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Working Paper

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CESifo Working Paper, No. 7668

Provided in Cooperation with:

Ifo Institute – Leibniz Institute for Economic Research at the University of Munich

Suggested Citation: de Pinto, Marco; Goerke, Laszlo (2019) : Welfare-enhancing trade unions in an oligopoly with excessive entry, CESifo Working Paper, No. 7668, Center for Economic Studies and ifo Institute (CESifo), Munich

This Version is available at:

<https://hdl.handle.net/10419/201894>

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Impressum:

CESifo Working Papers

ISSN 2364-1428 (electronic version)

Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH

The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute

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Editor: Clemens Fuest

www.cesifo-group.org/wp

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Abstract

Trade unions are often argued to cause allocative inefficiencies and to lower welfare. We analyze whether this evaluation is also justified in a Cournot-oligopoly with free but costly entry. If input markets are competitive and output per firm declines with the number of firms (business stealing), there is excessive entry into such oligopoly. If trade unions raise wages above the competitive level, output and profits per firm decline, which could deter entry and thus improve welfare. We find that an increase in the union's bargaining power raises welfare if the (inverse) demand curve is (sufficiently) concave. We also show that collective bargaining loosens the linkage between business stealing and excessive entry.

JEL-Codes: D430, J510, L130.

Keywords: endogenous entry, oligopoly, trade union, welfare.

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We greatly appreciate helpful comments by Florian Baumann, Jörg Lingens, Karol Mazur, Jürgen Meckl, Jochen Michaelis and Manfred Stadler. We also thank participants of the CESifo Area Conference on Employment and Social Protection, of the Annual Conference of the European Association of Labour Economists, of the Royal Economic Society Conference, of the Spring Meeting of Young Economists as well as seminar participants in Trier for inspiring discussions. Christoph Tasto provided excellent research assistance.

1 Introduction

In many OECD and European Union member states, wages and working conditions for an overwhelming fraction of the workforce are determined by collective bargaining (cf. Visser, 2016). A large body of academic research has thus analyzed the consequences of wage negotiations between firms and trade unions. The broad consensus is that trade unions acquire rents to benefit their members, but that this redistribution causes allocative inefficiencies. Accordingly, introducing trade unions into a world with perfectly competitive goods markets is predicted to reduce employment, output and welfare in so-called right-to-manage models.¹ Similar effects of unions also exist in other types of markets, as long as the number of firms is exogenously given.

If (costly) market entry is feasible, however, the endogenously determined number of firms could itself be inefficient. Mankiw and Whinston (1986) and Suzumura and Kiyono (1987) show that market entry is excessive in an oligopolistic market with firms producing a homogeneous good and facing entry costs if the so-called business stealing effect prevails, i.e. output per firm declines with the number of firms. The rationale for this excess entry theorem is that entrants do not take into account the fall in the payoff of incumbent firms and, accordingly, do not internalize an externality.² This prediction is based on the assumption of perfectly competitive input markets. Allowing for collective bargaining in such a setting implies higher wages and lower profits. Accordingly, the incentives to enter the market are reduced. Since welfare rises with fewer firms if there is excessive entry, collective bargaining and, hence, trade unions could be welfare-enhancing in an oligopoly with an endogenously determined number of firms.

¿From an empirical perspective, a unionized oligopoly seems to be extremely relevant. Despite this, relatively little is known about the allocative effects of such a combination of market imperfections. The present paper helps to fill this gap in two ways. First, we investigate how trade unions affect welfare in an oligopolistic market with excessive entry. Second, we analyze whether the presence of trade unions modifies the condition which has to be fulfilled for the excess entry theorem to hold.

To address these points, we set up a model in which consumers can allocate their income between two goods. The numeraire good is produced under

¹An inefficiency will also arise if there is bargaining over wages *and* employment, unless there is no input other than labor and the union's payoff is linear in wages and employment.

²This kind of externality is also present in other settings with imperfect product markets and not solely in a homogeneous Cournot-oligopoly. Therefore, the theoretical possibility that there can be excessive entry is also of great empirical relevance.

conditions of perfect competition, while the market for the other commodity is characterized by Cournot-competition. Production of this good of interest can only take place if fixed costs of entry are incurred. Input prices, i.e. wages, are negotiated between a firm and a trade union. As our main result, we show that collective bargaining can raise welfare.

The intuition for this welfare-enhancing role of trade unions is as follows: Union bargaining raises wages. This reduces profits and also tends to lower the number of firms. While the direction of the change in output per firm is ambiguous, it is always dominated by the variation in the number of firms. Consequently, aggregate output declines with collective bargaining. This effect on its own has detrimental welfare consequences. In contrast, a fall in the number of firms, c.p., raises welfare, because entry is excessive in the absence of unions. The net impact is uncertain and depends, *inter alia*, on the magnitude of market entry costs and on the curvature of the (inverse) demand curve.

We also find that, in the presence of trade unions, the business stealing effect is a necessary but no longer a sufficient requirement for excessive entry to occur. This implies that insufficient entry could be the equilibrium outcome even if there is business stealing, which puts into perspective the original excess entry theorem, (implicitly) derived for competitive input markets (cf. Mankiw and Whinston, 1986, Perry, 1984, Suzumura and Kiyono, 1987, von Weizsäcker, 1980). Furthermore, insufficient entry can already arise if trade unions have (virtually) no bargaining power. This is because wage payments (irrespective of their level) always deter entry since they reduce profits. This pure redistribution of income, however, does not alter welfare. While trade unions are, therefore, no prerequisite for welfare gains, the entry effect of wages becomes more pronounced the higher the unions' bargaining power is.

Our results have a number of policy implications. First, anti-competitive strategies which aim to prevent entry should be enacted cautiously. Reducing the number of firms would make a welfare-enhancing effect of trade unions less likely. Along the same lines, it can be argued that policies which allow the number of firms to fall, e.g. by raising the costs of market entry or by making mergers more feasible, can be particularly detrimental to welfare if there is no business stealing and wages are negotiated collectively. Second, restricting the legal framework of collective bargaining in order to decrease union bargaining power could be welfare-reducing because a less pronounced labor market inefficiency might strengthen another inefficiency (excessive entry). Put differently, our analysis reveals a further instance of a classic second-best world in which it is not true that "a situation in which more, but not all, of the optimum conditions are fulfilled is necessarily (...) superior to a situation in which fewer are fulfilled." (Lipsey and Lancaster,

1956, p. 11f.)

The remainder of our paper is structured as follows. Section 2 reviews the literature and highlights our contributions. In Section 3, we develop the analytical framework. In Section 4 we, first, consider a general setting and derive a condition for collective bargaining to enhance welfare. Since the curvature of the product demand curve features prominently in this condition we, second, consider various specifications of demand, which we distinguish according to this property. Third, we present a numerical evaluation in which we analyse the determinants of the welfare effect of unions, in particular fixed costs of market entry and the properties of the demand schedule, in more detail. Fourth, we scrutinize the robustness of our theoretical predictions with regard to an alternative objective of the trade union and with respect to different bargaining regimes. Section 5 investigates how collective bargaining alters the excess entry theorem. Section 6 concludes.

2 Literature Review

This paper is primarily related to contributions which scrutinize the welfare effects of trade unions in oligopolies and, in particular, to investigations of the robustness of the excess entry theorem with respect to imperfectly competitive input markets. Okuno-Fujiwara and Suzumura (1993), Suzumura (1995) and Mukherjee and Ray (2014) assume that firms can reduce marginal production costs through R&D investments. They show that this extension of the basic set-up does not alter the excess entry result. If, however, production costs are asymmetric, entry can be socially insufficient in the presence of endogenous R&D as shown by Chao et al. (2017). Our approach fundamentally differs from these contributions, *inter alia*, because wage bargaining tends to raise but not to lower marginal production costs.

Ghosh and Morita (2007a) investigate a framework in which upstream firms can enter a market, will then produce an intermediate good and compete in quantities. Each upstream firm is matched to one downstream firm. Downstream firms take the price of the intermediate good as given and produce a final good. The market for the final good is also characterized by Cournot-competition. In this setting, a business creation impact may dominate the business stealing effect because upstream firms generate profits for their downstream counterparts, which the former ignore when deciding about entry. In a companion paper, Ghosh and Morita (2007b) assume that the number of downstream firms is determined endogenously and that each pair of profit-maximizing downstream and upstream enterprises (Nash-) bargains over the price and the quantity of the downstream firm's input. The authors

again show that there may be insufficient entry. Our contribution substantially differs from both studies. First, in the case of labor as input there is no business creation impact. Second, we demonstrate that trade unions can only enhance welfare if their bargaining power is limited, because otherwise the output effect of higher wages dominates the impact on firm entry. Ghosh and Morita (2007b) show that the upstream firm must have sufficient bargaining power for insufficient entry to occur but do not derive the welfare consequences of changes in bargaining strength. Third, in our framework wage payments are akin to transfers from firms to workers. Therefore, they have no immediate welfare effects, whereas the use of inputs directly reduces welfare in the settings looked at by Ghosh and Morita (2007a,b).

