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ABSTRACT

Rent Sharing in Wage Determination: Evidence from Italy*

This Paper presents a two-stage bargaining framework which reproduces the key features of the Italian bargaining system, where wage negotiations occur first at the industry and then at the firm level. The framework we propose takes into account the presence of different degrees of union bargaining power at the two levels of wage negotiations, thus generating a potential distinction between the extent of rent sharing in centralized and in decentralized collective agreements. On the basis of this distinction, the Paper focuses on the study of rent sharing in the Italian basic metal industry by analysing separately what occurs at each of the two bargaining stages. In particular, by estimating a dynamic factor model and by measuring the dynamic correlation between wage and labour productivity, we evaluate how, through the bargaining process, aggregate and idiosyncratic productivity shocks influence respectively centralized and decentralized wage negotiations. It turns out that while centralized agreements generate rent sharing, at the decentralized bargaining level union power is absent.

JEL Classification: C10 and J50
Keywords: dynamic correlation analysis, dynamic factor model, rent sharing and two-stage bargaining

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NON-TECHNICAL SUMMARY

The question whether labour markets can be characterized as competitive or rent sharing has given rise to a long-running debate in labour economics. The rent-sharing hypothesis implies that improvements in the ability of firms or industries to pay leads to improvements in wages both in the short and in the long run. If, in contrast, competitive forces are at work, then changes in firm or industry performance could induce temporary changes in wages (e.g. if the short-run labour supply curve is upward sloping) but, apart from compensating differentials due to workers' skill or working conditions, in the long run competition among workers for jobs should equalize the price for labour everywhere.

Rent sharing may occur both in the presence and in the absence of unions. In the absence of unions, a positive comovement between wage and firm or industry profitability is possible in a competitive model with temporary frictions, in an optimal contract model, in an efficiency wage model or in an insider-outsider model. In the presence of unions, instead, rent sharing may occur in a bargaining model where rents are divided between unions and employers.

By taking into account the leading role of unions in the Italian system of wage determination, in the present Paper we focus on the analysis of the extent of rent sharing in Italy by relying on a framework where unions are present. The framework we propose is a two-stage bargaining model which reproduces in a stylized way the main features of the Italian wage bargaining system, where wage agreements occur both at the industry and at the firm level. In particular, while at a first bargaining level unions and employers fix a unique wage for the whole industry, at the second stage of wage negotiations unions and employers bargain at the firm level by setting a wage which can only be greater or equal to the wage set at the industry level.

A customary assumption of the theoretical analyses on two-stage bargaining is that social partners own the same degree of bargaining power at the first and at the second stage of wage negotiations. In this Paper, instead, by allowing union bargaining power to differ according to the bargaining level, we treat separately the extent of rent sharing in industry-level and firm-level wage agreements.

In line with our reference two-stage bargaining framework, we then perform an empirical analysis of rent sharing in Italy by studying at the same time how each of the two bargaining stages function. The aim is to assess whether movements in profitability lead to both short-run and long-run changes in workers' remunerations. Our main interest is to focus on the long-run properties of the relationship between wages and ability to pay: as a matter of fact, as we pointed out before, only by disentangling the short-run from the long-run comovements between these variables is it possible to discriminate between a competitive and a non-competitive model of wage determination.

The statistical tools we adopt are a dynamic factor model, which is developed according to the framework of Forni and Reichlin (1996, 1998, 1999), and an index of comovement, known as dynamic correlation, which has been recently proposed by Croux et al. (1999). These tools are especially suitable for our analysis not only because they allow us to analyse separately each of the two levels of wage negotiations but also because they are able to distinguish between short-run and long-run comovements between wages and ability to pay.

The empirical investigation focuses on a cross-section of 53 microsectors belonging to the Italian basic metal industry observed through the period 1983–98. In particular, we check whether the wage dynamics arising from centralized (i.e. industry-level) wage bargaining is related to the industry's average labour productivity dynamics and whether the wage drift arising from decentralized (i.e. firm-level) wage negotiations is related to firm-specific labour productivity dynamics.

Our main findings indicate that in Italy the centralized level of wage agreements generates rent sharing, while decentralized wage negotiations do not lead to any degree of rent sharing between unions and employers. This outcome confirms that a suitable theoretical framework to characterize the Italian two-stage bargaining system must take into account the presence of different degrees of union bargaining power at each of the two levels of wage negotiations. At the same time, this result suggests that in the case of industrial relations systems characterized by an intermediate degree of wage bargaining decentralization – like Italy – it may be necessary to perform a separate analysis of the functioning of each level of wage negotiations in order to avoid ambiguous conclusions about the relationship between the extent of rent sharing and the degree of decentralization of the wage bargaining system. The Paper also shows that centralized wage negotiations generate highly compressed sectoral wages with respect to sectoral labour productivity. This result indicates that it could be necessary to differentiate the centralized wage according to some more specific conditions of the sectors or microsectors that belong to the same industry. Alternatively, employers who are not able to pay workers the wage set at the first stage of wage negotiations could depart from centralized collective bargaining agreements.

1 Introduction[1]

A central question in labor economics is how the non-competitive features of the labor market can be modeled given that the simple competitive model does not provide an adequate representation of the reality. This topic has stimulated a lot of theoretical and empirical work. A line of research describes the stylized fact that when firms or industries are more prosperous, workers eventually receive rents: this is also the central prediction of a large class of rent sharing models, where changes in firm or industry performance ought to lead to changes in workers' remuneration both in the short and in the long run. In a competitive framework, in contrast, changes in firm or industry ability to pay could induce temporary changes in wages (e.g. if the short-run labor supply curve is upward sloping) but in the long run any wage differential results in an inflow of workers, and wages return to their initial level.

Rent sharing may occur both in the presence and in the absence of unions. In the absence of unions, a positive comovement between wage and firm or industry profitability is possible in a competitive model with temporary frictions or in an optimal contract model (Blanchflower et al., 1996); alternatively, it may arise in an efficiency wage model or in an insider-outsider model (Gregg and Machin, 1992). In the presence of unions, instead, rent sharing may occur in a bargaining model, where rents are divided between unions and employers.

Rent sharing models typically generate a wage equation where the firm-level wage depends both on a set of "internal" firm-specific factors and on a set of "external" factors (Gregg and Machin, 1992). Internal factors include different measures of firm performance, union presence, workers' bargaining power, financial factors and lagged wages. Among the external factors, in general, there is a role for industrywide or aggregate business cycle, the aggregate unemployment rate and the outside/alternative wage.

The responsiveness of wages to both internal and external factors has been tested in a number of recent microeconometric works.

A general result is that the responsiveness of wages to idiosyncratic profitability strictly depends on the degree of wage bargaining decentralization: in particular, the more a wage bargaining system is decentralized, the stronger is this link. As a matter of fact, in decentralized systems like

[1]We would like to thank Graziella Bertocchi, Giuseppe Bertola, Luigi Brighi, Marcello D'Amato, Sergio Destefanis, Michael Krause, Martin Ellison, Julián Messina-Granovsky and the seminar participants to the 3rd CEPR-IMOP Workshop on "New Approaches to the Study of Economic Fluctuations" (Hydra, 11/12 May 2001) for useful comments. We are also grateful to Mario Forni and Jorge Rodrigues for their helpful suggestions and for supplying us with the Matlab programs to estimate the dynamic factor model. The usual disclaimer applies.

the U.S., the U.K. and Canada wages show to be substantially responsive to changes in idiosyncratic performance (see e.g. Blanchflower et al., 1996, Holmlund and Zetterberg, 1991 and Estevao and Tevlin, 2000, for the U.S.; Christofides and Oswald, 1992 and Vahey and Wakerlym, 2001, for Canada; Nickell and Wadhwani, 1990, Nickell and Kong, 1992 and Hildred and Oswald, 1997, for the U.K.). At the same time the link between wages and external factors appears to be strictly related to the degree of wage bargaining centralization: centralized bargaining systems exhibit a relatively stronger relationship between wages and aggregate conditions. In Nordic countries, for example, which feature highly centralized wage bargaining systems, industry wages follow closely the evolution of the outside wage (Holmlund and Zetterberg, 1991).

