Wage Bargaining Systems and International Trade*

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Abstract

This paper sets up a two-country model with a unit mass of industries, a small number of oligopolistic competitors in each of these industries, and labor market imperfection due to union wage setting. The two countries are identical in all aspects except of the degree of centralization in wage bargaining. By accounting for this asymmetry, the model discusses how trade integration between countries with different labor market regimes affects aggregate employment and welfare distinguishing between short run and long run trade effects. Additionally we show that a unilateral policy reform may prevent capital flows and generates negative spillover effects for the trading partner.

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PRELIMINARY WORK
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1 Introduction

In the last two decades there appears to be a clear trend among OECD countries to shift the centralization of wage bargaining towards firm level agreements[1] while at the same time markets become more and more integrated. This development fits into the general perception that globalization requests more flexibility and decentralization of the labor market. Proponents of such claims argue that with increasing (international) competition, firms need to be able to find the best individual solutions in wages to secure employment. On the other hand, critics are concerned about a downward spiral of wages and a slump in living standards of workers. In this paper we study trade integration between two countries that differ in their bargaining regimes and analyze the effectiveness and spillover effects of a unilateral labor market reform in view of capital mobility.

A large theoretical literature suggests that the degree of centralization of wage bargaining has a profound impact on the macroeconomic performance of an economy. According to the well-known hump-shape hypothesis by Calmfors and Driffill (1988) both, very centralized and very decentralized bargaining systems are likely to moderate wage claims and thereby lead to high employment levels. In contrast, countries with bargaining at the industry level perform worst in this respect since neither internalization effects nor market forces are strong enough to restrain wages and thus lead to higher levels of unemployment. However, this result was derived under the severe assumptions of a closed economy and perfect competition. Therefore, facing ongoing market integration, the literature began to question this relationship. Danthine and Hunt (1994) showed that international competition reduces the possibility of domestic firms to increase prices and thereby flattens the hump-shaped curve. The empirical evidence regarding the hump-shaped association between the level of wage bargaining and unemployment (or other macroeconomic misery indicators) is mixed. Some studies find results that are in line with the hypothesis, others deny its existence (for recent surveys see e.g. Nickell, 1997; Flanagan, 1999, 2003).

A related strand in the literature analyzed the general impact of trade liberalization on the wage setting of unions in view of imperfect competition. The standard framework in this context is a model of unionized oligopoly with two symmetric countries. Early results by Huizinga (1993) and Sørensen (1993) showed that moving from autarky to free trade reduces the possibility of unions to realize a wage premium. However, Naylor (1998, 1999) qualified these findings by that the effect of trade integration on union wage setting is non-monotonic when considering liberalization as a reduction in trade costs. These results were confirmed and furthermore qualified by Bastos and Kreickemeier (2009) who considered for the first time a general equilibrium model of unionized oligopoly. In a similar framework Egger and Etzel (2012) confirm the former findings by accounting for general feedback effects through the unemployment rate.

What is however missing in this theoretical literature is an analysis of trade integration

[1] See the evidence provided in OECD (2004).

between two countries that differ in the centralization of wage bargaining regimes.[2] In such a situation it is not straightforward how union wage claims are affected in both countries. Furthermore, there seems to be a clear common trend among OECD countries to move towards less central systems of wage bargaining. Additionally, in the aftermath of the Eurozone crisis, policy makers in Europe are searching for possible reforms to stabilize the system. As one central reform option they suggest to"review the wage setting arrangements, and, where necessary, the degree of centralization in the bargaining process, [...], while maintaining the autonomy of the social partners in the collective bargaining process" (European Commission, 2011), which in other words means to move coordinately towards firm level agreements in order to cooperate in wage policies and restrain excessive wage increases.[3] By looking at the effects of such a policy reform on the labor market we also contribute to the literature on spillover effects of unilateral policy reforms. In this literature, results are mixed depending on the underlying type of international trade. In Davis (1998), trade occurs due to differences in factor endowments while the capital-abundant country has a labor market imperfection by means of a minimum wage. He argues that a reduction in this minimum wage reduces domestic unemployment but at the same time hurts its trading partner by exporting lower wages. A similar argument is brought forward by Davidson, Martin, and Matusz (1999). In contrast, recent contributions based upon intra-industry trade motives find opposing results. Egger, Egger, and Markusen (2009) construct a trade model with heterogenous firms along the lines of Melitz (2003) and analyze the effect of a minimum wage to compare results with Davis (1998). In this setup, only the labor costs of the marginal firms equalize, while minimum wages may still be different across the two countries. Consequently, a reduction in the minimum wage lowers domestic unemployment and props up average income. This income effect translates into higher demand of all varieties and thereby benefits the trading partner as well.

In the present paper, we set up a general equilibrium model of oligopolistic competition with two countries that have unionized labor markets but differ in the bargaining regime. This allows us to study the interplay of the degree of centralization and international trade. To analzye the role of capital mobility we distinguish between two scenarios; in the short-run the allocation of capital is fix and hence trade can not change the decision of entrepreneurs to adjust their investment decision whereas in the long-run capital owners have the opportunity to shift capital until profits are the same in both countries. Additionally, in line with the observed trend towards decentralized bargaining regimes and the suggested policy reform by the European Commission we analyze the (spillover) effects of a unilateral policy reform in one country towards firm level

[2]Two papers that study two asymmetric countries are by Brander and Spencer (1988) and Mezzetti and Dinopoulos (1991). However they do not consider two countries with different bargaining regimes but instead unions are only present in one country while the other country is characterized by a perfectly competitive labor market.

[3]It is recognized that the development of the unit labor cost (ULC) was very different within Eurozone countries over the past 10 years. Especially countries from Southern Europe experienced a big surge in ULC while at the same time wages were very stable in other countries of the Eurozone.

agreements. The baseline framework is the model of general oligopolistic equilibrium (GOLE) by Neary (2003, 2009) which features a continuum of sectors with a small exogenous number of firms that compete in quantities a la Cournot. We deviate from the baseline model in several respects. First, similar to Egger and Etzel (2012), we assume that all sectors are unionized which is not only the basic requirement for the research question at hand but allows us to explicitly model unemployment. Second, we distinguish two groups of agents. On the one hand we regard workers that may be employed or unemployed, and on the other hand we regard firm owners to whom accrue positive firm profits. Of course, both groups together form the mass of consumers. Finally, in contrast to the baseline model we consider an economy in which sectors and countries have the same productivity. While this assumption rules out the possibility *(i)* to model trade based upon comparative advantage and *(ii)* to analyze distributional effects within the two groups it allows us on the other hand to use the real income of the two groups as true measures of group-specific welfare and compare them between the two countries under autarky and pre- and post-reform free trade.

We start our analysis with a description of the basic model structure and a closer look at the role of the degree of centralization for the wage setting of unions in the context of imperfect competition on the product market. The characterization of the closed economy follows Egger and Etzel (2012) and is well in line with the left-side branch of the hump-shape curve of the Calmfors-Driffill hypothesis: The country with an intermediate level of centralization faces higher wage claims by unions that translate into a higher price level and more unemployment as compared to a country with decentralized wage setting. With these findings at hand we are well-equipped to study the impact of free trade between the two countries as described. Our analysis shows that in the short run, trade affects both countries similarly. With given investment decision by firms, free trade increases total employment and aggregate welfare in both countries. Assuming that in the long run capital owners are able to reallocate their resources and invest capital where it yields the highest return, we find that due to the competitive disadvantage based upon the structure of the labor market, entrepreneurs will deinvest in country 1 and shift capital to country 2. These capital flows increase aggregate employment and welfare in country 2, while decreasing aggregate welfare in country 1. Employment effects in country 1 are ambiguous and depend on both, the competitiveness on the product market and the generosity of the unemployment benefit. Furthermore, our study shows that due to the mobility of capital, entrepreneurs in both countries reach a higher level of welfare, whereas capital flows make workers in country 2 better off and workers in country 1 worse off. As a final exercise, we model a unilateral policy reform in one country towards bargaining at the firm level. As a first finding we note that the timing of action matters. If capital reallocation is earlier than policy intervention then the reform of the labor market in country 1 can not reverse the decision of firm owners. In the other case, the unilateral policy reform increases employment and aggregate welfare in country 1, while generating negative spillover effects in both variables for country 2. Workers in

country 1 may gain or lose due to the reform, while both income groups lose in country 2. The remainder of the paper is organized as follows. Section 2 introduces the theoretical framework and characterizes the autarky equilibrium. Section 3 considers trade between two asymmetric countries and shows how the opening up for trade affects wage payments, profits, aggregate employment, and welfare. Thereby we distinguish between a short run in which investment decision of firms are given and a long run in which entrepreneurs are able to reallocate capital. In section 5 we analyze the impact of a unilateral policy reform in country 1 on the domestic and foreign economy. 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 the production process. Product markets are modeled along the lines of Neary (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. Wages are determined by labor unions. 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:

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

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

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

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

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

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. However, the representative consumer also has a normative interpretation 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 $\tilde{U} = -\lambda\sigma$ 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 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. This is the heart of Neary's (2009) theory, and it is this feature that renders studying oligopolisitc competition in a general equilibrium environment analytically tractable. 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

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

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 $a > w_j(z)$ 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. 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, $\tilde{w}$.[4] For that reason, there is no difference from the perspective of unions between setting gross or net wages, and hence it simply saves parameters when choosing gross notation. 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.[5] 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

[4] In the background, there is a proportional tax on both sources of labor income, wages and unemployment 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 labor market institutions in isolation from tax policy.

