Wage Leadership Models: a country-by-country analysis of the EMU

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Abstract

We apply a Vector Error Correction Model on quarterly data for four macro sectors (Industry, Services, Construction and the Public Sector) for ten EMU countries to test for wage leadership in the long run, in the short run and wage adaptability across sectors. According to the theory of wage leadership, if there is free labor mobility across sectors in the economy, changes in the level of the (real) wage in the sector acting as the leader cause changes in the same direction in other sectors' wage. The "Scandinavian Model" of wage leadership suggests the traded sector (Industry) should be the leader, because it would be conducive to wage restraint. Our results show significant cross-country differences. Interestingly, countries that recently experienced a construction bubble such as Spain and Ireland show wage leadership of the construction sector. Moreover, in half of the countries included in the dataset, wages in different sectors are, to some extent, set autonomously, which would suggest a low degree of inter-sectorial labor mobility.

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1. Introduction

According to the theory of wage leadership (Aukrust 1970; Smith 1996), if there is labor mobility across sectors in the economy, changes in the level of the (real) wage in the sector acting as the "leader" cause changes in the same direction in the level of the wage in other sectors. These changes need not be proportional, and the adjustment across sectors will ultimately depend on the degree of cross-sectorial labor mobility.

First of all, which sector should lead wage determination? Aukrust's (1970) "Scandinavian Model" suggests it should be the internationally traded sector. The reason is that the latter is affected by international competitive pressure, which may help wage restraining: put it another way, in the traded sector, firms should increase wages in step with labor productivity; if wages increased faster, in fact, firms would either have to reduce their profit margins (which, in a highly competitive market, are not large), or have to increase prices, although this will hurt their competitiveness. Therefore, a country where the traded sector is the leader in wage determination will be, other things equal, in a better competitive position. In the non-traded sector, in fact, due to the lack of international competitive pressure, unions have more bargaining power and can extract a mark-up over productivity. Based on this principle, in several European countries it is established that each year the first sector to sign the agreements for collective bargaining is the manufacturing sector (Knell and Stiglbauer 2009).

Secondly, why do wages in different sectors co-move? There are three explanations. The first one is the labor supply channel. If wages in, say, the service sector increase relative to the industry sector, workers will move to the former, as long as inter-sectorial labor mobility is possible. The shrinking labor supply in the latter will, in turn, force the employers to increase wages (see Demekas and Kontolemis, 2000). According to the second explanation, the co-movement of wages in different sectors can be seen as the result of a Stackelberg game with one sector playing as the leader, and internalizing the moves of other sectors, and the others following (Calmfors and Larsson, 2011). Third, if the welfare of an agent, or a social group, depends on the welfare of others due to social comparison, co-movement in wages across sectors may be due to "envy effects" (Oswald 1979), whereby workers in one sector do not want to lose purchasing power relative to the others.

The issue of wage leadership is important because it is potentially related, as we have already described, to the development of real wages in a country. According to the Scandinavian model, leadership of the traded sector is consistent with wage moderation, for the reasons described above; however, Calmfors and Larsson (2011) challenged this approach, suggesting that in a Monetary Union, leadership of the non-traded sector is conducive to wage restraint. In other words, the wage leadership structure of the labor market should influence the level of the aggregate wage, but the economic literature is not unanimous towards the direction of this effect.

Which sector leads wage determination is ultimately an empirical issue. Several works have tested wage leadership since Aukrust's (1970) seminal work. Evidence in favor of the Scandinavian Model was found by Aukrust (1977) for Norway, the U.S. and France, while

Bemmels and Zaidi (1990) successfully applied it to Canada. However, this model has been found to be at odds with more recent data. Ultimately, the results seem to be country-dependent but there are also conflicting results for the same country. Demekas and Kontolemis (2000) find weak exogeneity of government wages over private wages in Greece. Jacobsson and Ohlsson (1994), in a Vector Error Correction Model for Sweden, find long-run wage leadership of the private sector, thus confirming the predictions of the Scandinavian model, a result which is shared by Lindquist and Vilhelmsson (2006). However, Friberg (2007), using a broader sector decomposition, does not find evidence of the Scandinavian model for Sweden[1].

Lamo et al. (2011) studied the co-movement and causality relationship between private and public wages using annual data for 18 OECD countries (plus the Euro Area as a whole), finding that private and public wages generally do not decouple and the former seem to exert a stronger influence on the latter than the reverse. As far as Euro Area countries are concerned, they found that the public sector leads wage determination in Germany, France, the Netherlands and Belgium.

With respect to previous work on the issue, the present paper uses a broader sector decomposition to analyze wage leadership for core EMU countries. The focus on the EMU is easily explained. From the above discussion we know how wage spillovers across sectors may affect the development of the aggregate wage and, in turn, the cost competitiveness of the traded sector. The adoption of the single currency has left Euro Area member states without the tool of the nominal exchange rate to correct divergent price dynamics. In this sense, when a country records persistently high inflation - for example due to increasing unit labor costs - with respect to the other member states of the Monetary Union, it will experience real exchange rate appreciation and a progressive loss of competitiveness, while the only way to correct such inflation differential in absence of nominal exchange rate depreciation is via internal devaluation.

We consider four different sectors, namely Industry, Services, Construction and the Public Sector. Industry proxies the traded sector, Services and Construction are non-traded sectors, and finally the Public sector is a non-market non-traded sector, where the wage is not related to the marginal product of labor[2]. This distinction is important, but the empirical literature on wage leadership so far has generally focused on the distinction between public and private sector wages, ignoring the role of the non-traded sector (with the exception of Friberg, 2007 and D'Adamo, 2011), although the theoretical models of reference clearly state the importance of the leadership of the traded private sector *vis à vis* the non-traded sector.