By adding evidence to the empirical relationship between rent sharing and the degree of decentralization of the wage bargaining system and by contributing to the international comparison on wage setting and rent sharing of Holmlund and Zetterberg (1991),[2] the present work focuses on Italy, which is a country characterized by an intermediate degree of wage bargaining decentralization.

In order to take into account the leading role of unions in the Italian system of wage determination, our analysis of rent sharing relies on a framework where unions are present. We propose a two-stage bargaining framework which reproduces in a stylized way the main features of the Italian bargaining system, where wage agreements occur both at the industry and at the firm level.

A customary assumption of the theoretical analyses on two-stage bargaining is that social partners own the same degree of bargaining power at the first and at the second stage of wage negotiations.[3] In this paper, instead, by allowing union bargaining power to differ according to the bargaining stage, we treat separately the extent of rent sharing at the industry and at the firm level.[4]

In line with our reference two-stage bargaining framework, we then perform an empirical analysis of the extent of rent sharing in Italy, which constitutes the main novelty of this paper. The reason is that this kind of

[2]The empirical investigation of Hulmlund and Zetterberg concerns five countries: Sweden, Norway, Finland, Germany and the U.S.

[3]The analysis of two-stage bargaining is a relatively recent topic in the labor economics literature (see e.g. Holden (1989a), Holmlund and Skedinger (1990) and Holden (1998), with reference to Scandinavian countries, and Ordine (1996) and Mulino (2000), with reference to Italy).

[4]The justification for this assumption lies on the fact that a common feature of two-stage bargaining systems is that the social partners who negotiate at the first bargaining stage are different from those who negotiate at the second stage. In Italy, for example, the union confederations (e.g. CGIL, CISL, UIL) bargain at the industry level, while the RSU (*Rappresentanze Sindacali Unitarie*) bargain at the firm level.

analysis allows us to study at the same time the extent of rent sharing at both the first and the second stage of wage negotiations. In particular, we check whether the wage dynamics arising from centralized wage bargaining is related to the industry's average labor productivity dynamics and whether the wage drift arising from decentralized wage negotiations is related to idiosyncratic labor productivity dynamics. We focus on the labor cost and labor productivity series for a cross-section of 53 microsectors belonging to the Italian basic metal industry. The reference period is 1983-1998.

As pointed out by Hildred and Oswald (1997), the main difficulty for an empirical study of rent sharing is the identification of the suitable statistical tools that allow to distinguish between long-run from short-run comovements between wages and ability to pay. This is crucial because, as we stressed before, while in rent sharing models if workers receive rents movements in profitability lead to changes in workers' remunerations both in the short and in the long run, in competitive models wages and profitability can only be positively correlated in the short run because of temporary frictions in the labor market. Hence, only by disentangling the short-run from the long-run comovements between wages and ability to pay it is possible to distinguish between a competitive and a non-competitive model of wage determination.

The statistical tools we adopt are a dynamic factor model, which is developed according to the framework of Forni and Reichlin (1996, 1998, 1999), and an index of comovement, known as dynamic correlation, which has been recently proposed by Croux et al. (1999). These tools are especially suitable for our analysis because they allow us to distinguish between short-run and long-run comovements between wages and profitability at both the industry and the firm level of wage negotiations. Moreover, these techniques permit to analyze the features of our highly disaggregated data characterized by both dynamic and cross-sectional heterogeneity while retaining both sophisticated dynamic modelling and parameter heterogeneity (Forni and Reichlin, 1999).

Our results indicate that in Italy the centralized level of wage agreements generates rent sharing, while decentralized wage negotiations do not lead to any degree of rent sharing between unions and employers. Moreover, centralized wage negotiations seem to generate highly compressed sectoral wages with respect to sectoral labor productivity.

The remainder of the paper is organized as follows. Section 2 introduces the main results of the reference theoretical framework. Section 3 describes the dataset. Section 4 presents the statistical model. Section 5 shows the results. Section 6 concludes. Finally, in the Appendix we describe the details of our reference two-stage bargaining framework and we review the main differences between static and dynamic factor models by illustrating the estimation procedure.

2 Reference framework

To reproduce the key features of the Italian bargaining system, where wage negotiations occur both at the industry and at the firm level, we adopt a two-stage bargaining framework. We refer to Appendix A for a detailed description of its main assumptions and derivations.

Wage negotiations are articulated as follows. While at a first bargaining stage unions and employers fix a unique wage for the whole industry, at the second stage of wage negotiations unions and employers bargain at the firm level by setting a wage which can only be greater or equal to the wage set at the industry level.

The two bargaining stages are not reciprocally interrelated: the underlying assumption is that at the first stage of wage negotiations the social partners do not take into account the results of the bargaining at the second stage. This typical *open loop* framework can be justified with the hypothesis of imperfect information between the social partners at the different negotiation levels: indeed, the local contractors have presumably more information about their own economic conditions than the central contractors. Another reason why at the first stage the social partners could not take into account the results of the bargaining at the second stage is the presence of different union densities at the two bargaining stages: as a matter of fact, if firm-specific unions are few, the central union presumably does not consider as relevant what happens at the second stage (see also Mulino, 2000).

In our framework the wage of the i-th firm (W_i) is defined as follows:

$$W_i \left\{ \begin{array}{ccc} = & W_C + W_{Fi} & if\ W_i > W_C \\ = & W_C & otherwise \end{array} \right\} (i = 1, ..., n) \tag{1}$$

where W_C is the contractual wage arising from industry-level bargaining and W_{Fi} represents the wage portion in excess of the contractual wage arising from firm-level bargaining. Changes in the "relative wage" W_{Fi} describe the so-called wage drift (i.e. the difference between the actual wage changes and the contractual wage changes).[5]

The optimal wage arising from centralized (i.e. industry-level) wage negotiations is:

$$W_C = \mu\overline{Q} + (1 - \mu)\,B. \tag{2}$$

According to expression (2), the wage set at the central level is a weighted average between the industry's average value added per worker ($\overline{Q}$) and the

[5]In Italy the contractual wages (*retribuzioni contrattuali*) are the wages which are set at the industry level and which act as tariff wages for decentralized wage negotiations. The wage drift represents instead the wage changes arising from firm-specific wage bargaining. For a description of the stages of wage negotiations in Italy see e.g. Erickson and Ichino (1995).

unemployment benefits (B). The weights are respectively given by the central union's bargaining power (μ) and the employers' confederation's bargaining power $(1-\mu)$.[6]

The optimal W_{Fi} arising from decentralized (i.e. firm-level) wage negotiations is:

$$W_{Fi} = W_i - W_C = \gamma \left(Q_i - \overline{Q} \right). \tag{3}$$

Expression (3) indicates that the wage portion of the i-th firm in excess of the contractual wage (i.e. the "relative wage") depends on the deviation of the firm-specific value added per worker from the industry's average value added per worker $(Q_i - \overline{Q})$. The degree of the correlation between W_{Fi} and $(Q_i - \overline{Q})$ is given by the union bargaining power at the firm level (γ).[7]

According to this simple two-stage bargaining framework, at each of the two levels of wage negotiations there thus exists a distinct relationship between wage and labor productivity (value added per worker): as a matter of fact, while the wage set at the central stage depends on the industry's average labor productivity ($W_C = W_C(\mu, \overline{Q}, B)$, from (2)), the wage set at the second stage of wage negotiations is related to the deviations of the firm-specific labor productivity from the average labor productivity ($W_{Fi} = W_{Fi}(\gamma, \left(Q_i - \overline{Q}\right))$, from (3)).

