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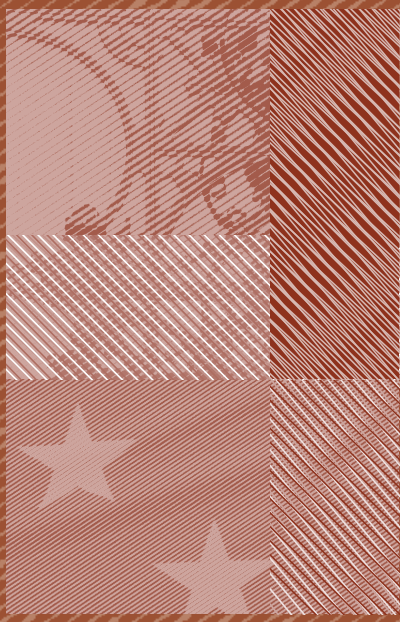

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**Abstract**

Do public sector wages exert presures on private sector wages, or has private sector a leadership role in wage setting?. This paper tries to isolate the pure signalling effect that one sector might exert on the other by controlling for other determinants of wages (prices, productivity, institutions) for the main euro area economies (Germany, France, Italy and Spain) and the periods 1980-2007 and 1991-2007. It exploits avilable quarterly information not yet used in the literature, and combine different data sources in the framework of mixed-frecuencies time series models. The quarterly frequency of our data allows us to check the existence of strong evidence of public wages' leadership, either in conjunction with bi-directional links from the private sector (Germany and Spain) or pure public wage leadership (France in the sample 1991-2007, Italy for within-the-year linkages).

**Keywords:** government wages, private sector wages, signalling, causality, mixed frequency data, casual graph.

**JEL classification:** C32, C53, J30, J51, E62, E63, H50, H6.

## Non technical summary

This paper empirically analyses the interaction between public and private sector wages for the four largest countries of the Euro area (Germany, France, Italy and Spain) over the period 1981-2007 using quarterly data. The relevance of this issue is clear from an analytical and policy perspective, given that the public sector is a key player in the labour market, employing some 20% of the working population. The determination of wages paid to public employees do not necessarily follow the same rules as those prevailing in the private sector, given that public employees provide public services (and goods) arising from social preferences that are not normally oriented to market activities. In this sense, their productivity, and the link of productivity with wages, is more difficult to assess than the productivity of workers linked to market-oriented activities. Differences in wage-setting behavior can also be attributed to a higher degree of unionisation in the public sector and the dominant position civil servants might exploit to achieve special wage and employment conditions.

According to the so-called Scandinavian model of wage determination, the tradable-goods sector would be, by definition, the wage setting leader and the other sector would follow. This model was developed for the case of small open economies, and has been highly debated in the Scandinavian countries. If wages in the sheltered sectors (sectors less open to competition than the tradable-goods sector) were to grow above those of the tradable-goods sector, this might lead to competitive losses that might end up damaging the competitiveness of a country. Applied to the interaction between public and private sector wages, the Scandinavian model suggests that public wages (the sheltered sector) could exert undue pressure on private sector wages (more open to competition).

Alternatively, and especially in European countries, the available evidence on downward wage rigidities would give a role to the public sector as a wage leader, in the sense that it might exert a moderating role as a wage setter in times of recession.

In addition to these direct links between public and private wages, other indirect effects might exist via prices (wage price indexation) and productivity. Finally, institutional features may play a role in determining how both sectoral labour markets are linked. First, there may be direct links via the wage bargaining process. If the government leads, adjustments in quantities (employment) are more likely to occur in the private sector. By contrast, if the private sector leads, prices (wages) are commonly adjusted first. Second, there are indirect linkages which come from social benefits and minimum wage levels.

Our study expands the available literature on public-private sector wage leadership for the biggest euro area countries, namely Germany, France, Italy and Spain, highlighting the intra-annual influences across sectors (signalling effects). We build up a quarterly dataset for the period 1980Q1-2007Q4 by combining available information from the Quarterly Government Finance Statistics (Eurostat) - not yet exploited in the literature - and other related information on government sector compensation of employees and government employment available from other sources (non-

market services, Federal and Central government variables). Given the sample length of the dataset we use, we can also analyse if linkages between public and private sector wages have been different in the 1990-2007 sample compared to the 1980-2007 sample, and thus proxy possible influences of the European Monetary union.

The main conclusion of our analysis is the existence of robust cross-country empirical evidence of mostly direct signals (intra-annual links) between wages in the public and the private sector. The results are broadly similar across the two selected samples. They are reinforced in a restricted VAR estimation. By this we mean that we leave out some quarterly information in order to isolate purely within-the-year interactions between wages in both sectors. Our results show strong linkages between wages in both sectors, with a predominance of bidirectional links in the cases of Germany and Spain. In addition, leadership of public wages in France in the sample 1991-2007, and in the case of Italy for within-the-year estimations are quite robust features of our data. Our empirical approach allows us to also unveil a complex and rich structure of indirect links of wages with other variables (prices, productivity, institutional factors).

Some policy implications are worth mentioning. Firstly, public sector wages play an important role in the determination of labour costs in the major euro area economies. Secondly, this role is relatively more important when only within-the-year links are considered (influence in the wage negotiation phase). Thirdly, institutional features also have a role in setting the links between wages, prices and productivity.

# 1 Introduction

This paper empirically analyses the interaction between public and private sector wages for the four largest countries of the Euro area (Germany, France, Italy and Spain) over the period 1981-2007 using quarterly data. The relevance of this issue is clear from an analytical and policy perspective, given that the public sector is a key player in the labour market, employing some 20% of the working population. The determination of wages paid to public employees do not necessarily follow the same rules than the ones prevailing in the private sector, given that public employees provide public services (and goods) arising from social preferences that are not normally oriented to market activities. In this sense, their productivity, and the link of productivity with wages, is more difficult to assess than the productivity of workers linked to market-oriented activities. In addition, the theoretical literature highlights some possible reasons why public sector wages could follow different setting rules than those in the private sector, like a higher degree of unionisation in the public sector or the dominant position civil servants might exploit to achieve special wage and employment conditions.

To the light of the so-called Scandinavian model of wage determination (see, for example, Strom, 1997), the tradable-goods sector would be, by definition, the wage setting leader and the other sector would follow. This model was developed for the case of small open economies, and has been highly debated in the Scandinavian countries. If wages in the sheltered sectors (sectors less open to competition than the tradable-goods sector) were to grow above those of the tradable-goods sector, this might lead to competitive losses that might end up damaging the competitiveness of a country. Against the background of this Scandinavian model, the parallel in the case of the interaction between public and private sector wages would be a case in which public wages (the sheltered sector) would exert undue pressure on private sector wages (more open to competition).

Alternatively, and especially in European countries, the available evidence on downward wage rigidities would give a role to the public sector as a wage leader, in the sense that it might exert a moderating role as a wage setter in times of recession, and thus influence the overall adjustment in the economy when needed.

In addition to these direct links between public and private wages, other indirect effects might exist via prices and productivity. For example, collective bargaining agreements may contain sector-specific clauses which protect workers against non-expected increases in prices (wage price indexation) which will cause automatic increases in wages. In the case of productivity, the issue remains as to how market and non-market related activities reflect productivity increases via wage increases.

Finally, institutional features may play a role in determining how both sectoral labour markets are linked. On the one hand, one may observe direct links via the wage bargaining process. If the government leads, adjustments in quantities (employment) are more likely to occur in the private sector. By contrast, if the private sector leads, prices (wages) are commonly adjusted first. On the

other hand, indirect linkages which come from social benefits and minimum wage levels should be noted.

The empirical literature on public or private sector wage leadership is relatively scarce. Against the framework of the Scandianvian model of inflation a rich set of papers for the Swedish economy have exploited the issue. Lindquist and Vilhelmsson (2006) apply a vector error correction approach to wage setting in Sweden with annual data for the period 1970-2002, and find long-run wage leadership of the private sector and no Granger causation from the public to the private sector in the short run, in line with the results previously obtained by Jacobson and Ohlsson (1994). However, some authors (see Friberg, 2007, Holmund and Ohlsson, 1992, and Tagstrom, 2000, among others) have found empirical evidence which point in the opposite direction. Some studies for other countries like Demekas and Kontolemis (1999) -for Greece-, Mizala and Romaguera (1995) -for Chile-, and Christou, Klemm and Tiffin (2007) -for Romania- show no clear-cut conclusions about a prevalent leadership role.

A broader study covering most euro area countries and other OECD countries is Lamo, Pérez and Schuknecht (2008). Using a cross-country dataset of annual data, they find robust contemporaneous correlation and feedback effects between private and public wages which occur in a direct manner, but also via prices (causality in nominal terms that disappears when the price level is included - "second round effects"). Causality from the private to the public sector dominates. Nevertheless, there are many instances in which public wages lead. Finally, they are able to rationalise the heterogeneity of leadership behaviour found across countries in the cross-country heterogeneity present in institutional variables.[1]

Our study expands the available literature on public-private sector wage leadership for the biggest euro area countries, namely Germany, France, Italy and Spain, highlighting the intra-annual influences across sectors (signalling effects). We can do this because we do not use annual data as in Lamo, Pérez and Schuknecht (2008) or Lindquist and Vilhelmsson (2006). On the contrary, we build up a quarterly dataset for the period 1980Q1-2007Q4 by using time series mixed-frequencies models, along the lines of Harvey and Chung (2000), Proietti and Moauro (2006) and Pedregal and Pérez (2009). This approach allows us to use available information from the Quarterly Government Finance Statistics (Eurostat) not yet exploited in the literature, together with other related information on government sector compensation of employees and government employment available from other sources (non-market services, Federal and Central government

[1] Some studies make use of pooled, annual data, and look at the average relationship between public and private wages, without focusing on a specific country. A seminal study along these lines is Alesina *et al.* (2002) that find a sizeable negative effect of public spending and in particular of its wage component (wage bill) on private sector profits and on business investment for a pool of OECD countries. On related grounds see Afonso and Gomes (2008). Algan *et al.* (2002) find a significant negative correlation between employment in the public and the private sector in a pool of OECD countries.

variables). Given the sample length of the dataset we use, we can also analyse if linkages between public and private sector wages have been different in the 1990-2007 sample compared to the 1980-2007 sample, and thus proxy possible influences of the European Monetary union.

