International outsourcing and trade union (de-)centralisation*

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Abstract

We study the effects of centralised versus decentralised wage setting in a unionsed duopoly where firms can outsource parts of input production to foreign subcontractors. We show that decentralised (as opposed to centralised) wage setting allows trade unions to capture a larger share of the rents generated by international outsourcing. Consequently, the equilibrium degree of outsourcing is lower under decentralised wage setting, which benefits unions if they are sufficiently employment oriented. We identify situations in which both firms and unions prefer decentralised over centralised wage setting. Thus, international outsourcing opportunities is a potential driver of trade union decentralisation.

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1 Introduction

Trade unions are waning in importance across the Western world. Membership rates are down, the fraction of workers covered by unionised agreements also. Not only is there a tendency towards deunionisation, but union wage settlements tend to be less centralised than before. Government interference with wage settlements is also dwindling. Documentation of these facts can be found in EEAG (2004) and OECD (1997); for more recent figures, see Krusell and Rudanko (2016). Without necessarily implying causality, all these developments have gone hand in hand with increased globalisation.

This paper studies theoretically the possible impacts of outsourcing possibilities on wages and employment in a unionised economy, with special emphasis on the degree of centralisation of the bargaining system. On the question of union centralisation, Calmfors and Driffill (1988) is perhaps the most influential paper. Their main point is that a central union will internalise many possible externalities in wage setting, simply because most of the working population will be members. Such a central union will therefore try to avoid large-scale inefficiencies and unemployment as results of the presence of union power. While Calmfors and Driffill focus on centralisation to the national level, which now has become rare, centralisation to the industry level can in a similar way internalise externalities inside an industry. However, we find that favorable results may prevail precisely when workers in one firm *do not* consider how their actions impact workers of other firms. Decentralisation can then be advantageous – to workers and firms alike.

We use a model where production takes place in a global value chain, where a series of complementary tasks can be outsourced to a low-cost country. Under the assumption that it is too costly to outsource all tasks, a union will respond to increased outsourcing by enforcing a higher wage for the workers performing the tasks that remain in the host country. With decentralised bargaining, unions will not coordinate their wage setting, so one union will not take into account the effects of its wage policy on other unionised workers. We show that this means that the wage increase following outsourcing will be even higher than in the centralised case. The firms, then, will know that a high degree of outsourcing can make the production that is not so easy to move, more expensive. The wage increase effect therefore deters outsourcing. If the union is sufficiently employment-oriented, this means that decentralisation betters the situation for the unions. Whether or not firms prefer decentralised bargaining will be discussed in the paper, but one argument in favour of decentralisation from a firm's viewpoint is that union rent extraction (for a given level of outsourcing) is less.

We show that there exist parameter sets where decentralisation is preferred by all involved parties, unions and firms alike.

A driving assumption is precisely that production takes place in a multi-stage value chain, where the individual tasks and production processes stand in a complementary relationship to each other. In international economics, the idea of global value chains and multi-stage production is commonplace.[1] In the context of trade unions and globalisation the notion is much less used, with Skaksen and Sørensen (2001), Skaksen (2004) and Lommerud et al. (2009) as exceptions.[2]

We would like to draw attention to some important assumptions underlying our analysis. Firstly, we study international outsourcing, or 'offshore outsourcing' as it is sometimes called, implying that parts of the production are moved out internationally to a legally independent supplier. The alternative would be international in-sourcing or 'captive outsourcing', which refers to the case where parts of the production process are moved out internationally to a subsidiary of the home-country firm. Note that the results here would apply for the most part also in the latter case. What is important is that the cost of the foreign production is seen as exogenous by the home country union, and this can well be the case whether the activities abroad are run by a subsidiary or an independent supplier.[3] Pongelli et al. (2019) find for a sample of European firms that about ten per cent of firms engage in moving some parts of production abroad, with broadly a fifty-fifty division between international outsourcing and international in-sourcing. Sturgeon et al. (2013) for a different data set for some Northern European countries find that a much larger fraction of firms, 30-40 per cent, engage in international sourcing of parts of its core functions, but do not distinguish between legally independent suppliers or foreign subsidiaries.

The timing assumptions of the model imply that choices concerning organisational structure are more long-term than wage settlements. This is a common but not ubiquitous way forward in the literature on trade unions. Starting to source from a foreign location and an outside supplier presumably requires some relationship-specific investments, so that sourcing decisions are over-

[1] See, among many others, Dixit and Grossman (1982), Autor et al. (2003), Acemoglu and Autor (2011), Grossman and Rossi-Hansberg (2008), and Antras and Chor (2013).

[2] There is a large and varied literature on union wages and globalisation and the organisation of global firms following different paths than this. We mention Carluccio and Bas (2015), Davidson et al. (2014), Egger et al. (2015), Jeon and Kwon (2018), Lommerud et al. (2003), Lommerud et al. (2012), Naylor (1998, 1999) and Sly and Soderberry (2014).

[3] It is interesting to note that there is some resemblance between the case of international outsourcing and labour-saving technological change, as the latter also would cause the wage cost of parts of the production to fall. Lommerud and Straume (2012) deal with labour-saving technical change in a unionised setting. Unions, innovation and the set-up of the bargaining structure are also topics addressed by, e.g., Haucap and Wey (2004), Calabuig and Gonzalez-Maestre (2002) and Mukherjee and Pennings (2011).

turned only infrequently. The opposite assumption would be that sourcing decisions could easily be changed in the short run. Then trade unions would have to consider the effect wage settlements would have on firms' incentives to move parts of the production out of the firm and out of the home country. Such considerations are not included in the present model.

A further important assumption is that the degree to which a union cares more for employment or for wages is exogenous and uninfluenced by whether bargaining is centralised or not. The degree of wage-orientation versus employment-orientation is often crucial both for predictions about how a union will behave and how a given outcome is to be evaluated seen from the union's point of view.[4] The beneficial effects of decentralisation of bargaining in the face of possible outsourcing, found in our work, build on unions being relatively employment-oriented. If outsourcing were to take place, wages for the retained workers would go up, which deters outsourcing. In turn, this implies that jobs are saved, but wages go up to a lesser degree. This is attractive to an employment-oriented union.

Little empirical work exists on the effect of trade unions on outsourcing decisions. We would like to mention Dekker and Koster (2018). They find indications that higher worker power is associated with more outsourcing, contrary to our model. However, the analysis is conducted at a rather aggregate level, so it is hard to discern for example what type of bargaining structures the various countries have, or if we are talking about offshoring of tasks in a global production chain or, alternatively, moving the whole production abroad. Sethupathy (2013) is also relevant. He studies outsourcing from the United States to Mexico, and uses as natural experiments two events of new outsourcing possibilities opening up. US firms likely to take up these new opportunities actually experience higher wages at home. Of course, private sector unionism in the US is in a sorry state, but there could be other mechanisms through which the retained workers at home secure higher wages, given that their strategic position has improved with more outsourcing.

It is also interesting to compare the implications of the model with the real life experiences of important trade unionised economies. Dustmann et al. (2014) discuss Germany's development from sick man of Europe after reunification to economic superstar in later years. They emphasise that the labour market institutions of unionised Germany can be more flexible than what is the case in countries that rely more on legal restrictions, for example statutory minimum wages. When the

[4] For example, Chu et al. (2016) predict that an increase in bargaining power of a trade union will lead to less employment, less innovation and lower economic growth – and that innovation is directed towards a foreign country. However, all of this builds on an assumption that unions are wage-oriented.

German labour market came under pressure following reunification and the possibilities to move production out to former east Germany, the answer was more decentralised bargaining structures. Our point is that this might have been a rationale response both from the side of employers and workers.

An interesting, but very broad question, is if trade unions are bad or good for an economy. Market power in the labour market is, of course, a deviation from the competitive model – and efficiency losses are to be expected, although the redistribution effects can be seen as positive. However, this does not tally well with the fact that many economies in Northern Europe both are characterised by high incomes and high productivity – and trade unions that are still relatively strong. Especially in the Swedish trade union movement there is a close to hundred years old argument that strong unions can move the economy towards more rapid structural change and innovation (see for example Agell and Lommerud, 1993, 1997; Moene and Wallerstein, 1997; and De Pinto and Lingens, 2019). Our analysis is partly in concordance with this positive view of trade unionism. True, we have not incorporated any reason why trade unions may bring about efficiency gains. In our framework, if trade unions were absent, wages would be driven down to the outside option of workers and outsourcing would take place according to an efficient comparison of workers' outside wage and the cost of producing abroad. Nevertheless, our model framework does signify, given unionised bargaining, that more powerful unions deter international outsourcing and keep jobs in the national economy. Strong unions are often seen in conjunction with centralised bargaining – and trade unionised involvement in wage setting now occurs more and more at decentralised levels. But our main and hopefully surprising result is that decentralisation can be a sound response to globalisation of production. For any given level of union power, the job-saving effect of unions is stronger in a decentralised bargaining structure. We would like to underline, though, that this paper does not include a full welfare analysis of trade unions, international outsourcing and decentralisation of bargaining. This is left as a possible avenue for future research.