The paper is structured as follows: section 2 briefly discusses the theoretical framework of reference. Section 3 shows the empirical approach adopted, which is a Vector Error

[1] In particular, he distinguishes between private sector, manufacturing sector, construction, wholesale and retail trade, financial sector, central government and county/municipal government.

[2] Theoretical models of public sector wage setting generally assume wages for public employees to be set exogenously. Alternatively, Demekas and Kontolemis (2000) assume the government maximizes an objective function in public goods provision and public wages. In this sense, wage bargaining in the public sector is affected by the pressure that public employees are able to exert on the government.

Correction Model; Section 4 presents the data used in the analysis; in Section 5 we discuss the results. Section 6 concludes.

2. The theoretical framework

As we explained in the introduction, Aukrust's (1970) Scandinavian Model suggests that the traded sector should lead wage determination. Figure 1 shows how the causal chain should run in that framework. Nominal wages in the traded sector, W_T, are set according to the evolution of productivity in that sector, the real exchange rate and the world price for traded goods. Free labor mobility across sectors would then ensure that changes in W_T spill over to the non-traded sector wages, W_N. As long as productivity growth in N is lower than T, firms in the non-traded sector will be forced to increase prices to compensate the wage increase[3].

As long as the traded sector is the leader in wage determination, pressures due to international competition should avoid wage increases in excess of productivity. However, alternative models of inter-sectorial wage spillovers might be in place, as we pointed out in Section 1, and the empirical analysis in Section 5 will prove that this is indeed the case. As it was pointed out by Friberg (2007), non-traded sector firms operate in a less competitive environment, since they are not subject to international competition: therefore, wage bargaining in non-traded sectors may lead to higher outcomes, *ceteris paribus*. As far as the public sector is concerned, theoretical models of public sector wage setting generally assume that wages for public employees are set exogenously or, as in Demekas and Kontolemis (2000), that the government maximizes an objective function in public goods provision and public wages (a form of political patronage). In this sense, wage bargaining in the public sector as well may lead to higher outcomes, depending on the bargaining power of public employees.
In general, if the leader in wage determination is not the traded sector, the result may be wage non-moderation and this would harm international competitiveness.

Whatever the leading sector, a wage leadership model works as follows. Suppose you only have two sectors in the economy, *i* and *j;* labor can freely move across sectors.
Let us assume that the leader in wage determination is sector *i*, and the real wage there is determined by productivity in that sector and the mark-up that unions are able to extract on productivity which, in turn, would depend on their bargaining power[4]:

$$w_{i,t} = c_{i,t} + m_{i,t} + \eta_{i,t} \qquad (1)$$

where $w_{i,t}$ is the (log) real wage in sector *i*, $c_{i,t}$ is labor productivity in sector *i*, $m_{i,t}$ is the mark-up (which in models of the wage equation is proxied by labor market factors that put upward

[3] This would be one explanation for the stylized fact that inflation in the non-traded sector is generally higher than in the traded sector.
[4] Note that we expect the mark-up to be lower if *i* is the traded sector and higher if it is the non-traded sector, because firms in the latter are not subject to international competition.

pressure on wages) and η_i represents stationary deviations from this long-run equilibrium real wage. Labor is mobile across sectors; for this reason, wage equalization occurs:

$$w_{j,t} = \delta_j + \theta_j w_{i,t} + \eta_{j,t} \quad (2)$$

where $\theta_j \geq 0$ is a parameter describing the degree of wage adaptability across sectors. Simple as it is, equation (2) is the center of our wage leadership model. It implies that in the sector that acts as the follower, wages are determined in the long run not by factors specific to that sector, but rather by developments in *i*. According to the theory of wage leadership, the deviations from equilibrium, η_j should be stationary and which sector is in the driver seat is ultimately a testable hypothesis[5]. According to the Scandinavian model, sector *i* should be the traded sector; moreover, not only should wages in different sectors co-move, but , $\delta_j = 0$ and the transmission of wage shocks should be one to one, a testable hypothesis that we will term "full wage adaptability" (see section 3). In other words, according to the Scandinavian Model the deviations from equilibrium, η_j, should be stationary and $\theta_j = 1$.

3. Empirical approach

In order to test wage leadership, as in previous studies on the issue (see Lamo et al. 2011, Lindqvist and Vilhelmsson 2006, Friberg 2007, among others), we will use a Vector Error Correction model (VECM). In fact, as it will be clear shortly, the VECM is a natural candidate to test empirically the predictions of alternative models of wage leadership, since they make precise statements on the long-run relations should look like as well as the causal links between wages in different sectors. Given the vector of variables x_t, a VECM of order n can be written as

$$\Delta x_t = \Pi \tilde{x}_{t-1} + \Gamma_1 \Delta x_{t-1} + \cdots + \Gamma_n \Delta x_{t-n} + \phi D_t + \mu + \varepsilon_t; \;\; \varepsilon_t \sim Niid(0, \Omega) \quad (3)$$

where D is a vector of unrestricted dummy variables, μ is a vector of constant terms and Ω is the $(p \times p)$covariance matrix of (white noise) residuals. $\Gamma_j, j = 1, \dots, n$are the matrices of the short-run coefficients. When the variables in x_t are $I(1)$ and cointegrated, the matrix Π will be of rank$r < p$, where r is the number of (long-run) cointegration relations. Therefore, the Π matrix can be decomposed as:

$$\Pi = \alpha \tilde{\beta}'; \;\; \tilde{\beta} = [\beta \quad \mu_0 \quad \beta_d \quad \beta_t]; \;\; \beta = [\beta_C \quad \beta_I \quad \beta_S \quad \beta_P]$$

$$\tilde{x}'_{t-1} = [x_{t-1} \quad 1 \quad D_s \quad t]; x'_{t-1} = [w_{C,t-1} \quad w_{I,t-1} \quad w_{S,t-1} \quad w_{P,t-1}]$$

where the elements in $\tilde{\beta}$ are *r* x 1 vectors, that is, the cointegration relations corresponding to equation (2); 1 represents a constant restricted to lie in the cointegration relation, D_s are dummies capturing shocks that do not cancel in the cointegration relations and t is a linear trend. The vector x'_t is a (4×1) vector of the real wage in four macro sectors with different

[5] In this sense, our definition of "wage equalization" is not very restrictive, since it would imply that the wage ratio is stable, rather than imply that the wage is the same across sectors.

degrees of tradability: Construction, Industry, Services and the Public sector[6]. The matrix α is called the matrix of loadings, which show how the variables in x_t adjust to the cointegration relations.