The theoretical literature provides some insights on the empirical models to be used. We set up a VAR empirical model that can be rationalized theoretically along the lines of the public-private union competition models of Maffezzoli (2001) and Ardagna (2007). In order to assess the existence of intra-annual signalling effects, in addition to a standard VAR approach with quarterly data, we estimate a restricted version of the VARs in which only within-the-year observations are used. In addition, we also interpret the output of the VARs along the lines of the literature on causal graphs (Lauritzen and Richardson, 2002, Demiralp and Hoover, 2003, Eichler, 2007).

The main conclusion of our analysis is the existence of robust cross-country empirical evidence of mostly direct signals (intra-annual links) between wages in the public and the private sector. The results are broadly similar across the two selected samples. They are reinforced in a restricted VAR estimation. By this we mean that we leave out some quarterly information in order to isolate purely within-the-year interactions between wages in both sectors. Our results show strong linkages between wages in both sectors, with a predominance of bidirectional links in the cases of Germany and Spain. In addition, leadership of public wages in France in the sample 1991-2007, and in the case of Italy for within-the-year estimations are quite robust features of our data. Our empirical approach allows us to also unveil a complex and rich structure of indirect links of wages with other variables (prices, productivity, institutional factors).

Moreover, we find robust evidence of the existence of a complex structure of indirect links via control variables. Some interesting conclusions emerge from the analysis of institutional control variables: (i) public ownership of strategic sectors firms negatively affects worker productivity; (ii) the size of the government decreases the probability of public sector wage leadership, specially in the cases of Germany and Spain, and to a lesser extent France and Italy; (iii) employment protection legislation damages labour productivity in the case of Spain, while it seems to have a positive effect in Germany; (iv) union density increases the probability of public wage leadership in Germany and Spain in the whole sample, that disappears when the 80s are excluded from the sample.; (v) the variable measuring globalisation exerts a positive effect on productivity.

The rest of the paper is organized as follows. In Section 2 we explain the empirical strategy used. In Section 3 we present the quarterly data used and the mixed-frequency approach used to interpolate part of the sample. In Section 4 we present the main results obtained and in section 5 the main conclusions of the study.

## 2 Empirical Strategy

The models in Ardagna (2007) and Maffezzoli (2001) provide a framework in which workers' trade unions in the public and the private sector try to maximise the wages of their affiliates, thus leading to a set of reaction functions in which wages in one sector react to wages in the other sector, in such a way that:

$$\log(w_{pt}/P) = f(\log(w_{gt}/P), \text{technological parameters}, \ldots) \quad (1)$$

$$\log(w_{gt}/P) = f(\log(w_{pt}/P), \text{technological parameters}, \ldots) \quad (2)$$

where $w_{pt}$ represents the after-tax private sector nominal wage, $w_{gt}$ the after-tax public sector nominal wage and $P$ the price level.

The problem we are interested in fits very well in a theoretical framework of this kind. One sector union's react to changes in wages in the other sector, via envy effects. Upon this basis, we consider an empirical model in which nominal public and private-sector wages are jointly determined in the presence of endogenous variables, such as productivity and prices, and exogenous variables (institutional features). Equations (1) and (2) can be expressed in empirical terms in a standard VAR framework as follows

$$\mathbf{Y}_t = C + \sum_{j=1}^{p} B_j \mathbf{Y}_{t-j} + G\mathbf{Z}_t + \varepsilon_t \quad (3)$$

where: (1) $\mathbf{Y}_t$ is the vector of endogenous variables ($w^{Pu}$, $w^{Pr}$, $P$ and $A$); $w^{Pu}$ denotes compensation per employee in the public sector, $w^{Pr}$ compensation per employee in the private sector, $P$ the expected price level (proxied here by current prices), and $A$ total economy labour productivity; (2) $\mathbf{Z}_t$ is a set of exogenous variables encompassing a set of institutional variables (that will be described in a subsequent section of the paper).

The VAR specification provides a regression framework with control variables, a standard environment of a strand of the empirical literature which explores the signalling role of specific variables. Illustrative examples are the following: (i) firms' dividends signalling role (see Garrett and Priestley, 2000); (ii) education as a signal used by employers because of its relationship with desired characteristics of workers (see Weiss, 1995, and Tyler *et al.*, 2000); (iii) market yields have recently become much better predictors of monetary policy movements (see Lange *et al.*, 2003).

Following Toda and Yamamoto (1995), we assume that a VAR in levels can be used to test general restrictions even in the presence of integrated or cointegrated series. First, a usual lag selection procedure is used with the aim of determining the lag length ($p^*$) to be used in the VAR[2]. Next, a $\widetilde{p} = p^* + p_{max}$ th-order VAR is estimated, where $p_{max}$ is the maximal order of integration suspected to occur among the variables involved. In order to test for wage leadership or signalling

[2]The maximum (across countries) median value of Schwarz, Hannan-Quinn and Akaike criteria is used.

behaviour, we carry out a conditional Granger causality test using equation (3) for each country and sample period considered in our analysis.

As an example, if $\widetilde{p} = 4$, the system (3) for the equations determining private sector wages can be expressed as:

$$
\begin{aligned}
w^{Pr}_{q^1_y} &= \alpha_1 w^{Pu}_{q^4_{y-1}} + \alpha_2 w^{Pu}_{q^3_{y-1}} + \alpha_3 w^{Pu}_{q^2_{y-1}} + \alpha_4 w^{Pu}_{q^1_{y-1}} + \sum_{j=1}^{4} \beta_j \mathbf{P}_{t-j} + \sum_{j=1}^{4} \gamma_j \mathbf{A}_{t-j} + \delta \mathbf{Z}_t + \varepsilon_t \\
w^{Pr}_{q^2_y} &= \alpha_1 w^{Pu}_{q^1_y} + \alpha_2 w^{Pu}_{q^4_{y-1}} + \alpha_3 w^{Pu}_{q^3_{y-1}} + \alpha_4 w^{Pu}_{q^2_{y-1}} + \sum_{j=1}^{4} \beta_j \mathbf{P}_{t-j} + \sum_{j=1}^{4} \gamma_j \mathbf{A}_{t-j} + \delta \mathbf{Z}_t + \varepsilon_t \\
w^{Pr}_{q^3_y} &= \alpha_1 w^{Pu}_{q^2_y} + \alpha_2 w^{Pu}_{q^1_y} + \alpha_3 w^{Pu}_{q^4_{y-1}} + \alpha_4 w^{Pu}_{q^3_{y-1}} + \sum_{j=1}^{4} \beta_j \mathbf{P}_{t-j} + \sum_{j=1}^{4} \gamma_j \mathbf{A}_{t-j} + \delta \mathbf{Z}_t + \varepsilon_t \\
w^{Pr}_{q^4_y} &= \alpha_1 w^{Pu}_{q^3_y} + \alpha_2 w^{Pu}_{q^2_y} + \alpha_3 w^{Pu}_{q^1_y} + \alpha_4 w^{Pu}_{q^4_{y-1}} + \sum_{j=1}^{4} \beta_j \mathbf{P}_{t-j} + \sum_{j=1}^{4} \gamma_j \mathbf{A}_{t-j} + \delta \mathbf{Z}_t + \varepsilon_t
\end{aligned}
$$

where $q^i_y$ refers to $i-th$ quarter's data and $y$ to the current year.

In addition to the previous standard analysis, we carry out a restricted estimation. By this we mean that we leave out some quarterly information in order to isolate purely within-the-year interactions between wages in both sectors. In this particular case, the previous set of equations becomes:

$$
\begin{aligned}
w^{Pr}_{q^1_y} &= \alpha_1 w^{Pu}_{q^4_{y-1}} + \alpha_2 w^{Pu}_{q^3_{y-1}} + \alpha_3 w^{Pu}_{q^2_{y-1}} + \alpha_4 w^{Pu}_{q^1_{y-1}} + \sum_{j=1}^{4} \beta_j \mathbf{P}_{t-j} + \sum_{j=1}^{4} \gamma_j \mathbf{A}_{t-j} + \delta \mathbf{Z}_t + \varepsilon_t \\
w^{Pr}_{q^2_y} &= \alpha_1 w^{Pu}_{q^1_y} + \cancelto{0}{\alpha_2 w^{Pu}_{q^4_{y-1}}} + \cancelto{0}{\alpha_3 w^{Pu}_{q^3_{y-1}}} + \cancelto{0}{\alpha_4 w^{Pu}_{q^2_{y-1}}} + \beta_1 \mathbf{P}_{q^1_y} + \gamma_1 \mathbf{A}_{q^1_y} + \delta \mathbf{Z}_t + \varepsilon_t \\
w^{Pr}_{q^3_y} &= \alpha_1 w^{Pu}_{q^2_y} + \alpha_2 w^{Pu}_{q^1_y} + \cancelto{0}{\alpha_3 w^{Pu}_{q^4_{y-1}}} + \cancelto{0}{\alpha_4 w^{Pu}_{q^3_{y-1}}} + \sum_{j=1}^{2} \beta_j \mathbf{P}_{t-j} + \sum_{j=1}^{2} \gamma_j \mathbf{A}_{t-j} + \delta \mathbf{Z}_t + \varepsilon_t \\
w^{Pr}_{q^4_y} &= \alpha_1 w^{Pu}_{q^3_y} + \alpha_2 w^{Pu}_{q^2_y} + \alpha_3 w^{Pu}_{q^1_y} + \cancelto{0}{\alpha_4 w^{Pu}_{q^4_{y-1}}} + \sum_{j=1}^{3} \beta_j \mathbf{P}_{t-j} + \sum_{j=1}^{3} \gamma_j \mathbf{A}_{t-j} + \delta \mathbf{Z}_t + \varepsilon_t
\end{aligned}
$$

Notice that the first quarter of each year for private sector wages is allowed to be influenced by public wages in previous years' quarters, while the second, third and fourth quarters are only allowed to be influenced by public wages in the previous quarters of the same year. We carry out this restricted estimation to isolate possible influences of wage negotiations in one sector affecting wage negotiations in the other sector. Normally wage negotiations are signed within the same year, or at the beginning of the first quarter of the subsequent year at the maximum. We presume this assumption is a fair proxy to standard practice[3].