To sum up, firm-specific (idiosyncratic) and industrywide (common) factors have a different role on wage determination according to the level at which negotiations occur: in particular, while the wages set at the central stage show to be related to aggregate determinants (i.e. the industry's average productivity, the industry-level union bargaining power and the outside alternative wage), the wages set at the decentralized stage show to depend on firm-specific factors (i.e. the firm-specific labor productivity and the firm-level union bargaining power).

In the following, in line with the key relationships we found above, we will present an empirical analysis of the extent of rent sharing in Italy: our aim is to study to what extent each of the existing two levels of wage negotiations conduce to rent sharing between workers and employers.

[6] For a similar framework, see Moene et al. (1993), where the wage set at the central level depends on the average industry's productivity. A related approach is in Mulino (2000), where the contractual wage depends on the productivity of the least productive firm (or class of firms) within the industry.

[7] Note that if $\left(Q_i - \overline{Q}\right)$ is negative, then $W_{Fi} = 0$: in this case there are no extra-rents to be divided between unions and employers at the firm level and workers simply get the contractual wage.

3 Data and stylized facts

We analyze microsectoral-level labor productivity and labor cost data for a sample of 53 sectors belonging to the Italian basic metal industry (*metalmeccanico*). The data are annual time series ranging from 1983 to 1998.[8] Labor productivity is here defined as nominal value added at market prices divided by the number of workers (value productivity), while labor cost is the nominal labor cost per worker.

This dataset is particularly useful because it allows us to make general inferences not only on collective bargaining at the industry level but also on collective bargaining at the firm level. This is due to the fact that the data are taken from a sample of medium-large firms, where the collective bargaining at the firm level mainly occurs. Moreover, this dataset is especially convenient for a study on the extent of rent sharing because this kind of analysis requires wage and productivity data with both a cross-sectional and a time-series dimension in order to isolate the long-run contribution of firm performance on wages.[9]

We now look at our data by comparing the labor productivity series with the labor costs series: we focus in particular on their relative sectoral dispersion, both in terms of *levels* (Figure 1) and in terms of *growth rates* (Figure 2). Note that from now on we will refer indiscriminately to wage or labor cost.[10]

Figure 1 shows that along the period 1983-1998 the coefficient of variation of sectoral wages is always lower than the coefficient of variation of sectoral labor productivities. At the same time, labor productivity dynamics is more heterogeneous than wage dynamics: as we can see from Figure 2, the sectoral dispersion of the labor productivity growth rates is on average greater than the sectoral dispersion of the wage growth rates.

To sum up, our data shows that sectoral wages are relatively more compressed with respect to sectoral labor productivities both in levels and in growth rates.

[8]The data were supplied by Prometeia (an Italian private research center), which grouped in microsectors the data of the Centrale dei Bilanci survey, which collects the balance-sheet information for 40000 medium-large firms of the Italian private industry.

[9]As pointed out before, the focus on the long-run properties of the relationship between wage and firm performance permits to discriminate between a competitive and a noncompetitive model of wage determination.

[10]One justification for this choice lies in the fact that the dynamics of labor compensation is the main determinant of the growth rate of labor cost (ISTAT, *Costo del lavoro e retribuzioni nette su base contrattuale*, Informazioni n.7, 1999). In addition, we use variables in which the deterministic components of the series heve been washed out. This allows us to get rid of indirect labor costs such as the employers' social security contributions, whose sectoral heterogeneity appears to be relatively stable over the period analyzed (ISTAT, *Lavoro e Retribuzioni,* Annuario n.3, 1999).

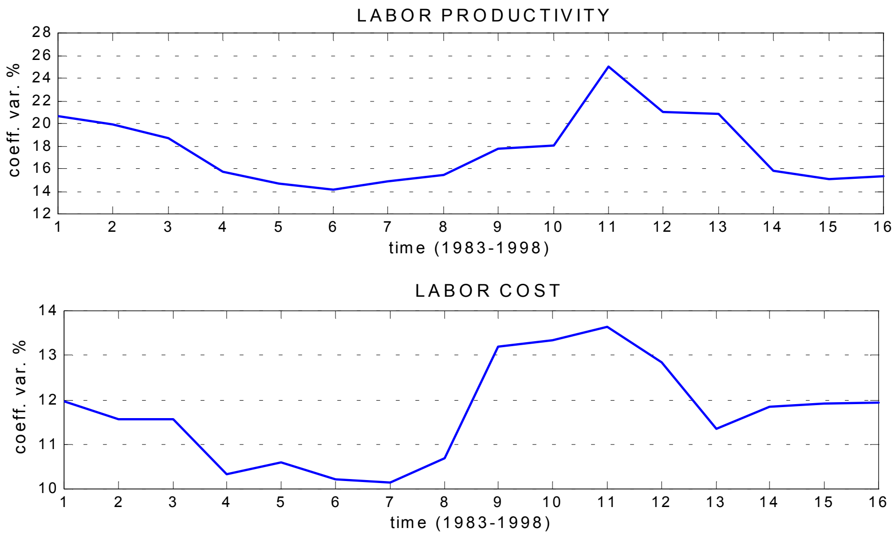

Figure 1: Coefficients of variation of labor cost and labor productivity: 1983-1998

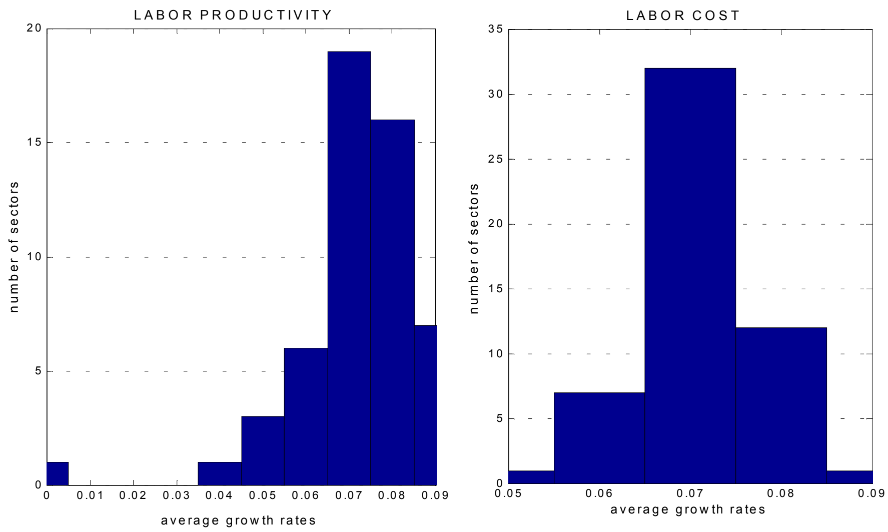

Figure 2: Distribution of the growth rate of labor productivity and labor cost (average: 1983-1998)

It is important to point out that the wage compression phenomenon could have been due both to the existence of centralized wage bargaining and to the functioning of an indexation mechanism known as *Scala Mobile*. The *Scala Mobile* mechanism was introduced immediately after the war and provided for each unit increase in the price index an equal wage increase to workers in all sectors and *inquadramento* levels.[11] This point-based mechanism was abandoned in 1986 in favor of a system in which the average overall degree of indexation was approximately 50% for the blue-collar workers and 40% for the white-collar workers. In 1992 this system was suspended.[12] Consequently, at least with reference to the period we focus on, the *Scala Mobile* mechanism might not be considered a major determinant of the wage compression phenomenon.

