Collective bargaining, firm heterogeneity and unemployment*

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May 9, 2012

Abstract

We compare labor market outcomes under firm-level and sector-level bargaining in a one-sector Mortensen-Pissarides economy with firm-specific productivity shocks. Our main theoretical results are twofold. First, unemployment is lower under firm-level bargaining, due both to a lower job destruction rate and a higher job-finding rate. Key to this result is the interplay between wage compression under sector-level bargaining and firm heterogeneity. Second, introducing efficient opting-out of sector-level agreements suffices to bring unemployment down to its level under decentralized bargaining.

Keywords: collective bargaining, firm-specific shocks, wage compression, unemployment

JEL codes: E10, J64

*The authors are very grateful to Marcel Jansen, Christian Haefke, Christian Merkl, Silvana Tenreyro, conference participants at ECB/CEPR/IfW Labor Market Workshop and seminar participants at Banco de España for helpful comments and suggestions. This article reflects the views of its authors and does not necessarily reflect the views of Banco de España

1 Introduction

In most of continental Europe, wage bargaining takes place predominantly in the form of collective bargaining. The proportion of workers covered by collective bargaining agreements typically exceeds by far union membership, and in some cases coverage is almost universal. Among European countries, however, there are noticeable differences in the levels at which wage bargaining takes place (national, regional, sector, firm), the way in which collective bargaining agreements overlap, the unions and employers which are entitled to bargain, and the extension rules by which the agreements may be applied to workers and firms outside their scope.[1] The idea that the characteristics of collective bargaining systems may influence unemployment has received a lot of attention, at least since the 1980s, with many empirical studies trying to assign cross-country differences in unemployment to some of these characteristics.[2]

Possibly the most influential argument to relate collective bargaining and unemployment was the "hump-shape" relationship between centralization of collective bargaining and real wages, proposed by Calmfors and Driffill (1988). The basis for this relationship is well-known: when collective bargaining takes place at firms facing competitive markets, there are not monopolistic rents to be shared among the wage-setters and real wages remain in line with productivity; when it takes place at the national level, wage-setters take into account "broader interests" and internalize the external effects of wage increases, such as, for instance, those on inflation, unemployment, and taxes needed to finance unemployment benefits. However, when collective bargaining takes place at an intermediate level (say, sectorial or regional) wages are not restrained by neither competition nor "corporatism", and, hence, unemployment is higher. This argument was extended to take into account other external effects of wage increases and to put it in the context of an open economy (Calmfors, 1993; Danthine and Hunt, 1994), with the conclusion that the hump shape hypothesis remains valid, although the unemployment consequences of the centralization of collective bargaining are less pronounced. Partly because of this, partly because of the difficulties to measure concepts like the "centralization" and the "coordination" of collective bargaining, the empirical literature has not found categorical evidence that cross-country differences in unemployment are related to cross-country differences in collective bargaining systems (OECD, 1997; Flanagan, 1999).

A striking feature in existing theoretical models on the macroeconomic effects of collective bargaining is the common assumption of symmetry across all firms in the economy, which differ only in the particular sector they belong to. To the extent that firms are affected both by firm-specific and sector-specific factors, analyses of the effects of collective bargaining that abstract

[1] See OECD (2004) and du Caju et al. (2008).

[2] For a survey of these studies, see, for instance, Flanagan (1999).

from such heterogeneity may miss an important part of the overall picture.[3] Furthermore, once we take heterogeneity into account, the question immediately arises as to how sensitive relative wages are to firm-specific and sector-specific factors. In this regard, the empirical evidence seems to suggest that centralization of wage bargaining tends to compress relative wages.[4] Hence, if collective bargaining takes place at the firm level it is more likely that wages react to firm-specific factors, such as productivity, than if collective bargaining takes place at the sector level and higher. A priori, the unemployment consequences of wage compression under firm heterogeneity are ambiguous. On the one hand, centralized collective bargaining may increase job destruction, as relative wages do not adjust sufficiently to negative firm-specific or sector-specific productivity shocks. On the other hand, wage compression may increase job creation, because wages do not incorporate positive firm-specific or sector-specific productivity shocks and therefore profits are higher for high productivity jobs.[5] Using a search and matching model similar to ours, Boeri and Burda (2009) show that, when there are firing costs, collective bargaining may arise endogenously as a choice of employers and workers and that endogenous adjustment of the coverage of collectively negotiated wages may alter the employment consequences of labor market reforms.

Rather than focusing on the conditions under which collective bargaining may arise as a the rational choice of employers and workers, this paper addresses the question as to how the structure of collective bargaining affects labor market performance in the presence of firm heterogeneity. In order to provide a modern treatment of this issue, we base our analysis on the search-and-matching labor market framework developed by Mortensen and Pissarides (1994), where unemployment is the result of endogenous gross job creation and gross job destruction flows. In particular, we introduce collective bargaining in a one-sector Mortensen-Pissarides economy where firms differ in their productivity levels.[6] We consider two alternative collective bargaining regimes: firm-level and sector-level bargaining. Motivated by the existing evidence on wage compression under centralized collective bargaining, we assume that under sector-level bargaining a common wage is chosen for all firms in the sector. In both cases, we assume Nash wage bargaining and model credible threats along the lines of Hall and Milgrom (2008), where fallback positions are determined by the possibility of rejecting offers and making counteroffers. In this framework, wages respond to firm-specific productivity under firm-level bargaining, whereas they respond to sector-wide average productivity under sector-level bargaining. In each bargaining scenario, those jobs that fall below

[3] The need to consider firm-specific and sector-specific factors when studying the macroeconomic effects of collective bargaining was acknowledged already in Calmfors and Driffill's seminal work (see Calmfors and Driffill, 1988, p. 46).

[4] See Kahn (2000), Blau and Kahn (1996) and Flanagan (1999).

[5] See Bertola and Rogerson (1997)

[6] Unlike Boeri and Burda (2009), we abstract from different workers' observable skills.

a certain productivity threshold will be destroyed; absent hiring and firing costs, new jobs are created above the same productivity threshold. The latter threshold depends on how wages are determined, and therefore differs across collective bargaining regimes.

Admittedly, there are good reasons to believe that wage setters may have different objective functions depending on the level at which bargaining takes place. For instance, it has been argued that centralized wage bargaining can internalize several externalities associated with wage-setting, while, in contrast, more decentralized wage bargaining leads to higher wage pressure because of "leapfrogging", that is, the inclusion of relative wages into the workers' objective function.[7] Moreover, from the employers' perspective, sectorial collective bargaining agreements can be perceived as instruments to "regulate" competition by imposing similar wages across all firms. While these considerations are relevant to the comparison of outcomes between sectorial and firm-level collective bargaining, they have been widely discussed in the theoretical literature, and, empirically, they are rather "fussy" to be approached quantitatively. Hence, in this paper we want to isolate the effect of sectorial collective bargaining on job creation, job destruction, and unemployment exclusively through wage compression.

Our main theoretical results are twofold. First, unemployment is *higher* under sector-level bargaining than under firm-level bargaining. The reason is the following. On the one hand, under sector-level bargaining the job destruction threshold is higher than it is under firm-level bargaining; therefore, low productivity jobs that would survive (or would be created) in the latter regime are destroyed (or are not created) in the former. On the other hand, under sector-level bargaining the anticipation of lower or no profits for low-productivity jobs discourages vacancy posting relative to firm-level bargaining. Both the higher separation rate and the lower job-finding rate translate into higher unemployment.

Our sector-level bargaining scenario can be interpreted as a situation in which firm-level agreements that lower the standards of higher level agreements are not possible, due for instance to legal constraints. We thus consider an alternative scenario in which those firms and workers that mutually agree to opt out of sector-level agreements can do so. The latter scenario, which we refer to as *efficient opting-out*, leads us to our second main result. We show that allowing for efficient opting-out is enough to bring unemployment down to its level under decentralized bargaining. This holds despite the fact that only a minority of firms (those which cannot afford to pay the wage agreed at the sector level) effectively opt out. The reason is the following. The productivity threshold for opting-out firms is lower than for non-opting-out firms, and therefore represents the relevant job creation and job destruction threshold in this scenario. We find that the latter thresh-

[7] See Calmfors (1993).

old is exactly the same as in the firm-level bargaining scenario. As a result, the two transition rates and unemployment will be the same too.

Finally, we assess numerically the magnitude of the theoretical effects just described by calibrating our model to an archetypical continental European economy. We find that moving from sector-level to firm-level bargaining (or to efficient opting-out) reduces the unemployment rate by about 5 percentage points. We also perform sensitivity analysis with respect both to parameter values and to the structure of sector-level bargaining. We find that a reasonable range for the unemployment gap between sector-level and firm-level bargaining is 1 to 5 percentage points.