In order to provide some advanced intuition that could help frame the empirical results, we provide some theoretical insights in the rest of this section on the basis of causal graphs. The

[3] Khun and Gu (1999), among others, deals with the learning process derived from sequential negotiations (captured by our full estimation). By contrast, our restricted estimation aims to break these links and isolate the effect of the contemporaneous (within-the-year) negotiations. Moreover, we have carried out a sensitivity analysis in which we allow all periods of current year to depend on the last quarter of the previous year, observing that our main results and conclusions remain.

procedure we use to compute them is as follows: (i) First, we carry out conditional causality tests for all the pairs of variables of the model ($w^{Pu}$, $w^{Pr}$, $P$ and $A$), (ii) Then, we draw a causal map including an arrow for those cases in which a significant causal effect is obtained. Moreover, we highlight (using a thicker line) the central links for our study ($w^{Pr} \leftrightarrow w^{Pu}$) over the other ones.

Figure 1 shows some theoretical insights on how private and public wages might interact using causal graphs. These figures help us to observe how *indirect effects* may also influence (by compensating, reducing or reinforcing) the intensity of the direct effect we observe between from $w^{Pr}$ to $w^{Pu}$ (left panel, thicker line) might be related to the direct influence of $w^{Pr}$ and $w^{Pu}$; nevertheless, the influence of $w^{Pr}$ on $w^{Pu}$ may also reflect other indirect effects that $P$ and $A$ may have on $w^{Pu}$ via $w^{Pr}$. In addition, direct effects from $P$ and $A$ may also exist. As an example, clauses which protect workers against non-expected increases in prices (indexation of wages by prices) may influence the evolution of wages. The inverse effect (from wages to prices) may be understood as inflationary effects (second-round effects) derived from increases in wages. In addition, interactions between productivity and wages can be explained by appealing to the efficiency wages' theory (employers aim at increasing workers' productivity by increasing their wage or to ensure their continuity in the firm -see Johansen and Strom, 2003-) or to the compensation payment theory (firms are not able to observe worker's productivity and only can adjust their wages subsequently). Finally, although the links between inflation and productivity are not central to our study, they may affect our conclusions and are consequently considered. These links have been previously analyzed in the literature by Ram (1987) and Freeman and Yerger (2000), among others. The basic intuition is that, on the one hand, prices may influence labour productivity by modifying the real wage and, on the other hand, changes in productivity modify aggregate supply and may, therefore, affect prices.

To the light of causal graphs, figure 2 shows some meaningful examples which could be useful in understanding the empirical results obtained later on in the paper. The top-left panel shows a scenario in which prices would be the common cause for both sectors' wages. Thus, we can not conclude that public and private sector wages are not linked. This may be the situation in an economy with a relevant presence of wage price indexation clauses in collective bargaining agreements. The top-right panel shows a case in which a government would identify the productivity of its workers by looking at the productivity level internalized by private wages. This scheme is consistent with the Scandinavian model explained above. The bottom-left panel displays a situation in which prices are influenced simultaneously by public sector and private sector wages, which are not directly connected between themselves. However, one may conclude that they are linked to some extent as they affect a common variable. A significant effect between public and private wages might have emerged in this case whether one had excluded prices from an estimated model. This scenario is consistent with the existence of second-round effects. The bottom-right panel shows a case in which private sector wages lead public sector wages, and at the same time wages affect productivity. This situation would be consistent with the efficiency wages theory.

# 3 The data

## 3.1 General government variables

As regards data on public sector wages and employment, the European System of National Accounts (ESA-95) provides only limited published time series and/or time coverage. As regards compensation of government sector employees, Eurostat (EU's statistical agency) started to disseminate recently quarterly series, fully consistent with the already existing annual figures (see the discussion in Pedregal and Pérez, 2009). Nevertheless, the starting point of these series is relatively short, ranging in our case from 1991Q1 in the case of France to 1999Q1 in the cases of Germany and Italy. At the same time, the ESA95 framework provides related quarterly series under the heading "Compensation of employees in other services", the basis of which is compensation in non-market services, the main part of which is the government sector. This information can be used as an indication of the target concept of "general government compensation of employees". Furthermore, it is possible to obtain monthly and quarterly information on personnel expenditures by some sub-sectors of the general government sector, typically the central or Federal government sectors.[4]

The situation is quite different for the case of government employment. EU member states do not generally report to Eurostat standardized annual employment figures for the general government sector. Thus, in most cases it is necessary to resort to national sources, and the issue of homogeneity across countries is more delicate. The OECD Economic Outlook database presents the best choice as regards cross-country availability and homogeneity of annual data in this respect. For statistical issues regarding the definition of government employment see OECD (1997). As in the case of compensation of government employees, in order to obtain quarterly information, it is possible to resort to ESA95 figures on "Employment in other services", the bulk of which are related to government (non-market) activities. We take the avenue of using as much official information as possible, especially as regards recently available quarterly compensation of employees series provided by Eurostat. At the same time, given the limitations of the information available (annual frequency), we make extensive use of other sources of quarterly information, in particular that related to non-market services.

To use all this information in the most efficient way, we set up mixed-frequencies time series models, as described in Appendix A. These models allow us to also tackle a problem related with newly available compensation of government employees and employment series. Eurostat does not

[4] We focus on total compensation rather than on wages for two reasons. The first one is practical: there is no data with the same level of coverage and detail for wages than the one we use for compensation. The second is conceptual. We follow Feldstein (2008) and prefer to use compensation as a broader concept of personnel expenditures. Fringe benefits, noncash payments and other benefits play an important role in wage negotiations and thus set the grounds for potential spillover effects via "envy effects" between the public and the private sector.

provide seasonally adjusted series. We seasonally adjust the series within the selected time series models.

### 3.2 Other variables

Table 1 details all data sources.

Given the public sector variables, the corresponding private sector variables are obtained as the difference between the total economy variable and the estimated public sector variable. Our variable of interest in each sector is then obtained by dividing compensation of employees by employment. Figure 3 shows the resulting compensation per employee series in the public and the private sector for the four countries considered. As a measure of $P$, we use the private consumption deflator[5]. Productivity ($A$) is defined as total economy labor productivity for the whole economy. Regarding institutional variables, we consider the following: (i) the size of the public sector as an employer, measured as the ratio of public employment and total employment ($SIZE_{Pu}$); (ii) an indicator of public sector ownership, $OWN_{Pu}$ (see Conway and Nicoletti, 2006); (iii) a globalization index (see Drehen, 2008), $GLOB$, which measures the degree of openness of the economy; (iv) an indicator which codifies the existing employment protection legislation ($EP$); (v) the degree of unionisation of the labour market, through two variables: union density -$UD$- which is defined as the ratio between union membership and employment, and union coverage -$UC$- which measures the percentage of workers which are covered by collective agreements; (vi) the degree of bargaining coordination -$COW$- and centralization -$CEW$-, as defined in Nickell (2006). Some of the institutional variables are not available for the whole sample, and thus some kind of extension is needed; for the variables showing stable values over the previous periods, we just keep the same levels; otherwise we use simple trends to interpolate or extrapolate the series.

## 4 Results

As stated above, our empirical strategy is as follows. A conditional causality analysis is carried out between the variables which compose $\mathbf{Y}$ for two different sample periods (1981-2007 and 1991-2007).

Figures 4-7 show the P-values resulting from our conditional causality analysis, the sign of coefficients related to institutional features variables and the causal map generated combining this information. Based on these results, the main conclusion we draw is the robust cross-country empirical evidence of mostly direct intra-annual links observed between both sector wages. Some heterogeneity of results emerges though, when looking in detail at country specific results. Firstly, in the case of Germany, the leadership role is mostly assumed by the private sector although the public sector gains relative relevance during the 1990s and when only the within-the-year effects are

[5]The results in qualitative terms are similar if we use the GDP deflator. The results are available upon request.

considered. Secondly, for France, when the 1980s are included, the private sector leads clearly the wage setting process. By contrast, when the sample period starts in the 1990s, the public sector leads. Thirdly, in the case of Italy, a stronger relationship between both sector wages is observed when the 1980s are in our sample. Indeed, the public sector leads if only within-the-year linkages are considered. Otherwise, the private sector seems to lead. Finally, the Spanish case shows a robust bi-directional link between both sector wages in our baseline estimation for the whole sample, while in the restricted case (within-the-year linkages) the public sector leads for the whole period but the private sector leads for the 1991-2007 sample. All in all, for the sample covering the 1981-2007 period, we find evidence of increased public sector leadership in the restricted estimation case (Germany, Spain, and Italy). On the contrary, for the sample starting from the 1990s, we observe this effect only for Italy. This means that "signalling effects" might have lost prominence in the past two decades for Germany and Spain.

We also find strong evidence of persistence in public and private sector wages. The past of each sector wages shows predictive power for the future of wages in this very sector. This can also be seen as evidence in favour of wage stickiness.