More recently, Basak and Mukherjee (2016) assume that the input supplier is a monopolist from which all oligopolists have to purchase. They show that the number of firms is insufficient (can be excessive) if they use a constant (decreasing) returns to scale production technology. In contrast to Basak and Mukherjee (2016), in our analysis suppliers of inputs, i.e. trade unions, cannot internalize interactions among oligopolists.

Turning to labor as input, imperfections in this market have basically played no role in Cournot-oligopolies with free but costly entry. Marjit and Mukherjee (2013) represent a partial exception. They consider a setting in which a single foreign firm produces at lower marginal cost than its domestic competitors but incurs transport costs. Initially assuming a competitive input market, the authors establish conditions for entry of domestic firms to be excessive. In an extension, they analyze an encompassing domestic trade union, while wages paid by the foreign competitor are unaffected by collective bargaining. The authors show that entry by domestic firms is insufficient. This prediction results from a combination of effects, such as wage setting, the focus on domestic welfare and marginal cost differences between firms. Our approach, in contrast, isolates the impact of collective bargaining in a closed-economy setting. Hamada et al. (2018) consider labor-managed firms which maximize the sum of profits and wage payments. They show that if there is business stealing, excess entry will also result if firms have this alternative objective.

Further, a number of studies analyze the effect of trade unions on entry deterrence in oligopolistic markets (cf. Bughin, 1999, Haucap et al., 2001, Ishiguro and Shirai, 1998, Ishiguro and Zhao, 2009). This line of research also differs from our approach in various perspectives. First, collective bargaining is used as an instrument by the incumbent firms to deter entry. In contrast, in our model there is no strategic wage setting. Second, the number of firms is exogenously determined or varied such that the possibility of endogenous excessive entry is ruled out by construction. Third, welfare effects of trade

unions are usually disregarded. The studies by Dewatripont (1987, 1988) are a partial exception. He investigates the role of unions in settings in which an incumbent firm trades off the costs of preventing another firm from entering the market with the fall in revenues if such entry actually occurs. Dewatripont (1987, 1988) argues that unions may raise welfare if they counteract the negative impact of an incumbent's strategy of entry deterrence. Our investigation is conducted in a similar spirit but undertaken in a completely different analytical framework in which entry decisions are made simultaneously.³

Finally, our approach also bears some analytical resemblance to investigations of the impact of taxes in Cournot-models with free entry. The payment of taxes can, c.p., be welfare neutral, as it is true for wages. In addition, taxes and wages both lower the difference between marginal revenues and costs. Besley (1989), for example, shows that a marginal increase of a unit tax from an initial level of zero raises welfare because it reduces excessive entry (see also Delipalla and Keen, 1992). Clearly, the policy consequences resulting from the analysis of taxes and collective negotiations differ fundamentally. Moreover, the costs of inputs, i.e. of wages, are bargained about in our framework. This is usually not feasible with regard to tax rates.

3 Analytical Framework

3.1 Set-up

We consider a two-sector economy. In each sector, one labor unit is required to produce one unit of output. In sector 0, good 0 is supplied under conditions of perfect competition on goods and labor markets. We choose good 0 as the numeraire and normalize its price to unity, such that the wage per labor unit paid in this sector is equal to one. In sector 1, there are $j = 1, \dots, n$, $n > 1$, firms and each of them produces the same consumption good. The market for good 1 is imperfectly competitive. Our two-sector approach differs from the framework commonly used in the excessive entry literature, where only one sector is considered. The more general setting enables us to derive demand schedules from first principles and to consistently specify individual and collective preferences. In order to ensure comparability with earlier contributions, we assume that sector 0 is relatively large such that production decisions in sector 1 have (virtually) no effects on outcomes in

³Naylor and Soegaard (2014) show that profits in a Cournot-oligopoly can increase in the number of firms if labor markets are unionized. This result suggests that trade unions do not necessarily have to deter entry as argued in related studies.

sector 0.

Profits of firm j consist of the difference between revenues and the sum of labor and market entry costs. Revenues are the product of the price $p(X)$ and the quantity x_j produced by firm j . The price decreases with aggregate output, X , which consists of the sum of output by firm j and output of all other firms, X_{-j} : $X \equiv x_j + X_{-j}$. Labor costs equal wage payments $w_j x_j$. Finally, and in order to ensure economies of scale, there are market entry or set-up costs denoted by k , $k > 0$, which are the same for all firms. Profits are, hence, defined by:

$$\pi_j = p(x_j + X_{-j})x_j - w_j x_j - k. \quad (1)$$

Firms maximize profits with respect to output and assume the choices by other firms to be given, i.e. we consider a Cournot-Nash-setting. Moreover, firms only enter the market if entry costs are less than or equal to operating profits, which are defined by $\pi_j^o = \pi_j + k$.

There is a representative consumer who is a price taker on goods markets and whose preferences are given by a quasi-linear utility function:

$$U = x_0 + u(X), \quad (2)$$

with x_0 denoting the consumed quantity of the numeraire good. The sub-utility function u satisfies $u''(X) < u'(0) = 0 < u'(X)$. The representative consumer inelastically supplies a given quantity of labor. Correctly anticipating labor demand by firm j , the consumer supplies x_j units of labor to firm j , such that total labor supply to sector 1 equals $X = x_j + X_{-j}$. Accordingly, the wage income in sector 1 is given by $W = w_j + W_{-j}$. The remaining amount of labor is supplied to sector 0 and the associated wage income is denoted by W_0 .⁴ To close the model and to be able to abstract from distributional effects, we assume that the representative consumer owns all firms. Aggregate profits in sector 1 are denoted by Π , whereas profits in sector 0 are zero due to perfect competition. The consumer receives wages paid in both sectors and, additionally, an exogenously given income $\Theta > 0$. This guarantees that the consumer is able to purchase the utility-maximizing quantity of good 1 (see, inter alia, Armstrong and Vickers, 1991, Langenmayr et al., 2015, Varian, 1985 for the same assumption).

⁴Alternatively, we could assume that the economy is endowed with an exogenously given mass of (homogeneous) labor which would also equal the mass of consumers. Labor units would be inelastically supplied. Moreover, consumers would decide about individual demand given the quasi-linear utility function (2), while the market demand would be the sum of all individual demand schedules. Our approach can be treated as a special case of this setting, with the mass of labor normalized to one, such that the economy is (quasi) endowed with one representative consumer.

The labor market in sector 1 is unionized. The trade union represents the interests of (all identical) consumers. We follow the dominating approach and presume a utilitarian trade union (Oswald, 1985), which implies that it aims to maximize the representative consumer's utility. Wages are the outcome of a Nash-bargain between the firm and a firm-specific trade union. The union takes as given wages obtained in other firms, income from sources other than labor and anticipates the firm's output choice. We assume that labor is fully mobile across firms and sectors ex-ante, i.e. before the wage is determined. Ex-post, labor is immobile within sector 1, i.e. changing jobs across sector 1 firms is not feasible, but labor can always move from sector 1 to the competitive labor market in sector 0.⁵

The timing is as follows:

1. Firms enter the market.
2. Wage bargaining simultaneously takes place at the firm level.
3. Firms simultaneously decide about their output level.
4. Consumption decisions are made.

As usual, we solve the model by backward induction.

It could be argued that our model is set up in such a manner that a trade union has to be welfare-enhancing because it is utilitarian and, thus, implicitly a welfare-maximizing entity. We show in Section 4 that this conjecture is not warranted. First, the trade union does not take into account the effects of its bargaining behavior on other firms. In consequence, the union considers the number of firms as given. The reason is that bargaining occurs only in firms which have entered the market and the entry decision cannot be made contingent on bargaining outcomes. This feature is independent of the scope of bargaining, i.e. whether negotiations take place at the firm or more centralized level, or whether they include wages and employment instead of wages only. Second, the trade union bargains over wages (and possibly output). Therefore, it cannot affect welfare via a change in the number of firms directly. Instead, it may expand the absolute magnitude of its share of the pie by reducing its size and, hence, welfare.

⁵The assumption of ex-post immobility of labor units within sector 1 guarantees that trade unions can raise wages above the competitive level. Furthermore, labor mobility across sectors ensures that there is no unemployment. See Oswald (1982, 1985) for the basic idea.