The structure of the paper is as follows. Section 2 lays out the model. Section 3 characterizes the equilibrium in each bargaining regime, as well as in the efficient opting out scenario, obtaining along the way a number of theoretical results. Section 4 provides a numerical application of our framework to an average continental European economy. In Section 5 we consider an alternative form of sector-level bargaining and compare it numerically to the other bargaining scenarios. Section 6 presents concluding remarks.

2 Model

We now present a model of a one-sector Mortensen-Pissarides economy where firms differ in their idiosyncratic productivity levels. There is one job in each firm, occupied by a single worker. Time is discrete. We focus on steady state equilibria throughout the paper.

2.1 Matching technology

Labor market frictions are summarized by a matching function, $m(u, v)$, where u is the number of unemployed and v is the number of vacancies. The matching function is strictly increasing in each argument. We normalize the size of the labor force to one, such that u also represents the unemployment rate. Under the assumption of constant returns to scale, the matching probability for vacancies is given by $m(u, v)/v = m((v/u)^{-1}, 1) \equiv q(v/u)$, with q strictly decreasing in the ratio of vacancies to unemployment, $v/u \equiv \theta$, also known as *labor market tightness*. Similarly, the matching probability for unemployed workers is $m(u, v)/u = m(1, v/u) = \theta q(\theta)$, which is strictly increasing in labor market tightness.

2.2 Firm and worker value functions

An active job produces z units of output, where z differs across firms. The process z is iid both over time and across firms, and has cumulative distribution function $F(z)$. Let $b = s, f$ denote the bargaining regime, where s denotes firm-level bargaining and f denotes sector-level bargaining. Each period, those jobs that fall below a certain reservation productivity R^b become unprofitable for the firm and are thus destroyed. The value for the firm of a job with idiosyncratic productivity z in bargaining regime b is given by

$$J^b(z) = z - w^b(z) + \frac{1-\rho}{1+r} \int_{R^b} J^b(x) dF(x), \tag{1}$$

where $w^b(z)$ is the wage (which may depend on the job's productivity), r is the real interest rate and ρ is an exogenous separation rate. The value of the same job for the worker is given by

$$W^b(z) = w^b(z) + \frac{1-\rho}{1+r} \left\{ \int_{R^b} W^b(x) dF(x) + F\left(R^b\right) U^b \right\} + \frac{\rho U^b}{1+r}, \tag{2}$$

where U^b is the value of unemployment. The latter is given by

$$U^b = \delta + \theta^b q\left(\theta^b\right) \frac{1-\rho}{1+r} \int_{R^b} \left(W^b(x) - U^b\right) dF(x) + \frac{U^b}{1+r}, \tag{3}$$

where δ is the flow payoff of being unemployed.

2.3 Wage bargaining

We consider two alternative bargaining scenarios. In the firm-level bargaining scenario, each firm-worker pair bargains individually. In the sector-level bargaining scenario, a sector union and a sector federation of employers bargain over the wages to be paid in the sector. For both bargaining regimes, we assume credible threats as in Hall and Milgrom (2008). As argued by these authors, employment relationships generate a joint surplus that glues the negotiating parties together. As a result, unions do not seriously consider permanent resignation of workers as an alternative to reaching an agreement, and firms do not consider discharging the workers permanently either. In other words, neither party can credibly commit to dissolving the match and walking away in the absence of agreement, as is typically assumed in the search and matching literature. Instead, each party's credible threat point is to reject the other party's offer and continue negotiating in the following period. Whereas this line of reasoning is generally appealing, we find it particularly plausible when collective bargaining takes place at the sector level. In both cases, we assume Nash wage bargaining. We first describe the case of firm-level bargaining.

2.3.1 Firm-level bargaining

In each period, firm and worker negotiate over the wage to be paid in that period. If no agreement is reached, then no production takes place during the current period. The firm incurs a cost γ, and the worker enjoys the payoff δ. Both parties take up the negotiation again at the beginning of the following period. We define the disagreement values for the firm and the worker,

$$\tilde{J}^f = -\gamma + \frac{1-\rho}{1+r} \int_{R^f} J^f(x) dF(x), \tag{4}$$

$$\tilde{W}^f = \delta + \frac{1-\rho}{1+r} \left\{ \int_{R^f} W^f(x) dF(x) + F\left(R^f\right) U^f \right\} + \frac{\rho U^f}{1+r}, \tag{5}$$

respectively. Notice that $\tilde{J}^f$ and $\tilde{W}^f - U^f$ must both be positive in order for both sides to be willing to postpone production today and resume negotiations in the following period, rather than simply take their respective outside options.[8] Using equation (3) for $b = f$, it can be showed that $\tilde{W}^f - U > 0$ only if $W^f - U > 0$, which holds in equilibrium. Regarding $\tilde{J}^f$, later we will show the conditions under which the latter object is positive. Relative to the disagreement values, the surplus enjoyed by the firm and the worker equals

$$J^f(z) - \tilde{J}^f = z - w^f(z) + \gamma,$$

$$W^f(z) - \tilde{W}^f = w^f(z) - \delta,$$

respectively, where we have used equations (1) and (2) for $b = f$. Following standard practice, we assume Nash bargaining. For ease of exposition, we assume symmetric bargaining power between firm and worker. However, all of our theoretical results go through in the more general case with asymmetric bargaining power.[9] The wage agreement therefore maximizes the product of firm and worker surplus,

$$w^f(z) = \arg\max_{w^f(z)} \left[z - w^f(z) + \gamma\right] \left[w^f(z) - \delta\right]$$

The resulting wage agreement is given by

$$w^f(z) = \frac{z}{2} + \frac{\delta + \gamma}{2}. \tag{6}$$

[8] The firm's outside option is to close down the job and open a new vacancy. As we discuss later, in equilibrium the value of vacancies is driven down to zero.

[9] Results are available upon request.

Therefore, the worker is paid the average of her product, z, and the sum of the disagreement payoff δ and the disagreement cost γ. Equation (6) implies that the worker's surplus, $w^f(z) - \delta$, is one half of the joint match surplus, $z - (\delta - \gamma)$.

2.3.2 Sector-level bargaining

In the sector-level bargaining scenario, a sector-wide employer federation bargains with a sector-wide union over the wages to be paid in the sector. Based on empirical evidence on wage compression under centralized collective bargaining, we assume that both parties choose a common wage for all firms in the sector, $w^s(z) = w^s$. The employer federation and the union care about the aggregate surplus of those firms and workers, respectively, that will be covered by the wage agreement. Such aggregate payoffs are given by the number of firm-worker pairs that are left once the wage agreement comes into effect, n^s, times their respective average payoff. As before, we assume that in the absence of agreement no production takes place. Each firm and each worker in the sector receives the payoff $-\gamma$ and δ, respectively, and sector-level representatives resume negotiations in the following period. The individual disagreement values are given by equations (4) and (5), with the superscript s replacing f. Again, $\tilde{J}^s$ and $\tilde{W}^s - U^s$ must both be positive in order for each firm and worker to be willing to wait for the sector-level negotiators to reach an agreement in the following period. Using equations (1) and (2) for $b = s$, the surplus of each firm and worker relative to the disagreement values is given by

$$J^s(z) - \tilde{J}^s = z - w^s + \gamma,$$

$$W^s - \tilde{W}^s = w^s - \delta,$$

respectively. The aggregate surplus for those firms and those workers that actually benefit from the wage agreement is given by

$$n^s \int_{R^s} \left(J^s(z) - \tilde{J}^s\right) \frac{dF(z)}{1 - F(R^s)} = n^s \left(\int_{R^s} z \frac{dF(z)}{1 - F(R^s)} - w^s + \gamma\right), \tag{7}$$

$$n^s \left(W^s - \tilde{W}^s\right) = n^s (w^s - \delta), \tag{8}$$

respectively. Notice that all workers enjoy the same surplus, $w^s - \delta$, because they all earn the same wage.

We assume that sector-level negotiators take as given the job destruction threshold R^s and the number of jobs that benefit from the agreement, n^s. We make this assumption both in order to maximize comparability with the firm-level bargaining scenario, and to focus the discussion on the effects of wage compression at the sector level.[10] Nash bargaining implies maximizing the product of (7) and (8). Given our assumption that n^s is taken as given, the wage agreement equivalently solves the following problem,

$$w^s = \arg\max_{w^s} \left[\int_{R^s} z \frac{dF(z)}{1 - F(R^s)} - w^s + \gamma \right] [w^s - \delta]$$

for given R^s. The resulting wage agreement is given by

$$w^s = \frac{E(z \mid z \geq R^s)}{2} + \frac{\delta + \gamma}{2}, \tag{9}$$

where $E(z \mid z \geq R^s) \equiv \int_{R^s} z dF(z) / [1 - F(R^s)]$ is the average productivity across surviving jobs. Equation (9) is analogous to the wage equation in the firm-level bargaining scenario, equation (6), with average productivity replacing job-specific productivity. In this case, worker surplus, $w^s - \delta$, is one half of the *average* match surplus, $E(z \mid z \geq R^s) - (\delta - \gamma)$.