Causal graphs (at the bottom of each figure) show a complementary view of our results by drawing the direct links for each country included in this study. The level of significance used as a reference is 10 % as standard in this literature. Some issues are worth highlighting to the light of these figures. First, we find robust evidence of wage price indexation for the whole set of countries but this effect is less important from the 1990s. Second, wages exert pressures on prices, specially for Germany and France. Third, efficiency wages theory helps to explain the role of productivity for Germany and France whereas Spain and Italy evidence is consistent with compensation payments' theory.

In addition, some interesting conclusions emerge from the analysis of institutional control variables: (i) The size of the government decreases the probability of public sector wage leadership, specially in the cases of Germany and Spain, and to a lesser extent France and Italy;[6] (ii) public ownership of strategic sectors firms negatively affects worker productivity; (iii) employment protection legislation damages labor productivity in the case of Spain, while it seems to have a positive effect in Germany; (iv) union density increases the probability of public wage leadership in Germany and Spain in the whole sample, that disappears when the 80s are excluded from the sample; (v) the variable measuring globalization exerts a positive effect on productivity developments.

[6] Notice that, for those countries, the coefficients related to $SIZE^{Pu}$ in estimations with $w^{Pr}$ and $w^{Pu}$ as dependent variables are significant and present opposite signs. Thus, any change of $SIZE^{Pu}$ will reduce the links between both sectors wages.

# 5 Conclusions

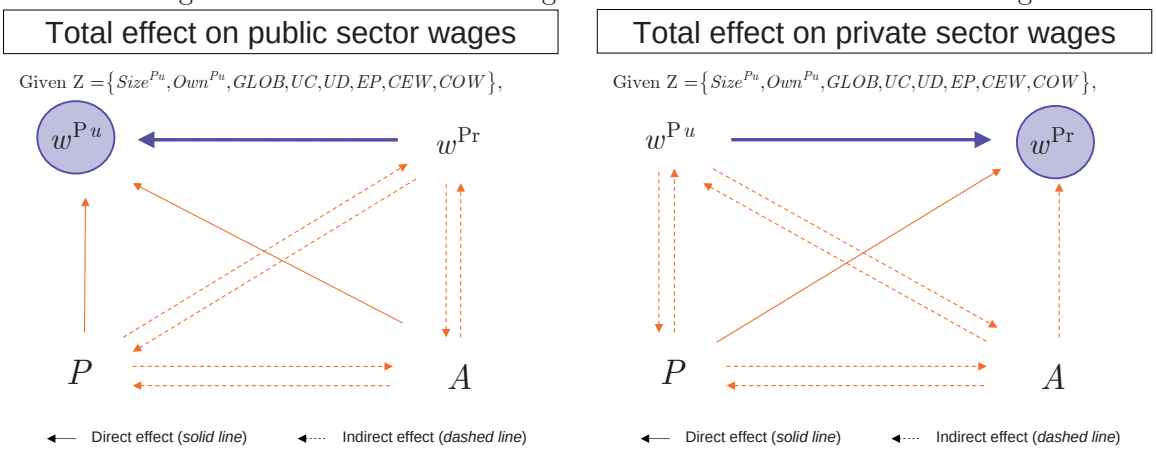
This paper deals with the interactions between public and private sector wages. This issue has been previously explored by other authors (Lamo, Pérez and Schuknecht, 2008, among others), but we use instead of annual data, quarterly data in order to explore what the intra-annual interactions are. A conditional causality analysis is carried out which also considers the existing indirect links with other endogenous variables, such as prices and productivity (in line with empirical papers facing "signalling" issues). Furthermore, a restricted estimation which isolates the within-the-year effects is also performed.

As regards the interaction of public and private sector wages, the main conclusion is the robust cross-country empirical evidence of mostly direct signals (intra-annual links) between both sector wages. They are reinforced if only periods of the current year are considered. In addition, some other results are found; (i) evidence of price indexation of wages, (ii) the existence of a significant role of labor productivity in determining wages. Finally, the heterogeneity of our results is not surprising given the different institutional framework and set-ups across countries. Nevertheless, some patterns can be found throughout on the role of public ownership, the size of the government, employment protection legislation, union density and globalization.

Some policy implications are worth mentioning. Firstly, public sector wages play an important role in the determination of labor costs in the major euro area economies. Secondly, this role is relatively more important when only within-the-year links are considered (influence in the wage negotiation phase). Thirdly, institutional features also have a role in setting the links between the variables we manage here: wages, prices and productivity.

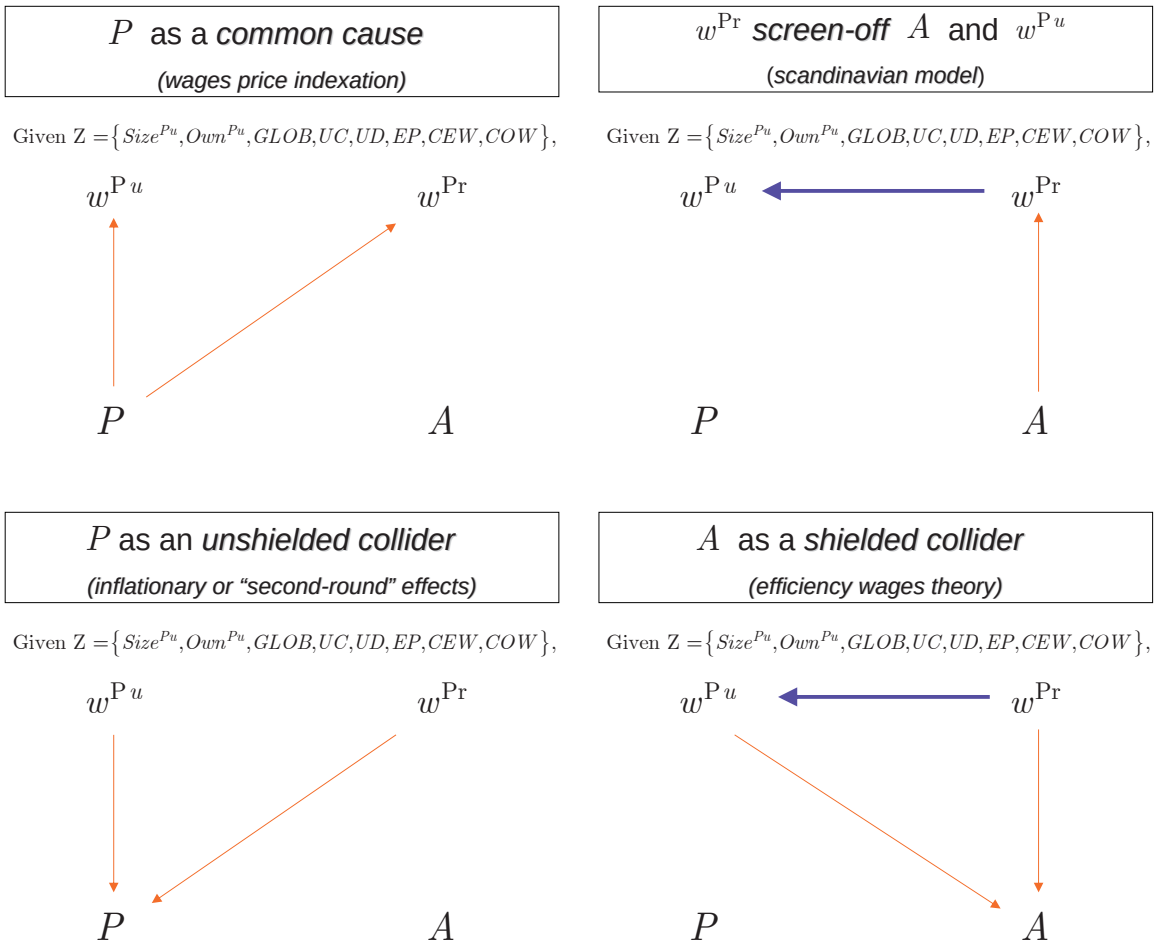
# 6 Tables and figures

Figure 1: Prior theoretical insights on the links between sectoral wages.




Notes: (1) $w^{Pu}$ and $w^{Pr}$ are public sector and private sector compensation per employee, $P$ the prices level and $A$ the labour productivity. Institutional features are included by considering the following set of variables; (i) the size of the public sector (as employer) -$SIZE^{Pu}$- (ii) an indicator which measures the public ownership, -$OWN^{Pu}$-, (iii) a globalization index (see Drehen (2008)) -$GLOB$-, (iv) employment protection legislation -$EP$-, (v) union density -$UD$-, (vi) union coverage -$UC$- and (vii) wage bargaining coordination -$COW$- and centralization -$CEW$- (see Nickell (2006)).

Figure 2: Causal graphs. Some introductory and economic meaningful examples upon the basis of our baseline specification.




Notes: (1) $w^{Pu}$ and $w^{Pr}$ are public sector and private sector compensation per employee, $P$ the prices level and $A$ the labour productivity. Institutional features are included by considering the following set of variables; (i) the size of the public sector (as employer) -$SIZE^{Pu}$- (ii) an indicator which measures the public ownership, -$OWN^{Pu}$-, (iii) a globalization index (see Drehen (2008)) -$GLOB$-, (iv) employment protection legislation -$EP$-, (v) union density -$UD$-, (vi) union coverage -$UC$- and (vii) wage bargaining coordination -$COW$- and centralization -$CEW$- (see Nickell (2006)).

