MACROECONOMIC EFFECTS OF OLIGOPOLISTIC COMPETITION WITH WAGE BARGAINING[1]

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Abstract

Modelling oligopoly in general equilibrium is about understanding the aggregate effects of the strategic behavior that nonatomistic agents may exhibit in their markets. Real-world economies appear to be characterized by (monopoly) power-endowed agents behaving strategically - namely, firms and unions. By abstracting from this behavior, we risk missing some important features of the macroeconomy. We develop a general equilibrium model of unionized oligopoly aimed at addressing this point. We evaluate the macroeconomic effects of supply-side shocks under alternative product and labor market structures. In addition, the micro foundations of the model capture an alternative channel for the development of strategic interactions among firms, unions and the monetary authority. This channel creates a transmission mechanism for real effects of monetary policy-related shocks, which we investigate. Finally, in the light of the predictions of the model, we discuss macroecomic performance in Continental Europe over the 1990s.

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1. Introduction

Nowadays, it is widely accepted that imperfect competition constitutes an important pillar for understanding macroeconomic phenomena. Existing models within the literature of imperfectly competitive macroeconomics have commonly used the monopolistically competitive general equilibrium framework developed by Blanchard and Kiyotaki [1987].[1] A relatively unexplored path within this literature relates to the functioning of the oligopolistically competitive and unionized economy. A type of 'theoretical' economy, one might argue, that closely describes the actual structure of many economies in the industrial world. This observation justifies the search for alternative routes to modelling the macroeconomy. The aim is to achieve a better understanding of the macroeconomic effects of the (optimal) strategic behavior that characterizes price (quantity)-setting and wage-setting agents operating in oligopolistic sectors.

This paper integrates different aspects of oligopoly theory and labor theory, traditionally limited to partial equilibrium analysis, into a general equilibrium framework. Specifically, imperfect competition emerges from two sources: (i) firms interact within differentiated oligopolies; (ii) the labor force is unionized. Ultimately, the labor market is the recipient of the effects of these sources of imperfection, where oligopolistic competition locates labor demand schedules and unionization controls the effective supply of labor.

In Sections 2 and 3, we develop a model of unionized oligopoly in general equilibrium. We assume that the economy is composed of a large number of symmetric oligopolies. In each oligopoly, firms produce differentiated goods. Marginal costs are endogenous and entirely determined by the wage rate. Firms cooperatively choose to compete in either prices (Bertrand

[1] Blanchard and Kiyotaki's [1987] general equilibrium model is based on monopolistic competition, à la Dixit-Stiglitz, in goods and labor markets. This implies isoelastic product demand functions and constant markups. Their framework was not the first attempt to model imperfect competition at the macroeconomic level (see, for example, earlier work in Hart [1982] or, for a survey, see Dixon and Rankin [1995]).

competition) or quantities (Cournot competition). Wage formation occurs in a number of independent and simultaneous right-to-manage negotiations. The model is solved for two alternative degrees of centralization of the wage-setting process: industry-wide centralization (sectoral union-employers' confederation bargain) and decentralization (union-firm bargain), where the competitive labor supply produces the benchmark outcome.

In this theoretical framework, we explore how macroeconomic variables vary with alternative specifications governing product and labor markets. Much of existing literature in oligopoly theory has placed emphasis on the comparison of Cournot and Bertrand partial equilibrium outcomes (see, for example, Singh and Vives [1984], Vives [1985], Qiu [1997], Dastidar [1997], Häckner [2003], and Correa López and Naylor [forth.]). However, to the best of our knowledge, none of the comparisons carried out in the aforementioned literature has been taken to the general equilibrium level. One of the obvious reasons is the difficulty of finding suitable underlying preferences to embed oligopoly in a secure general equilibrium foundation (for a discussion, see Neary [2003b]). Section 3 aims to fill this gap in the literature by comparing Cournot and Bertrand general equilibrium outcomes, in the context of differentiated goods and endogenous labor costs. Furthermore, we assess how macroeconomic variables change in response to certain supply-side shocks captured by the model, such as a shock to union bargaining power. By doing so, we address the recent literature on the macroeconomic effects of deregulating product and labor markets (see, for example, Blanchard and Giavazzi [2003]).

The model produces a wide variety of results. Some of them are standard to the literature of imperfectly competitive macroeconomics - namely, the inefficiency of the oligopolistically competitive equilibrium and money neutrality. Other results include: the positive output (and employment) effect of moving from quantity-setting to price-setting competition, and the finding that unionization may produce the competitive outcome in the labor market. The latter implies that there is a threshold value of union bargaining power at which workers are indifferent between union wage coverage and the outcome produced by the competitive labor supply. The exact threshold value of union power depends upon product market characteristics. Interestingly, we also find that perfect competition in the labor market does not always yield higher equilibrium employment compared to imperfect competition - that is, equilibrium employment under Bertrand in the presence of unions can exceed equilibrium employment under Cournot in a perfectly competitive labor market. The latter seems to give support to the notion - as in Blanchard and Giavazzi [2003] - that deregulation should start from the product market. To the extent that in the real world the outcome of the wage negotiation is located on the labor demand schedule, a by-product of deregulating the product market is a more competitive outcome in the labor market.

Let us emphasize that the models developed by Hart [1982] and Blanchard and Kiyotaki [1987] have already captured the inefficiency of the imperfectly competitive equilibrium. In a monopolistically competitive economy, Blanchard and Kiyotaki [1987] show that such inefficiency is caused by an aggregate demand externality. On the other hand, Soskice [2000] outlines that an inefficient equilibrium in the labor market is the result of a prisoners' dilemma type of outcome that may be present in unionized economies. An alternative recent approach to formalize oligopoly in general equilibrium can be found in Neary [2003a, 2003b].

The theoretical setting introduced in this paper adopts the 'extended linear-homothetic' preferences to model consumer's choice over specific goods. The micro foundations that the 'extended linear-homothetic' preferences provide, allow us to work with product demand functions that exhibit the following properties: (i) (perceived) linearity; (ii) variable elasticity; and (iii) cut axes. These properties open the possibility of embedding oligopoly in a tractable general equilibrium framework. From a labor theory perspective, this approach is able to provide a formalization of the macroeconomic outcomes of the right-to-manage model. Also, it opens up a new route to model the strategic interactions that may take place among firms, unions and the central bank.

To explore this route, Section 4 extends the basic closed-economy model, where we allow for strategic interactions between the monetary authority and price-setting firms. We capture a transmission mechanism for the existence of real effects of monetary policy-related shocks. This transmission mechanism operates via sectoral price indices. In particular, we argue that, *as long as firms and unions internalize the sectoral price effects of their individual pricing strategies and as long as the monetary authority monitors sectoral price indices in order to set money supply changes*, real effects may be expected from a change in either the type of institution conducting monetary policy - a domestic central bank vis-à-vis a (monetary) union-wide central bank - or the specific monetary rule it adheres to - from full tightening to full accommodation.

Finally, we apply the model to address a topical issue. Thus, Section 5 informally discusses the predictions of the model in terms of the (joint) evolution of the labor share and of the unemployment rate in Continental Europe over the 1990s. We point to the roles that the degree of product substitutability, the type of monetary institution, and the character of the monetary policy rule may have in explaining macroeconomic evolutions. Section 6 concludes by outlining the main implications of this approach, and by pointing out directions for further research.

2. A General Equilibrium Model with Money

2.1. Description of the Economy

The economy consists of K sectors ($k = 1, ..., K$) with n firms ($i = 1, ..., n$) in each, where K is large and $n \geq 2$. Hence, F_{ik} denotes firm i of sector k producing good x_{ik}. We assume that goods across sectors are independent and goods produced within a sector are substitutes. Sectors are assumed to be symmetric. Firms within a sector exhibit the following short-run technology: $x_{ik} = l_{ik}$. Firms within sectors are assumed to be symmetric.

There is a large number of identical consumers in the economy. Each consumer demands goods from each sector and owns a fraction of every firm in the economy. Workers are identical and evenly distributed across sectors. Workers in each sector are fully unionized and divided evenly into n unions, where U_{ik} denotes union i of sector k. Unions are firm-specific. Hence, U_{ik} receives demand for labor from firm F_{ik} and controls the supply of labor to F_{ik}. Labor is not mobile from union to union: neither to a union of the same sector nor to a union of any other sector.

Overall, we can talk about consumer-workers. Therefore, given K large, the assumption that each consumer-worker consumes goods from all sectors implies that a firm cannot significantly influence the income of its consumers, hence firms take income as given. The underlying assumptions of the model imply that economic agents take aggregate income and aggregate price as given when making their sectoral strategic decisions.[2]

2.2. The Model

The representative consumer-worker s derives utility from consumption of goods and accumulation of real money balances, and disutility from work. We model consumer choice as occurring in two sequential steps. Firstly, individual s allocates income between consumption and money holdings. Secondly, individual s allocates consumption across specific goods. The individual delegates its labor supply decision to the union.