2 Model and analysis

Consider a Cournot duopoly market for a homogeneous good with inverse demand given by

$$p = a - b\sum_{i=1}^{2} q_i, \tag{1}$$

where q_i is output by Firm i. Each firm produces the final good by using a continuum of perfectly complementary inputs with total measure equal to one. All these inputs can be produced in-house using unionised labour in a one-to-one technology.[5] However, each of these inputs can also be bought from a foreign supplier at a unit cost c, which is equal for all outsourced inputs. If Firm i outsources the production of α_i inputs, gross profits are given by

$$\pi_i = (p - \alpha_i c - (1 - \alpha_i) w_i) q_i, \tag{2}$$

where w_i is the wage rate that Firm i must pay per unit of in-house production. We assume that the outsourcing of each input is associated with a fixed cost, such as the cost of searching for a suitable sub-contractor, the cost of sub-contract management and supervision, and the coordination cost of linking different production processes. The magnitude of these costs will typically depend on the characteristics of the input being outsourced, and we therefore assume that the fixed outsourcing cost varies across different inputs. If we order the inputs according to the size of the outsourcing cost (from lowest to highest), the fixed cost of outsourcing α_i inputs is assumed given by an increasing and strictly convex cost function $K(\alpha_i)$. Net profits of Firm i are then given by

$$\Pi_i = \pi_i - K(\alpha_i). \tag{3}$$

Domestic workers are organised in trade unions. We assume that the aggregate utility of the trade union members from which Firm i recruits its workers, is given by the following Stone-Geary utility function:

$$U_i = (w_i - \overline{w})^{\theta} L_i, \tag{4}$$

where $\overline{w}$ is the workers' reservation wage, L_i is the number of workers employed by Firm i, and $\theta > 0$ is a parameter measuring the degree to which trade union members value wages over employment. We classify the trade union as being *employment oriented* if $0 < \theta < 1$, *wage oriented* if $\theta > 1$, and *rent-maximising* if $\theta = 1$. More generally, a higher value of θ implies that the trade union is more wage oriented (or less employment oriented). Recall that Firm i's labour demand is

$$L_i = (1 - \alpha_i) q_i. \tag{5}$$

[5] Note that all workers are seen as identical. Had they not been, it could have been that the more skilled workers were less prone to lose their jobs to outsourcing. Questions about skill premia and deunionisation would then become relevant (Açikgöz and Kaymak, 2014).

It is easily shown that a necessary condition for outsourcing to be profitable is $c < \overline{w}$. Thus, without loss of generality, we simplify the analysis by setting $c = 0$, which implies that $\overline{w}$ also measures the potential profitability of outsourcing (all else equal). In order to ensure that both firms have positive output in the Cournot subgame, for all possible outsourcing configurations and for all $\theta \geq 0$, we assume that $\overline{w} < \frac{a}{2}$.

For analytical simplicity, we adopt a monopoly union model where we give the trade unions the power to unilaterally set the wage at each firm.[6] However, there are two potential wage setting regimes: *centralised* or *decentralised* wage setting. Under decentralised wage setting, each firm's trade union sets the wage that maximises its utility function without taking into account the utility of workers at the other firm. In contrast, under centralised wage setting, a uniform (industry-wide) wage is set by a union representative who maximises the aggregate utility of both trade unions.

We consider the following three-stage game:

1. The two firms simultaneously and non-cooperatively decide how much of their production is outsourced to foreign subcontractors.

2. Wages are set, either by both trade unions simultaneously and non-cooperatively (decentralised wage setting) or by a single agent representing both trade unions (centralised wage setting).

3. The two firms simultaneously and non-cooperatively decide how much to produce.

The above-described order of events relies on an implicit assumption that the outsourcing decision should be seen as a relatively inflexible investment decision, implying that the unions cannot credibly commit to a particular wage level prior to this decision. As usual, we solve the game by backwards induction, looking for a subgame perfect Nash equilibrium (SPNE). Since, by assumption, the outsourcing cost function is identical for both firms, this equilibrium will be symmetric. We also assume that the characteristics of the outsourcing cost function are such that the equilibrium has an interior solution, where some, but not all, production is outsourced.

[6] In Section 3 we explain how our main results would be affected if wages (and possibly also employment) were determined by Nash bargaining between firms and unions.

2.1 Wage responses to outsourcing

If we denote the marginal cost of Firm i by $\sigma_i := \alpha_i c + (1 - \alpha_i) w_i$, the Nash equilibrium in the third-stage Cournot game is given by the following familiar expression:

$$q_i = \frac{a - 2\sigma_i + \sigma_j}{3b}; \quad i, j = 1, 2; \quad i \neq j. \tag{6}$$

The parameters σ_i and σ_j depend both on the firms' outsourcing decisions and on the wage setting regime. In the following we will present the optimal wage setting under each of the two wage setting regimes.

2.1.1 Decentralised wage setting

Under decentralised wage setting, the trade unions set firm-specific wages in a context where they compete with each other for labour demand. For a given outsourcing configuration, equilibrium wages are given by

$$w_i^d(\alpha_i, \alpha_j) = \frac{(3\theta + 2)(\theta a + 2\overline{w}) - 2(2\alpha_i(\theta + 1) + \alpha_j\theta)\overline{w}}{(1 - \alpha_i)(\theta + 2)(3\theta + 2)}; \quad i, j = 1, 2; \quad i \neq j. \tag{7}$$

The effects of outsourcing on equilibrium wages when these are decided at firm level, are the following:[7]

Lemma 1 *An increase in outsourcing by Firm i leads to an increase in w_i and a reduction in w_j.*

More outsourcing leads to higher wages for the remaining workers of the outsourcing firm, a result that is equivalent to Proposition 1 in Lommerud et al. (2009). In the present model, there are two effects contributing to this result. First, partial outsourcing of complementary input production implies that marginal production costs are partly 'exogenised', which makes domestic labour demand less wage elastic. Aggregate trade union utility is consequently maximised at a higher wage level. This is the sole effect that drives the result in Lommerud et al. (2009). However, when there is product market competition between firms, and therefore, indirectly, competition between firm-specific trade unions, wages respond positively to outsourcing also for a second reason. Increased outsourcing by Firm i implies lower marginal cost, which improves the firm's competitive position vis-à-vis Firm j. Therefore, the direct domestic employment loss of more outsourcing is

[7] Proofs of all Lemmas and Propositions can be found in Appendix A2.

compensated by a capture of market share from the competing firm, which, all else equal, leads to higher, and thus less elastic, labour demand by Firm i. In sum, these two effects imply that increased outsourcing by one firm gives that firm's trade union a stronger incentive to increase wages.

However, the second of the two above described effects imply that, under decentralised wage setting, the wage responses to increased outsourcing by Firm i are markedly different for Firm i and Firm j. Higher outsourcing by Firm i implies that the trade union of Firm j has an incentive to reduce its wage claims, because labour demand from this firm drops as a result of a worsening of its competitive position.

It follows from the above analysis and discussion that the effect of (partial) outsourcing as an instrument to reduce marginal production costs is partly counteracted by union wage responses. The strength of this counteracting effect depends on how wage oriented unions are. This can be seen by considering the effect of outsourcing on marginal production costs, which is given by

$$\frac{\partial \sigma_i^d}{\partial \alpha_i} = -\frac{4\left(\theta+1\right)\overline{w}}{\left(\theta+2\right)\left(3\theta+2\right)}. \tag{8}$$

It is easily confirmed that the cost-reducing effect of outsourcing is smaller when unions are more wage oriented,[8] and eventually vanishes in the extreme case where unions care only about wages.[9]

2.1.2 Centralised wage setting

Under centralised wage setting, a uniform wage w is set by a single agent representing all workers in the industry.[10] For a given outsourcing configuration, the optimal wage is given by

$$w^c\left(\alpha_i,\alpha_j\right) = \frac{\overline{w}}{\theta+1} + \frac{a\theta\left(2-\alpha_i-\alpha_j\right)}{2\left(\theta+1\right)\left(1-\alpha_i-\alpha_j+\alpha_i^2+\alpha_j^2-\alpha_i\alpha_j\right)}. \tag{9}$$

The effect of outsourcing on centralised wage setting is given as follows:

[8] From (8):

$$\frac{\partial\left(\left|\frac{\partial \sigma_i^d}{\partial \alpha_i}\right|\right)}{\partial\theta} = -\frac{4\left(6\theta+3\theta^2+4\right)\overline{w}}{\left(\theta+2\right)^2\left(3\theta+2\right)^2} < 0.$$

[9] From (8):

$$\lim_{\theta\to\infty}\left(\left|\frac{\partial \sigma_i^d}{\partial \alpha_i}\right|\right) = 0.$$

[10] Thus, under centralised wage setting, w is set to maximise $\sum_{i=1}^{2} U_i\left(w\right) = \left(w-\overline{w}\right)^{\theta}\sum_{i=1}^{2} L_i\left(w\right)$.