Related to this, note that in the next sections we will investigate the relationship between sectoral wage differentials and idiosyncratic performances of the basic metal sectors under the hypothesis that any wage differential is due in the long run only to decentralized wage agreements. This means that we will assume that the wage compression phenomenon, if relevant, is only due to centralized wage negotiations.[13] Notice that the assumption that the wage indexation mechanism has a negligible role in wage compression during the period considered is supported not only by the above brief review of the history of the *Scala Mobile* mechanism, but also by the results of Gavosto and Sestito (1991), who find a strong compression of wage differentials even in the period when the *Scala Mobile* mechanism was not very effective.[14] More recently, a similar point of view is also found in Ericksson and Ichino (1995) and in Fabiani et al. (1997).

4 Dynamic factor models and bargaining levels

In this section we study the extent of rent sharing in wage determination in the Italian basic metal industry. The focus is on the distinction between the analysis of the comovement between wage and productivity dynamics both according to the bargaining stage (i.e. industry-level vs firm-level bargaining) and according to the features of the economic cycles (i.e. short-run vs long-run cycles). We perform our analysis by checking whether the contractual wage dynamics is related to the industry's average labor productivity dynamics and whether the wage drift is related to firm-specific labor productivity dynamics. In particular, by focusing on these relationships in the long run and by analyzing the sign and the magnitude of the comovements

[11] The *inquadramento* levels represent categories of workers with similar skills and education levels.

[12] On the history of the *Scala Mobile* mechanism see e.g. Erickson and Ichino (1995).

[13] This point will be better clarified below, when we will present the specification of the statistical model we adopt. Unfortunately, we cannot directly test for the relative weight of centralized wage bargaining and of the *Scala Mobile* mechanism in wage compression because of the short range of our data.

[14] To see this in our data, note that in Figure 1 the compression result holds as well in the period when the *Scala Mobile* mechanism was no more effective (i.e. after 1992).

between these series, we will derive some implications about the degree of rent sharing at each of the two existing levels of wage negotiations, following what suggested by the reference framework of Section 2.

The analysis is performed through the estimation of a dynamic factor model (Forni and Reichlin, 1996, 1998, 1999) for the wage and the productivity series. By estimating a dynamic factor model for manufacturing wages, we are able to isolate the wage dynamics which is common across sectors from the wage dynamics which is idiosyncratic to each single sector: while the former proxies for the contractual wage dynamics, the latter proxies for the wage drift dynamics. At the same time, in the case of labor productivity, the factor model decomposition we adopt allows us to estimate the contribution of both aggregate and idiosyncratic shocks to labor productivity.

After the estimation of the common and idiosyncratic components of wages and labor productivity, we measure the degree of rent sharing by using the dynamic correlation index, which has been recently proposed by Croux et al. (1999). This index identifies not only the average degree of comovement between two series (in the same way as simple correlation) but also the degree of comovement between them at different moments in time.[15] This is particularly important for our purposes since in order to study the degree of rent sharing it is crucial to identify which is the degree of comovement between wage and productivity in the long run. In particular, while a long-run positive dynamic correlation across the common components of the two variables is an index for the existence of rent sharing at the central level of wage negotiations (aggregate rent sharing), a long-run positive dynamic correlation among the idiosyncratic components suggests the existence of rent sharing at the firm level (idiosyncratic rent sharing). In other words, a positive dynamic correlation among wage and productivity in the long run indicates the presence of union bargaining power in wage negotiations, as suggested by the theoretical framework of Section 2.

4.1 Statistical model and dynamic structure of the data

In the following we present two dynamic factor models we use to analyze labor productivity and wage fluctuations: the focus is on the description of the model dynamic structure, that emerges both from economic considerations and statistical analysis (i.e. from the Akaike information criterion analysis).[16] The detailed estimation procedure and the comparison between

[15] Note that by using this index we can isolate comovements in the *growth rates* of the variables as well as long-run comovements in their *levels*: this happens in the special case in which the series share a common trend (i.e. they are cointegrated).

[16] There are various model selection criteria that trade off a reduction in the sum of squares of the residuals for a more parsimonious model. One of the most commonly used

the dynamic and the static version of the model is shown in Appendix B.

We consider the following dynamic factor models:

$$q_{i,t} = a_i(L)\pi_t + b_i(L)\pi_{i,t} \quad (4)$$

$$w_{i,t} = c_i(L)\upsilon_t + d_i(L)\upsilon_{i,t} \quad (5)$$

where $q_{i,t}$ and $w_{i,t}$ are respectively the growth rate of labor productivity and the growth rate of wage in sector i ($i = 1, ..., n$) at time t. More precisely, $q_{i,t}$ is the first difference of labor productivity, $Q_{i,t}$ (in logs) and $w_{i,t}$ is the first difference of wage, $W_{i,t}$ (in logs). We take the first differences of the variables because the series are I(1) processes.[17] $\pi_t, \upsilon_t, \pi_{i,t}, \upsilon_{i,t}$ are all *white noises* mutually uncorrelated at all leads and lags. In particular, while π_t and υ_t are common shocks across sectors respectively to the growth rate of labor productivity and to the growth rate of wage, $\pi_{i,t}$ and $\upsilon_{i,t}$ are idiosyncratic shocks. These shocks define the common components, $a_i(L)\pi_t$ and $c_i(L)\upsilon_t$, and the idiosyncratic components, $b_i(L)\pi_{i,t}$ and $d_i(L)\upsilon_{i,t}$.

Following the estimation procedure in Appendix B, models (4) and (5) can be estimated by OLS equation by equation by using $\overline{q}_t$ (i.e. the growth rate of the simple average of sectoral labor productivities) to proxy for the unobservable common shock π_t and $\overline{w}_t$ (i.e. the growth rate of the simple average of sectoral wages) to proxy for the unobservable common shock υ_t. The idiosyncratic components of the growth rate of labor productivity, $b_i(L)\pi_{i,t}$, and of wage, $d_i(L)\upsilon_{i,t}$, are the estimated OLS residuals.

The dynamic specification of the propagation mechanisms of model (4) and (5) describes two sources of heterogeneity in the variables: (i) a heterogeneity due to different responses of the variables to a common shock and (ii) a heterogeneity due to different responses of the variables to idiosyncratic shocks. In the first case the response functions are represented by $a_i(L)\pi_t$ and $c_i(L)\upsilon_t$, while in the second case they are described by $b_i(L)\pi_{i,t}$ and $d_i(L)\upsilon_{i,t}$.

The heterogeneity of type (i) implies that the sectoral responses to a common shock can be characterized in the short-medium run by completely heterogeneous sectoral impulse response functions: in this case, the sectoral responses to an aggregate shock can be different in magnitude, in sign, but also in timing. In the long run, instead, the common components cannot diverge in a permanent way, since they are driven by a unique shock. As a consequence, in the long run the only source of heterogeneity in the variables, if it exists, has an idiosyncratic nature (i.e. there is only the heterogeneity of type (ii)) that is wage or productivity differentials across sectors are only determined by the idiosyncratic components.

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ones is the Akaike information criterion (AIC). For details, see e.g. Enders (1995).

[17]The results on the degree of integration of the variables are available on request. We remember that the variables were also washed out by the deterministic components. Hence, we work with zero-mean first differences.

Why is the dynamic structure of the model so relevant? More properly, why is it important to model the short-medium run dynamics of the common components of the model? The dynamic specification of the common components is crucial because it can take into account, for example, phenomena like the different sectoral propagation mechanisms of the labor productivity shocks and the staggering of collective bargaining agreements. Note that, in case these phenomena are economically and statistically important, an unsuitable static filtering procedure may induce spurious results: in particular, all the omitted common dynamics of the variables could be spuriously captured by the idiosyncratic components.[18]

In particular, in model (4), the dynamic specification of the labor productivity common components, $a_i(L)\pi_t$, allows us to take into account the possibility that a common productivity shock (e.g. a technological shock) may generate a certain kind of response in one sector at a specific moment and a response (of the same or different sign and magnitude) in another sector after a certain time. In an attempt to model a similar phenomenon (e.g. the heterogeneous dynamic diffusion of the technological progress),[19] we estimate the common components of the growth rate of labor productivity with one lead and one lag. This lag structure is also confirmed by the Akaike information criterion.