Since preferences are homothetic over consumption and real money balances, we can extrapolate and deal with the aggregated individual, who solves the following optimization problem:

$$\underset{\{X,\,M\}}{Max} \quad \frac{1}{c^c(1-c)^{1-c}}\, X^{\,c} \left(\frac{M}{P}\right)^{1-c} - \rho N^e, \tag{1}$$

$$s.t.\, PX + M = I$$

[2] The assumptions specified above follow, to a large extent, the Hartian tradition. Hence, from the point of view of consumer-workers, the beneficial effect derived from a wage increase exceeds any adverse effect in the form of a higher output price or lower profit. Correspondingly, from the point of view of shareholders, the beneficial effect of any profit increase exceeds any adverse effect yielded by a higher output price. The dominance of those beneficial effects are due to how consumption and shareholding of consumer-workers are spread among the K sectors of the economy. Additionally, they justify the fact that firms maximize profits and unions care about total wage receipts.

where, in utility, X is total quantity demanded of the nK goods, M are nominal money balances held by individuals, P is an aggregate price associated with consumption, and parameter $c : 0 < c < 1$ weights consumption and real money balances in utility. The term ρN^e captures the disutility from supplying N units of labor (e.g. hours), where $N \leq T$ and T is the total number of labor units available, $\rho : \rho > 0$ parameterizes marginal disutility from work, and $e - 1$ captures the elasticity of marginal disutility with respect to work, where $e \geq 1$. In the budget constraint, PX is aggregate nominal expenditure on the nK goods, and I is nominal income where: $I = WL + \Omega + M^s$, hence I is the sum of total rents from labor, WL, total profits, Ω, and the initial level of nominal money balances, M^s. Following the assumptions of the model, the individual takes P and I as exogenously given. The solution to (1) constitutes the basic macroeconomic framework, where $PX = Y = cI$ and $M = (1 - c)\, I$. Thus, the income-expenditure identities yield: $Y = (c/(1 - c))M^s$.[3]

In the second step, the aggregated individual optimally allocates its consumption budget cI across the nK goods produced in the economy, such that $PX = Y = cI$ must hold. In order to solve for the optimal allocation of nominal expenditure, we model consumer choice by using the 'extended linear-homothetic' preferences.[4]

The aggregated individual's expenditure function is described by: $E(p, u) = b(p)\, u$, where $p \in \Re_+^{nK}$ is the price vector of the nK goods. The unit cost function $b(p) : \Re_+^{nK} \longrightarrow \Re_+$ takes the following form:

$$b(p) = (1 - \delta)\mu + \delta\Psi + \gamma\left[\mu - \pi\right], \tag{2}$$

where $\delta : \delta \in (0, 1]$ and $\gamma : \gamma > 0$ are parameters of the model. Function $b(p)$ is composed of

[3] Notice that the utility function in (1) is similar to the one we find in Blanchard and Kiyotaki [1987] (the difference being that X is not a Constant-Elasticity-of-Substitution function of the nK goods produced in the economy).

[4] 'Extended linear-homothetic' preferences are developed next. The preferences make use of the expenditure function approach. More particularly, they are an extended version of the 'linear-homothetic' preferences introduced in Datta and Dixon [2000].

the following price indices:

$$\mu = \frac{\sum_{k=1}^{K}\sum_{i=1}^{n} p_{ik}}{nK} \quad ; \Psi = \frac{\sum_{k=1}^{K}\psi_k}{K} ; \psi_k = \left(\frac{2\sum_{i=1}^{n}\sum_{\substack{j=1 \\ i<j}}^{n} p_{ik}\, p_{jk}}{n(n-1)} \right)^{\frac{1}{2}} ; \pi = \left(\frac{\sum_{k=1}^{K}\sum_{i=1}^{n} p_{ik}^2}{nK} \right)^{\frac{1}{2}} ; \tag{3}$$

μ is the arithmetic average of individual prices, Ψ is the arithmetic average of sectoral-specific price indices, where ψ_k captures the interaction of prices within sector k or 'within-sector effects', and π is the variance of prices from zero. Notice that $b(p)$ would produce Datta and Dixon's [2000] 'linear-homothetic' preferences when $\delta = 0$, and Leontieff preferences when $\delta = 0$ and $\gamma = 0$. Validity of the unit cost function defined by (2) and (3) is shown in Appendix A.1.[5]

We apply Shephard's lemma to (2): $p_{ik}x_{ik}/Y = (\partial b/\partial p_{ik})(p_{ik}/b) \equiv \alpha_{ik}$, hence α_{ik} is the share of aggregate nominal expenditure going to good x_{ik}. Thus, we derive the Marshallian demand function for the representative good:

$$x_{ik} = \frac{Y}{bnK}\left(1 + \gamma - \delta + \frac{\delta}{(n-1)}\sum_{\substack{j=1 \\ j\neq i}}^{n}\frac{p_{jk}}{\psi_k} - \gamma\frac{p_{ik}}{\pi}\right). \tag{4}$$

To begin with, we assume that n is not too small. Hence, firm F_{ik} perceives (4) linear in own-price, p_{ik}, and the individual prices of the goods produced by other firms in the sector, $\sum_{j\neq i}^{n} p_{jk}$. In other words, each firm takes b, π and its sectoral-specific index ψ as given when making optimal production decisions. In (4), it is straightforward to check that own-price elasticity and markup vary along the linear product demand schedule, where the absolute value of price elasticity is increasing in own-price. Let us emphasize that a novel aspect introduced by the 'extended linear-homothetic' preferences is the presence of a sectoral-specific price index in firm's direct demand.[6]

[5] The first version of the preferences considered a unit cost function of the form: $b(p) = \mu + \delta\Psi + \gamma[\mu - \pi]$. I am indebted to Huw Dixon for suggesting the normalization in (2).

[6] The assumption of n not too small implies that the effect of an individual price on the sectoral-specific price index can be ignored. In the duopoly case, where $n = 2$, it is reasonable to think that an individual firm would take into account the effect of its strategy on ψ - such that product demand would not be linear in price. At this stage, we abstract from this additional channel - through which

We focus on product demand functions when symmetry in price indices is anticipated, that is when $\mu = \psi_1 = \psi_2 = ... = \psi_K = \Psi = \pi = P$ and $b = P$. The direct demand function for the representative good simplifies to:

$$\frac{x_{ik}}{y} = \frac{1}{nK}\left(1 + \gamma - \delta + \frac{\delta}{(n-1)}\sum_{\substack{j=1\\j\neq i}}^{n}\frac{p_{jk}}{P} - \gamma\frac{p_{ik}}{P}\right), \tag{5}$$

where $y = Y/P$ is real aggregate expenditure. The symmetric own-price elasticity of direct product demand is given by: $|\widehat{\varepsilon}_{ik}| = \gamma$, such that $|\widehat{\varepsilon}_{ik}| > 1 \leftrightarrow \gamma > 1$. Hence, γ characterizes elasticity in symmetric equilibrium. The symmetric cross-price elasticity is given by: $\widehat{\varphi}_{ik}^{j} = (\partial x_{ik}/\partial p_{jk})(p_{jk}/x_{ik}) = \delta/(n-1)$. Parameter δ captures the degree of substitutability of goods within a sector in the sense that the cross-price elasticity increases in δ. A greater δ implies closer substitutes.[7]

The inverse demand function for good x_{ik} is derived from (4). It is given by:

$$\frac{p_{ik}}{P} = \frac{nK}{(\gamma-\delta)}\left(\frac{1+\gamma-\delta}{nK} - \frac{\delta}{\gamma(n-1)+\delta}\sum_{\substack{j=1\\j\neq i}}^{n}\frac{x_{jk}}{y} - \frac{(\gamma-\delta)(n-1)+\delta}{\gamma(n-1)+\delta}\frac{x_{ik}}{y}\right), \tag{6}$$

where the simplifying assumption of symmetry in price indices is introduced. Notice that (6) is perceived linear in own-output, x_{ik}, and competitors' outputs, $\sum_{j\neq i}^{n} x_{jk}$, by the representative firm. The symmetric own-price elasticity of (inverse) product demand is given by: $|\widehat{\varepsilon}_{ik}| = (\gamma-\delta)(\gamma(n-1)+\delta)/((\gamma-\delta)(n-1)+\delta)$.[8]

the individual price can affect product demand - and we keep linearity to confine attention to the comparison of Bertrand and Cournot general equilibria with endogenous labor costs. The case of n small is addressed in Section 5. Overall, aggregate-price-taking is in the spirit of the monopolistic competition model of Dixit and Stiglitz [1977].

[7] Symmetric elasticity refers to elasticity evaluated in the symmetric solution, where $p_{ik} = p_{jk}$ $\forall i, j = 1, ..., n, \forall k = 1, ..., K$. On the other hand, notice that an increase in n would simply replicate the Bertrand economy, hence elasticity in symmetric equilibrium is invariant to n. We could introduce n in elasticity by assuming: $\gamma = \theta f(n)$, where θ is an exogenous constant and $f'(\cdot) > 0$. In symmetric equilibrium, the unit cost of utility would be still invariant to n. However, in this paper, we leave aside the issue of the appearance of new capacity - in the form of entry in a sector (n endogenous) or, for example, an increase in the number of sectors. Hence, we assume throughout the analysis n and K fixed. Finally, note that $\gamma > \delta$, which obtains from the elasticity condition, ensures that in absolute terms the own-price effect on product demand is greater than the sum of the cross-price effects.

[8] Accordingly, we obtain an implicit assumption on γ for inverse demand to be elastic, $|\widehat{\varepsilon}_{ik}| > 1 \leftrightarrow \gamma > \underline{\gamma}^{C}$. It is applicable when product market competition is Cournot.

Having derived the product demand functions that follow from the aggregated individual's optimal behavior, we turn to present how price and wage formation takes place in the economy. It occurs in two stages. In the first stage, nominal wages are agreed between bargaining parties, unions and firms, in a number of simultaneous and independent negotiations carried out throughout the economy. In the knowledge of their corresponding nominal wage, firms simultaneously set product market variables by optimizing profits - thus, firms set employment. Previously, they have cooperatively chosen to compete in either prices or quantities. The model is solved by backward induction.

