Profit Sharing and firms' strategies

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March 2016

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Abstract

Profit sharing, with one form or the other, has been in wide use all over the world. Unionization does survive and plays a major role in wage setting in most OECD countries. It is crucial to qualitatively define the interaction between them, under different oligopoly competition. We set up a four stage duopoly game, in order to endogenize both the decision of the unions to merge, and the decision of the firms to introduce a profit sharing scheme. We find that when unions merge, and firms use profit sharing, Bertrand profits are greater than Cournot profits. Under Cournot competition, unions gain the most, and have always incentives to merge; that's not valid in Bertrand competition. Quantities produced (prices), consumer surplus and employment are greater (lower) in Bertrand competition under any scenario.

JEL Classification: **J30; J40; J20**

Keywords: union oligopoly; bargaining; profit sharing;

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†We would like to thanks seminar participants of CRETE 2015, CRESSE 2015 and ASSET 2015 for their useful comments. We would like to thanks Stamatopoulos G., Vlassis M., and Garella P. for their useful insights. Full responsibility for all shortcomings is ours.

1 Introduction

Profit sharing schemes are a type of remuneration scheme, in which part of a worker's salary is based on the profits made by the firm. Profit sharing schemes can be paid in cash, stocks or other forms, and can be paid annually or be kept by the firm, and be given to workers at the form of a pension. In practice, profit sharing is quite complex, and contains a set of different elements (OECD 1995). Nevertheless, profit sharing, with one form or the other, has been in wide use all over the world (Dhillon and Petrakis 2001). A survey of the largest 1250 global corporations (Weeden et al. 1998) found that 33% of them, offered some short of profit sharing schemes to all employees, and another 11% had plans to put in place a broad-based profit sharing scheme.

The objective of this paper is to explore the role of profit sharing in decentralized and central (coordinated) bargaining between firms and unions, and the welfare effects that take place among these different bargaining and contract types. To fulfill this objective, we consider an environment with two workers' unions, and two firms. The firms use the (homogeneous and single quality) labor force supplied by the unions, as the only input to produce a differentiated product, and to compete with it in product market à la Cournot or Bertrand. Using a Leontief-style production function for both firms (constant returns to scale), in the last stage firms also decide for the amount of labor force they will *"buy"* from their respective unions.

In this environment, the choice of horizontal merging (or not) of unions, allows the internalization of an institutional choice often found in labor economics: if a central grand union can delegate better (and produce more welfare) in a bargain over wages, in contrast to multiple firm-specific unions, which delegate in a decentralized fashion. Furthermore, the choice of contract type from firms (fixed wage or profit share), internalizes the choice of the optimum remuneration scheme over different states of unions. All these are backed from a competition stage, in which firms compete over quantities or price, forming a right-to-manage framework, where the amount of labor force used by firms, is a firm-specific choice, but at the same time, the total compensation is a matter of bargain between firm and union.

Our contribution to literature is multi-fold; We highlight the significance of remuneration schemes for the merger incentives in the unions. We have shown that in contrast to literature (Horn and Wolinsky (1988)), in Cournot style competition, it is always op-

timal for unions to merge in stage one, and form a grand union. But, in Bertrand style competition, it is not always optimal for the unions to merge. Applying profit sharing will produce more Bertrand profits than Cournot profits. Product differentiation can create significant wage fluctuations above or below unemployment benefit, no matter what remuneration scheme is in force. This wage fluctuation can create incentives for firms to introduce or toavoid profit sharing systems.

We have chosen the so called "right to manage" delegation model, in which wages are set via bargain between firms and unions, while the output and employment is set via competition of firms in an oligopoly setting. We believe that this mathematical modeling is more realistic than a monopoly wage setting from unions. Horn and Wolinsky (1988) criticize those who simply assume that unions are setting wages unilaterally, rather than participating in some bargain process with the firm.

The rest of the paper is as follows: second section makes a literature review; third section describes the model; fourth section makes the equilibrium analysis, solves the game and shows the results; fifth section states the results of this research; sixth section makes some conclusions and suggest further research. Finally, follows an appendix, and references.

2 Literature Review

Profit sharing schemes gained a lot of attention due to Weitzman's work. Weitzman (1983, 1984, 1985, 1987), a pioneer of profit sharing schemes, states that profit sharing makes the cost of labor completely flexible and gives firms the incentive to hire as many workers as are willing to take jobs. This leads to an economy of profit sharing firms with lower levels of unemployment and greater macroeconomic stability.

Literature on the motive of introduction of profit sharing (OECD 1995) suggests that several groups of variables such as: firm size, internal organizational structure, industrial relations, labor and legal institutions, and the external environment, affects the introduction of profit sharing.

Sesil, Kroumova, Blasi et al. (2002), studied 229 US major "New Technology" Firms (pharmaceuticals, semiconductors, software, telecommunications & high-technology manufacturing), all offering broad-based profit sharing plans. Using multivariate analysis with

panel data they found that, in contrast with their non-profit sharing counterparts, profit sharing firms' productivity increased 4%, total shareholder returns increase by 2%, and profit levels jump by about 14%. These gains are after dilution effect is taken into account.

Arriving at similar results, Kruse (1992), uses data from almost 3000 US firms, from 1971 to 1985, and shows that the introduction of a profit sharing scheme is (statistically significant) associated with a productivity increase of 2.8% to 3.5% for manufacturing firms, and 2.5% to 4.2% for non-manufacturing firms. In a different country, Germany, Kraft and Ugarkovic (2005), using data from more than 2000 German firms from 1998 to 2002, show that the introduction of a profit sharing system improves profitability.

Petrakis and Vlassis (2004) have proven that technological asymmetries among same sector firms may be one driving force behind the variation in remuneration bargain. This plethora of factors makes the introduction of a profit sharing scheme a difficult matter to assess and account, and thus to introduce. Some researchers (like Kruse 1992) suggest that only the most profitable and most productive firms introduce profit sharing schemes, in order to align firm and workers interests, and through this alignment to reach new, higher levels of profitability and market share.