Let us now turn to model (5) and to its dynamic specification.

The common components in model (5), $c_i(L)\upsilon_t$, describe both the contribution of centralized wage bargaining to sectoral wage dynamics (through the contractual wage determination) and the automatic wage changes due to overtime work. In particular, long-run movements in wage common components are induced by *permanent* common shocks to sectoral wages due to the renewal of collective bargaining agreements at the central level.[20] In the short run, movements in wage common components mainly reflect *temporary* wage changes due to overtime work changes induced by transitory common shocks in aggregate demand[21] Note that we perform this hypothesis since centralized wage bargaining in Italy does not induce temporary

[18]A static filtering procedure is instead typical of static factor models, which have been extensively used in the labor market literature (see Appendix B).

[19]On this topic, see Lippi and Reichlin (1994) and the references therein.

[20]Related to this, it is important to highligh that the comparison between the ISTAT official data on contractual wages (see ISTAT, *Lavoro e retribuzioni*, various years) and our estimated common components suggests that two series have a similar time evolution. The main difference between them is the scale: our labor cost common components overestimate the official data on contractual wages. The reason is that our components also include common transitory wage changes due to overtime work.

[21]A transitory common shock in aggregate demand induces heterogeneous temporary increases in worked hours which are not reflected into changes in employment: this leads to heterogeneous temporary wage increases which are not due to centralized wage bargaining, but to overtime work.

wage changes.

In the light of the above interpretations, the dynamic specification of the common components in (5) reveals to be crucial. More precisely, the dynamic specification of the wage common components can take into account phenomena like the staggering of collective bargaining agreements at the central level, the lack of synchronization in sectoral wage increases over the period between two different renewals, the possible interactions across sectors in the process of wage determination and, finally, the possibility that a common transitory shock to aggregate demand may generate different responses in overtime work across sectors and hence in sectoral wage responses. In an attempt to model these phenomena, we estimate the common component of the growth rate of wage with one lead and one lag. This lag structure is confirmed by the Akaike information criterion analysis.

The idiosyncratic components in model (5), $d_i(L)v_{i,t}$, reflect both the contribution of decentralized wage bargaining (through the wage drift determination) and the automatic wage changes due to firm-specific overtime work. In the short run, in particular, the wage idiosyncratic components describe both temporary wage fluctuations due to firm-specific overtime work and temporary wage changes due to unions that bargain at the firm level transitory changes in productivity (through production premia or/and incentive bonuses).[22] However, since overtime work is only a cyclical phenomenon, in the long run the wage idiosyncratic components are mainly due to the renewal of collective bargaining agreements at the firm level.[23]

Related to this, it is worth pointing out that in general the relative wage (and consequently the wage drift) set at the firm level could reflect both collective and individual firm-level wage bargaining. In our framework, however, the role of individual wage bargaining in the evolution of the relative wage is assumed to be negligible. There are some reasons to justify this hypothesis. One reason is that since we use microsectoral data instead of firm-level data, many individual wage components cancel each other out by leaving the wage drift mainly to represent the collective wage bargaining at the firm level. A second reason is that we washed out the residual differences in sectoral wages by removing the deterministic components of the variables. A further reason is related to the results of some of the previous empirical analyses on wage differentials in Italy, where it is shown that sectoral characteristics, such as value added and union density, are more

[22] On incentive bonuses and production premia, see Erickson and Ichino (1995).

[23] Note that the local increments to the wage rates that prevail after the central negotiations constitute the main part of the wage drift. In the wage statistics, however, the wage drift is calculated as a residual (i.e. as the difference between the total wage increases - including overtime - and the wage increases that are due to central wage negotiations). As a consequence, the wage drift consists of more than the increments due to local bargaining. On this point, see Holden (1989b).

important than individual characteristics in explaining wage differentials in Italy (see e.g. Quintieri and Rosati, 1994).

To conclude, the hypothesis that the common components of the wage series reflect centralized wage bargaining while the idiosyncratic components of the wages series reflect decentralized collective bargaining agreements holds in the long run but not necessarily in the short run. Note that, as discussed in the introduction, this long-run result is crucial for our empirical investigation, because only by analyzing the long-run behavior of wage and productivity we can discriminate between a competitive and a non-competitive model of wage determination.

4.2 Variance decomposition and dynamic correlation analysis

By estimating model (4) and (5) it is possible to perform two types of empirical investigations: (i) the variance decomposition of each variable in common and idiosyncratic components and of each component with respect to the cycle frequencies; (ii) the dynamic correlation analysis.

(i) The variance decomposition analysis (see Section 5.1) focuses on the study of the relative weight of common and sector-specific components of wage and labor productivity over the frequency domain. This analysis allows us to describe the role of centralized bargaining in the determination of wage levels and the role of decentralized bargaining in the evolution of wage differentials. Moreover, it permits to study the role of aggregate and idiosyncratic shocks to sectoral productivity fluctuations and to compare the weight of wage differentials with respect to productivity differentials.

(ii) The dynamic correlation analysis (see Section 5.2) is performed considering model (4) versus model (5). This analysis concentrates on the comovement among the common components of wage and labor productivity and on the comovement among the idiosyncratic components of wage and labor productivity. The analysis of the comovement among the common components of wage and labor productivity allows us to evaluate the degree of rent sharing at the central level of wage negotiations, while the analysis of the comovement among the idiosyncratic components of wage and labor productivity allows us to evaluate the degree of rent sharing at the decentralized level of wage negotiations.

To study the relationship among common and idiosyncratic components of wage and labor productivity, we use an index of comovement, known as *dynamic correlation*, that has been recently proposed by Croux et al. (1999).[24] We provide an intuition about this concept.

[24]The dynamic correlation index between two I(0) series x and y is expressed by $\rho_{xy}(\lambda) = \frac{C_{xy}(\lambda)}{\sqrt{S_x(\lambda)S_y(\lambda)}}$, where S_x and S_y are the spectral density functions of x and y while C_{xy} is

The dynamic correlation index, from now on $\rho(\lambda)$, ranges from 1 to -1 (as the simple correlation index) but it is defined on the frequency domain, $\lambda \in (0, \pi)$.[25] This index identifies not only the average degree of comovement between two series (in the same way as simple correlation) but also the degree of comovement between them at different frequencies, λ, that is at different moments in time. This implies that $\rho(\lambda)$ can be used to study business cycle dynamics as well as the long-run features of the data. In particular, by using this index we can isolate both short and medium-run comovements in the *growth rates* of the variables (at frequencies different from zero) and comovements in the long-run *levels* of the variables (at zero frequency). This is important because the variables in levels can comove weakly in the long run even if their growth rates are strongly correlated in the short run or viceversa.

The importance of this comovement index with respect to the simple correlation can be captured in the following example. Let us consider two series that have no contemporaneous comovements (i.e. the simple correlation index is zero) but that are cointegrated (i.e. the long-run levels of the variables comove). In this case, the dynamic correlation index is "on average" (over the frequencies) equal to zero as the simple correlation measure, but at the zero-frequency (corresponding to trends) it will be equal to 1, that is $\rho(0) = 1$,[26] thus suggesting the true feature of the data: the presence of large positive long-run comovements canceling out with large short-run negative comovements. More precisely, this example suggests that $\rho(0) = 1$ implies that the series are perfectly correlated *in levels*, that is cointegrated.

Why is the dynamic correlation analysis better than traditional techniques based on rank reduction to study the long run comovements between time series?[27] There are mainly two reasons. First, cointegration analysis performed by using rank reduction methods gives only a binary answer about the comovement: it says if two variables are perfectly correlated or not, but it is not able to suggest the degree of association.[28] Second, gen-

the co-spectrum. This index is related to the well-known concept of coherence, which is generally used to study the degree of association between two variables. However, as stressed in Croux et al. (1999), "coherence does not measure the correlation at different frequencies because it disregards the phase differences between the variables". In other words, coherence is not a good measure of syncronisation of the business cycle fluctuations.