The objective function of the representative firm is given by:

$$\Omega_{ik} = (p_{ik} - w_{ik})x_{ik}. \tag{7}$$

The objective function of a typical union, say U_{ik}, is given by:

$$U_{ik} = \frac{w_{ik}}{P} l_{ik} - \rho l_{ik}^{e}. \tag{8}$$

In (8), we assume that the union cares about the total surplus of its representative worker, that is the (expected) real wage bill minus the disutility from supplying l_{ik} units (hours) of labor. We also assume that there is equal rationing of employment among workers, hence the model is one of underemployment rather than unemployment. For analytical convenience the model is solved for $e = 2$, this implies a constant unitary elasticity of marginal disutility with respect to work.[9]

In sector k, the bargained nominal wage, w_k, is the outcome of the maximization of the sub-game perfect Nash bargaining maximand B_k:

$$B_k = \left(\sum_{i=1}^{n} U_{ik}\right)^{\beta} \left(\sum_{i=1}^{n} \Omega_{ik}\right)^{1-\beta}. \tag{9}$$

[9] Expression (8) is derived from the aggregated individual's utility function in (1), once the individual has allocated wealth between consumption and real money balances. The individual's utility is linear in labor income, where marginal utility of real wealth equals one. Notice that expectations are rational since the expected price level is equal to the actual one.

In (9), parameter $\beta \in [0,1]$ reflects the bargaining strength of each party. The negotiation is carried out at the industry level, that is a single negotiation takes place in each sector over the industry-wide wage. The disagreement payoffs for the sectoral union and the employers' confederation are set equal to zero. Overall, expression (9) shows that we model centralization following the approach in Horn and Wolinsky [1988]. Note that throughout the analysis we impose, when necessary, the restriction of employment being the minimum of the labor demand and the competitive labor supply.[10]

Due to the symmetric nature of the economy, we first solve for partial equilibrium in sector k. Then, we derive the imperfectly competitive equilibrium for the aggregate economy. The solution of the model is straightforward. To strive for brevity, we report various partial equilibrium results in Appendix A.2.

3. Unionized Oligopoly in General Equilibrium

3.1. Equilibrium under Bertrand Competition

Consider the scenario where firms throughout the economy cooperatively choose to compete in prices. The price elasticity of demand for the representative good is derived from (5):[11]

$$\left|\varepsilon_{ik}^{B}\right| = \frac{\gamma\left(\frac{p_{ik}}{P}\right)}{1+\gamma-\delta+\frac{\delta}{(n-1)}\sum_{j\neq i}^{n}\frac{p_{jk}}{P}-\gamma\frac{p_{ik}}{P}}. \tag{10}$$

The first order condition of profit optimization, $p_{ik}(1-(1/\left|\varepsilon_{ik}^{B}\right|)) = w_{ik}$, yields the following

[10] In order to illustrate macroeconomic equilibrium in the right-to-manage model, we explicitly solve the general equilibrium model under industry-wide centralization. Equally, the model can be solved under decentralized bargaining. In this scenario, the representative Nash bargaining maximand is rewritten as: $B_{ik} = (U_{ik})^{\beta}(\Omega_{ik})^{1-\beta}$. The solution of the model under decentralization is reported in subsection 3.4 below.

[11] Throughout the analysis, superscripts B and C stand for, respectively, Bertrand and Cournot outcomes; subscripts D and IW stand for, respectively, decentralized and industry-wide bargaining.

Bertrand-Nash price best-reply function:[12]

$$\frac{p_{ik}}{P}=\frac{1}{2\gamma}\left(1+\gamma-\delta+\frac{\delta}{(n-1)}\sum_{\substack{j=1\\j\neq i}}^{n}\frac{p_{jk}}{P}+\gamma\frac{w_{ik}}{P}\right). \tag{11}$$

The Bertrand-Nash equilibrium, where no party has an incentive to change its strategy taking into account the (re)actions of the other parties, is achieved at the following price:

$$\frac{p_{ik}}{P}=\frac{\gamma}{(2\gamma-\delta)}\left(\frac{1+\gamma-\delta}{\gamma}+\frac{\delta}{2\gamma(n-1)+\delta}\sum_{\substack{j=1\\j\neq i}}^{n}\frac{w_{jk}}{P}+\frac{2\gamma(n-1)-\delta(n-2)}{2\gamma(n-1)+\delta}\frac{w_{ik}}{P}\right). \tag{12}$$

From (5) and (12), we derive the expression for firm F_{ik}'s labor demand:

$$\frac{x_{ik}}{y}=\frac{\gamma}{nK\,(2\gamma-\delta)}\left(1+\gamma-\delta+\frac{\delta\gamma}{2\gamma(n-1)+\delta}\sum_{\substack{j=1\\j\neq i}}^{n}\frac{w_{jk}}{P}-\frac{\gamma(2\gamma(n-1)-\delta(n-2))-\delta^{2}}{2\gamma(n-1)+\delta}\frac{w_{ik}}{P}\right). \tag{13}$$

Under industry-wide centralization, the firm's labor demand simplifies to:

$$\frac{x_{ik}}{y}=\frac{\gamma}{nK\,(2\gamma-\delta)}\left(1+\gamma-\delta-(\gamma-\delta)\frac{w_k}{P}\right), \tag{14}$$

since $w_{ik}=w_{jk}=w_k\ \forall i,j\in k$. The first order condition of the right-to-manage negotiation is obtained from the maximization of (9) with respect to the nominal wage. The representative bargaining parties anticipate expression (14). The outcome of the optimization yields firm's wage rule, which depends upon aggregate variables and product and labor market parameters. The expression of the wage rule is reported in Appendix A.2.

Macroeconomic equilibrium under symmetry implies that the relative price p_{ik}/P equals one. From the first order condition of profit optimization, we derive the equilibrium real wage:

$$\left(\frac{w}{P}\right)^{B*}=1-\frac{1}{\gamma}. \tag{15}$$

Expression (15) indicates that in macroeconomic equilibrium the bargained nominal wage w^{B*} is below the price level P^{B*}, hence the Bertrand firm keeps a constant markup given by:

[12] Firm F_{ik}'s choice variable is the nominal price p_{ik}, we easily write the outcome of the optimization in terms of the relative price p_{ik}/P. Note that firm F_{ik}'s price best-reply function is upward-sloping, this indicates that the Bertrand game is played in strategic complements.

$\lambda^B = 1/\left|\widehat{\varepsilon}_{ik}^B\right| = 1/\gamma$. From (15) and the wage rule under industry-wide centralization, it follows that equilibrium under Bertrand competition occurs at the aggregate output and employment level given by:[13]

$$y_{IW}^{B*} = \frac{nK}{\rho}\left(1 - \lambda^B - \frac{\beta}{2}\left(\frac{1+\gamma-\delta}{\gamma-\delta}\right)\right). \tag{16}$$

The equilibrium price level is derived from expression (16) and the macroeconomic income-expenditure identity, $y = (c/(1-c))(M^s/P)$. Similarly, by introducing the macroeconomic income-expenditure identity and the equilibrium price level in the wage rule, we obtain the equilibrium bargained nominal wage for every firm and union in the economy. It can be expressed as follows:

$$w_{IW}^{B*} = \frac{2\rho c M^S}{nK(1-c)}\left(\frac{(1-\lambda^B)(\gamma-\delta)}{2(1-\lambda^B)(\gamma-\delta) - \beta(1+\gamma-\delta)}\right). \tag{17}$$

Finally, equilibrium nominal profits under Bertrand competition are given by:

$$\Omega_{ik}^{B*} = \frac{cM^S}{nK(1-c)\gamma} \equiv \frac{Y}{nK}\lambda^B. \tag{18}$$

Next, we consider the scenario where firms cooperatively choose to compete in quantities.

3.2. Equilibrium under Cournot Competition

Profit maximization yields the following Cournot-Nash quantity best-reply function:[14]

$$\frac{x_{ik}}{y} = \frac{(\gamma(n-1)+\delta)}{2((\gamma-\delta)(n-1)+\delta)}\left(\frac{1+\gamma-\delta}{nK} - \frac{\delta}{\gamma(n-1)+\delta}\sum_{\substack{j=1\\ j\neq i}}^{n}\frac{x_{jk}}{y} - \frac{\gamma-\delta}{nK}\frac{w_{ik}}{P}\right). \tag{19}$$

The labor demand schedule under Cournot competition and industry-wide centralization is given by:

$$\frac{x_{ik}}{y} = \frac{(\gamma(n-1)+\delta)}{nK(2\gamma(n-1)-\delta(n-3))}\left(1+\gamma-\delta-(\gamma-\delta)\frac{w_k}{P}\right). \tag{20}$$

[13] Note that, when necessary, we apply a lower-bound limit on γ - i.e. $\gamma > \overline{\gamma}^B$ where $\overline{\gamma}^B > 1$ - to exclude negative solutions. In particular, $\overline{\gamma}^B$ is obtained by setting $y_{IW}^{B*} = 0$ when $\beta = 1$. We check whether $\overline{\gamma}^B$, when applicable, is overlyrestrictive. It is straightforward to show that for $\gamma = \overline{\gamma}^B$ symmetric elasticity $\left|\widehat{\varepsilon}_{ik}^B\right| \in (3, 3.41)$ and markup $\lambda_{ik}^B = 1/\left|\widehat{\varepsilon}_{ik}^B\right| \in (0.33, 0.29)$ when $\delta = \{0,1\}$, respectively. In other words, when we apply $\overline{\gamma}^B$ we implicitly ask product demand elasticity to be above 3−3.41% and the markup not to exceed 29−33%. Given that we expect high product demand elasticities when competition is oligopolistic, this does not seem overlyrestrictive.

[14] The quantity best-reply function is downward-sloping, this indicates that the Cournot game is played in strategic substitutes.

As in the Bertrand case, we derive the wage rule. Its expression is reported in Appendix A.2.

