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\\ 252 \\

Federal Policies and Local Economies:
Europe and the US

by

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ABSTRACT

This paper establishes stylized facts on regional output fluctuations in Europe and the US. Moreover, it proposes a measure of the potential output target of the future European central bank, estimates the potential variance stabilization of a fiscal federation and constructs a regional map of the potential beneficiaries of monetary and fiscal federal policies.

The econometric model is an extention of the dynamic factor model *a' la* Sargent and Sims (1977) where we introduce an intermediate-level shock, which is common to all regions (counties) in each country (state), but it is not common to Europe (US) as a whole. We build on Forni and Reichlin (1996, 1998a) to propose an estimation method which exploits the large cross-sectional dimension of our data set.

Our analysis shows that (i) Europe has a level of integration similar to that of the US and that national shocks are not a sizeable source of fluctuations: around 75 % of output variance is explained by global and purely local dynamics; (ii) Europe, unlike the US, has no traditional business cycle; (iii) the core of the most integrated regions in Europe does not have national boundaries; (iv) the future European Central Bank has a potential stabilization target of about 18% of total output fluctuations; (v) a fiscal federation, if implemented, could have a smoothing effect on output in addition to what done by national fiscal policy, which accounts also for about 18% of total output fluctuations.

JEL Classification: C51, E32, O30.
Keywords: dynamic factor model, business cycle, European integration.

1. Introduction

The European central bank will soon start functioning and establish targets for Europe as a whole. Although output targets are not officially discussed, it is known that national central banks react to output gap indicators in order to stabilize income fluctuations (e.g., Clarida, Gali and Gertler, 1998 and Gerlach and Schnabel, 1998). It is then reasonable to assume that the European central bank will target some average of the cyclical output variances of the different nations belonging to the union. How much each nation and each region in Europe will be affected will depend on the structure of correlation of the regional business cycles with this average. The first task of this paper is to estimate, for each region, the degree of "commonality" with the aggregate cycle. These estimates will provide numbers for the potential output stabilization role of the central bank.

Once, with the establishment of a central bank, the first step towards policy integration has been accomplished, it is natural to ask whether to make a further step and join a fiscal federation. This question has already been the object of a small but growing academic literature (e.g., Sala-i-Martin and Sachs, 1992, von Hagen, 1992, Bayoumi and Masson, 1995, Asdrubali, Sørensen and Yosha, 1996, Fatás, 1998, Forni and Reichlin, 1998b). Our second question is then on the potential stabilization role of such federation. Unlike monetary policy, which can only stabilize common fluctuations over time. fiscal policy has an additional role as a provider of insurance, since taxes and transfers act as automatic stabilizers which reallocate income across regions. In a separate paper (Forni and Reichlin, 1998b) we have argued that the potential insurance role of a European fiscal federation is large. Here, analyzing regional as opposed to national data, we can ask the question of whether such federation would be more effective than a nation in providing insurance. National fiscal systems can insure against region specific shocks, but a European wide federation can have an additional insurance role in smoothing fluctuations induced by national shocks. How large is this component of output volatility?

Our estimates of potential regional targets of common European monetary policy and fiscal insurance will give, as a byproduct, the geographical distribution of potential winners from these policies which will allow us to ask the additional political economy question of whether policy makers in the future are likely to face national constituencies or coalitions of regions belonging to different countries.

The model we propose is an extension of the traditional dynamic factor model à la Sargent and Sims. We build on Forni and Reichlin (1996, 1998a) to propose a simple method of estimation which is based on Law of Large Numbers results and exploits the large cross-sectional dimension of our data set. In each region, total output growth is seen as generated by shocks which are purely

1

specific to that local economy, shocks affecting all areas in the same nation and Europe-wide shocks. Correspondingly, GDP growth is decomposed into a local, a national, and a European component.

The main advantage of our method with respect to the econometric strategies proposed elsewhere, as for example panel VAR, is that we can analyze a data set with high geographical disaggregation while retaining both sophisticated dynamic modeling and parameter heterogeneity. We are not relying on arbitrary averaging either over time or across cross-sectional units, and we can do this without sacrificing simplicity.

The dynamic aspect of the analysis is relevant because targets are implicitly or explicitly defined at some time horizon. By estimating the variance at different frequency bands, we are able to extract information about volatility of cycles of different lenght. This is useful in order to establish some stylized facts about Europe and the US, and to estimate the potential stabilization target of the European monetary policy.

The regional geographic disaggregation is relevant because we can study heterogeneity. This, besides being intersting *per se*, is important for the analysis of the political economy aspects of stabilization policies. What is the regional distribution of the potential winners and losers of federal policies?

This paper focus on the role of policy for variance stabilization. We do not discuss the role of policy for convergence of the levels or growth rates of regional income per capita. Both income levels and average growth can potentially be affected by structural policies, but not by the traditional stabilization tools discussed in this paper.