2.4 Job creation and job destruction

In each bargaining regime $b = f, s$, the job destruction threshold is determined by the zero firm surplus condition,

$$J^b(R^b) = 0.$$

Regarding job creation, we assume stochastic job matching as in Pissarides (2000, Ch. 6). Upon being matched to an unemployed worker, the firm draws an idiosyncratic productivity for the new job from the same distribution as continuing jobs, $F(x)$. Given such a productivity, the firm creates the job only if the value of doing so is positive, $J^b(x) \geq 0$. Therefore, the productivity threshold above which jobs are created is the same as the job destruction threshold, R^b. Firms post vacancies until the value of doing so equals cero. This implies the familiar free-entry condition,

$$\frac{\kappa}{q(\theta^b)} = \frac{1 - \rho}{1 + r} \int_{R^b} J^b(x) dF(x), \tag{10}$$

where κ is the flow vacancy cost.

[10] For a similar approach in the context of a different model, see Moene and Wallerstein (1997). In section 5 we will consider an alternative bargaining setup in which sector-level negotiators internalize the effects of wages on employment.

3 Equilibrium

We now characterize the equilibrium in the jump variables $\left(\theta^b, R^b\right)$ and the unemployment stock u^b in each bargaining regime $b = f, s$. Consider the surplus function (1) in regime $b = f$. Evaluating the latter at the threshold R^f, substracting the resulting expression from (1), and using the fact that $J^f(R^f) = 0$, we have that $J^f(z) = z - R^f - \left[w^f(z) - w^f(R^f)\right]$. The wage function (6) implies that $w^f(z) - w^f(R^f) = \left(z - R^f\right)/2$. Therefore, the firm's surplus function under firm-level bargaining can be expressed as

$$J^f(z) = \frac{z - R^f}{2}. \tag{11}$$

Similarly, combining $J^s(R^s) = 0$ with the surplus function (1) for $b = s$, and the common wage in equation (9), the firm's surplus function under sector-level bargaining can be expressed as

$$J^s(z) = z - R^s. \tag{12}$$

Evaluating (1) at the productivity threshold R^b, $b = f, s$, using the wage equations (6) (evaluated at R^f) and (9), making use of the reduced-form surplus functions (11) and (12), and equating the resulting expressions to zero, we obtain the *job destruction condition* in the firm-level bargaining regime,

$$0 = \frac{R^f}{2} - \frac{\delta + \gamma}{2} + \frac{1 - \rho}{1 + r} \int_{R^f} \frac{x - R^f}{2} dF(x). \tag{JD^f}$$

and in the sector-level bargaining regime,

$$0 = R^s - \frac{E\left(z \mid z \geq R^s\right)}{2} - \frac{\delta + \gamma}{2} + \frac{1 - \rho}{1 + r} \int_{R^s} \left(x - R^s\right) dF(x). \tag{JD^s}$$

Notice that equations (JD^f) and (JD^s) uniquely determine the equilibrium productivity thresholds R^f and R^s, respectively. In other words, both job destruction conditions are flat lines in (θ, R) space. We now obtain the following result.[11]

Lemma 1 *The productivity threshold in the sector-level bargaining equilibrium is higher than in the firm-level bargaining equilibrium:* $R^s > R^f$.

Therefore, the job destruction condition in the sector-level bargaining scenario lies above its firm-level bargaining counterpart in (θ, R) space. Both lines are represented in Figure 1 with the labels JD^s and JD^f, respectively. The intuition for Lemma 1 is straightforward. Under sector-level bargaining, firms' profits shrink faster with idiosyncratic productivity than they do under

[11] The proof of all Lemmas are in the appendix.

firm-level bargaining, because firm-specific wages do not go down in parallel. As a result, the productivity threshold below which jobs become unprofitable is reached earlier in the case of sector-level bargaining.

Consider now equation (10) in each bargaining regime $b = f, s$. Combining them with the surplus functions (11) and (12), we obtain the *job creation condition* in the firm-level bargaining regime,

$$\frac{\kappa}{q(\theta^f)} = \frac{1-\rho}{1+r} \int_{R^f} \frac{x - R^f}{2} dF(x), \tag{JC^f}$$

and in the sector-level bargaining regime,

$$\frac{\kappa}{q(\theta^s)} = \frac{1-\rho}{1+r} \int_{R^s} (x - R^s) \, dF(x). \tag{JC^s}$$

Both (JC^f) and (JC^s) are downward-sloping relationships in (θ, R) space. Notice that, evaluated at the same productivity threshold, the right-hand side of (JC^s) is higher than that of (JC^f). Since the left-hand side is increasing in θ, the curve (JC^s) lies above (JC^f). Both lines are represented in Figure 1 with the labels JC^s and JC^f, respectively. Equilibrium in the pair labor market tightness-reservation productivity in each bargaining regime $b = f, s$ is given by the intersection point between JD^b and JC^b. In principle, the fact that JC^f lies below JC^s means that the former could intersect JD^f at a point where $\theta^f < \theta^s$. It is however possible to obtain the following result.

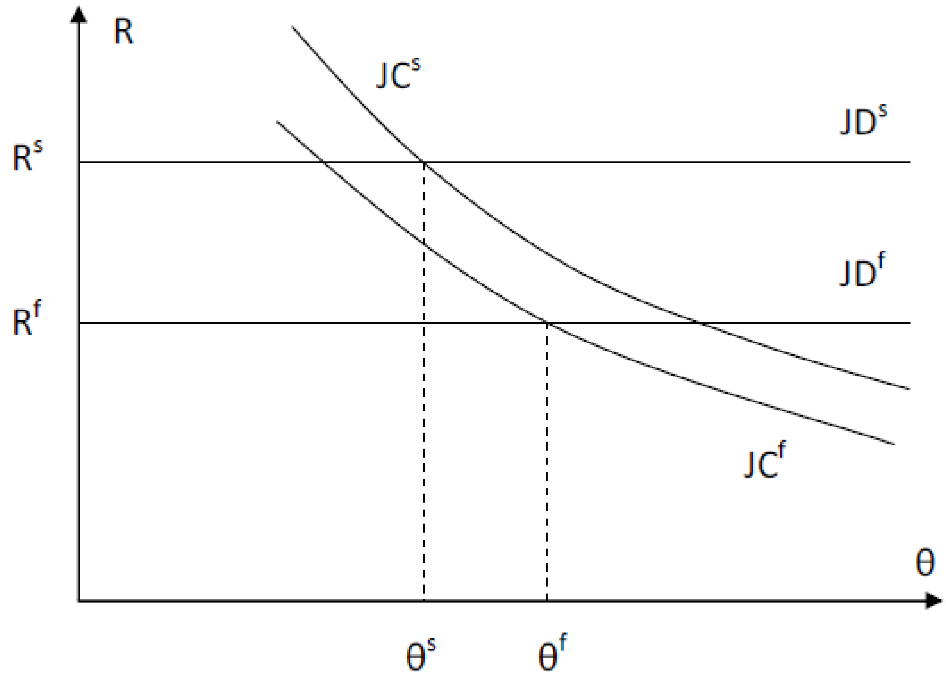
Lemma 2 *Labor market tightness in the sector-level bargaining equilibrium is lower than in the firm-level bargaining equilibrium:* $\theta^s < \theta^f$.

Therefore, JC^f intersects JD^f at a point where labor market tightness is higher than under sector-level bargaining, $\theta^f > \theta^s$, as depicted in Figure 1. The intuition of Lemma 2 is again simple. The fact that relative wages are not responsive to firm-specific productivity shocks under sector-level bargaining has two opposing effects on hiring incentives. On the one hand, firms anticipate higher profits from high-productivity new jobs than they would under firm-level bargaining. On the other hand, they expect lower profits from low-productivity new jobs; furthermore, new matches that draw a productivity in the range $[R^f, R^s)$ are not even formed, unlike in the case of firm-level bargaining, and thus generate zero profits. As it turns out, the second effects dominates, with the resulting discouragement of vacancy posting relative to firm-level bargaining.