The real wage in macroeconomic equilibrium under quantity-setting competition takes the following form:

$$\left(\frac{w}{P}\right)^{C*} = 1 - \frac{(\gamma-\delta)(n-1)+\delta}{(\gamma-\delta)(\gamma(n-1)+\delta)}, \tag{21}$$

and the Cournot firm keeps a constant markup: $\lambda^C = 1/\left|\widehat{\varepsilon}_{ik}^C\right| = ((\gamma-\delta)(n-1)+\delta)/((\gamma-\delta)(\gamma(n-1)+\delta))$.

The equilibrium level of output is obtained from (21) and the wage rule under industry-wide centralization:[15]

$$y_{IW}^{C*} = \frac{nK}{\rho}\left(1-\lambda^C - \frac{\beta}{2}\left(\frac{1+\gamma-\delta}{\gamma-\delta}\right)\right). \tag{22}$$

The equilibrium price level is evaluated from expression (22) and the macroeconomic income-expenditure identity. Accordingly, the resulting bargained nominal wage can be expressed as follows:

$$w_{IW}^{C*} = \frac{2\rho c M^S}{nK(1-c)}\left(\frac{(1-\lambda^C)(\gamma-\delta)}{2(1-\lambda^C)(\gamma-\delta)-\beta(1+\gamma-\delta)}\right). \tag{23}$$

Finally, equilibrium nominal profits under Cournot competition are given by:

$$\Omega_{ik}^{C*} = \frac{cM^S((\gamma-\delta)(n-1)+\delta)}{nK(1-c)(\gamma-\delta)(\gamma(n-1)+\delta)} \equiv \frac{Y}{nK}\lambda^C. \tag{24}$$

Note that, in the absence of other distortions, money is neutral in the oligopolistically competitive economy.[16] Having solved the model of unionized oligopoly in general equilibrium, we turn to explore how equilibrium is affected by alternative market structures and shocks.

3.3. Price and Quantity Competition in General Equilibrium

One of the obvious questions the above analysis poses is to what extent the two different types of product market competition that may govern the K differentiated oligopolies yield dif-

[15] We apply a lower-bound limit on γ - i.e. $\gamma > \overline{\gamma}^C$ where $\overline{\gamma}^C > \underline{\gamma}^C$ - to exclude negative solutions. It is straightforward to show that this lower-bound limit, when applicable, is not overlyrestrictive (product demand elasticity is asked to be above $3-3.41\%$ and the markup not to exceed $29-33\%$).

[16] Under Bertrand and Cournot competition, nominal variables are homogenous of degree one in M^S.

ferent aggregate outcomes. If we start from the well-known result in oligopolistic theory stating that Bertrand competition yields higher efficiency, we expect that a switch from quantity-setting to price-setting competition will bring about an outcome closer to the perfectly competitive one. Despite the fact that it is not our objective to discuss the mechanisms that might induce firms to switch strategy, we can still compare macroeconomic outcomes under alternative types of competition. Results are summarized in Proposition 1.

PROPOSITION 1: *In general equilibrium, Cournot competition yields lower output, employment and real wage and higher price level, markup and profits than Bertrand. Accordingly, the absolute values of product and labor demand elasticities are greater under Bertrand competition.*

Proof. See Appendix A.3.

Figure 1 represents general equilibrium under Cournot and Bertrand competition in the $\{l, w/P\}$-space. The product-market-determined real wage (PRW) schedules arise from expressions (15) and (21). The labor demand schedules under Bertrand (l_{ik}^B) and Cournot (l_{ik}^C) competition follow from (14) and (20), respectively. Notice that, other things unchanged, an exogenous increase in real aggregate expenditure pivots out and flattens labor demand under both types of product market competition. As real aggregate expenditure increases, both the bargained nominal wage and the level of employment rise, since the union faces a trade-off between employment and the wage. Thus, the relationship among real aggregate expenditure, the real wage and employment is captured by the bargained-real-wage (BRW) schedule drawn in the $\{l, w/P\}$-space.[17]

[17] In the model, bargained-real-wage schedules are derived from (A.2.1) under Bertrand (BRW^B), and (A.2.2) under Cournot (BRW^C). Their relative location in Figures 1 and 2 is orientative. The proofs on their slopes and shapes are reported in Appendix A.4.

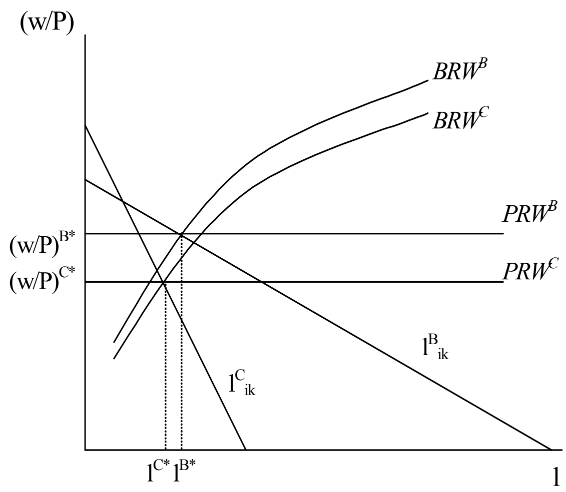

FIGURE 1. Unionized Oligopoly in General Equilibrium

Equilibrium employment occurs at the intersection of the product-market-determined real wage schedule and the bargained-real-wage schedule, specifically l^{B*} under Bertrand and l^{C*} under Cournot. Any deviation from the unique equilibrium employment rate would capture a scenario of either accelerating or decelerating inflation, depending upon whether the economy is to the right or to the left of equilibrium. In our analytical framework, rational expectations ensure that no deviations are possible, hence actual employment equals equilibrium employment. Or, in other words, real aggregate demand is always at the equilibrium employment rate.

A common feature of the bargained-real-wage schedules is their shape: as real aggregate expenditure goes up, the opportunity cost of wage increases rises. The latter has a restraining effect in union's demands on wages, yielding the shape of the schedules.[18] The comparison of equilibrium nominal wages across types of competition yields Proposition 2.

PROPOSITION 2: *In industry-wide bargaining, the equilibrium nominal wage is higher under Cournot than under Bertrand competition.*

[18] An additional aspect of 'buoyant' demand refers to the (potential) positive relation between the state of aggregate demand and union's bargaining power. In this theoretical setting, this relation is captured as two *separate* effects. Hence, if an exogenous increase in real aggregate expenditure increases union's bargaining power, then the bargained-real-wage schedule would shift upwards as a result of the aggregate demand shock. The latter follows from (A.2.1) and (A.2.2).

Proof. See Appendix A.3.

The result established in Proposition 2 is consistent with the predictions we find in existing literature (see, for example, Soskice [2000], and the partial equilibrium analysis under decentralization in Correa López and Naylor [forth.]). Hence, we expect that the higher wage elasticity of labor demand under Bertrand competition produces a lower bargained nominal wage. This is because it is more costly in terms of employment to negotiate higher wages in the face of a Bertrand oligopoly.

The benchmark scenario we use to compare the above outcomes is established by the competitive labor supply, or labor supply in short, and represented in Figure 2. The representative worker maximizes $(w/P)l - \rho l^e$, where $e = 2$, in order to choose l. Thus, labor supply is given by: $l^S = (1/2\rho)(w/P)$. The intersection of the product-market-determined real wage schedule and the labor supply schedule yields equilibrium output (and employment) when the labor market operates in perfect competition. Under Bertrand, this is given by:

$$y^B = \frac{nK}{2\rho}\left(1 - \frac{1}{\gamma}\right). \tag{25}$$

Accordingly, we obtain the equilibrium output (and employment) under Cournot and perfect competition in the labor market:

$$y^C = \frac{nK}{2\rho}\left(1 - \frac{(\gamma-\delta)(n-1)+\delta}{(\gamma-\delta)(\gamma(n-1)+\delta)}\right). \tag{26}$$

From the comparison of equilibrium real wages carried out in Proposition 1, it is straightforward to conclude that $y^B > y^C$.[19]

[19] Note that we impose the restriction that employment is the minimum of labor supply and labor demand. In other words, an equilibrium employment outcome occurring to the right of the labor supply, as point B'' in Figure 2 indicates, is not compatible with either the existence of unions in the labor markets or with the representative worker's choice over employment. In this scenario, the restriction applies and the labor supply binds.

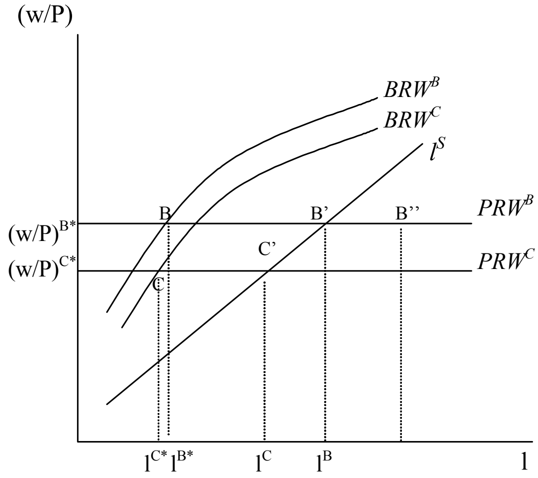

FIGURE 2. Competitive Labor Supply and the Union Employment Outcome

Next, we consider whether a unionized labor market may produce the competitive outcome. Specifically, *we find, across types of competition, combinations of parameter values* - $\{\gamma, \delta, n, \beta\}$ - *that produce the competitive equilibrium employment outcome in the labor market.* This result obtains when product and labor market parameters meet the necessary condition for the bargained-real-wage schedule to intersect the product-market-determined real wage schedule where the labor supply does. We might also interpret this result by stating that, given certain product market characteristics, workers are 'indifferent' to union wage coverage for sufficiently low values of β - that is where the labor supply binds.