Bensaïd and Gary-Bobo (1991) are the first to view profit sharing schemes as a strategic commitment, not just as an internal incentive system. They prove that the adoption of a profit sharing scheme by a firm and its union shifts market equilibrium and is a Pareto improvement for both parties. Furthermore, they have shown that the choice of a profit sharing scheme by each firm is an equilibrium, and in the case of Cournot competition, the game has the structure of the Prisoners' Dilemma. Last, they argue that profit sharing schemes seems to be credible in short and middle run, but not in the long run, because of institutional and legal influences in contracts.

Sorensen (1992) analyzes when it is optimal for firms to introduce a profit sharing scheme. He sets a three stage game, in which two firms producing a single type homogeneous product, and two unions, one for each firm, as a single labor supplier for that firm. In stage one, firms decide the remuneration system (fixed wage versus profit share), in stage two there is a determination of wages and profit share via bargaining among firms and unions, and in stage three there is a Cournot style competition among firms, which determines output, prices, and employment levels.

Takami and Nakamura (2012), who tried to endogenize the order of moves of unions

choosing a remuneration scheme (in a monopoly union framework). In their paper, they use a 'classical' duopoly model, with firms compete in quantities, and the monopoly union assumption, i.e. unions determine wages while firms determine output and employment. Between the two firms, only one firm applies profit sharing scheme. Their model consists of three stages; in stage 1 the two unions of the firms decide whether to move simultaneously (to determine wages) or in a Stackelberg way (leader-follower). In stage 2, the two unions have seen the outcome of stage 1, and they maximize their remuneration scheme. In stage 3 the two firms compete Cournot-style over quantities, determining output and employment. They end up with the proposition that the only Stackelberg equilibrium that emerges in stage 1 is one union to move first and the other second. It is not an equilibrium to move simultaneously, and it is beneficial for the union that receives more than 75% of firm's profits as a profit share, while for profit shares less than 75% it is Stackelberg equilibrium to move first the union with the fixed base wage.

Fung (1989a) examines profit sharing in three different competition regimes: monopoly, perfect competition and Cournot oligopoly. He found that profit sharing can lower wages in all three different types of competition. This will not lower rents extracted from the union, because there will be a positive profit share percentage taken as well. Also, states that the joint rents of the union and the firm will increase with profit sharing. Finally, he shows that, under some restrictions, union's wage demand will be smaller under profit sharing than under fixed wage regime.

In an article related with the previous, Fung (1989b) sets up a two-stage duopoly game in order to explore the effects of profit sharing in unemployment rates. In first stage unions set wages as Bertrand duopolists (maximizing the economic rent extracted from labor), while in the second stage firms compete à la Cournot. Under the assumptions of his model, Fung finds out that the effects of profit sharing can be decomposed in two parts; first, an industry wide effect in which profit sharing causes a wage reduction, which leads to a lower product price and thus in bigger total quantities produced. This causes employment to rise. Second, a firm specific effect in which firms using profit sharing schemes gain a bigger market share, and have higher employment with lower wage rates. These beneficial effects give to the profit sharing firm a strategic advantage over the non profit sharing counterparts. An argument in this paper is that because in many Japanese industry sectors, profit sharing is common, this might be a possible explanation for the

low unemployment rates and economy's success in this country.

Stewart (1989) proves that while for a monopolist, the introduction of a profit sharing scheme it is not a Pareto improvement, for a firm in an oligopolistic sector there are incentives for such an introduction. He sets up a two stage n-opoly game, using standard assumptions. In first stage, one of the homogeneous n-firms commit to profit sharing scheme, while in second stage all n-firms compete à la Cournot. Holding workers' income constant (subsidizing equally a part of fixed wage with a profit share), there is an increase in firm's profits. This creates incentives to more firms entering a profit sharing scheme, even if entering all n-firms in profit sharing schemes creates profits below the level obtained under the wage system.

Goeddeke (2010) analyzes the emergence of profit sharing schemes, when wages are negotiated in two extremes: a bilateral monopoly way or decentralized way. She is based upon Sorensen (1992) model, but it extends it, by using an $n-opoly$ structure. She founds that in $n-opoly$, under decentralized bargains, firms have incentives to replace fixed base wage schemes with profit sharing schemes. But when the majority of firms (depends on magnitude of n) adopts profit sharing schemes, it is in the collective interest of both firms and unions to move back to fixed base wages. Also, she shows that the existence of profit sharing scheme creates incentives for firms to bargain independently, and not centrally.

Negotiations between firm and union over the profit share are not common in all industrial countries. Poole (1988), surveys British firms, and shows that the decision about the level (percentage) of profit shares made by the managers in 97.7% of the cases studied, while only 0.7% was made under bargain. This assumption is behind the research made by Pemberton (1991); he assumes that the very existence and extent of profit sharing cannot be a process of bargain between firm and union, but in real world is part of firm's profit maximization strategy. He proves that in the absence of product subsidies, profit sharing schemes will not be profitable for the firm, but if firms' facing heterogeneous demand, and have different technologies, there are incentives for firms to apply a profit share.

In France, since 1967, there is a legal obligation for firms employing more than 50 workers, to apply some short of profit share, calculated on a basis of predetermined profit sharing formula. In 2011 this legal obligation was reinforced and became wider, requiring firms to also pay a "social" dividend, if their net profits were higher than last year.

In a recent study (Fang, 2016) there has been a review of empirical studies showing that profit sharing is beneficial for employees through higher earnings and employment stability, and at the same time is beneficial for employers through higher workspace productivity, and thus higher firm profitability. Profit sharing reduces supervision costs and is against shirking behavior, while at the same time creates a bigger flexibility in wages. The author concludes that labor unions may want to work collaboratively with management to enhance the mutual benefits of profit sharing.

A short literature review over unionization could reveal a great variation: unionization is still strong in some countries, while in other is not. Union density[1] in Visser (2006) and OECD Statistics online[2], shows that during the first decade of 2000, in some countries (e.g. Iceland, Belgium, Finland, Denmark, Norway, Sweden) unionization is way above 50%, while in some other countries (e.g. France, Korea, USA, Japan, Spain, Turkey, Netherlands) unionization is below 20%. Many countries lie in between 20% and 50% (Canada, Italy, Ireland, Greece, Austria, Luxembourg). These charts shows a great variation in unionization, but nevertheless unionization is in effect and with stable percentages during 2000's.