[5] 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.

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.[6] In summary, we can express the objectives of sector- 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.

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 output to maximize (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

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

As outlined above, we consider two different degrees of centralization in the organization of unions. In the case of sector-level unions, the union sets a uniform industry-wide wage and since the profit-maximization problem is the same for all firms in this industry, we have $w_k(z) = w^s(z)$ and thus $y_k(z) = y^s(z)$ 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 $w_k(z) = w^f(z)$ and thus $y_k(z) = y^f(z)$ for all $k \neq j$. In view of these

[6] 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.

insights, we can reformulate Eq. (9) in the following way:

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

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 $w^s(z)$ and $w_j(z)$, respectively, gives the first-order conditions

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

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

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

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 a unionized oligopoly. However, it refers to a partial equilibrium perspective 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

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

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 shrink in the number of competitors. Hence, income maximization of capital owners requires an equal

number of firms in all industries and thus a K allocation according to the no arbitrage condition $\Pi^s(z) = \Pi^s$ and $\Pi^f(z) = \Pi^f$ 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. Due to this *ex post* symmetry, we can set $\bar{w} = \beta w^s$ and $\bar{w} = \beta w^f$ in the presence of sector-level and firm-level unions, respectively. 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 assuming that not all workers find a job in equilibrium, total employment under the two labor market regimes is therefore 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. Furthermore, sector-level unions generate a stronger labor market imperfection leading to higher unemployment and lower welfare than in the case of firm-level unions i.e. $u^s > u^f$ and $\tilde{U}^s < \tilde{U}^f$.[7]

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

[7]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 implies that aggregate revenues, $Pny = P(1-u)L$, equals aggregate income, λI, we can safely conclude that $u^s > u^f$, according to (15), implies $\tilde{U}^s < \tilde{U}^f$.

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 income of this group (see the discussion in Fn. 7). In view of (13) and (15), we can determine economy-wide labor income, $\Phi \equiv (1-u)LW$:[8]

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

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

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

Since, by definition, economy-wide wage and profit income must add up to total income, i.e. $\Phi^\eta + \Psi^\eta = (\lambda I)^\eta$ for $\eta = s, f$, we can calculate $\Phi^\eta = \phi^\eta(\lambda I)^\eta$ and $\Psi^\eta = \psi^\eta(\lambda I)^\eta$, where

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

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

and $\phi^s > \phi^f$ and $\psi^s < \psi^f$, provided that $n > 1$. Noting further that a binding budget constraint implies that total income must equal total revenues, $(\lambda I)^\eta = P^\eta n y^\eta$, with $P^\eta = (\lambda p)^\eta$ being the consumer price index under labor market regime η, we can calculate $(\Phi/P)^\eta = \phi^\eta(1-u^\eta)L$ and $(\Psi/P)^\eta = \psi^\eta(1-u^\eta)L$. Recollecting from above that $u^s > u^f$, while $\psi^s < \psi^f$, it is immediate that capital owners are better off with wage setting at the firm instead of the industry level. Furthermore, using (15), (18), and (19), it is straightforward to show that workers are also better off under firm-level wage setting, i.e. $(\Phi/P)^f > (\Phi/P)^s$. However, this does not mean that individual workers necessarily prefer firm-level to sector-level unions. As formally shown in the Appendix, real net wages under sector- and firm-level bargaining, ω^s and ω^f, respectively, are given by

$$\omega^s \equiv \frac{nA(1-\beta)\phi^s}{bL(n+1)(2-\beta)\beta + nA(1-\beta)^2}, \quad \omega^f = \frac{n^2A(1-\beta)\phi^f}{bL(n+1)\left[1+n(1-\beta)\right]\beta + n^2A(1-\beta)^2}. \tag{20}$$

There are two counteracting effects of a higher degree of centralization in union wage setting on the ranking of wages ω^s, ω^f. On the one hand it can be inferred from our previous discussion that gross real wages, $(W/P)^\eta$, are proportional to rent-sharing parameter ϕ^η and thus higher under sector-level bargaining. On the other hand, sector-level bargaining leads to a lower employment

[8] 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.

rate, $1-u^{\eta}$, and thus a higher income tax rate, which lowers disposable labor income of those who have a job, *ceteris paribus*. The tax effect is less pronounced if the replacement ratio 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, while 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. However, when investing abroad we assume that capital owners repatriate their profits to their home country. This assumption implies that the number of consumers within an economy remains unchanged. Regarding labor markets, we assume that the two economies differ in the degree of centralization of 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 of both income groups in the autarky equilibrium.

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

$$p^t(z) = \frac{1}{\bar{\lambda}} \left[2A - b\bar{x}^t(z) \right], \tag{21}$$

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

$$\Pi_j^t(z) \equiv \bar{\lambda}\pi_j^t(z) = \left(2A - b \sum_{k=1}^{n^t(z)} y_k(z) - \bar{\lambda} w_j(z) \right) y_j(z), \tag{22}$$

where $n^t(z)$ is the total number of domestic $n(z)$ and foreign firms $n^*(z)$.[9] Solving the firm's

[9]It is noteworthy that the structural form of profits is the same in the two economies, and hence we can suppress country indices here. From the perspective of firm j, a domestic firm therefore refers to a local firm that

profit maximization problem, we can calculate j's optimal output

$$y_j(z) = \frac{2A + n^*(z)\bar{\lambda}w^*(z) + (n(z)-1)\,\bar{\lambda}w(z) - (n(z)+n^*(z))\,\bar{\lambda}w_j(z)}{b\,(n(z)+n^*(z)+1)} \tag{23}$$

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 (23) into the union objectives in (8) and maximize the resulting expression for the union wage rate. As formally shown in the Appendix, this gives a system of two equations that characterize the unions' optimal wage choice for a given capital allocation:

$$\begin{aligned}\bar{\lambda}w_1(z) = {} & \frac{2A\,[2\,(n_1(z)+n_2(z))+1] + n_2(z)\,(n_1(z)+n_2(z))\,\bar{\lambda}\bar{w}_2}{3n_1(z)n_2(z)+2n_2(z)^2+4n_1(z)+4n_2(z)+2} \\ & + \frac{(n_2(z)+1)\,[2n_1(z)+n_2(z)+1]\,\bar{\lambda}\bar{w}_1}{3n_1(z)n_2(z)+2n_2(z)^2+4n_1(z)+4n_2(z)+2}\end{aligned} \tag{24}$$

$$\begin{aligned}\bar{\lambda}w_2(z) = {} & \frac{2A\,[n_1(z)+2n_2(z)+2] + n_1(z)\,(n_2(z)+1)\,\bar{\lambda}\bar{w}_1}{3n_1(z)n_2(z)+2n_2(z)^2+4n_1(z)+4n_2(z)+2} \\ & + \frac{2\,(n_2(z)+1)\,(n_1(z)+n_2(z))\,\bar{\lambda}\bar{w}_2}{3n_1(z)n_2(z)+2n_2(z)^2+4n_1(z)+4n_2(z)+2}\end{aligned} \tag{25}$$

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 $n_1(z) = n_2(z) = n(z)$, and there are no international capital flows by assumption. Accounting for $\bar{w}_i = \beta w_i$, we can therefore simplify wage rates (24) and (25) in the following way:

$$W_1 \equiv \bar{\lambda}w_1 = \frac{2A\,[(2n+1)+2n(1-\beta)]}{(n+1)(1-\beta)\,[(3n+1)+2n(1-\beta)]+(2n+1)}, \tag{26}$$

$$W_2 \equiv \bar{\lambda}w_2 = \frac{2A\,[(2n+1)+(n+1)(1-\beta)]}{(n+1)(1-\beta)\,[(3n+1)+2n(1-\beta)]+(2n+1)}. \tag{27}$$

produces in the same country as j, while a foreign firm refers to a firm that produces abroad.

