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AGGREGATION AND EURO AREA PHILLIPS CURVES

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Contents

Abstract

This paper examines the issue of the impact of aggregation in the empirical analysis of euro area labour markets. A Phillips Curve describing the adjustment of unit labour costs is estimated at the national and aggregate level for the 5 largest euro area countries. Potential sources of aggregation bias are investigated – such as differences in parameter coefficients and a lack of correlation in the independent variables across countries – as well as the potentially offsetting statistical averaging effect. Finally the out-of-sample forecasting performance of both approaches is evaluated. The results point to some limited advantages of analysing wage developments at the national rather than at the area-wide level. The paper concludes that if major advantages in undertaking national analysis do exist, they are likely to arise from the ability to develop country-specific structures for the Phillips Curves and not from aggregation biases that emerge when a common structure is used.

JEL Classification: C52, C53, E24, J30 .

Key words: Euro area; Phillips curve; wage growth.

Non-Technical Summary

Since the start of stage 3 of EMU attention has increasingly been paid to euro area aggregate rather than national developments. This is true for a wide range of economic and financial information, reflecting the notion of the euro area as a single economic entity – 'Euroland'. At the same time, whilst a single monetary policy has been adopted, it is recognised that many important differences in economic structures remain across countries. Such differences raise issues about whether one should analyse labour market developments at the area-wide level or whether it is more appropriate to conduct analysis at the national level and aggregate the outcomes to the euro area level. The key question in this regard is whether there is an aggregation bias that emerges when estimating relationships at an aggregate rather than national level. Such a bias will emerge unless either the estimated parameters in such relationships are identical across countries or the independent variables are perfectly correlated. Neither of these conditions appears likely to hold – particularly in the field of labour market analysis – so it seems highly probable that some form of aggregation bias is present.

This paper aims to seek answers to three questions. The first is, to what extent is the relationship between wage growth, inflation and the tightness of the labour market similar across the large euro area countries? The second is, what are the potential gains and losses from pursuing aggregate as opposed to country level analysis of such a relationship? The third is, if, since the start of EMU, one had used country level or aggregate analysis to forecast the rate of growth of trend unit labour costs, which would have performed better?

To seek to answer the first question we estimate Phillips-type relationships for the five largest euro area countries, both individually and as an aggregate. We test the extent to which there is a common relationship (across the countries) between wage growth and the cyclical position of the economy, measured by the gap between the current unemployment rate and its long-run value. To address the second question we examine the evidence of correlations in both the independent variables and the residuals from the national equations. In addition we compare the performance of the aggregate equation against the aggregated results from national equations with and without imposing a common parameter on the unemployment gap variable across countries. Finally, to address the third question we undertake a comparison of the out of sample forecast properties of the country and area-wide equations since the start of EMU.

In answer to the first question, our analysis suggests that freely estimated Phillips curves do generate different estimates of the impact of unemployment gap on wage formation. However, when estimated jointly in a panel system, these differences do not prove to be statistically significant and it is possible to impose a common unemployment gap effect. Nevertheless, many national idiosyncrasies remain in the equations.

In answer to the second question, the value of area-wide analysis is enhanced if there is a similarity in parameters across the national equations, a high positive correlation between the independent variables and a negative correlation between the residuals from the national equations. As already indicated, the evidence on the common parameters was mixed, with it being possible to impose a restriction on the unemployment gap parameter. All the other unit labour cost and price variables, as well as the constant, showed marked differences across countries. It is also noteworthy that for most of the independent variables we found evidence of positive and statistically significant cross-country correlations. Overall there did not appear to be evidence of strong correlation – either positive or negative – in the residuals from the national equations. In addition, to further shed light on this second question we estimated an aggregate unit labour cost equation and compared the results with the aggregation of results from the national equations. Although the statistical properties of the area-wide equation were quite good overall, its standard error was slightly higher than the aggregated standard errors from the national equations, both estimated independently and as a system.

In relation to the third question, we found that if the Phillips curves developed in this paper had been used, then this variable would have been slightly better predicted if the national approach had been adopted and the results aggregated. However, the gains from the diasaggregate approach tended to disappear as the forecast horizon lengthened. One caveat here is that, if a constant rather than the time-varying NAIRU computed by the OECD is assumed, the relative forecast performance of the area-wide approach deteriorates further.

1. Introduction[2]

Since the start of stage 3 of EMU attention has increasingly been paid to euro area aggregate rather than national developments. This is true for a wide range of economic and financial information, reflecting the notion of the euro area as a single economic entity – 'Euroland'. At the same time, whilst a single monetary policy has been adopted, it is recognised that many important differences in economic structures remain across countries. Nowhere is this more evident than in labour markets. Structural features relating to labour market institutions, the legislative framework and social security systems differ to a large degree across the euro area countries. Such differences raise issues about whether one should analyse labour market developments at the area-wide level or whether it is more appropriate to conduct analysis at the national level and aggregate the outcomes to the euro area level.

There is a growing literature on aggregation issues which is summarised in Dedola et al (2001). Much of the recent work has focussed on the aggregation of money demand relationships (Fagan and Henry (1998), Dedola et al (2001)) but some analysis has also been undertaken with respect to labour markets (Turner and Seghezza (1999) and OECD (2000)). The question that is often addressed by researchers is whether there is an aggregation bias that emerges when estimating relationships at an aggregate rather than national level. As discussed in Fagan and Henry (1998) an aggregation bias will emerge unless either the estimated parameters in such relationships are identical across countries or the independent variables are perfectly correlated. Neither of these conditions appears likely to hold – particularly in the field of labour market analysis – so it seems highly probable that some form of aggregation bias is present.