The paper is organized as follows. We first describe the model, the estimation procedure and the data. We then report empirical results and discuss policy implications. Next come a methodological section and summary and conclusions.

2. The model

Let us denote with y_t^{ij} the growth rate of output for the i-th region of nation j, expressed in deviation from the time-series mean. We assume

$$y_t^{ij} = E_t^{ij} + N_t^{ij} + \mathcal{L}_t^{ij} = a^{ij}(L)\epsilon_t + b^{ij}(L)n_t^j + c^{ij}(L)l_t^{ij}, \qquad (1)$$

for $j = 1, \ldots, J$ and $i = 1, \ldots, I^j$. E_t^{ij}, N_t^{ij} and $\mathcal{L}_t^{ij}$ are the European component, the national component and the local component respectively. The functions $a^{ij}(L)$, $b^{ij}(L)$ and $c^{ij}(L)$ are rational functions in the lag operator L. The European shock e_t, the national shocks n_t^j and the local shocks l_t^{ij} are unobserved unit-variance white noises, mutually uncorrelated at all leads and lags.

The difference of this model with respect to the traditional dynamic factor model or index model (see Sargent and Sims 1977, Geweke 1977) is that the factor n_t^j is neither common nor idiosyncratic. It is an intermediate-level factor, common for regions belonging to the same country but orthogonal across

countries.[1]

Some comments may be useful in order to avoid possible misunderstandings about the model.

First, the local shock of a region cannot affect other regions and the national shock of a nation cannot affect other nations. Therefore, if a shock originated in a large country, e.g. a large policy shock in Germany, has non-negligible effects on other countries, it must be considered as a European shock, not as a German national shock. Similarly, a shock should be labeled as national or local depending on its effects rather than on its origin.

Second, the European components E_t^{ij}, as well as the national components of regions belonging to the same country, though driven by the same shock, have heterogeneous response functions to allow for possible heterogeneity of local economic structures. Different regions may be affected by the same shock with different time delays or even with opposite signs. In such cases, the correlation across regions of the European components may be low, or even negative. In the same way, we do not assume restrictions on the long-run effects $a^{ij}(1)$, $b^{ij}(1)$ and $c^{ij}(1)$, so that all shocks are permanent in general, but may be transitory for particular regions.

Finally, since the three components are mutually orthogonal, the variance of y_t^{ij} can be decomposed into the sum of the variances. The percentage of the total output variance explained by the European component measures the extent to which income fluctuations of region ij are affected by Europe-wide events. Moreover, we can distinguish between long-run and cyclical fluctuations by looking at the spectral density function. Similar considerations hold for the national and the local components.

The average across regions of the variance explained by the European component can thus be considered as a synthetic index of the importance of Europe-wide comovements in local incomes. Such an index cannot be interpreted immediately as measuring the degree of synchronization between regional GDP fluctuations, because of the heterogeneity of the response functions; in order to get a complete picture about synchronization of cycles we have to look at the cross-correlations between the European components of different areas.

3. Estimation procedure

To estimate the model we use an adapted version of the procedure proposed in Forni and Reichlin (1996, 1998a), which is based on the implications of the Law of Large Numbers. To get an intuition of the basic idea, consider only regions belonging to the same country and assume that the European component is zero. Assume also for simplicity only contemporaneous responses to the shocks. Dropping the index for the nation, model (1) becomes

$$y_t^i = N_t^i + \mathcal{L}_t^i = b^i n_t + c^i l_t^i, \quad i = 1, \ldots, I.$$

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[1] Note that (1) can be interpreted as a $J + 1$ common factors model with the regional responses restricted in such a way that regions in nation j react only to the j-th factor.

Now consider the average $\bar{y}_t = \bar{b}n_t + \sum c^i l_t^i / I$. If I is large, the local component $\sum c^i l_t^i / I$ should be small in variance as compared with the common one, owing to the orthogonality of the local shocks. Hence $\bar{y}_t$ is almost collinear to the national shock. But this means that the unobserved common factor becomes observable, so that we can simply substitute $\bar{y}_t$ for n_t and estimate the model by applying OLS equation by equation (clearly we have an estimation bias, which will be smaller the smaller is the percentage of the variance of $\bar{y}_t$ explained by the local idiosyncratic component).

The same argument holds when considering for instance a weighted average of regions, rather than the simple average $\bar{y}_t$. Hence we have different candidates to use as regressors in OLS estimation. Obviously some of them will be better than others, depending on the percentage of idiosyncratic variance surviving aggregation. Are there optimal weights, i.e. weights minimizing the variance explained by the local components? The problem of finding the optimal regressor is particularly relevant when the number of cross-sectional observations is not very large, as is the case with the European part of our data set (see Section 4).

