), we can show that the sign of $\tilde{\Delta}_2^{\Psi}$ is equivalent to the sign of $\tilde{\gamma}_2^{\Psi} \equiv 4n^2 + 12n + 7 + (1-\beta)12n(n+1) + (1-\beta)^2 4n^2$ and thus positive. Hence, capital owners in country 2, while losing from capital inflow, are better off in a long-run open economy equilibrium than under autarky. *QED*

The impact of ex-ante decentralization in union wage-setting on employment and welfare

Let us first look at country 1, where we can infer the employment effects of ex-ante decentralization in union wage setting from determining the sign of $\hat{\Delta}_1^{u} \equiv u_1^{sr} - u_1^{r}$. Accounting for (32) and (52), we can show that the sign of $\hat{\Delta}_1^{u}$ is equivalent to the sign of $\hat{\gamma}_1^{u}(n,\beta) \equiv (n-1)[(2n+1) + 2n(n+1)(1-\beta)]$. Since $\hat{\gamma}_1^{u}(n,\beta) > 0$ holds for any $n > 1$ and $\beta \in (0,1)$ we can conclude that ex-ante decentralization in the wage-setting of domestic unions stimulates employment and – in the absence of international capital flows – also welfare in country 1 relative to the short-run open economy equilibrium in Section 3. These positive aggregate

effects of decentralization also extend to the long run, because we know from the previous analysis that capital outflow, which is prevented by the reform of country 1's wage-setting institutions, is associated with a decline in employment and welfare in country 1. For country 2, we can infer the employment and welfare effects of ex-ante decentralization in union wage-setting from the sign of $\hat{\Delta}_2^u \equiv u_2^{sr} - u_2^r$, which, in view of (33) and (52), is equivalent to the sign of $\hat{\gamma}_2^u(n,\beta) \equiv -(1-\beta)n(n-1)$ and thus negative. We can therefore conclude that ex-ante decentralization in the wage-setting of country 1 unions lowers employment and welfare in country 2 relative to the short-run and – since there are no international capital flows after the reform – the long-run open economy equilibrium in Section 3. *QED*

The impact of ex-ante decentralization in union wage-setting on total real labor income

For country 1, we can infer the short-run impact of ex-ante decentralization in the wage-setting of local unions on total real labor income from the sign of $\hat{\Delta}_1^{\Phi} \equiv (\Phi_1/P)^r - (\Phi_1/P)^{sr}$. In view of (40) and (55), we can show that the sign of $\hat{\Delta}_1^{\Phi}$ is equivalent to the sign of $(n-1)\hat{\gamma}_1^{\Phi}$, with $\hat{\gamma}_1^{\Phi} \equiv (2n+1)^2 + (1-\beta)2n(n+1)(2n+1) - (1-\beta)^2 2n(n+1)^2 - (1-\beta)^3 4n^2(n+1)$. It is easily confirmed that $\hat{\gamma}_1^{\Phi}(n,1) = (2n+1)^2 > 0$, while $\hat{\gamma}_1^{\Phi}(n,0) = -2n^3 + 2n^2 + 4n + 1$, where $\hat{\gamma}_1^{\Phi}(1,0) = 1 > 0$, and $\lim_{n\to\infty} \hat{\gamma}_1^{\Phi}(n,0) < 0$ imply that the sign of $\hat{\gamma}_1^{\Phi}(n,0)$ is not clearcut in general. To be more specific, there exists a unique $\hat{n}(\beta) > 1$ such that $\hat{\gamma}_1^{\Phi}(n,0) > 0$ if $n < \hat{n}(\beta)$, while $\hat{\gamma}_1^{\Phi}(n,0) < 0$ if $n > \hat{n}(\beta)$. Accounting for the properties of $\hat{\gamma}_1^{\Phi}(n,\beta)$, we can therefore conclude that ex-ante decentralization in the wage-setting of domestic unions can lower total real labor income in country 1 relative to the short-run open economy in Section 3, if n is sufficiently high, while β is sufficiently small. Otherwise, workers in country 1 benefit form this change in local wage-setting institutions. Regarding the long-run implications of the ex-ante decentralization in domestic union wage-setting, it is straightforward to infer from (49) and (55) that $(\Phi_1/P)^r - (\Phi_1/P)^{lr} > 0$. Furthermore, we can determine the short-run consequences of ex-ante decentralization in the wage-setting of country 1 for total real labor income in country 2 when looking at the sign of $\hat{\Delta}_2^{\Phi} \equiv (\Phi_2/P)^r - (\Phi_2/P)^{sr}$, which, in view of (41) and (55), is equivalent to the sign of $\hat{\gamma}_2^{\Phi} \equiv -(1-\beta)n(n-1)$ and thus negative. Since we also know from the previous analysis that capital inflow renders workers in country 2 better off, we can conclude that decentralization in the wage-setting of country 1 unions lowers total real labor income in country 2 relative to the short-run and long-run open economy equilibria analyzed in Section 3. *QED*

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