Lemma 2 *(i) An increase in outsourcing by Firm i will lead to a wage increase unless Firm i has already outsourced sufficiently much more than Firm j. (ii) For any symmetric outsourcing configuration (i.e., $\alpha_i = \alpha_j$), the wage response to a marginal increase in outsourcing by Firm i is always smaller under centralised than under decentralised wage setting.*

Under centralised wage setting, the wage response to a unilateral increase in outsourcing by Firm i is determined by the following trade-off: On the one hand, the fact that labour demand from Firm i becomes less elastic gives an incentive to increase the wage. On the other hand, because of the relative improvement in the competitive position of Firm i (because of lower marginal costs), labour demand from Firm j becomes *more* elastic and therefore gives the union representative an incentive to *reduce* the wage. The former effect dominates, leading to a positive wage response, if the relative competitiveness of Firm i is not too strong; i.e, if α_i is not too high relative to α_j.

The second part of Lemma 2 describes a key mechanism of the model. Because centralised wage setting implies that the union representative's trade-off between wages and employment takes the interest of all workers into account, the wage response to outsourcing is smaller than if wages are set at firm level. In the former case, the incentive to dampen the loss of employment in Firm j restricts the wage increase when Firm i outsources more production.

2.2 Outsourcing decisions

At the first stage of the game, the two firms simultaneously and non-cooperatively choose the degree of outsourcing. When making this decision, each firm anticipates the subsequent wage responses, which depend on the existing wage setting regime, as we have shown above. Let the outsourcing decisions in the symmetric Nash equilibrium under centralised and decentralised wage setting, respectively, be given by $\alpha_i = \alpha_j = \alpha^c$ and $\alpha_i = \alpha_j = \alpha^d$. As previously mentioned, we assume that the characteristics of the outsourcing cost function is such that both α^c and α^d are interior solutions; i.e., $\alpha^c \in (0,1)$ and $\alpha^d \in (0,1)$. The following proposition describes how the equilibrium degree of outsourcing depends on the wage setting regime:

Proposition 1 *Equilibrium outsourcing is always higher under centralised than under decentralised wage setting; i.e., $\alpha^c > \alpha^d$.*

In other words, decentralised wage setting dampens the firms' incentives for outsourcing. The reason is clearly related to the differences in the unions' wage responses to outsourcing under the

two wage setting regimes, as shown by Lemmas 1 and 2. Under decentralised wage setting, there are two effects that make it less attractive to outsource more production: (i) the outsourcing firm's wage increases more, as indicated by the second part of Lemma 2, and (ii) the wage of the competing firm falls, which, in itself, worsens the competitive position of the outsourcing firm, as indicated by Lemma 1. Because of these two effects, a switch from centralised to decentralised wage setting reduces the equilibrium degree of outsourcing, all else equal.

In the symmetric Nash equilibrium, where each firm outsources the production of α^d inputs under decentralised wage setting and α^c inputs under centralised wage setting, the wage level in each of the two different wage setting regimes is given by (7) for $\alpha_i = \alpha_j = \alpha^d$ and (9) for $\alpha_i = \alpha_j = \alpha^c$, respectively. The corresponding expressions for equilibrium profits and union utility are given in Appendix A1.

2.3 Who benefits from centralised versus decentralised wage setting?

For a given outsourcing configuration, firms and trade unions have clearly conflicting interests regarding the choice of wage setting regime. Decentralised wage setting implies competition between trade unions which erodes union rents and boosts profits. This competition is eliminated if wage setting is centralised. Thus, all else equal, firms are better off with decentralised wage setting, whereas the unions are better off with centralised wage setting.

However, in our setting all else is not equal, since decentralised wage setting dampens outsourcing incentives, as previously shown. This affects the relative benefits of decentralised versus centralised wage setting – for the trade unions as well as for the firms. In order to detail the trade-offs involved, it is instructive first to look at how outsourcing affects union utility for a given wage setting regime.

Lemma 3 *Regardless of whether wage setting is centralised or decentralised: (i) rent-maximising or wage-oriented trade unions always prefer more outsourcing; (ii) trade unions always prefer less outsourcing if they are sufficiently employment oriented.*

Whether outsourcing is beneficial or not for the trade unions essentially boils down to a trade off between wages and employment. On the one hand, partial outsourcing leads to a loss of employment. On the other hand, the remaining domestic workers obtain higher wages. Intuitively, the wage increase more than compensates for the employment loss if the trade unions are sufficiently

wage-oriented. In fact, Lemma 3 confirms that this is the case even for rent-maximising unions, the reason being that outsourcing increases total industry rents (as long as $\overline{w} > 0$) without negatively affecting the ability of the trade unions to capture parts of these rents. Thus, a necessary (and sufficient) condition for outsourcing to have a negative effect on union utility is that the wage preference parameter θ is sufficiently below one. More specifically, there exists a threshold value $\widehat{\theta} \in (0,1)$ such that union utility increases with the degree of outsourcing if $\theta > \widehat{\theta}$ and decreases with the degree outsourcing if $\theta < \widehat{\theta}$.

The results in Lemma 3 imply that trade unions might potentially benefit from decentralised wage setting if they are sufficiently employment oriented; i.e., if $\theta < \widehat{\theta}$, such that less outsourcing yields higher union utility (for a given wage setting regime). This will be the case if the benefits from less outsourcing outweigh the costs of less wage coordination. The next proposition confirms the existence of such cases and provides more specific conditions.

Proposition 2 *Trade unions prefer decentralised over centralised wage setting if two conditions are satisfied: (i) they are sufficiently employment oriented, and (ii) the difference in equilibrium outsourcing between the two wage setting regimes is sufficiently large.*

Whereas the firms always prefer decentralised wage setting for a given level of outsourcing, this might not be the case when the degree of outsourcing is endogenised. On the one hand, decentralisation implies less union rent extraction for a given outsourcing level; on the other hand, decentralisation implies larger union extraction of outsourcing rents, leading to less outsourcing in equilibrium. *A priori*, it is not obvious that the first effect dominates. In other words, it is not obvious whether firms and trade unions have coinciding or conflicting interests with respect to wage setting regimes. However, the next proposition confirms the existence of a parameter set for which the interests of firms and trade unions actually coincide.

Proposition 3 *If trade unions are sufficiently employment oriented, there exists a parameter set for which all parties (firms and trade unions) prefer decentralised over centralised wage setting.*

The proof of this proposition (see Appendix A2) provides sufficient conditions for this parameter set to exist. If these conditions are satisfied, an obvious implication of Proposition 3 is that, under any reasonable set of decision rules, decentralised bargaining will be an equilibrium outcome of an extended game in which the wage setting regime is endogenised.

In Appendix A3 we provide a numerical example illustrating the result stated in Proposition 3 and its underlying mechanisms. In this example we show that the parameter set identified in Proposition 3, for which both firms and unions are better off with decentralised wage setting, is characterised by a sufficiently low degree of convexity in the outsourcing cost function, which implies that the difference in the degree of outsourcing across the two wage setting regimes is relatively large. In this case, unions characterised by $\theta < \widehat{\theta}$ benefit from decentralised wage setting because the employment gains from less outsourcing more than outweigh the wage reduction caused by uncoordinated wage setting. The firms also benefit from decentralised wage setting, not only because it promotes trade union competition, but also because it dampens excessive 'outsourcing competition' between the firms.

3 Extensions

In this section we briefly report the robustness of our main results with respect to three different extensions of the main model: (i) Bertrand competition instead of Cournot competition; (ii) firm-specific instead of uniform wages under centralised wage setting; and (iii) bargaining instead of union wage setting, where we consider both right-to-manage bargaining and efficient bargaining.

3.1 Price competition

Suppose that firms compete in prices á la Bertrand. In order to make the analysis meaningful, we relax the simplifying assumption of product homogeneity and assume that the two goods are horizontally differentiated. Adopting a standard Bowley demand system, inverse demand for Good i is given by

$$p_i = a - q_i - \delta q_j; \quad i, j = 1, 2; \quad i \neq j,$$

where $\delta \in (0, 1)$ is an inverse measure of product differentiation. By standard computations, the Bertrand-Nash equilibrium of the third-stage subgame is given by

$$p_i = \frac{a\,(2+\delta)\,(1-\delta) + 2\sigma_i + \delta\sigma_j}{4-\delta^2}; \quad i, j = 1, 2; \quad i \neq j. \tag{10}$$

Under *decentralised* wage setting, equilibrium wages in the second-stage subgame are

$$\begin{aligned} w_i^d(\alpha_i, \alpha_j) &= \frac{(\gamma(\theta+1)+\delta\theta)(\gamma(\overline{w}+a\theta)-a\delta\theta)-\overline{w}\gamma^2(\theta+1)\alpha_i-\delta\overline{w}\theta\gamma\alpha_j}{\left(\gamma^2(\theta+1)^2-\delta^2\theta^2\right)(1-\alpha_i)}; \\ i,j &= 1,2; \quad i \neq j, \end{aligned} \tag{11}$$

where $\gamma := 2 - \delta^2 > 0$. Under *centralised* wage setting, the equilibrium uniform wage is now

$$w^c(\alpha_i, \alpha_j) = \frac{\overline{w}}{\theta+1} + \frac{a\theta(2+\delta)(1-\delta)(2-\alpha_i-\alpha_j)}{(\theta+1)\left(2(2+\delta)(1-\delta)(1-\alpha_i-\alpha_j)+\gamma(\alpha_i^2+\alpha_j^2)-2\delta\alpha_i\alpha_j\right)}. \tag{12}$$

As before, we assume that symmetric interior equilibria exist. This allows us to derive the following result (see Appendix A2 for a complete proof):

Proposition 4 *All results in Propositions 1-3 hold also with price competition and horizontally differentiated goods.*

The fact that our main results are robust to the assumption of price competition is perhaps not too surprising. The reason is that the main mechanisms behind our results do not critically rely on the mode of competition in the output market. More specifically, the fact that decentralised wage setting implies wage competition between trade unions – which is key to our results – does not depend on the nature of strategic interaction between the firms.