Given the solution for the productivity thresholds and labor market tightness, $\left(R^b, \theta^b\right)$ for $b = f, s$, employment and unemployment evolve according to the following laws of motion,

$$n_t^b = \left[1 - F\left(R^b\right)\right](1-\rho)\left[n_{t-1}^b + \theta^b q(\theta^b) u_{t-1}^b\right], \tag{13}$$

Figure 1: Equilibrium labor market tightness and productivity threshold: firm-level vs. sector-level bargaining



$$u_t^b = 1 - n_t^b,$$

for $b = f, s$. In the steady state, unemployment equals

$$u^b = \frac{\rho + (1-\rho) F\left(R^b\right)}{\rho + (1-\rho) F\left(R^b\right) + \theta^b q(\theta^b)(1-\rho)\left[1 - F\left(R^b\right)\right]},$$

for $b = f, s$. Lemma 1 implies that the total separation rate, $\rho + (1-\rho) F\left(R^b\right)$, is higher under sector-level bargaining. Lemmas 1 and 2 imply that the job-finding rate, $\theta^b q(\theta^b)(1-\rho)\left[1 - F\left(R^b\right)\right]$, is also lower under sector-level bargaining. We thus obtain the following result.

Proposition 1 *Unemployment is higher in the sector-level than in the firm-level bargaining equilibrium.*

3.1 Efficient opting-out

Our previous sector-level bargaining setup is best interpreted as a situation in which reaching firm-level agreements that lower worker standards relative to the sector-level agreement is either illegal or very costly/difficult in practice. In this subsection we consider an alternative scenario in which every firm-worker pair is free to costlessly opt out of the sector-level agreement and strike a new firm-level agreement *if* such an arrangement is mutually beneficial. In this scenario, which we henceforth refer to as *efficient opting-out*, both sector-level and wage-level agreements will coexist.

In particular, consider a situation in which sector-wide firm and worker representatives strike a sectorial wage agreement like the one studied before. Let now $J^{s*}(z)$ denote the firm surplus from a job with idiosyncratic productivity z conditional on paying the wage agreed at the sector level, w^{s*}, where we use asterisks to denote equilibrium values in this efficient opting-out scenario. Let also R^{s*} denote the reservation productivity below which firms affected by the sectorial agreement have negative surplus, implicitly defined by $J^{s*}(R^{s*}) = 0$. Similarly, let $J^{f*}(z)$ denote the firm surplus function for firms that are able to opt out of the sector-level agreement and thus pay the firm-level wage $w^{f*}(z)$. The corresponding productivity threshold for such firms, R^{f*}, is implicitly defined by $J^{f*}(R^{f*}) = 0$.

It is straightforward to show that wage agreements at each bargaining level (sector and firm) in this scenario have the same form as when we considered each level separately, that is,

$$w^{f*}(z) = \frac{z}{2} + \frac{\delta + \gamma}{2},$$

$$w^{s*} = \frac{E(z \mid z \geq R^{s*})}{2} + \frac{\delta + \gamma}{2},$$

where $E(z \mid z \geq R^{s*})$ is the average productivity in non-opting-out firms. Both $J^{s*}(z)$ and $J^{f*}(z)$ are the sum of current profits and a certain continuation value. Later we will solve explicitly for such continuation value, but as of now it suffices to know that they are exactly the same for all firms, regardless of whether they opt out today or not. Current profits in opting-out and non-opting-out firms are given respectively by

$$z - w^{f*}(z) = \frac{z}{2} - \frac{\delta + \gamma}{2}, \tag{14}$$

$$z - w^{s*} = z - \frac{E(z \mid z \geq R^{s*})}{2} - \frac{\delta + \gamma}{2}. \tag{15}$$

Evaluating the latter two expressions at R^{f*} and R^{s*}, respectively, using the zero surplus conditions $J^{f*}(R^{f*}) = 0$ and $J^{s*}(R^{s*}) = 0$, and imposing symmetry of continuation values, it follows that

$$R^{f*} = R^{s*} - [E(z \mid z \geq R^{s*}) - R^{s*}] < R^{s*}. \tag{16}$$

Therefore, the productivity threshold for opting-out firms is lower than for firms that stick to the sector-level agreement, in analogy with the ordering between R^f and R^s previously analyzed. It is also straightforward to show that the firm surplus functions at each bargaining level have the same form as when we considered firm-level and sector-level bargaining separately,

$$J^{f*}(z) = \frac{z - R^{f*}}{2}. \tag{17}$$

$$J^{s*}(z) = z - R^{s*}. \tag{18}$$

Notice finally that the profit functions (14) and (15) attain the same value at $z = E(z \mid z \geq R^{s*})$. This, together with symmetry of continuation values, implies that $J^{f*}(E(z \mid z \geq R^{s*})) = J^{s*}(E(z \mid z \geq R^{s*}))$. Following a similar reasoning, it can be showed that $W^{f*}(E(z \mid z \geq R^{s*})) = W^{s*}$. That is, the surplus functions of opting-out and non-opting-out firms intersect each other at the average productivity of non-opting-out firms, and similarly for the involved workers. Taking all these elements together, it is possible to represent graphically the surplus functions of workers and firms in each bargaining scenario. This is done in Figure 2, where firm surplus functions are represented in the upper part, and worker surplus functions (gross of the outside option of becoming unemployed, U^*) are represented in the lower part.[12]

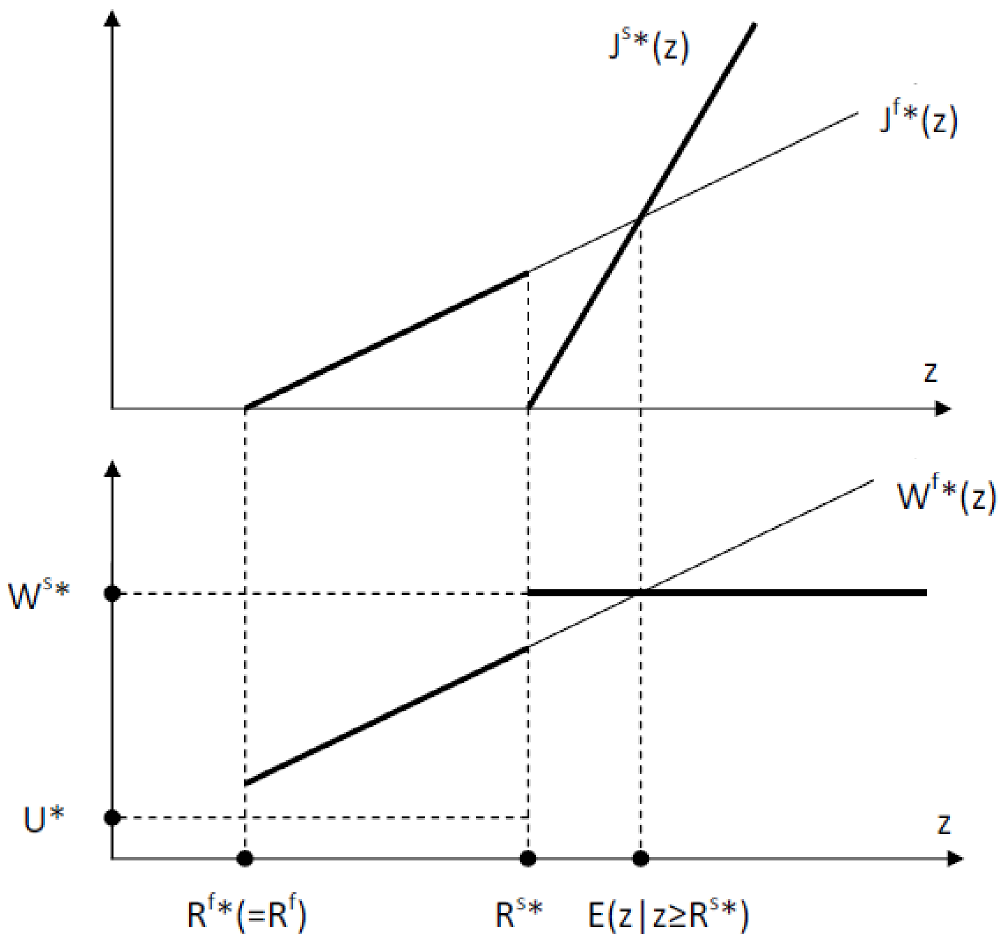
The key question is which firm-worker pairs will agree to opt out of the sector-level agreement. Notice first that, in the productivity range $z \geq E(z \mid z \geq R^{s*})$, workers would like to opt out and bargain at the firm-level, as this would give them a higher payoff: $W^{f*}(z) > W^{s*}$. However, firms are better off by sticking to the sector-level agreement, $J^{f*}(z) < J^{s*}(z)$, and therefore will not agree to opt out. Similarly, in the range $z \in [R^{s*}, E(z \mid z \geq R^{s*}))$ firms would like to opt out of the sector-level agreement but workers are happy to stick to it, and therefore opting out will not happen. Finally, firm-worker pairs in the range $z \in [R^{f*}, R^{s*})$ have a mutual interest in opting out, because doing so leaves both parties better off than by accepting the destruction of the job: the firm obtains the surplus $J^{f*}(z) > 0$ and the worker enjoys the surplus $W^{f*}(z) - U^* > 0$. It follows that firms with productivity above R^{s*} will stick to the sector-level wage agreement, whereas firms with productivity in-between R^{f*} and R^{s*} will reach firm-level agreements with their employees. This allows us to write the surplus functions as

$$J^{f*}(z) = \frac{z}{2} - \frac{\delta + \gamma}{2} + \frac{1-\rho}{1+r}\left[\int_{R^{f*}}^{R^{s*}} J^{f*}(x)dF(x) + \int_{R^{s*}} J^{s*}(x)dF(x)\right],$$

$$J^{s*}(z) = z - \frac{E(z \mid z \geq R^{s*})}{2} - \frac{\delta + \gamma}{2} + \frac{1-\rho}{1+r}\left[\int_{R^{f*}}^{R^{s*}} J^{f*}(x)dF(x) + \int_{R^{s*}} J^{s*}(x)dF(x)\right].$$