Labor market institutions show high variability as of the level of wage negotiations. In United States, United Kingdom, Australia, Canada, and Japan, wages are usually bargained on a decentralized firm level between unions and firms. In contrast, in Germany, Austria, Belgium, Greece and Scandinavian countries, bargain take place either on an sector-wide level or even at a national level (Petrakis and Vlassis 2004, and Goeddeke 2010).

In order to clarify what centralization and what coordination is, we have to refer to Ortigueira (2011). He states that: *"Centralization describes the locus of the formal structure of wage bargaining. Typically, three broad levels are distinguished: national, industry and firm-level bargaining. Coordination refers instead to the degree of consensus between bargaining partners, or in other words, to the degree of intentional harmonization in the wage-setting process. Coordination can thus be the result of communication and guidance between bargaining units without calling for the centralization of negotiations".*

[1]Ratio of employed union members to all employed civilians.

[2]OECD Trade Union Density charts could be found at https://stats.oecd.org

3 The model

3.1 Market structure and contract types

We solve a duopoly, with two firms competing on quantities (Cournot style) or prices (Bertrand style). Each firm has either a single, dedicated, separate union to bargain with (decentralized version), or both firms face the same grand union of workers (central coordinated version). Firms and union(s) bargain over a remuneration scheme, which could be a fixed wage scheme, or a profit sharing scheme. Timing if the game follows in a separate subsection.

We assume a two-factor Leontief technology, were firms produce under constant returns to scale, and the amount of capital K_i is fixed in the short run, and large enough not to induce zero marginal product of labor L_i, so: $q_i = L_i$, $i = 1, 2$. Each firm produces a single type of a differentiated good. The inverse demand function has the form: $P_i = \alpha - q_i - \gamma * q_j$, $i = 1, 2$, where $\gamma \in (0, 1)$ measures the differentiation between the two products [3].

We use the symbol $Q = q_i + q_j$ for the total market quantity sold by firms. Because of the assumption $q_i = L_i$, total market quantity Q equals total employment $L = L_i + L_j$. We assume that market is big enough (α is big enough) to consume all quantity produced and sold, and thus no stock is kept by the firms. We assume a constant marginal cost per product, being the sum of a (non-labor) cost: average cost = marginal cost = $c > 0$ per quantity q_i produced, and a labor cost (wage rate) w_i per unit of labor $L_i = q_i$. Firms assumed to have no other costs or income, so they have a (*gross* [4]) profit function equal to: $\pi_i = (\alpha - c - w_i - q_i - \gamma q_j)q_i$, $i = 1, 2$ & $i \neq j$.

Firm's decision makers are assumed to be risk-neutral, thus their (*net*) profits, which are their utility functions, can be modeled by the following: a) with profit share $\pi_i = (1 - a_i) * \Pi_i, i = 1, 2$, and b) without profit share: $\pi_i = \Pi_i, i = 1, 2$.

Union is also assumed to be risk-neutral, thus their utility function can be modeled as following: a) with profit share $UW_i^P = [((w_i - w_0) + \frac{a_i \Pi_i}{L_i})L_i] = [(w_i - w_0)q_i + a_i \Pi_i]$, and

[3] As in Singh and Vives (1984), this demand function comes from a quadratic and strictly concave utility function of a continuous of representative consumers.

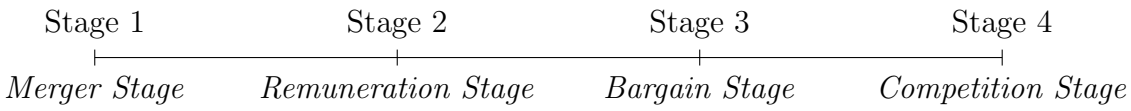
[4] For firms we use $\Pi =$ for gross profits i.e. profits before profit share (if applicable), and $\pi =:$ net profits i.e. profits after profits share deduction(if applicable). In case of using a fixed base wage as remuneration scheme, then gross and net profits are the same $\pi = \Pi$. For unions we use UW: union's welfare, which is calculated always after the addition of profit share percentage.

b) without profit share $UW_i^W = [(w_i - w_0)L_i = (w_i - w_0)q_i]$ where w_i is the fixed base wage, and $w_0 \geq 0$ is the (exogenous, and assumed constant) unemployment benefit.

We use the union's utility function of Pemberton (1988), who shows that a rent-maximizing union is equivalent to a 'managerial union' with union leaders who are interested in employment, and union members who are interested in excess wages (i.e. the amount $(w_i - w_0)$).

3.2 Sequence of events

Game timing reflects the idea that long run decisions, such as the forming of grand coalitions of workers, may have considerable strategic effects in short run decisions, such as the employment decision made by a firm. This timing captures the idea that some variables (such as employment) are easier to change and are greatly affected by other variables, which may be much more difficult to alter. This timing is standard in literature, and allows us to capture the contract forms' commitment value.



Stage 1; *The merger stage.* This is a union's decision stage. The unions decide whether they will merge or not horizontally, forming a grand union of workers. We use two different types of bargain: central coordinated and decentralized.

Stage 2; *The remuneration scheme stage.* This is a firm's decision stage. Firms decides whether to offer a fixed base wage, or a profit sharing scheme made from a fixed wage **plus** a profit share percentage. This is a take it or leave it offer. It is a right-to-manage bargain framework, where firms decide over employment, but the bargain between firms and unions determine the compensation. In case of deciding to implement a fixed wage remuneration scheme, they bargain (in stage 3) with their union over a fixed base wage w_i. In case of deciding to implement a profit sharing scheme, they bargain (in stage 3) with their union over both a fixed base wage w_i **and** a profit sharing percentage a_i, as a percentage over firm's i profits. There are four possible outcomes: a)both firms implement a profit sharing scheme, b)both firms implement fixed base wage schemes, and c) & d)a double symmetrical outcome were one firm applies a profit sharing scheme, while the other applies a fixed base wage scheme.

