ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA
CAMPUS DI FORLÌ

AICCON

Working Paper 191

Beyond Illyria: Workers' Firm in Mixed Oligopoly

Flavio Delbono, *University of Bologna*
Diego Lanzi, *University of Bologna*
Carlo Reggiani, *University of Manchester*

+39 0543 62327
ecofo.aiccon@unibo.it
www.aiccon.it

aiccon
cooperazione | non profit

AICCON – Italian Association for the Promotion of the Culture of Co-operation and of Nonprofit is an association formed in 1997 among the **University of Bologna, Faculty of Economics, Forlì Campus**, within the academic course on Social Economy. The aim of the Association is to encourage, support, and organise initiatives to promote the culture of solidarity with particular attention to idealities, perspectives, activities, and problems connected to Nonprofit Organizations and Co-operative Enterprises.

AICCON is part of network of people and institutions (**EMES Network**) at national and international level that, starting from its members, forms the environment in which it is located. AICCON, throughout the years, has increased its reach and succeeds to the local, national and international context in which it works.

Beyond Illyria: Workers' Firm in Mixed Oligopoly*

Flavio Delbono† Diego Lanzi‡ Carlo Reggiani§

March 10, 2022

Abstract

We rationalize several facts emerging from the recent empirical research on cooperatives owned by workers (workers' firms, WF) as: the concern of WFs for employment; the interplay between membership and workplace safeguard within WFs; the different reaction to shocks between WFs and profit-making firms. We do so by means of a new model of WFs short-run behavior in mixed duopoly. We consider an industry in which a WF competes with a profit maximizing company and we innovate with respect to the conventional Illyrian objective function. We then reconcile the literature on labor-concerned maximands in competitive markets and the one dealing with WFs in oligopolistic markets under the Illyrian maximand.

JEL Classification: L13, L21, P13.
Keywords: workers firm, employment, oligopoly.

*We thank Vincenzo Denicolò and John Pencavel for helpful comments. The usual disclaimer applies.

†Department of Economics, University of Bologna, Italy. Email: flavio.delbono@unibo.it. Corresponding author.

‡Department of Statistical Sciences and Department of Management, University of Bologna, Italy. E-mail: diego.lanzi@unibo.it.

§Department of Economics, University of Manchester, United Kingdom. Email: carlo.reggiani@manchester.ac.uk.

1 Introduction

The last thirty years have witnessed an increasing volume of empirical research aimed at understanding the actual behavior of cooperative firms. The exponential growth of such an empirical literature is well illustrated and classified in Dow (2018), Jones (2018) and Mirabel (2021). This interest is likely fueled by the diffusion of the cooperative movement worldwide: according to the International Cooperative Alliance reports, in 2020, at least 12% of humanity is a cooperator of any of the 3 million cooperatives on earth (Euricse, 2020).

In what follows, we shall concentrate on workers' firms (WF, hereafter), i.e., a type of cooperative firm (in the past often named *labor-managed firms*) that has the following characteristics. "All, or most of, the capital is owned by employees (members) whether individually and/or collectively (capital ownership arrangements vary). All categories of employees can become members; and most employees are members.[1] Following international cooperative principles, members each have one vote, regardless of the amount of capital they have invested in the business. Members vote on strategic issues" (Pérotin, 2016, p. 2). Such enterprises have received a great deal of attention in the economic literature since John Stuart Mill as a model of enterprise alternative to the capitalistic one.[2] They are operating more in service industries (transportation, catering, facility management, logistics, tourism, cultural activities, professionals) than in manufacturing.[3]

A lasting issue in comparative economics deals with the differences between WFs and conventional, i.e., capitalistic firms (CFs, hereafter). To tackle this issue, the traditional Illyrian approach pioneered by Ward (1958) is unsatisfactory. Indeed, his assumption that a WF maximizes added value, net of non-labor costs, per member,[4] raises two severe objections. On theoretical grounds, in a competitive economy, such formulation entails the strange negative relationship between output price shock and output response.[5] Moreover, such approach finds a limited empirical support.

[1] We will refer to the *membership ratio* as to the ratio between (working) members and total employment at the firm or industry level. Obviously, the membership ratio deals with firms where members confer their work to the company that they co-own, whereas it would be meaningless for, say, users' cooperatives where members are customers as in retail trade, utilities, credit, insurance, housing. See Zamagni (2015) for a classification of cooperatives.

[2] Mill seemed fairly optimistic about the success of the cooperative form, as it transpires from his *Principles of Political Economy*, published in 1848. He thought that such worker-run cooperative organizations would eventually crowd capitalist enterprises out of the market because of their major efficiency and other benefits for the working owners.

[3] See Bonin *et al.* (1993), Dow (2003, 2018) and the updated Euricse (2020). For the rich Italian experience, see Zamagni and Zamagni (2010) and the detailed map of Italian cooperatives in Cori *et al.* (2021).

[4] Under price taking behavior and unitary membership ratio, this is equivalent to maximize profit per worker-member.

[5] This is well-known as the perverse effect, and it is not the only one: another one is that the short-run output adjustment would be positive as a response to an increase in fixed costs. Moreover, as shown in Delbono and Lambertini (2014), in an infinite supergame among Ward-like players, in equilibrium tacit collusion is increasing in the number of participants, as opposed to the familiar conclusion under profit-maximizing behaviour. Delbono and Lambertini (2016) show that horizontal mergers between Illyrian firms entail very different consequences with respect to similar arrangements between CFs.

However, one may arguably disregard competitive market structures as, in reality, WFs normally operate in oligopolistic product markets,[6] more precisely, in *mixed* oligopolies, i.e., concentrated industries hosting companies pursuing different goals (De Fraja and Delbono, 1990).

We go beyond Ward's Illyrian approach in three directions. First, including employment, in addition to profits, in the WF's maximand. Second, employment, in turn, is split between members and non-member workers. Third, the weight assigned to profits and employment is made dependent of the market size. Indeed, we propose a new model of mixed duopoly in which a WF aims at maximizing a weighted sum of total profits and its employment. Moreover, we emphasize the different concern of the WF for working members and non-member workers. This captures the fact that WFs do not exhibit a unitary membership ratio (as it is usually assumed in the theoretical literature, since Ward, 1958),[7] and there are reasons to believe that members be more protected than hired workers during downturns. In doing so, we bridge theory and the robust empirical evidence collected in the last three decades (see Section 3).

The results of our analysis succeed to capture and rationalize the following *stylized facts*. First, WFs operate in oligopolistic product markets where they compete with capitalistic enterprises. Second, WFs care about their employees. Third, WFs protect their employment with different intensity between working members and non member workers. Finally, during downturns, WFs may prefer to sacrifice profits if required to safeguard employment.