# Table 1: Data Sources

| **Dataset** *Provider* | **Variables** [Frequency] *A = annual, Q = quarterly, M = monthly.* | **Availability**[(1)] **Germany**[(2)] | **Spain** | **France** | **Italy** |
|---|---|---|---|---|---|
| National Accounts (ESA-95) | Employment, Other Services [Q] | 1980-2007 | 1980-2007 | 1990-2007 | 1980-2007 |
| *Eurostat* | Final consumption of General Government, Current Prices [Q] | 1980-2007 | 1980-2007 | 1980-2007 | 1980-2007 |
| | Final consumption of General Government, Constant Prices [Q] | 1980-2007 | 1980-2007 | 1980-2007 | 1980-2007 |
| | Compensation of employees, SA [Q] | 1980-2007 | 1980-2007 | 1980-2007 | 1980-2007 |
| | Compensation of employees, Other services [Q] | 1980-2007 | 1980-2007 | 1990-2007 | 1980-2007 |
| | Total employment, domestic [Q] | 1980-2007 | 1980-2007 | 1980-2007 | 1980-2007 |
| | Labour Productivity, SA [Q] | 1991-2007 | 1980-2007 | 1980-2007 | 1980-2007 |
| | Labour Productivity -Index-, SA [Q] | 1991-2007 | 1980-2007 | 1980-2007 | 1980-2007 |
| | Labour Productivity, Other Services, SA [Q] | 1991-2007 | 1980-2007 | 1990-2007 | 1980-2005[(7)] |
| Economic Outlook | Government final wage consumption expenditure [A] | 1980-2007 | 1980-2007 | 1980-2007 | 1980-2007 |
| *OECD* | General Government employment [A] | 1980-2007 | 1980-2007 | 1980-2007 | 1980-2007 |
| | Compensation of employees [A] | 1980-2007 | 1980-2007 | 1980-2007 | 1980-2007 |
| | Total self-employed [Q] | 1980-2007 | 1980-2007 | 1980-2007 | 1980-2007 |
| | Total employment -national accounts basis- [Q] | 1980-2007 | 1980-2007 | 1980-2007 | 1980-2007 |
| | Private final consumption expenditure -deflator- [Q] | 1980-2007 | 1980-2007 | 1980-2007 | 1980-2007 |
| | Gross domestic product, value, market prices [Q] | 1980-2007 | 1980-2007 | 1980-2007 | 1980-2007 |
| | Gross domestic product, volume, market prices [Q] | 1980-2007 | 1980-2007 | 1980-2007 | 1980-2007 |
| | Government final consumption expenditure, volume [Q] | 1980-2007 | 1980-2007 | 1980-2007 | 1980-2007 |
| | Dependent employment, Total economy [Q] | 1980-2007 | 1980-2007 | 1980-2007 | 1980-2007 |
| | Government final consumption expenditure, deflator [Q] | 1980-2007 | 1980-2007 | 1980-2007 | 1980-2007 |
| Government Finance Statistics | Compensation of employees [Q] | 1999-2007 | 1995-2007 | 1991-2007 | 1999-2007 |
| *Eurostat* | | | | | |
| National Accounts (ESA-95) | Personnel Expenditure General government (cash) [Q] | 1991-2007 | ---- | ---- | ---- |
| *Bundesbank, Germany* | | | | | |
| National Accounts (ESA-95) | Compensation of government employees [M] | 1980-2007 | ---- | ---- | ---- |
| *Federal Ministry of Finance, Germany* | | | | | |
| National Accounts (ESA-95) | Compensation of government employees [M] | ---- | 1984-2007[(5)] | ---- | ---- |
| *Spanish Statistical Institute, Spain* | | | | | |
| National Accounts (ESA-95) | Total Government expenditures [M] | ---- | ---- | 1980-2007 | ---- |
| *Ministry of Finance, France* | | | | | |
| National Accounts (ESA-95) | Total Government expenditures [M] | ---- | ---- | ---- | 1980-2007 |
| *Banca d'Italia, Italy* | | | | | |
| Labour Fource Survey | Employment, Total [Q] | 1983-2007[(3)] | 1986-2007[(4)] | 1983-2007[(6)] | 1983-2007[(8)] |
| *Eurostat* | Employment, Education [Q] | 1992-2007[(3)] | 1992-2007[(4)] | 1992-2007[(6)] | 1992-2007[(8)] |
| | Employment, Health and social work [Q] | 1992-2007[(3)] | 1992-2007[(4)] | 1992-2007[(6)] | 1992-2007[(8)] |
| | Employment, Public admin and defence [Q] | 1992-2007[(3)] | 1992-2007[(4)] | 1992-2007[(6)] | 1992-2007[(8)] |
| CEP-OECD Institutions Data Set | Employment Protection legislation [A] | 1980-2003 | 1980-2003 | 1980-2003 | 1980-2003 |
| *Nickell (2006)* | Employment Protection legislation [A] | 1980-2003 | 1980-2003 | 1980-2003 | 1980-2003 |
| | Union Density [A] | 1980-2003 | 1981-2003 | 1980-2003 | 1980-2003 |
| | Union Coverage [A] | 1980-2000 | 1980-2000 | 1980-2000 | 1980-2000 |
| | Wage Bargaining coordination [A] | 1980-2000 | 1980-2000 | 1980-2000 | 1980-2000 |
| | Wage Bargaining centralization [A] | 1980-2000 | 1980-2000 | 1980-2000 | 1980-2000 |
| OECD International Regulation Database | Public ownership [A] | 1980-2003 | 1980-2003 | 1980-2003 | 1980-2003 |
| *Conway and Nicoletti (2006)* | | | | | |
| KOF Index of Globalization | Overall Index [A] | 1980-2005 | 1980-2005 | 1980-2005 | 1980-2005 |
| *Drehen (2008)* | | | | | |

Notes: (1) "—-" means that this variable is not used for this country. (2) Before 1991, Western Germany is considered. (3) Before 2005, only the second quarter is available. (4) Before 1996, only the second quarter is available. (5) Jan-2002 and Dec-2004 is not available. (6) Before 2003, only the first quarter is available. (7) Last quarter of 2005 is not available. (8) Before 1997, only one quarter per year is available.

Figure 3: Nominal compensation per employees. Level (Logs).

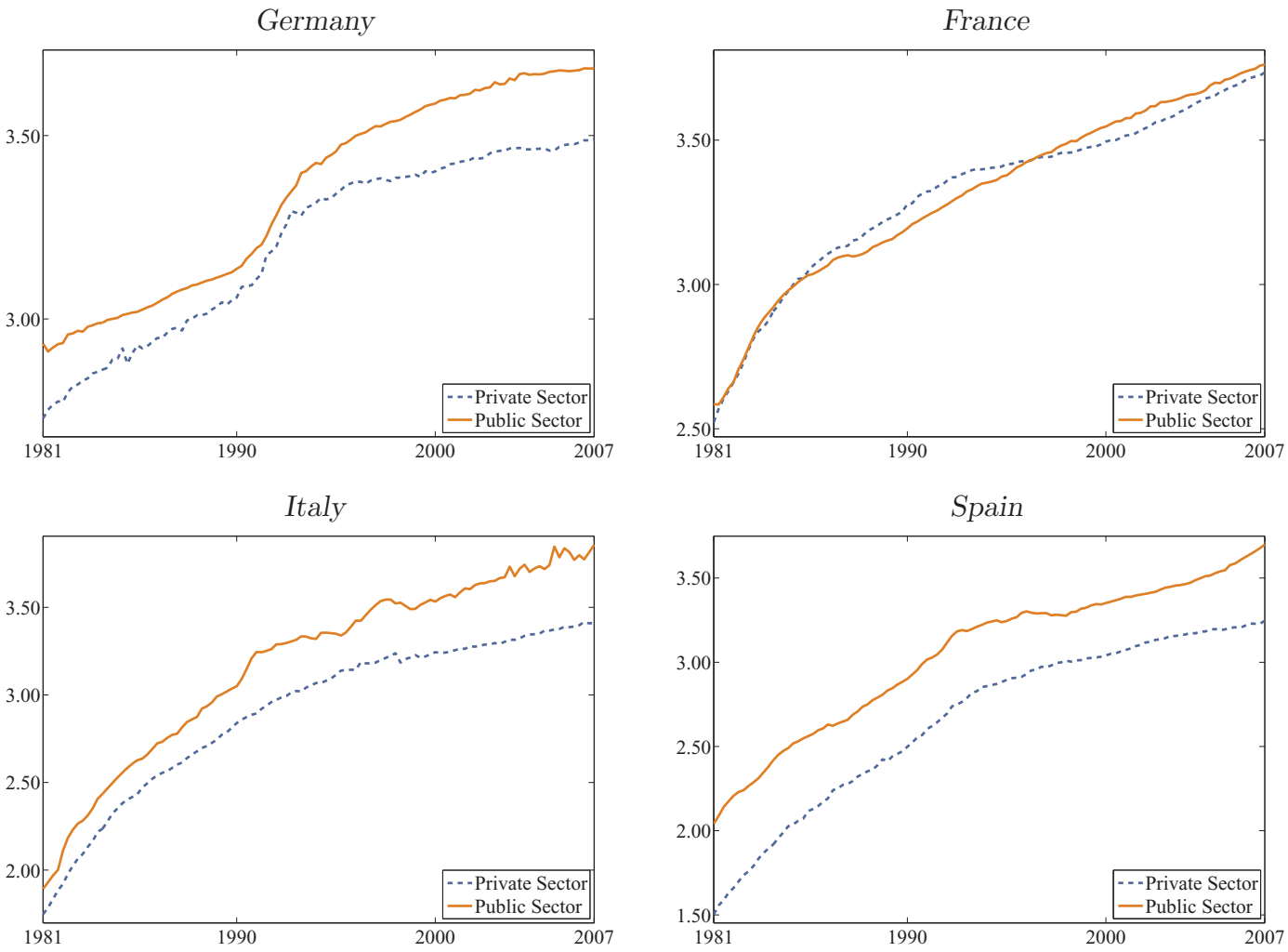
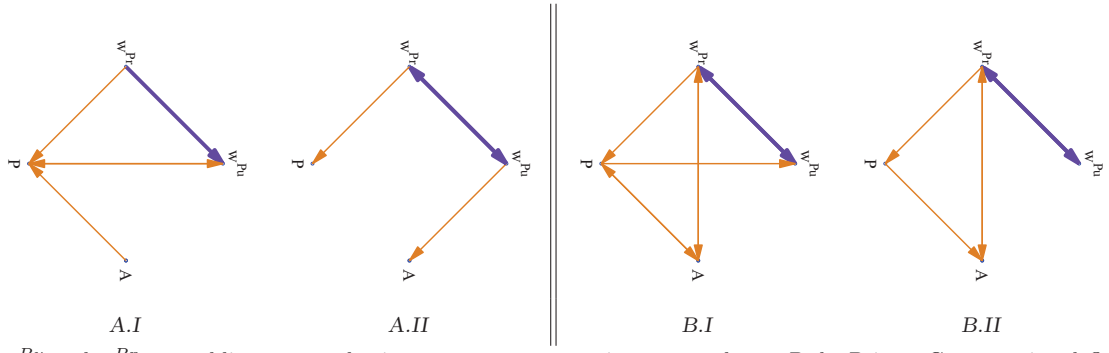