[25]Notice that, with annual data, frequencies close to 3.14 correspond to short-run growth cycles (i.e. short-run periods): in particular, the frequency $\lambda = 3.14$ corresponds to two-year growth cycles. Frequencies close to 0 correspond instead to long-run growth cycles: for example, $\lambda = 0.63$ corresponds to ten-year growth cycles, while $\lambda = 0$ corresponds to trends. On the spectral analysis see Priestley (1981).

[26]Note that the long-run dynamic correlation is related to the parametric concept of cointegration: in particular, $\rho(0) = 1$ implies stochastic cointegration.

[27]See Croux et al. (1999) for a detailed analysis of the traditional literature to study the comovements among time series based on a notion of rank reduction.

[28]We saw before that if two variables have a dynamic correlation index equal to 1 this

erally to study cointegration in the rank reduction framework, we need to estimate a VAR, which is not a suitable procedure when the cross-sectional dimension of the data is large (as it occurs in our dataset).

5 Results

5.1 Wage and productivity cycles

Table 1 reports the variance decomposition of the common and idiosyncratic components of wage and labor productivity at different frequencies of the cycle. In particular, it shows the average variances for cycles of less than five years (i.e. short-run cycles) and cycles between five and ten years (i.e. medium-run cycles). With respect to the long run (zero-frequency), it reports the variance of the trends (i.e. cycles of infinite period).

From Table 1 we derive the following results.

The growth rate of wage is mainly due to idiosyncratic shocks of transitory nature which decay in less than five years (42%). Hence, sectoral wage dynamics is mainly determined by the wage drift, which primarily includes short-lasting deviations of the actual wage dynamics from the contractual wage dynamics.[29]

In the same way as wage, labor productivity is mainly driven by transitory idiosyncratic shocks lasting less than five years (45%): this means that the idiosyncratic busyness cycle is the major determinant of the labor productivity fluctuations. Moreover, the role of short-run fluctuations in labor productivity dynamics is similar to the role of short-run fluctuations in wage dynamics. This result could imply that the wage drift is related to the idiosyncratic business cycle.

In the long run, wage is mainly determined by permanent common shocks. These shocks represent 18% of the total variance of wages and 82% of their long-run variance (18/22). Hence, collective bargaining negotiations at the central level define the long-run behavior of wages.

From a different perspective, Table 1 tells us that the relative weight of permanent wage differentials across sectors is small (4%): in other words, there is only a minor portion of wages which is set in decentralized collective bargaining.

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means that the variables are cointegrated. At the same time, if the dynamic correlation index is very high (e.g. equal to 0.8-0.9) this means that two non-cointegrated variables are highly synchronized.

[29]Similar results are obtained by Dell'Aringa and Lucifora (1994) for Italy. For an international comparison on the role of wage drift, see Holmlund and Zetterberg (1991).

Table 1 Variance decomposition

Wage				
Period	Frequency	Common	Idiosyncratic	*Total*
trend	$\lambda = 0$	0.18	0.04	0.22
5-10 years	$0.63 \leq \lambda \leq 1.26$	0.08	0.09	0.17
< 5 years	$\lambda > 1.26$	0.19	0.42	0.61
	Total	0.45	0.55	100
Labor productivity				
Period	Frequency	Common	Idiosyncratic	*Total*
trend	$\lambda = 0$	0.04	0.08	0.12
5-10 years	$0.63 \leq \lambda \leq 1.26$	0.08	0.12	0.20
< 5 years	$\lambda > 1.26$	0.23	0.45	0.68
	Total	0.35	0.65	100

Note: Variances derived by the spectral density function of the average of the common components, $a_i(L)\pi_t$ and $c_i(L)\upsilon_t$, and of the idiosyncratic components, $b_i(L)\pi_{i,t}$ and $d_i(L)\upsilon_{i,t}$, at different frequencies.

Differently from wage, labor productivity is driven in the long run by both common and idiosyncratic shocks of permanent nature. Note that the weight of labor productivity permanent differentials is relatively small, but double with respect to permanent wage differentials (8% versus 4%).[30] This imbalance could reflect a low bargaining power of the unions at the firm level.

With respect to the long run, the weight of the permanent common component in wage is greater than the weight of permanent common component in labor productivity (18% versus 4%). Hence, collective bargaining at the central level seems to induce in the long run a relatively high wage compression. As a consequence, collective bargaining leads to a contractual wage dynamics which is not adequate with respect to industry's average labor productivity dynamics. This result suggests that when a central union bargains the contractual wage, it takes into account not only the long-run productivity evolution, but also the medium-run persistent (but *not* permanent) changes in labor productivity (e.g. the long-lasting shocks in labor productivity, which correspond to frequencies $0.63 \leq \lambda \leq 1.2$ and whose weight is 8% of the total variance).

Finally, differently from the permanent common components, the relative weight of transitory common components in wages is similar to that

[30]The existence of wage and productivity differentials may be due to imperfections which interfer with migration of labor and capital toward the optimal remuneration.

of transitory common components in labor productivity. This result could imply that there is a relationship between the wage dynamics and the aggregate business cycle (i.e. the business cycle which is common across all the basic metal sectors).

To sum up, our results tell us that while the long-run evolution of wages is mainly determined by the first level of wage negotiations (through the contractual wage determination), the transitory wage dynamics is mainly due to the second level of wage negotiations (through the wage drift determination). Moreover, while contractual wage does not seem adequate to the average productivity level in the basic metal industry, the wage drifts seem to be sufficiently similar to productivity differentials (idiosyncratic productivity), especially at the business cycle frequencies.

5.2 Union power and bargaining levels

Figure 3 shows the two possible types of dynamic correlation among the variables: (i) correlation between wage common components and labor productivity common components (left plot of Figure 3); (ii) correlation between wage idiosyncratic components and labor productivity idiosyncratic components (right plot of Figure 3). The dynamic correlation is reported on the vertical axes of the figures, while the frequency domain is specified on the horizontal axes.

The right plot of Figure 3 shows that the dynamic correlation among the wage idiosyncratic components and the labor productivity idiosyncratic components is positive only till around $\lambda = 1.5$, which corresponds to four-year growth cycles: this means that there is a positive comovement among the variables only in the short run. Hence, the wage drift is strictly related to the idiosyncratic business cycle. This result can be due to decentralized collective agreements at the firm level, through the bargaining of transitory firm-specific productivity changes (e.g. production premia), or to the presence of firm-specific overtime work.

The right plot of Figure 3 also shows that there is no significant positive relationship between permanent relative wages and permanent idiosyncratic labor productivities. Since in the long run the relative wages are only due to the contribution of decentralized collective wage bargaining, this means that there is no rent-sharing at the firm level.[31] This outcome also casts

[31] To support our result of the absence of rent sharing at the firm level (i.e. the absence of a long-run relationship between idiosyncratic wages and idiosyncratic productivities), we also computed the *coherence* among the idiosyncratic components of labor cost and labor productivity. This index has the same interpretation of the R^2 of a regression: it measures the linear dependence between the variables. According to our results, in the long run the coherence among the idiosyncratic components of labor cost and labor productivity is not significantly different from zero, thus meaning that wage drift and idiosyncratic labor productivity are not significantly and permanently related.

some doubts on the existence of bargaining power at the firm level in the short run.

As a result, our analysis suggests that in the long-run the second level of wage negotiations behaves almost like a competitive labor market: rent-sharing is absent and, at the same time, there are no relevant wage differentials (see Table 1). This may suggest that along the whole time period considered labor has been enough mobile across the firms belonging to the basic metal industry.