The rest of the paper is organized as follows. In Section 2, we summarize the two relevant streams of theoretical literature that we bridge in our model also on the basis of insights stemming from the empirical research discussed in Section 3. In Section 4 we draw some results from a fairly general mixed duopoly model. To gain further insights, we specialize the model in Section 5. Section 6 contains a discussion and the conclusions.

2 Theory: three decades after Ward's Illyria

An altrnative formulation of the WF objective function with respect to Ward (1958) is in Kahana and Nitzan (1989), who proceed along the path suggested by Fellner (1947) and Law (1977). Under price-taking behavior, a workers' enterprise chooses inputs and output to maximize income per worker/member subject to an employment constraint or, alternatively, the level of employment subject to a profit per worker/member constraint (bounded below by the collective wage). Standard duality arguments show the equivalence between both formulations which try to consider the concern for employment that should

[6]A remarkable exception comes from local markets for childcare services, disadvantaged people, elderly: here the buyers are often local public institutions auctioning the provision of such services to groups of social cooperatives (active in Italy since the early '90s of the last century). Such markets often echo oligopsonistic types of competition. In Italy, the social cooperatives represent an increasingly large subset of WFs.

[7]This number is not registered in the balance sheets. In Italy, the national average value was around 0.7 ten years ago (Delbono and Reggiani, 2013) and it seems unchanged according to one of the major cooperative associations (Legacoop) in 2019.

shape the decisions of firms owned and run by workers-members according to a democratic governance (one head-one vote). The inspiring paper by Law actually considered an "augmented" utility function of the representative working-member in which, in addition to income per worker, there is room also for "employment". While interesting, these attempts (see also Miyazaki and Neary, 1985) of modeling the objective function of a WF are confined to price-taking behavior in the product market.

Another group of papers have then tackled the behavior of WFs within models of mixed oligopoly. To the best of our knowledge, the first research investigating the strategic interaction between a CF and a WF has been proposed by Miyamoto (1982) in the wake of Meade (1974). He models a homogeneous duopoly where a CF plays a Cournot game with an Illyrian one, i.e., a firm which maximizes net income per worker. Miyamoto (1982) also provides a taxonomy of the properties of the Cournot equilibrium of such mixed oligopoly.

Especially in the early '90s, several papers have then dealt with mixed oligopolies: for instance, Mai and Hwang (1989), Horowitz (1991), Cremer and Crémer (1992), Delbono and Rossini (1992). In these last papers the comparative statics properties of the Cournot equilibrium all fit quite squarely the taxonomy in Miyamoto (1982).

3 Empirical evidence: the last three decades

Starting from the early 90's, a major attention has been dedicated to the empirical analysis of cooperatives. In a number of papers, Craig and Pencavel (1992, 1993) and Craig *et al.* (1995) investigate the plywood industry in the US Pacific Northwest between the late '60s and mid '80s of the last century. They conclude that, with respect to conventional firms, a WF "is more likely to adjust earnings and less likely to adjust employment" (Craig and Pencavel, 1992, p. 1103) as a reaction to changes in their market conditions.

In another paper, they estimate the parameters of a general objective function for WFs which nests dividend maximization and employment maximization as special cases, and they conclude that "employment seems figure more prominently than earnings in the cooperatives" objectives" (Craig and Pencavel, 1993, p. 307). They reach this finding within a model where the product market is a mixed oligopoly in which price-taking cooperatives choose wages, hours, employment and the level of a non-labor input.

The same methodology of Craig and Pencavel (1993) is shared by Burdín and Dean (2012) using a panel of Uruguayan firms between 1996 and 2005, including the entire population of WFs. Burdín and Dean (2012) conclude that WFs put some weight on both employment and income per worker (close to profit maximization, as we know), and estimate a value ranging from 0.7 to 0.9 for the weight assigned to profit. Using the same database as in their 2012 paper, Burdín and Dean (2009), compare employment and wage decisions within workers' cooperatives. They show, inter alia, that the employment adjustment is larger in CFs than in WFs.

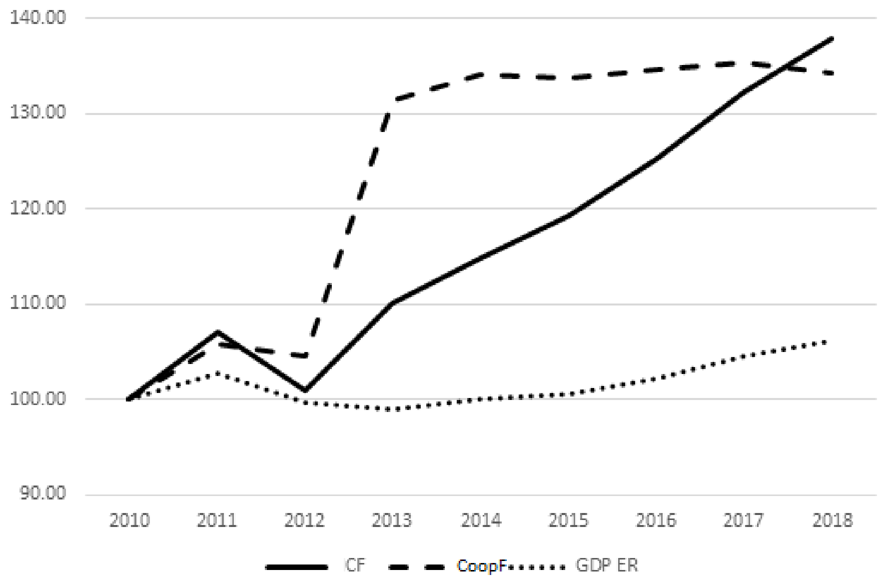
The institutional settings considered in these empirical researches vary of course across countries and periods as for labor market rules, collective contracts, civil and fiscal legislation, and the like. However, overall, the evidence suggests that while CFs tend to adjust employment relatively to fluctuations in demand, WFs adjust pay to protect workplaces, at least towards their members (Pérotin, 2012).[8]

This conclusion has been confirmed, for instance, by Delbono and Reggiani (2013) for a large group of Italian WFs immediately after the 2008 financial crisis; Euricse (2013, pp. 87-102) for a large sample of medium-large Italian cooperatives between 2006 and 2010; Navarra (2016) for a small sample of Italian WFs between 2000 and 2005; Istat-Euricse (2019, pp. 22-26) comparing employment in Italian cooperatives (not only WFs) with respect to other firms in 2007 and 2015; Caselli *et al.* (2021) for all cooperatives and cooperative controlled firms in the Emilia-Romagna region between 2010 and 2018.