Figure 4: Germany. Main results.

| | *Panel A: sample period 1981.Q1-2007.Q3* | | | | | | | | *Panel B: sample period 1991.Q1-2007.Q3* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **(I) Baseline estimation** | | | | **(II) Restricted estimation** | | | | **(I) Baseline estimation** | | | | **(II) Restricted estimation** | | | |
| **Dependent Variable** | **$w^{Pu}$** | **$w^{Pr}$** | **P** | **A** | **$w^{Pu}$** | **$w^{Pr}$** | **P** | **A** | **$w^{Pu}$** | **$w^{Pr}$** | **P** | **A** | **$w^{Pu}$** | **$w^{Pr}$** | **P** | **A** |
| **$w^{Pu}$ →** | 0.00*** | 0.18 | 0.04** | 0.52 | 0.00*** | 0.02** | 0.59 | 0.03** | 0.00*** | 0.09* | 0.34 | 0.16 | 0.00*** | 0.01** | 0.65 | 0.25 |
| **$w^{Pr}$ →** | 0.00*** | 0.00*** | 0.00*** | 0.24 | 0.00*** | 0.00*** | 0.06* | 0.30 | 0.01*** | 0.00*** | 0.00*** | 0.02** | 0.03** | 0.00*** | 0.00*** | 0.05** |
| **P →** | 0.03** | 0.16 | 0.00*** | 0.16 | 0.36 | 0.63 | 0.00*** | 0.14 | 0.01** | 0.15 | 0.00*** | 0.00*** | 0.22 | 0.24 | 0.00*** | 0.01** |
| **A →** | 0.24 | 0.52 | 0.01** | 0.00*** | 0.59 | 0.39 | 0.54 | 0.00*** | 0.31 | 0.00*** | 0.07* | 0.00*** | 0.34 | 0.01*** | 0.12 | 0.00*** |
| $SIZE^{Pu}$ | (-)*** | (+) | (-)** | (+) | (-)*** | (+) | (-) | (+) | (-)** | (+) | (-) | (+) | (-)** | (+) | (+) | (+) |
| GLOB | (-)** | (+) | (-) | (+)*** | (-)* | (+)** | (-) | (+)*** | (-)** | (-) | (+) | (+)*** | (-)* | (-) | (+) | (+)** |
| EP | (-)* | (+) | (-) | (+) | (-) | (+) | (-) | (+) | (-) | (+)** | (-) | (+)** | (-) | (+)*** | (-) | (+) |
| UD | (+)*** | (+)** | (+)*** | (+) | (+)*** | (+)*** | (+)*** | (+) | (-)** | (-) | (+) | (+) | (-)*** | (-) | (+) | (+) |
| UC | (-) | (-) | (-)*** | (-) | (+) | (-) | (-)* | (-) | (+) | (-) | (-)*** | (-) | (+) | (-) | (-)*** | (+) |
| $OWN^{Pu}$ | (-)* | (-) | (-)** | (-) | (-) | (-) | (-) | (-) | (+) | (+) | (+) | (-)** | (+) | (-) | (+) | (-)** |
| COW | | | | | | | | | | | | | | | | |
| CEW | | | | | | | | | | | | | | | | |
| *No. Obs.* | *104* | *104* | *104* | *104* | *104* | *104* | *104* | *104* | *64* | *64* | *64* | *64* | *64* | *64* | *64* | *64* |

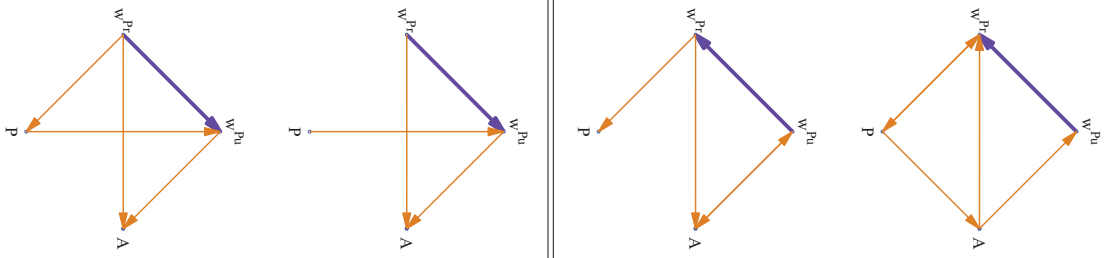



*A.I* *A.II* *B.I* *B.II*

Notes: (1) $w^{Pu}$ and $w^{Pr}$ are public sector and private sector compensation per employee, $P$ the Private Consumption deflator and $A$ the labour productivity. Institutional features are included as follows; (i) the size of the public sector (as employer) -$SIZE^{Pu}$- (ii) an indicator of the public ownership, -$OWN^{Pu}$-, (iii) a globalization index -$GLOB$-, (iv) employment protection legislation -$EP$-, (v) union density -$UD$-, (vi) union coverage -$UC$- and (vii) wage bargaining coordination -$COW$- and centralization -$CEW$-). (2) The asterisks show which values are significant at standard levels. (3) The level of significance used in causal graphs is 10 %.

Figure 5: France. Main results.

| | *Panel A: sample period 1981.Q1-2007.Q3* | | | | | | | | *Panel B: sample period 1991.Q1-2007.Q3* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **(I) Baseline estimation** | | | | **(II) Restricted estimation** | | | | **(I) Baseline estimation** | | | | **(II) Restricted estimation** | | | |
| **Dependent Variable** | **$w^{Pu}$** | **$w^{Pr}$** | **P** | **A** | **$w^{Pu}$** | **$w^{Pr}$** | **P** | **A** | **$w^{Pu}$** | **$w^{Pr}$** | **P** | **A** | **$w^{Pu}$** | **$w^{Pr}$** | **P** | **A** |
| **$w^{Pu}$ →** | 0.00*** | 0.50 | 0.70 | 0.01*** | 0.00*** | 0.87 | 0.22 | 0.00*** | 0.00*** | 0.00*** | 0.73 | 0.07* | 0.00*** | 0.05** | 0.58 | 0.15 |
| **$w^{Pr}$ →** | 0.00*** | 0.00*** | 0.00*** | 0.00*** | 0.00*** | 0.00*** | 0.51 | 0.01** | 0.24 | 0.00*** | 0.00*** | 0.06* | 0.46 | 0.00*** | 0.00*** | 0.15 |
| **P →** | 0.09* | 0.25 | 0.00*** | 0.43 | 0.01** | 0.42 | 0.00*** | 0.80 | 0.36 | 0.18 | 0.00*** | 0.77 | 0.42 | 0.01*** | 0.00*** | 0.05** |
| **A →** | 0.23 | 0.70 | 0.11 | 0.00*** | 0.40 | 0.40 | 0.63 | 0.00*** | 0.02** | 0.11 | 0.42 | 0.00*** | 0.05* | 0.00*** | 0.67 | 0.00*** |
| $SIZE^{Pu}$ | (-) | (-) | (-)** | (-) | (-)* | (-)** | (-)* | (-) | (-) | (-)*** | (+) | (+) | (-) | (-)*** | (-) | (+) |
| GLOB | (+)* | (-) | (+) | (+) | (+)** | (-) | (+) | (+) | (-) | (-)*** | (-) | (-) | (-) | (-)*** | (+) | (+) |
| EP | (-) | (-) | (+) | (-) | (+) | (-) | (-) | (-) | | | | | | | | |
| UD | (+) | (+) | (-) | (+) | (+) | (+) | (+) | (+) | | | | | | | | |
| UC | (-) | (-) | (+)* | (-) | (+) | (-) | (+) | (-) | | | | | | | | |
| $OWN^{Pu}$ | (+) | (+) | (+)* | (-)* | (+) | (+) | (+)* | (-)* | | | | | | | | |
| COW | (-)** | (+) | (+) | (-)*** | (-)*** | (+) | (+) | (-)*** | | | | | | | | |
| CEW | | | | | | | | | | | | | | | | |
| *No. Obs.* | *104* | *104* | *104* | *104* | *104* | *104* | *104* | *104* | *64* | *64* | *64* | *64* | *64* | *64* | *64* | *64* |

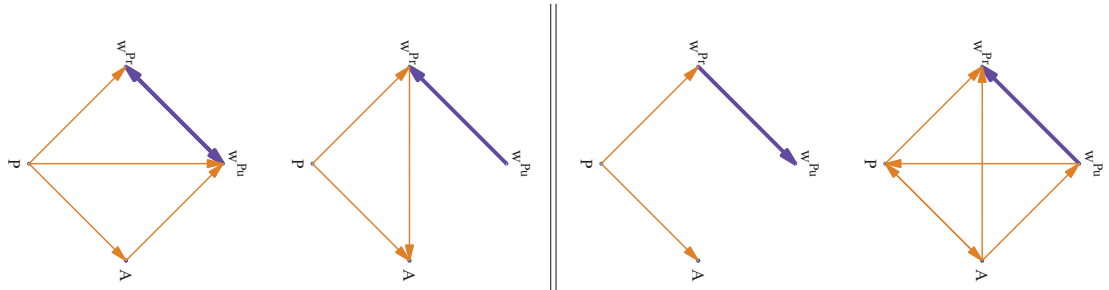



*A.I* *A.II* *B.I* *B.II*

Notes: (1) $w^{Pu}$ and $w^{Pr}$ are public sector and private sector compensation per employee, $P$ the Private Consumption deflator and $A$ the labour productivity. Institutional features are included as follows; (i) the size of the public sector (as employer) -$SIZE^{Pu}$- (ii) an indicator of the public ownership, -$OWN^{Pu}$-, (iii) a globalization index -$GLOB$-, (iv) employment protection legislation -$EP$-, (v) union density -$UD$-, (vi) union coverage -$UC$- and (vii) wage bargaining coordination -$COW$- and centralization -$CEW$-). (2) The asterisks show which values are significant at standard levels. (3) The level of significance used in causal graphs is 10 %.