Substituting (26) and (27) into Eq. (23) yields short-run equilibrium output levels

$$y_1 = \frac{2A(n+1)(1-\beta)\left[(2n+1)+2n(1-\beta)\right]}{b(2n+1)\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}}, \tag{28}$$

$$y_2 = \frac{4nA(1-\beta)\left[(2n+1)+(n+1)(1-\beta)\right]}{b(2n+1)\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}}. \tag{29}$$

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

$$(1-u_1)L = \frac{2nA(n+1)(1-\beta)\left[(2n+1)+2n(1-\beta)\right]}{b(2n+1)\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}}, \tag{30}$$

$$(1-u_2)L = \frac{4n^2A(1-\beta)\left[(2n+1)+(n+1)(1-\beta)\right]}{b(2n+1)\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}}. \tag{31}$$

Recollecting from the closed economy that we can infer welfare effects from changes in total employment, we can determine aggregate short-run implications of trade liberalization by contrasting (15) with (30) and (31). The following proposition summarizes the main insights from this comparison.

Proposition 1 *In the short run, a movement from autarky to free trade increases total employment and aggregate welfare in both countries, irrespective of whether wages are set at the firm or industry level.*

Proof. Analysis in the text. ■

We are not only interested in the impact of trade on aggregate employment and welfare, but also on its group-specific effects. For this purpose, we now determine aggregate labor and profit income, $\Phi_i = (1-u_i)LW_i$ and $\Psi_i = n\Pi_i = bny_i^2$, respectively. Substituting W_i from (26) and (27) as well as $(1-u_i)L$ from (30) and (31), it is easily confirmed that economy-wide labor income equals

$$\Phi_1 = \frac{4nA^2(n+1)(1-\beta)\left[(2n+1)+2n(1-\beta)\right]^2}{b(2n+1)\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}^2}, \tag{32}$$

$$\Phi_2 = \frac{8n^2A^2(1-\beta)\left[(2n+1)+(n+1)(1-\beta)\right]^2}{b(2n+1)\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}^2}, \tag{33}$$

in the two economies. In a similar vein, we can account for y_i in (28) and (29) for calculating total profit income in the two economies:

$$\Psi_1 = \frac{4nA^2(n+1)^2(1-\beta)^2\left[(2n+1)+2n(1-\beta)\right]^2}{b(2n+1)^2\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}^2}, \tag{34}$$

$$\Psi_2 = \frac{16n^3A^2(1-\beta)^2\left[(2n+1)+(n+1)(1-\beta)\right]^2}{b(2n+1)^2\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}^2}. \tag{35}$$

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 calculate $\Phi_i/P = \phi_i(1-u_i)L$ and $\Psi_i/P = \psi_i(1-u_i)L$, with

$$\phi_1 = \frac{2n+1}{(2n+1)+(n+1)(1-\beta)}, \qquad \psi_1 = \frac{(n+1)(1-\beta)}{(2n+1)+(n+1)(1-\beta)}, \tag{36}$$

$$\phi_2 = \frac{2n+1}{(2n+1)+2n(1-\beta)}, \qquad \psi_2 = \frac{2n(1-\beta)}{(2n+1)+2n(1-\beta)}. \tag{37}$$

From inspection of (36) and (37) we can conclude that access to trade lowers real marginal production costs and thus increases the price-cost margin of all producers. As a consequence, a smaller share of total rents is attributed to workers and a larger one to capital owners in the open economy. In view of our previous insight that trade increases the total size of rents which can be distributed between capital owners and workers, we can infer from $\psi_i > \psi^\eta$ that capital owners are unambiguously better off in the open than in the closed economy. But what about workers?

To answer this question, we have to compare total real labor income in the closed and the open economy. Similar to other models with union wage setting in oligopolistic markets, trade exerts two counteracting effects, it lowers (gross) wages but raises employment due to stronger competition in the product market and more moderate union wage claims. As formally shown in the Appendix, it is the employment stimulus that dominates in both countries, and hence access to trade increases real labor income and the welfare of workers, irrespective of the degree of centralization in the wage-setting process.

The following proposition summarizes the short-run effects of trade on welfare of both income groups.

Proposition 2 *In the short run, a movement from autarky to free trade 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. ■

A long-run trade equilibrium

In the long run, capital owners adjust their investment decision in order to maximize profit income. Abstracting from costs of adjusting the investment decision, 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 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 (23). In the Appendix we show that a full diversification equilibrium exists and that this equilibrium is unique. The equilibrium firm allocation is symmetric across industries, i.e. $n_i(z) = n_i$ for all z, and represented by $n_1 = 1$ and $n_2 = n^t - 1$, where $n^t = 2n$ and $n = K$ as in the closed economy. Intuitively, there are capital flows from the country with more

centralized union wage setting to the country with the more flexible labor market, i.e. from country 1 to country 2. This 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. $\bar{\lambda}w_1 > \bar{\lambda}w_2$. 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 leads to the same outcome in the two economies irrespective of the prevailing differences 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.[10]

With the equilibrium firm allocation at hand, we can now calculate employment, welfare and group-specific income in the long-run trade equilibrium. Setting $\bar{\lambda}w_i = \bar{\lambda}w$, $n_1 = 1$, and $n_2 = 2n - 1$, we rewrite (24) and (25) in the following way:

$$W \equiv \bar{\lambda}w = \frac{2A}{1 + 2n(1-\beta)}. \tag{38}$$

Substituting the latter into (23) gives firm-level employment and output in the long-run trade equilibrium:

$$y = \frac{4nA(1-\beta)}{b(2n+1)\left[1 + 2n(1-\beta)\right]}. \tag{39}$$

Comparing the output levels from the short run equilibrium in (28) and (29) with (39), we can show that $y_1 < y < y_2$. This ranking is intuitive. On the one hand, firms in country 1 lose their cost disadvantage in the long run and thus experience an output increase. On the other hand, firms in country 2 lose their cost advantage relative to foreign producers and thus experience an output reduction. Since profits $\bar{\lambda}\pi$ are quadratic in output y, we can therefore conclude that in the long run capital owners from country 1 are better off, while capital owners in country 2 are worse off than in the short run trade equilibrium.

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 (39), this gives

$$(1-u_1)L = \frac{4nA(1-\beta)}{b(2n+1)\left[1 + 2n(1-\beta)\right]}, \qquad (1-u_2)L = \frac{4n(2n-1)A(1-\beta)}{b(2n+1)\left[1 + 2n(1-\beta)\right]}. \tag{40}$$

Comparing (40) with the aggregate employment levels of the short-run trade equilibrium in (30) and (31), we see that capital allocation towards the country with more decentralized wage

[10] 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 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 would not be the same in the two countries in this case.

setting lowers employment in country 1 and raises 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 effect of trade in the short run. 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 from capital reallocation. 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 outflows.

To determine country-specific welfare, we must look at real total 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

$$\frac{\bar{\lambda}I_1}{P} = \frac{4nA(1-\beta)}{b(2n+1)\left[1+2n(1-\beta)\right]}\frac{(2n+1)+2n^2(1-\beta)}{(2n+1)+2n(1-\beta)} \tag{41}$$

$$\frac{\bar{\lambda}I_2}{P} = \frac{4nA(1-\beta)}{b(2n+1)\left[1+2n(1-\beta)\right]}\frac{(2n-1)(2n+1)+2n^2(1-\beta)}{(2n+1)+2n(1-\beta)} \tag{42}$$

according to (39) and (40).[11] Recalling our assumption that profits generated abroad are repatriated and noting that under autarky and in the short run open economy, we have $\bar{\lambda}I_i = (1-u_i)L$, it follows from a comparison of (15), (23), and (41) that total capital outflows increase welfare in country 2 while they reduce welfare in country 1 relative to the short-run trade equilibrium, but that the respective welfare losses are smaller than the welfare gains from opening up for international goods trade. The following proposition summarizes the effect of capital mobility on aggregate employment and welfare:

Proposition 3 *In the long run, capital flows from country 1 to country 2, thereby increasing aggregate employment and welfare in country 2. Capital outflow decreases aggregate welfare in country 1, while employment effects are ambiguous and depend on the generosity of the social security system and the competitive environment.*

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

Since we are not only interested in total welfare but also in individual welfare of workers and entrepreneurs we calculate the real income of both groups, respectively. Starting with workers

[11] Total income of country 1 is given by $\bar{\lambda}I_1 = \Phi_1\left[1+2n^2(1-\beta)/(2n+1)\right]$, while total income of country 2 is given by $\bar{\lambda}I_2 = \Phi_2\left[1+2n^2(1-\beta)/(4n^2-1)\right]$. Furthermore, the value of total *domestic* output equals $n_iPy = \Phi_i\left[1+2n(1-\beta)/(2n+1)\right]$. Putting together and substituting for y and n_i, we can calculate $I_1/P, I_2/P$ in Eqs. (41) and (42), respectively.

we get

$$\frac{\Phi_1}{P} = \frac{4nA(1-\beta)}{b[(2n+1)+2n(1-\beta)][1+2n(1-\beta)]}, \tag{43}$$

$$\frac{\Phi_2}{P} = \frac{4n(2n-1)A(1-\beta)}{b[(2n+1)+2n(1-\beta)][1+2n(1-\beta)]}. \tag{44}$$

Comparing (43) with real (gross) wage income of workers in the short-run open economy we note that capital outflows to country 2 decrease the real income and thus welfare of workers in country 1. However, a comparison of (43) with the autarky welfare level of workers yields that these losses are not necessarily large enough to overcompensate the gains from trade. As for aggregate employment we find that it is more likely that positive welfare gains remain the more generous is unemployment compensation and the more competition exists on the product market. With capital flowing from country 1 to country 2, workers in country 2 are unambiguously better off in the long-run trade equilibrium.