It is then necessary to investigate how large such a bias is and whether there are any potentially offsetting factors that make it more useful to conduct an area-wide analysis rather than estimating national relationships. As Fagan and Henry (1998) discuss, the magnitude of the bias depends positively on the extent to which the parameter coefficients are different and inversely on the degree of correlation in the movement of the independent variables at the national level. A potential offsetting factor is what is known as the statistical averaging effect. This emerges because, typically, the variance of the weighted sum of the country equation

[2] This paper was presented at the 3rd ECB Labour Market Workshop, held in Frankfurt on the 10th-11th of December 2001. We thank, without implicating, Olivier de Bandt, Michael Burda, Gabriel Fagan, Dennis Snower, an anonymous referee and other participants to the workshop.

residuals is lower than the variance of the residuals in any one country. In other words some residuals will tend to offset each other leading to lower residuals at the aggregate rather than national level. The extent to which this happens clearly depends on the degree of correlation in the residuals across countries. Another way of looking at this, as argued by OECD (2000), is that the national equations may be mis-specified in that they wrongly exclude important area wide variables. For example, in the context of money demand, national equations would be affected by foreign variables if there was currency substitution within European portfolios. This may lead to negative cross-country correlations in the residuals from national money demand equations.

The issue of the validity of aggregation therefore becomes an empirical question on the extent to which parameters differ across countries and on the comparison of the correlations in both the independent variables and the residuals. In the context of money demand, Fagan and Henry (1998) estimate a long-run money demand function on 14 EU countries and at the aggregate level. Despite the fact that there are marked differences in the parameter estimates between the national equations, they find a superior performance of the aggregate equation with a lower standard error and stronger evidence for cointegration than the national equations. The statistical averaging effects are found to lower the standard error at the aggregate level, as there is a small tendency towards a negative correlation in the residuals from national equations. However, a point forcefully made by Dedola et al (2001) is that it is not necessarily appropriate to compare the performance of an aggregate equation against the performance of a typical national equation. Rather comparison should be made between the performance of the aggregate equation and the performance of the aggregated results from the national equations. This way the statistical averaging effect of residuals falls out of the comparison and no longer serves to favour the aggregate approach. Nevertheless, in the paper by Fagan and Henry (1998), the aggregate money demand equation still outperforms the aggregation of national equations.

This paper aims to make a practical contribution to this debate in the context of labour market analysis by seeking answers to three questions. The first is, to what extent is the relationship between wage growth, inflation and the tightness of the labour market similar across the large euro area countries? The second is, what are the potential gains and losses from pursuing aggregate as opposed to country level analysis of such a relationship? The third is, if, since the start of EMU, one had used country level or aggregate analysis to forecast the rate of growth of trend unit labour costs, which would have performed better?

To seek to answer the first question we estimate Phillips-type relationships for the five largest euro area countries, both individually and as an aggregate. We test the extent to which there is a common relationship across the five countries between wage growth and the cyclical position of the economy, measured by the gap between the current unemployment rate and its long-run value. To address the second question we examine the evidence of correlations in both the independent variables and the residuals from the national equations. In addition we compare the performance of the aggregate equation against the aggregated results from national equations with and without imposing a common parameter on the unemployment gap variable across countries. Finally, to address the third question we undertake a comparison of the out of sample forecast properties of the country and area-wide equations since the start of EMU.

The paper is structured as follows. In the next section we discuss the specification adopted to model the dynamics of wage growth. Next we report estimates of the aggregate and national equations. In the latter cases these are estimated separately and as a system to test whether the restriction of a common parameter on the unemployment gap is accepted. We also provide evidence on the correlation structure in the independent variables and the single equation residuals. The residuals of the various approaches are compared. The paper then gives details of the out of sample forecast properties of the approaches before concluding.

2. An Overview of the Wage Growth Equation

We examine the potential importance of aggregation biases in labour markets using a simple wage-price Phillips curve (following Gordon (1997)). The equation describes a disequilibrium adjustment process in the labour market: the change in nominal wages adjusted for trend productivity growth provides a measure of trend unit labour costs. This is postulated to depend on price inflation and labour market tightness. Price inflation is measured by the first difference in (the log of) consumption deflator (current and lagged values). In the absence of a specific measure of expected inflation, this lag structure is assumed to capture both price inertia and the formation of inflationary expectations. Labour market tightness is measured by the unemployment gap, that is, the difference between the actual rate of unemployment and the NAIRU, where the latter is computed as a filtered version of observed unemployment. The equation also contains shocks to import prices as an additional factor which might influence wage growth other than the stance of the labour market.

The specification chosen includes among the regressors lagged values of the dependent variable, lagged values of the change in (the log of) consumer prices and import prices (in second differences) and current values of the unemployment gap.

$$\Delta \ln ulc_t = a + bgap_t + \sum_{j=1}^{k} c_j \Delta \ln ulc_{it-j} + \sum_{j=0}^{h} d_j \Delta \ln p_{it-j} + \sum_{j=0}^{p} g_j \Delta\Delta \ln pm_{it-j} + z_t \qquad (1)$$

where *ulc* is the ratio of nominal wages to trend labour productivity, *p* is the consumers' expenditure deflator, *pm* is the import deflator, *gap* is the difference between the unemployment rate (ILO measure) and the time-varying NAIRU and *z* is an error term.

As is standard practice in Phillips curve-based analysis, a long-run nominal homogeneity restriction is imposed. This assumption guarantees the existence of an equilibrium in the labour market and implies that inflation depends only on nominal factors in the long run, that is: $\sum_{j=1}^{4} c_j + \sum_{j=0}^{4} d_j = 1$.[3]

The choice of analysing a reduced-form relationship such as the Phillips Curve described above is partly motivated by the idea that an area-wide approach might be more justified for an empirical analysis of the euro area labour market based on this type of relationship rather than, say, on a structural model. It is in fact sometimes argued that the Phillips Curve approach and, relatedly, the concept of NAIRU, is more relevant for large closed economies (such as the US) than for small open ones, where domestic factors play a lesser role in determining inflation when compared to foreign variables such as the exchange rate and competitiveness. Indeed, as indicated in Fabiani and Mestre (2000, 2001), area-wide estimates of the NAIRU show significant inflation forecasting ability and are able to produce sensible measures of the output gap at the euro area level.