In the VECM, if a variable is found to be weakly exogenous, i.e. it does not adjust to any cointegrating relation, then shocks to that variable are identified as one of the common stochastic trends of the system. Moreover, the number of cointegration relations that we can identify can be interpreted as a proxy of inter-sectorial labor mobility. With free labor mobility (full-fledged wage leadership), given that we include four sectors in our analysis, we should find three cointegrating vectors (i.e. $= 3$) and therefore only one common stochastic trend. In other terms, only one sector should affect wage setting in the other sectors in the long run. However, if inter-sectorial labor mobility is low and therefore the labor supply channel is not working fully, then wage setting in sector y does not affect the wage in sector z, w_z although y is wage leader. As a result, we would have $r < 3$ and more than one stochastic trend. Thus, following Lindquist and Vilhelmsson (2006) and Lamo et al. (2011), we distinguish between wage leadership in the long-run model from wage leadership in the short-run model. Long-run wage leadership corresponds to weak exogeneity in the VECM (3):

<u>Definition 1. Wage Leadership in the Long-Run Model.</u> Sector i is wage leader in the model defined by equation (3) if $\alpha_{ij} = 0 \ \forall j = 1, \dots, r$, i.e. if Sector i is weakly exogenous in (3).

Secondly, as we anticipated in the introduction, while we expect co-movement (i.e. cointegration) among wages in different sectors, adjustment after a change in the wage in the leading sector does not need to be proportional: therefore, we follow Friberg (2007) to introduce the concept of full wage adaptability, which will be tested as a restriction on the cointegration space:

<u>Definition 2. Full Wage Adaptability.</u> There is full wage adaptability between w_i and w_j if the former is weakly exogenous in system (4) and a restriction to, respectively, -1 and 1 of the coefficients in the pairwise cointegration vector of w_i and w_j cannot be rejected.

Finally, as far as short-run leadership is concerned, we rely on the concept of Granger (non-) causality: a sector is wage leader in the short-run if all other sectors do not Granger-cause it and the same cannot be said for the other sectors:

<u>Definition 3. Wage Leadership in the Short-Run Model.</u> Given the model:

$$\begin{bmatrix} \Delta w_{i,t} \\ \Delta w_{-i,t} \end{bmatrix} = \Gamma_1 \begin{bmatrix} \Delta w_{i,t-1} \\ \Delta w_{-i,t-1} \end{bmatrix} + \cdots + \Gamma_n \begin{bmatrix} \Delta w_{i,t-n} \\ \Delta w_{-i,t-n} \end{bmatrix} + \phi D_t + \mu + \varepsilon_t; \ \varepsilon_t \sim Niid(0, \Sigma)$$

[6] This distinction is quite standard in the empirical literature, for example the recent literature on the Balassa-Samuelson effect in Eastern Europe (Mihaljek and Klau 2004) usually identifies the traded sector with industry and the non-traded sector with services. See section 4 for a precise definition of the wage series.

Where w_{-i} is a (3×1) vector including all sectors other than i from (3), we say that Δw_i is leader in the short-run model if Δw_{-i} does not Granger-cause Δw_i.[7]

Thus, while a full chain of wage leadership would imply only one leader in the short and the long run, we allow for more than one wage leader in both models, which is clearly possible in our case as we include four sectors.

Table 1 summarizes the hypotheses and definitions we have exposed so far and how they will be tested in the framework of the VECM.

4. Data and series definition

We use quarterly data on 10 EMU countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands and Spain[8]. The length of the sample differs across countries: Austria, Belgium and Netherlands 1995Q1 – 2011Q4; Finland 1975Q1 – 2011Q4; Germany 1991Q1 – 2011Q4; France 1990Q1 – 2011Q4; Spain 1985Q1 – 2011Q4; Italy 1992Q1 – 2011Q4; Ireland 1998Q1 – 2009Q4; Greece 2000Q1 – 2011Q4.

Indeed, for some countries the series are quite short, as we can see. However, there are several reasons why the cointegration analysis is still reliable. First, we can reasonably expect that it takes a shorter time for the relations we will estimate to go back to equilibrium with respect to other business cycle relations. D'Adamo (2011) shows that, in the case of Central and Eastern Europe, it takes 2 to 6 quarters for disequilibrium to be corrected in a wage leadership model. Second, we estimate the VECM progressively, adding one variable at a time to the system, exploiting the property of superconsistency of cointegration relations. This allows us to estimate the model parsimoniously maintaining the same restrictions. Third, again to save on degrees of freedom, we will gradually restrict to zero all insignificant coefficients in the short run matrices, using a general-to-specific approach. Nevertheless, we acknowledge that the results obtained for Greece must be taken with caution.