Stage 3; *The bargaining stage.* In stage 3, two separate unions or one grand union from one side, and two firms on the other side, bargain over the remuneration scheme. Union(s) has bargain power equal to $\beta \in (0,1)$ while firm(s) has bargain power equal to $1-\beta$. We assume that unions engage in wage bargaining on behalf of their (same skill/homogeneous) affiliated workers, firms and their matching unions negotiate simultaneously, and at the end will reach an agreement. The main goal of solving this stage is to find, under all possible remuneration schemes and under all possible forms of centralized/decentralized bargain, Nash equilibria values of wages w_i^* and of profit sharing (if applicable) a_i^* for $i = 1, 2$, as functions of exogenous variables only. Exogenous variables, in our model are: non labor cost c, inverse demand function parameter α, differentiation factor γ, unemployment benefit w_0 and bargain power β.

One spot that has to be highlighted is that we model the bargain between one grand union and two separate firms as to be done simultaneously and separately. This assumption captures the fact that each pair of negotiations (there are two pairs: grand union and firm i, and grand union and firm j) has incentives to behave opportunistically and to reach a mutually favorable agreement that enhances firm's competitive position in expense to the other rival firm.

Stage 4; *The competition stage.* This stage includes the so called manager's right to manage. The set up of our game is based on the assumption that unions bargain with firms over wages, but the level of employment is a privilege of firm's management. Employment equals quantity ($L_i = q_i$), so it is determined from competition. Competition stage comes in two flavors: Cournot style competition, where firms maximize profits over quantity, and Bertrand style competition, where firms maximize profits over price.

4 Equilibrium Analysis

4.1 Product market competition

In the last stage of the game, firms engage in quantity (price) competition. They have profits of the form: $\Pi_i = P_i * q_i - (c + w_i) * q_i$, where $P_i = \alpha - q_i - \gamma * q_j$. Firms maximize their profits over the (same) strategic variable (quantity in Cournot competition, or price in Bertrand competition), getting maximized equilibrium quantities and profits q_i^k, Π_i^k respectively. Superscript "k" denotes either Q=quantity or P=price competition.

Note that in quantity competition: $\Pi_i^Q = (q_i^Q)^2 = (\frac{2(\alpha-c-w_j)-\gamma(\alpha-c-w_i)}{4-\gamma^2})^2$, while in price competition: $\Pi_i^P = (1-\gamma^2)(q_i^P)^2 = (1-\gamma^2)(\frac{(2-\gamma^2)(\alpha-c-w_j)-\gamma(\alpha-c-w_i)}{\gamma^4-5\gamma^2+4})^2$.

4.2 Decentralized bargain outcome

4.2.1 Fixed wage schemes

Unions have decided to bargain separately, while firms have decided to give fixed wage. Firms and unions bargain over the following Nash bargain product: $NBP_i^{kDF} = [\Pi_i^k]^{1-\beta} * [(w_i - w_0) * q_i^k]^\beta$, where the superscript "kDF" denotes "k" either Q=quantity or P=price competition, and D=Decentralized bargains, and F=Fixed wage. Using standard methodology, we maximize NBP_i^{kDF} over wage w_i, in order to find the equilibrium variables stated in the Appendix.

Lemma 1. *In decentralized bargains with fixed wage, and under any price of β, γ, price (quantity) is higher in Cournot (Bertrand) style of competition. Firm's profits are higher in Cournot style competition, while union's welfare is higher in Cournot for:* $\beta < \frac{2(4(\gamma^2-2)-\frac{\sqrt{2}(\gamma^2-4)\sqrt{\gamma^4-3\gamma^2+2}}{\gamma})}{(\gamma-1)\gamma(\gamma+4)-4}$.

4.2.2 Profit sharing schemes

Unions have decided to bargain separately, while firms have decided to give profit sharing schemes. Firms and unions bargain over the following Nash bargain product: $NBP_i^{kDP} = [(1-a_i) * \Pi_i^Q]^{1-\beta} * [(w_i - w_0) * q_i^k + a_i * \Pi_i^k]^\beta$, where the superscript "kDP" denotes either Q=quantity or P=price competition, and D=Decentralized bargains, and P=Profit sharing. We maximize NBP_i^{kDP} over profit share a_i, while we maximize joint profits [5]: $JP_i^{kDP} = \Pi_i^k + (w_i - w_0) * q_i^k$ over wage w_i, in order to find the equilibrium variables stated in the Appendix.

Lemma 2. *In decentralized bargains with profit sharing, and under any price of β, γ, price (quantity) is higher in Cournot (Bertrand) style of competition. Firm's profits, and union welfare are higher in Cournot style competition.*

[5] Reasoning behind this methodology is quite clear, similar to two-part tariff instruments; we use profit share a_i to maximize the quantity over which two parties bargain NBP_i^{kDP}, and we use wage w_i to share joint profits JP_i^{kDP} between two parties.

4.3 Central (coordinated) bargain outcome

In decentralized bargains, if a firm-union pair fails to reach an agreement over wages, then they both get a zero profit. Things become different in central bargains. If a grand common union of workers fail to reach an agreement with one firm, then there is always the other firm to bargain with. This creates a so called "outside option" in favor of the grand union. While firm still gets zero profits if an agreement is not set, a grand union has a minimum "security net" of profits, which holds it way above zero.

In Horn and Wolinsky (1988), we encounter a report over different types of outside options. In their paper, they use a "contingent" outside option: if central grand union fails to bargain with one firm, then the other firm will not notice that, and thus this pair will bargain in a duopoly style. We, in our paper, choose to use a "non-contingent" outside option: if central grand union fails to bargain with one firm, then the other firm will notice that, and thus this last pair will bargain in a bilateral monopoly style. We choose this type of outside option because we feel it is more reasonable to suppose that the failure in negotiations between the first pair (grand union and firm i) will be noticed by the other firm j, which will adjust its behavior from duopolist to monopolist, knowing that it is the last and only chance the grand union has to "sell" its workforce.