These findings hint at a WF's objective function along the lines of Craig and Pencavel (1993) and Burdín and Dean (2012) according to whom the (implicit) WFs' maximand is a weighted average of profits and employment, the weight assigned to the latter being risen during slums, even at the cost of incurring temporary losses.

The following figures, both from Caselli *et al.* (2021), show the pattern of GDP in the Italian region Emilia-Romagna, the world's most sizable cooperative district, the added value of all cooperatives (not only WFs) and of CFs (Figure 1). In Figures 2a and 2b, we plot employment and profits, respectively, in the same time span.

Figure 1: Value added of firms in Emilia-Romagna. Source: Caselli *et al.* (2021).



[8]Note that, since the wage is frequently set through national collective bargaining, such adjustment may regard the number of working hours as well as the distribution of the rebates.

Figure 2: Employment and profits of firms in Emilia-Romagna. Source: Caselli *et al.* (2021).

(a) Employment (b) Profits

The differences between cooperatives and non cooperative firms are striking. The added value increases in both groups of firms. However, such a similar expansion yields drastically diverging consequences: profits grow fourteen-fold in CFs and only 53% in cooperatives, whereas the number of employees increase by 19% in CFs and almost by 25% in cooperatives. While CFs tend to be pro-cyclical, cooperatives seem to stabilize their employment and, given their critical mass, they contribute to flatter also the overall regional employment level, even by giving up profits (Caselli *et al.*, 2021).

4 The general model

We consider a mixed duopoly in which a workers' firm (labeled W) and a capitalistic one (labeled C) produce an homogeneous good, and compete *à la* Cournot-Nash with labor as the choice variable. Workers are homogeneous in skills and abilities; the nominal wage, $\omega > 0$, and the length of the workday are institutionally fixed. The labor supply is unconstrained at the market wage. Both firms have a short run production function, f, defined as: $q = F\left(L, \overline{K}\right) = f\left(L\right)$, in which the amount of capital is fixed. Regarding $f\left(L\right)$ we assume:

$$\text{(i) } f\left(0\right) = 0, \text{ (ii) } f^{'} > 0, \text{ (iii) } f^{''} < 0, \text{ (iv) } \lim_{L \to 0} f^{'} = \infty, \text{ (v) } \lim_{L \to \infty} f^{'} = 0.$$

Assumptions (iii)-(iv)-(v) are the well-known Inada conditions ensuring an interior solution. In our setting, these are sufficient to guarantee the existence and uniqueness of a Cournot-Nash equilibrium. Moreover, both producers have short run fixed costs (Γ). Market price is strictly decreasing with respect to total quantity: $p = p\left(Q\right)$, $\frac{dp}{dQ} < 0$, $Q = q_W + q_C$. There is a finite upper bound of demand when the price is approaching zero.

The CF maximizes its profit function with respect to L_C:

$$\Pi_C(L_C, L_W) = p(f(L_C) + f(L_W)) f(L_C) - \omega L_C - \Gamma. \tag{1}$$

The WF, instead, maximizes the following objective function with respect to L_W:

$$\begin{aligned} &V = \phi \Pi_W(L_W, L_C) + (1-\phi)[m + \beta(1-m)] L_W = \\ &\phi [p(f(L_C) + f(L_W)) f(L_W) - \omega L_W - \Gamma] + (1-\phi)[m + \beta(1-m)] L_W. \end{aligned} \tag{2}$$

Notice that equation (2) is a weighted-average of the WF's profits and its employment, where $\phi \in (0, 1]$ is the weight assigned to profits.[9] Expression (2) also encompasses the presence of corporate stock companies controlled by WFs. Indeed, in many industries we observe subsidiaries controlled by cooperative firms or cooperative groups (for the case of Italy, see Istat-Euricse, 2019). Clearly, if $\phi = 1$ the standard Cournot duopoly model obtains. For the moment, we consider ϕ as a fully exogenous parameter, but we will make it dependent on the parameters of the demand function to illustrate the anti-cyclical behavior of the workers' firm.

Moreover, in equation (2) workers of the WF are divided into members, L_M, and non-members, L_{NM}, with $L_W = L_M + L_{NM}$. Hence, the membership ratio, m, is:

$$m = \frac{L_M}{L_W} = 1 - \frac{L_{NM}}{L_W}. \tag{3}$$

Only members share WF's profits, if any, in the form of rebates. If $m = 1$ all workers are members. If $m < 1$, the WF distinguishes between labor supplied by members and by non-members, and the latter may receive less protection than the former in case of negative shocks. Indeed, the parameter $\beta \in [0, 1]$ in (2) measures how the WF internalizes the employment of non-members in its overall payoff.

To recap, according to expression (2), the WF experiences a constant marginal benefit $(1 - \phi)$ in hiring workers. Such a positive reward from employment depends on both the WF's membership ratio m, i.e., the percentage of workers who are also members, and the weight assigned to non-members employees, β.

In our model, the source of divergence between market players' behavior stems from the value assigned to employment by the WF. The less important and inclusive such an aim is, the lower will be the *employment-enhancing* effect of the WF. This claim is proved in Proposition 1, where, for ease of notation, we set $\gamma \equiv m + (1 - m)\beta$, $\gamma \in (0, 1]$. The parameter γ summarizes the importance of membership within the WF's objective function. Indeed, an increase in m corresponds to a larger number of working members, while an increase in β amounts to treating non-member workers more similarly to members in the WF's concern for employment.

[9] Assuming that ϕ is strictly positive ensures the concavity of (2) with respect to L_W. At any rate, if ϕ goes to zero, the optimal L_W is bounded above by the maximum quantity that can be sold.

Notice that m must be strictly positive (in Italy, for instance, there must be at least three members to register a co-operative). Moreover, as γ is strictly increasing in m, if m shrinks, the WF degenerates into a CF. This happens when non-member workers replace departing member workers, a phenomenon often observed in large WFs.[10]

Proposition 1. *In the unique Cournot-Nash equilibrium of this mixed duopoly, the WF hires more workers and produces more output than the CF.*

Proof: From expressions (1) and (2), it is apparent that the marginal revenue functions of the two firms, absent any concern for employment by the WF, are strictly decreasing in their own L. Indeed, after dividing (2) by ϕ, we can write:

$$MR_C = MR_W = \frac{\partial pf(L_i)}{\partial L_i}, \ i = C, W.$$

Hence, the optimal quantity of labor L_i^* for each firm is determined by the following condition:

$$L_C^* |\ MR\,(L_C) = \omega$$

$$L_W^* |\ MR\,(L_W) = \omega - \frac{1-\phi}{\phi}\gamma$$

Straightforwardly, given that: $\frac{1-\phi}{\phi}\gamma > 0$ for $\phi \neq 1$, it is true that $L_W^* > L_C^*$. Since output is strictly increasing in labor, it follows that in equilibrium $q_W^* > q_C^*$. *Q.E.D.*

Note that in our model, both in the $L_C - L_W$ space and in the $Q_C - Q_W$ one, the reaction functions are monotonically decreasing as in the textbook version of the Cournot model. This feature is driven by our formulation of the WF's objective function, (2). In contrast, had the WF been Illyrian as in Ward (1958), then its reaction function would be upward sloping and its equilibrium output lower than the CF's (Delbono and Rossini, 1992).