Data come from Eurostat. We define the real wage as real compensation per hour worked[9], and calculate it as:

$$rcomh = \ln\left(\frac{Total\ Compensation\ of\ employees\ in\ sector\ i}{Hours\ worked\ in\ sector\ i}\right) - \ln(CPI)$$

We think this definition is preferable to compensation per employee, which is used for example in Lamo et al. (2011), because the latter measure may be affected by the increased relevance of part-time contracts, which may impact sectors differently.

[7] Note that, strictly speaking, according to the Scandinavian Model there should be no short-run feedback effects among wages in different sectors. Testing for short-run wage leadership, therefore, can be seen as checking for another departure from the Scandinavian Model. Even if the traded sector leads other sectors, this does not rule out the possibility that transitory shocks elsewhere may affect the traded sector wage.

[8] The remaining Euro Area countries were excluded due to lack of data.

[9] For Spain, thousands of hours worked were only available from 2000; thus, the real wage is calculated there as real compensation per full-time equivalent, and the denominator is "thousands of full time equivalents".

We include four sectors in our empirical model: Construction; Industry except Construction; Services of the Business Economy; Public Administration, Defense, Compulsory Social Security (henceforth: Public sector). In a preliminary analysis, Agriculture and Fishing was also included; however, in most cases it was long-run excludable from the system or the corresponding real compensation appeared to be stationary. Given the peculiarities related to the agriculture sector (the effect of price controls on the products of the sector due to the CAP, the progressive loss of relative purchasing power of the sector, and so on) it may make sense to exclude it from the analysis.

From the point of view of tradability, Industry can be identified with the traded sector; services is a mixed traded and non-traded market sector, but mainly non-traded; construction is a market non-traded sector; public administration is a non-market non-traded sector.

The graphs of nominal compensation per hour worked for the four sectors included in the analysis are reported in Figure 2. Already from a descriptive point of view, we can see close co-movement of the four wage series in the case of Belgium, Finland, Spain, Germany and the Netherlands, while in the case of Italy and Austria in particular the picture appears more blurred.

5. Results

As we would expect, results are quite different across countries. We begin the estimation of our Vector Error Correction Model with the results of the choice of the cointegration rank in Table 2 and the specification of the long-run matrix[10]..

As far as the choice of the rank is concerned, we based our choice on three criteria: the results of Johansen's trace test; the modulus of the largest unrestricted root of the characteristic polynomial; and the largest t-value in the *r*-th vector. We do this in order to make sure that, by excluding a cointegration relation, albeit persistent, we are not throwing away potentially important information. These criteria need not suggest the same rank, as it is the case in Table 2, and in this sense some room for judgment is left[11].

The rank of the long-run matrix tells us the number of cointegration relations and, therefore, the number of stochastic trends. Within our four-variable system, full-fledged wage leadership is present if we find a rank of three (i.e. three cointegration relations and one common stochastic trend). As shown in Table 2, this is the case only for five countries out of ten: Belgium, Finland, Germany, Greece and Spain.

We now move to the core of our empirical analysis, i.e. the tests of long-run leadership according to Definition 1 above. Results are reported in Table 3.

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[10] All models present white noise residuals. Results of the tests on lag choice, normality, autocorrelation and ARCH are available from the authors upon request.

[11] See the discussion in Juselius (2006), chapter 8.

France and Austria present only one cointegration vector (CV henceforth) to which Construction is adjusting. Public Sector and Industry are long-run excludable. In other words, we have three distinct stochastic trends that can be identified with shocks to wages in Industry, the Public Sector and Services and only the last one has a long-run impact on another sector, namely Construction.

In the case of Belgium, we found three CVs, and one common stochastic trend identified with shocks to Public sector wages. Thus, the Public sector is long-run leader in wage determination.

Finland as well has three CVs; the model includes a restricted broken trend, with a break in 1992Q1. The linear trend was found to be excludable from the system. The trend break appears at the beginning of the Finnish deep economic and financial crisis of the early 1990s. A recursive estimation of our system (first sample: 1975Q1-1990Q4) shows a remarkable stability of our estimates over the whole sample, except for the years 1992-1994 which were exactly the years of the crisis. Industry is weakly exogenous and therefore is the leading sector. Therefore, Finland confirms Aukrust's (1977) Scandinavian Model.

The results for Germany and Greece confirm those of previous studies (respectively Lamo et al., 2011 and Demekas and Kontolemis, 2000)[12] that used a different empirical model, in particular only distinguished between private and public sector wages. In both countries, we find three CVs, with the Public sector weakly exogenous[13]. Exogeneity of other sectors is rejected at all significance levels.

Ireland presents two CVs, where Industry and Construction weakly exogenous. The former cointegrates with the Services wages and the latter with Public Sector's ones.

Italy and the Netherlands present similar results with two CVs, where Industry and Services are weakly exogenous. However, in both cases, in the Moving Average representation we could see that only the former has a significant long-run impact on Public Sector and Construction[14].

Finally, Spain has 3 CVs, where Construction is weakly exogenous and the other sectors are significantly adjusting to those CVs. The over-identified model could not be rejected with a p-value of 0.05, which is quite borderline; however, as a robustness check we performed a recursive estimation of the system, which has shown a remarkable stability of the results.

While results are, as we have already stated, country-dependent, and notwithstanding the short data sample for some of the countries, we have some interesting insights: (1) for some countries, they confirm results in previous works that were using a different framework and dataset; (2) the countries that had a construction bubble, Spain and Ireland, show weak exogeneity of the Construction sector; (3) only one country, Finland, follows the predictions of the Scandinavian model; however, traded sector wages are long-run weakly exogenous also in Austria, France, Ireland, Italy and the Netherlands.

[12] Actually Greece is also present in Lamo et al. (2011) but they do not find public sector wage leadership.
[13] In the case of Greece, we had to add two-step dummies in 2002Q1 and 2009Q1.
[14] Results on the Moving Average representation of the system are available from the authors upon request.