Having these in mind, we model outside option as: $OutOpt_i^F = (w_j - w_0) * q_j^{Mon}$ for fixed wage remuneration schemes, and $OutOpt_i^P = (w_j - w_0) * q_j^{Mon} + a_j * \Pi_j^{Mon}$ for profit sharing schemes. Notice that in monopoly with linear demand function, quantities and profits equals to: $q_i^{Mon} = \frac{1}{2}(\alpha - c - w_i)$, and $\Pi_i^{Mon} = (q_i^{Mon})^2$.

4.3.1 Fixed wage schemes

Unions have decided merge and to bargain as one grand union, while firms have decided to give fixed wage. Firms and grand union bargain over the following Nash bargain product: $NBP_i^{kCF} = [\Pi_i^Q]^{1-\beta} * [(w_i - w_0) * q_i^k + (w_j - w_0) * q_j^k - (w_j - w_0) * q_j^{Mon}]^\beta$, where the superscript "kCF" denotes: "k" either Q=quantity or P=price competition, C=Central coordinated bargains, and F=Fixed wage. Following similar methodology as in decentralized version, we maximize NBP_i^{kCF} over wage w_i, in order to find the equilibrium variables stated in the Appendix.

4.3.2 Profit sharing schemes

Unions have decided merge and to bargain as one grand union, while firms have decided to give profit sharing schemes. Firms and grand union bargain over the following Nash bargain product: $NBP_i^{kCP} = [(1-a_i) * \Pi_i^k]^{1-\beta} * [(w_i - w_0) * q_i^k + (w_j - w_0) * q_j^k + a_i * \Pi_i^k + a_j * \Pi_j^k - (w_j - w_0) * q_j^{Mon} - a_j * \Pi_j^{Mon}]^{\beta}$, where the superscript "kCP" denotes: "k" either Q=quantity or P=price competition, C=Central coordinated bargains, and P=Profit sharing scheme. As in decentralized version, we maximize NBP_i^{kCP} over profit share a_i, while we maximize (excess)[6] joint profits: $EJP_i^{kCP} = \Pi_i^k + (w_i - w_0) * q_i^k + (w_j - w_0) * q_j^k + a_j * \Pi_j^k - (w_j - w_0) * q_j^{Mon} - a_j * \Pi_j^{Mon}$ over wage w_i, in order to find the equilibrium variables stated in the Appendix.

Lemma 3. *In order for the grand union, under Bertrand competition and profit sharing, to have positive utility, the following constrain must apply:* $\frac{(\gamma-2)\gamma^3(\gamma+1)}{\gamma(\gamma+1)((\gamma-2)\gamma^2+4)-8} < \beta$.

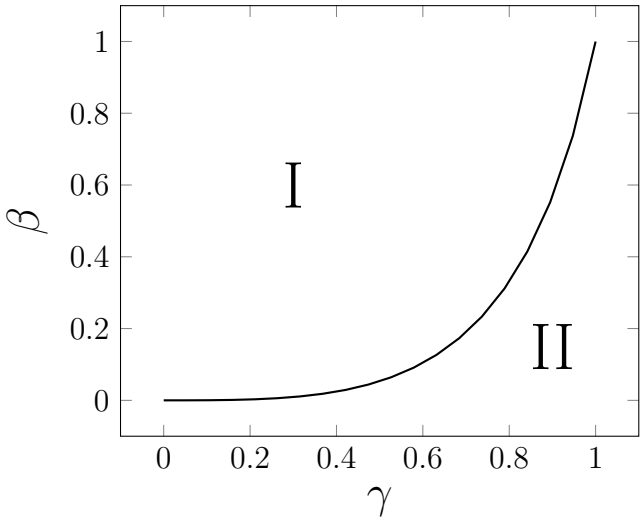


Figure 1: Grand union's incentives to bargain under Bertrand competition and profit sharing.

This Lemma comes from a straightforward necessary assumption that if a union has to face negative utility, then it will leave the bargain negotiations with the respective firm. For the sake of game continuity, this Lemma must hold under any version or regime of

[6]We use the word "excess" in joint profits only here, in central coordinated version, to underline the fact that the grand union has a minimum level of gains (the outside option), and bargains for gains in excess of that level.

the game. Else, spurious propositions may occur. Grand union will find it profitable to bargain only for β, γ found in area I of figure 1. For β, γ found in area II of figure 1, grand union will suffer from negative profits, which is something unacceptable.

Lemma 4. *Under central coordinated bargains, Bertrand competition, and profit sharing, for a price to be rationale, the following inequality must apply:* $\gamma(3(\beta-1)\gamma^2+(6\beta-2)\gamma-8\beta+12) < 3(\beta-1)\gamma^4+8$.

This Lemma comes from the fact that the price of a product can not be higher than the biggest price a consumer is willing to pay for this product (the so called "choke" price α in demand function), according to its utility function, and at the same time can not be lower than the cost a firm has to endure in order to produce this unit of product (non-labor plus labor cost per unit of product: $c + w_0$).

5 Results

After solving the proposed game by using backwards induction and sub perfect Nash equilibrium concepts, some interesting results come by straightforward comparing expressions stated in the Appendix.

It is proven several times in literature (e.g. Sorensen 1992, Goeddeke 2010 et al.) that when both firm (or n-firms in Goeddeke 2010) have fixed base wages as their remuneration scheme, the introduction of profit sharing from one firm creates the so called prisoner's dilemma situation. This leads all firms to introduce profit sharing; else they will suffer from low profitability and minimum market shares.

So, a mix situation with one (or some in n-opoly) firms using fixed wage, while the other (or some other in n-opoly) uses profit sharing is not an equilibrium. Possible deviations could be examined directly between the two situations: all firms using fixed wage versus all firms using profit sharing. This is something we have also encounter in our research for both price and quantity competition. Thus, we will not prove all possible deviations in mix situations (e.g. one firm uses fixed wage while the other uses profit sharing), and we will go directly to compare the two remuneration schemes. Nevertheless, exact expressions of quantities, prices, wages, profits, et.c. for this so called mix contract type situation are available upon request.