The following corollary can be stated:

Corollary 1. *In the mixed duopoly, the equilibrium price is lower than in a purely capitalistic duopoly.*

The corollary descends from the total output in the mixed duopoly being larger than in the conventional profit-making setting, and the downward sloping demand function. Larger quantities, and a lower price, make the market equilibrium more competitive than the one with only profit-maximizing firms. Hence, consumers are better off in presence of a workers' firm in the industry. Such a result is reminiscent of the effect emerging in

[10]If the membership ratio progressively shrinks and the original WF tends to mimic a CF. This phenomenon has been stigmatized as the *degeneration* of the WF. For a thorough analysis, see Pencavel (2013) and Dow (2018), chapters 7 and 9.

a Cournot-Nash equilibrium of a mixed oligopoly where one company maximizes the industry social welfare (De Fraja and Delbono, 1989). Moreover:

Corollary 2. *In the mixed duopoly, the equilibrium output of the WF decreases with ϕ and increases in m as well as in β.*

Unsurprisingly, the employment-enhancing effect of the WF increases when the weight of labor in its objective function increases, i.e., for lower ϕ. On the other hand, an increase in m and/or β raises the relative importance of labor *vis-à-vis* profits in equation (2). In the case of m, the share of members increases, whereas in the case of β it harmonizes the concern for the employment of members and non-member workers. Both these changes expand the optimal level of employment and output of the WF.

5 The specialized model

In order to further study the properties of the mixed duopoly, we specialize the previous model as follows. We assume a quadratic production function:

$$q_i = \sqrt{L_i}, \quad i = C, W, \tag{4}$$

and a linear inverse demand function:

$$p = a - Q, \tag{5}$$

where $a \in (\omega, \overline{a}]$ is the maximum quantity when price vanishes. As for the finite parameter $\overline{a}$, it can be understood as the maximum potential quantity, for example, resulting from a positive demand shock.

Plugging (4) and (5) into the objective functions (1)-(2) and solving for the labor demands, we then obtain the following optimal output:

$$\begin{aligned} q_C^* &= \frac{a[(2\omega+1)\phi - 2\gamma(1-\phi)]}{(4\omega^2+8\omega+3)\phi - 4\gamma(\omega+1)(1-\phi)} \\ q_W^* &= \frac{a(2\omega+1)\phi}{(4\omega^2+8\omega+3)\phi - 4\gamma(\omega+1)(1-\phi)} \end{aligned} \tag{6}$$

Consistently with Proposition 1, it is easy to verify that the WF produces more than the CF. The equilibrium can now be fully characterized, and all the expressions can be found in Appendix A. More precisely, we can now compare the equilibrium profits of the two firms.

Proposition 2. *If the weight of profits in the WF's objective function is large enough, the WF profits are larger than the CF ones.*

Proof: We start by noting that the non-negativity of the equilibrium profits of both firms requires the fixed cost Γ being not too large. Alternatively, for a given fixed cost Γ, there is a minimum value of ϕ, the weight of profits in the WF's objective function, ensuring that it is the case. We identify such minimum values, as a function of the parameters of the model with $\underline{\phi}_W(a, \omega, \gamma, \Gamma)$ and $\underline{\phi}_C(a, \omega, \gamma, \Gamma)$ for the WF and CF, respectively. Their explicit expressions can be found in Appendix A, equations (12) and (13). In what follows, we focus on parameters' constellations such that:

$$\phi \geq \underline{\phi} = \max\left\{\underline{\phi}_W, \underline{\phi}_C\right\}.$$

Given the equilibrium quantities derived above, we can compute the corresponding profits. The difference between the profits of the CF and the WF is:

$$\Delta\pi = -\frac{2a^2\gamma(1-\phi)[2\gamma(\omega+1)(1-\phi)-(2\omega+1)\phi]}{[(4\omega^2+8\omega+3)\phi-4\gamma(\omega+1)(1-\phi)]^2}.$$

The denominator is always positive. The numerator is negative if the term $2\gamma(\omega+1)(1-\phi)-(2\omega+1)\phi$ is positive. This is the case for:

$$\phi > \phi^* = \frac{8\gamma(\omega+1)^2}{8\gamma+8\gamma\omega^2+4\omega^2+16\gamma\omega+8\omega+3}.$$

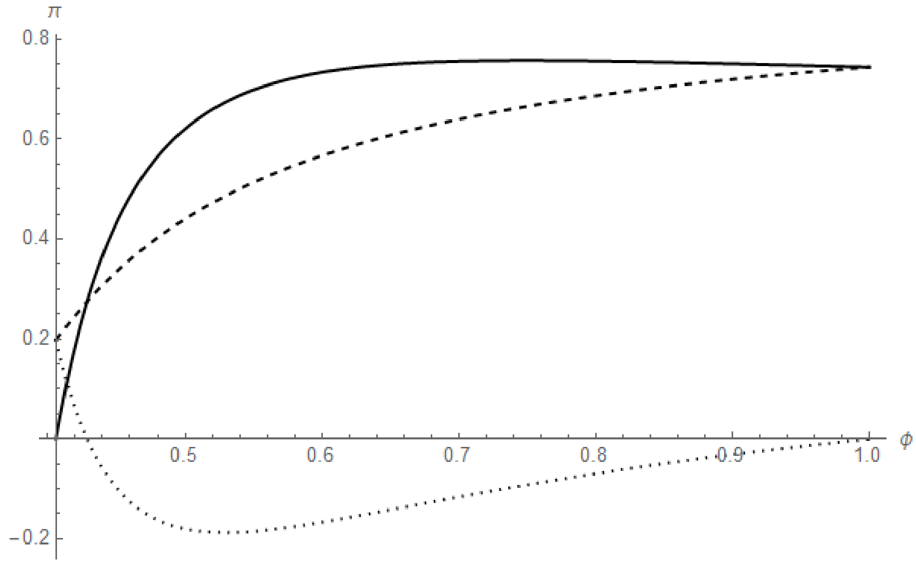
It can be verified that: $\underline{\phi} < \phi^* < 1$. This completes the proof. *Q.E.D.*

The contents of Proposition 2 are illustrated in Figure 3, where the origin of the horizontal axis is set at $\underline{\phi}$, i.e., the minimum value that warrants non-negative profits to both firms. For values of ϕ in the region on the left of ϕ^*, CF makes more profits than the WF. In correspondence of the parameters in the example of Figure 3, it turns out that $\underline{\phi} = 0.406$ and $\phi^* = 0.429$. For values of ϕ greater than ϕ^*, the WF is more profitable than the CF.