In a similar vein, we can calculate the real income for capital owners, which is given by

$$\frac{\Psi}{P} = \frac{8n^3A(1-\beta)^2}{b(2n+1)[(2n+1)+2n(1-\beta)][1+2n(1-\beta)]}. \tag{45}$$

Of course, with capital being mobile and an integrated product market, real profit income has to be the same for entrepreneurs from both countries. We find that welfare of capital owners increases in both countries due to the possibility to shift capital until the no arbitrage condition holds.

Proposition 4 *In the long run, capital mobility increases the possibility of entrepreneurs to allocate their resources which leads to an increase of their real income. Workers in country 2 benefit in real terms due to the inflow of capital, whereas workers in country 1 lose in welfare due to the outflow of capital.*

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

4 A unilateral policy reform in country 1

In this section we study the effects of a unilateral policy reform on the labor market in country 1 to address the described trend among OECD countries to decentralize the process of wage bargaining. Therefore, we assume that country 1 that has so far been populated by industry-level unions decides to switch towards a system with bargaining at the firm-level. Having firm-level unions in both countries, we can calculate output, employment and (group-specific) welfare after the policy reform. With the same union objective in both countries we can rewrite

(24) and (25) in the following way

$$W^r \equiv \bar{\lambda} w^r = \frac{2A}{1 + 2n(1-\beta)}, \tag{46}$$

where superscript r is introduced for referring to reform variables. After the reform has been implemented, unions in country 1 now also take into account that they influence the competitiveness of a firm. Hence, due to this policy reform, unions in both countries set the same wage rate. Comparing (46) with Eq. (38) of the long-run trade equilibrium (with full diversification), we find that in both scenarios unions have the same wage claims. With other words, both, capital mobility and the policy reform to decentralize the wage setting process lead to the same outcome in wages. Therefore, we can conclude that the timing of action determines the effectiveness of an activist government. If a government decides to conduct such a reform after entrepreneurs have adjusted their capital allocation, such a policy has no impact anymore since wages and thus production cost have already equalized. In contrast, if the reallocation of capital takes more time than policy intervention, then the government in country 1 is able to reduce the wage claims and to increase the competitiveness of its domestic firms. In the subsequent analysis we will investigate further consequences for the domestic economy as well as potential spillover effects for country 2 of such a unilateral policy reform.

Substitution of the wage rate into (23) yields firm-level output and employment

$$y^r = \frac{4nA(1-\beta)}{b(2n+1)[1 + 2n(1-\beta)]}. \tag{47}$$

Comparing the output levels from the short-run trade equilibrium in (28) and (29) with (47), we find that $y_1 < y^r < y_2$. Similarly to capital mobility, the policy reform in country 1 renders domestic firms more competitive since they lose their cost disadvantage compared to rivals from country 2. In contrast, producers from country 2 reduce their production because of the relative loss in competitiveness. Despite this similarity, the two scenarios show important differences and lead to opposing consequences. Since the policy reform equalizes the costs of production in both countries, entrepreneurs from country 1 have no longer an incentive to de-invest at home and shift capital to country 2 so that the number of active firms within a country does not change. With this insight at hand and plugging (47) into nl^r we can furthermore determine aggregate employment in both countries

$$(1 - u^r)L = \frac{4n^2A(1-\beta)}{b(2n+1)[1 + 2n(1-\beta)]}. \tag{48}$$

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. Looking at country 2, we note that the unilateral policy reform exerts negative spillover effects. Since firms in country 2 lose their competitive advantage they produce less and demand less workers. Contrary to

the long run trade economy, there are no capital inflows to compensate for this loss in output (employment) and therefore aggregate employment in country 2 slumps due to the policy reform in country 1. In sum, we can therefore notice that an active government can successively prevent negative employment effects that would occur if entrepreneurs have the opportunity to reallocate their ressources. As a further consequence, we can again infer welfare effects directly from changes in total employment. By contrasting (48) with (30) and (31) we note that the reform is welfare enhancing for country 1 while reducing aggregate welfare in country 2.

Proposition 5 *A unilateral poliy reform on the labor market in country 1 increases domestic employment and welfare and generates negative spillover effects for employment and welfare in country 2.*

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

To complete our analysis we finally take a closer look at the individual welfare level of our two income groups, workers and entrepreneurs. Starting with the former group we need to calculate total wage income, which, in view of (46) and (48) is given by

$$\Phi^r = \frac{8n^2A^2(1-\beta)}{b(2n+1)[1+2n(1-\beta)]^2}, \tag{49}$$

and is of course the same in both countries. In a similar vein, we can account for (47) to calculate total profit income in the two economies:

$$\Psi^r = \frac{16n^3A^2(1-\beta)^2}{b(2n+1)^2[1+2n(1-\beta)]^2}. \tag{50}$$

Furthermore, as in the closed and open economy we can calculate the share of economic rents, ϕ, ψ, that accrues to workers and capital owners. Using (49) and (50) this yields

$$\phi^r = \frac{2n+1}{(2n+1)+2n(1-\beta)}, \qquad \psi_r = \frac{2n(1-\beta)}{(2n+1)+2n(1-\beta)}, \tag{51}$$

for both groups, respectively. From inspection of (51) we see that the labor marekt reform lowers real marginal production costs and thus increases the price-cost margin of producers in country 1. However, the reform generates no spillover effects for rent shares in country 2.

Individual welfare of workers then is given by

$$\frac{\Phi^r}{P} = \frac{4n^2A(1-\beta)}{b[1+2n(1-\beta)][(2n+1)+2n(1-\beta)]}. \tag{52}$$

From inspection of (52) with the welfare level of workers in the short-run trade equilibrium in both countries, respectively, we find that whether workers in country 1 gain or lose due to the policy reform depends on the competition in the market as well as on the generosity of the

unemployment benefits. In contrast, the policy reform in country 1 implies negative effects on the welfare level of workers in country 2. Workers in country 2 lose unambiguously because of the reform on the labor market of its trading partner, despite still being better off than in the closed economy.

In a similar vein, we finally calculate individual welfare of capital owners

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

and find that the unilateral labor market reform benefits entrepreneurs located in country 1 and makes their rivals from country 2 worse off.

The following proposition summarizes the short-run effects of trade on welfare of capital owners and workers.

Proposition 6 *A unilateral policy reform of the labor market in country 1 generates negative spillover effects on both income groups in country 2. Welfare of capital owners in country 1 increases while welfare effects of workers in country 1 are ambiguous and depend on the generosity of the unemployment benefit and the competitive environment.*

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

5 Concluding remarks

This paper presents a general oligopolistic equilibrium model with a unit mass of industries and two countries that differ in the degree of centralization in the wage bargaining process. In this setting, we investigate how trade integration affects employment and welfare in these two asymmetric countries and the effectiveness of a unilateral policy reform in view of capital mobility. In particular, we show that the movement from autarky to trade increases employment and aggregate as well as group-specific welfare in both countries, irrespective of the wage bargaining regime as long as capital is internationally immobile. When we relax this assumption and allow entrepreneurs to change their investment decision we find that firm owners in country 1 shift capital to the country with the lower degree of centralization in wage bargaining. As a consequence our study shows that the country with the decentralized labor market benefits by capital inflows in terms of higher welfare and employment, while the other countries loses in welfare and potentially employment.

Aside from investigating trade integration and distinguishing between short-run and long-run effects, we furthermore highlight the effectiveness and consequences of a unilateral policy reform of the labor market in country 1. As pointed out in the paper, the timing of government action is decisive. If the policy intervention takes more time than capital reallocation of firms, the policy reform can not prevent negative consequences of capital outflows. In the other case, a switch towards firm-level bargaining keeps domestic firms in country 1, thereby increasing

aggregate employment and welfare in country 1 while generating negative spillover effects for the other country.

In view of recent trends in this institutional feature of the labor market and current policy debates within the European Union we consider an analysis of trade between asymmetric countries in view of capital mobility as very important. We think that our model adds to the literature on spillover effects of unilateral labor market reforms and qualifies their findings by studying a new model of intra-industry trade. While we think that accounting for general equilibrium feedback effects and allowing for capital to be internationally mobile makes our analysis suitable to tackle the beforementioned real world polices, there are still simplifying assumptions of our model for deriving concrete policy recommendations.