Another important part of the analysis is the fact that *net* profits are bigger under fixed wage regime than profit sharing. This seems to be the case under Cournot competition with decentralized bargains or central coordinated bargains. Of course, gross profits (before the deduction of profit share percentage given to workers) are higher in profit sharing, but if we subtract profit share percentage, firms are worse off than under fixed wage regime. Profit sharing is maximizing the joint profits (or joint rents) created by the pair firm-union, but this does not mean that the firm will receive more profits now than in the previous fixed wage regime.

The new think we have to offer to literature, is what profits do between remuneration schemes, and under Bertrand style competition.

Proposition 5.1. *In Bertrand competition, under decentralized bargains, firm's (net) profits under profit sharing are higher than firm's net profits under fixed wage when* $2\beta < \gamma^2$ *(Ineq.1). Under central coordinated bargains the same holds for:* $\frac{2(\gamma^2+\gamma-2)}{\gamma^4-\gamma^3-2\gamma+4} + 1 < \beta$ *(Ineq.2).*

Proofs of these inequalities are a straightforward comparison of the profit functions stated in the Appendix.

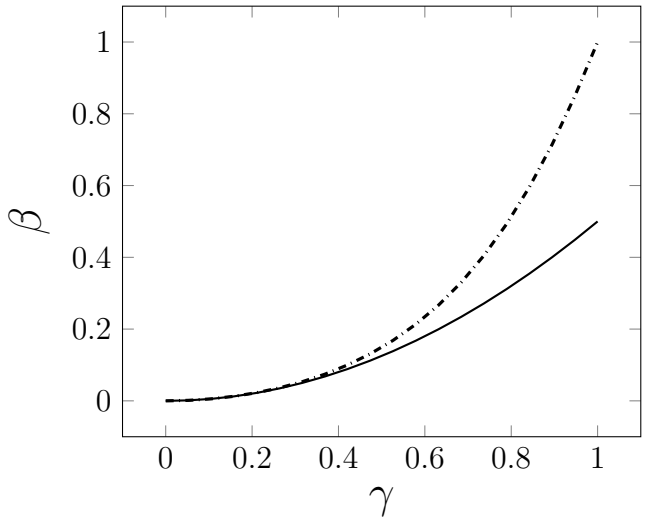


Figure 2: Firm's moving from fixed wage to profit sharing

In figure 2, dash-dotted line represents inequality *Ineq.1*, while the concrete thick line represents inequality *Ineq.2*. In the area right to Ineq.1 (Ineq.2) it is profitable for a firm to introduce a profit sharing scheme, while bargain decentralized fashion (centrally). It

is easy to see that when a firm is facing a grand union, it has a smaller area of β's and γ's to move from fixed wage to profit sharing schemes.

Moving to a different comparison, it is useful to compare profits under profit sharing, and between different competition styles.

Proposition 5.2. *In Central coordinated case, and under profit sharing, firm's profits are greater in Bertrand competition than Cournot competition:* $\pi^{PCP} > \pi^{QCP}$*, for any* $\beta, \gamma \in (0, 1)$.

After Singh and Vives (1984), it is generally accepted that quantity competition is less fierce, and thus it generates more profits, than price competition. It is always interesting and useful to spot occasions in which this general rule does not apply. This case seems to be one of these rare exceptions. For any $\beta, \gamma \in (0, 1)$ a firm using profit sharing and facing a grand union, can gain more profits under Bertrand competition, rather than Cournot competition.

Proposition 5.3. *Both in Central coordinated and in Decentralized version, and under profit sharing, union(s) gain more in Cournot competition, rather than Bertrand competition.*

One union's extra gain in quantity competition is that under our assumption that employment equals quantity [7], maximizing profits over quantity, basically it is maximized over employment.

Proofs derive straightforward, with simple algebraic manipulations, from comparing the expressions stated in Appendix A.

Proposition 5.4. *In Cournot competition, unions have always incentives to merge. In Bertrand competition, it is not always optimal for the unions to merge.*

Trying to endogenize the decision of unions to bargain separate (decentralized) or to merge and form a grand union (bargain centrally), we encounter major differences between quantity and price competition.

In Cournot competition, the sum of gains for the two separate unions in decentralized version is always less than the gains of the grand union of the central coordinated version. This gives incentives to unions to merge always.

[7] Assuming a more general affine relationship between employment and quantity does not alter this qualitative result.

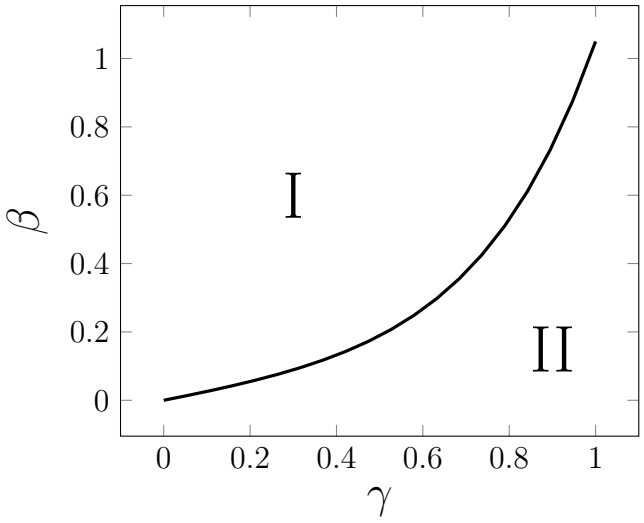


Figure 3: Union's merging incentives areas.

In Bertrand Competition, that's not the case. There are regions of β and γ where the two separate unions have incentives (higher gains) to merge (area marked with an **I** in figure 3), mostly for high values of β, and there are regions where the two separate unions do not have incentives (higher gains) to merge (area marked with an **II** in figure 3), mostly for high values of γ.

Proposition 5.5. *Under profit sharing, and under a grand union, in Cournot competition, for* $\beta > \frac{\gamma(\gamma(\gamma+4)-4)}{(\gamma^2(\gamma+4)-8)}$ *fixed wages are below unemployment benefit. In Bertrand competition, the same holds for* $\beta < \frac{\gamma(\gamma((\gamma-3\gamma+8)-4)}{(\gamma-2)(\gamma((\gamma-1)\gamma+2)-4)}$.