3.2 Firm-specific wages under centralised wage setting

A key assumption in our main analysis is that centralised wage setting implies setting a uniform (industry-wide) wage that applies to all workers in the industry. Given the underlying assumption of homogeneous labour, this is a reasonable assumption that accords with the nature of centralised wage agreements in the real world, where wages are usually specified according to occupational type without being firm-specific. However, whereas a uniform wage might be perceived as the only fair outcome by union members, it is not an *ex post* optimal outcome (i.e., it does not maximise aggregate union utility) if firms differ in terms of outsourcing levels (and thus marginal production costs).[11]

[11] Potential fairness considerations among union members could in principle be incorporated into the union objective functions. However, a departure from the familiar Stone-Geary functional form would make the analysis intractable.

If we allow for firm-specific wages under centralised wage setting, this will have an impact on firms' outsourcing incentives. Even under the assumption of Cournot competition with homogeneous products, solving the model analytically is not feasible. We have therefore used simulations to study the validity of Proposition 1, which is the key result and from which the results in Proposition 2 and 3 follow. We only study symmetric equilibria.[12]

With firm-specific wage setting, wage coordination does not necessarily imply a smaller wage response to outsourcing by one of the firms. For this reason, it is no longer clear that centralised wage setting yields stronger outsourcing incentives. Indeed, it turns out that the results depend crucially on the ratio between consumers' reservation price (a) and domestic workers' reservation wage ($\overline{w}$), which is a measure of the total rents potentially available to domestic workers. Our simulations suggest that Proposition 1 still holds for sufficiently low values of $\frac{a}{\overline{w}}$ and θ. Otherwise, the result is reversed and equilibrium outsourcing is higher under decentralised wage setting.[13]

3.3 Bargaining

For analytical tractability, we have in the main analysis adopted the monopoly union model, which gives all bargaining power to the unions. Since our results are to a large degree driven by wage responses to outsourcing, it is natural to ask what happens if unions cannot determine wages unilaterally. We therefore extend the model to allow for Nash bargaining between firms and trade unions. Once more, the key question we aim to address in this extension is under which conditions Proposition 1 still holds.

We will consider two different types of bargaining. We start out by retaining the right-to-manage set-up, implying that bargaining between firms and unions is over wages only. Subsequently, we consider the case of efficient bargaining, where firms and unions bargain simultaneously over both wages and employment. In both cases, we keep the Cournot set-up with homogeneous goods, and we also restrict attention to single-unit bargaining, implying that both the firms and the unions act as a single unit under centralised Nash bargaining. Under decentralisation, there are two simultaneous Nash bargaining games between each firm and its trade union. Whether bargaining is centralised or decentralised, we assume that the disagreement payoff of each party is zero.[14]

[12] In a symmetric equilibrium, wages will be equal for both firms even if we allow for firm-specific wages under centralised wage setting. However, the possibility of firm-specific wages affects the out-of-equilibrium wage response to outsourcing, which in turn affects the (symmetric) equilibrium degree of outsourcing.

[13] Our simulations were performed using MATLAB, and the file containing the MATLAB codes is available at http://link.uib.no/supplement.

[14] A disagreement payoff of zero is a standard assumption under single-unit bargaining. However, under multi-unit

3.3.1 Right-to-manage bargaining

Suppose that bargaining is over wages only. With *decentralised* wage bargaining, the equilibrium wage is simply found by replacing θ with $\theta\beta/(2-\beta)$ in (7), where β is the relative bargaining power of the trade unions.[15] Thus, giving the firms some bargaining power (i.e., $\beta < 1$) is equivalent to making monopoly trade unions less wage oriented. In turn, this implies that a decrease in union bargaining power increases the equilibrium degree of outsourcing.

With *centralised* wage bargaining, it is once more infeasible to solve the model analytically. We have therefore studied this case using simulations. The results suggest that Proposition 1 is only invalid if the unions have little bargaining power *and* outsourcing levels are generally low. If the unions have more than 50% of the bargaining power, Proposition 1 applies in all cases. Thus, our results do not seem to depend critically on the monopoly union assumption.[16]

3.3.2 Efficient bargaining

Suppose instead that bargaining is over both wages and employment (which, for given outsourcing levels, is equivalent to bargaining over wages and output). For simplicity we assume equal bargaining strengths of the two parties, which allows us to handle the problem analytically. The equilibrium wage and output levels under *decentralised bargaining* are derived in Appendix A4. From these expressions we can derive the symmetric Nash equilibrium at the outsourcing stage, where the equilibrium degree of outsourcing, α^d, is implicitly given by

$$\left.\frac{\partial \Pi_i^d}{\partial \alpha_i}\right|_{\alpha_i=\alpha_j=\alpha^d} = \frac{(a-(1-\alpha)\overline{w})\,4\,(\theta+3)\,\overline{w}}{(\theta+1)\,b\,(\theta+5)^2} - K'\left(\alpha^d\right) = 0. \tag{13}$$

Characterising the equilibrium under *centralised bargaining* is somewhat less straightforward. If both firms are producing positive quantities, maximisation of the Nash product (see Appendix A4 for details) yields

$$w = \frac{\overline{w}}{1-\theta} \text{ and } q_i = \frac{a\,[a(1-\theta)-4(1-\alpha_j)\overline{w}]}{8b\,(\alpha_j-\alpha_i)\,\overline{w}}; \quad i,j=1,2; \quad i \neq j. \tag{14}$$

These expressions clearly only apply for $\theta < 1$ and $\alpha_i \neq \alpha_j$, which are also sufficient conditions for

bargaining, the choice of disagreement payoff is a non-trivial issue that can have important implications for the bargaining outcome (see, e.g., Mukherjee, 2010).

[15] The fact that $\lim_{\beta\to 1} \theta\beta/(2-\beta) = \theta$ illustrates that the monopoly union model is a special case of the Nash bargaining model, where the union has all the bargaining power.

[16] The file with MATLAB codes for the simulations is available at http://link.uib.no/supplement.

a local maximum of the Nash product. We will therefore assume $\theta < 1$ in the following. Also, we must assume non-negative quantities. This requires that α_i and α_j satisfy the condition

$$\alpha_j \geq \alpha^* \geq \alpha_i; \quad i,j = 1,2; \quad i \neq j, \tag{15}$$

where

$$\alpha^* := 1 - \frac{a(1-\theta)}{4\overline{w}}. \tag{16}$$

If this condition is not met, production at one of the firms will be closed down, or, in the case of $\alpha_1 = \alpha_2$, the distribution of production between the two firms is indeterminate. In this case, the bargaining outcome is given by (see Appendix A4)

$$w = \frac{3(1-\alpha)\overline{w} + a\theta}{(1-\alpha)(\theta+3)} \text{ and } Q = \frac{2\left(a - (1-\alpha)\overline{w}\right)}{b(3+\theta)}, \tag{17}$$

where Q is either the production of the only active firm, or the combined production of the two firms when $\alpha_i = \alpha_j = \alpha$. We will assume that, if $\alpha_i = \alpha_j$, both firms will retain some production (though not necessarily equal amounts).

In Appendix A4 we show that there may only exist one symmetric equilibrium of the first stage outsourcing game, namely $\alpha_i = \alpha_j = \alpha^*$, where α^* is given by (16).[17] A comparison of (16) and the equilibrium outsourcing level under decentralised bargaining, which is implicitly given by (13), then shows that whether outsourcing will be higher or lower under centralised bargaining is determined primarily by the characteristics of the outsourcing cost function.[18] If the outsourcing costs are sufficiently convex, the value of α^d that solves (13) is below α^*, implying that centralised bargaining will generate a higher outsourcing level (in line with Proposition 1), while the opposite occurs if costs are less convex. Thus, Proposition 1 may also hold under efficient bargaining.

4 Concluding remarks

We have employed a framework where production takes place in a series of complementary stages. Some of these are cheap to outsource, some less so. A general reduction in outsourcing costs will lead to more tasks being outsourced, but the remaining workers will typically perform tasks that

[17] We here assume that the outsourcing costs produce non-negative net profits at this outsourcing level. If not, at least one firm would withdraw from the market at stage 1.