3. The Data

Data for the five largest euro area countries are seasonally adjusted quarterly time series collected from various sources, namely the ESA95 database published by Eurostat, the Quarterly National Account (QNA), the Quarterly Labour Force Statistics and the Main

[3] For a detailed explanation of the implications of the assumption of long-run homogeneity, see Fabiani and Mestre (2000).

Economic Indicators (MEI) databases published by the OECD and the BIS database. The time range covered by the series differs across countries. In order to achieve the highest possible degree of comparability we selected a common sample period, starting in 1982q1 and ending in 2000q4.

Data on GDP, final consumption of households, imports of goods and services (all at constant and current prices), the number of employees and total compensation of employees at current prices were available from the ESA95 database since 1978q1 for France, 1970q1 for Italy, 1980q1 for Spain and 1991q1 for Germany.

For Germany, data prior to 1991 were reconstructed by the authors using time series for West Germany from different sources: namely the QNA database for GDP at current and constant prices, private final consumption expenditure at current and constant prices, imports of goods and services at current and constant prices and the BIS database for compensation of employees and the number of employees for the whole economy. In order to be coherent with the seasonally adjusted ESA95 data available since 1991, as a first step the data prior to 1991 from the QNA database were adjusted for seasonal effects by the authors.[4]

For the Netherlands, ESA95 data on GDP and imports at constant and current prices are available from 1977q1, while time series on private final consumption started only in 1995. For the latter, the BIS private consumption deflator series, seasonally adjusted and starting in 1977q1, was used.

For the unemployment rate, Eurostat standardised unemployment rate series available on the OECD MEI database were used for all countries, with the exception of Italy, for which the series for unemployment in the Centre-North provided by Banca d'Italia was adopted[5]. Trend unemployment (or the NAIRU) was derived by filtering the unemployment rate series for each country using the standard Hodrick-Prescott methodology. Finally, data on total employment for all countries were taken from the OECD Quarterly Labour Force Statistics database. Trend unit labour costs time series were constructed as follows. First an estimate of

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4 Using the package available in the FAME software.

5 As a first attempt, we tried to model the Phillips curve by computing the unemployment gap on the basis of the national unemployment rate, as in the other countries. This variable, however, performed very poorly, in line with the claim, often made in the literature on the subject, that the strong regional segmentation of the Italian labour market implies that unemployment in the Northern regions is the main factor affecting the bargaining process and hence the determination of wages in Italy (see also Fabiani at al (1997), Turner and Seghezza (1999)).

whole economy productivity was derived as the ratio of real GDP to total employment. This series was smoothed with a Hodrick-Prescott filter to obtain a measure of trend productivity. Trend unit labour costs were then calculated as the ratio of wages (compensation per employee) to trend productivity. The consumption deflator was computed as the ratio of nominal to real private consumption expenditure, with the exception of the Netherlands, as mentioned above. The import deflator was obtained as the ratio of nominal to real imports of goods and services, for all countries.

In order to compare the results at the single country level with those obtained at the area-wide level, the national data for trend unit labour costs, the consumption deflator, the import deflator, the unemployment rate described above were aggregated into area-wide variables.[6] For this purpose, we adopted the so-called index method: national nominal and price variables were transformed into logarithms and then aggregated using fixed weights, namely GDP at PPP exchange rates for 1995. These weights were also used to compute the area-wide unemployment rate. As stressed by Fagan and Henry (1998) this approach has the advantage of facilitating the comparison of results from area-wide and national equations.

4. Empirical evidence

4.1. Cross-correlations in the independent variables

As discussed in the introduction, the degree of correlation in the national independent variables is an important indicator of the extent to which aggregation biases may be relevant. To recap, the higher the degree of correlation in the movement of the independent variables at the national level the smaller the expected magnitude of the aggregation bias. As shown in Table 1, which gives details of the correlations in the independent variables across countries, we generally find a positive and statistically significant correlation coefficients. In the case of the change in the log of trend unit labour costs the correlation coefficient is around 0.4 to 0.6 for France-Italy, France-Spain and Italy-Spain and highly statistically significant. The correlation coefficients for each country with respect to Germany are also positive, but lower in magnitude and not statistically significant. However, in the case of the Netherlands the

6 For the main methods of constructing consistent aggregate data from disaggregate ones, see Fagan and Henry (1998).

correlation coefficients with the other countries are generally negative. The overall average of the correlation coefficients was 0.14. As for the unemployment gap, there is a significant and generally large positive correlation for all pairs of countries. The overall average correlation coefficient was 0.65. For the inflation variable, that is, the first difference of the log of the consumers' expenditure deflator, all correlation coefficients are positive, and most are statistically significant, with an overall average of 0.41. Finally, in all cases there is a positive correlation in the change in the log of import price growth across the 5 countries, with the overall average being 0.32. In all but one case these correlation coefficients are statistically significant.[7]

4.2. The Aggregate Equation

We estimated an area-wide Phillips curve described in equation 1 using data obtained by aggregating the time series of the five countries. Prior to the estimation, we tested for stationarity of the unit labour cost growth and inflation time series by means of standard Augmented Dickey Fuller tests. As the last two rows of Table 2 show, it is possible to reject the null hypothesis that both series have a unit root when an order of augmentation of the test of at least two is selected.

After having ascertained that the series were stationary, a search for the preferred specification of the Phillips curve was undertaken. Both Akaike and Schwartz selection criteria suggested the introduction of only one lagged value of the dependent variable among the regressors. As for the independent variables, the preferred specification was one that included three lags of price inflation, the current change in import price inflation. For the variable measuring the stance of the labour market, we followed Gordon (1996) in including the current value of the unemployment gap and, as a result of our specification search, we choose not to enter first differences of the unemployment rate as an additional regressor capturing hysteresis effects. The final specification adopted was:

$$\Delta \ln ulc_t = a + b\,gap_t + c\Delta \ln ulc_{it-1} + \sum_{j=1}^{3} d_j \Delta \ln p_{it-j} + e\Delta\Delta \ln pm_{it} + D84q2 + D91q2 + D98q1 + z_t \quad (2)$$

7 It should be noted that these correlations relate to the variables as used in the equation. In their raw form the correlation coefficients are generally much higher – in fact in the case of wages and the consumers' expenditure deflator they range from 0.96 to 0.99.