It is known to literature (Goeddeke 2010) that under profit sharing schemes, wages are below unemployment benefit in decentralized bargain, and above unemployment benefit in central coordinated bargain. Unfortunately, these findings are for homogeneous products, i.e. $\gamma = 1$. When product differentiation emerges, wages does not have a stable performance above or below unemployment benefit. Total worker's compensation is higher than unemployment benefit, due to profit share. With this proposition, we contrast this belief. The fact that under central coordinated bargains, wages are above unemployment benefit has to do with product differentiation factor and bargain power.

Proposition 5.6. *Prices (Quantities & Employment) are higher (lower) in Cournot competition, under profit sharing, and under either decentralized or central coordinated bargains. Consumer surplus is higher in Bertrand competition.*

This proposition states that under Bertrand competition, quantities (which equals employment) are higher and prices are lower, comparing to Cournot competition. Thus, consumer surplus ($= \frac{1}{2}Q^2$) is higher in Bertrand competition.

6 Conclusions

Our main goals where to examine profit sharing in a context of different types of oligopoly bargain, and different unions regimes.

We have shown that, in contrast to literature, Bertrand competition can produce higher profits than Cournot competition, in the case of a common union.

We have shown that in contrast to Cournot style competition, in Bertrand style competition, firms can be more profitable (net profits, after the deduction of profit share percentage) in profit sharing than in fixed wage regime.

In contrast with the rest literature (which assumes homogeneous products), we have shown that wages fluctuate above or below unemployment benefit, based on a (β, γ)-inequality.

Furthermore, under Bertrand competition, unions are not always better off if they merge. This depends on their bargain power, and product differentiation.

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8 Appendix A, Table of Results