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Appendix

Derivation of Eq. (20) and the ranking of ω^s, ω^f

A balanced budget of the government requires

$$t^\eta(1-u^\eta)LW^\eta = (1-t^\eta)\,u^\eta L\beta W^\eta, \tag{54}$$

where t^η is the proportional income tax rate under labor market regime $\eta = s, f$. Solving (54) 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

$$1-t^s = \frac{nA(1-\beta)}{bL(n+1)(2-\beta)\beta + nA(1-\beta)^2}, \tag{55}$$

$$1-t^f = \frac{n^2A(1-\beta)}{bL(n+1)\left[1+n(1-\beta)\right]\beta + n^2A(1-\beta)^2}. \tag{56}$$

Furthermore, we can combine $(1-u^\eta)L(W/P)^\eta = (\Phi/P)^\eta$ with the insights 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 and ϕ^η from (18), (19), finally gives ω^s and ω^f in (20).

With respect to the ranking of ω^s and ω^f, we can note from (20) that $\omega^s >, =, < \omega^f$ is equivalent to $\rho(\beta) >, =, < 0$, with

$$\rho(\beta) \equiv (n-1)\left\{n^2A(1-\beta)^3 - \beta bL(n+1)\left[1+\beta n(2-\beta)\right]\right\}. \tag{57}$$

It is easily shown that $\rho(0) > 0$, $\rho(1) < 1$ and $\rho'(\beta) < 0$, which confirms the respective statement in the main text.[12] *QED*

Derivation of Eq. (23)

Maximizing profits (22) 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 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

[12] 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 $n^2A(1-\beta) < bL(n+1)\left[1+n(1-\beta)\right]$ must hold. However, this parameter restriction does not influence our findings regarding the ranking of ω^s and ω^f.

following way:

$$y_j(z) = \frac{2A - b\,(n(z)-1)\,y(z) - bn^*(z)y^*(z) - \bar{\lambda}w_j(z)}{2b}, \tag{58}$$

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

$$y(z) = \frac{2A - bn^*(z)y^*(z) - by_j(z) - \bar{\lambda}w(z)}{n(z)b} \tag{59}$$

$$y^*(z) = \frac{2A - b\,(n(z)-1)\,y(z) - by_j(z) - \bar{\lambda}w^*(z)}{(n^*(z)+1)\,b}, \tag{60}$$

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 (59) and (60) for $y(z)$ and $y^*(z)$. This gives

$$y(z) = \frac{2A - by_j(z) + n^*(z)w^*(z) - (n^*(z)+1)\,\bar{\lambda}w(z)}{(n(z)+n^*(z))\,b} \tag{61}$$

$$y^*(z) = \frac{2A - by_j(z) + (n(z)-1)\,w(z) - n(z)\bar{\lambda}w^*(z)}{(n(z)+n^*(z))\,b} \tag{62}$$

And, substituting (61) and (62) into (58), finally gives (23). *QED*

Derivation of Eqs. (24) and (25)

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 (23) 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

$$\bar{\lambda}w_1(z) = \frac{2A + n_2(z)\bar{\lambda}w_2(z) + (n_2(z)+1)\,\bar{\lambda}\bar{w}_1}{2\,(n_2(z)+1)} \tag{63}$$

In a similar vein, we can now substitute (23) together with $l_{2j}(z) = y_{2j}(z)$ into the objective function of firm-level union 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

$$\bar{\lambda} w_2(z) = \frac{2A + n_1(z)\bar{\lambda} w_1(z) + (n_1(z) + n_2(z))\,\bar{\lambda}\bar{w}_2}{2n_1(z) + n_2(z) + 1}. \tag{64}$$

Eqs. (63) and (64) constitute a system of two equations, which jointly determine wages rates $\bar{\lambda} w_1(z)$ and $\bar{\lambda} w_2(z)$ in (24) and (25). *QED*

The impact of trade on real labor income in the short run

Starting with country 1, which hosts sector-level unions, we can infer the impact of trade on real labor income from the ranking of $\Phi_1/P = \phi_1(1-u_1)L$ and $\Phi^s/P^s = \phi^s(1-u^s)L$. According to (15), (18), (30), and (36), we can thus conclude that real labor income (and thus the welfare of workers) in country 1 is in the open economy higher than, equal to, or smaller than in the closed economy if $\Gamma_1(n,\beta) >, =, < 0$, with

$$\Gamma_1(n,\beta) \equiv \frac{2nA(n+1)(1-\beta)\left[(2n+1)+2n(1-\beta)\right]}{b\left[(2n+1)+(n+1)(1-\beta)\right]\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}} - \frac{nA(1-\beta)}{b(2-\beta)\,(n+2-\beta)}.$$

Rearranging terms, it is tedious but straightforward to show that the sign of $\Gamma_1(n,\beta)$ is equivalent to the sign of

$$\gamma_1(n,\beta) \equiv 4n^3 + 6n^2 + 4n + 1 + (1-\beta)\left(2n^2+7n+2\right)(n+1) - (1-\beta)^2\left(3n^2-6n-1\right)(n+1) - 2(1-\beta)^3 n\,(n-1)\,(n+1). \tag{65}$$

Noting that $\gamma_1(n,\beta) > 0$ holds for any possible combination of n and β, we can safely conclude that trade increases real income and welfare of workers in country 1.

Let us now turn to the impact of trade on total labor income in country 2. Contrasting $\Phi_2/P = \phi_2(1-u_2)L$ and $\Phi^f/P^f = (1-u^f)L$ and accounting for (15), (19), (31), and (37), it is immediate that trade increases, does not affect, lowers welfare of workers in country 2 if $\Gamma_2(n,\beta) >, =, < 0$, with

$$\Gamma_2(n,\beta) \equiv \frac{4n^2A(1-\beta)\left[(2n+1)+(n+1)(1-\beta)\right]}{b\left[(2n+1)+(n+1)(1-\beta)\right]\left\{(n+1)(1-\beta)\left[(3n+1)+2n(1-\beta)\right]+(2n+1)\right\}} - \frac{n^2A(1-\beta)}{b\left[(n+1)+n(1-\beta)\right]\left[1+n(1-\beta)\right]}.$$

Rearranging terms, we can show that the sign of $\Gamma_2(n,\beta)$ is equivalent to the sign of

$$\gamma_2(n,\beta) \equiv (2n+1)(2n+3) + (1-\beta)[(n+1)^2(2n+1) + (2n+1)^2 + 1] + 2n(3n^2+n+1)(1-\beta)^2. \tag{66}$$

Noting that $\gamma_2(n,\beta) > 0$ holds for any possible combination of n and β, we can safely conclude that trade increases real income and welfare of workers in country 2. *QED*

The allocation of capital (firms) in a long-run trade equilibrium

It is the aim of this proof to show that there exists a unique full diversification equilibrium, where full diversification means that both countries produce all goods.[13] Throughout the proof, we ignore the integer problem and assume that there are no costs of capital reallocation. 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 invest. 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) $\Pi^t(z) = \Pi^t$ 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 (23), we can further note that $y_1(z) = y_2(z)$ is equivalent to $\bar{\lambda}w_1 = \bar{\lambda}w_2$, and from (24), (25) we can infer that international factor price equalization requires

$$(2A - \bar{\lambda}\bar{w}_1)\,[n_1(z) - 1] = \left(\bar{\lambda}\bar{w}_2 - \bar{\lambda}\bar{w}_1\right)[n_1(z) + n_2(z)]\,[n_2(z) + 2]\,. \tag{67}$$

Furthermore, we can combine (23) with (24) and (25) to calculate

$$y_1(z) = \frac{\left(2A - \bar{\lambda}\bar{w}_1\right)\left[2n_1(z)n_2(z) + 2n_2(z)^2 + 2n_1(z) + 3n_2(z) + 1\right]}{b\,[n_1(z) + n_2(z) + 1]\,[3n_1(z)n_2(z) + 2n_2(z)^2 + 4n_1(z) + 4n_2(z) + 2]} + \frac{\left(\bar{\lambda}\bar{w}_2 - \bar{\lambda}\bar{w}_1\right)[n_1(z) + n_2(z)]\,[n_2(z) + 1]\,n_2(z)}{b\,[n_1(z) + n_2(z) + 1]\,[3n_1(z)n_2(z) + 2n_2(z)^2 + 4n_1(z) + 4n_2(z) + 2]} \tag{68}$$

Solving (67) for $2A - \bar{\lambda}\bar{w}_1$, substituting the resulting expression into (68), and recollecting from

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

above that $y_i(z) \equiv y(z)$ for $i = 1, 2$, we can calculate

$$y(z) = \frac{\left(2A - \bar{\lambda}\bar{w}_2\right)}{b\left[n_1(z) + n_2(z) + 1\right]^2}. \tag{69}$$