[12]Notice that Figure 2 assumes $W(R^{f*}) \geq U^*$. The latter can be ensured for instance by calibrating the unemployment flow payoff ξ appropriately.

Figure 2: Surplus functions in the efficient opting-out scenario



Evaluating the latter two expressions at R^{f*} and R^{s*}, respectively, and using the zero surplus conditions, we find two equations that jointly determine the pair of productivity thresholds $\left(R^{f*}, R^{s*}\right)$ in the efficient opting-out equilibrium,

$$0 = \frac{R^{f*}}{2} - \frac{\delta+\gamma}{2} + \frac{1-\rho}{1+r}\left[\int_{R^{f*}}^{R^{s*}} \frac{z-R^{f*}}{2} dF\left(x\right) + \int_{R^{s*}} \left(z - R^{s*}\right) dF\left(x\right)\right], \tag{19}$$

$$0 = R^{s*} - \frac{E(z \mid z \geq R^{s*})}{2} - \frac{\delta+\gamma}{2} + \frac{1-\rho}{1+r}\left[\int_{R^{f*}}^{R^{s*}} \frac{z-R^{f*}}{2} dF\left(x\right) + \int_{R^{s*}} \left(z - R^{s*}\right) dF\left(x\right)\right],$$

where we have also used (17) and (18) to substitute for the surplus functions $J^{f*}(x)$ and $J^{s*}(x)$, respectively. It is now possible to obtain the following result.

Lemma 3 *The productivity threshold for opting-out firms in the efficient opting-out equilibrium is the same as the productivity threshold in the firm-level bargaining equilibrium:* $R^{f*} = R^{f}$.

The explanation of Lemma 3 is the following. Opting out firms know that if next period's productivity shock falls in the range $[R^{f*}, R^{s*})$ they will opt out again, whereas if the new productivity exceeds R^{s*} they will not do so. This creates two opposing effects on the continuation value of opting-out firms, relative to the fully decentralized bargaining regime. On the one hand, for future productivity levels above $E(z \mid z \geq R^{s*})$ they expect to obtain a higher surplus (see figure 2). On the other hand, for future productivity levels between R^{s*} and $E(z \mid z \geq R^{s*})$ they expect to obtain a lower surplus. The position of average productivity in non-opting-out firms, $E(z \mid z \geq R^{s*})$, is such that both effects exactly cancel each other out, hence equalizing the continuation values of firms in the firm-level bargaining scenario and of opting-out firms in the efficient opting-out scenario. As a result, the productivity thresholds in both scenarios coincide.

The job creation condition in the efficient opting-out scenario is given by

$$\frac{\kappa}{q(\theta^*)} = \frac{1-\rho}{1+r}\left[\int_{R^{f*}}^{R^{s*}} \frac{z-R^{f*}}{2} dF\left(x\right) + \int_{R^{s*}} \left(z - R^{s*}\right) dF\left(x\right)\right], \tag{20}$$

where θ^* denotes labor market tightness in the efficient opting-out equilibrium. It is straightforward to prove the following.

Lemma 4 *Labor market tightness in the efficient opting-out equilibrium is the same as in the firm-level bargaining equilibrium:* $\theta^* = \theta^f$.

In the efficient opting-out scenario, only those jobs with productivity below the threshold for opting-out firms, R^{f*}, are destroyed, and only new matches with productivity above the same threshold are actually formed. Therefore, the job-finding rate is given by $(1-\rho)\left[1-F\left(R^{f*}\right)\right]\theta^* q(\theta^*)$, and the total separation rate is given by $\rho+(1-\rho)F\left(R^{f*}\right)$. Lemmas 3 and 4 imply that both transition rates are exactly the same as in the firm-level bargaining scenario. This leads us to the following result.

Proposition 2 *Unemployment in the efficient opting-out equilibrium is the same as in the firm-level bargaining equilibrium.*

An important corollary follows from Proposition 2. In order to bring unemployment down to its level under firm-level bargaining, it is not necessary to scrap sector-level bargaining altogether. Instead, it suffices to allow firm-worker pairs to freely and costlessly opt out of sector-level agreements should both parties find it mutually beneficial.

4 Calibration and quantitative analysis

The previous section has obtained a number of analytical results regarding the relationship between alternative bargaining scenarios. It is nonetheless interesting to assess the magnitude of the effects previously described from a quantitative point of view. With this purpose, we now perform a tentative calibration of our model economy.

Let the time period be a quarter. We calibrate our model to an average continental European labor market. Given the prevalence of collective bargaining at the sector level and higher in most continental European countries (Du Caju et al. 2008), we take the sector-level bargaining scenario as our baseline.

We set the discount rate, r, to 0.01, or 4 per cent per annum. We target a job-finding rate, $[1-F(R^s)](1-\rho)\theta^s q(\theta^s)$, of 20 per cent per quarter, and a separation rate, $\rho+(1-\rho)F(R^s)$, of 2 per cent per quarter, which are roughly in line with evidence for continental European countries.[13] These transition rates imply a steady-state unemployment rate, u^s, of 9.09 per cent. Based on the literature, we assume that one half of all separations are exogenous, which implies $\rho=0.01$.[14]

We choose a lognormal distribution for the idiosyncratic productivity shock: $F(z)=\Phi\left(\frac{\log(z)-\mu}{\sigma}\right)$, where Φ is the standard normal cdf. Calibrating the dispersion parameter σ is difficult, given the lack of comprehensive evidence on intra-sectoral productivity dispersion for continental European countries. Therefore, for illustrative purposes we set σ to 0.15, and later perform sensitivity

[13] See e.g. OECD (2004) and Lechthaler, Merkl and Snower (2010).

[14] For instance, Den Haan, Ramey and Watson (2000) and Pissarides (2007) estimate that exogenous separations account for 68% and 40% of all separations, respectively. The midpoint of these estimates is 54%.

analysis with respect to this parameter. We normalize μ to $-\sigma^2/2$, such that $E(z) = 1$. These assumptions imply a job destruction threshold of $R^s = F^{-1}\left(\frac{0.02-\rho}{1-\rho}\right) = 0.6979$.

We assume a Cobb-Douglas specification for the matching function, $m(u,v) = m_0 u^{\epsilon} v^{1-\epsilon}$. We set the elasticity of the matching function, ϵ, to one half.[15] We target a vacancies-to-unemployment ratio, θ^s, of 1/4, which seems reasonable for continental European countries. The latter value, together with our target for the job-finding rate and the fact that $\theta^s q(\theta^s) = m_0(\theta^s)^{1-\epsilon}$, imply a scale parameter of $m_0 = 0.4082$.

Given the equilibrium values for R^s and θ^s, we can then use the job destruction and job creation conditions (equations JD^s and JC^s, respectively) to back out the sum of disagreement payoffs and the cost of posting a vacancy, obtaining $\delta + \gamma = 0.9853$ and $\kappa = 0.2420$. As explained in section 2.3, the disagreement value for the firm, $\tilde{J}^b$, must be positive in both bargaining scenarios ($b = f, s$) in order for firms not to close down if no agreement is reached in the current period. Equation (10), together with equation (4) and the same equation with superscripts s, imply that $\tilde{J}^b = -\gamma + \kappa/q(\theta^b)$, which is positive only if $\gamma < \kappa/q(\theta^b)$. Since our calibration pins down uniquely the sum $\gamma+\delta$, and it is only through the latter sum that γ affects both bargaining equilibria, we are free to choose any value of γ that satisfies $\gamma < \kappa/q(\theta^s)$.[16] For our baseline calibration, the upper bound for γ is $\kappa/q(\theta^s) = 0.2964$. Equivalently, the lower bound for δ is $(\gamma + \delta) - 0.2964 = 0.6889$.