We conclude by pointing out that: *for those combinations of parameter values where the labor supply does not bind, perfect competition in the labor market does not always yield higher employment than imperfect competition.* In other words, point B may lie in between points C' and B' in Figure 2. This indicates that equilibrium output under Bertrand in the presence of unions (l^{B*}) can exceed equilibrium output under Cournot in a perfectly competitive labor market (l^C).[20]

[20] The proofs of these results are reported in Appendix A.5.

3.4. The Role of Supply Shocks

We analyze the macroeconomic effects of exogenous shocks to parameters that characterize product and labor markets. In the spirit of Blanchard and Giavazzi [2003], product and labor market parameters reflect the degree of (de)regulation. Results are summarized in the following Propositions.

PROPOSITION 3: *An increase in γ increases output, employment and the real wage and reduces the price level, markup and profits. This result holds under both types of product market competition.*

Proof. See Appendix B.1.

An exogenous increase in γ will increase the own-price elasticity of product demand, and will reduce the markup of the firm. Eventually, more competition lowers the aggregate price level and increases output and employment. In other words, at a higher γ the firm perceives that one percent increase in its price reduces its share of aggregate expenditure by a larger percentage. As a result, firms pursue a lower price (higher quantity) strategy in the product market.[21]

The model can capture labor market reform through two direct channels: (i) the degree of centralization in wage-setting, (ii) the distribution of bargaining power. We bear in mind that the model does not capture the conditions under which labor market deregulation may bring about more competition in the product market - that is the equilibrium real wage is not a function of labor market parameters. Thus, deregulation in the labor market induces a change in equilibrium employment due to, exclusively, a shift of the bargained-real-wage schedule. Note, however, that the model captures the conditions under which product market

[21] The price elasticity of the individual good's share of aggregate nominal expenditure is given, in symmetric equilibrium, by: $\widehat{\xi}_{ik} = \frac{\partial \alpha_{ik}}{\partial p_{ik}} \frac{p_{ik}}{\alpha_{ik}} = 1 - \gamma < 0$, hence $\partial \widehat{\xi}_{ik} / \partial \gamma = -1$. On the other hand, note that the effect of a shock to parameter δ is explored in Section 4, where n is small and the assumption of sectoral-price taking is relaxed. In this scenario, parameter δ also affects the own-price elasticity of direct demand.

deregulation, by increasing the (absolute value of) labor demand elasticities, induces a more competitive outcome in the labor market. First, we report the solutions of the model when bargaining is decentralized. In price-setting competition, we derive the following expression for equilibrium output (and employment):

$$y_D^{B*} = \frac{nK}{\rho}\left(1-\lambda^B-\frac{\beta}{2}\left(\frac{(1+\gamma-\delta)(2\gamma(n-1)+\delta)+\delta(n-1)(\gamma-1)}{\gamma(2\gamma(n-1)-\delta(n-2))-\delta^2}\right)\right). \tag{27}$$

Correspondingly, in quantity-setting competition:

$$y_D^{C*} = \frac{nK}{\rho}\left(1-\lambda^C-\frac{\beta}{2}\left(\frac{(1+\gamma-\delta)(\gamma(n-1)+\delta)A-\delta(n-1)(A+\delta)}{(\gamma-\delta)(\gamma(n-1)+\delta)A}\right)\right), \tag{28}$$

where $A = 2\gamma(n-1)-\delta(n-2)$. The predictions of the model in terms of the macroeconomic effects of labor market-related shocks are summarized next.

PROPOSITION 4. *(i) A decentralized wage bargaining system yields higher equilibrium employment than industry-wide centralization; (ii) An increase in β reduces output and employment and increases the price level - the real wage, markup and profits are not altered. Results (i) and (ii) hold under both types of product market competition.*

Proof. See Appendix B.2 for part (i). Part (ii) is easily inferred from the expressions in general equilibrium.

A wage bargaining system centralized at the sectoral level, which emerges from the coordinating activities of unions and firms, reduces equilibrium employment. The labor demand elasticity effect is smaller when the negotiation occurs over the sectoral wage.[22] This has the effect of increasing the bargained real wage for all levels of employment, hence reducing equilibrium employment. Thus, we capture one of the aspects of the Calmfors and Driffill's [1988] argument - namely, an intermediately centralized wage bargaining system produces a higher equilibrium rate of unemployment compared to a decentralized system.

[22] The labor demand elasticity effect captures the extent of the employment loss induced by a wage increase. It is perceived as a (proportional) marginal cost by the union in the right-to-manage negotiation.

An increase in β can be graphically represented as a shift upwards, for all levels of employment, of the bargained-real-wage schedules depicted in Figures 1 and 2. Therefore, for a given level of real aggregate expenditure - that is for a certain labor demand schedule - higher union bargaining power increases the bargained real wage. Since the bargained real wage is above the product-market-determined real wage, that is marginal cost is above marginal revenue from the firm's point of view, firms adjust by reducing output and increasing prices. The latter is subsequently translated into an increase in the price level, a reduction in real aggregate expenditure and, hence, an inward-shifted labor demand schedule. The process continues until the new equilibrium is reached, where the new bargained-real-wage schedule intersects the unchanged product-market-determined real wage schedule. Notice that rational expectations imply an instantaneous adjustment to the new equilibrium.

Overall, an increase in union bargaining power reduces equilibrium employment and output. In dynamic terms, we would argue that, in the event of a permanent shock that increases β, real aggregate expenditure falls in order to stabilize inflation at a higher rate, where equilibrium unemployment has also increased. Thus, the predictions of the model are consistent with earlier literature (see, for example, Layard, Nickell and Jackman [1991]). Finally, note that an increase in worker's marginal disutility from work (parameter ρ increases) reduces equilibrium output and increases the price level under price and quantity competition.

Sections 4 and 5 are devoted to, respectively, an extension of the basic model - where we consider the strategic interactions that may occur among firms, unions and the monetary authority - and an application of the model to explain a topical issue - namely, the (joint) performance of the labor share and the unemployment rate in Continental Europe over the 1990s.

4. Extension: Unionized Oligopoly and Monetary Policy

We present an alternative channel for the development of strategic interactions among firms, unions and the monetary authority. This channel creates a transmission mechanism for the existence of real effects of monetary policy-related shocks. The basic message conveyed in this transmission mechanism is straightforward: as long as firms and unions care about the sectoral price effects of their individual pricing strategies *and* as long as the central bank monitors sectoral price indices when conducting monetary policy, real effects might be expected from a change in either the type of institution conducting monetary policy or the specific monetary rule it adheres to. Let us point out that our approach does not challenge the money neutrality thesis: changes in nominal money supply do not have real effects. Thus, this section explores a path opened by the general equilibrium model developed above.

Perhaps a more accurate description of the economy would allow for a large number of sectors with a relatively small number of firms operating in each. For n small, it is reasonable to think that an individual firm would take into account the effect of its product market strategy on the sectoral-specific price index ψ, which in turn affects product demand. In this scenario, the direct demand function perceived by the firm is re-written as follows:

$$x_{ik} = \frac{cM^S}{nK(1-c)P}\left(1+\gamma-\delta+\frac{\delta}{(n-1)}\sum_{\substack{j=1\\ j\neq i}}^{n}\frac{p_{jk}}{\psi_k}-\gamma\frac{p_{ik}}{P}\right), \tag{29}$$

where the income-expenditure identity is already introduced, and symmetry in aggregate price indices is anticipated. In (29), we observe that product demand is not linear in own-price, since ψ_k depends upon p_{ik}. However, since K is large, the assumptions of aggregate-price-taking and aggregate-income-taking at partial equilibrium are not violated.

Prior to wage and price formation, we introduce a stage of the game where the monetary authority (credibly) precommits to a monetary rule described by parameter ϕ. We consider two alternative monetary regimes under which the economy may be functioning: a domestic central bank (DCB) regime; a monetary union (MU) regime. In each monetary regime, the domestic money supply M^S is given by:

$$M^S_{DCB} = \left(\sum_{k=1}^{K} \alpha_k \psi_k\right)^{\phi} \;;\; M^S_{MU} = \left(\frac{\sum\limits_{k=1}^{K} \alpha_k \psi_k + \sum\limits_{k=1}^{K} \alpha^*_k \psi^*_k}{2}\right)^{\phi} \;;\text{ where } -1 \leq \phi \leq 1. \qquad (30)$$

Parameter α_k represents the share of aggregate expenditure allocated to sector k by the (aggregated) individual. Accordingly, α^*_k and ψ^*_k capture foreign country variables, such that the domestic and foreign countries are assumed of equal size. In (30), we assume that the monetary authority is sensitive to a weighted average of sectoral price indices - domestic and foreign (when relevant) - in setting nominal money supply. A monetary authority sensitive to sectoral price indices is not new to the monetary policy-making literature (see, more recently, Mankiw and Reis [2003]).

Regarding the monetary rule: for $\phi > 0$, the central bank accommodates any price increase through an expansion of the nominal money supply, such that $\phi = 1$ delivers full accommodation. For $\phi < 0$, the central bank reduces nominal money in response to a price increase. The limiting case occurs at $\phi = -1$ where we capture full monetary contraction (tightening) - that is, the fall in M^S is of identical size to the increase in, say, ψ_k once the central bank accounts for the weight of ψ_k in M^S. For $\phi = 0$, the nominal money supply is fixed and equal to 1, hence we assume exogenous M^S.[23] Note that, at the start of the game, the monetary authority is endowed with a certain value of ϕ as a result of past reputation-building.