Where D84q2 and D91q2 are time dummy variables accounting for large outliers in German data. The first relates to a major period of industrial unrest whilst the second relates to reunification. The dummy variable labelled as D98q1 accounts instead for a break in the series of compensation of employees for Italy, due to the introduction of a new tax scheme (IRAP). In order to achieve nominal dynamic homogeneity in the long run, we imposed the restriction $c+d_1+d_2+d_3=1$.

The OLS estimates of the aggregate Phillips curve for the period 1982:1 2000:4[8] are reported in the last column of Table 3. The unemployment gap term is correctly signed and significant with a coefficient of –0.0016.

The statistical properties of the model are quite satisfactory. The long-run homogeneity restriction is not rejected by the data. The goodness of fit is high, considering that the equation is specified in first differences and that the estimation period covers a long period of time. The LM test for serial correlation shows that the chosen specification captures quite well the dynamic properties of the endogenous variable, while the RESET test supports the validity of the linear specification. The estimated equation exhibits no signs of heteroscedasticity. In order to verify whether the relationship linking nominal wage growth to inflation and the unemployment gap has undergone significant modifications during the estimation period we followed two different strategies. First, we estimated the equation up to 1998:1 and used the obtained coefficients to predict the wage growth pattern over the following two years. The Chow test for the adequacy of such predictions does not seem to signal the existence of a structural break in the relationship. Second, given that the timing of structural breaks cannot in general be established a priori, we performed a Hansen test aimed at detecting instability of a general form (which is approximately an LM test of the null of constant parameters against the alternative that they follow a martingale). The test was carried out on the overall equation and on some relevant parameters. As the last column of Table 4 shows, none of the parameters show signs of instability and the statistic for the entire equation is well below the 5% critical value.

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[8] This was the longest period for which data were available for all countries.

4.3. The National Equations

After having investigated the stationarity properties of the national series of trend unit labour cost growth and inflation (see Table 2), equation (1) was estimated for each single country. The results of the OLS regressions are reported in the first five columns of Table 3. Excluding the case of France, the unemployment gap always has the expected negative coefficient, ranging from –0.0014 in Italy to –0.0037 in Germany. For France and Italy the coefficient is not significantly different from zero. For the other countries, the statistical significance of the unemployment gap coefficient is quite high, as it has a t-statistic in the range of 2.6-2.9.

As each national model is specified exactly as the one chosen for the aggregate equation and its performance varies quite widely across countries. The estimated equation performs quite poorly in the case of France, showing signs of residual auto-correlation and heteroscedasticity, but reasonably well for the remaining countries. Hansen tests (reported in the first five columns of Table 4) point to a certain degree of instability of the overall equation for France and Germany, although the result for latter is driven by the necessity to exclude the dummy variables from the specification for carrying out the test. In the case of the Netherlands the test finds evidence of instability for the unemployment gap coefficient. Conversely, Chow tests for stability of the regression coefficients for 1999:1-2000:4 and predictive failure tests based on estimates for the period up to 1998:4 both reject the hypothesis of a structural break at the start of Stage 3 of EMU.

Table 5 gives details of the cross correlation matrix of the national OLS residuals. In general, there is somewhat mixed evidence on the co-movement of these residuals, but in almost all cases the results are not statistically significant. The correlation coefficients for the residuals of the German equations and each of the other countries are negative except in the case of Italy. A negative pattern emerges also for the correlation coefficients for the residuals of Netherlands-Spain and France-Spain. It appears that there is some sign of a small mutual positive correlation in the other residuals, although the coefficients are nearly all below 0.3. The lack of a strong positive correlation in the residuals means that the aggregate equation should benefit from the statistical averaging effect described in the introduction, leading to a lower standard error than is present in the typical national equation.

4.4. System estimation: imposing restrictions across countries

The national Phillips Curves were then estimated together as a panel system with fixed effects and (following Turner and Seghezza, 1999) tested for the imposition of a common unemployment gap term across countries.[9] As this assumption was not rejected by the data, it was imposed and the results reported in Table 6. Overall, the pattern of results is similar to the individual OLS regressions. The main notable improvement is an increase in the significance of the unemployment gap term which, at –0.002 is slightly larger in magnitude than in the aggregate equation..

It is noteworthy that this finding of a common parameter on the unemployment gap for these countries finds some support from other studies. Morgan and Mourougane (2001), who estimate a panel system including a structural wage and labour demand equation for the same five countries and in addition the UK, find that it is possible to impose a common unemployment parameter. Turner and Seghezza (1999), who estimate a Phillips Curve with an output gap variable using a SURE system, also find that it is possible to impose a common coefficient for the gap variable for a wide group of OECD countries.

Although the restriction required for the long-run nominal dynamic homogeneity in the wage-price system was imposed in all countries, we did not investigate the extent to which it would be possible to impose a common price dynamics, i.e. common coefficients on trend unit labour cost, consumer and import prices. It is clear from the tables that although it may be possible to group individual parameters in some countries, it is highly unlikely to be possible to group them all given the range of outcomes reported in the tables (as for of them the estimated coefficients are positive and significant in one country and negative and significant in another).