3.2 Optimization

3.2.1 Demand

The representative consumer chooses the consumption quantities x_0 and X to maximize utility (2), subject to the constraint that total income I , which is predetermined at the final stage, equals total expenditure. Replacing the consumption quantity of good 0 according to this constraint, the first-order condition for a maximum is:

$$\frac{dU}{dX} = u'(X) - p(X) = 0. \quad (3)$$

The inverse demand function $p(X)$ defined by (3) is downward-sloping in the price-quantity space. Its curvature depends on the third derivative of the utility function which is a priori ambiguous.

For later use, we define the elasticity of the slope of the inverse demand curve with respect to aggregate output as:

$$\eta(X) \equiv p''(X) \frac{X}{p'(X)}, \quad (4)$$

This elasticity, in general, depends on aggregate output, X . From its definition, we obtain:

Lemma 1

The inverse demand curve is

- (i) *linear if $\eta = 0$,*
- (ii) *strictly concave if $\eta(X) > 0 \forall X$,*
- (iii) *strictly convex if $\eta(X) < 0 \forall X$.*

Since Eq. (3) uniquely defines the optimal consumption quantity, X^* , of the good produced in sector 1, the remaining income is used to purchase the numeraire good according to the budget constraint. Therefore, we obtain:

$$x_0^* = I - p(X^*) X^*. \quad (5)$$

With (5) at hand, utility of the representative consumer can be rewritten as:

$$V \equiv U(I, X^*) = I - p(X^*) X^* + u(X^*). \quad (6)$$

This shows that utility is linear in income, which is defined by $I = W + W_0 + \Pi + \Theta$.

3.2.2 Output

The first-order condition for a profit maximum of firm j is given by:

$$\frac{d\pi_j}{dx_j} = p'(X)x_j + p(X) - w_j = 0. \quad (7)$$

The second-order condition implies:

$$\frac{d^2\pi_j}{dx_j^2} = p''(X)x_j + 2p'(X) < 0. \quad (8)$$

Using (8) and $d^2\pi_j / (dx_j dw_j) = -1$, we can derive the slope of the firm's labor demand curve as:

$$\frac{dx_j}{dw_j} = \frac{1}{p''(X)x_j + 2p'(X)} < 0. \quad (9)$$

3.2.3 Wage Determination

The firm-specific trade union and firm j bargain over the wage w_j to maximize the Nash-product, NP_j , subject to (9). The (asymmetric) Nash-product is defined as (see Svejnar, 1986):

$$NP_j = \left(V_j - \tilde{V}_j\right)^\alpha (\pi_j - \tilde{\pi}_j)^{1-\alpha}, \quad (10)$$

where V_j (π_j) denotes utility (profits) in case of an agreement between firm j and the trade union, and \tilde{V}_j ($\tilde{\pi}_j$) represents utility (profits) if no agreement is reached, while α [$1 - \alpha$], $0 \leq \alpha < 1$, describes the union's [firm's] bargaining power.

In case of an agreement, labor units demanded by firm j obtain wage income w_j . Because utility is linear in income and output is linear in employment, the union's payoff is given by [see (6)]:

$$V_j = w_j x_j + W_{-j} + W_0 + \Pi + \Theta - p(X^*)X^* + u(X^*), \quad (11)$$

where we assume that aggregate variables are exogenously given from the perspective of the firm-level union. In addition, we do not explicitly model how aggregate income components, such as profits Π , are distributed across firm-specific unions. As it will become clear below, this simplification is without impact on the union's bargaining objective.

If no agreement is reached, labor units receive the competitive wage normalized to unity. Using the same assumptions as for the derivation of (11),

the fallback utility of the firm-specific trade union becomes:⁶

$$\tilde{V}_j = 1 \times x_j + W_{-j} + W_0 + \Pi + \Theta - p(X^*)X^* + u(X^*). \quad (12)$$

Using (11) and (12), the union's gain from negotiating is given by $V_j - \tilde{V}_j = (w_j - 1)x_j$.

Turning to the firm, profits in case of an agreement are represented by (1). Otherwise, the firm faces a loss in terms of the market entry costs, $\tilde{\pi}_j = -k$. Therefore, the firm's gain from a successful negotiation reads $\pi_j - \tilde{\pi}_j = \pi_j^o = (p(X) - w_j)x_j$.

Consequently, the Nash-product can be written as:

$$NP_j = ((w_j - 1)x_j)^\alpha ((p(X) - w_j)x_j)^{1-\alpha}. \quad (13)$$

The first-order condition for a maximum of NP_j is:

$$\alpha (V_j - \tilde{V}_j)^{\alpha-1} \frac{d(V_j - \tilde{V}_j)}{dw_j} (\pi_j^o)^{1-\alpha} + (1 - \alpha) (V_j - \tilde{V}_j)^\alpha \frac{d\pi_j^o}{dw_j} (\pi_j^o)^{-\alpha} = 0. \quad (14)$$

We assume that the solution to (14) is unique and that the second-order condition for a maximum is fulfilled. Canceling common terms, making use of the firm's first-order condition (7), and rearranging, we obtain:

$$(1 - \alpha)(w_j - 1)x_j = \alpha(p(X) - w_j)x_j (1 - \mu(x_j, w_j)). \quad (15)$$

$\mu(w_j, x_j) \in [0, 1]$ is defined as the weighted wage elasticity of labor demand:

$$\mu(x_j, w_j) \equiv -\frac{w_j - 1}{w_j} \frac{w_j}{x_j} \frac{dx_j}{dw_j}. \quad (16)$$

The restriction $\mu(w_j, x_j) \in [0, 1]$ ensures that $w_j \geq 1$.

The Nash-bargaining solution balances the gains from negotiations, i.e. wage payments in excess of the amount paid in sector 0, $(w_j - 1)x_j$, on the one hand and operating profits, $\pi_j^o = (p(X) - w_j)x_j$, on the other. The two components are weighted according to the parties' bargaining power, α and $1 - \alpha$, and the responsiveness with which a wage change alters the gain from bargaining. These indicators of wage responsiveness can be summarized in the (weighted) wage elasticity of labor demand, $\mu(w_j, x_j)$.

⁶A breakdown of negotiations between firm j and union j could change aggregate output. Since the direction of this effect depends, inter alia, on responses of competitors, we do not consider this possibility in the following.

3.2.4 Market Entry

Firms enter the market until operating profits equal entry costs. The corresponding free-entry condition follows immediately from $\pi_j(n) = 0$ and (1).

Since output per firm and the wage are uniquely determined for a given number of firms, the free-entry condition implicitly defines the equilibrium number of firms. Following the approach commonly pursued (see, for instance, Amir et al., 2014, Besley, 1989, Ghosh and Morita, 2007a, Marjit and Mukherjee, 2013), we ignore the integer constraint with regard to the number of firms.

3.3 Equilibrium

We consider a symmetric equilibrium such that all firm-specific trade unions set the same wage, $w = w_j \forall j$, and all firms choose the same output level, $x = x_j \forall j$. For a given number of firms, n , aggregate output, hence, equals $X = nx$. Using (4), we can rewrite the firm's second-order condition (8) as (cf., inter alia, Besley, 1989, Seade, 1980, Suzumura and Kiyono, 1987):

$$\frac{d^2\pi}{dx^2} = \frac{p'(nx)}{n} (2n + \eta(X)) < 0. \quad (17)$$

As such, $2n + \eta(X) > 0$ (or, equivalently $\eta(X) > -2n$) must hold to guarantee a profit maximum.

The equilibrium levels of wages, output per firm, the number of firms, and aggregate output are denoted by w^* , x^* , n^* and $X^* = x^*n^*$, respectively. Given the free-entry equilibrium, they are (implicitly) determined by the subsequent conditions:

$$A \equiv (1 - \alpha)(w^* - 1)x^* - \alpha k(1 - \mu(x^*, w^*)) = 0, \quad (18)$$

$$B \equiv p'(X^*)x^* + p(X^*) - w^* = 0, \quad (19)$$

$$C \equiv p(X^*)x^* - w^*x^* - k = 0. \quad (20)$$

The partial derivatives of (18) to (20) with respect to the endogenous variables are given by $A_n = 0$, $B_w = -1$, $C_w = -x$, and the subsequent expressions, where we omit the indication of the endogenous variables as equilibrium outcomes by a '*' for simplicity:

$$\begin{aligned} A_x &= (1 - \alpha)(w - 1) + \alpha k \mu_x, \\ A_w &= (1 - \alpha)x + \alpha k \mu_w, \end{aligned} \quad (21)$$

$$\begin{aligned} B_x &= p'(X)(1 + n) + p''(X)xn = p'(X)(1 + n + \eta(X)) < 0, \\ B_n &= x(p''(X)x + p'(X)) = p'(X)\frac{x}{n}(\eta(X) + n), \end{aligned} \quad (22)$$

$$\begin{aligned} C_x &= p'(X)x(n-1) < 0, \\ C_n &= p'(X)x^2 < 0. \end{aligned} \tag{23}$$

Note that the derivatives of the (weighted) wage elasticity of labor demand, μ_x and μ_w , are ambiguous. Since stability of the equilibrium requires $1 + n + \eta(X) > 0$ in the absence of trade unions (see Seade, 1980), we also assume this restriction to hold.