We then move to the tests of full wage adaptability. Remember from Definition 2 that this amounts to imposing long run homogeneity on the cointegration vectors identified above and reported in Table 3. We had stated in Section 2 that wage spillovers across sectors, in principle, need not be proportional, although such long-run homogeneity is assumed by the Scandinavian model. Together with the cointegration rank, we can interpret it as a proxy of labor mobility across sectors since, the higher labor mobility, the more unions will be able to obtain a proportional change in the wage when the leading sector wage increases. Indeed, given our previous restrictions and the order of cointegration chosen for each country, in Austria, Belgium, Ireland and Italy the one-to-one restriction in the cointegration vectors could not be rejected. The most interesting case is Belgium, where there are 3 cointegration vectors, and we therefore have full one-to-one transmission of wage shocks from the public sector to the rest of the economy.

Full wage adaptability was rejected at all significance levels in France and Spain. In the remaining countries, it was accepted only for a subset of the cointegration system.

Finally, following Definition 3, we test for wage leadership in the short-run model. In other words, we estimate the VAR in first differences:

$$\begin{bmatrix}\Delta w_{I,t}\\ \Delta w_{C,t}\\ \Delta w_{S,t}\\ \Delta w_{P,t}\end{bmatrix} = \mathbf{\Gamma}_1 \begin{bmatrix}\Delta w_{I,t-1}\\ \Delta w_{C,t-1}\\ \Delta w_{S,t-1}\\ \Delta w_{P,t-1}\end{bmatrix} + \cdots + \mathbf{\Gamma}_n \begin{bmatrix}\Delta w_{I,t-n}\\ \Delta w_{C,t-n}\\ \Delta w_{S,t-n}\\ \Delta w_{P,t-n}\end{bmatrix} + \mu + \Phi D_t + \varepsilon_t$$

Then, for each sector *i*, we test the null hypothesis that Δw_{-i} does not Granger-cause Δw_i, where w_{-i} is the (3×1) vector of the wage in all sectors except *i*.

Results of the short-run wage leadership analysis are reported in table 5. First of all, in principle short-run wage leadership may not correspond to long-run wage leadership, as is the case in our results. Second, as in the case of long-run leadership, in this case there can be more than one sector which acts as a leader, i.e. affects the level of the wage in other sectors in the short run. However, it is also possible that no short-run effects are present. In the former case, for less than three sectors we reject the null hypothesis of the Granger non-causality test described above, while in the latter case we cannot reject the null for any sector.

As it is clear from table 5, there are four countries where no short-run effects among wages in different sectors are present: Austria, Finland, France and Germany. In the Netherlands, we reject the null for all four sectors, meaning that we find two-way short run causality among sectors.

In the case of Belgium, short-run wage leadership is consistent with the long run analysis, since the public sector is wage leader in this case as well.

In Ireland, there are three wage leaders (Construction, Services and Public Sector) with Industry (i.e. the traded sector) being the only follower.

In Italy, Industry and Construction are short run leaders, while, in the case of Spain, Construction (which was found to be long-run wage leader) leads wage determination together with Industry and the Public Sector.

6. Conclusions

This work has analyzed wage leadership models in 10 EMU countries. With respect to previous literature, we have used a broader sector decomposition including Industry, Construction, Services and the Public Sector. While Industry is traditionally identified with the traded sector, the other sectors are, to different extents, sheltered. While the economic literature is not unanimous on which sector should lead wage determination in order to ensure wage restraint, the Scandinavian Model of wage leadership, suggesting that the traded sector should act as a leader, traditionally received the favor of both policymakers and economists.

Using a Cointegrated VAR model for each of the countries in our dataset, we studied wage leadership from three perspectives: long-run wage leadership, wage adaptability (i.e. the degree of proportionality in wage changes across sectors) and short-run wage leadership. We have shown that a significant heterogeneity across countries is present. In 5 out of ten countries, more than one common stochastic trend was found, meaning that sectors have been setting wages autonomously, up to a certain extent. This may suggest a limited degree of inter-sectorial labor mobility in those countries.

Moreover, in the case of Belgium, Germany, Greece and Spain, the Industry wage was not found to be weakly exogenous, i.e. it adjusts in the long run to the wage in sheltered sectors. This result contradicts the prediction of the Scandinavian Model.

Interestingly, in Spain and Ireland, the countries in the sample which experienced a construction bubble, Construction is weakly exogenous and also wage leader In the short run.

In three countries out of ten, i.e. Germany, Greece and Belgium, it is the Public sector which acts as a leader in wage setting. While the results for Greece have to be taken with caution due to the shortness of the data sample, in the case of Belgium and Germany they were robust and showed stability in a recursive estimation. In Belgium, moreover, the public sector is wage leader also in the short run and full wage adaptability is found through all sectors. Moreover, for both Germany and Greece, our results confirm those of previous studies which used different empirical specifications.

While the cross-country heterogeneity we have found was to be expected, given the existing literature which we also discussed in the introduction, there is not a clear pattern that can allow us to associate countries which are homogeneous in terms of size or macroeconomic fundamentals and their wage leadership structure. Moreover, while we find that, for some countries, our results in terms of wage leadership are consistent with the dominant view in the literature that leadership of the traded sector is good for competitiveness (on the positive side, Finland and, on the negative side, Spain, Belgium and Greece), this is not the case for all (in particular Germany).

Summing up, our work confirms previous studies in showing that spillovers in wage determination across sectors are present and they work differently across countries. A more comprehensive analysis of wage formation would be needed, however, in order to measure the impact of different wage leadership structures on the aggregate wage and unit labor costs, and this may be the subject of further research.