Our calibration implies an average worker product of $\int_{R^s} z dF(z) / [1 - F(R^s)] \equiv \bar{z}^s = 1.0034$, and a (common) real wage of $w^s = \bar{z}^s/2 + (\delta + \gamma)/2 = 0.9944$. Table 1 summarizes the baseline calibration, while the third column of Table 2 displays the equilibrium values in the baseline sector-level bargaining scenario.

Table 1. Calibration

Parameter	Notation	Value	Target/source
Discount factor	r	0.01	real interest rate = 4% p.a.
Exogenous separation rate	ρ	0.01	1/2 total separation rate (2% p.q.)
SD idiosyncratic (log)productivity	σ	0.15	illustrative
Mean idiosyncratic (log)productivity	μ	$-\sigma^2/2$	$E(z) = 1$
Elasticity matching function	ϵ	0.5	Petrongolo & Pissarides 2001
Scale parameter matching function	m_0	0.4082	job-finding rate = 20% p.q.
Sum of disagreement payoffs	$\delta + \gamma$	0.9853	total separation rate = 2% p.q.
Vacancy posting cost	κ	0.2420	vacancy/unemployment ratio = 1/4

[15] See e.g. Petrongolo & Pissarides (2001).

[16] Lemma 2 and the fact that $q'(\theta) < 0$ then automatically imply $\gamma < \kappa/q(\theta^f)$ in the firm-level bargaining scenario.

4.1 Comparative statics

We now calculate the steady-state effects of moving from our baseline sector-level bargaining scenario to a firm-level bargaining scenario, that is, a situation in which every firm bargains individually with its worker. The results are displayed in Table 2. We can emphasize the following. First, the steady-state unemployment rate goes down by about 5 percentage points. As already emphasized in the theoretical analysis, this is the result of both an increase in the job-finding rate and a fall in the total separation rate. In our calibrated example, the former increases from 20 per cent to about 25 per cent, whereas the latter falls from 2 to 1 per cent. In particular, the fall in the reservation productivity is such that the endogenous separation rate, $F(R)$, drops to basically zero in the firm-level bargaining scenario. As a result, the total separation rate converges to its exogenous component, ρ. Finally, despite the noticeable gap between the productivity threshold in both regimes, average productivity is very similar and so is the average wage. The reason is that, under our calibration, the productivity distribution accumulates little mass between both thresholds.

Table 2. Comparative statics, baseline calibration

		Bargaining scenario	
Variable	Notation	Sector-level (baseline)	Firm-level
Labor market tightness	θ	0.25	0.3776
Productivity threshold	R	0.6979	0.2566
Average worker product	$E(z \mid z \geq R)$	1.0034	1.0000
Average real wage	$E(w(z) \mid z \geq R)$	0.9944	0.9926
Job-finding rate	$[1 - F(R)](1-\rho)\theta q(\theta)$	0.20	0.2483
Separation rate	$\rho + (1-\rho)F(R)$	0.02	0.01
Unemployment rate	u	**0.0909**	**0.0387**

As explained before, in our baseline calibration we assumed an illustrative value for the parameter that controls the dispersion in firm-specific productivity shocks, σ. Since the latter is likely to be an important determinant of the differences between both bargaining scenarios, we now study how sensitive our results are to calibrating the sector-level bargaining scenario under different values of σ. In doing so, we continue to target the same transition rates and the same vacancies-unemployment ratio.[17] The results are displayed in Table 3. As the table makes clear, results under the baseline calibration ($\sigma = 0.15$) are barely affected as we increase or decrease the dispersion in firm-specific shocks. The main effect is that the drop in the productivity threshold from moving to firm-level bargaining becomes larger as we increase σ. However, the fact that the productivity distribution accumulates little mass below the productivity threshold implies that even relatively large reductions in such threshold have small quantitative effects on the transition rates, and therefore on unemployment. In particular, in the firm-level bargaining regime the job-finding rate continues to be close to 25 per cent, whereas the separation rate continues to drop to 1 per cent.

Table 3. Sensitivity analysis

	$\sigma = 0.10$		$\sigma = 0.15$ (baseline)		$\sigma = 0.20$	
Variable	Sector-level	Firm-level	Sector-level	Firm-level	Sector-level	Firm-level
Labor market tightness	0.25	0.3760	0.25	0.3776	0.25	0.3792
Productivity threshold	0.7888	0.4813	0.6979	0.2566	0.6160	0.0532
Average worker product	1.0024	1.0000	1.0034	1.0000	1.0043	1.0000
Average real wage	0.9961	0.9949	0.9944	0.9926	0.9928	0.9906
Job-finding rate	0.20	0.2478	0.20	0.2483	0.20	0.2488
Separation rate	0.02	0.01	0.02	0.01	0.02	0.01
Unemployment rate	0.0909	0.0388	0.0909	0.0387	0.0909	0.0386

5 Alternative sector-level bargaining setup

In our baseline model, we made the assumption that sector-level negotiators take as given the number of jobs that actually apply the sectorial wage agreement. Here, we consider an alternative setup in which both parties internalize the effects of their wage claims on employment. Given last period's employment and the number of new matches, employment in the current period is determined by the reservation productivity, which is the level of productivity below which jobs become unprofitable for firms and are thus destroyed. Given the sector-level wage agreement, it

[17] Notice that the values of κ and $(\delta + \gamma)$ consistent with our targets vary with σ. All other parameters remain as in Table 1.

is therefore the firms that eventually determine the level of employment. In this sense, we may interpret this situation as a *right-to-manage* scenario, as is typically understood in the literature.

Henceforth we use the superscript r to denote the right-to-manage bargaining regime. As in the baseline model, sector-level negotiators care about the aggregate payoff of firms on the one side and workers on the other. The latter are given again by equations (7) and (8), respectively, with r replacing the superscripts s. The difference is that both parties now take into account how the number of jobs benefiting from the agreement is determined. In particular, the Nash bargaining outcome is the solution to the following maximization problem,

$$w^r = \arg\max_{w^r} \left[n_t^r \left(\int_R z \frac{dF(z)}{1-F(R)} - w^r + \gamma \right) \right] \left[n_t^r \left(w^r - \delta \right) \right]$$

subject to

$$n_t^r = \left[1 - F(R)\right](1-\rho)\left[n_{t-1}^r + \theta^r q(\theta^r) u_{t-1}^r\right] \tag{21}$$

and

$$R = w^r - \frac{1-\rho}{1+r} \int_{R^r} J^r(x) dF(x) . \tag{22}$$

Equation (21) is the law of motion of employment in the right-to-manage scenario (equation 13 for $b = r$). Equation (22) is the job destruction condition under right-to-manage, which is the result of evaluating the surplus function (1) for $b = r$ at $z = R$, and setting the resulting expression equal to zero. Here we are using R to denote the current period's reservation productivity, and R^r to denote the equilibrium productivity threshold in future periods. Since wage agreements last for one period, the current wage affects the current threshold, but not future thresholds.[18] Using (21) to substitute for n_t^r in the objective function, and using the fact that $n_{t-1}^r + \theta^r q(\theta^r) u_{t-1}^r$ is predetermined, the problem simplifies to maximizing

$$\left[\int_R \left(z - w^r + \gamma \right) dF(z) \right] \left[\left(1 - F(R)\right)\left(w^r - \delta \right) \right]$$

subject to (22). The first order condition is given by

$$\frac{1 - F(R^r) - f(R^r)(w^r - \delta)}{w^r - \delta} = \frac{1 - F(R^r) + f(R^r)(R^r - w^r + \gamma)}{\int_R z dF(z) / \left[1 - F(R^r)\right] - w^r + \gamma} \tag{23}$$

where we have used $dR/dw^r = 1$ and the fact that in equilibrium $R = R^r$. Henceforth we restrict our attention to equilibria in which $1 - F(R^r) > f(R^r)(w^r - \delta)$, such that the numerator on the

[18] Of course, in equilibrium we have $R = R^r$.

left-hand side of (23) is positive. We can rewrite the latter equation as

$$w^r = \frac{E(z \mid z \geq R^r) + \gamma}{2+\chi} + \frac{1+\chi}{2+\chi}\delta, \tag{24}$$

where

$$\chi \equiv \frac{f(R^r)\left[w^r - \delta + (R^r - w^r + \gamma)\right]}{1 - F(R^r) - f(R^r)(w^r - \delta)} = \frac{f(R^r)\left[R^r + \gamma - \delta\right]}{1 - F(R^r) - f(R^r)(w^r - \delta)}. \tag{25}$$

The term χ captures two effects. On the one hand, it reflects the sector union's concern for the job loss resulting from higher wage claims. In particular, a marginal increase in the wage w^r and therefore in the threshold R^r eliminates the surplus $w^r - \delta$ enjoyed by the measure $f(R^r)$ of workers at the threshold. This concern acts towards reducing the union's effective bargaining power, $1/(2+\chi)$, hence pushing down the wage. On the other hand, notice that $R^r - w^r + \gamma = J^r(R^r) - \tilde{J}^r$.[19] Since $J^r(R^r) - \tilde{J}^r = -\tilde{J}^r < 0$, we have that firms at the threshold are better off without an agreement. The incentive in this case works in the opposite direction: a higher wage eliminates firms for which the surplus from reaching an agreement is negative, hence stimulating a higher wage. If the effect stemming from the union's concern for job losses dominates, such that $\chi > 0$, then *ceteris paribus* the bargained wage will be lower than in our baseline sector-level bargaining scenario. This effect should then reduce the gap in unemployment rates between the firm-level and the sector-level bargaining scenarios.