4.5. In-Sample Properties

Despite the generally satisfactory nature of the area-wide equation, as Dedola et al (2001) point out, it is necessary to compare its residuals with those obtained by aggregating the

9 Another approach would have been to implement a Seemingly Unrelated Regression Estimation (SURE). However for such an approach to have been worthwhile there would needed to have been a clear sign that there was a correlation in the residuals from the national equations.

residuals from the national equations. For this purpose, we have aggregated the national residuals derived from the estimation exercises (both single OLS and system estimates) described in the first part of this section, using the same weights adopted to construct the area-wide variables. Figure 1 compares the aggregated residuals from the single OLS and the restricted system estimation with the residuals from the area-wide equation. Table 7 also gives details of the respective standard errors. Both the table and the graph clearly show that the volatility of the area-wide residuals is slightly higher than that of the aggregated national ones. In particular, the OLS single country estimation seems to generate residuals that, once aggregated, provide the lowest standard error. According to the test of Grunfeld and Griliches (1960), this provides grounds for selecting the disaggregate model over the aggregate one. However, it should be noted that the differences in the standard errors are not particularly large – ranging from 0.29% for the aggregated national equations to 0.30% for the system and the aggregate approach. The difference of 0.01% compares with an average quarterly change in aggregate unit labour costs of 0.7% over the estimation period.

4.6. Forecast Properties

The last part of this empirical section focuses on the performance of our Phillips Curves in forecasting aggregate trend unit labour costs. More precisely, we investigate the out-of-sample forecast properties of the area-wide equation as compared with the aggregation of the out-of-sample forecasts based on the national equations. It should be emphasised that the results presented here should be seen as simple tests of the performance of the equations analysed thus far in this paper and are not the outcome of a careful fine-tuning of equations providing optimal forecasts of area-wide wage growth.

The approach to out of sample forecasting that we adopted here is that of Staiger et al (1997), based on recursive least squares. This approach provides a consistent way to evaluate real-time forecasting performance, since at each point in time the forecast is truly out of sample. We examined what forecasts would have been made during each quarter from the start of 1999 to the end of 2000 based on quarterly data for the period from 1982q1 up to the quarter when the forecast was made, by estimating our equations on actual data over the same time period.[10] For example, for 1999q1 we estimated the equation up to this quarter, we derived a forecast for the next four quarters and we saved the 1, 2 3, and 4 steps ahead forecast errors. The process was then repeated for 1999q2, using data up to that date and a new set of 1, 2, 3 and 4 step ahead errors was saved. After having repeated this exercise recursively until the quarter before the last (i.e. 2000q3) we computed the Mean Absolute Error (MAE), the Root Mean Square Error (RMSE) and the Theil's U statistics (U) for 1, 2, 3 and 4 steps ahead (Table 8).[11]

Table 8 is divided into two panels. The first panel is based on forecast errors generated by aggregating the five national wage growth forecasts; the second panel refers instead to the forecasting performance of the area-wide equation. In both cases the equations used to compute each forecast have exactly the same specification as the ones adopted in the OLS exercise described above.

Both the RMSE and the Theil's U statistic are lower in the top panel for the first two rows, corresponding to the forecasts for 1 and 2 steps ahead. However, the better forecasting performance of the national equations is not maintained for the 3 and 4 steps ahead forecasts. Hence, the results presented in the table indicate that if one had used the Phillips curve to forecast aggregate trend unit labour cost growth since the start of 1999, then such a variable would have been better predicted if one had relied on national equations and then aggregated the results rather than adopting an area-wide specification. However, if one had wished to predict the rate of growth of trend unit labour costs more than six months ahead, then there would have been no benefit in using national equations. The gain from using the national equations, in terms of lower RMSEs, was 0.02 for both the 1 and 2 period ahead forecasts. This compares with an average quarter-on-quarter growth rate in the variable about 0.3% over the forecast horizon.

In specifying the Phillips Curve, we have so far computed the NAIRU in each country and at the area-wide level as a smoothed version of observed unemployment. In order to check the robustness of the results, we also considered an alternative framework, based on the assumption that the NAIRU is constant over the whole time horizon. In other words, we

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10 When running the n-steps ahead forecasts we used autoregressive processes (with four lags and a constant) to generate subsequent observations for the regressors (inflation, unemployment, the NAIRU and the change in the import deflator).

modelled trend unit labour cost growth as depending on the actual unemployment rate instead of the unemployment gap.[12] The pattern of results obtained under these alternative hypotheses framework was very similar to that described above, as are the standard errors for both the aggregated and aggregate results. However, under the hypothesis of constant NAIRU the forecasting ability of the area-wide equation was markedly worse than when using a time-varying NAIRU. Although the performance of the national equations also worsened when using a constant NAIRU, the deterioration in the forecast performance of the area-wide equation was much more marked.[13]

5. Conclusions

At the start of this paper we set out to find information to help answer three questions. The first was the extent to which the relationship between wages and productivity growth, inflation and the tightness of the labour market is similar in the large euro area countries. Our analysis suggests that freely estimated Phillips curves do generate different estimates of the impact of the rate of unemployment on wage formation. However, when estimated jointly in a panel system, these differences do not prove to be statistically significant and it is possible to impose a common unemployment gap effect. Nevertheless, many national idiosyncrasies remain, which, within the reduced form equation considered in this paper, are captured by the constant and by the dynamic pattern of consumer and import prices.

The second question related to the potential gains and losses from pursuing aggregate as opposed to country-level analysis of such relationships. As discussed in the early part of the paper, the value of area-wide analysis is enhanced if there is a similarity in parameters across the national equations, a high positive correlation between the independent variables and a negative correlation between the residuals from the national equations. As already indicated, the evidence on the common parameters was mixed, with it being possible to impose a restriction on the unemployment gap parameter. All the other unit labour cost and price variables, as well as the constant, showed marked differences across countries. It is also

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11 The Theil's U statistic is a unit-free measure computed as the ratio of the root mean square error to the root mean square error of the 'naïve' forecast of no change in the dependent variable. A value of zero implies no forecast error.