[18] Parameters a, $\overline{w}$, b and θ also play a role, since they affect both the incentives to outsource in the decentralised case, and the value of α^* in the centralised case.

are hard to outsource. Knowing this, they will tend to push for higher wages. In such a framework we study the particular question how decentralisation of bargaining influences outsourcing and wages and employment at home – and the utility of unionised workers and the profits of firms. We identify parameter sets where decentralisation is advantageous both for firms and workers. If globalisation is taken to mean that outsourcing abroad generally becomes cheaper, the fact that globalisation and less centralisation in bargaining seem to appear in conjunction must not mean that the employer side uses globalisation to force unions to abandon centralised wage settlements – but rather that employers and unions alike see decentralisation as a rational reaction to better outsourcing possibilities, in a mutually beneficial way. An important building block in reaching this result is precisely the fact that in the described framework, cheaper outsourcing makes it rational for the remaining workers in expensive-to-outsource jobs to drive up wages – and this partly protects workers against outsourcing. When wage setting is decentralised, unions will to a lesser extent care about how a wage hike affects the rest of the economy, and this implies that this wage increase is more pronounced. More decentralisation can therefore be advantageous for workers facing more intense globalisation. Firms can also prefer that unionised workers are less coordinated, which generally makes the workers less powerful.

The potentially advantageous effects of decentralised wage setting – not only for the firms but also for the workers – fly in the face of conventional wisdom regarding the merits of union centralisation as a means to obtain a better outcome for domestic workers. This perhaps surprising result relies on the key assumption that trade unions are unable to credibly commit to a certain wage level prior to firms' outsourcing decisions. The lack of credible commitment, which we think is highly plausible, means that *ex post internalisation* of competition externalities can be counterproductive from an *ex ante* perspective. Borrowing from the famous business strategy taxonomy of Fudenberg and Tirole (1984), we have shown that, as a response to increased outsourcing opportunities for firms, it can be optimal for trade unions to adopt a 'lean-and-hungry-look' strategy in the form of decentralised wage agreements. Decentralisation leads to lower wages for a given outsourcing level (making the unions more 'lean'), while simultaneously paving the way for stronger wage responses to an increase in the outsourcing intensity (making the unions more 'hungry').

In this model we have not built in any efficiency gain from trade unionism. The efficient outcome would be realised if there were no unions. Though outside the scope of the present paper, it would be interesting to take the model further to incorporate for example technology investments and

education, that could be influenced by how many workers are retained at home and how much they earn. Is cheaper outsourcing then good or bad? In line with earlier literature on beneficial trade unionism, there could be inefficiencies in technology and skill formation decisions – and in the full picture these need to be evaluated against the need for efficient outsourcing.

Moreover, we live in a time where the open trade regime which has evolved since WWII seems to be under siege. What if political actions increased the costs of outsourcing? Would this diminish the positive aspects of decentralisation of wage bargaining? This is also an interesting direction for future research.

Appendix

A1. Profits and union utility

Decentralised wage setting

In the subgame that starts at Stage 2, equilibrium gross profits and union utility (at firm level) are given by, respectively,

$$\pi^d(\alpha_i, \alpha_j) = \frac{4\left((3\theta+2)(a-\overline{w}) + ((4+3\theta)\alpha_i - 2\alpha_j)\overline{w}\right)^2}{9b(\theta+2)^2(3\theta+2)^2} \tag{A1}$$

and

$$U^d(\alpha_i, \alpha_j) = \frac{2(1-\alpha_i)^{1-\theta}\theta^\theta}{3b}\left(\frac{(3\theta+2)(a-\overline{w}) + ((4+3\theta)\alpha_i - 2\alpha_j)\overline{w}}{(\theta+2)(3\theta+2)}\right)^{\theta+1}. \tag{A2}$$

The equivalent equilibrium expressions for the full game are

$$\pi^d\left(\alpha^d\right) = \frac{4\left(a-\left(1-\alpha^d\right)\overline{w}\right)^2}{9b(\theta+2)^2} \tag{A3}$$

and

$$U^d\left(\alpha^d\right) = \frac{2\left(1-\alpha^d\right)^{1-\theta}\theta^\theta}{3b}\left(\frac{a-\left(1-\alpha^d\right)\overline{w}}{\theta+2}\right)^{\theta+1}. \tag{A4}$$

Centralised wage setting

In the subgame that starts at Stage 2, gross equilibrium profits and union utility (at firm level) are given by, respectively,

$$\pi^d(\alpha_i,\alpha_j)=\frac{\left(2\Phi\left(a-\overline{w}+\left(2\alpha_i-\alpha_j\right)\overline{w}\right)+3a\theta\left(1-\alpha_j\right)\left(\alpha_i-\alpha_j\right)\right)^2}{36b\Phi^2\left(\theta+1\right)^2} \tag{A5}$$

and

$$U^d(\alpha_i,\alpha_j)=\frac{\left(1-\alpha_i\right)\left(\begin{array}{c}2\Phi\left(a-\overline{w}+\left(2\alpha_i-\alpha_j\right)\overline{w}\right)\\+3a\theta\left(1-\alpha_j\right)\left(\alpha_i-\alpha_j\right)\end{array}\right)\left(\frac{\theta}{2}\left(\begin{array}{c}a\left(2-\alpha_i-\alpha_j\right)\\-2\overline{w}\Phi\end{array}\right)\right)^{\theta}}{6b\Phi^{\theta+1}\left(\theta+1\right)^{\theta+1}}, \tag{A6}$$

where $\Phi:=1-\alpha_i-\alpha_j+\alpha_i^2+\alpha_j^2-\alpha_i\alpha_j$. The equivalent equilibrium expressions for the full game are

$$\pi^c(\alpha^c)=\frac{\left(a-\left(1-\alpha^c\right)\overline{w}\right)^2}{9b\left(\theta+1\right)^2} \tag{A7}$$

and

$$U^c(\alpha^c)=\frac{\left(1-\alpha^c\right)^{1-\theta}\theta^{\theta}}{3b}\left(\frac{a-\left(1-\alpha^c\right)\overline{w}}{\theta+1}\right)^{\theta+1}. \tag{A8}$$

A2. Proofs

Proof of Lemma 1

From (7) we derive

$$\frac{\partial w_i^d(\alpha_i,\alpha_j)}{\partial\alpha_i}=\theta\frac{\left(3\theta+2\right)a+2\left(1-\alpha_j\right)\overline{w}}{\left(1-\alpha_i\right)^2\left(\theta+2\right)\left(3\theta+2\right)}>0 \tag{A9}$$

and

$$\frac{\partial w_i^d(\alpha_i,\alpha_j)}{\partial\alpha_j}=-\frac{2\theta\overline{w}}{\left(\theta+2\right)\left(1-\alpha_i\right)\left(3\theta+2\right)}<0. \tag{A10}$$

Q.E.D.

Proof of Lemma 2

(i) From (9) we derive

$$\begin{aligned}\frac{\partial w^c(\alpha_i,\alpha_j)}{\partial \alpha_i} &= \frac{\theta a\left(1-(4-\alpha_i)\alpha_i+2(1-\alpha_j)\alpha_j+2\alpha_i\alpha_j\right)}{2(\theta+1)\left(1-\alpha_i-\alpha_j+\alpha_i^2+\alpha_j^2-\alpha_i\alpha_j\right)^2} \\ &> (<)\,0 \quad if \quad \alpha_i<(>)\,2-\alpha_j-(1-\alpha_j)\sqrt{3}.\end{aligned} \tag{A11}$$

(ii) From (7) and (9) we derive, respectively,

$$\left.\frac{\partial w^d(\alpha_i,\alpha_j)}{\partial \alpha_i}\right|_{\alpha_i=\alpha_j=\alpha} = \theta\frac{(3\theta+2)a+2(1-\alpha)\overline{w}}{(1-\alpha)^2(\theta+2)(3\theta+2)}>0. \tag{A12}$$

and

$$\left.\frac{\partial w^c(\alpha_i,\alpha_j)}{\partial \alpha_i}\right|_{\alpha_i=\alpha_j=\alpha} = \frac{a\theta}{2(1-\alpha)^2(\theta+1)}>0, \tag{A13}$$

from which it follows that

$$\left.\frac{\partial w^d(\alpha_i,\alpha_j)}{\partial \alpha_i}\right|_{\alpha_i=\alpha_j=\alpha} - \left.\frac{\partial w^c(\alpha_i,\alpha_j)}{\partial \alpha_i}\right|_{\alpha_i=\alpha_j=\alpha} = \theta\frac{a\theta(3\theta+2)+4\overline{w}(1-\alpha)(\theta+1)}{2(3\theta+2)(\theta+2)(\theta+1)(1-\alpha)^2}>0. \tag{A14}$$

Q.E.D.