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Figure 1. The causal chain in the Scandinavian Model

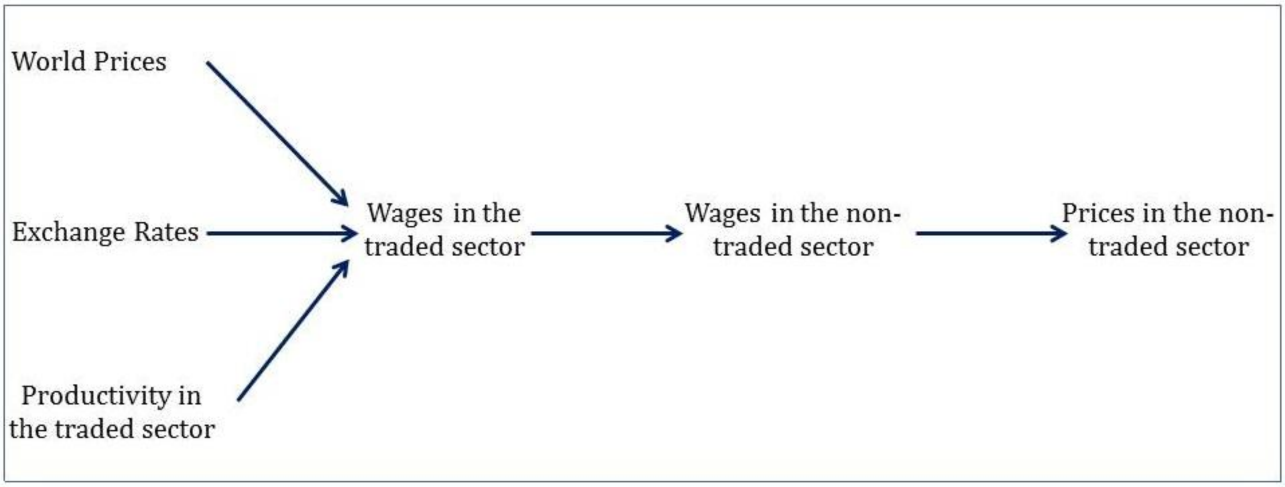

Figure 2. Real compensation per hour worked (scaled)