To make our point on the existence of real effects of monetary institution and monetary rule, we derive from (29) the own-price elasticity of demand in symmetric equilibrium. To strive for

[23] The choice of 1 owes to analytical simplicity. Instead, we could introduce parameter m, and changes in m would capture exogenous changes in nominal money supply that would be present for any ϕ-value. In the cross-country symmetric solution, where all individual prices (domestic and foreign) are identical and equal to P, the specifications above amount to Soskice and Iversen's [2000] where $M^S = P^{\alpha}$. The difference being that Soskice and Iversen [2000] do not consider the possibility of nominal contraction, that is $\alpha \in [0, 1]$. Evidence suggesting nominal tightening from the monetary authority in response to excessive wage agreements has commonly pointed out to the German Bundesbank.

simplicity, we assume price-setting competition in each oligopoly and cross-country symmetry. Note that the firm, when it optimizes profits, takes into account the effect of its price strategy on its corresponding sectoral price index. In the knowledge of the structure of money supply given by (30), this implies that the firm internalizes the effect of its price strategy on M^S, which in turn affects product demand. This effect depends upon parameter ϕ and the existing monetary regime, and acts as a link between the productive side of the economy and monetary policy.

Thus, the own-price elasticity under alternative monetary regimes is given by:

$$|\widehat{\varepsilon}_{ik}|_{DCB} = \gamma + \frac{\delta}{n} - \frac{\phi}{nK}; \quad |\widehat{\varepsilon}_{ik}|_{MU} = \gamma + \frac{\delta}{n} - \frac{\phi}{2nK}; \tag{31}$$

where $|\widehat{\varepsilon}_{ik}|$ increases in the degree of substitutability δ. The second term in price elasticity depends upon n: a larger n implies a smaller impact of firm F_{ik}'s price on the sectoral price index ψ_k, thus a smaller reduction in x_{ik} after an increase in $p_{ik.}$

There are two major implications that follow from (31):

- *Elasticity in symmetric general equilibrium depends upon the monetary rule - this holds across monetary institutions.* For $\phi < 0$, firms perceive a more elastic product demand. This is because nominal tightening implies that any individual price increase is followed by a reduction in M^S, hence in product demand. For $\phi > 0$, firms perceive a less elastic product demand, since individual price increases expand product demand through the expansion of nominal money. Hence, the character of the monetary rule - accommodating vis-à-vis tightening - has real effects: it determines whether the firm will have an incentive to follow a lower or a higher price strategy than otherwise.[24] Note that, the larger nK the smaller the individual price effect on nominal money supply.
- *The macroeconomic effects of the establishment of a monetary union depend upon the character of the monetary rule.*[25] For $\phi > 0$, firms perceive a more elastic product demand

[24] By 'otherwise' we mean the scenario of exogenous M^S, captured by $\phi = 0$, and solved in Section 3.
[25] In an attempt to isolate the effects of the formation of a monetary union, we assume that no

when the monetary union is formed. In a monetary union, the (domestic) monetary expansion that follows after an individual 'domestic' price increase is reduced, due to the fact that the monetary authority reacts now to individual prices across the monetary union. In other words, an individual price has a smaller impact on monetary policy. For $\phi < 0$, firms perceive a less elastic product demand when the monetary union is formed. In a monetary union, the (domestic) monetary contraction that follows after an individual 'domestic' price increase is reduced, since an individual price has a smaller impact on monetary policy. Thus, the establishment of a monetary union, by altering the incentives of firms towards price formation, will have real effects. The sign and extent of these effects will depend upon the character and the specific value of the monetary rule.

The above sketch of the extended model has helped to construct our argument. In fact, if the labor market is perfectly competitive, we arrive to the following expressions for equilibrium output (and employment) across monetary regimes:

$$y^B_{DCB} = \frac{nK}{2\rho}\left(1 - \frac{1}{\gamma + \frac{\delta}{n} - \frac{\phi}{nK}}\right); \; y^B_{MU} = \frac{nK}{2\rho}\left(1 - \frac{1}{\gamma + \frac{\delta}{n} - \frac{\phi}{2nK}}\right). \tag{32}$$

In (32), we find that a switch from accommodation to tightening increases equilibrium employment. Also, if the monetary authority reduces the money supply in response to price increases, the formation of a monetary union may have a negative impact on employment. On the other hand, note that an increase in the degree of product substitutability, δ, induces a more efficient outcome in general equilibrium.

However, in order to provide a full account of the real effects of the monetary factors addressed here, we need to introduce imperfect competition in the labor market. For n small, we anticipate that wage bargaining agents who behave strategically would also internalize the effect of their wage-setting strategies on the sectoral-specific price index (hence on M^S and

structural parameter or objective function is altered with its formation. Although simplistic, this is a common assumption in the literature (see, for example, Cukierman and Lippi [2001]).

on labor demand). Thus, the evaluation of the output and employment effects of shocks to monetary policy factors should take into account the interactions among: (i) monetary policy rule (character and value of ϕ), (ii) monetary institution (domestic central bank vis-à-vis monetary union), (iii) degree of competition in oligopolistic markets (proxied by γ), and (iv) degree of competition in labor markets (proxied by β). Finally, in (31) we note that perfect competition in product markets ($\gamma \to \infty$) yields neutrality of both monetary rule and monetary institution.[26]

5. Application: A Discussion on European Performance

We conclude with an informal and brief discussion on the predictions of the model regarding the performance of the unemployment rate and of the labor share in Continental Europe over the 1990s. Blanchard and Giavazzi [2003] report a dramatic fall of the labor share in Continental Europe in the early to mid-1980s, matched by increasing unemployment. During the 1990s, the labor share (proxied by the real wage) has recorded a milder but steady fall. Meanwhile, the unemployment rate has persisted high - with a respite in the late 1990s, when it started to fall.[27]

In their explanation on the joint evolution of the labor share and the unemployment rate in Continental Europe since the early 1980s, Blanchard and Giavazzi [2003] place emphasis on two outcomes that may accompany product and labor market deregulation: the (initial) redistribution of rents among economic players (workers and firms), and its subsequent dynamic effects - when further redistribution takes place. Their key contribution is to show that a decrease in workers' bargaining power reduces the real wage in the short-run, with the potential

[26] The analytical solution of the extended model under industry-wide bargaining can be found in Correa López [2004], where we explore the output and employment effects induced by shocks to the monetary rule and the monetary regime.

[27] The decline of the labor share over the 1990s averages about 3 per cent for the four large Continental European economies - Germany, France, Italy and Spain. For country-specific evidence, see Blanchard and Giavazzi [2003].

benefit of a fall in unemployment and an unchanged (pre-shock) real wage in the long-run.[28] Furthermore, by assuming concave utility for workers - that is an upward-sloping contract curve - labor market deregulation yields a lower real wage *and* increased unemployment in the short-run, in exchange for lower unemployment and an unchanged real wage in the long-run. Blanchard and Giavazzi [2003] argue that the recent evolution of the labor share and of the unemployment rate recorded in Continental Europe may be the result of the decline in unions' bargaining power experienced over the 1980s. Their theoretical setting supports this argument *if* the effects of the decline in workers' bargaining power (as a result of labor market deregulation policies) *dominate* the effects of the decline in the markup (as a result of product market deregulation policies).

In our model wages are allocative and the equilibrium real wage mirrors the markup, hence the discussion that follows is necessarily different to the one presented in Blanchard and Giavazzi [2003]. Suppose that some of the effects associated to product and labor market deregulation in Europe over the 1990s are captured by: (i) increases in product demand elasticities (component γ in elasticity increases), (ii) falling union bargaining power (β decreasing) , (iii) a shift to a decentralized wage bargaining system. A casual look at the evidence suggests that the aforementioned deregulatory moves may not have had the expected employment-enhancing effects. Furthermore, they do not explain the evolution of the labor share.

The model identifies another factor - namely, the degree of product substitutability - whose evolution may have played a role in the steady decline of the labor share and in the persistence of high unemployment in Continental Europe over the 1990s. Specifically, let us consider that firms, in an attempt to offset the pressure of integration on the markup, have placed more effort on differentiating their products (δ decreases due to, for example, increased advertising

[28] Note that Blanchard and Giavazzi's [2003] results crucially depend upon the assumption of efficient bargaining in the labor market. They show that their main prediction breaks down when bargaining is described by the right-to-manage model, since there is no intertemporal trade-off emerging from a decline in workers' bargaining power.

budgets and more aggressive marketing). The latter, in turn, may discourage entry by making it more 'costly' (see a related discussion in Solow [1998]). In (31), we observe that a fall in δ reduces the price elasticity of direct product demand - which, in turn, reduces the real wage (labor share) and increases unemployment. Note that, in order to explain the evolution of the labor share, the effect on the markup of a lower degree of product substitutability must have dominated the effect of a higher γ as a result of product market deregulation.[29]

We finish by emphasizing that the actual relevance of the aforementioned factors in explaining European performance is a matter of empirical assessment. Furthermore, the evolution of other factors need also be taken on board - such as technological ones and the monetary factors identified in Section 4. In fact, we anticipate that monetary factors might create a transmission mechanism of product and labor market deregulation in a monetary union. That is, *if* the union-wide central bank designs its optimal monetary policy rule (ϕ^* in our setting) by considering the structural characteristics of product and labor markets of countries across the union, we may find that a country embarked on a deregulatory path influences, through its effect on ϕ^*, the macroeconomic performance of a second country. This effect would be particularly noticeable if the country deregulating is one of the large economies in the union.

6. Conclusion

This paper has introduced a tractable model of unionized oligopoly in general equilibrium. By adopting the dual approach to model consumer choice, we developed a theoretical framework able to embed in general equilibrium the strategic interactions that may take place among firms in oligopolistic markets and firms and unions in labor markets. The aim was to explore the macroeconomic effects of a variety of characteristics that may govern the oligopolistically

[29] An additional aspect relevant to the degree of competition refers to the pace of the appearance of new sectors in the economy (K increasing). New sectors imply new goods potentially able to win part of the share of aggregate expenditure going to existing goods (recall that $\alpha_{ik} = 1/(nK)$ in equilibrium). One may argue that the introduction of these new sectors has been relatively slow in Europe over the 1990s. Note that the model, as it stands, is not ready to evaluate the dynamics of the appearance of new sectors.

competitive and unionized economy.