The determinant of the system consisting of Eqs. (18) to (20) is given by $D = A_x(B_n C_w - B_w C_n) - A_n(B_x C_w - B_w C_x) + A_w(B_x C_n - B_n C_x)$. Inserting the respective terms and simplifying yields:

$$D = \underbrace{p'(X) \frac{x^2}{n}}_{<0} \left[A_w \underbrace{(2n + \eta(X))}_{<0} p'(X) - A_x \eta(X) \right]. \tag{24}$$

We assume that the equilibrium in the presence of trade unions is also well behaved and stable, which requires that profits per firm decrease in the number of firms n . This implies that the determinant D is positive (see Appendix A.1).

Finally, welfare is given by the representative consumer's utility V , as defined by (6) since consumers receive all profit income. Equilibrium income equals $I^* = w^* X^* + W_0 + \Pi^* + \Theta$. Because we have assumed that sector 0 is sufficiently large, total wage income in this sector, W_0 , is unaffected by outcomes in sector 1. Using the definition of profits, welfare can be expressed as:

$$V^* = u(X^*) - n^* k + W_0 + \Theta. \tag{25}$$

4 Welfare Effects of Trade Unions

How does an increase in the bargaining power α affect welfare V^* ? In subsection 4.1 we, first, show that the answer to this question depends, inter alia, on the curvature of the inverse demand curve. As a second step, we scrutinize in subsection 4.2 the answer to this question for several types of demand functions. A numerical evaluation of our results is conducted in subsection 4.3. We consider a number of extensions to our main specification in subsection 4.4. In particular, we investigate a different (Stone-Geary-) trade union objective, efficient negotiations about wages and employment and bargaining at a more centralized level than in each firm.

4.1 General Results

Before we analyze the welfare effects of trade unions, let us first investigate how wages react to changes of the union's bargaining power. Because Eqs. (19) and (20) do not depend on α , totally differentiating Eqs. (18) – (20) and rearranging the resulting expressions yields:

$$\frac{dw^*}{d\alpha} = -\frac{A_\alpha}{D} (p'(X^*))^2 (x^*)^2 \frac{2n^* + \eta(X^*)}{n^*} > 0, \quad (26)$$

where A_α denotes the partial derivative of (18) with respect to α :

$$A_\alpha = -k \frac{1 - \mu(x^*, w^*)}{(1 - \alpha)^2} < 0 \quad \text{for} \quad 0 < \alpha < 1. \quad (27)$$

This leads to the following Lemma:

Lemma 2

An increase in the union's bargaining power raises the equilibrium wage rate.

As it will become clear below, Lemma 2 indicates that irrespective of the exact manner in which wages are determined, our results apply as long as greater union bargaining power raises wages and affects other outcomes only via the remuneration level of employees. Consequently, the assumption of Nash-bargaining is not crucial for the subsequent findings. Moreover, the result in Lemma 2 has been established for other output market structures as well (see Dowrick, 1989, Nickell and Andrews, 1983).

Next, we look at the welfare effects of more powerful trade unions. Making use of the assumption that W_0 is unaffected by the outcomes in sector 1 and differentiating welfare as defined by (25) with respect to α yields:

$$\frac{dV^*}{d\alpha} = u'(X^*) \underbrace{\left[\frac{dx^*}{d\alpha} n^* + x^* \frac{dn^*}{d\alpha} \right]}_{dX^*/d\alpha} - \frac{dn^*}{d\alpha} k. \quad (28)$$

As elucidated in the introduction, the welfare effect of an increase in the union's bargaining power depends on two effects: (i) the variation in aggregate output X^* because this directly alters the representative consumer's utility, and (ii) the variation in the number of firms n^* because this changes aggregate market entry costs.

The variations in equilibrium output per firm, x^* , the number of firms, n^* , and aggregate output, X^* , owing to a higher bargaining power of unions are given by:

$$\frac{dx^*}{d\alpha} = \underbrace{\frac{A_\alpha p'(X^*) (x^*)^2}{D}}_{>0} \frac{\eta(X^*)}{n^*}, \quad (29)$$

$$\frac{dn^*}{d\alpha} = - \underbrace{\frac{A_\alpha p'(X^*)x^*}{D}}_{<0} (2 + \eta(X^*)), \quad (30)$$

$$\frac{dX^*}{d\alpha} = - \frac{2A_\alpha p'(X^*)(x^*)^2}{D} < 0. \quad (31)$$

This leads to the following Proposition:

Proposition 1

A necessary condition for an increase in the union's bargaining power to raise welfare is that an increase in α deters entry, that is $\eta(X^) > -2$ must hold.*

Proof 1

See (28), (30) and (31).

It is evident from (31) that aggregate output unambiguously decreases in the union's bargaining power which, c.p., reduces welfare. In the following, we label this the welfare-reducing output effect (of trade unions). If the number of firms would additionally increase in α , welfare would certainly decline because of higher entry costs. Such an increase in n can occur if profits rise, which is feasible because higher wages (due to more powerful unions) lower aggregate output and the resulting rise in the price enhances profits. If the elasticity of the slope of the inverse demand curve with respect to aggregate output is not too negative, that is, if $2 + \eta(X^*) > 0$, the price impact will be dominated by the direct wage effect and an increase in α deters entry. In this case, welfare, c.p., increases because entry costs can be saved. We refer to this as the welfare-enhancing number-of-firms effect (of trade unions). This implies, furthermore, that welfare increases in the union's bargaining power if and only if savings in market entry costs outweigh the reduction of aggregate output. The sign of $dV^*/d\alpha$, i.e. the sign of the overall welfare effect of trade unions, is then parameter-dependent. The next Proposition formalizes this requirement:

Proposition 2

*An increase in the union's bargaining power raises welfare if and only if $2(x^*p(X^*) - k) - \eta(X^*)k < 0$. A necessary but not a sufficient condition for that is $\eta(X^*) > 0$, i.e., that the inverse demand curve is strictly concave at X^* (see Lemma 1).*

Proof 2

Inserting (30) and (31) into (28) as well as using (3) yields:

$$\frac{dV^*}{d\alpha} = - \underbrace{\frac{A_\alpha p'(X^*)x^*}{D}}_{<0} [2(x^*p(X^*) - k) - \eta(X^*)k], \quad (32)$$

where $x^*p(X^*) - k > 0$ holds because of free entry.

Proposition 2 shows that the slope of the inverse demand curve $\eta(X^*)$ is crucial for the overall welfare effect of unions. In particular, the inverse demand curve has to be strictly concave, otherwise the welfare-reducing output effect will always outweigh the welfare-enhancing number-of-firms effect. Moreover, the absolute size of $\eta(X^*)$ plays a decisive role for the welfare effect of unions. Suppose that $\eta(X^*)$ is positive and consider an exogenous increase in this elasticity. Then, the welfare-reducing output effect declines because lower competition raises prices relatively strongly and, hence, output per firm increases. Holding everything else constant, this direct impact suggests that that a welfare-enhancing effect is more likely to occur the higher $\eta(X^*)$ is. Because of the change in revenues, however, the term $p(X^*)x^*$ in Eq. (32) will adjust as well. The sign of this indirect impact cannot be determined analytically, which is then also true for the overall effect. In subsection 4.3, we therefore use a numerical example to get a more detailed picture about interplay of the potentially counteracting direct and indirect effects.

In addition, market entry costs k affect the welfare effect of unions. Holding everything else constant, higher entry costs imply that the welfare-enhancing number-of-firms effect becomes stronger. This direct effect, hence, suggests that a welfare-enhancing effect is more likely to occur the higher k is. As before, there is, however, an indirect impact as well, since market entry costs affect revenues. In our numerical example (see subsection 4.3,) we also analyze the role of market entry costs, taking both the direct and indirect effect into account.

4.2 On the Role of Demand Functions

Propositions 1 and 2 establish necessary conditions for the number of firms to decline, respectively, welfare to rise with greater trade union bargaining power. In this subsection, we investigate which classes of demand functions fulfill this requirements. In particular, we take a look at iso-elastic, log-concave and linear (direct) demand.⁷ All of these specifications allow us to draw conclusions with respect to the welfare effect of trade unions, without having to rely on particular parameter values of numerical examples.