Proof of Proposition 1

The symmetric Nash equilibrium in the outsourcing game under centralised and decentralised wage setting, respectively, is implicitly given by

$$\left.\frac{\partial \Pi_i^c}{\partial \alpha_i}\right|_{\alpha_i=\alpha_j=\alpha^c} = \frac{(a-\overline{w}(1-\alpha^c))(4\overline{w}(1-\alpha^c)+3\theta a)}{9b(1-\alpha^c)(\theta+1)^2} - K'(\alpha^c)=0 \tag{A15}$$

and

$$\left.\frac{\partial \Pi_i^d}{\partial \alpha_i}\right|_{\alpha_i=\alpha_j=\alpha^d} = \frac{\left(a-\overline{w}(1-\alpha^d)\right)8(3\theta+4)\overline{w}}{9b(3\theta+2)(\theta+2)^2} - K'\left(\alpha^d\right)=0. \tag{A16}$$

Suppose that $\alpha^c=\alpha^d$. Subtracting (A16) from (A15) then gives

$$\begin{aligned}&\left.\frac{\partial \Pi_i^c}{\partial \alpha_i}\right|_{\alpha_i=\alpha_j=\alpha^d} - \left.\frac{\partial \Pi_i^d}{\partial \alpha_i}\right|_{\alpha_i=\alpha_j=\alpha^d} \\ &= \frac{\theta\left(a-\overline{w}\left(1-\alpha^d\right)\right)\left[3a(3\theta+2)(\theta+2)^2-4\left(1-\alpha^d\right)\left(6\theta+3\theta^2+2\right)\overline{w}\right]}{9b(3\theta+2)(\theta+2)^2(\theta+1)^2(1-\alpha^d)}.\end{aligned} \tag{A17}$$

The sign of this expression depends on the sign of the expression in square brackets, which is positive for all $\overline{w} < a/2$. Thus, the expression in (A17) is strictly positive for all permissible parameter configurations. Since, by definition of the Nash equilibrium, $\left(\partial \Pi_i^d / \partial \alpha_i\right)\big|_{\alpha_i=\alpha_j=\alpha^d} = 0$, this implies $\left(\partial \Pi_i^c / \partial \alpha_i\right)|_{\alpha_i=\alpha_j=\alpha^d} > 0$. By convexity of $K(\cdot)$, it follows directly that $\alpha^c > \alpha^d$. *Q.E.D.*

Proof of Lemma 3

From (A4) and (A8) we derive

$$\frac{\partial U^d}{\partial \alpha^d} = \frac{2\theta^\theta \left(a - \overline{w}\left(1-\alpha^d\right)\right)^\theta}{3b\left(\theta+2\right)^{\theta+1}\left(1-\alpha^d\right)^\theta}\left[\left(\theta-1\right)a + 2\left(1-\alpha^d\right)\overline{w}\right] \tag{A18}$$

and

$$\frac{\partial U^c}{\partial \alpha^c} = \frac{\theta^\theta \left(a - \overline{w}\left(1-\alpha^c\right)\right)^\theta}{3b\left(\theta+1\right)^{\theta+1}\left(1-\alpha^c\right)^\theta}\left[\left(\theta-1\right)a + 2\left(1-\alpha^c\right)\overline{w}\right] \tag{A19}$$

Both expressions are positive (negative) if

$$\theta > (<)\, 1 - \frac{2\left(1-\alpha^k\right)\overline{w}}{a}, \quad k = d, c. \tag{A20}$$

Since $\overline{w} < a/2$, the parameter set given by $\theta < 1 - \left(2\left(1-\alpha^k\right)\overline{w}/a\right)$ is non-empty. *Q.E.D.*

Proof of Proposition 2

By defining

$$G(\alpha) := \frac{\theta^\theta}{3b}\left(1-\alpha\right)^{1-\theta}\left(a - \overline{w}(1-\alpha)\right)^{1+\theta} > 0, \tag{A21}$$

we can re-write $U^d\left(\alpha^d\right)$ and $U^c\left(\alpha^c\right)$ as

$$U^d\left(\alpha^d\right) = \frac{2G(\alpha^d)}{(\theta+2)^{\theta+1}} \tag{A22}$$

and

$$U^c\left(\alpha^c\right) = \frac{G(\alpha^c)}{(\theta+1)^{\theta+1}}. \tag{A23}$$

The trade unions prefer decentralised wage setting if $U^d\left(\alpha^d\right) > U^c\left(\alpha^c\right)$. Since $U^d < U^c$ for $\alpha^c = \alpha^d$, and since $\alpha^c > \alpha^d$, it follows from (A22)-(A23) that a necessary (but not sufficient) condition for $U^d\left(\alpha^d\right) > U^c\left(\alpha^c\right)$ is $G\left(\alpha^c\right) < G(\alpha^d)$. We already know from Lemma 3 that this possibility is ruled

out for $\theta \geq 1$. Since

$$G'(\alpha) = -\frac{1}{3b}\left(\frac{\theta\left(a-\overline{w}(1-\alpha)\right)}{1-\alpha}\right)^{\theta}\left[a(1-\theta)-2\overline{w}(1-\alpha)\right], \tag{A24}$$

it follows that G is monotonically decreasing in α over the interval $[\alpha^d, \alpha^c]$ if $\theta < 1-\left(2\left(1-\alpha^d\right)\overline{w}/a\right)$. Since $\lim_{\alpha^c \to 1} U^c = 0$ and $U^d > 0$ for $\alpha^d < 1$, this means that there exists a threshold $\widehat{\alpha}^c\left(\alpha^d\right) < 1$, such that the trade unions prefer decentralised over centralised wage setting (i.e., $U^d\left(\alpha^d\right) > U^c\left(\alpha^c\right)$) if $\theta < 1 - \left(2\left(1-\alpha^d\right)\overline{w}/a\right)$ and if $\alpha^c > \widehat{\alpha}^c$. *Q.E.D.*

Proof of Proposition 3

Expressed as a function of wages and outsourcing, equilibrium net profits are given by

$$\Pi\left(w^k, \alpha^k\right) = \frac{\left(a-(1-\alpha^k)w^k\right)^2}{9b} - K(\alpha^k), \tag{A25}$$

where $k = c, d$. Since $\alpha^c > \alpha^d$, and since higher outsourcing yields higher outsourcing costs, a sufficient condition for equilibrium profits to be higher under decentralised wage setting is

$$(1-\alpha^d)w^d < (1-\alpha^c)w^c. \tag{A26}$$

From (7) and (9) we have

$$(1-\alpha^d)w^d = \frac{a\theta+2\overline{w}}{\theta+2} - \frac{2}{2+\theta}\overline{w}\alpha^d \tag{A27}$$

and

$$(1-\alpha^c)w^c = \frac{a\theta+\overline{w}}{\theta+1} - \frac{1}{\theta+1}\overline{w}\alpha^c. \tag{A28}$$

Thus, the condition in (A26) can be re-written as

$$\alpha^c < \frac{(a-\overline{w})\theta}{(2+\theta)\overline{w}} + \frac{2+2\theta}{2+\theta}\alpha^d := \widetilde{\alpha}^c(\alpha^d). \tag{A29}$$

It follows that both the trade unions and the firms prefer decentralised wage setting if $\theta < 1 - \left(2\left(1-\alpha^d\right)\overline{w}/a\right)$ and $\alpha^c \in (\widehat{\alpha}^c, \widetilde{\alpha}^c)$. This parameter set is non-empty if $\widehat{\alpha}^c < \widetilde{\alpha}^c$, which requires

$U^c(\widetilde{\alpha}^c(\alpha^d)) < U^d(\alpha^d)$. Using (A4), (A8) and (A29), we have

$$\begin{aligned} \frac{U^c\left(\widetilde{\alpha}^c(\alpha^d)\right)}{U^d(\alpha^d)} &= 2\left(\left(\frac{\theta+1}{\theta+2}\right)\left(1-\frac{\theta a}{2\left(\theta+1\right)\left(1-\alpha^d\right)\overline{w}}\right)\right)^{1-\theta} \\ &< (>)\,1 \quad if \quad \frac{a}{\left(1-\alpha^d\right)\overline{w}} > (<)\frac{2\left(\theta+1\right)}{\theta} - \frac{\theta+2}{\theta 2^{\frac{\theta}{1-\theta}}}. \end{aligned} \tag{A30}$$

Since the condition $\theta < 1-\left(2\left(1-\alpha^d\right)\overline{w}/a\right)$ is equivalent to $a/\left(1-\alpha^d\right)\overline{w} > 2/\left(1-\theta\right)$, we have the following sufficient conditions for an agreement between firms and trade unions about the preference for decentralised wage setting:

$$\frac{a}{\left(1-\alpha^d\right)\overline{w}} > \max\left(\frac{2}{1-\theta}, \frac{2\left(\theta+1\right)}{\theta} - \frac{\theta+2}{\theta 2^{\frac{\theta}{1-\theta}}}\right) \tag{A31}$$

and

$$\widehat{\alpha}^c < \alpha^c < \widetilde{\alpha}^c. \tag{A32}$$

Q.E.D.