Variables	Dec.W-W	Dec.PS-PS	Centr.W-W	Centr.PS-PS
		Cournot		
Quantity	$\frac{2(\beta-2)\tilde{a}}{(\gamma+2)(\beta\gamma-4)}$	$\frac{2\tilde{a}}{(2-\gamma)\gamma+4}$	$\frac{(2-\beta)\tilde{a}}{2(\gamma+2)}$	$\frac{(2-\gamma)((\beta-1)\gamma^2+4)\tilde{a}}{16-2\gamma((\gamma+2)((\beta-1)\gamma^2-2\beta)+6\gamma)}$
Price	$\alpha-\frac{2(2-\beta)(1+\gamma)}{(2+\gamma)(4-\beta\gamma)}*\tilde{a}$	$\alpha-\frac{2(1+\gamma)*\tilde{a}}{(2-\gamma)\gamma+4}$	$\alpha-\frac{(2-\beta)(1+\gamma)\tilde{a}}{2(2+\gamma)}$	$\alpha-\frac{(2-\gamma)(\gamma+1)((\beta-1)\gamma^2+4)\tilde{a}}{16-2\gamma((\gamma+2)((\beta-1)\gamma^2-2\beta)+6\gamma)}$
Wage	$w_0+\frac{\beta(2-\gamma)}{4-\beta\gamma}*\tilde{a}$	$w_0-\frac{\gamma^2\tilde{a}}{4+(2-\gamma)\gamma}$	$w_0+\frac{1}{2}\beta\tilde{a}$	$w_0+\frac{\gamma(\gamma(\gamma(\gamma+4)-4)-\beta(\gamma^2(\gamma+4)-8))*\tilde{a}}{2\gamma((\gamma+2)((\beta-1)\gamma^2-2\beta)+6\gamma)-16}$
Profit Sharing	N/A	$\beta-\frac{1}{2}(\beta-1)\gamma^2$	N/A	$\frac{4(\beta+2)}{(\beta-1)\gamma^2+4}-2$
Profits	$\frac{4(\beta-2)^2\tilde{a}^2}{(\gamma+2)^2(\beta\gamma-4)^2}$	$\frac{2(\beta-1)(\gamma^2-2)\tilde{a}^2}{((\gamma-2)\gamma-4)^2}$	$\frac{(\beta-2)^2\tilde{a}^2}{4(\gamma+2)^2}$	$\frac{(\beta-1)(\gamma-2)^2(3\gamma^2-4)((\beta-1)\gamma^2+4)\tilde{a}^2}{4(\gamma((\gamma+2)((\beta-1)\gamma^2-2\beta)+6\gamma)-8)^2}$
Consumer's Surplus	$\frac{8(\beta-2)^2\tilde{a}^2}{(\gamma+2)^2(\beta\gamma-4)^2}$	$\frac{8\tilde{a}^2}{((\gamma-2)\gamma-4)^2}$	$\frac{(\beta-2)^2\tilde{a}^2}{2(\gamma+2)^2}$	$\frac{(\gamma-2)^2((\beta-1)\gamma^2+4)^2\tilde{a}^2}{2(\gamma((\gamma+2)((\beta-1)\gamma^2-2\beta)+6\gamma)-8)^2}$
Union's Welfare	$\frac{2(\beta-2)\beta(\gamma-2)\tilde{a}^2}{(\gamma+2)(\beta\gamma-4)^2}$	$\frac{2\beta(2-\gamma^2)\tilde{a}^2}{((\gamma-2)\gamma-4)^2}$	$\frac{(2-\beta)\beta\tilde{a}^2}{2(\gamma+2)}$	$\frac{(\gamma-2)((\beta-1)\gamma^2+4)(\beta(\gamma(\gamma(\gamma+2)+4)-4)-8)-\gamma^3(\gamma+2))\tilde{a}^2}{2(\gamma((\gamma+2)((\beta-1)\gamma^2-2\beta)+6\gamma)-8)^2}$
		Bertrand		
Quantity	$\frac{(2-\beta)(2-\gamma^2)\tilde{a}}{(2-\gamma)(\gamma+1)(4-\gamma(\beta+2\gamma))}$	$\frac{(2-\gamma^2)\tilde{a}}{(\gamma+1)(4-\gamma(\gamma+2))}$	$\frac{(\beta((\gamma-1)^2\gamma(\gamma+1)-2)-\gamma^4+\gamma^3-2\gamma+4)\tilde{a}}{(\gamma-2)(\gamma+1)(\gamma(\gamma+1)((\beta-1)(\gamma-2)\gamma-2)+4)}$	$\frac{(\gamma(\gamma(\beta((\gamma-5)\gamma+2)-(\gamma-3)(\gamma-2))-4)+8)\tilde{a}}{4(\gamma^2-1)(\beta(\gamma-2)(\gamma+1)\gamma-\gamma^3+\gamma^2-4)}$
Price	$\alpha-\frac{(2-\beta)(2-\gamma^2)*\tilde{a}}{(2-\gamma)(4-\gamma(\beta+2\gamma))}$	$\alpha-\frac{(2-\gamma^2)\tilde{a}}{4-\gamma(\gamma+2)}$	$\alpha-\frac{(\beta((\gamma-1)^2\gamma(\gamma+1)-2)-\gamma^4+\gamma^3-2\gamma+4)\tilde{a}}{(2-\gamma)(\gamma(\gamma+1)((\beta-1)(\gamma-2)\gamma-2)+4)}$	$\alpha-\frac{(\gamma(\gamma(\beta((\gamma-5)\gamma+2)-(\gamma-3)(\gamma-2))-4)+8)*\tilde{a}}{4(\gamma-1)(\beta(\gamma-2)(\gamma+1)\gamma-\gamma^3+\gamma^2-4)}$
Wage	$w_0+\frac{\beta(2-\gamma^2-\gamma)}{4-\gamma(\beta+2\gamma)}$	$w_0+\frac{(1-\gamma)\gamma^2\tilde{a}}{4-\gamma(\gamma+2)}$	$w_0+\frac{\beta(2-\gamma^2-\gamma)*\tilde{a}}{\gamma(\gamma+1)((\beta-1)(\gamma-2)\gamma-2)+4}$	$w_0+\frac{\gamma(\beta(\gamma-2)(\gamma((\gamma-1)\gamma+2)-4)-\gamma(\gamma((\gamma-3)\gamma+8)-4))*\tilde{a}}{4(\gamma-1)(\beta(\gamma-2)(\gamma+1)\gamma-\gamma^3+\gamma^2-4)}$
Profit Sharing	N/A	$\frac{2\beta-\gamma^2}{2-\gamma^2}$	N/A	$\frac{2\beta(\gamma^4-\gamma^3-2\gamma+4)-2\gamma^2((\gamma-1)\gamma+2)}{\gamma(\gamma(\beta((\gamma-5)\gamma+2)-(\gamma-3)(\gamma-2))-4)+8}$
Profits	$\frac{(\beta-2)^2(1-\gamma)(\gamma^2-2)^2\tilde{a}^2}{(\gamma-2)^2(\gamma+1)(\gamma(\beta+2\gamma)-4)^2}$	$\frac{2(1-\beta)(1-\gamma)(2-\gamma^2)\tilde{a}^2}{(\gamma+1)(\gamma(\gamma+2)-4)^2}$	$-\frac{(\gamma-1)(\beta((\gamma-1)^2\gamma(\gamma+1)-2)-\gamma^4+\gamma^3-2\gamma+4)^2\tilde{a}^2}{(\gamma-2)^2(\gamma+1)(\gamma(\gamma+1)((\beta-1)(\gamma-2)\gamma-2)+4)^2}$	$\frac{(\beta-1)(\gamma+2)(\gamma(\gamma^2+\gamma-4)+4)}{16(\gamma^2-1)(\beta(-\gamma^2+\gamma+2)\gamma+(\gamma-1)\gamma^2+4)^2}*$ $*(\gamma(\gamma(\beta((\gamma-5)\gamma+2)-(\gamma-3)(\gamma-2))-4)+8)*\tilde{a}^2$
Consumer's Surplus	$\frac{2(\beta-2)^2(\gamma^2-2)^2\tilde{a}^2}{(\gamma-2)^2(\gamma+1)^2(\gamma(\beta+2\gamma)-4)^2}$	$\frac{2(\gamma^2-2)^2\tilde{a}^2}{(\gamma+1)^2(\gamma(\gamma+2)-4)^2}$	$\frac{2(\beta((\gamma-1)^2\gamma(\gamma+1)-2)-\gamma^4+\gamma^3-2\gamma+4)^2\tilde{a}^2}{(\gamma-2)^2(\gamma+1)^2(\gamma(\gamma+1)((\beta-1)(\gamma-2)\gamma-2)+4)^2}$	$\frac{(\gamma(\gamma(\beta((\gamma-5)\gamma+2)-(\gamma-3)(\gamma-2))-4)+8)^2\tilde{a}^2}{8(\gamma^2-1)^2(\beta(\gamma-2)(\gamma+1)\gamma-\gamma^3+\gamma^2-4)^2}$
Union's Welfare	$\frac{(2-\beta)\beta(2-\gamma^2)(2-\gamma^2-\gamma)\tilde{a}^2}{(2-\gamma)(\gamma+1)(4-\gamma(\beta+2\gamma))^2}$	$\frac{2\beta(\gamma-1)(\gamma^2-2)\tilde{a}^2}{(\gamma+1)(\gamma(\gamma+2)-4)^2}$	$\frac{2\beta(\gamma^2+\gamma-2)(\beta((\gamma-1)^2\gamma(\gamma+1)-2)-\gamma^4+\gamma^3-2\gamma+4)\tilde{a}^2}{(\gamma-2)(\gamma+1)(\gamma(\gamma+1)((\beta-1)(\gamma-2)\gamma-2)+4)^2}$	$\frac{-(\beta(\gamma(\gamma+1)((\gamma-2)\gamma^2+4)-8)+(-\gamma^2+\gamma+2)\gamma^3)}{8(\gamma-1)^2(\gamma+1)(\beta(-\gamma^2+\gamma+2)\gamma+(\gamma-1)\gamma^2+4)^2}*$ $*(\gamma(\gamma(\beta((\gamma-5)\gamma+2)-(\gamma-3)(\gamma-2))-4)+8)*\tilde{a}^2$