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. (69) that in a full diversification equilibrium the total number of competitors, $n^t(z) \equiv n_1(z) + n_2(z)$, is the same in all industries z: $n^t(z) = n^t$. In view of a unit mass of sectors, we furthermore have $n^t = 2K > 1$. According to (67), we can then define the implicit function

$$\zeta\left(n_1(z)\right) \equiv \left[\left(2A - \bar{\lambda}\bar{w}_1\right) + \left(\bar{\lambda}\bar{w}_2 - \bar{\lambda}\bar{w}_1\right) n^t\right]\left[n_1(z) - 1\right] - \left(\bar{\lambda}\bar{w}_2 - \bar{\lambda}\bar{w}_1\right) n^t(n^t - 1) = 0. \tag{70}$$

From inspection of (70), we can conclude that if $\zeta(\cdot) = 0$ has a solution in $n_1(z)$, this solution must be unique. Hence, if a full diversification equilibrium exists, the number of competitors in the two countries must be the same in all industries: $n_1(z) = n_1$ and $n_2(z) = n^t - n_1 = n_2$ for all z. However, if industries are symmetric in this respect, it follows from (24), (25), and the previous insight that diversification requires $\bar{\lambda}w_i(z) = \bar{\lambda}w(z)$ in $i = 1, 2$ that wages are the same in all industries, $\bar{\lambda}w_i(z) = \bar{\lambda}w$ for all z, and thus $\bar{\lambda}\bar{w}_i = \beta\bar{\lambda}w$ for $i = 1, 2$. In view of the latter, we can calculate

$$W \equiv \bar{\lambda}w = \frac{2A\left(2n_1 + 2n_2 + 1\right)}{(1-\beta)\left(3n_1n_2 + 2n_2^2 + 2n_1 + 2n_2 + 1\right) + \left(2n_1 + 2n_2 + 1\right)}, \tag{71}$$

$$W \equiv \bar{\lambda}w = \frac{2A\left(n_1 + 2n_2 + 2\right)}{(1-\beta)\left(3n_1n_2 + 2n_2^2 + 3n_1 + 2n_2\right) + \left(n_1 + 2n_2 + 2\right)}, \tag{72}$$

according to (24) and (25). Accounting for $n_2 = n^t - n_1$, system (71) and (72) establishes an implicit relationship between n_1 and n^t:

$$\Gamma\left(n_1, n^t\right) \equiv -n_1^3 - n_1^2 n^t + n_1^2 + 2n_1\left(n^t\right)^2 + 5n_1n^t + 2n_1 - 2\left(n^t\right)^2 - 4n^t - 2 = 0. \tag{73}$$

From $\Gamma(0, n^t) = -2\left(n^t + 1\right)^2 < 0$ and – in view of $n^t > 2$ – $\Gamma(n^t, n^t) = 4\left(n^t\right)^2 - 2n^t - 2 > 0$, it is clear that $\Gamma\left(n_1, n^t\right) = 0$ has a solution in $n_1 \in \left(0, n^t\right)$, and noting that $\partial\Gamma(\cdot)/\partial n_1 = -3n_1^2 - 2n_1n^t + 2n_1 + 2\left(n^t\right)^2 + 5n^t + 2$, $\partial^2\Gamma(\cdot)/\partial n_1^2 = -6n_1 - 2\left(n^t - 1\right) < 0$, we can furthermore conclude that this solution is unique. Finally, noting that $\Gamma(1, n^t) = 0$, it is immediate that system (71) and (72) determines a unique firm allocation $n_1 = 1$, $n_2 = n^t - 1$, with wages and output corresponding to this firm allocation being given by

$$W^t = \frac{2A}{1 + n^t(1-\beta)}, \qquad y^t = \frac{2An^t}{b\left(n^t + 1\right)\left[1 + n^t(1-\beta)\right]}. \tag{74}$$

Taking stock, we have so far shown that there exists a unique candidate for a full diversifi-

cation equilibrium, which is characterized by firm location $n_1(z) = 1$, $n_2(z) = n^t - 1$, and we now show that capital owners do not have an incentive to deviate from this solution so that the respective outcome indeed characterizes a best response equilibrium. Since capital owners foresee that their investment decision influences product 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 (24) and (24) $\bar{\lambda}\bar{w}_i = \bar{\lambda}\bar{w}$ and substituting the resulting expression into (23) gives

$$y_1(z) = \frac{2A - \bar{\lambda}\bar{w}}{b} \frac{2n_1(z)n_2(z) + 2n_2(z)^2 + 2n_1(z) + 3n_2(z) + 1}{[n_1(z) + n_2(z) + 1]\,[3n_1(z)n_2(z) + 2n_2(z)^2 + 4n_1(z) + 4n_2(z) + 2]}, \tag{75}$$

$$y_2(z) = \frac{2A - \bar{\lambda}\bar{w}}{b} \frac{3n_1(z)n_2(z) + 2n_2(z)^2 + 2n_1(z) + 2n_2(z)}{[n_1(z) + n_2(z) + 1]\,[3n_1(z)n_2(z) + 2n_2(z)^2 + 4n_1(z) + 4n_2(z) + 2]}. \tag{76}$$

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

$$\frac{\partial y_1(z)}{\partial n_1(z)} = -\frac{2A - \bar{\lambda}\bar{w}}{b} \frac{n^t\left(3n^t - 2\right) + \left[6n^t + 9n^t + 2\right]\left(n^t - 1\right)^2}{\left(n^t + 1\right)^4\left(2n^t + 1\right)^2}, \tag{77}$$

$$\frac{\partial y_2(z)}{\partial n_2(z)} = -\frac{2A - \bar{\lambda}\bar{w}}{b} \frac{\left(n^t - 1\right)^2 + \left[2\left(n^t\right)^2 + 11n^t + 2\right]\left[2\left(n^t\right)^2 + 10n^t - 1\right]}{\left(n^t + 1\right)^4\left(2n^t + 1\right)^2}. \tag{78}$$

In view of $n^t > 2$, we have $dy_i(z)/dn_i(z) < 0$ and thus $d\Pi_i(z)/dn_i(z) < 0$, which implies that a capital owner cannot benefit from adjusting his/her investment if $n_1 = 1$ and $n_2 = n^t - 1$. This proves existence of a unique full diversification equilibrium. *QED*

The impact of capital mobility on aggregate employment

Starting with country 1, from which capital flows out to country 2, we can infer the impact of these outflows on aggregate employment from the ranking of $(1 - u_1)L$. According to (30) and (40), we can thus conclude that aggregate employment in country 1 is in the long-run open economy higher than, equal to, or smaller than in the short-run open economy if $\Gamma_1(n, \beta) >, =, < 0$ with

$$\Gamma_1(n, \beta) \equiv \frac{4nA(1 - \beta)}{b(2n + 1)[1 + 2n(1 - \beta)]} - \frac{2nA(n + 1)(1 - \beta)[(2n + 1) + 2n(1 - \beta)]}{b(2n + 1)\{(n + 1)(1 - \beta)[(3n + 1) + 2n(1 - \beta)] + (2n + 1)\}}.$$

Rearranging terms, it is tedious but straightforward to show that the sign of $\Gamma_1(n,\beta)$ is equivalent to the sign of

$$\gamma_1(n,\beta) \equiv -(n-1)[(2n+1)+2(n+1)(2n+1)(1-\beta)+4n(n+1)(1-\beta)^2]. \tag{79}$$

We note that $\gamma_1(n,\beta) \leq 0$ for $n \geq 1$ and any $\beta \in (0,1)$, i.e. aggregate employment in country 1 decreases in the long run open economy compared to the short run open economy if more than one firm is active. To see, whether capital mobility reverses positive employment effects that occured when opening up for trade, we need to compare $(1-u_1)L$ and $(1-u^s)L$. According to (40) and (15), we can thus conclude that aggregate employment in country 1 is in the long-run open economy higher than, equal to, or smaller than in the closed economy if $\Gamma_1(n,\beta) >, =, < 0$ with

$$\Gamma_1(n,\beta) \equiv \frac{4nA(1-\beta)}{b(2n+1)[1+2n(1-\beta)]} - \frac{nA(1-\beta)}{b(n+1)(2-\beta)}.$$

Rearranging terms, it is tedious but straightforward to show that the sign of $\Gamma_1(n,\beta)$ is equivalent to the sign of

$$\gamma_1(n,\beta) \equiv (2n+3) - 4(n-1)(n+1)(1-\beta) + 2n(1-\beta). \tag{80}$$

It is easily confirmed that $\gamma_1(n,1) = 2n+3 > 0$, while $\gamma_1(n,0) = -4n^2+4n+7 \equiv g_1(n)$, where $g_1(0) = 7$ and $\lim_{n\to\infty} g_1(n) < 0$ imply that the sign of $g_1(n)$ is ambiguous. In addition, we can show that $\gamma_1(1,\beta) = 7-2\beta > 0$. Accounting for these properties of $\gamma_1(n,\beta)$, we can therefore be sure that a negative long-run impact of trade on aggregate employment in country 1 is possible if n is sufficiently high, while β is sufficiently small.