The model produced some of the standard results we find in the literature of imperfectly competitive macroeconomics: the inefficiency of the oligopolistically competitive equilibrium and money neutrality. It also yielded a variety of other results. These include: the positive employment effect of moving from quantity-setting to price-setting competition, and the finding that perfect competition in the labor market does not always yield higher equilibrium employment compared to imperfect competition - that is, equilibrium employment under Bertrand in the presence of unions can exceed equilibrium employment under Cournot in a perfectly competitive labor market. Hence, under certain product and labor market conditions, we may find that a unionized economy with price-setting firms may outperform a nonunionized one with quantity-setting firms. In addition, we concluded that unionization may produce the competitive outcome in the labor market. Thus, there is a threshold value of union bargaining power at which workers are indifferent between union wage coverage and the outcome delivered by the competitive labor supply. The exact threshold value of union power depends upon product market characteristics: a more elastic product demand implies a higher threshold value. A corollary of this result is to argue that the more competitive product markets are, the more difficult is for unions to survive - unless they take up other roles apart from wage bargaining coverage. Overall, the above results seem to give support to the notion - as in Blanchard and Giavazzi [2003] - that deregulation should start from the product market. To the extent that the outcome of the wage negotiation is located on the labor demand schedule, a by-product of deregulating the product market is a more competitive outcome in the labor market.

The micro foundations of the model offered an alternative transmission mechanism of monetary policy. This transmission mechanism operates via sectoral price indices. Specifically, we argued that, *as long as firms and unions care about the inflationary 'signals' their sector is sending to consumers and as long as the central bank is responsive to sectoral inflation*, real effects may be present from a change in either the type of institution conducting monetary policy or the specific monetary rule it adheres to. Finally, we informally applied the model to explain a topical issue: the (joint) performance of the labor share and the unemployment rate in Continental Europe over the 1990s. This application had in mind the recent deregulatory path embarked on by several Continental European economies. We conclude by pointing out that macroeconomic performance may be explained, to a significant extent, by the joint evolution of a wide array of factors: from 'productive side' factors - such as the degree of product substitutability and the distribution of bargaining power in the labor market - to 'monetary policy' factors - such as the monetary policy rule and the type of monetary institution.

There are a number of directions for further research. These include: (i) to explore the effects of capital stock and productivity changes in general equilibrium with unionized oligopoly; (ii) to evaluate the macroeconomic impact of alternative bargaining structures, such as efficient bargaining, and of 'within-sector' asymmetries, such as partial unionization; and (iii) to investigate trade-related issues, where strategic interactions among domestic and foreign economic agents occur.

Appendix

A.1. *Validity of the expenditure and unit cost functions*

The domain of function $b(p)$ is defined by $S \equiv \{p \in \Re^{nk}_{+} : p_{ik} > 0, i = 1, ..., n, k = 1, ..., K\}$. We check that $b(p)$ exhibits the sufficient properties: (i) Non-negative and non-decreasing in prices; (ii) Homogeneity of degree one and concavity in p; (iii) Continuous differentiability. As Datta and Dixon [2000] emphasize, property (iii) is not necessary for validity but for the application of Shephard's lemma. Given K large, $n \geq 2$, $\gamma > 0$ and $\delta \in (0, 1]$, it is straightforward to conclude that $b(p)$ is continuously differentiable and homogeneous of degree one.

Concavity in p is proven by checking that $b_1(p)$ and $b_2(p)$ are concave, where $b_1(p) = (1 - \delta)\mu + \gamma[\mu - \pi]$ and $b_2(p) = \delta\Psi$. Specifically, concavity of $b_1(p)$ implies that $\varphi b_1(\widetilde{p}) + (1-\varphi) b_1(\overline{p}) \leqslant b_1(\varphi\widetilde{p} + (1 - \varphi)\overline{p})$ where $0 < \varphi < 1$ and $\{\widetilde{p}, \overline{p}\} \in S$. In order to assess the concavity of $b_2(p)$ we start by checking the concavity of the *representative* sectoral price index ψ_k, whose domain $s_k : s_k \subset S$ is defined by $s_k \equiv \{p_k \in \Re^{n}_{+} : p_{ik} > 0, i = 1, ..., n\}$. Denote H^{ψ_k} as the Hessian matrix associated to ψ_k. Hence, given a n-size sector k, where $n \geq 2$, it is straightforward to check that *all* principal minors of H^{ψ_k} exhibit the following signs: $\left|H^{\psi_k}_m\right| < 0$ for m odd and $m < n$, $\left|H^{\psi_k}_m\right| > 0$ for m even and $m < n$ and $\left|H^{\psi_k}_m\right| = 0$ for $m = n$ (i.e. when $\left|H^{\psi_k}_m\right| = \left|H^{\psi_k}\right|$). More specifically, for $m < n$, the *leading* principal minors can be expressed as follows:

$$\left|H^{\psi_k}_m\right| = \frac{(-1)^m}{(n-1)^{m+1}\, n^{m+1}\, \psi_k^{m+2}} \Big[-n(m-1)(n-1)\psi_k^2 - \tag{A.1.1}$$

$$(m-2)\left(\left(\sum_{\substack{j=1\\ j\neq 1}}^{n} p_{jk}\right)^2 + \left(\sum_{\substack{j=1\\ j\neq 2}}^{n} p_{jk}\right)^2 + ... + \left(\sum_{\substack{j=1\\ j\neq m}}^{n} p_{jk}\right)^2\right) +$$

$$2\,\Big(\sum_{\substack{j=1\\ j\neq 1}}^{n} p_{jk} \sum_{\substack{j=1\\ j\neq 2}}^{n} p_{jk} + \sum_{\substack{j=1\\ j\neq 1}}^{n} p_{jk} \sum_{\substack{j=1\\ j\neq 3}}^{n} p_{jk} + ... + \sum_{\substack{j=1\\ j\neq 1}}^{n} p_{jk} \sum_{\substack{j=1\\ j\neq m}}^{n} p_{jk} + \sum_{\substack{j=1\\ j\neq 2}}^{n} p_{jk} \sum_{\substack{j=1\\ j\neq 3}}^{n} p_{jk} +$$

$$\sum_{\substack{j=1\\ j\neq 2}}^{n} p_{jk} \sum_{\substack{j=1\\ j\neq 4}}^{n} p_{jk} + ... + \sum_{\substack{j=1\\ j\neq 2}}^{n} p_{jk} \sum_{\substack{j=1\\ j\neq m}}^{n} p_{jk} + ... + \sum_{\substack{j=1\\ j\neq (m-1)}}^{n} p_{jk} \sum_{\substack{j=1\\ j\neq m}}^{n} p_{jk}\Big)\Big],$$

such that the long term in brackets in (A.1.1) equals zero for $m = n$. Overall, we conclude that the Hessian matrix associated to ψ_k is negative semidefinite, hence ψ_k is concave. Note that the sectoral price indices - $\{\psi_1, \psi_2, ..., \psi_K\}$ - have the same functional form as ψ_k in their corresponding subset of S. Thus, they are also characterized by negative semidefinite Hessian matrices whose principal minors exhibit the pattern of signs described above.

Finally, given $\Psi = (\sum_{k=1}^{K} \psi_k)/K$, the Hessian matrix associated to Ψ is given by:

$$H^{\Psi} = \begin{pmatrix} H^{\psi_1} & 0 & 0 & ... & 0 \\ 0 & H^{\psi_2} & 0 & ... & 0 \\ 0 & 0 & H^{\psi_3} & ... & 0 \\ ... & ... & ... & ... & ... \\ 0 & 0 & 0 & ... & H^{\psi_K} \end{pmatrix}, \tag{A.1.2}$$

where the positive constant term $(1/K)$ is omitted for simplicity. The Hessian matrix H^{Ψ} is $nK \times nK$, where 0 stands for a $n \times n$ null matrix. From the structure of (A.1.2) and the analysis of H^{ψ_k} it can be shown that H^{Ψ} is negative semidefinite, more particularly, all its principal minors exhibit the following signs: $\left|H_m^{\Psi}\right| \leq 0$ for m odd and $m < nk$, $\left|H_m^{\Psi}\right| \geq 0$ for m even and $m < nk$ and $\left|H_m^{\Psi}\right| = 0$ for $m = nk$ (i.e. where $\left|H_m^{\Psi}\right| = \left|H^{\Psi}\right|$). Overall, we can conclude that Ψ and, hence, $b_2(p)$ are concave.

Given the domain defined by S, property (i) is re-written such that $b(p)$ has to be positive and non-decreasing in prices. Property (i) implies that *demands are non-negative*; it also implies that an additional unit of utility is costly. This property is met given the nature of firms operating in imperfectly competitive markets. Oligopolistic firms competing in substitutes will not, in general, find profitable to set a price above the choke-off price such that demands become negative. Finally, from the analysis derived above we note that the expenditure function is homothetic.