If demand is iso-elastic, the elasticity of the slope of the inverse demand curve, η , will be given by $\eta = \epsilon - 1$, where ϵ , $\epsilon < 0$, is the inverse of the price elasticity of demand (see Appendix A.2). Therefore, validity of the second-order condition (17) and the stability of equilibrium requires that ϵ is not

⁷We are grateful to an anonymous referee for suggesting this generalization of our findings.

too high in absolute value. More importantly, the inverse demand curve is strictly convex (see Lemma 1). Thus, the necessary condition for the number of firms to fall with trade union bargaining power can be fulfilled. However, in our setting, trade unions will never be welfare-enhancing if demand is iso-elastic (see Proposition 2). The reason is that the welfare-reducing fall in output due to higher wages raises the output price to an extent such that the welfare-enhancing decline in the number of firms, if it occurs at all, will not be strong enough to dominate the output effect.

If demand is log-concave, $\eta(X) \geq -1$ holds (see, inter alia, Ara and Ghosh, 2016, Ara et al., 2017, Mizuno, 2003 and Appendix A.2). Therefore, the second-order condition (17) and the stability requirement are fulfilled. In addition, the necessary condition for the number of entrants to fall with trade union bargaining power is warranted. Furthermore, the requirement which makes a welfare-enhancing role of trade unions feasible ($\eta(X) > 0$) may also hold. Therefore, assuming log-concavity of demand is not sufficient to establish that the welfare-increasing number-of-firms effect outweighs the detrimental consequences of lower output. In order to provide an intuition for this result, note that log-concavity is a rather encompassing characterization. All linear, strictly concave and exponential demand functions are log-concave. Since a linear demand function is characterized by $\eta = 0$ (see Lemma 1), which is incompatible with a welfare-enhancing role of trade unions, the assumption of log-concavity does not ensure that the condition formulated in Proposition 2 always holds.

In the next subsection, we consider an example of a strictly concave demand function. It fulfills the necessary condition for greater trade union bargaining power to raise welfare. Moreover, we establish that the positive welfare impact occurs for a substantial range of unions bargaining power.

4.3 Numerical Evaluation

The numerical evaluation is based on a particular specification of a strictly concave and, thus, also log-concave direct demand function of the type $X = (a - p)^b$, $a > 0 < b < 1$, which is characterized by a constant elasticity of the slope of the indirect demand curve, η . We, first, outline the various scenarios we consider which, inter alia, differ in the values of a and b . Subsequently, we present findings for a baseline setting and show that, for all manifestations of the measure, α , of the trade union's bargaining power which is less than some critical value, collective bargaining raises welfare. Moreover, we illustrate our findings graphically and provide an intuition. Finally, we investigate alternative scenarios to the baseline specification in order to ascertain the robustness of our findings and to discuss the determinants of a

welfare-enhancing effect of union in more detail.

4.3.1 Scenarios

In our baseline scenario, we assume $a = 200$ and $b = 0.5$ and, hence, consider the strictly concave inverse demand function $p(X) = 200 - X^2$. This implies $p'(X) = -2X < 0$, $p''(X) = -2 < 0$ and $\eta = 1$. Consequently, the second-order condition for a profit maximum and the stability condition hold. Moreover, there is business stealing in the absence of trade unions. And, most importantly, a welfare-enhancing effect of trade unions is possible because the condition in Proposition 2 is fulfilled. In addition, we assume $\Theta = 1$ and $W_0 = 1$ to guarantee that $x_0 > 0$.⁸ Finally, we set $k = 100$ to obtain a sufficiently low equilibrium number of firms that is compatible with an oligopolistic market.

As alternative scenarios, we consider four different settings. In the first case, we increase the value of market entry costs. Cases two to four deal with alternative assumptions on the inverse demand curve. We vary either the value of the choke price, a , or its curvature, that is, the parameter b . All scenarios are summarized in Table 1, where bold numbers illustrate changes relative to our baseline setting.

Table 1: Scenarios

	Baseline	I	II	III	IV
$p(X)$	$200 - X^2$	$200 - X^2$	250 $- X^2$	$200 - X^{2.5}$	$200 - X^{1.5}$
Θ	1	1	1	1	1
W_0	1	1	1	1	1
k	100	200	100	100	100
η	1	1	1	1.5	0.5

As our main outcome variable, we compute welfare V^* as a function of α , i.e. $V^*(\alpha, n^*(\alpha))$. In addition, we calculate the welfare effects of unions if the number of firms would be exogenously fixed at $\bar{n} = n^*(\alpha = 0)$, i.e. $V(\alpha, \bar{n})$. By comparing $V^*(\alpha, n^*(\alpha))$ and $V(\alpha, \bar{n})$, we can evaluate the role of the number-of-firms effect, as explained below. Moreover, we compute two critical values of bargaining power. First, $\alpha_1^{crit} \in [0, 1]$ measures the level of bargaining power at which welfare $V^*(\alpha, n^*(\alpha))$ is maximized. Second, $\alpha_0^{crit} \in [0, 1]$ depicts the value of bargaining power for which welfare in the presence

⁸As evident from (25), changes in Θ and W_0 have only an effect on the level of welfare but not on the sign of $dV^*/d\alpha$. Hence, the subsequent results are robust in this regard.

of trade unions equals welfare in the case of competitive labor markets, i.e. $V^*(\alpha_0^{crit}, n^*(\alpha_0^{crit})) = V^*(\alpha = 0, n^*(\alpha = 0))$. For all values of $\alpha < \alpha_0^{crit}$ or $\alpha < \alpha_1^{crit}$ welfare rise with trade union bargaining power, where the choice of the critical value reflects the standard of comparison. For α_0^{crit} , the reference point is a competitive labor market, while α_1^{crit} relates to settings in which collective bargaining prevails.

4.3.2 Results – Baseline Setting

The results of our baseline setting are illustrated in Figure 1. The lower (blue) curve depicts welfare as a function of union bargaining power, assuming that the number of firms is exogenously given. Unions only have a detrimental impact on aggregate output and, thus, on welfare. Accordingly, welfare unambiguously declines with the extent of union bargaining power if there is no number-of-firm effect, as the downward-sloping curve $V(\alpha, \bar{n})$ indicates.⁹

The upper (red) curve in Figure 1 combines the output and the number-of-firms effects [see Eqs. (28) and (32)]. It indicates that the latter impact dominates for a wide range of values of α , the indicator of union bargaining power. Moreover, the simulation suggests that a measure of union bargaining power of around 0.4 maximizes welfare in the presence of two distortions, namely market power by firms, interpreted as free-entry oligopoly, and non-competitive wage determination due to collective bargaining. In consequence, the rise in revenues $x^*p(X^*)$ resulting from an increase in α reduces the negative term in Eq. (32) until α reaches a value of almost 0.4 and then turns it positive, such that the derivative in Eq. (32) becomes negative.

We can summarize the insights depicted in Figure 1 in:

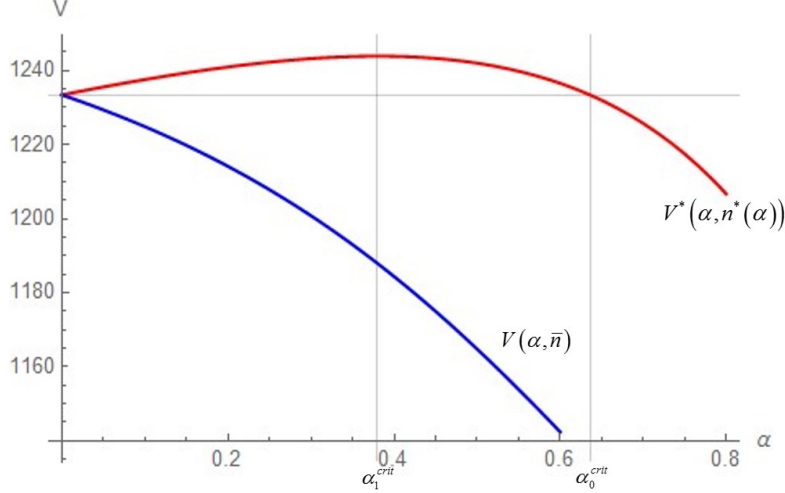
Corollary 1

Suppose that the inverse demand equals $p(X) = 200 - X^2$, implying that $\eta = 1$.

- (i) If the number of firms is held constant at $\bar{n} = n^*(\alpha = 0)$, welfare unambiguously declines with greater union bargaining power.*
- (ii) If n is allowed to vary and then decreases in α , as $\eta = 1$ implies that $dn^*/d\alpha < 0$ [see (30)], the relationship between the union's bargaining power and welfare is hump-shaped. We find an welfare enhancing-effect*

⁹This can also be seen in Eq. (28). Using $n^* = \bar{n}$, we obtain $dX/d\alpha < 0$, $d\bar{n}/d\alpha = 0$ and therefore $dV(\alpha, \bar{n})/d\alpha < 0$.