12 The constant NAIRU then forms a part of the constant.

13 Full results using the constant NAIRU are available upon request from the authors.

noteworthy that for most of the independent variables we found evidence of positive and statistically significant cross-country correlations. Overall there did not appear to be evidence of strong correlation – either positive or negative – in the residuals from the national equations. In addition, to further shed light on this second question we estimated an aggregate unit labour cost equation and compared the results with the aggregation of results from the national equations. Although the statistical properties of the area-wide equation were quite good overall, its standard error was slightly higher than the aggregated standard errors from the national equations, both estimated independently and as a system.

The third question was, if, since the start of EMU, you had used country-based or area-wide analysis to forecast aggregate unit labour cost growth, which would have performed better? We found that if the Phillips curves developed in this paper had been used, then this variable would have been slightly better predicted if the national approach had been adopted and the results aggregated. However, the gains from the diasaggregate approach tended to disappear as the forecast horizon lengthened. One caveat here is that, if a constant rather than the time-varying NAIRU computed by the OECD is assumed, the relative forecast performance of the area-wide approach deteriorates further.

Overall, our results point to some limited advantages from estimating wage-price Phillips Curves at the national level rather than conducting the analysis at the area-wide level. Most notably the standard errors and the 1-period ahead out-of-sample forecasts from the aggregated national equations are found to be lower than those from the area-wide equation. However, the differences between the forecast errors disappear at longer horizons (3-4 periods ahead) are not large. Furthermore, some support for adopting an area-wide approach in Phillips curves-based analysis stems from the fact that it proved possible to impose a common coefficient on the unemployment gap across countries and that there is some positive correlation in the movements of some of the national independent variables.

These results are open to different interpretations. In support of the aggregate approach, it could be argued that the key finding is the common unemployment coefficient. The other coefficients – on lagged prices – reflect expectations formation and the properties of the inflation process which clearly, in the past, differed a lot across countries. Given the move to monetary union, we may expect a tendency towards a common inflation process and convergence of expectations formation. In other words, the coefficients on lagged inflation may become more similar across countries over time. Therefore the relative position of the aggregate approach may improve over time. Alternatively, it could be argued that the simple models used in the paper do not do justice to the more sophisticated, detailed type of analysis which could be carried out at the national level. Indeed, one of the key advantages of national as opposed to aggregate analysis may lie in the possibility to take account of country-specific features in the specification of the Phillips Curves, rather than adopting a common specification as we do here. Hence the results may provide only a lower bound estimate of the likely superiority of bottom-up versus top-down approaches to area-wide labour market analysis. Nevertheless, our results suggest that if major advantages in undertaking national analysis do exist, they are likely to arise from the ability to develop country-specific structures for the Phillips Curves and not from aggregation biases that emerge when a common structure is used.

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Tables and Figures

Table 1 : Correlation Matrix for Independent Variables

(a) Trend Unit Labour Costs Growth

	Germany	France	Italy	Netherlands	Spain
Germany	1.000	0.078	0.122	0.089	0.268
France		1.000	0.622***	-0.356***	0.404***
Italy			1.000	-0.350***	0.564***
Netherlands				1.000	-0.109
Spain					1.000

(b) Unemployment Gap

	Germany	France	Italy	Netherlands	Spain
Germany	1.000	0.636***	0.748***	0.569***	0.764***
France		1.000	0.725***	0.239**	0.788***
Italy			1.000	0.638***	0.856***
Netherlands				1.000	0.560***
Spain					1.000

(c) Inflation

	Germany	France	Italy	Netherlands	Spain
Germany	1.000	0.346***	0.345***	0.198*	0.216*
France		1.000	0.884***	0.211*	0.775***
Italy			1.000	0.174	0.842***
Netherlands				1.000	0.139
Spain					1.000

(d) Change in Import Price Growth

	Germany	France	Italy	Netherlands	Spain
Germany	1.000	0.363***	0.407***	0.391***	0.096
France		1.000	0.309***	0.405***	0.274**
Italy			1.000	0.390***	0.270**
Netherlands				1.000	0.265**
Spain					1.000

Significance given by *'s: 90% (*), 95% (**) and 99% (***)

Table 2: Stationarity tests

Variable	ADF		ADF(1)		ADF(2)		ADF(3)		ADF(4)	
	c	*c,t*	*c*	*c,t*	*c*	*c,t*	*c*	*c,t*	*c*	*c,t*
France										
DULC	-4.36	-5.55	-3.07	-3.48	-2.86	-3.18	-3.41	-4.10	-3.07	-3.68
DPC	-3.89	-4.76	-4.04	-4.03	-3.97	-3.67	-4.37	-4.73	-4.68	-4.42
Germany										
DULC	-9.13	-9.34	-5.32	-5.52	-3.98	-4.19	-2.98	-3.18	-2.04	-2.22
DPC	-5.23	-5.18	-4.24	-4.21	-2.89	-2.87	-2.16	-2.13	-2.02	-1.98
Italy										
DULC	-4.79	-6.39	-3.78	-5.33	-3.02	-4.03	-2.85	-3.74	-2.73	-3.52
DPC	-2.80	-3.90	-2.64	-3.26	-2.85	-2.92	-2.95	-2.88	-2.83	-2.86
Netherlands										
DULC	-3.01	-3.72	-2.29	-2.91	-2.13	-2.77	-2.62	-3.39	-2.41	-3.23
DPC	-10.28	-10.36	-5.91	-5.91	-5.14	-5.14	-3.22	-3.23	-2.65	-2.64
Spain										
DULC	-5.50	-6.37	-3.58	-3.98	-3.37	-3.79	-3.24	-3.71	-2.69	-2.92
DPC	-3.19	-5.31	-2.33	-3.46	-2.21	-3.22	-2.18	-3.30	-2.12	-2.54
Aggregate										
DULC	-5.63	-7.31	-3.25	-4.28	-2.49	-3.27	-2.29	-2.99	-2.02	-2.50
DPC	-3.28	-3.88	-2.91	-3.31	-2.71	-2.61	-2.69	-2.57	-2.77	-2.50

Notes:

For each lag, the two columns report the results of Dickey-Fuller regressions including an intercept (*c*) and including an intercept and a time trend (*c,t*), respectively