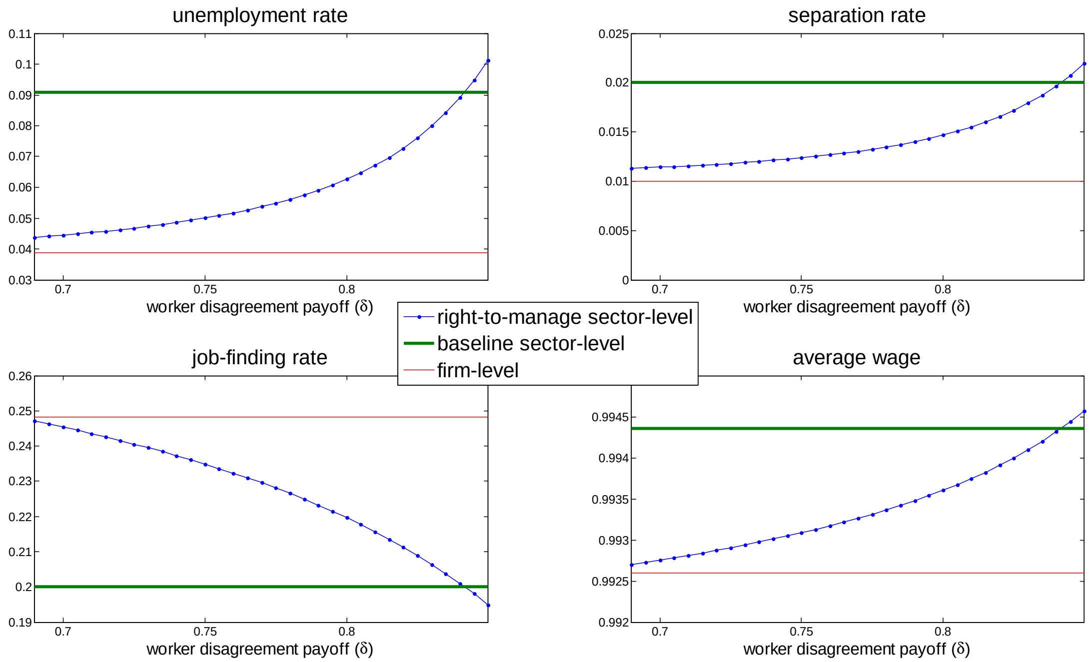
In this case, we are no longer able to obtain analytical results regarding the comparison to firm-level bargaining in terms of equilibrium unemployment. Therefore, we proceed to simulate the right-to-manage sector-level bargaining scenario under our baseline calibration. As we explained in section 4, our calibration strategy uniquely pins down the sum $\delta + \gamma$, and it is only through that sum that both parameters affect the firm-level and baseline sector-level bargaining equilibria. Here, however, it does matter how that sum is distributed between both parameters, because they enter non-linearly in the wage equation (see 24 and 25). As a result, equilibrium values in the right-to-manage scenario depend on the specific calibration of δ, with γ then computed as $(\delta + \gamma) - \delta$.

Figure 3 plots the equilibrium values of unemployment, the transition rates and the average wage under the right-to-manage sector-level bargaining regime for different values of δ, together with their counterparts in the firm-level and the baseline sector-level bargaining setups.[20] For most values of δ, unemployment under right-to-manage sector-level bargaining is lower than in the base-

[19] The disagreement value for the firm under right-to-manage, $\tilde{J}^r$, is given by equation (4) with r replacing f superscripts.

[20] As explained in section 4, the requirement that the firm's disagreement payoff $\tilde{J}^s$ is positive imposes a lower bound for δ, given by 0.6889.

Figure 3: Equilibrium under alternative bargaining regimes



line sector-level bargaining scenario. This reflects the sector union's concern for the employment effects of higher wage claims in the former scenario. Such a concern manifests itself in a lower wage agreement (lower right panel), which in turn leads to a lower separation rate and a higher job-finding rate.

More importantly, for all values of δ unemployment under right-to-manage sector-level bargaining is *higher* than in the firm-level bargaining regime. This means that the wage restraint effect discussed above is not strong enough to compensate the negative effects of wage compression on unemployment. This is reflected in a higher job destruction threshold, which in turn leads to a higher separation rate (upper right panel) and a lower job-finding rate (lower left panel). Moreover, the figure shows the unemployment gap between both bargaining scenarios increases with δ. Intuitively, *ceteris paribus* a higher payoff under disagreement reduces the surplus lost by the marginal workers as the wage increases, which weakens the wage restraint effect under right-to-manage sector-level bargaining.

The specific calibration of δ will typically depend on certain characteristics of the labour legislation, such as strike regulations or the existence of wage floors during the period in which a collective agreement has expired and a new one must be negotiated. During sectorial negotiations, typically workers are employed under the terms of the most recent collective bargaining agreement.

Also, strikes during negotiations are frequently short-lived and, in case of strike, trade unions support workers with strike funds. It therefore seems natural to assume that δ is not too far from the wage while working. Hence, a reasonable range for the worker income loss during the negotiations could be 20-25% which, for an average wage close to 1, translates into a range of about 0.75-0.80 for δ. This, as shown in Figure 3, would yield an equilibrium unemployment rate that would be about 1 to 2.4 percentage points higher than under firm-level bargaining.

6 Conclusions

This paper shows that sectorial collective bargaining has implications for job creation and job destruction that lead to an increase in the unemployment rate. When firms differ in productivity, the wage compression delivered by a unique sectorial wage increases job destruction and reduces job creation with respect to the situation under which there is bargaining at the firm level and, thus, relative wages accommodate firm-specific productivity shocks. Another relevant result of the analysis is that the unemployment rate associated with collective bargaining at the firm level can be replicated under the sectorial collective bargaining regime insofar as firms are allowed to opt out of the sectorial agreement by mutual consent of employers and workers. In our baseline sector-level bargaining setup, negotiators do not internalize the employment effects of the wage agreement. When our framework is generalized to allow such employment effects to be internalized, the equilibrium unemployment rate depends on the disagreement payoff received by workers. Assuming that this payoff is reasonably close to the wage while working (as would be typically the case under the strike and collective bargaining regulations prevailing in most European countries), we find that the unemployment rate is closer to the one in our baseline sector-level bargaining setup than to the one under firm-level bargaining.

We have obtained these results in a Mortensen-Pissarides framework with Nash wage bargaining, where fallback positions are determined by credible threats as in Hall and Milgrom (2008). We have focused on one single characteristic of collective bargaining, namely the level of the negotiation, and we have investigated the consequences of the fact that sectorial collective bargaining yields a wage distribution across firms which is more compressed than the productivity distribution. There are other reasons why sectorial collective bargaining may produce different unemployment outcomes than firm-level collective bargaining. For instance, the objective functions of the wage-setters may depend on the level of negotiation. Also, strategic complementarities may arise when wage-setters in sector-level negotiations have payoffs functions which are different from the payoff functions of the representative firm and worker. One may also consider the extent to which wage-setters at different levels of negotiation internalize the externality effects considered by Calmfors and Driffill (1988). Finally, while we have focused on the relative wage rigidity implied by sectorial collective bargaining, there are other characteristics of collective bargaining that have implications for nominal wage rigidity and, thus, for the variability of wages and unemployment along the business cycle. We plan to pursue these and other issues regarding the relationship between collective bargaining and unemployment in future work.