Figure 1: Welfare and Bargaining Power



of trade unions, i.e. $dV^*(\alpha, n^*(\alpha))/d\alpha > 0$ if $\alpha < \alpha_1^{crit} = 0.38$. Moreover, welfare in the presence of trade unions exceeds welfare in the case of competitive labor markets as long as $\alpha < \alpha_0^{crit} = 0.64$.

Table 2: Estimations of the Union Bargaining Power

Study	Country	Time	Bargaining Coefficient
Amador and Soares (2017)	Portugal	2006-2009	0.13
Boulhol et al. (2011)	UK	1988-2003	0.4
Brock and Dobbelaere (2006)	Belgium	1987-1995	0.12
Dobbelaere (2004)	Belgium	1988-1995	0.24
Hirsch and Schnabel (2014)	Germany	1992-2007	≈ 0.18
Kraft (2018)	Germany	1973-1990	≈ 0.15
Moreno and Rodríguez (2011)	Spain	1990-2005	0.16
Svejnar (1986)	US	1955-1979	< 0.5
Veugelers (1989)	Belgium	1978	0.19

Notes: The reported estimated bargaining coefficients are the average values over all sectors that are considered by the respective study. Hirsch and Schnabel (2014) and Svejnar (1986) do not report such a value. The former study shows the evolution of union bargaining power over the time span graphically such that an approximated value is reported. The latter shows that union bargaining power is below 0.5 for almost all considered sectors. Note further that a similar overview of the estimated bargaining coefficients is provided by de Pinto and Michaelis (2019), but there the focus lies on the variability of the union's bargaining strength across sectors within countries.

To evaluate whether the possibility of a welfare-enhancing effect of trade unions is an empirically relevant setting, we compare α_1^{crit} and α_0^{crit} with

estimated magnitudes of union bargaining power in the literature. In Table 2, we show that the estimated average value of the bargaining coefficient varies widely across countries and sectors. However, all studies report values of less than 0.5 and it seems that a union's bargaining strength of about 0.2 is the most realistic scenario. Given $\alpha_1^{crit} = 0.38$ and $\alpha_0^{crit} = 0.64$, we can, thus, conclude that the restrictions on the indicator of union bargaining power summarized in Corollary 1 (ii) are compatible with empirical evidence.¹⁰

4.3.3 Results – Alternative Settings

The results of our four alternative settings are presented in Table 3 where we have also repeated the findings of our baseline setting for ease of comparison. In the first line, we provide information on the optimal number of firms in the case of competitive labor markets. This shows the effects of the different scenarios on market entry per se, i.e. without considering the consequences of unionization on the incentives to enter the market. The second and third lines in Table 3 enumerate the critical values of trade union bargaining power.

Considering an increase in market entry costs k (scenario I), we find that the number of competitors in a world without collective bargaining would fall and that α_1^{crit} and α_0^{crit} decline, showing that a welfare-enhancing effect of trade unions will become less likely if entry costs rise. As discussed in subsection 4.1, there is a direct and an indirect impact of market entry costs on the welfare effects of variations in trade union bargaining power. On the one hand, $k(2 + \eta)$ increases (direct effect). On the other hand, there is a substantial reduction of the number of firms. This implies that revenues, $x^*p(X^*)$, increase (indirect effect). This is because each of the fewer firms produces more, while aggregate output declines, implying a higher price. This indirect effect overcompensates the direct one, implying that α_1^{crit} declines. Consequently, in the example considered, higher market entry costs make it less likely that collective bargaining results in a welfare increase.

A different picture emerges if the choke price, a , increases (scenario II). More specifically, the levels of union bargaining power, which either maximize welfare (α_1^{crit}) or ensure a welfare level which equals that occurring in a competitive labor market (α_0^{crit}), increase moderately. These effects occur because a higher choke price reduces revenues, when incorporating adjustments in the number of firms and in output per firm. If revenues are lower,

¹⁰Note that the hump-shaped relationship between α and V^* is similar to the finding of Calmfors and Driffill (1988) who derive such a relationship between the bargaining level and unemployment. We consider, however, only firm-level negotiations, but vary the bargaining power of firm-specific unions, an issue not looked at by Calmfors and Driffill (1988).

the welfare gain from higher union bargaining is still positive at the critical value of α calculated for the baseline case, such that α_1^{crit} and α_0^{crit} go up. A welfare-enhancing effect of unionization becomes thus more likely.

Table 3: Alternative Settings

	Baseline	I	II	III	IV
$\bar{n} = n^*(\alpha = 0)$	6.048	3.879	7.410	4.792	8.853
α_1^{crit}	0.3802	0.3800	0.3823	0.5138	0.1937
α_0^{crit}	0.636	0.634	0.649	0.8033	0.3529

Moreover, the results of scenarios III and IV enrich our analytical findings and the discussion at the end of subsection 4.1. If the inverse demand curve becomes more concave, i.e. η increases from 1 in our baseline setting to 1.5 in scenario III, we find that α_0^{crit} and α_1^{crit} rise, implying that a welfare-enhancing effect of trade unions is now more likely. This change comes about because a rise in η increases the marginal gain from expanding union power (direct effect). Moreover, the rise in revenues due to the greater concavity of the inverse demand curve (indirect effect) mitigates but does not reverse the direct impact. Finally, scenario IV indicates that if the inverse demand curve becomes less concave, i.e. η decreases to 0.5 in IV, α_0^{crit} and α_1^{crit} decline, with an analogous explanation.

Note further that all considered scenarios indicate a hump-shaped relationship between V^* and α illustrated in Figure 1. The possibility of a welfare-enhancing effect of trade unions is hence quite robust.

4.4 Extensions

Proposition 2 has established a condition which guarantees that greater trade union bargaining power raises welfare because the (welfare-enhancing) number-of-firms effect dominates the (welfare-reducing) output effect. Moreover, we have provided an illustration which indicates that this condition can actually hold and have, furthermore, shown the robustness of this numerical example. All these findings have been derived for a particular set of modeling features. In this subsection, we relax some of these assumptions. In particular, we consider an alternative specification of trade union preferences, enhance the scope of bargaining and modify the assumption of a small, firm-specific trade union.

4.4.1 Stone-Geary Objective

Our analysis thus far presumes that the trade union is an unbiased representative of individual preferences. This is tantamount to the assumption that the union pursues no objectives on its own. A frequent alternative to the utilitarian approach, which dissociates the union's behavior to some extent from its members' preferences, is the Stone-Geary objective. This framework postulates that the union's payoff is determined by the weighted product of a wage and employment objective. The wage objective equals the difference between the bargained wage and some minimum or reference level. The employment objective is defined in analogy. The relative weights of each objective have been interpreted as bargaining power of the trade union's leadership and members, respectively (Pemberton, 1988). Alternatively, the relative weight of the wage objective could indicate to which extent more senior employees, who are insulated from employment fluctuations, can enforce their preferences upon members whose job may be at risk. While the Stone-Geary objective cannot be derived from the employee's preferences (Oswald, 1985), its analysis provides an interesting extension to our main specification.

The Stone-Geary objective implies that the union's payoff is not based on V_j , but on the difference between the bargained wage, w_j , and a reference wage \bar{w} , $w_j > \bar{w}$. The relative weight of this wage objective, $w_j - \bar{w}$, is given by γ , $0 \leq \gamma < 1$. The relative weight of the employment objective, x_j , is given by $1 - \gamma$. Following, for example, Zhao (1995) and Lommerud et al. (2006), the reference level of employment and the fallback payoff are normalized to zero. The union's gain from negotiating then equals:

$$V_j^s - \tilde{V}_j^s = (w_j - \bar{w})^\gamma x_j^{1-\gamma}, \quad (33)$$

where the superscript s indicates the Stone-Geary objective. The wage equation can be derived in analogy to (15) such that the equilibrium wage condition (18) can be rewritten as:

$$A^s \equiv (1 - \alpha)(w^* - \bar{w})x^* = \alpha k(\gamma - (1 - \gamma)\mu^s(x^*, w^*)) = 0, \quad (34)$$

where $\mu^s(w^*, x^*) \in [0, 1]$ is defined as the weighted wage elasticity of labor demand in analogy to (16).

Eq. (34) shows that the signs of the partial derivatives A_n^s , A_x^s , A_w^s and A_α^s are identical to the ones in our main specification [see $A_n = 0$, (21) and (27)]. Because the results shown in Proposition 1 and 2 only depend on the signs of these partial derivatives but not on their magnitudes or exact specifications, they hold in case of a Stone-Geary variant of union preferences as well.