Figure 6: Italy. Main results.

| | *Panel A: sample period 1981.Q1-2007.Q3* | | | | | | | | *Panel B: sample period 1991.Q1-2007.Q3* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **(I) Baseline estimation** | | | | **(II) Restricted estimation** | | | | **(I) Baseline estimation** | | | | **(II) Restricted estimation** | | | |
| **Dependent Variable** | **$w^{Pu}$** | **$w^{Pr}$** | **P** | **A** | **$w^{Pu}$** | **$w^{Pr}$** | **P** | **A** | **$w^{Pu}$** | **$w^{Pr}$** | **P** | **A** | **$w^{Pu}$** | **$w^{Pr}$** | **P** | **A** |
| **$w^{Pu}$ →** | 0.00*** | 0.10* | 0.62 | 0.31 | 0.00*** | 0.04** | 0.27 | 0.11 | 0.01** | 0.33 | 0.16 | 0.88 | 0.00*** | 0.09* | 0.08* | 0.77 |
| **$w^{Pr}$ →** | 0.00*** | 0.02** | 0.55 | 0.19 | 0.17 | 0.00*** | 0.25 | 0.09* | 0.09* | 0.08* | 0.68 | 0.46 | 0.15 | 0.01*** | 0.20 | 0.13 |
| **P →** | 0.09* | 0.00*** | 0.00*** | 0.01** | 0.40 | 0.00*** | 0.00*** | 0.01** | 0.69 | 0.00*** | 0.00*** | 0.04** | 0.11 | 0.00*** | 0.00*** | 0.01** |
| **A →** | 0.02** | 0.63 | 0.81 | 0.00*** | 0.29 | 0.72 | 0.10 | 0.00*** | 0.23 | 0.25 | 0.24 | 0.00*** | 0.04** | 0.00*** | 0.04** | 0.00*** |
| $SIZE^{Pu}$ | (-) | (+) | (-)*** | (+)*** | (-) | (+) | (-)*** | (+)** | (+) | (+) | (-) | (+)** | (+) | (-) | (-) | (+)* |
| GLOB | (-) | (+)* | (-) | (+) | (+) | (+) | (-) | (-) | (+) | (+) | (+) | (+)** | (+) | (-) | (-) | (+) |
| EP | (+) | (-) | (-) | (-)** | (+) | (-) | (-) | (-)*** | (+) | (-) | (-) | (-) | (+) | (+) | (-) | (-)** |
| UD | (-) | (-) | (+) | (-) | (-) | (-) | (+) | (-) | (-) | (-)* | (+) | (-) | (-) | (-)** | (+) | (-) |
| UC | (+) | (-)*** | (-)*** | (-)* | (+) | (-)*** | (-)*** | (-)** | (+) | (-)*** | (-)*** | (-)** | (+) | (-)*** | (-)*** | (-)** |
| $OWN^{Pu}$ | (-) | (+)* | (-) | (-) | (-) | (+)* | (-)* | (-) | (-) | (-) | (-)*** | (-) | (-) | (-) | (-)*** | (-) |
| COW | (+) | (-) | (-) | (+)** | (+) | (-) | (-)** | (+)* | (+) | (+) | (-)*** | (-) | (+) | (+)* | (-)** | (-)** |
| CEW | (-) | (+) | (+) | (-)** | (-) | (+) | (+) | (-)* | | | | | | | | |
| *No. Obs.* | *104* | *104* | *104* | *104* | *104* | *104* | *104* | *104* | *64* | *64* | *64* | *64* | *64* | *64* | *64* | *64* |

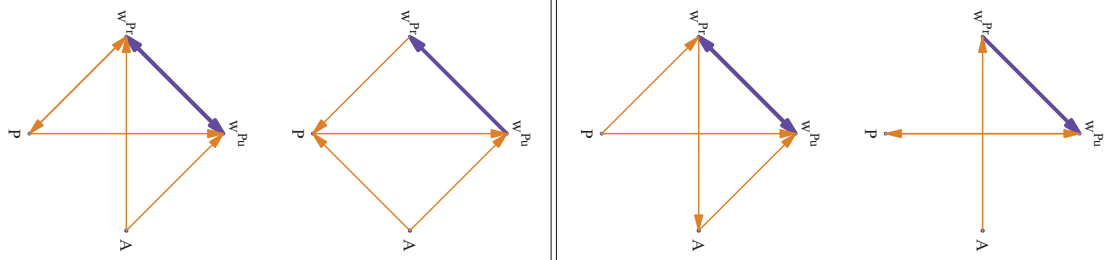



*A.I* *A.II* *B.I* *B.II*

Notes: (1) $w^{Pu}$ and $w^{Pr}$ are public sector and private sector compensation per employee, $P$ the Private Consumption deflator and $A$ the labour productivity. Institutional features are included as follows; (i) the size of the public sector (as employer) -$SIZE^{Pu}$- (ii) an indicator of the public ownership, -$OWN^{Pu}$-, (iii) a globalization index -$GLOB$-, (iv) employment protection legislation -$EP$-, (v) union density -$UD$-, (vi) union coverage -$UC$- and (vii) wage bargaining coordination -$COW$- and centralization -$CEW$-). (2) The asterisks show which values are significant at standard levels. (3) The level of significance used in causal graphs is 10 %.

Figure 7: Spain. Main results.

| | *Panel A: sample period 1981.Q1-2007.Q3* | | | | | | | | *Panel B: sample period 1991.Q1-2007.Q3* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **(I) Baseline estimation** | | | | **(II) Restricted estimation** | | | | **(I) Baseline estimation** | | | | **(II) Restricted estimation** | | | |
| **Dependent Variable** | **$w^{Pu}$** | **$w^{Pr}$** | **P** | **A** | **$w^{Pu}$** | **$w^{Pr}$** | **P** | **A** | **$w^{Pu}$** | **$w^{Pr}$** | **P** | **A** | **$w^{Pu}$** | **$w^{Pr}$** | **P** | **A** |
| **$w^{Pu}$ →** | 0.00*** | 0.01*** | 0.14 | 0.94 | 0.00*** | 0.01** | 0.21 | 0.86 | 0.00*** | 0.10* | 0.13 | 0.32 | 0.00*** | 0.40 | 0.02** | 1.00 |
| **$w^{Pr}$ →** | 0.01*** | 0.00*** | 0.01** | 0.66 | 0.23 | 0.00*** | 0.02** | 0.58 | 0.02** | 0.00*** | 0.52 | 0.08* | 0.05* | 0.00*** | 0.78 | 0.37 |
| **P →** | 0.00*** | 0.01*** | 0.00*** | 0.78 | 0.00*** | 0.38 | 0.00*** | 0.46 | 0.02** | 0.01** | 0.00*** | 0.69 | 0.04** | 0.10 | 0.00*** | 0.97 |
| **A →** | 0.08* | 0.00*** | 0.23 | 0.00*** | 0.00*** | 0.51 | 0.00*** | 0.00*** | 0.08* | 0.39 | 0.68 | 0.00*** | 0.17 | 0.03** | 0.78 | 0.00*** |
| $SIZE^{Pu}$ | (-)*** | (+)*** | (-) | (+) | (-)*** | (+)*** | (+) | (+) | (-)*** | (+)*** | (-) | (+)** | (-)*** | (+)*** | (-) | (+) |
| GLOB | (+)* | (+)*** | (+) | (+) | (+) | (+)*** | (+) | (+) | (-)** | (+)*** | (-) | (+)*** | (-)** | (+)*** | (-) | (+)*** |
| EP | (-) | (+) | (+) | (-)*** | (-) | (+) | (+) | (-)*** | (-) | (+) | (+) | (-)*** | (-) | (+) | (-) | (-)*** |
| UD | (+)*** | (+)** | (+) | (+)** | (+)*** | (+) | (-) | (+)** | (-) | (-) | (+) | (+)*** | (+) | (+) | (+) | (+)*** |
| UC | (+) | (-) | (+)** | (-) | (-) | (+) | (+) | (+) | (-) | (+) | (+) | (+) | (-) | (+) | (+) | (+) |
| $OWN^{Pu}$ | (+)*** | (-)*** | (-) | (-)** | (+)** | (-)* | (+) | (-) | (+) | (-) | (-) | (-) | (+) | (-) | (-) | (-) |
| COW | (-)** | (+) | (-)** | (-) | (-)** | (+) | (-) | (-)** | | | | | | | | |
| CEW | | | | | | | | | | | | | | | | |
| *No. Obs.* | *104* | *104* | *104* | *104* | *104* | *104* | *104* | *104* | *64* | *64* | *64* | *64* | *64* | *64* | *64* | *64* |




*A.I* *A.II* *B.I* *B.II*

Notes: (1) $w^{Pu}$ and $w^{Pr}$ are public sector and private sector compensation per employee, $P$ the Private Consumption deflator and $A$ the labour productivity. Institutional features are included as follows; (i) the size of the public sector (as employer) -$SIZE^{Pu}$- (ii) an indicator of the public ownership, -$OWN^{Pu}$-, (iii) a globalization index -$GLOB$-, (iv) employment protection legislation -$EP$-, (v) union density -$UD$-, (vi) union coverage -$UC$- and (vii) wage bargaining coordination -$COW$- and centralization -$CEW$-). (2) The asterisks show which values are significant at standard levels. (3) The level of significance used in causal graphs is 10 %.