The intuition for these findings is as follows. Start from the limit case of capitalist duopoly, i.e., $\phi = 1$. Moving left means that the WF gives increasing weight to employment. As we know, this entails a greater output, and greater profits. Because of the decreasing returns to scale in production, as the weight keeps increasing, the profit gap shrinks and ends in correspondence of ϕ^*. Such profit gap is then non-monotonic and it reaches a maximum in our example at $\phi = 0.529$.

A notable feature of Proposition 2 is that, in a mixed duopoly under quadratic technology and linear demand, the WF can earn higher profits than the CF even by pursuing *not only* profits. This result evokes the conclusion of the literature pioneered by Vickers (1985, p. 138) that, in markets where firms are interdependent, "it is not necessarily true that maximum profits are earned by firms whose objective is profit maximization". In Vickers (1985)'s model such a finding is obtained in an oligopolistic model of managerial incentives where managers may be asked to maximize a mix of firm's profits and output. Under Cournot rules in the product market, this arrangement ultimately yields an outward shift of the reaction function of the managerial company, a larger market share and higher profits (as it would happen because of a reduction in its marginal costs).

Figure 3: Equilibrium profits of the WF, CF and their difference ($a = 3$, $\omega = 3$, $\Gamma = 0.1$, $\gamma = 0.5$). Profit of WF: full line; profit of CF: dashed; profit difference: dotted.



Besides the previously discussed capitalist duopoly ($\phi = 1$), an even more interesting benchmark is a duopolistic market in which both firms are WF. The equilibrium output and price of the WFs' duopoly are:

$$q^d = \frac{a\phi}{2\gamma\phi - 2\gamma + 2\omega\phi + 3\phi}$$
$$p^d = \frac{a(2\gamma\phi - 2\gamma + 2\omega\phi + \phi)}{2\gamma\phi - 2\gamma + 2\omega\phi + 3\phi}$$

The output of each firm in this "pure" WFs duopoly lies in between the output of the CF and the WF in the mixed duopoly. Clearly, the three quantities tend to the same value as ϕ tends to one. The overall quantity, however, is larger under the pure duopoly, implying a lower equilibrium price and a higher consumer surplus. As for profits, it turns out that now each WF obtains less than in a mixed duopoly, but more than a CF in such a market provided that the weight of profits is large enough. For more details, see Appendix B.

5.1 The anti-cyclical behavior of the workers' firm

In order to address the well documented anti-cyclical behavior of the WFs, we relate the weight the WF assigns to profits, ϕ, to the position parameter of the demand function, a. In particular, we set

$$\phi(a) = \frac{a - \omega}{\bar{a} - \omega} \tag{7}$$

By construction, $\phi(a) \in (0,1]$; this derives from the fact that $\overline{a}$ has been defined as the largest possible market size. Hence, a reduction of a represents a negative demand shock.

Through this extended version of the model, we can show the following:

Proposition 3. *If the market size a is small enough, in the Cournot-Nash equilibrium of the mixed duopoly, the WF behaves anti-cyclically.*

Proof: The equilibrium output levels of the extended model with (7) are given by:

$$\begin{aligned} q_C^{**} &= \frac{a\left(2a\gamma + 2a\omega + a - 2\gamma\overline{a} - 2\omega^2 - \omega\right)}{4a\gamma + 4a\omega^2 + 4a\gamma\omega + 8a\omega + 3a - 4\gamma\overline{a} - 4\gamma\overline{a}\omega - 4\omega^3 - 8\omega^2 - 3\omega}, \\ q_W^{**} &= \frac{a(2\omega+1)(a-\omega)}{4\gamma(\omega+1)(a-\overline{a}) + (4\omega^2+8\omega+3)(a-\omega)}. \end{aligned} \tag{8}$$

By taking the derivative of q_W^{**} with respect to a we obtain:

$$\frac{\partial q_W^{**}}{\partial a} = \frac{(2\omega+1)\left[4\gamma(\omega+1)\left(a^2 - 2a\overline{a} + \overline{a}\omega\right) + (2\omega+1)(2\omega+3)(a-\omega)^2\right]}{\left[4\gamma(\omega+1)(a-\overline{a}) + (4\omega^2+8\omega+3)(a-\omega)\right]^2}.$$

The sign of the derivative is the same as the sign of the numerator. It can be shown that it is negative for a below a critical threshold, reported in Appendix C, equation (14). *Q.E.D.*

Proposition 3 provides an interpretation of the reaction of the WF to demand shocks. More precisely, it establishes that, if the market size (or the choke price) is not too large, the labor demand and the corresponding output move in the opposite direction as compared to the demand shock. For instance, in recessionary period when demand shrinks the WF expands its employment and then, as observed in a number of articles surveyed in Section 3, its output.

6 Discussion and conclusions

In this paper, we have tried to innovate upon Ward's workers's firm approach. First, we embed employment, in addition to profits, in the WF's objective function. Moreover, we split employees between members and non-member. Finally, we made the weight assigned to profits and employment dependent on the demand parameters.

It turns out that in the Cournot-Nash equilibrium of our mixed duopoly, the WF employs more workers and, as capital is fixed, utilizes more labor intensive production processes than capitalistic firms. Moreover, it may behave anti-cyclically in front of demand shocks hitting the industry. These traits of WFs make the market equilibrium of the mixed duopoly more competitive than a standard Cournot-Nash duopolistic equilibrium.