More generally, our findings will remain the same as long as the union faces a trade-off between wages and employment, i.e for $\gamma < 1$. Therefore, we can conclude that the exact manner in which union preferences are specified does not affect the result that trade unions may raise welfare in an oligopoly with excessive entry. This suggests that other trade union objectives, which result in a differential treatment of employees, for example, based on the seniority principle or distinguishing between union members and non-members, may also give rise to similar predictions. Moreover, institutions which raise labor costs and thereby increase the employees' income, such as minimum wage laws or employment protection regulations, can also be expected to have welfare-enhancing effects in oligopoly.

4.4.2 Efficient Bargaining

So far, we have considered a setting in which the trade union and the firm bargain over wages. By doing so they forgo efficiency gains which they can realize by negotiating over quantities, that is employment, as well. Hence, it could be argued that we bias our analysis by incorporating a second efficiency, in addition to the entry externality. Given this second source of welfare loss, the possibility that an increase in union bargaining power raises welfare may be amplified. Moreover, there is some evidence that collective bargaining is not only restricted to remuneration (see Lawson, 2011). Therefore, the question arises if our main findings also occur in a setting characterized by efficient bargaining, i.e. negotiations over prices and quantities.

As we show in Appendix A.3, Nash-bargaining over wages *and* employment (or output) leads to results that are qualitatively identical to bargaining over wages alone. In particular, the welfare-enhancing effect of trade unions requires $\eta(X) > 0$. The reason for this qualitative equivalence is that greater union bargaining power reduces profits in the context of efficient negotiations, too. Since lower profits deter entry, the basic mechanism outlined in subsection 4.1 continues to apply.

4.4.3 Multi-firm Bargaining

The present analysis assumes bargaining at the firm level in a small sector of the economy. This feature is incorporated into the framework by assuming, first, that the level of profit income Π accruing to workers is given and, second, that the union's actions will have no impact on sector 0, implying that the wage income W_0 is given as well. If, however, the trade union bargains with more than one firm and, in the limit, with all oligopolists, it will take into account that its actions affect wages in many firms and, thus,

change the profit income workers obtain. Similarly, it can be argued that the union is aware of the fact that wage negotiations in many firms will alter aggregate quantities which, in turn, may have an impact on sector 0 and the income earned by trade union members. In order to analyze the robustness of our findings with respect to the assumption of firm-specific negotiations, we investigate the implications of both assumptions.

We, first, consider multi-firm negotiations over wages. If the trade union bargains with more than one firm, but does not fully internalize the consequences of wage variations, the trade-off between wages and output as described by (15) will qualitatively also apply. In the limiting case of a trade union negotiating for all employees in sector 1 with an employer association including all n firms, however, this will no longer be the case.

In order to illustrate this assertion, it is helpful to determine the trade union's and employer's gain from bargaining for this setting. If there is an agreement, profits of all n firms are given by $\Pi = p(X)X - wX - nk$. All workers are paid the same wage and obtain aggregate profits, such that the sectoral union's payoff is given by

$$\begin{aligned} V &= wX + W_0 + p(X)X - wX - nk + \Theta - p(X)X + u(X) \\ &= W_0 - nk + \Theta + u(X). \end{aligned} \quad (35)$$

If the sector-wide union does not reach an agreement with the employer association, there is no production, and the latter's payoff equals $\tilde{\Pi} = -nk$. Furthermore, union members obtain the competitive wage of unity. Hence, the union's payoff is

$$\tilde{V} = X + W_0 - nk + \Theta. \quad (36)$$

Thus, the trade union's gain from bargaining, $V - \tilde{V} = u(X) - X$, does only depend on aggregate output, X , which in turn varies with the wage, $X = X(w)$. As output per firm declines in the wage, for a given number of firms, and therefore also aggregate output ($\partial X / \partial w < 0$), the union will prefer the lowest feasible wage, given that its payoff rises in aggregate output. This preference for the competitive wage comes about because the sectoral union fully internalizes the income and output effects of higher wages. In consequence, the trade union will not wish to raise the wage above the level preferred by the employer association.

In limiting case of sector-wide negotiations, therefore, collective bargaining does not alter the excessive entry result. Put differently, as long as the trade union does not negotiate with all firms jointly, the positive welfare effect of greater union bargaining power will continue to be feasible in a Cournot-oligopoly with endogenously determined number of firms.

An alternative analytical tool to relax the small union-setting is to assume that the union's actions have an impact on sector 0. Suppose, therefore, that the representative consumer is endowed with L labor units. Total wage income in sector 0 is then given by:

$$W_0^* = L - X^*. \quad (37)$$

As a result, higher employment in sector 1 reduces employment in sector 0, which is paid the competitive wage. Accordingly, the union takes into account the repercussions of its bargaining behavior on income from other sources. Given this modification, welfare (25) can be rewritten as:

$$V^* = u(X^*) - n^*k + L - X^* + \Theta. \quad (38)$$

Differentiating (38) with respect to α yields:

$$\frac{dV^*}{d\alpha} = (u'(X^*) - 1) \underbrace{\left[\frac{dx^*}{d\alpha} n^* + x^* \frac{dn^*}{d\alpha} \right]}_{dX^*/d\alpha} - \frac{dn^*}{d\alpha} k. \quad (39)$$

This shows that the welfare effect of greater union bargaining power is qualitatively identical to the one described by Eq. (28) as long as $u'(X^*) > 1$. This inequality holds in our setting because (i) the zero profit condition requires $p(X) > w$, (ii) the union's gain from bargaining will only be positive if $w > 1$, and (iii) $u'(X) = p(X)$ holds [see (3)].

We can conclude that the basic result of the analyses in Sections 4.1 to 4.3, according to which an increase in trade union bargaining power can raise welfare, will hold also for encompassing trade unions which bargain with more than one firm over wages. The only exception is a situation in which the trade union does not benefit from higher wages because their increase is fully offset by a fall in income from other sources.

5 Excess Entry Theorem and Trade Unions

In a world with competitive input markets, there will be excessive entry if and only if there is business stealing, i.e. if output per firm declines with the number of competitors (see Amir et al., 2014). In our model, however, labor markets are imperfect due to collective wage bargaining and it is thus a priori questionable whether business stealing remains a sufficient condition for excessive entry.

In order to analyze this point, we consider how an exogenous increase in the number of firms, denoted by \tilde{n} , alters output per firm and welfare if there

is wage bargaining. We focus on a second-best outcome and assume that welfare V as defined by (25) can be maximized, e.g. by a social planner, solely with regard to the number of firms. As before, firms decide about output while wages are the outcome of Nash-bargaining, where the equilibrium levels of w^* and x^* are given by (18) and (19).

This yields the (second-best) optimal number of firms, \tilde{n}^{**} :

$$\frac{dV}{d\tilde{n}} = u'(X(\tilde{n}^{**})) \left[x^*(\tilde{n}^{**}) + \tilde{n}^{**} \frac{dx^*}{d\tilde{n}} \right] - k = 0. \quad (40)$$

The second-order condition for a maximum implies $d^2V/d\tilde{n}^2 < 0$. Evaluating (40) at $\tilde{n}^{**} = n^*$ as well as using (20) and $p(X^*) = u'(X^*)$, we obtain:

$$\frac{dV}{d\tilde{n}}_{\tilde{n}^{**}=n^*} \equiv \hat{V} = p(X^*) n^* \frac{dx^*}{d\tilde{n}} + w^* x^*, \quad (41)$$

where $dx^*/d\tilde{n} < 0$ holds if there is business stealing. If $\hat{V} < 0$ and utility V is strictly concave in n , there is excessive entry, i.e. the number of firms entering sector 1 in market equilibrium, n^* , exceeds the second-best, welfare-maximizing optimal number. This yields:

Proposition 3

In the presence of wage payments and thus also in the presence of trade unions, the existence of a business stealing effect is a necessary but not a sufficient condition for excessive entry.

Proof 3

See (41).

To illustrate Proposition 3, suppose that labor is not required as input such that firms do not incur wage payments. In such a setting, excessive entry will occur if and only if there is business stealing. Each entrant does not take into account the negative output and profit effect occurring in other firms, i.e. ignores a negative externality. If production costs do not directly reduce welfare, because they raise the income of consumers, there is a further externality. Each firm which enters the market is less likely to do so the higher wages are. Thus, labor costs c.p. mitigate entry. From a welfare perspective wages are, however, irrelevant. This implies that entry features a positive income externality ignored by firms. A trade union which raises wages above the competitive level strengthens this positive welfare effect. Consequently, the existence of a negative business stealing externality does not guarantee excessive entry.