# A Construction of general government series on a quarterly basis

This appendix details how we set-up mixed-frequencies time series models. These models allow us to achieve long quarterly time series on general government compensation of employees and employment what constitute an essential input for our analysis. Our approach follows closely Harvey and Chung (2000), Proietti and Moauro (2005) and Pedregal and Pérez (2009). The starting point is to consider a multivariate Unobserved Components Model known as the Basic Structural Model (Harvey, 1989). A given time series is decomposed into unobserved components which are meaningful from an economic point of view (trend, $T_t$, seasonal, $S_t$, and irregular, $e_t$). Equation (A4) displays a general form, where $t$ is a time sub-index measured in quarters, $z_t$ denotes the variable in ESA95 terms expressed at an annual and quarterly sampling interval (depending on availability) for our objective time series (compensation of employees and employment), and $u_t$ represents the vector of quarterly indicators (compensation and employment in other services, etc)

$$\begin{bmatrix} \mathbf{z}_t \\ \mathbf{u}_t \end{bmatrix} = \mathbf{T}_t + \mathbf{S}_t + \mathbf{e}_t \tag{A4}$$

Generally, unobserved components of the same type are allowed to interact but those from different types are independent. For instance, trends are interrelated, but do not depend on seasonal components. The full model is a standard BSM that may be written in State-Space form as (see Harvey, 1989)

$$\mathbf{x}_t = \mathbf{\Phi x_{t-1}} + \mathbf{E w_t} \tag{A5}$$

$$\begin{bmatrix} \mathbf{z}_t \\ \mathbf{u}_t \end{bmatrix} = \begin{bmatrix} \mathbf{H} \\ \mathbf{H}^u \end{bmatrix} \mathbf{x}_t + \begin{bmatrix} \epsilon_t \\ \mathbf{v}_t \end{bmatrix} \tag{A6}$$

where $\epsilon_t \sim N(0, \Sigma_\epsilon)$ and $\mathbf{v}_t \sim N(0, \Sigma_{\mathbf{v}_t})$

The system matrices $\mathbf{\Phi}$, $\mathbf{E}$, $\mathbf{H}$ and $\mathbf{H}^u$ in equations (A5)-(A6) include the particular definitions of the components and all the vector noises have the usual Gaussian properties with zero mean and constant covariance matrices ($\epsilon_t$ and $\mathbf{v}_t$ are correlated among them, but both are independent of $\mathbf{w}_t$). The particular structure of the covariance matrices of the observed and transition noises defines the structures of correlations among the components across output variables. Due to the fact that our objective variables are observed at different frequencies, an accumulator variable has to be included

$$C_t = \begin{cases} 0, & t = \text{first quarter} \\ 1, & \text{otherwise} \end{cases} \tag{A7}$$

so that the previous model turns out to be:

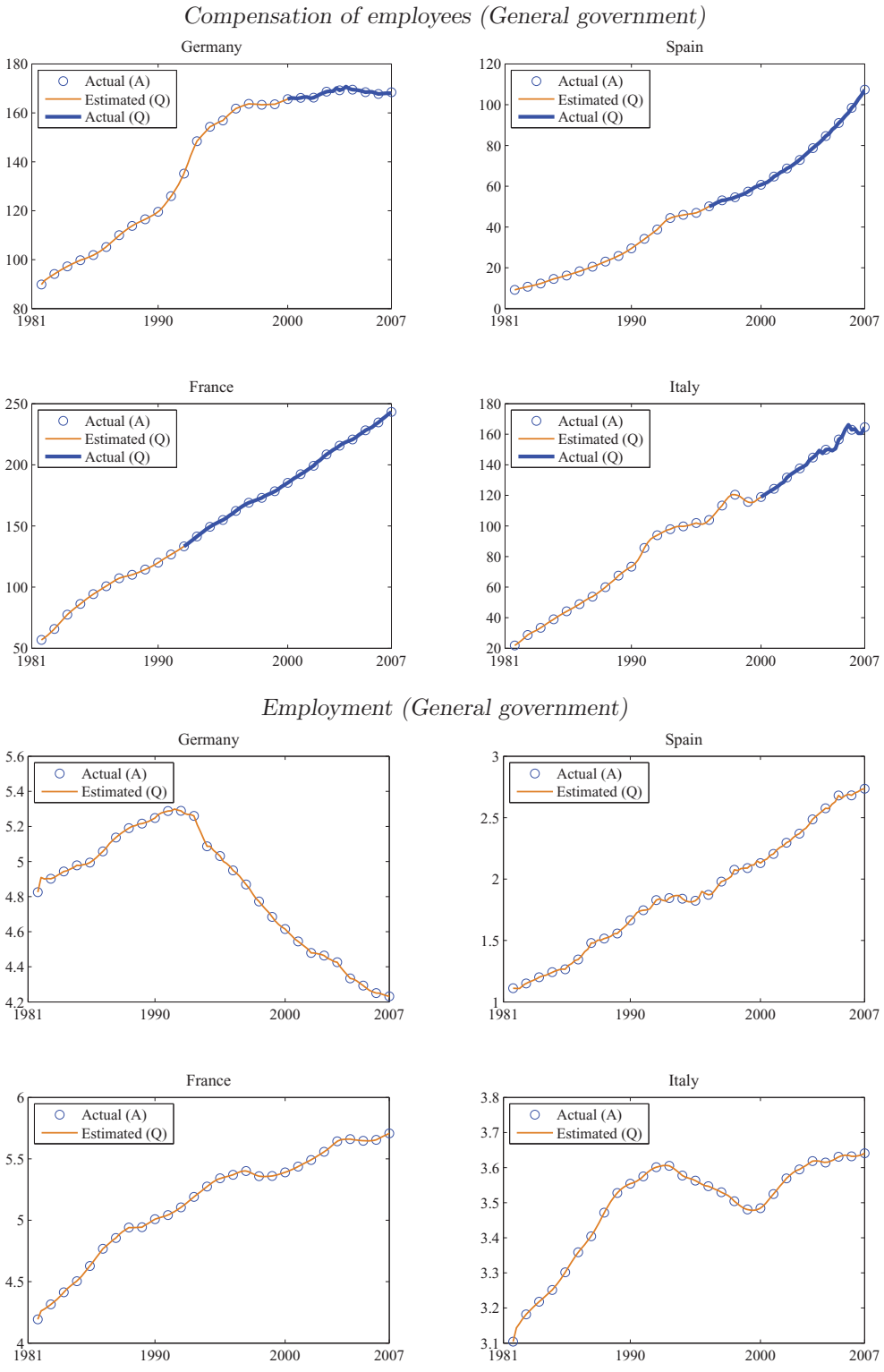
$$\begin{bmatrix} \mathbf{z}_t \\ \mathbf{x}_t \end{bmatrix} = \begin{bmatrix} C_t \otimes \mathbf{I} & \mathbf{H\Phi} \\ \mathbf{0} & \mathbf{\Phi} \end{bmatrix} \begin{bmatrix} \mathbf{z}_{t-1} \\ \mathbf{x}_{t-1} \end{bmatrix} + \begin{bmatrix} 1 & \mathbf{HE} \\ \mathbf{0} & \mathbf{E} \end{bmatrix} \begin{bmatrix} \epsilon_t \\ \mathbf{w}_t \end{bmatrix} \tag{A8}$$

$$\begin{bmatrix} \mathbf{z}_t \\ \mathbf{u}_t \end{bmatrix} = \begin{bmatrix} \mathbf{I} & \mathbf{0} \\ \mathbf{0} & \mathbf{H}^u \end{bmatrix} \begin{bmatrix} \mathbf{z}_t \\ \mathbf{x}_t \end{bmatrix} + \begin{bmatrix} \mathbf{0} \\ \mathbf{I} \end{bmatrix} \mathbf{v}_t \tag{A9}$$

In our particular empirical specifications, for the case of compensation of government employees, z = [Compensation of government sector employees, (A) from 1981-$\widehat{T}-1$ and (Q) from $\widehat{T}$-end], where (A)=annual, (Q)=quarterly, and $\widehat{T}$ indicates the starting date of available quarterly information for each country and u = [$u_1$,$u_2$,$u_3$] where $u_1$ is the final consumption of general government (Q), $u_2$ is the compensation of employees, other services (Q), and $u_3$ is either the *federal/central government* compensation of employees (M) -(M)=monthly- or total government expenditures (M) when the former indicator is not available. In the case of the model for government employment z = [general government employment, A], and u = [$u_1$,$u_2$,$u_3$,$u_4$] where $u_1$ is other services' employment (Q), $u_2$ the final consumption of general government in real terms (Q), $u_3$ is the estimated compensation of employees in real terms (Q) (output of the model for compensation), and $u_4$ is other services' employment -labour force survey figures- (Q).

In short, we obtain flow, seasonally-adjusted quarterly series for public wages (compensation of employees) and employment. Figure A1 shows how the estimated series perfectly match the actual annual and quarterly data for all countries.

Figure A1: Actual (Annual and Quarterly) versus Estimated values (4-quarters moving sum)



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