Proof of Proposition 4

The equilibrium prices and wages are given by (10)-(12) in Section 3, and quantities are found by inserting these into

$$q_i = \frac{a\left(\delta+2\right)\left(1-\delta\right) - \gamma\sigma_i + \delta\sigma_j}{\left(1-\delta^2\right)\left(4-\delta^2\right)}. \tag{A33}$$

Gross profits are given by $\Pi_i = (1-\delta^2)q_i^2$. In the following, we repeat the proofs of Proposition 1-3, applied to the case of Bertrand competition with differentiated products. (i) *Proposition 1.* The Nash equilibrium in the outsourcing game under centralised and decentralised wage setting, respectively, is implicitly given by

$$\left.\frac{\partial\Pi_i^c}{\partial\alpha_i}\right|_{\alpha_i=\alpha_j=\alpha^c} = \frac{\left[a-\overline{w}(1-\alpha^c)\right]\left[2\overline{w}\gamma\left(1-\alpha^c\right)+a\theta\left(1+\delta\right)\left(2-\delta\right)\right]}{\left(1+\delta\right)\left(\theta+1\right)^2\left(1-\alpha^c\right)\left(2-\delta\right)^2\left(2+\delta\right)} - K'\left(\alpha^c\right) = 0 \tag{A34}$$

and

$$\left.\frac{\partial\Pi_i^d}{\partial\alpha_i}\right|_{\alpha_i=\alpha_j=\alpha^d} = \frac{2\overline{w}\left(a-\overline{w}(1-\alpha^d)\right)\gamma^2[\theta(4-\delta^2)(1-\delta^2)+\gamma^2]}{\left(1+\delta\right)\left(2+\delta\right)\left(2-\delta\right)^2[\gamma(1+\theta)-\delta\theta]^2[\gamma(1+\theta)+\delta\theta]} - K'\left(\alpha^d\right) = 0. \tag{A35}$$

Suppose $\alpha^c = \alpha^d$. Define

$$F := \frac{\frac{\partial \Pi_i^c}{\partial \alpha_i}\Big|_{\alpha_i=\alpha_j=\alpha^d} + K'(\alpha^d)}{\frac{\partial \Pi_i^d}{\partial \alpha_i}\Big|_{\alpha_i=\alpha_j=\alpha^d} + K'(\alpha^d)} = \frac{\frac{2\overline{w}\gamma\left(1-\alpha^d\right)+a\theta(1+\delta)(2-\delta)}{(\theta+1)^2\left(1-\alpha^d\right)}}{\frac{2\overline{w}\gamma^2\left(\theta(4-\delta^2)(1-\delta^2)+\gamma^2\right)}{(\gamma(1+\theta)-\delta\theta)^2(\gamma(1+\theta)+\delta\theta)}} \tag{A36}$$

Since

$$\frac{\partial F}{\partial \alpha^d} = \frac{a\theta\left(1+\delta\right)\left(2-\delta\right)\left(\gamma(1+\theta)+\delta\theta\right)\left(\gamma(1+\theta)-\delta\theta\right)^2}{2\overline{w}\left(\theta+1\right)^2\left(1-\alpha^d\right)^2\gamma^2\left(\theta(4-5\delta^2+\delta^4)+4(1-\delta^2)+\delta^4\right)} > 0 \tag{A37}$$

and

$$\frac{\partial F}{\partial a} = \frac{\theta\left(1+\delta\right)\left(2-\delta\right)\left(\gamma\left(\theta+1\right)+\delta\theta\right)\left(\gamma\left(\theta+1\right)-\delta\theta\right)^2}{2\overline{w}\left(\theta+1\right)^2\left(1-\alpha^d\right)\gamma^2\left(\theta(4-5\delta^2+\delta^4)+4(1-\delta^2)+\delta^4\right)} > 0, \tag{A38}$$

F reaches a minimum level at $\alpha^d = 0$ and $a = 2\overline{w}$. At this minimum:

$$F|_{\alpha^d=0,a=2\overline{w}} = \frac{(\gamma^2(\theta+1)^2-\delta^2\theta^2)^2}{\left(\theta+1\right)^2\gamma^2\left(\theta(4-5\delta^2+\delta^4)+4(1-\delta^2)+\delta^4\right)}. \tag{A39}$$

From (A39) we derive

$$\frac{\partial F|_{\alpha^d=0,a=2\overline{w}}}{\partial \theta} = \frac{\left(\gamma^2(1+\theta)^2-\delta^2\theta^2\right)\Omega}{\left(\theta+1\right)^3\gamma^2\left(\theta(4-5\delta^2+\delta^4)+4(1-\delta^2)+\delta^4\right)^2}, \tag{A40}$$

where

$$\Omega := \left(1-\delta^2\right)^2\left(4-\delta^2\right)^2\left(\theta^3+3\theta^2\right)+(3\theta(1-\delta^2)(4-\delta^2)+4-3\delta^2+\delta^4)\gamma^2. \tag{A41}$$

From (A41) we derive $\partial^3\Omega/\partial\theta^3 = 6\left(1-\delta^2\right)^2\left(4-\delta^2\right)^2 \geq 0$, which implies $\partial^2\Omega/\partial\theta^2 \geq \lim_{\theta\to 0}\left(\partial^2\Omega/\partial\theta^2\right) = 6\left(1-\delta^2\right)^2\left(4-\delta^2\right)^2 \geq 0$. Consequently, $\partial\Omega/\partial\theta \geq \lim_{\theta\to 0}\left(\partial\Omega/\partial\theta\right) = 3\gamma^2\left(1-\delta^2\right)\left(4-\delta^2\right) \geq 0$, which implies $\Omega \geq \lim_{\theta\to 0}\Omega = \left(4-3\delta^2+\delta^4\right)\gamma^2 > 0$. Thus, $\partial F|_{\alpha^d=0,a=2\overline{w}}/\partial\theta > 0$ and $F|_{\alpha^d=0,a=2\overline{w}} > \lim_{\theta\to 0} F|_{\alpha^d=0,a=2\overline{w}} = 1$. Since $F|_{\alpha^d=0,a=2\overline{w}}$ is a minimum of F, we can conclude that $F > 1$ and thus $\left(\partial\Pi_i^c/\partial\alpha_i\right)|_{\alpha_i=\alpha_j=\alpha^d} > \left(\partial\Pi_i^d/\partial\alpha_i\right)\big|_{\alpha_i=\alpha_j=\alpha^d}$. Since, by the definition of the Nash equilibrium, $\left(\partial\Pi_i^d/\partial\alpha_i\right)\big|_{\alpha_i=\alpha_j=\alpha^d} = 0$, this implies $\left(\partial\Pi_i^c/\partial\alpha_i\right)|_{\alpha_i=\alpha_j=\alpha^d} > 0$. By convexity of $K(\cdot)$, it follows directly that $\alpha^c > \alpha^d$. (ii) *Proposition 2.* Equilibrium union utility in the decentralised and centralised cases, respectively, are given by

$$U^d(\alpha^d) = \frac{(a-\overline{w}(1-\alpha^d))^{\theta+1}(1-\alpha^d)^{1-\theta}\theta^\theta\gamma(2+\delta)^\theta(1-\delta)^\theta}{(1+\delta)(2-\delta)\left(\theta\left(2+\delta\right)\left(1-\delta\right)+\gamma\right)^{\theta+1}} \tag{A42}$$

and

$$U^c(\alpha^c) = \frac{(a-\overline{w}(1-\alpha^c))^{\theta+1}(1-\alpha^c)^{1-\theta}\theta^\theta}{(\theta+1)^{\theta+1}(1+\delta)(2-\delta)}. \tag{A43}$$

By defining

$$H(\alpha) := \frac{(1-\alpha)^{1-\theta}\theta^\theta(a-\overline{w}(1-\alpha))^{\theta+1}}{(1+\delta)(2-\delta)}, \tag{A44}$$

we can re-write $U^d(\alpha^d)$ and $U^c(\alpha^c)$ as

$$U^d(\alpha^d) = \frac{(2+\delta)^\theta(1-\delta)^\theta\gamma H(\alpha^d)}{\left(\theta\left(2+\delta\right)\left(1-\delta\right)+\gamma\right)^{\theta+1}} \tag{A45}$$

and

$$U^c(\alpha^c) = \frac{H(\alpha^c)}{(\theta+1)^{\theta+1}}. \tag{A46}$$

$U^d < U^c$ for $\alpha^c = \alpha^d$ and $\delta > 0$, as in the Cournot case. Furthermore, $H(\alpha)$ is always increasing in α for $\theta \geq 1$. Again, therefore, unions might only be worse off under wage centralisation if $\theta < 1$. From (A44) we have

$$H'\left(\alpha\right) = \frac{\theta^\theta\left(a-(1-\alpha)\overline{w}\right)^\theta\left(a(1-\theta)-2(1-\alpha)\overline{w}\right)}{\left(1-\alpha\right)^\theta\left(1+\delta\right)\left(2-\delta\right)}, \tag{A47}$$

implying that H is monotonically decreasing in α over the interval $\left[\alpha^d, \alpha^c\right]$ if $\theta < 1-\left(2(1-\alpha^d)\overline{w}/a\right)$. Since $\lim_{\alpha^c\to 1} U^c = 0$ and $U^d > 0$ for $\alpha^d < 1$, there exists again a threshold $\widehat{\widehat{\alpha}}^c(\alpha^d) < 1$, such that unions prefer decentralised wage setting if $\alpha^c > \widehat{\widehat{\alpha}}^c$ and $\theta < 1 - \left(2(1-\alpha^d)\overline{w}/a\right)$. (iii) *Proposition 3.* As in the Cournot case, a sufficient condition for equilibrium profits to be higher under decentralised wage setting is that the effective wage costs are lower in the decentralised case, i.e., $(1-\alpha^d)w^d < (1-\alpha^c)w^c$. From previous results we have

$$(1-\alpha^d)w^d = \frac{\left(1-\alpha^d\right)\gamma\overline{w} + a\theta\left(2+\delta\right)\left(1-\delta\right)}{\gamma+\theta(\gamma-\delta)} \tag{A48}$$

and

$$(1-\alpha^c)w^c = \frac{a\theta\left(1+\delta\right)^2 + \left(1-\alpha^c\right)\overline{w}}{1+\theta}. \tag{A49}$$