The 95% critical value for the ADF statistics is -2.9 in the regression (*c*) and -3.5 in the regression (*c,t*)

Table 3: OLS estimation for individual countries and 5-country aggregate

Variable	France	Germany	Italy	Netherlands	Spain	Aggregate
Constant	-0.0017 *(2.98)*	-0.0013 *(1.55)*	-0.0031 *(3.42)*	-0.0006 *(1.32)*	-0.0012 *(1.57)*	-0.0021 *(4.91)*
GAP_t	0.0001 *(0.07)*	-0.0037 *(2.79)*	-0.0014 *(0.70)*	-0.0027 *(2.63)*	-0.0019 *(2.88)*	-0.0016 *(2.04)*
$DULC_{t-1}$	0.2872 *(2.16)*	-0.1278 *(1.50)*	0.2085 *(1.88)*	0.7079 *(9.37)*	0.2408 *(1.91)*	0.0696 *(0.75)*
DPC_{t-1}	0.3326 *(1.44)*	0.3951 *(2.37)*	0.4203 *(1.61)*	0.1008 *(1.73)*	0.6244 *(3.00)*	0.5010 *(2.79)*
DPC_{t-2}	0.0329 *(0.15)*	0.1876 *(0.93)*	0.5068 *(1.59)*	0.0675 *(1.20)*	-0.1144 *(0.57)*	0.0723 *(0.32)*
DPC_{t-3}	0.3473 *(2.25)*	0.5451 *(3.29)*	-0.1356 *(0.50)*	0.1237 *(2.11)*	0.2493 *(1.38)*	0.3570 *(2.11)*
$DDPM_t$	0.0124 *(0.44)*	0.1324 *(2.39)*	0.0497 *(1.47)*	0.0019 *(0.10)*	-0.0568 *(1.09)*	0.0682 *(2.22)*
d84q2		-0.4107 *(5.61)*				-0.0176 *(5.03)*
d91q2		0.0337 *(4.59)*				0.0153 *(4.38)*
d98q1			-0.0283 *(4.18)*			-0.0062 *(1.82)*
$R(bar)^2$	0.4864	0.6002	0.5646	0.5808	0.3651	0.6923
DW	2.0974	1.6625	1.9021	2.1314	2.1465	1.9138
SE	0.0044	0.0068	0.0066	0.0034	0.0061	0.0032
Homogeneity restriction - $\chi^2(1)$	5.6465 *[0.017]*	0.5097 *[0.475]*	2.1928 *[0.139]*	5.2967 *[0.021]*	9.6705 *[0.002]*	2.5692 *[0.109]*
A - Serial correlation - $\chi^2(4)$	15.8336 *[0.003]*	4.6366 *[0.327]*	2.5431 *[0.637]*	5.6370 *[0.228]*	7.0066 *[0.136]*	5.0731 *[0.280]*
B - Functional form - $\chi^2(1)$	2.8795 *[0.090]*	1.2975 *[0.255]*	0.3080 *[0.579]*	0.0496 *[0.824]*	3.2031 *[0.073]*	0.4721 *[0.492]*
C - Normality - $\chi^2(2)$	1.2284 *[0.541]*	0.3772 *[0.828]*	0.1249 *[0.939]*	1.3269 *[0.515]*	0.3238 *[0.851]*	1.8520 *[0.396]*
D - Heteroscedasticity - ($\chi^2(1)$)	5.3481 *[0.021]*	0.1826 *[0.669]*	1.3452 *[0.246]*	2.3690 *[0.124]*	0.4509 *[0.502]*	1.2277 *[0.268]*
E - Predictive Failure ($\chi^2(8)$)	11.4063 *[0.180]*	7.2976 *[0.505]*	1.6240 *[0.990]*	4.9867 *[0.759]*	3.1129 *[0.927]*	7.6699 *[0.466]*
F - Chow test ($\chi^2(6)$)	11.2071 *[0.082]*			4.0573 *[0.669]*	2.9360 *[0.817]*	

Notes:

Brackets show absolute values of t statistics; square brackes show the significance level of the reported tests.

A: Lagrange multiplier tests of residual serial correlation;

B: Ramset's RESET test using the square of fitted values;

C: based on a test of skewness and kurtosis of residuals;

D: based on the regression of squared residuals on squared fitted values;

E: test of adequacy of predictions for 1999:1- 2000:4 based on the estimates for the period up to 1998:4 (Chow second test);

F: test for stability of the regression coefficients for 1999:1- 2000:4 based on the estimates for the period up to 1998:4 (Chow first test).

Table 4: Hansen stability tests for individual countries and 5-country aggregate OLS equations

Variable	France	Germany	Italy	Netherlands	Spain	Aggregate
Equation	2.655	3.025	1.034	1.676	1.618	1.783
GAP_t	0.384	0.078	0.088	0.679	0.132	0.055
$DULC_{t-1}$	0.274	0.094	0.086	0.081	0.097	0.066
DPC_{t-1}	0.074	0.254	0.129	0.477	0.062	0.176
DPC_{t-2}	0.039	0.062	0.122	0.486	0.036	0.139
DPC_{t-3}	0.074	0.099	0.117	0.280	0.093	0.130
$DDPM_t$	0.225	0.199	0.316	0.084	0.113	0.092

Notes
The 5% critical values are 0.470 for individual coefficients and 2.110 for the whole equation
The test for Germany and for the aggregate was run without including the dummy variables.