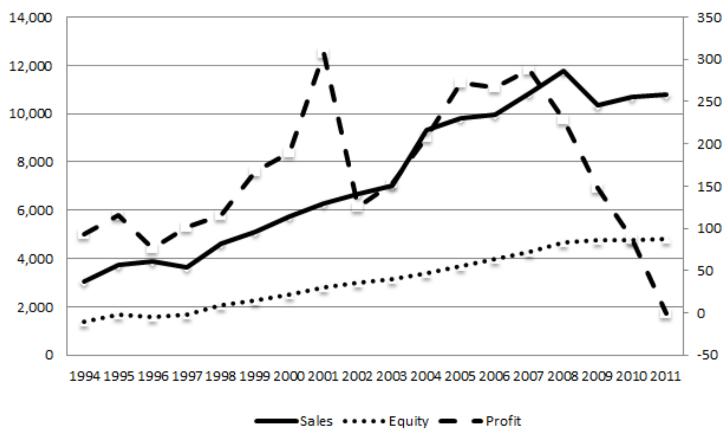
It is worth stressing that also our specification of the WF's objective function may yield what the literature has stigmatized as "perverse effects" of the WF's supply curve, although we have apparently ennobled them as anti-cyclical responses. However, such comparative statics finds in our model a very different explanation with respect to the Illyrian approach. In Ward (1958)'s model the WF always increases output and then the number of workers-members as a reaction to a fall in output price, and vice-versa. Since the WF maximizes net income per member, it restricts the workforce and then memberships by using fewer workers than a CF if profits increase. If the output price augments, the WF has an incentive to shrink the workforce, opening the door to a negatively sloped output supply curve. By the same token, the WF increases its labor demand as a response to higher fixed costs, in order to split it among a larger number of members-workers.

Our model too may predict such responses, but they emerge only under some circumstances and, above all, they are driven by the explicit concern for employment (in some proportion between members and non-members) featuring the strategies of the WF in a mixed oligopoly.

A further comment is worthwhile regarding profits. Notwithstanding that our analysis is static and short-run in nature, the empirical evidence indicates that a WF is better equipped to resist temporary losses than a capitalistic one. Although in our model we rule out that the WF makes negative profits in equilibrium, it might be able to absorb them if needed to protect employment. Empirically this has been detected as in the case visualized in Figure 2(b).

In this respect, Figure 4 is revealing. It shows neatly the forward-looking policy of a large sample of Italian WFs; on average, they distributed about 5% of profits to members. In the same period, the largest Italian capitalistic companies distribute more than two thirds of their profits in the form of dividends. This is the basic reason why the Italian WFs have been more resilient than the profit-making enterprises during the downturn following the 2008 financial crisis. Our model can easily accommodate an amended profit constraint that allows for temporary losses for the WF.

Figure 4: Sales, equity, and profits of a sample of Italian workers' firms. Source: Delbono and Reggiani (2013).



Illyria is an idealized economy in which workers-owned companies produce and sell in a decentralized market environment. Firms are supposed to be under the control of worker councils elected in a democratic, one-head/one vote basis, which select managers running the firm in a perfectly competitive product market, absent any constraint from the (unmodelled) labor market. Illyrian firms were of obvious interest in the debate about market socialism, as emphasized by Ward (1967), because they are one of the simplest organizational forms satisfying the requirements for a decentralized and socialist economy. In this paper, we have dropped the assumption of perfect competition in the product market, and the market syndicalism embedded into Ward (1958)'s objective function, and focused our attention on mixed duopolies in which a labor-concerned WF and a CF compete in output levels. Our simple analysis shows that, even beyond market socialism, the role of WFs can be relevant in shaping the equilibrium of imperfectly competitive markets.

Our simple model could be extended in several directions: we mention three of them. First, one can consider an oligopoly and investigate different combinations of the number of WFs and CFs. Second, our game may be seen as the last stage of a multi-stage game where the WF initially chooses the membership ratio and/or the concern for non-member workers. For example, the membership ratio may be made endogenous as the choice entails a trade-off for the initial members. Indeed, allowing new membership to workers yields an increase in the assets of the company (because of the entry fee) but also a larger number of recipients of the distributable profits. Third, the representation of the technology may be enhanced with a parameter capturing the productivity of labor. For instance, an increase of such parameter may be thought of as resulting from labor-saving technical progress.

References

Bonin, John P, Derek C Jones, and Louis Putterman (1993), "Theoretical and empirical studies of producer cooperatives: will ever the twain meet?" *Journal of Economic Literature*, 31, 1290–1320.

Burdín, Gabriel and Andrés Dean (2009), "New evidence on wages and employment in worker cooperatives compared with capitalist firms." *Journal of Comparative Economics*, 37, 517–533.

Burdín, Gabriel and Andrés Dean (2012), "Revisiting the objectives of worker-managed firms: An empirical assessment." *Economic Systems*, 36, 158–171.

Caselli, Guido, Michele Costa, and Flavio Delbono (2021), "What do cooperative firms maximize, if at all? Evidence from Emilia-Romagna in the pre-Covid decade." *Annals of Public and Cooperative Economics*, forthcoming.

Cori, Andrea, Mattia Granata, Keti Lelo, and Salvatore Monni (2021), "Mapping cooperatives in italy." *Entrepreneurship and Sustainability Issues*, 8, 136–162.

Craig, Ben and John Pencavel (1992), "The behavior of worker cooperatives: The plywood companies of the Pacific Northwest." *The American Economic Review*, 82, 1083–1105.

Craig, Ben and John Pencavel (1993), "The objectives of worker cooperatives." *Journal of Comparative Economics*, 17, 288–308.

Craig, Ben, John Pencavel, Henry Farber, and Alan Krueger (1995), "Participation and productivity: a comparison of worker cooperatives and conventional firms in the plywood industry." *Brookings papers on economic activity. Microeconomics*, 26, 121–174.

Cremer, Helmuth and Jacques Crémer (1992), "Duopoly with employee-controlled and profit-maximizing firms: Bertrand vs Cournot competition." *Journal of Comparative Economics*, 16, 241–258.

De Fraja, Giovanni and Flavio Delbono (1989), "Alternative strategies of a public enterprise in oligopoly." *Oxford Economic Papers*, 41, 302–311.

De Fraja, Giovanni and Flavio Delbono (1990), "Game theoretic models of mixed oligopoly." *Journal of Economic Surveys*, 4, 1–17.

Delbono, Flavio and Luca Lambertini (2014), "Cartel size and collusive stability with non-capitalistic players." *Economics Letters*, 125, 156–159.

Delbono, Flavio and Luca Lambertini (2016), "Horizontal mergers with capital adjustment: Workers' cooperatives and the merger paradox." *Annals of Public and Cooperative Economics*, 87, 529–539.

Delbono, Flavio and Carlo Reggiani (2013), "Cooperative firms and the crisis: evidence from some italian mixed oligopolies." *Annals of Public and Cooperative Economics*, 84, 383–397.

Delbono, Flavio and Gianpaolo Rossini (1992), "Competition policy vs horizontal merger with public, entrepreneurial, and labor-managed firms." *Journal of Comparative Economics*, 16, 226–240.

Dow, Gregory K (2003), *Governing the firm: workers' control in theory and practice*. Cambridge University Press.

Dow, Gregory K (2018), *The labor-managed firm: Theoretical foundations*. Cambridge University Press.