Thus, $(1-\alpha^d)w^d < (1-\alpha^c)w^c$ can be re-written as

$$\alpha^c < \frac{\delta\theta\left(a\left(5+\delta\left(\gamma-2\delta\right)+\theta\left(1-\delta\right)\left(2+\delta\right)^2\right)-\overline{w}\right)+(1+\theta)\gamma\overline{w}\alpha^d}{\left(\gamma+\theta(\gamma-\delta)\right)\overline{w}} := \widetilde{\widehat{\alpha}}^c(\alpha^d). \tag{A50}$$

As in the Cournot case, to establish that the both firms and unions can prefer decentralised wage setting, we need to show that $\widehat{\widetilde{\alpha}}^c < \widetilde{\widetilde{\alpha}}^c$. Since the expressions are considerably more involved than in the Cournot case, it is difficult to find an exact parameter cut-off. However, to prove the statement in Proposition 3, we only need to show that the statement is true for one particular parameter configuration. Defining $a/\overline{w} = 3$, $\delta = 1/2$ and $\theta = 1/8$, we have

$$\frac{U^c(\widetilde{\widetilde{\alpha}}^c(\alpha^d))}{U^d(\alpha^d)} = \frac{\sqrt[8]{305}\sqrt[8]{3796\,875}\left(101 - 224\alpha^d\right)^{\frac{7}{8}}\left(672\alpha^d + 1649\right)^{\frac{9}{8}}}{2186\,240\left(1-\alpha^d\right)^{\frac{7}{8}}\left(\alpha+2\right)^{\frac{9}{8}}}, \tag{A51}$$

which is less than unity, which implies $\widehat{\widetilde{\alpha}}^c < \widetilde{\widetilde{\alpha}}^c$, for $\alpha^d < 101/224 \approx 0.45$. Thus, by continuity, a parameter space where both unions and firms prefer decentralised wage setting exists also under Bertrand competition. *Q.E.D.*

A3. Numerical example

We illustrate the general result of Proposition 3 by considering the following specific example. Suppose that $a = 4$, $\overline{w} = 1$, $\theta = 1/4$ and $b = 1$. Suppose also that the outsourcing cost function is given by $K(\alpha_i) = k\alpha_i + \left(\kappa\alpha_i^2\right)/2$, where $k = 2^7\left(19/3^5 11\right) \approx 0.91$. With decentralised wage setting, equilibrium outsourcing is given by $\alpha^d = 0$, whereas, under centralised wage setting, equilibrium outsourcing is given by[19]

$$\alpha^c = \frac{5\left(13\,365\kappa - 7408\right) - 297\sqrt{\frac{4336\,601\,344}{88\,209} + \frac{25}{33}\kappa\left(66\,825\kappa - 230\,048\right)}}{594\left(225\kappa - 64\right)}. \tag{A52}$$

This is an interior solution equilibrium ($\alpha^c < 1$) if $\kappa > 64\sqrt{11}\sqrt{2437}/7425 + 115\,024/66\,825 \approx 3.1325$.

Table A1 shows the relative gain of centralised wage setting for firms and trade unions, based on the parameter values in the above example, for different values of the parameter κ, which measures

[19] We have chosen the lowest value of k for which $\alpha^d = 0$.

both the size and the convexity of outsourcing costs.

Table A1: Centralisation vs. decentralisation

κ	Relative profits: $\frac{\Pi^c}{\Pi^d}$	Relative union utility: $\frac{U^c}{U^d}$
3.2	0.17	0.84
4	0.31	0.94
6	0.38	0.99
10	0.42	1.02
100	0.45	1.04

In this example, we see that the unions prefer decentralised (centralised) wage setting if κ is sufficiently low (high). This is quite intuitive. If outsourcing costs are not very convex (which is the case for low values of κ), the difference in equilibrium outsourcing between the two wage setting regimes is sufficiently large to outweigh the benefits of wage coordination. In this case, unionised workers are better off with decentralised wage setting. In contrast, the firms prefer decentralised wage setting for all values of κ. It is quite obvious that decentralised wage setting yields higher firm profits for sufficiently high values of κ, since $\alpha^c \to \alpha^d = 0$ if $\kappa \to \infty$. That firms also prefer decentralised wage setting for low values of κ is partly a reflection of the Prisoners' Dilemma nature of the outsourcing game. This is perhaps best seen by noticing that, since $\alpha^d = 0$ for all κ, a larger value of κ increases not only relative but also absolute profits under centralised wage setting. This implies that the firms are better off with higher outsourcing costs which dampens the (destructive) outsourcing competition. Thus, the firms prefer decentralised wage setting for two different reasons: (i) it promotes trade union competition and therefore leads to lower wages for a given outsourcing level, and (ii) it works as mechanism to remove the Prisoners' Dilemma features of the outsourcing game.

A4. Efficient bargaining

Under *decentralised efficient bargaining*, there are two firm-union pairs, bargaining simultaneously over both wages and employment. We look for a Nash equilibrium in wage-production pairs. Assuming that firms and unions have the same bargaining power and reservation payoffs are zero,

the Nash product of Firm i and Union i is given by

$$N_i = (w_i - \overline{w})^{\theta}(1-\alpha_i)q_i^2\left(a - b\sum_{s=1}^{2} q_s - (1-\alpha_i)w_i\right). \tag{A53}$$

The first-order conditions are satisfied for

$$w_i = \frac{\theta\,(a - bq_j) + 3\,(1-\alpha_i)\,\overline{w}}{(1-\alpha_i)\,(\theta+3)}, \tag{A54}$$

$$q_i = \frac{2\,(a - (1-\alpha_i)\,\overline{w} - bq_j)}{(\theta+3)\,b}, \tag{A55}$$

with $i, j = 1, 2$ and $i \neq j$. The Nash equilibrium for any possible outsourcing configuration, (α_i, α_j), is then given by

$$w_i = \frac{(\theta+1)\,(a\theta + 5\overline{w}) - (\alpha_i\,(3\theta+5) + 2\theta\alpha_j)\,\overline{w}}{(1-\alpha_i)\,(\theta+5)\,(\theta+1)}, \tag{A56}$$

$$q_i = \frac{2\,(\theta+3)\left(a - (1-\alpha_i)\overline{w} - \frac{2(a-(1-\alpha_j)\overline{w})}{\theta+3}\right)}{(\theta+5)\,(\theta+1)\,b}, \tag{A57}$$

for $i, j = 1, 2$ and $i \neq j$. By substituting these wage and output expressions into the profit function of Firm i, taking the partial derivative of net profits with respect to the outsourcing degree and evaluating the resulting expression at the symmetric equilibrium $\alpha_i = \alpha_j = \alpha^d$, we arrive at the equilibrium condition given by (13).

Under *centralised efficient bargaining*, the Nash product when both firms are producing positive quantities is

$$N = (w - \overline{w})^{\theta}\sum_{i=1}^{2}(1-\alpha_i)q_i\left(\left(a - b\sum_{i=1}^{2} q_i\right)\sum_{i=1}^{2} q_i - w\sum_{i=1}^{2}(1-\alpha_i)q_i\right). \tag{A58}$$

Maximising this product with respect to w and q_i yields the expressions in (14).

If the condition given by (15) does not hold, or in the limit case where $\alpha_i = \alpha_j = \alpha$, the Nash product is given by

$$N = (w - \overline{w})^{\theta}(1-\alpha)Q(a - bQ - (1-\alpha)w)Q, \tag{A59}$$

where Q is either the production of the only active firm, or the combined production of the two firm when $\alpha_i = \alpha_j = \alpha$. Maximising (A59) with respect to w and Q yields the expression given by (17).

We argue that there may only exist one symmetric equilibrium of the first stage outsourcing game, namely $\alpha_i = \alpha_j = \alpha^*$, where α^* is given by (16), if the outsourcing costs are such that net profits are non-negative at this outsourcing level. The reason is the following. For any symmetric situation $\alpha_i = \alpha_j < \alpha^*$, if one firm unilaterally increases its outsourcing marginally, it will be the sole producer. This will lead to a discontinuous increase in production, so there is an infinite marginal profit gain from doing so. Conversely, if $\alpha_i = \alpha_j > \alpha^*$, one of the firms would become the sole producer by unilaterally *reducing* its outsourcing level, thus there are always incentives to aim for lower outsourcing levels in this case.[20] This leaves only the possibility of $\alpha_i = \alpha_j = \alpha^*$. This is indeed an equilibrium, because if one of the firms unilaterally either increases or decreases its level of outsourcing, this would discontinuously reduce the firm's production and stage 2 profits to zero. Thus, if $\alpha_i = \alpha_j = \alpha^*$, neither firm has any incentive to unilaterally change its outsourcing level.

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