Table 5: Correlation Matrix for the Residuals from the National OLS Equations

	Germany	France	Italy	Netherlands	Spain
Germany	1.000	-0.141	0.139	-0.115	-0.202*
France		1.000	0.012	0.309***	-0.031
Italy			1.000	0.066	0.101
Netherlands				1.000	-0.126
Spain					1.000

Significance given by *'s: 90% (*), 95% (**) and 99% (***)

Table 6: Restricted Pooled estimation for individual countries

Variable	France		Germany		Italy		Netherlands		Spain	
Constant	-0.0017	*-(2.22)*	-0.0013	*-(1.90)*	-0.0032	*-(4.09)*	-0.0005	*-(0.74)*	-0.0012	*-(1.71)*
GAP_t	-0.0020	*-(4.39)*	-0.0020	*-(4.39)*	-0.0020	*-(4.39)*	-0.0020	*-(4.39)*	-0.0020	*-(4.39)*
$DULC_{t-1}$	0.3218	*(1.90)*	-0.0866	*-(1.31)*	0.1995	*(2.19)*	0.7357	*(6.73)*	0.2306	*(2.09)*
DPC_{t-1}	0.2384	*(0.82)*	0.4040	*(2.93)*	0.4205	*(1.91)*	0.0926	*(0.97)*	0.6283	*(3.29)*
DPC_{t-2}	0.0732	*(0.27)*	0.1613	*(0.96)*	0.5084	*(1.89)*	0.0553	*(0.61)*	-0.1117	*-(0.61)*
DPC_{t-3}	0.3666	*(1.85)*	0.5213	*(3.81)*	-0.1284	*-(0.57)*	0.1164	*(1.21)*	0.2528	*(1.53)*
$DDPM_t$	0.0102	*(0.28)*	0.1310	*(2.86)*	0.0490	*(1.72)*	0.0000	*(0.00)*	-0.0587	*-(1.24)*
d84q2			-0.0422	*-(7.00)*						
d91q2			0.0362	*(6.15)*						
d98q1					-0.0284	*-(4.96)*				

$R(bar)^2$ 0.6232
SE 0.0056
$\chi^2(4)$ test for the equality of the coefficient of GAP_t for all countries = 5.0855 [p-value=0.279]

Table 7: Standard error of residuals

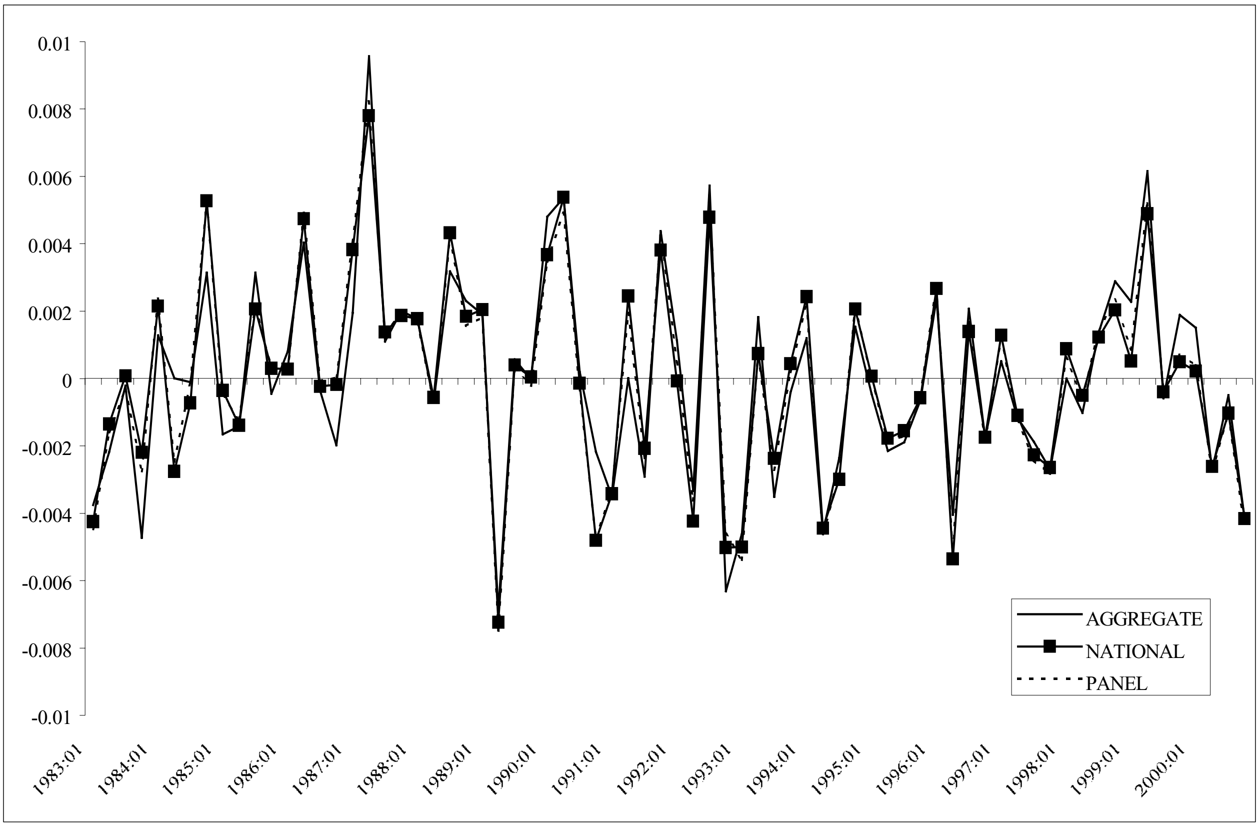
National OLS	0.0029
Restricted pooled system	0.0030
Aggregate OLS	0.0030

Table 8: Out of sample recursive forecasts of aggregate wage growth

	mean absolute error	root mean squared error	Theil U
steps ahead	**national equations**		
1	0.0023	0.0031	0.9389
2	0.0027	0.0031	0.9934
3	0.0021	0.0026	1.2059
4	0.002	0.0024	0.7320
steps ahead	**aggregate equation**		
1	0.0027	0.0033	0.9854
2	0.0028	0.0033	1.0478
3	0.0021	0.0024	1.1079
4	0.0020	0.0024	0.7097

Notes
Theil U is computed as the ratio of the root mean square error to the root mean square error of a "naive" forecast of no change in the dependent variable

Figure 1 : Residuals from the Aggregate, National and Panel Equations



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