A.2. *Partial Equilibrium Outcomes*

Under price-setting competition and industry-wide centralization, the wage rule is given by:

$$\left(\frac{w_k}{P}\right)^B_{IW} = \frac{(1+\gamma-\delta)}{2(\gamma-\delta)}\left(\frac{2\rho\gamma(\gamma-\delta)\,y + \beta\,nK(2\gamma-\delta)}{\rho\gamma(\gamma-\delta)\,y + nK(2\gamma-\delta)}\right). \tag{A.2.1}$$

Accordingly, the wage rule when competition is Cournot is given by:

$$\left(\frac{w_k}{P}\right)^C_{IW} = \frac{(1+\gamma-\delta)}{2(\gamma-\delta)}\left(\frac{2\rho(\gamma-\delta)(\gamma(n-1)+\delta)\,y + \beta\,nK(2\gamma(n-1)-\delta(n-3))}{\rho(\gamma-\delta)(\gamma(n-1)+\delta)y + nK(2\gamma(n-1)-\delta(n-3))}\right). \tag{A.2.2}$$

A.3. *Proof of Proposition 1*

Real wage: the comparison of (15) and (21) yields $(w/P)^{B^*} > (w/P)^{C*} \leftrightarrow -\delta^2 < 0$, which holds $\forall\delta : \delta \in (0,1]$. The latter, together with the first order condition of profit optimization, yields the conclusion on the markups, such that $\lambda^C > \lambda^B$, and on the product (and labor) demand elasticities. Output: we compare (16) and (22), since $\lambda^C > \lambda^B$ it follows that $y^{B*}_{IW} > y^{C*}_{IW}$. The result on the price level is derived from the output comparison together with the macroeconomic income-expenditure identity, $y = (c/(1-c))(M^s/P)$. Nominal profits: we compare (18) and (24), since $\lambda^C > \lambda^B$ it follows that $\Omega^{C*}_{ik} > \Omega^{B*}_{ik}$.

Proof of Proposition 2

Equilibrium nominal wages: we compare (17) and (23), such that $w^{C*}_{IW} > w^{B*}_{IW} \leftrightarrow \beta\delta^2(1+\gamma-\delta) > 0$, which holds for $\gamma > 1$, $\delta \in (0,1]$ and $\beta \in (0,1]$. Note that $\beta = 0$ yields identical nominal wages - however, the labor supply binds.

A.4. *The slope and shape of the bargained-real-wage schedules*

From expressions (A.2.1) and (A.2.2), we evaluate the derivative of the corresponding wage rule with respect to real aggregate expenditure:

$$\frac{\partial(\frac{w_k}{P})^B_{IW}}{\partial y} = \frac{nK\rho\gamma(1+\gamma-\delta)(2\gamma-\delta)(2-\beta)}{2(\rho\gamma(\gamma-\delta)y + nK(2\gamma-\delta))^2};$$

$$\frac{\partial(\frac{w_k}{P})^C_{IW}}{\partial y} = \frac{nK\rho(1+\gamma-\delta)(\gamma(n-1)+\delta)(2\gamma(n-1)-\delta(n-3))(2-\beta)}{2(\rho(\gamma-\delta)(\gamma(n-1)+\delta)y + nK(2\gamma(n-1)-\delta(n-3)))^2};$$

which are strictly positive for $n \geq 2$, $\gamma > 1$, $\delta \in (0,1]$, $\rho > 0$ and $\beta \in [0,1]$. It is straightforward to conclude that the second order derivatives with respect to y are strictly negative, yielding the shape of the BRW schedules.

A.5. *Showing that* $l^B = l^{B*}_{IW}$ *for certain combinations of parameter values*

We compare (16) and (25) - divided by nK: $l^B = l^{B*}_{IW}$ requires $(\gamma-\delta)(\gamma-1)-\gamma\beta(1+\gamma-\delta) = 0$. This holds for the following combinations of $\{\gamma,\delta,\beta\}$ values: $\widetilde{\beta}^B_{IW} = (\gamma-\delta)(\gamma-1)/(\gamma(1+\gamma-\delta))$, where $0 < \widetilde{\beta}^B_{IW} < 1$ for $\gamma > 1$ and $\delta \in (0,1]$. Thus, it is straightforward to conclude that, given $\{\gamma,\delta\}$, $\beta = \widetilde{\beta}^B_{IW}$ yields $l^B = l^{B*}_{IW}$, any $\beta > \widetilde{\beta}^B_{IW}$ yields $l^B > l^{B*}_{IW}$, and any $\beta < \widetilde{\beta}^B_{IW}$ yields $l^B < l^{B*}_{IW}$. In the latter scenario, the restriction applies and the labor supply binds.

Showing that $l^C = l^{C*}_{IW}$ *for certain combinations of parameter values*

We compare (22) and (26) - divided by nK: $l^C = l^{C*}_{IW}$ requires $(1-\lambda^C) - \beta((1+\gamma-\delta)/(\gamma-\delta)) = 0$. This holds for the following combinations of $\{\gamma,\delta,n,\beta\}$ values: $\widetilde{\beta}^C_{IW} = (1-\lambda^C)(\gamma-\delta)/(1+\gamma-\delta)$, where $0 < \widetilde{\beta}^C_{IW} < 1$ for $n \geq 2$, $\gamma > 1$ and $\delta \in (0,1]$. Thus, it is straightforward to conclude that, given $\{\gamma,\delta,n\}$, $\beta = \widetilde{\beta}^C_{IW}$ yields $l^C = l^{C*}_{IW}$, any $\beta > \widetilde{\beta}^C_{IW}$ yields $l^C > l^{C*}_{IW}$, and any $\beta < \widetilde{\beta}^C_{IW}$ yields $l^C < l^{C*}_{IW}$. In the latter scenario, the restriction applies and the labor supply binds.

Showing that $l^{B*}_{IW} > l^C$ *for certain combinations of parameter values*

We compare (16) and (26) - divided by nK: $l^{B*}_{IW} = l^C$ implies that $(\gamma-\delta)(\gamma-1)(\gamma(n-1)+\delta)+\delta^2-\beta\gamma(1+\gamma-\delta)(\gamma(n-1)+\delta) = 0$, which holds for the following combinations of $\{\gamma,\delta,n,\beta\}$ values:

$$\overline{\beta}_{IW} = \frac{(\gamma-\delta)(\gamma-1)(\gamma(n-1)+\delta)+\delta^2}{\gamma(1+\gamma-\delta)(\gamma(n-1)+\delta)},$$

where $0 < \overline{\beta}_{IW} < 1$ for $n \geq 2$, $\gamma > 1$ and $\delta \in (0,1]$. This implies that, given $\{\gamma,\delta,n\}, \beta = \overline{\beta}_{IW}$ yields $l^{B*}_{IW} = l^C$. We check that for those combinations of parameter values captured by $\beta = \overline{\beta}_{IW}$, where $l^{B*}_{IW} = l^C$, the labor supply does not bind. This requires to show that $\overline{\beta}_{IW} > \widetilde{\beta}^B_{IW}$. Specifically, we find that $\overline{\beta}_{IW} > \widetilde{\beta}^B_{IW} \leftrightarrow \delta^2 > 0$, which holds $\forall\delta$. Overall, it is straightforward to conclude that, given $\{\gamma,\delta,n,\beta\}$, $\overline{\beta}_{IW} < \beta \leq 1$ yields $l^{B*}_{IW} < l^C$, $\beta = \overline{\beta}_{IW}$ yields $l^{B*}_{IW} = l^C$, and $\widetilde{\beta}^B_{IW} < \beta < \overline{\beta}_{IW}$ yields $l^{B*}_{IW} > l^C$.

B.1. *Proof of Proposition 3*

Price-setting competition: in (15), we observe that the real wage (markup) increases (decreases) in γ. The derivative of equilibrium output with respect to γ is given by:

$$\frac{\partial y_{IW}^{B*}}{\partial \gamma} = \frac{nK}{\rho}\left(\frac{1}{\gamma^2} + \frac{\beta}{2(\gamma-\delta)^2}\right),$$

which is positive for $n \geq 2$, $\gamma > 1$, $\delta \in (0,1]$, $\rho > 0$ and $\beta \in [0,1]$. The result on equilibrium output, together with the macroeconomic income-expenditure identity, yields the sign of the effect of γ on the price level. Finally, nominal profits fall as γ increases, since λ^B decreases in γ. Quantity-setting competition: from (21), it follows that the markup (real wage) decreases (increases) in γ since

$$\frac{\partial \lambda^C}{\partial \gamma} = -\frac{1}{n}\left(\frac{1}{(\gamma-\delta)^2} + \frac{(n-1)^3}{(\gamma(n-1)+\delta)^2}\right) < 0$$

for $n \geq 2$, $\gamma > 1$ and $\delta \in (0,1]$. The derivative of equilibrium output with respect to γ is given by:

$$\frac{\partial y_{IW}^{C*}}{\partial \gamma} = \frac{nK}{\rho}\left(-\frac{\partial \lambda^C}{\partial \gamma} + \frac{\beta}{2(\gamma-\delta)^2}\right),$$

which is positive for $n \geq 2$, $\gamma > 1$, $\delta \in (0,1]$, $\rho > 0$ and $\beta \in [0,1]$. Once again, the result on equilibrium output together with the macroeconomic identity, yields the sign of the effect of γ on the price level. Finally, Cournot profits fall as γ increases, since λ^C decreases in γ.

B.2. *Proof of Proposition 4*

Price-setting competition: we compare (27) and (16). Specifically, $y_D^{B*} > y_{IW}^{B*} \leftrightarrow \beta\delta(n-1)(2\gamma-\delta)/(2(\gamma-\delta)(\gamma(2\gamma(n-1)-\delta(n-2))-\delta^2)) > 0$, which holds for $n \geq 2$, $\gamma > 1$, $\delta \in (0,1]$ and $\beta \in (0,1]$. Note that $\beta = 0$ yields identical employment outcomes. Quantity-setting competition: we compare (28) and (22), such that $y_D^{C*} > y_{IW}^{C*} \leftrightarrow \beta\delta(n-1)^2(2\gamma-\delta)/(2(\gamma-\delta)(\gamma(n-1)+\delta)(2\gamma(n-1)-\delta(n-2))) > 0$, which holds for $n \geq 2$, $\gamma > 1$, $\delta \in (0,1]$ and $\beta \in (0,1]$. Once again, $\beta = 0$ yields identical employment outcomes.

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