Turning to country 2, which is the destination of the capital flows we can infer aggregate employment effects by comparing $(1-u_2)L$ in the short-run and the long-run open economy according to (31) and (40). Our analysis shows that aggregate employment in the long-run is higher than, equal to, or smaller than in the short run if $\Gamma_2(n,\beta) >, =, < 0$, with

$$\Gamma_2(n,\beta) \equiv \frac{4n(2n-1)A(1-\beta)}{b(2n+1)[1+2n(1-\beta)]} - \frac{4n^2A(1-\beta)[(2n+1)+(n+1)(1-\beta)]}{b(2n+1)\{(n+1)(1-\beta)[(3n+1)+2n(1-\beta)]+(2n+1)\}},$$

which, after rearranging terms, depends on the sign of

$$\gamma_2(n,\beta) \equiv (n-1)\{(1-\beta)[2n(n+1)+(2n+1)]+2n(n+1)(1-\beta)^2+(2n+1)\}, \tag{81}$$

which is unambiguously non-negative for any combination of n and β. As we have positive employment effects for country 2 when opening for trade, we can therefore safely conclude that aggregate employment in the long-run open economy is at least as high as in the short-run open economy and higher than in autarky. *QED*

The impact of capital mobility on aggregate welfare

Starting with country 1, from which capital flows out to country 2, we can infer the impact of these outflows on aggregate welfare from the ranking of $(\bar{\lambda}I_1)/P$ and $(1-u_1)L$. According to (30) and (41), we can thus safely conclude that aggregate welfare in country 1 is in the long-run open economy higher than, equal to, or smaller than in the short-run open economy if $\Gamma_1(n,\beta) >, =, < 0$ with

$$\Gamma_1(n,\beta) \equiv \frac{4nA(1-\beta)[(2n+1)+2n^2(1-\beta)]}{b(2n+1)[1+2n(1-\beta)][(2n+1)+2n(1-\beta)]} - \frac{2nA(n+1)(1-\beta)[(2n+1)+2n(1-\beta)]}{b(2n+1)\{(n+1)(1-\beta)[(3n+1)+2n(1-\beta)]+(2n+1)\}}.$$

Rearranging terms, it is tedious but straightforward to show that the sign of $\Gamma_1(n,\beta)$ is equivalent to the sign of

$$\gamma_1(n,\beta) \equiv -(n-1)(2n+1)^2 - 2(2n+1)[(n-1)(n+1)^2+(n^3-1)](1-\beta) - 4n(n-1)(n+1)(2n+1)(1-\beta)^2. \tag{82}$$

We note that $\gamma_1(n,\beta) < 0$ for $n > 1$ and any value of β, i.e. capital mobility decreases the aggregate welfare in country 1 compared to the short-run trade equilibrium if more than one firm is located in country 1. To see, whether capital mobility reverses positive welfare effects that occured when opening up for trade, we need to compare $(\bar{\lambda}I_1)/P$ and $(1-u^s)L$. According to (15) and (41), we can thus conclude that aggregate welfare in country 1 is in the long-run open economy higher than, equal to, or smaller than in the closed economy if $\Gamma_1(n,\beta) >, =, < 0$ with

$$\Gamma_1(n,\beta) \equiv \frac{4nA(1-\beta)[(2n+1)+2n^2(1-\beta)]}{b(2n+1)[1+2n(1-\beta)][(2n+1)+2n(1-\beta)]} - \frac{nA(1-\beta)}{b(n+1)(2-\beta)}.$$

Rearranging terms, it is tedious but straightforward to show that the sign of $\Gamma_1^r(n,\beta)$ is equivalent to the sign of

$$\gamma_1(n,\beta) \equiv (2n+1)(2n+3) + 2(n+1)^2(2-\beta) + 4n^2(1-\beta)^3, \tag{83}$$

Noting that $\gamma_1(n,\beta) > 0$ holds for any combination of n and β we can safely conclude that aggregate welfare in country 1 is always higher in the long run open economy than in the closed economy. Hence, capital mobility does not reverse positive aggregate welfare gains from trade for country 1.

Turning to country 2, which is the destination of the capital flows we can infer aggregate welfare effects by comparing $(\bar{\lambda}I_2)/P$ and $(1-u_2)L$ in the short-run and the long-run open economy. Accounting for (31) and (42) our analysis shows that aggregate employment in the long-run is

higher than, equal to, or smaller than in the short run if $\Gamma_2(n,\beta) >, =, < 0$, with

$$\Gamma_2(n,\beta) \equiv \frac{4nA(1-\beta)[(2n-1)(2n+1)+2n^2(1-\beta)]}{b(2n+1)[1+2n(1-\beta)][(2n+1)+2n(1-\beta)]} - \frac{4n^2A(1-\beta)[(2n+1)+(n+1)(1-\beta)]}{b(2n+1)\{(n+1)(1-\beta)[(3n+1)+2n(1-\beta)]+(2n+1)\}},$$

which, after rearranging terms, depends on the sign of

$$\gamma_2(n,\beta) \equiv (n-1)(2n+1)^2 + n(2n+1)(1-\beta)[2n^2(2n+1) - 3(n+1)] + 2n(1-\beta)^2(9n^3+6n^2-2n-1), \quad (84)$$

which is unambiguously non-negative for any combination of n and β, i.e. capital inflows increase the aggregate welfare in country 2. As we have already positive welfare effects for country 2 when opening for trade, we can therefore safely conclude that aggregate welfare in the long-run open economy is higher than in autarky. *QED*

The impact of capital mobility on real labor income

Starting with country 1, from which capital flows out to country 2, we can infer the impact of these outflows on real wage income from the ranking of Φ_1/P. According to (30), (36) and (43) we can thus conclude that aggregate welfare in country 1 is in the long-run open economy higher than, equal to, or smaller than in the short-run open economy if $\Gamma_1(n,\beta) >, =, < 0$ with

$$\Gamma_1(n,\beta) \equiv \frac{4nA(1-\beta)}{b(2n+1)[1+2n(1-\beta)][(2n+1)+2n(1-\beta)]} - \frac{2nA(n+1)(1-\beta)[(2n+1)+2n(1-\beta)]}{b[(2n+1)+(n+1)(1-\beta)]\{(n+1)(1-\beta)[(3n+1)+2n(1-\beta)]+(2n+1)\}}.$$

Rearranging terms, it is tedious but straightforward to show that the sign of $\Gamma_1(n,\beta)$ is equivalent to the sign of

$$\gamma_1(n,\beta) \equiv -(n-1)(2n+1)^2 - 4(n-1)(n+1)^2(2n+1)(1-\beta) - 2(n+1)(8n^3-n^2-6n-1)(1-\beta)^2 - 4n(n-1)(n+1)(2n+1)(1-\beta)^3. \quad (85)$$

We note that $\gamma_1(n,\beta) < 0$ holds for $n > 1$ and any value of β, i.e. capital outflows reduce the welfare of workers in country 1 compared to the short-run open economy if more than one firm exists in country 1. Hence, to see whether capital mobility reverses positive trade effects for the welfare of workers, we need to compare Φ_1/P and Φ^s/P. According to (15), (18) and (43), we can thus conclude that workers' welfare in country 1 is in the long-run open economy higher

than, equal to, or smaller than in the closed economy if $\Gamma_1(n,\beta) >, =, < 0$ with

$$\Gamma_1(n,\beta) \equiv \frac{4nA(1-\beta}{b)[1+2n(1-\beta][(2n+1)+2n(1-\beta)]} - \frac{nA(1-\beta)}{b(n+2-\beta)(2-\beta)}.$$

Rearranging terms, it is tedious but straightforward to show that the sign of $\Gamma_1(n,\beta)$ is equivalent to the sign of

$$\gamma_1(n,\beta) \equiv (2n+3) + 4(1-\beta) - 4(n-1)(n+1)(1-\beta)(2-\beta). \tag{86}$$

It is easily confirmed that $\gamma_1(n,1) = 2n+3 > 0$, while $\gamma_1(n,0) = 15+2n-8n^2 \equiv g_1(n)$, where $g_1(0) = 15 > 0$ and $\lim_{n\to\infty} g_1(n) < 0$ imply that the sign of $g_1(n)$ is ambiguous. In addition, we can show that $g_1(1,\beta) = 9-4\beta > 0$. Accounting for these properties of $\gamma_1(n,\beta)$, we can therefore be sure that a negative long-run impact of trade on the welfare of workers is possible if n is sufficiently high, while β is sufficiently small.