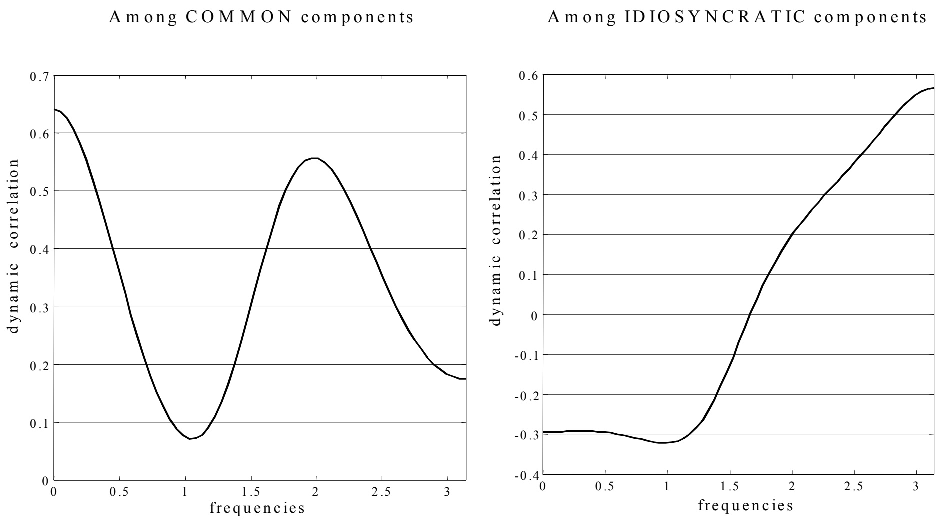

Figure 3: Dynamic correlation among common components and among idiosyncratic components of wage and labor productivity (average across sectors): 1983-1998.

The left plot of Figure 3 shows a peak around $\lambda = 2$, which corresponds to three-years growth cycles. The dynamic correlation is $\rho(2) \simeq 0.6$ and suggests a high positive relationship between common wage growth and aggregate business cycle. This short-run comovement mainly derives from the existence of overtime work at the industry level: in other words, there is a part of the wage flexibility which is due to aggregate business cycle primarily because of cyclical fluctuations in overtime work occurring when a common transitory shock hits the whole industry.[32]

[32]As we discussed in Section 4.1, centralized wage bargaining does not induce temporary wage increases. However, it is worth pointing out that the comovement between short-run wage and productivity fluctuations could also be a spurious outcome related to the average duration of the Italian collective agreements at the central (industry) level. Note that these agreements had a three-years duration until 1993, while since 1993 they have had a four-year duration (even if the renewal of the economic part of them occurs every two years).

The left plot of Figure 3 also shows that the long-run comovement (at zero frequency) among the wage common components and the labor productivity common components is around 0.65, $\rho(0) \simeq 0.65$. The existence of this high positive comovement implies that there is union bargaining power at the centralized level of wage negotiations.

To sum up, our results seem to suggest that the central stage of wage negotiations generates rent-sharing. On the contrary, the second level of wage negotiations behaves almost like a standard competitive labor market model, where there is no permanent relationship between wage differentials and idiosyncratic labor productivity. Idiosyncratic productivity improvements in a firm may lead to short-run wage increases to the extent that labor demand rises, but wage "premium" is gradually eliminated as new workers enter the firm. This result also suggests that decentralized wage bargaining seems to be a way to redistribute only the cyclical firm-specific productivity gains, while not allowing workers to really participate to the long-run firm evolution.

6 Conclusions

In this paper we have studied the functioning of the Italian two-stage bargaining system by focusing on the analysis of the wage and productivity dynamics of the basic metal industry during the period 1983-1998. Our empirical investigation has shed light both on the behavior of centralized (industry-level) and decentralized (firm-level) collective agreements with respect to the heterogeneity of the labor productivity dynamics and on the existence of rent sharing at each of the two existing levels of wage negotiations.

Our main results are the following:

(i) The dynamics of sectoral wages is mainly due to decentralized collective bargaining agreements, while their long-run evolution is mostly a result of centralized collective bargaining agreements.

(ii) Wage drifts (arising from decentralized collective agreements) are sufficiently similar to productivity differentials, especially at business cycle frequencies. At the same time, the contractual wage dynamics (arising from centralized collective agreements) appears not adequate to the industrywide average productivity dynamics.

(iii) Decentralized collective agreements do not generate rent-sharing at the firm level, while centralized wage negotiations generate strong rent-sharing at the industry level.

Results (i) and (ii) seem to suggest that there can be a reason to discuss a modification of the current Italian industrial relation system in light of a possible reform of the functioning of centralized collective agreements.

Since we have derived that centralized wage negotiations lead to a too compressed contractual wage dynamics with respect to the industrywide average productivity dynamics, it could be necessary either to differentiate the contractual wage according to some more specific conditions of the sectors or microsectors which belong to the same industry or to allow the employers which are not able to pay workers the contractual wage to depart from centralized collective bargaining agreements (e.g. through the so called *exit clauses*, already adopted in Germany: see Checchi and Flabbi, 2000).

Result (iii) suggests instead that a careful evaluation of the extent of rent sharing between unions and employers must take into account the stage at which wage negotiations occur. In the case of Italy, in particular, rent sharing is present at the industry level but it does not arise at the firm level. This result confirms that a suitable theoretical framework to characterize the Italian two-stage bargaining system must take into account the presence of different degrees of union bargaining power at the two levels of wage negotiations, in the same way as it occurs in our reference two-stage bargaining model. Moreover, this result adds evidence to the international analysis on rent sharing of Holmlund and Zetterberg (1991). These authors show that in centralized countries (Sweden, Finland, Norway) sectoral wages respond to industrywide economic conditions while in decentralized countries (the U.S.) wages respond to idiosyncratic productivity performances. At the same time, no significant relationship among wages and aggregate or idiosyncratic conditions is shown for countries with intermediate degrees of wage bargaining decentralization (Germany). In light of our empirical investigation, the ambiguous results that Holmlund and Zetterberg obtain for Germany may be due to the lack of a separate analysis of the functioning of the different levels of wage negotiations.

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Appendix A
A two-stage bargaining framework

The utility of the union associated with the i-th firm ($i = 1, ..., n$) is represented by:

$$U_i = N_i W_i \tag{A.1}$$

where N_i is the level of employment and W_i is the wage of the i-th firm. We assume that each firm-specific union only cares about the employed workers: in other words, each decentralized union aims at maximizing the wage bill of insider workers.

The profit function of the i-th firm is:

$$\Pi_i(N_i) = R(N_i, \theta_i) - W_i N_i \tag{A.2}$$

where $R(N_i, \theta_i)$ is a value-added function which depends on the amount of labor hired, N_i, and on a firm-specific productivity parameter, θ_i. $R(N_i, \theta_i)$ is increasing and concave in N_i.[33]

The utility of the central union is represented by:

$$U = NW_C + (L - N)\, B. \tag{A.3}$$

According to the above expression, the central union cares at the same time of employed workers (N) and of unemployed workers ($L - N$). The employed workers receive the wage W_C, while the unemployed workers get the unemployment benefit B.[34]

As far as the employers' confederation is concerned, we assume that it maximizes the average industry profits: the justification for this assumption lies on the fact that at the central stage the employers' confederation must bargain at the same time for all the different firms. This implies that the employers' confederation maximizes the profits of the firm which is considered to be representative of the whole industry. In our framework the representative firm is characterized by:

$$R(N_i, \overline{\theta}) = R(N, \overline{\theta}), \text{where } \overline{\theta} = \frac{1}{n}\sum_{i=1}^{n} \theta_i.$$

Hence, the profit function of the employers' confederation is the following:

$$\Pi = R(N, \overline{\theta}) - W_C N \tag{A.4}$$

[33] Note that nominal variables and real variables are the same since we normalize the general price index to 1. The assumption of exogenous general price index level is justified by our partial equilibrium approach.