7 Appendix

7.1 Proof of Lemma 1

Let $\breve{\beta} \equiv (1-\rho)/(1+r)$. Substracting (JD^s) from (JD^f), we obtain

$$0 = \frac{R^f - R^s}{2} + \left(\frac{1}{1-F(R^s)} - \breve{\beta}\right) \int_{R^s} \frac{z-R^s}{2} dF(z) + \breve{\beta} \int_{R^f} \frac{z-R^f}{2} dF(x) - \breve{\beta} \int_{R^s} \frac{z-R^s}{2} dF(z). \tag{26}$$

We first show that there cannot be an equilibrium with $R^f = R^s \equiv R$. Imposing the latter in (26), we have

$$0 = \left(\frac{1}{1-F(R)} - \breve{\beta}\right) \int_R \frac{z-R}{2} dF(z) > 0,$$

which is a contradiction. We now show that there cannot be an equilibrium with $R^f > R^s$ either. Assume that the latter holds. We can then write

$$\int_{R^s} \frac{z-R^s}{2} dF(z) = \int_{R^s}^{R^f} \frac{z-R^s}{2} dF(z) + \int_{R^f} \frac{z-R^s}{2} dF(z).$$

This in turn allows us to write (26) as

$$\begin{aligned}
0 &= \frac{R^f - R^s}{2}\left[1 - \breve{\beta}\left(1 - F\left(R^f\right)\right)\right] + \left(\frac{1}{1-F(R^s)} - \breve{\beta}\right) \int_{R^s} \frac{z-R^s}{2} dF(z) - \breve{\beta} \int_{R^s}^{R^f} \frac{z-R^s}{2} dF(z) \\
&> \frac{R^f - R^s}{2}\left[1 - \breve{\beta}\left(1 - F\left(R^f\right)\right)\right] + \left(\frac{1}{1-F(R^s)} - \breve{\beta}\right) \int_{R^s} \frac{z-R^s}{2} dF(z) - \breve{\beta} \frac{R^f\text{-}R^s}{2}\left[F\left(R^f\right)\text{-}F(R^s)\right] \\
&= \frac{R^f - R^s}{2}\left[1 - \breve{\beta}\left(1 - F(R^s)\right)\right] + \left(\frac{1}{1-F(R^s)} - \breve{\beta}\right) \int_{R^s} \frac{z-R^s}{2} dF(z) > 0,
\end{aligned} \tag{27}$$

where in the first inequality we have used the fact that $\int_{R^s}^{R^f} (z - R^s)\, dF(z) < \int_{R^s}^{R^f} \left(R^f - R^s\right) dF(z) = \left(R^f - R^s\right)\left[F\left(R^f\right) - F(R^s)\right]$. Again, equation (27) implies a contradiction. Therefore, it must be the case that $R^s > R^f$. Q.E.D.

7.2 Proof of Lemma 2

Using (JD^f) and (JD^s), we can express (JC^f) and (JC^s) respectively as

$$\frac{\kappa}{q(\theta^f)} = \frac{\delta+\gamma}{2} - \frac{R^f}{2}, \tag{28}$$

$$\frac{\kappa}{q(\theta^s)} = \frac{\delta+\gamma}{2} - R^s + \frac{1}{2}\int_{R^s} z\frac{dF(z)}{1-F(R^s)}. \tag{29}$$

Substracting (29) from (28), we obtain

$$\frac{\kappa}{q(\theta^f)} - \frac{\kappa}{q(\theta^s)} = \frac{R^s - R^f}{2} - \int_{R^s} \frac{z-R^s}{2}\frac{dF(z)}{1-F(R^s)}. \tag{30}$$

Notice now that

$$\begin{aligned}\int_{R^f} \frac{z-R^f}{2}dF(x) - \int_{R^s}\frac{z-R^s}{2}dF(z) &= \int_{R^f}^{R^s}\frac{z-R^f}{2}dF(x) + \int_{R^s}\frac{z-R^f}{2}dF(x) - \int_{R^s}\frac{z-R^s}{2}dF(z)\\ &= \int_{R^f}^{R^s}\frac{z-R^f}{2}dF(x) + \frac{R^s-R^f}{2}\left[1-F(R^s)\right].\end{aligned}$$

Using this, equation (26) in the proof of Lemma 1 can be expressed as

$$\left\{1-\breve{\beta}\left[1-F(R^s)\right]\right\}\frac{R^s-R^f}{2} = \left(\frac{1}{1-F(R^s)} - \breve{\beta}\right)\int_{R^s}\frac{z-R^s}{2}dF(z) + \breve{\beta}\int_{R^f}^{R^s}\frac{z-R^f}{2}dF(x). \tag{31}$$

Multiplying both sides of (30) by $\{1-\breve{\beta}\left[1-F(R^s)\right]\}$ and using (31), we have that

$$\begin{aligned}\left\{1-\breve{\beta}\left[1-F(R^s)\right]\right\}\left[\frac{\kappa}{q(\theta^f)} - \frac{\kappa}{q(\theta^s)}\right] &= \left(\frac{1}{1-F(R^s)} - \breve{\beta}\right)\int_{R^s}\frac{z-R^s}{2}dF(z) + \breve{\beta}\int_{R^f}^{R^s}\frac{z-R^f}{2}dF(x)\\ &\quad -\left\{1-\breve{\beta}\left[1-F(R^s)\right]\right\}\int_{R^s}\frac{z-R^s}{2}\frac{dF(z)}{1-F(R^s)}\\ &= \breve{\beta}\int_{R^f}^{R^s}\frac{z-R^f}{2}dF(x) > 0.\end{aligned}$$

It follows that $q(\theta^f) < q(\theta^s)$. Since $q(\theta)$ is strictly decreasing in θ, we have that $\theta^f > \theta^s$. Q.E.D.

7.3 Proof of Lemma 3

Equations (JD^f) and (19) imply that

$$\frac{1+r}{1-\rho}\frac{R^{f*}-R^f}{2} = \int_{R^f}\frac{z-R^f}{2}dF(z) - \int_{R^{f*}}^{R^{s*}}\frac{z-R^{f*}}{2}dF(x) - \int_{R^{s*}}(z-R^{s*})\,dF(x).$$

We now guess that $R^{f*} = R^f$. This implies

$$\begin{aligned}
\frac{1+r}{1-\rho}\frac{R^{f*}-R^f}{2} &= \int_{R^f}^{R^{s*}} \frac{z\text{-}R^f}{2} dF\left(z\right) + \int_{R^{s*}} \frac{z\text{-}R^f}{2} dF\left(z\right) - \int_{R^f}^{R^{s*}} \frac{z\text{-}R^f}{2} dF\left(x\right) - \int_{R^{s*}} \left(z\text{-}R^{s*}\right) dF\left(x\right) \\
&= \int_{R^{s*}} \frac{z-R^f}{2} dF\left(z\right) - \int_{R^{s*}} \left(z-R^{s*}\right) dF\left(x\right) \\
&= \frac{R^{s*}-R^f}{2}\left[1-F(R^{s*})\right] - \int_{R^{s*}} \frac{z-R^{s*}}{2} dF\left(x\right). \qquad (32)
\end{aligned}$$

Our guess and equation (16) imply that $R^f = R^{f*} = R^{s*} - [E(z \mid z \geq R^{s*}) - R^{s*}]$. Therefore, $R^{s*} - R^f = E(z - R^{s*} \mid z \geq R^{s*})$. Using this in (32), we have that

$$\frac{1+r}{1-\rho}\frac{R^{f*}-R^f}{2} = E\left(\frac{z-R^{s*}}{2} \mid z \geq R^{s*}\right)\left[1-F(R^{s*})\right] - \int_{R^{s*}} \frac{z-R^{s*}}{2} dF\left(x\right) = 0.$$

It follows that $R^{f*} - R^f = 0$, which verifies our guess. Q.E.D.

7.4 Proof of Lemma 4

Let again $\breve{\beta} \equiv (1-\rho)/(1+r)$. Equations (JC^f) and (20) imply that

$$\frac{\kappa}{q(\theta^f)} - \frac{\kappa}{q(\theta^*)} = \breve{\beta}\left[\int_{R^f} \frac{z-R^f}{2} dF(x) - \int_{R^{f*}}^{R^{s*}} \frac{z-R^{f*}}{2} dF\left(x\right) - \int_{R^{s*}} \left(z-R^{s*}\right) dF\left(x\right)\right].$$

Using now (JD^f) and (19), we have that

$$\frac{\kappa}{q(\theta^f)} - \frac{\kappa}{q(\theta^*)} = \frac{R^{f*}}{2} - \frac{R^f}{2} = 0,$$

where in the second equality we have used Lemma 3. It follows that $q(\theta^f) = q(\theta^*)$, which in turn implies $\theta^* = \theta^f$. Q.E.D.

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