Turning to country 2, which is the destination of the capital flows we can infer workers' welfare effects by comparing Φ_2/P in the short-run and the long-run open economy. Accounting for (31), (37) and (44) our analysis shows that individual welfare of workers in the long-run is higher than, equal to, or smaller than in the short run if $\Gamma_2(n,\beta) >, =, < 0$, with

$$\Gamma_2(n,\beta) \equiv \frac{4nA(2n-1)(1-\beta)}{b[1+2n(1-\beta)][(2n+1)+2n(1-\beta)]} - \frac{4n^2A(1-\beta)[(2n+1)+(n+1)(1-\beta)]}{b[(2n+1)+2n(1-\beta)]\{(n+1)(1-\beta)[(3n+1)+2n(1-\beta)]+(2n+1)\}},$$

which, after rearranging terms, depends on the sign of

$$\gamma_2(n,\beta) \equiv (n-1)(2n+1) + (2n^3+2n^2-3n-1) + 2n(n-1)(n+1)(1-\beta)^2, \tag{87}$$

which is unambiguously non-negative for any combination of n and β, i.e. capital inflows increase the welfare of workers in country 2. As we have already positive welfare effects for workers from country 2 when opening for trade, we can therefore safely conclude that in the long-run open economy workers are better off than in autarky. *QED*

The impact of capital mobility on real capital income

Starting with country 1, from which capital flows out to country 2, we can infer the impact of these outflows on real capital income from the ranking of Ψ_1/P. According to (30), (36) and (45), we can thus conclude that welfare of capital owners in country 1 is in the long-run open economy

higher than, equal to, or smaller than in the short-run open economy if $\Gamma_1(n,\beta) >, =, < 0$ with

$$\Gamma_1(n,\beta) \equiv \frac{8n^3A(1-\beta)^2}{b(2n+1)[1+2n(1-\beta)][(2n+1)+2n(1-\beta)]} - \frac{2nA(n+1)^2(1-\beta)^2[(2n+1)+2n(1-\beta)]}{b[(2n+1)+(n+1)(1-\beta)]\{(n+1)(1-\beta)[(3n+1)+2n(1-\beta)]+(2n+1)\}}.$$

Rearranging terms, it is tedious but straightforward to show that the sign of $\Gamma_1(n,\beta)$ is equivalent to the sign of

$$\gamma_1(n,\beta) \equiv (3n^2-2n-1)(2n+1)^2 + 2n(n+1)(2n+1)(1-\beta)(4n^2-n-3) + 4n^2(n+1)(1-\beta)^2(3n^2-n-2), \tag{88}$$

which is non-negative for any combination of n and β. Hence, we can safely conclude that capital owners in the long-run open economy are definitely better off than in the short-run open economy and under autarky.

Turning to country 2, which is the destination of the capital flows we can infer entrepreneurs' welfare effects by comparing Ψ_2/P in the short-run and the long-run open economy. Accounting for (31), (37) and (45) our analysis shows that individual welfare of workers in the long-run is higher than, equal to, or smaller than in the short run if $\Gamma_2(n,\beta) >, =, < 0$, with

$$\Gamma_2(n,\beta) \equiv \frac{8n^3A(1-\beta)^2}{b(2n+1)[1+2n(1-\beta)][(2n+1)+2n(1-\beta)]} - \frac{8n^3A(1-\beta)^3[(2n+1)+(n+1)(1-\beta)]}{b(2n+1)[(2n+1)+2n(1-\beta)]\{(n+1)(1-\beta)[(3n+1)+2n(1-\beta)]+(2n+1)\}},$$

which, after rearranging terms, depends on the sign of

$$\gamma_2(n,\beta) \equiv (n+1)(3n-1)(1-\beta), \tag{89}$$

which is unambiguously non-negative for any combination of n and β. As we have positive welfare effects for entrepreneurs from country 2 when opening for trade, we can therefore safely conclude that in the long-run open economy they are higher than in autarky. *QED*

The impact of the policy reform on aggregate employment (welfare)

Starting with country 1, which conducts the policy reform on the labor market, we can infer the impact of the reform on aggregate employment (welfare) from the ranking of $(1-u^r)L$ and $(1-u_1)L$. According to (48) and (30), we can thus conclude that aggregate employment (and thus aggregate welfare) in country 1 is in the post-reform open economy higher than, equal to,

or smaller than in the short-run open economy if $\Gamma_1(n,\beta) >, =, < 0$, with

$$\Gamma_1(n,\beta) \equiv \frac{4n^2A(1-\beta)}{b(2n+1)[1+2n(1-\beta)]} - \frac{2nA(n+1)(1-\beta)[(2n+1)+2n(1-\beta)]}{b(2n+1)\{(n+1)(1-\beta)[(3n+1)+2n(1-\beta)]+(2n+1)\}},$$

which, after rearranging terms, depends on the sign of

$$\gamma_1(n,\beta) \equiv (n-1)[2n(n+1)(1-\beta)+(2n+1)]. \tag{90}$$

Noting that $\gamma_1(n,\beta) > 0$ holds for any $n > 1$ and $\beta \in (0,1)$ we can safely conclude that the policy reform increases aggregate employment and thus aggregate welfare in country 1.

Turning to country 2, we find that according to (48) and (31) aggregate employment (welfare) is in the post-reform world smaller than, equal to, or higher than in the short-run open economy if $\Gamma_2(n,\beta) >, =, < 0$, with

$$\Gamma_2(n,\beta) \equiv \frac{4n^2A(1-\beta)}{b(2n+1)[1+2n(1-\beta)]} - \frac{4n^2A(1-\beta)[(2n+1)+(n+1)(1-\beta)]}{b(2n+1)\{(n+1)(1-\beta)[(3n+1)+2n(1-\beta)]+(2n+1)\}},$$

which after rearranging terms depends on the sign of

$$\gamma_2(n,\beta) \equiv -4n^3(n-1)A(1-\beta)^2. \tag{91}$$

Noting that $\gamma_2(n,\beta) < 0$ holds for any $n > 1$ and $\beta \in (0,1)$ we can safely conclude that the policy reform in country 1 reduces aggregate employment (and thus aggregate welfare) in country 2. This confirms our respective findings in the main text. *QED*

The impact of the policy reform on the rent shares ϕ_i and ψ_i

Starting with country 1, which conducts the policy reform on the labor market, we can infer the impact of the reform on the rent share of workers by comparing ϕ^r and ϕ_1. This analysis shows that share accruing to workers shrinks due to the policy reform in country 1. In country 2 we note that the share of rents remains unaffected, i.e. the labor market reform generates no spillover effects for the distribution of economic rents. *QED*

The impact of the policy reform on real labor income

Starting with country 1, which conducts the policy reform on the labor market, we can infer the impact of the reform on real labor income from the ranking of $\Phi^r/P = \phi^r(1-u^r)L$ and $\Phi_1 = \phi_1(1-u_1)L$. According to (30), (36) and (52), we can thus conclude that aggregate real

labor income (and thus the welfare of workers) in country 1 is in the post-reform open economy higher than, equal to, or smaller than in the short-run open economy if $\Gamma_1(n,\beta) >, =, < 0$, with

$$\Gamma_1(n,\beta) \equiv \frac{4n^2A(1-\beta)}{b[1+2n(1-\beta)][(2n+1)+2n(1-\beta)]} - \frac{2nA(n+1)(1-\beta)[(2n+1)+2n(1-\beta)]}{b[(2n+1)+(n+1)(1-\beta)]\{(n+1)(1-\beta)[(3n+1)+2n(1-\beta)]+(2n+1)\}}.$$

Rearranging terms, it is tedious but straightforward to show that the sign of $\Gamma_1(n,\beta)$ is equivalent to the sign of

$$\gamma_1(n,\beta) \equiv (2n+1)^2 + 2n(n+1)(1-\beta)[(2n+1)-(n+1)(1-\beta)-2n(1-\beta)^2]. \tag{92}$$

It is easily confirmed that $\gamma_1(n,1) = (2n+1)^2 > 0$, while $\gamma_1(n,0) = -2n^3+2n^2+4n+1 \equiv g_1(n)$, where $g_1(0) = 1 > 0$, and $\lim_{n\to\infty} g_1(n) < 0$ imply that the sign of $g_1(n)$ is ambiguous. To be more specific, there exists an $\hat{n} > 1$ such that $g_1(n) > 0$ if $n < \hat{n}$, while $g_1(n) < 0$ if $n > \hat{n}$. In addition, we can show that $\gamma_1(1,\beta) = 5+28\beta-32\beta^2+8\beta^3 > 0$. Accounting for these properties of $\gamma_1(n,\beta)$, we can therefore be sure that a negative effect of the policy reform on the welfare of workers in country 1 is possible if n is sufficiently high, while β is sufficiently small.