[34] We are assuming that the labor force, L, is greater than N.

As to the bargaining process, the reference model is a typical efficient bargaining model, where firms and unions bargain over both wages and employment (McDonald and Solow, 1981).

The bargaining process is articulated as follows. At the first stage the social partners bargain at the industry level (i.e. negotiations occur between the central union and the employers' confederation) while at the second stage the social partners bargain at the firm level (i.e. negotiations occur between each firm and its firm-specific union). As we pointed out in Section 2, in our framework the two bargaining levels are not reciprocally interrelated (*open loop* framework).

At the central level, the Nash bargaining function to be maximized is:

$$\Omega = (U - U_0)^{\mu} (\Pi - \Pi_0)^{1-\mu} \tag{A.5}$$

where the bargaining powers of the central union and of the employers' confederation are respectively μ and $(1-\mu)$, $\mu \in [0,1]$. The union and firm outside options are respectively U_0 and Π_0:

$$U_0 = LB \tag{A.6}$$

$$\Pi_0 = 0 \tag{A.7}$$

Expressions (A.6) and (A.7) indicate that in the case of disagreement at the central level workers get the unemployment benefits and firms do not produce by getting zero profits.

By substituting (A.3), (A.4), (A.6) and (A.7) in (A.5), the total surplus to be maximized at the first stage of wage negotiations is the following:

$$\Omega = [(W_C - B)\, N]^{\mu} \left[R(N, \overline{\theta}) - W_C N\right]^{1-\mu}$$

The maximization of the above expression with respect to wage and employment produces the following optimal contractual wage W_C:

$$W_C = \mu \overline{Q} + (1-\mu)\, B \tag{A.8}$$

where $\overline{Q} = \dfrac{R(N, \overline{\theta})}{N}$ is the industry's average value added per worker (i.e. the industry's average labor productivity).[35]

At the firm level, the Nash bargaining function to be maximized is:

$$\Omega_i = (U_i - U_{0i})^{\gamma} (\Pi_i - \Pi_{0i})^{1-\gamma} \tag{A.9}$$

[35] Note that we do not report the solution for the employment variable: the reason is that we are only interested in the process of wage determination.

where the union and firm bargaining powers are respectively γ and $(1-\gamma)$, $\gamma \in [0,1]$, where . The union and firm outside options are respectively U_{0i} and Π_{0i}, and the union surplus and the firm surplus are:[36]

$$U_i - U_{0i} = W_{Fi} N_i \tag{A.10}$$

$$\Pi_i - \Pi_{0i} = R(N_i, \theta_i) - R(N_i, \overline{\theta}) - W_{Fi} N_i \tag{A.11}$$

Expressions (A.10) and (A.11) indicate that at the decentralized level of wage negotiations workers maximize the wage in excess of the contractual wage while firms maximize the difference between the profits they get and the profits of the representative firm.[37]

By substituting (A.10) and (A.11) in (A.9), the maximization of (A.9) with respect to wage and employment leads to the following optimal wage:

$$W_{Fi} = \gamma \left(Q_i - \overline{Q}\right) \tag{A.12}$$

where $Q_i - \overline{Q} = \dfrac{R(N_i, \theta_i) - R(N_i, \overline{\theta})}{N_i}$ is the deviation of the firm-specific labor productivity from the industry's average labor productivity.

[36]Note that in our framework we allow for the possibility that unions have a different bargaining power according to the level at which wage negotiations occurs (μ at the first level and γ at the second level).

[37]It is important to underline that, due to the above definitions, expression (A.9) is valid only insofar $R(N_i, \theta_i)$ is greater than $R(N_i, \overline{\theta})$, that is in the case a firm has rents in excess of the industry's representative firm.

Appendix B
Statistical Model

1. Static vs dynamic factor models

A simple *static factor model* can be characterized as follows:

$$X_{i,t} = a_i x_t + b_i(L) x_{i,t} \tag{B.1}$$

where $a_i x_t$ are the common components and $b_i(L)x_{i,t}$ are the idiosyncratic components. x_t and $x_{i,t}$ are *white-noise* shocks with unit variance which are mutually uncorrelated at all leads and lags: in particular, x_t is a shock that is common to all the units of analysis, while $x_{i,t}$ is a shock that is specific to each single unit, where the index i represents the cross-sectional dimension. From now on we will refer to index i as the index of the i-th sector $(i = 1, ..., n)$.[38]

As it is possible to see from model (B.1), all the sectoral responses $(a_i x_t)$ to a common shock x_t have the same propagation mechanism across sectoral units up to a multiplication by a scalar a_i: this means that the static model (B.1), by imposing strong restrictions to the sectoral responses to a *common* shock, determines also restricted sectoral responses to each idiosyncratic shock. In other words, an unsuitable static filtering procedure may induce spurious dynamics in the idiosyncratic components.

A simple *dynamic factor model* can instead be characterized as follows:

$$X_{i,t} = a_i(L) x_t + b_i(L) x_{i,t} \tag{B.2}$$

where $a_i(L)x_t$ are common components and $b_i(L)x_{i,t}$ are the idiosyncratic components. As in (A.1), x_t and $x_{i,t}$ are respectively common and idiosyncratic *white-noise* shocks with unit variance and mutually uncorrelated at all leads and lags.

As we can see from model (B.2), the common components exhibit a dynamic structure: this means that a dynamic factor model allows to decompose the series into common and idiosyncratic components by taking into account a more general dynamics of the sectoral responses.

As in Forni and Reichlin (1996, 1998, 1999), the dynamic specification of the propagation mechanism implies that the sectoral responses to a *common* shock can be characterized by completely heterogeneous sectoral impulse response functions. In particular, according to this model, the sectoral responses to an aggregate shock can be different not only in sign and magnitude, but also in timing.

[38]Applications of static factor models to the analysis of the labor market are in Blanchard and Katz (1992), Decressing and Fatas (1995) and Bentolila and Jimeno (1995).

2. Dynamic factor models: estimation procedure

To estimate models like (B.2), it is possible to use a modified version of the procedure proposed by Forni and Reichlin (1999). To get an intuition of this procedure, let us consider the following simplified version of a factor model:

$$X_{i,t} = x_t + x_{i,t}. \tag{B.3}$$

Let us now rewrite model (B.3) by using the arithmetic means of the variables:

$$\frac{1}{n}\sum X_{i,t} = x_t + \frac{1}{n}\sum x_{i,t}. \tag{B.4}$$

Note that, if the cross-sectional dimension is large, when aggregating across sectors the idiosyncratic component should be small in variance as compared to the common one. In particular, when the cross-sectional dimension tends to infinity the variance of the second term on the RHS of equation (B.4) tends to zero: $var(\overline{X}_t - x_t) \to 0$ (i.e. convergence in variance), so that:

$$\lim_{n\to\infty}\frac{1}{n}\sum X_{i,t} = x_t. \tag{B.5}$$

According to result (B.5), $\overline{X}_t = \frac{1}{n}\sum_i X_{i,t}$ (i.e. the arithmetic mean of $X_{i,t}$) is the asymptotic aggregate for the unobservable factor x_t. This means that when the cross section is large the unobservable common component x_t can be proxied by the (observable) arithmetic mean of the variables $\overline{X}_t$.[39]

A similar argument applies to the general dynamic model (B.2): the unobservable dynamic common component $a_i(L)x_t$ can be proxied by using $a_i(L)\overline{X}_t$. Hence, model (B.2) can be estimated by OLS equation by equation by treating the residuals as the idiosyncratic components and by using *model selection criteria* to determine the correct lead and lag structure.

[39] When the cross section is not large, the unobservable component can be estimated by using a weighted average, where the optimal weights minimize the variance of the idiosyncratic components. For details on this estimation procedure see Forni and Reichlin (1999).