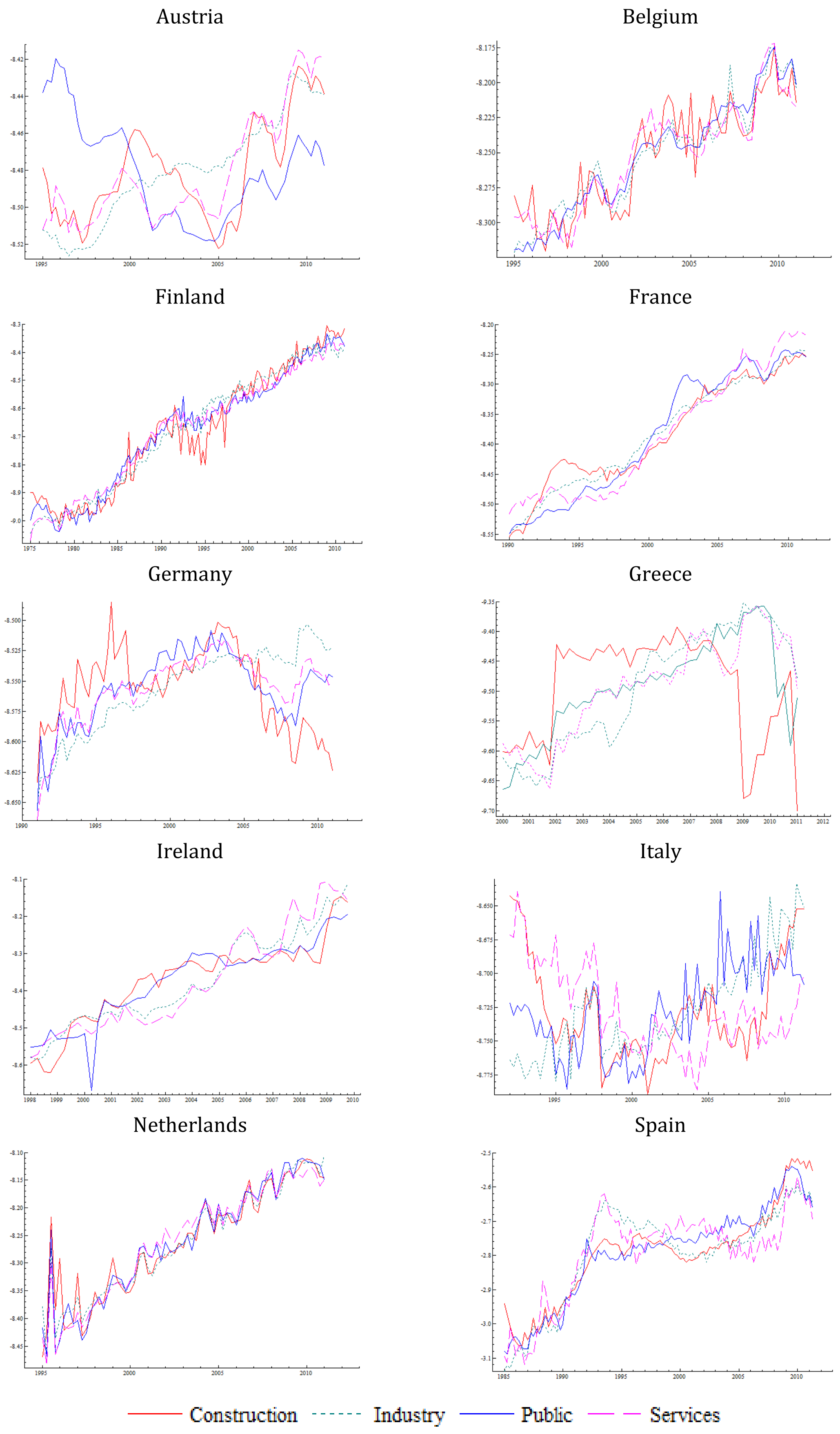

Table 1. Testable hypotheses on wage leadership

Hypothesis	Test	
Full-fledged wage leadership (perfect inter-sectorial labor mobility)	Johansen's (1995) trace test	rank = 3
Scandinavian Model (leadership of the Traded Sector)	LR test	$\alpha'_I = \mathbf{0}$ in Equation (3)
Full wage adaptability	LR test	In cointegrating vector β, $\beta_j = -\beta_i$ and $\beta_s = 0\ \forall s \neq i, j$
Short run wage leadership	Granger non-causality test	$w_{-i} \overset{not}{\longrightarrow} w_i$ and $w_{-j} \rightarrow w_j, \forall j \in -i$

Table 2. Choice of the rank of the long run matrix

Country	Lags in VECM	Model	Trace Test p-value (*)	Largest unrestricted root	Largest absolute t-value of *r*-th CV	Rank Choice
Austria	2	a	r=0 0.054 r=1 0.084 r=2 0.136 r=3 (N.A.)	r=0 0.644 r=1 0.771 r=2 0.752 r=3 0.831	- r=1 4.110 r=2 2.170 r=3 1.163	1
Belgium	2	a	r=0 0.000 r=1 0.007 r=2 0.100 r=3 (N.A.)	r=0 0.646 r=1 0.646 r=2 0.560 r=3 0.782	- r=1 4.743 r=2 3.899 r=3 1.294	3
Finland	2	b	r=0 0.000 r=1 0.005 r=2 0.164 r=3 0.282	r=0 0.409 r=1 0.460 r=2 0.653 r=3 0.841	- r=1 4.185 r=2 5.514 r=3 2.896	3
France	2	b	r=0 0.034 r=1 0.230 r=2 0.716 r=3 0.486	r=0 0.594 r=1 0.753 r=2 0.868 r=3 0.909	- r=1 2.711 r=2 2.801 r=3 2.028	1
Germany	2	b	r=0 0.002 r=1 0.049 r=2 0.374 r=3 0.398	r=0 0.439 r=1 0.417 r=2 0.702 r=3 0.848	- r=1 4.145 r=2 4.590 r=3 2.681	3
Greece	2	a	r=0 0.000 r=1 0.003 r=2 0.017 r=3 0.005	r=0 0.384 r=1 0.874 r=2 0.858 r=3 0.739	- r=1 4.858 r=2 5.257 r=3 3.238	3
Ireland	2	a	r=0 0.005 r=1 0.134 r=2 0.303 r=3 (N.A.)	r=0 0.322 r=1 0.542 r=2 0.645 r=3 0.793	- r=1 2.769 r=2 2.074 r=3 2.053	2
Italy	2	a	r=0 0.039 r=1 0.261 r=2 0.449 r=3 0.118	r=0 0.478 r=1 0.718 r=2 0.866 r=3 0.914	- r=1 2.913 r=2 3.384 r=3 2.104	2
Netherlands	2	b	r=0 0.000 r=1 0.018 r=2 0.252 r=3 0.229	r=0 0.325 r=1 0.564 r=2 0.557 r=3 0.930	- r=1 5.924 r=2 1.691 r=3 1.489	2
Spain	4	b	r=0 0.000 r=1 0.019 r=2 0.323 r=3 0.487	r=0 0.776 r=1 0.738 r=2 0.749 r=3 0.828	- r=1 2.977 r=2 4.446 r=3 2.924	3

Note: Model (a) unrestricted constant, no trend; (b) unrestricted constant, restricted trend. When deterministics (i.e. restricted or unrestricted dummies, restricted level shifts or trend breaks) are included in the model, we simulate the distribution of the trace test by bootstrapping.

Table 3. Cointegration vectors and long-run wage leadership*

Country	# of Coint. Vectors	Restriction/Normalization	weakly exogenous sector(s)	LR test statistic (p-val.)
Austria	1	$\hat{\beta}' = [0 \quad 1 \quad \beta_{1S} \quad 0]'$	Public, Services and Industry	10.803 (0.055)
Belgium	3	$\hat{\beta}' = \begin{bmatrix} \beta_{1I} & 0 & 0 & 1 \\ 0 & 1 & \beta_{2S} & 0 \\ 1 & 0 & 0 & \beta_{3P} \end{bmatrix}'$	Public	4.801 (0.187)
Finland	3	$\hat{\beta}' = \begin{bmatrix} \beta_{1I} & 1 & 0 & 0 \\ 0 & \beta_{2C} & 1 & 0 \\ 0 & 0 & \beta_{3S} & 1 \end{bmatrix}'$	Industry	3.123 (0.373)
France	1	$\hat{\beta}' = [0 \quad 1 \quad \beta_{1S} \quad 0]'$	Public, Services and Industry	5.391 (0.249)
Germany	3	$\hat{\beta} = \begin{bmatrix} 0 & 1 & 0 & \beta_{1P} \\ 0 & 0 & 1 & \beta_{2P} \\ 1 & 0 & 0 & \beta_{3P} \end{bmatrix}$	Public	5.293 (0.152)
Greece	3	$\hat{\beta}' = \begin{bmatrix} \beta_{1I} & 0 & 1 & 0 \\ 0 & 1 & 0 & \beta_{2P} \\ 1 & 0 & 0 & \beta_{3P} \end{bmatrix}$	Public	7.180 (0.208)
Ireland	2	$\hat{\beta}' = \begin{bmatrix} 0 & \beta_{1C} & 0 & 1 \\ \beta_{2I} & 0 & 1 & 0 \end{bmatrix}'$	Industry and Construction	11.189 (0.083)
Italy	2	$\hat{\beta}' = \begin{bmatrix} \beta_{1I} & 0 & 0 & 1 \\ \beta_{2I} & 1 & 0 & 0 \end{bmatrix}'$	Industry and Services	12.611 (0.082)
Netherlands	2	$\hat{\beta}' = \begin{bmatrix} \beta_{1I} & 1 & 0 & 0 \\ \beta_{2I} & 0 & \beta_{2S} & 1 \end{bmatrix}'$	Industry and Services	6.675 (0.246)
Spain	3	$\hat{\beta}' = \begin{bmatrix} 1 & \beta_{1C} & 0 & 0 \\ \beta_{2I} & 0 & 0 & 1 \\ 0 & 0 & 1 & \beta_{3P} \end{bmatrix}'$	Construction	7.804 (0.050)