Proposition 3 can be compared to the findings derived by Ghosh and Morita (2007b). They show that if there is efficient bargaining with respect to the price and quantity of non-labor inputs between an upstream and a downstream firm which both maximize profits, there will be insufficient (excessive) entry if the upstream firm has full (no) bargaining power. This prediction differs from our findings in that insufficient entry can already arise if the trade union has (virtually) no bargaining power. Wage payments always mitigate the incentives to enter the market because they reduce profits. However, they do not lower welfare since they represent a redistribution of income. This entry effect of wages becomes more pronounced the higher wages are on account of collective bargaining. This cost effect will be different if the upstream firm's production costs directly lower welfare, as in Ghosh and Morita (2007b). Moreover, in our setting entry may still be excessive if the trade union is endowed with maximum bargaining power, i.e. in a monopoly union model. This is also in contrast to the finding by Ghosh and Morita (2007b) because the maximum wage a trade union will desire in a right-to-manage model is determined by the slope of the labor demand curve, *inter alia*, and not a zero-profit level. Finally, our analysis clarifies that excessive or insufficient entry in a world with trade unions is not tantamount to a statement about their welfare effects.

6 Conclusion

In this paper, we analyze a model with oligopolistic competition and costly market entry, where excessive entry can arise if output per firm declines with the number of competitors, i.e. if there is a business stealing effect. The excessive entry prediction has usually been derived assuming perfectly competitive input markets. We extend this setting and introduce imperfections in the labor market by assuming that wages (and potentially employment) are negotiated by firms and (firm-specific) trade unions.

As our main result, we find that trade unions can deter entry and may thus raise welfare. Such a welfare-enhancing effect of trade unions requires a strictly concave inverse demand function and is more likely to occur the smaller the reduction in aggregate output due to the wage increase is. In addition, we show that excessive entry need not arise even in the presence of a business stealing externality. This is the case because wage payments reduce profits and, hence, make entry less attractive. Since trade unions raise wages, this positive externality surely mitigates and may even dominate the negative externality due to business stealing.

Our paper also contributes to the series of studies that investigate how

robust the excessive entry prediction is. Mostly, these studies focus on alternative assumptions with regard to the output but not with respect to the input market. Despite the relative neglect of input markets, we believe that our analysis has wider implications. First, while the robustness of the excess entry theorem has been looked at from a variety of perspectives, the implications of non-competitive input markets and of the assumption that production costs constitute welfare losses need to be considered more intensively. Second, trade unions are often viewed as institutions which cause inefficiencies or exploit them to the advantage of their members. We adopt an alternative perspective and show that one inefficiency can counteract the effects of another, such that trade unions may be welfare-enhancing. Third, if output and input market imperfections interact, industrial and labor market policies should not be based on the analysis of only one type of deviation from the competitive benchmark.

A Appendix

A.1 Stability of the Equilibrium

To ensure that the equilibrium is well-behaved and stable, profits have to decline in the number of firms operating in the market. In order to analyze under which conditions this restriction is fulfilled, we vary the number of firms exogenously and calculate $d\pi/d\tilde{n}$, where \tilde{n} denotes the exogenously given number of firms.

This approach implies that only the wage rate w and output per firm x are determined endogenously according to Eqs. (18) and (19). The determinant of this reduced system of Eqs. is given by $D_{\tilde{n}} = A_x B_w - A_w B_x$. Inserting the respective terms yields:

$$D_{\tilde{n}} = -[(1 - \alpha)(w - 1) + \alpha k \mu_x] - [(1 - \alpha)x + \alpha k \mu_w] p'(X)(1 + n + \eta(X)). \quad (\text{A.1})$$

If labor markets are not unionized, i.e. $\alpha = 0$, stability of the equilibrium requires $1 + n + \eta(X) > 0$ (see Seade, 1980), which in turn implies that the determinant is positive. We suppose that wage negotiations do not give rise to instability and assume $D_{\tilde{n}} > 0$.

Differentiating (1) with respect to \tilde{n} yields:

$$\frac{d\pi}{d\tilde{n}} = \underbrace{C_n}_{<0} + \underbrace{C_x}_{<0} \frac{dx}{d\tilde{n}} + C_w \frac{dw}{w\tilde{n}}. \quad (\text{A.2})$$

The effect of a variation in the number of firms on x and w can be calculated

as:

$$\frac{dx}{d\tilde{n}} = \frac{A_w B_n}{D_{\tilde{n}}}, \quad (\text{A.3})$$

$$\frac{dw}{d\tilde{n}} = -\frac{A_x B_n}{D_{\tilde{n}}}. \quad (\text{A.4})$$

Inserting (A.3) and (A.4) into (A.2), rearranging as well as observing the definition of the determinant D , we obtain:

$$\frac{d\pi}{d\tilde{n}} = -\frac{D}{D_{\tilde{n}}}. \quad (\text{A.5})$$

Given $D_{\tilde{n}} > 0$, profits decline in \tilde{n} if and only if $D > 0$. This proves the claim in the main text (see Section 3.3).

A.2 Demand Functions

The inverse of the price elasticity of demand is defined by:

$$\epsilon(X) = \frac{p'(X)X}{p(X)}. \quad (\text{A.6})$$

Differentiating with respect to X implies:

$$\begin{aligned} \frac{d\epsilon}{dX} &= \frac{p'(X)}{p(X)} \left(\frac{p''(X)X}{p'(X)} + 1 - \frac{p'(X)X}{p(X)} \right) \\ &= \frac{p'(X)}{p(X)} (\eta(X) + 1 - \epsilon(X)), \end{aligned} \quad (\text{A.7})$$

where we have used (4) and (A.6). In case of an iso-elastic demand function, $d\epsilon/dX = 0$ holds, which implies $\eta = \epsilon - 1$.

Next, we define $G \equiv \log(X(p))$. Then, we can compute:

$$G' \equiv \frac{dG}{dp} = \frac{X'(p)}{X(p)} < 0, \quad (\text{A.8})$$

$$G'' \equiv \frac{d^2 G}{dp^2} = \left(\frac{X'(p)}{X(p)} \right)^2 \left(\frac{X''(p)X(p)}{X'(p)^2} - 1 \right) \quad (\text{A.9})$$

Using $X'(p) = 1/p'(X(p))$, $X''(p) = -p''(X)X'(p)/(p'(X)^2)$ and (4) yields:

$$G'' = -\left(\frac{X'(p)}{X(p)} \right)^2 (\eta(X) + 1). \quad (\text{A.10})$$

For a log-concave demand function, $G'' \leq 0$ must hold. A direct demand function is hence log-concave if $\eta(X) \geq -1$.

A.3 Efficient Bargaining

Maximizing (10) with respect to x^{eff} and w^{eff} , where the superscript eff indicates the equilibrium outcomes of efficient bargaining, yields:

$$A^{eff} = \alpha p(X^{eff}) + 1 - \alpha - w^{eff} = 0, \quad (\text{A.11})$$

$$B^{eff} = p'(X^{eff})x^{eff} + p(X^{eff}) - 1 = 0. \quad (\text{A.12})$$

Differentiating (A.11), (A.12) and (20) with respect to α yields:

$$\frac{dx^{eff}}{d\alpha} = \underbrace{\frac{p'(X^{eff})(x^{eff})^2}{n^{eff}D^{eff}}}_{>0} \underbrace{A_{\alpha}^{eff}}_{>0} (\eta(X^{eff}) + n^{eff}), \quad (\text{A.13})$$

$$\frac{dn^{eff}}{d\alpha} = - \underbrace{\frac{A_{\alpha}^{eff} p'(X^{eff}) x^{eff}}{D^{eff}}}_{>0} \underbrace{(1 + n^{eff} + \eta(X^{eff}))}_{>0} < 0, \quad (\text{A.14})$$

$$\frac{dX^{eff}}{d\alpha} = - \underbrace{\frac{A_{\alpha}^{eff} p'(X^{eff})(x^{eff})^2}{D^{eff}}}_{>0} < 0. \quad (\text{A.15})$$

Note that $D^{eff} < 0$ holds such that the stability of the equilibrium is guaranteed. Inserting (A.14) and (A.15) into $dV^{eff}/d\alpha$, we can calculate the welfare-effect of an increase in union's bargaining power as:

$$\frac{dV^{eff}}{d\alpha} = - \underbrace{\frac{A_{\alpha}^{eff} u''(X^{eff}) x^{eff}}{D^{eff}}}_{>0} (2w^{eff} x^{eff} - k\eta(X^{eff})), \quad (\text{A.16})$$

which shows that the welfare-enhancing effect of unions requires $\eta(X) > 0$.

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