Euricse (2013), "World cooperative monitor: Exploring the co-operative economy." https://www.euricse.eu/publications/world-cooperative-monitor-report-2013/. [Last accessed March 10, 2022].

Euricse (2020), "World cooperative monitor: Exploring the co-operative economy." https://www.euricse.eu/publications/world-cooperative-monitor-2020/. [Last accessed March 10, 2022].

Fellner, William (1947), "Prices and wages under bilateral monopoly." *The Quarterly Journal of Economics*, 61, 503–532.

Horowitz, Ira (1991), "On the effects of Cournot rivalry between entrepreneurial and cooperative firms." *Journal of Comparative Economics*, 15, 115–121.

Istat-Euricse (2019), "Structure and performance of italian co-operatives: year 2015." https://www.euricse.eu/structure-and-performance-of-italian-cooperatives/. [Last accessed March 10, 2022].

Jones, Derek C (2018), "The economics of participation and employee ownership (peo): an assessment." *Journal of Participation and Employee Ownership*, 1, 4–37.

Kahana, Nava and Shmuel Nitzan (1989), "More on alternative objectives of labor-managed firms." *Journal of Comparative Economics*, 13, 527–538.

Law, Peter J (1977), "The illyrian firm and fellner's union-management model." *Journal of Economic Studies*, 4, 29–37.

Mai, Chao-Cheng and Hong Hwang (1989), "Export subsidies and oligopolistic rivalry between labor-managed and capitalist economies." *Journal of Comparative Economics*, 13, 473–480.

Meade, James E (1974), "Labour-managed firms in conditions of imperfect competition." *Economic Journal*, 84, 817–824.

Mirabel, Thibault (2021), "Past, present and future of empirical research on employee-owned firms: a structured literature review over 1970–2019." *Journal of Participation and Employee Ownership*, 4, 1–25.

Miyamoto, Yoshinari (1982), "A labour-managed firm's reaction function reconsidered." Research Paper 218, Department of Economics, University of Warwick.

Miyazaki, Hajime and Hugh M Neary (1985), "Output, work hours and employment in the short run of a labour-managed firm." *The Economic Journal*, 95, 1035–1048.

Navarra, Cecilia (2016), "Employment stabilization inside firms: An empirical investigation of worker cooperatives." *Annals of Public and Cooperative Economics*, 87, 563–585.

Pencavel, John (2013), "Worker cooperatives and democratic governance." In *Handbook of Economic Organization* (Anna Grandori, ed.), Edward Elgar Publishing.

Pérotin, Virginie (2012), "The performance of workers' cooperatives." In *The cooperative business movement, 1950 to present* (Patrizia Battilani and Harm G Schroter, eds.), 195–221, Cambridge University Press.

Pérotin, Virginie (2016), "What do we really know about workers' co-operatives?" In *Mainstreaming co-operation* (Anthony Webster, Linda Shaw, and Rachael Vorberg-Rugh, eds.), Manchester University Press.

Vickers, John (1985), "Delegation and the theory of the firm." *The Economic Journal*, 95, 138–147.

Ward, Benjamin (1958), "The firm in Illyria: market syndicalism." *American Economic Review*, 48, 566–89.

Ward, Benjamin N (1967), *The Socialist Economy: A Study of Organizational Alternatives*. New York, Random House.

Zamagni, Stefano and Vera Negri Zamagni (2010), *Cooperative enterprise: Facing the challenge of globalization*. Edward Elgar Publishing.

Zamagni, Vera Negri (2015), "The cooperative movement." In *The Oxford Handbook of Italian Politics* (Erik Jones and Gianfranco Pasquino, eds.), Oxford University Press.

A The equilibrium of the specialized model

This appendix provides a full characterization of the equilibrium of the specialized model in Section 5. From the simultaneous maximization of the firms' objective functions, the following Nash equilibrium employment is:

$$\begin{aligned} L_C^* &= \frac{a^2[(2\omega+1)\phi - 2\gamma(1-\phi)]^2}{[(4\omega^2+8\omega+3)\phi - 4\gamma(\omega+1)(1-\phi)]^2}, \\ L_W^* &= \frac{a^2(2\omega+1)^2\phi^2}{[(4\omega^2+8\omega+3)\phi - 4\gamma(\omega+1)(1-\phi)]^2}. \end{aligned} \tag{9}$$

As reported in the text, the equilibrium output of each firm is:

$$\begin{aligned} q_C^* &= \frac{a[(2\omega+1)\phi - 2\gamma(1-\phi)]}{(4\omega^2+8\omega+3)\phi - 4\gamma(\omega+1)(1-\phi)}, \\ q_W^* &= \frac{a(2\omega+1)\phi}{(4\omega^2+8\omega+3)\phi - 4\gamma(\omega+1)(1-\phi)}. \end{aligned}$$

The total output is then:

$$Q^* = \frac{2a[2(1+\omega)\phi - \gamma(1-\phi)]}{(4\omega^2+8\omega+3)\phi - 4\gamma(\omega+1)(1-\phi)}, \tag{10}$$

and the corresponding equilibrium price:

$$p^* = \frac{a(2\omega+1)[(2\omega+1)\phi - 2\gamma(1-\phi)]}{4\phi(\omega^2+\gamma\omega+8\omega) + 4\gamma(\phi+\omega-1) + 3\phi}. \tag{11}$$

The equilibrium profits can be obtained as $\pi_i^* = p_i^* q_i^* - \omega L_i^* - \Gamma$. The non-negativity of the equilibrium profits of both firms requires the fixed cost Γ being not too large. As for the WF, the minimum value of ϕ, which depends on Γ, ensuring that it is the case is the following:

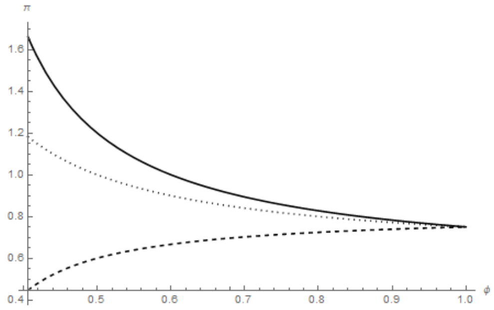
$$\underline{\phi}_W = \frac{a\gamma(2\omega+1)\sqrt{(2a\omega+a)^2 - 8\Gamma(\omega+1)(2\omega(\omega+2)+1)} + (2a\omega+a)^2 - 4\gamma\Gamma(\omega+1)(4\gamma+4\omega^2+4\gamma\omega+8\omega+3)}{(2a\omega+a)^2(2\gamma+\omega+1) - \Gamma(4\gamma+4\omega(\gamma+\omega+2)+3)^2}. \tag{12}$$

The equivalent threshold for the CF is:

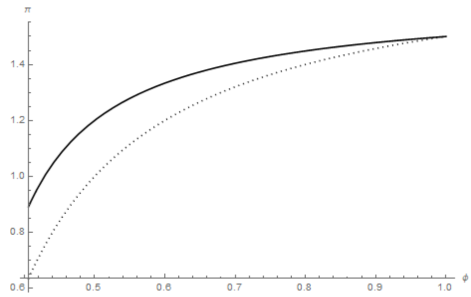
$$\underline{\phi}_C = \frac{2\gamma^2(\omega+1)\left[4\Gamma(\omega+1) - a^2\right]}{\sqrt{a^2\gamma^2\Gamma(\omega+1)(2\omega+1)^2} + \gamma(w+1)\left[2\Gamma\left(4(\gamma+\omega^2+\Gamma\omega+2\Gamma\omega)+3\right) - a^2(2(\gamma+\omega)-1)\right]}. \tag{13}$$

In the main text, we focus on parameters' constellations such that $\phi \geq \underline{\phi} = \max\left\{\underline{\phi}_W, \underline{\phi}_C\right\}$.

Figure B.1: Output and price comparison between a pure and a mixed WFs duopoly ($a = 3$, $\omega = 3$, $\Gamma = 0.1$, $\gamma = 0.5$).



(a) Equilibrium output of pure WFs duopoly firms, the mixed duopoly WF and CF. Output of the pure duopoly WFs: dotted line; output of the mixed duopoly WF: full; output of the mixed duopoly CF: dashed.



(b) Equilibrium price of pure WFs duopoly versus mixed WFs duopoly. Price of the pure WFs duopoly: dotted line; price of the mixed WFs duopoly: full.

B Pure WFs duopoly

This appendix provides a characterization of the equilibrium of a pure WFs duopoly benchmark and a comparison with the mixed duopoly, as discussed at the end of Section 5.

The objective function of one of the competitors i, with $i = 1, 2$ in this case, is:

$$V_i = \phi\left[a - \sqrt{L_i} - \sqrt{L_{-i}}\sqrt{L_i} - \omega L_i - \Gamma\right] + (1-\phi)\,\gamma L_i.$$

Simultaneously maximizing profits in L_i leads to the following symmetric equilibrium employment:

$$L_i^d = \frac{a^2\phi^2}{(2\gamma\phi - 2\gamma + 2\omega\phi + 3\phi)^2}.$$

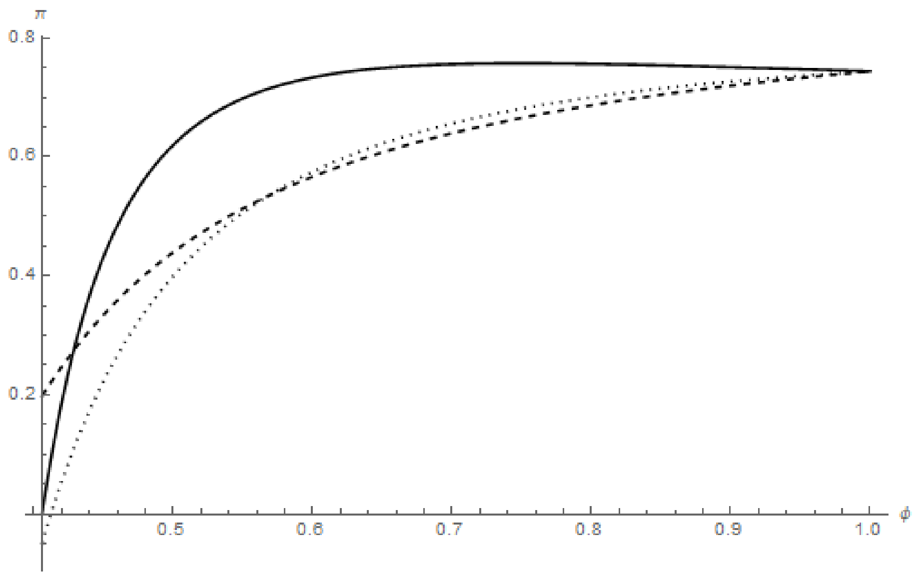
The corresponding equilibrium individual and aggregate output and price are as follows:

$$q_i^d = \frac{a\phi}{2\gamma\phi - 2\gamma + 2\omega\phi + 3\phi}$$
$$Q^d = \frac{2a\phi}{2\gamma\phi - 2\gamma + 2\omega\phi + 3\phi}$$
$$p^d = \frac{a(2\gamma\phi - 2\gamma + 2\omega\phi + \phi)}{2\gamma\phi - 2\gamma + 2\omega\phi + 3\phi}$$

Simple comparisons, illustrated in Figure B.1a, show that the output of each firm in the "pure" WFs duopoly lies in between the output of the CF and the WF in the mixed duopoly. The three quantities tend to the same value as ϕ tends to one. The overall quantity, however, is larger under the pure duopoly, implying a lower equilibrium price, as by Figure B.1b.

Turning to the profits, it can be seen from Figure B.2 that each duopoly WF obtains less than in a mixed duopoly but, provided that the weight of profits is large enough, profits exceeds those of a CF in such a market.

Figure B.2: Equilibrium profits of pure WFs duopoly firms, mixed duopoly WF and CF ($a = 3$, $\omega = 3$, $\Gamma = 0.1$, $\gamma = 0.5$). Profit of pure WFs duopoly: dotted line; profit of mixed duopoly WF: full; profit of mixed duopoly CF: dashed.



C Demand and the countercyclicality of WF

In the main text, we showed that the optimal output of the WF, q_W^{**} may be increasing if the demand parameter a decreases (negative shock). This happens if the sign of derivative $\partial q_W^{**}/\partial a$ is negative, i.e.:

$$\frac{\partial q_W^{**}}{\partial a} = \frac{(2\omega+1)\left[4\gamma(\omega+1)\left(a^2-2a\overline{a}+\overline{a}\omega\right)+(2\omega+1)(2\omega+3)(a-\omega)^2\right]}{\left[4\gamma(\omega+1)(a-\overline{a})+(4\omega^2+8\omega+3)(a-\omega)\right]^2} < 0.$$

The critical value is, then:

$$a^{**} = \frac{4\gamma\overline{a}(\omega+1)+4\omega^3+8\omega^2+3\omega+2\sqrt{\gamma(1+\omega)(\overline{a}-\omega)\left[4\gamma\overline{a}(\omega+1)+4\omega^3+8\omega^2+3\omega\right]}}{4\gamma(\omega+1)+4\omega^2+8\omega+3}, \quad (14)$$

and the output increases as a decreases as long as $a < a^{**}$.