Note: the vectors are normalized on the variable which was found to be significantly adjusting. The order in which coefficients appear is always β_{iT}, β_{iN} , β_{iP}. N.A. = not applicable. The LR-test of the restricted model is distributed as a χ^2_q, where q is the number of degrees of freedom.

* The order in which sectors are inserted is Industry, Construction, Services, Public Sector. β_{ij}, i = 1,2,3 and j = I,C,S,P indicates an unrestricted coefficient in vector *i* for sector *j*.

Table 4. Full wage adaptability

Country	Restriction/Normalization	LR test statistic (p-val.)
Austria	$\hat{\beta}' = [0 \quad 1 \quad -1 \quad 0]'$	10.803 (0.095)
Belgium	$\hat{\beta}' = \begin{bmatrix} -1 & 0 & 0 & 1 \\ 0 & 1 & -1 & 0 \\ 1 & 0 & 0 & -1 \end{bmatrix}'$	10.715 (0.098)
Finland	$\hat{\beta}' = \begin{bmatrix} -1 & 1 & 0 & 0 \\ 0 & \beta_{2C} & 1 & 0 \\ 0 & 0 & -1 & 1 \end{bmatrix}'$	3.949 (0.557)
France	$\hat{\beta}' = [0 \quad 1 \quad \beta_{1S} \quad 0]'$	5.391 (0.249)
Germany	$\hat{\beta} = \begin{bmatrix} 0 & 1 & 0 & -1 \\ 0 & 0 & 1 & -1 \\ 1 & 0 & 0 & \beta_{3P} \end{bmatrix}$	6.695 (0.244)
Greece	$\hat{\beta}' = \begin{bmatrix} \beta_{1I} & 0 & 1 & 0 \\ 0 & 1 & 0 & \beta_{2P} \\ 1 & 0 & 0 & -1 \end{bmatrix}$	7.191 (0.304)
Ireland	$\hat{\beta}' = \begin{bmatrix} 0 & -1 & 0 & 1 \\ -1 & 0 & 1 & 0 \end{bmatrix}'$	12.089 (0.147)
Italy	$\hat{\beta}' = \begin{bmatrix} -1 & 0 & 0 & 1 \\ -1 & 1 & 0 & 0 \end{bmatrix}'$	13.491 (0.096)
Netherlands	$\hat{\beta}' = \begin{bmatrix} \beta_{1I} & 1 & 0 & 0 \\ -1 & 0 & 0 & 1 \end{bmatrix}'$	14.799 (0.039)
Spain	$\hat{\beta}' = \begin{bmatrix} 1 & \beta_{1C} & 0 & 0 \\ \beta_{2I} & 0 & 0 & 1 \\ 0 & 0 & 1 & \beta_{3P} \end{bmatrix}'$	7.804 (0.050)

Note: We normalize to 1 the coefficient of the variable which was found to be significantly adjusting. The order in which coefficients appear is always β_{iT}, β_{iN} , β_{iP}. The LR-test of the restricted model is distributed as a χ^2_q, where q is the number of degrees of freedom. When all full wage adaptability restrictions were rejected at any significance level, the reported long run matrix and LR test refer to the "basic" model in Table 3.

* The order in which sectors are inserted is Industry, Construction, Services, Public. β_{ij}, i = 1,2,3 and j = I,C,S,P indicates an unrestricted coefficient in vector *i* for sector *j*.

Table 5. Leadership in the short-run model

Country / Short-run leader	w_I	w_C	w_S	w_P
Austria	0.673 (0.672)	0.627 (0.709)	0.742 (0.617)	0.418 (0.867)
Belgium	2.129 (0.051)*	2.617 (0.018)**	2.547 (0.021)**	1.383 (0.223)
Finland	0.556 (0.765)	0.601 (0.730)	0.654 (0.687)	0.276 (0.948)
France	0.330 (0.921)	0.403 (0.877)	0.311 (0.931)	0.273 (0.950)
Germany	0.913 (0.486)	0.669 (0.675)	1.718 (0.117)	1.513 (0.174)
Greece	1.129 (0.351)	3.115 (0.008)***	1.911 (0.086)*	0.827 (0.551)
Ireland	2.292 (0.039)**	1.533 (0.172)	0.159 (0.987)	1.790 (0.105)
Italy	0.727 (0.629)	0.746 (0.613)	2.205 (0.043)**	2.706 (0.015)**
Netherlands	2.634 (0.017)**	2.621 (0.018)**	2.583 (0.019)**	2.563 (0.020)**
Spain	1.339 (0.196)	1.142 (0.326)	3.434 (0.000)***	1.558 (0.104)

Note: P-values of the Granger non-causality test. Null hypothesis: $\boldsymbol{w}_{-i}$ does not Granger-cause w_i.