In Appendix 1 we show that the optimal regressor, within the class of all linear combinations of the y_t^i's, is obtained by using as coefficients the entries of the eigenvector corresponding to the larger eigenvalue of the matrix $\Sigma^{-1}\Gamma$, where Σ is the covariance matrix of the local components $\mathcal{L}_t^i$ and Γ is the covariance matrix of the variables y_t^i. Moreover, the reciprocal of the larger eigenvalue is an estimate of the percentage of the idiosyncratic variance in this linear combination and can therefore be used for diagnostic checking.[2]

Since the matrix Σ cannot be estimated directly from the data, we followed a two-stage procedure. In the first stage we assumed proportionality of Σ and the diagonal matrix having the same main diagonal as Γ. The weights obtained under this hypothesis were then used for a preliminary estimate of the model and the diagonal entries of Σ (the non-diagonal entries were set equal to zero according to the orthogonality assumption). In the second stage this estimate of Σ was used to get the final regressor.

Now let us come back to the general case of the three-level factor model (1). A fully detailed description of our estimation procedure is reported in Appendix 2. Here we give the main lines. First, by averaging across regions belonging to the same country we obtained J national aggregates with no local component. Second, by averaging across these national aggregates we obtained a European aggregate with neither national nor local component. Finally, the model was estimated by regressing region ij on both the European and the j-th national aggregate.

With this procedure we estimate, for each region, the three components—European, national and local. All the variances and spectral densities described in Section 5 are computed from the estimated components.

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[2] We do not treat here the case of $q > 1$ common factors. However, note that in this case we should take q averages instead of only one in order to capture the common factor space, and this could be done by taking as weights the first q eigenvectors of $\Sigma^{-1}\Gamma$.

4. The Data

The quality of data on regional output is poorer in Europe than in the US: the sample period is shorter and the level of geographical disaggregation not as fine; moreover, the level of disaggregation at which data are available is not homogenous across different European countries. We tried to cope with this problem by constructing two different data sets.

For the first one we aimed at the longest possible series, by reducing the number of countries and local disaggregation and merging heterogeneous data. The sources are Regio Eurostat and Eurostat, regional yearbook, 1983. We selected from the Regio data set observations on GDP in national currency from 1977 to 1993, for 82 regions.[3] Then we deflated by the national consumer price indexes published by the Eurostat. For the period 1973-77 and for the same regions, we used data on gross value added at market prices in national currency published in the Regional Yearbook of 1983 and deflated in the same way. Groningen (Netherlands) experienced an exceptionally large (idiosyncratic) income variation during the eigthies; we excluded this outlier from the data set when computing average variances and spectra.

In the second data set, we tried to include as many nations as possible. Data on GDP in national currency are available from Regio for 138 regions (including Greece, Spain and Portugal) from 1980 to 1993.[4] To compute real GDP we deflated by the national consumption price index as before.

The source of US data is BEA, Regional Economic Information System. Total personal income by county, from 1969 to 1993, was deflated by the US implicit GDP deflator. Alaska and Hawaii were excluded because of missing data, the District of Columbia because it contains one region only. In the final data set we have 48 states and 3075 counties. Notice that the geographical disaggregation here is much finer than European NUTS2; a better comparison would have required NUTS3 data, which unfortunately are not available. To cope with this, we distinguished between large, medium and small areas. Large areas are defined as those having income greater than 30 billion of US dollars in 1993; medium areas have more than one billion but less than 30 billion dollars; small areas have less than one billion dollars. Small areas, while being the majority of US areas, are absent in Europe.

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[3] These are the 11 NUTS1 regions for West Germany (the west landers); the 11 NUTS1 UK regions; 21 NUTS2 Franch regions (Corsica and the colonies are excluded); the 20 NUTS2 Italian regions; the 9 NUTS2 Belgian regions; the 10 Duch regions obtained by taking NUTS1 for Est-Netherlands and NUTS2 for other areas. West Berlin was estimated for 1992 and 1993 by applying the ratio West Berlin/Berlin of 1991 to the Berlin data.

[4] In this data set the disaggregation level is NUTS2 for all nations but the UK and Est-Nederland. West Germany: 31 regions; UK: 11 regions; France: 21 regions (Corsica and the colonies are excluded); Italy: 20 regions; Belgium: 9 regions; Netherland: 10 regions; Greece: 13 regions; Spain: 18 regions; Portugal: 5 regions (Acores and Madeira are excluded). West Berlin was estimated as explained in the previous note.

5. Empirical Results

5.1 The basic facts

Table 1 shows national averages across regions of the percentage of variance explained by the three components for the two European data sets.

Table 1. Average variance explained by the European component, the national component and the local component

Country	σ_E^2/σ_y^2 $\times 100$	σ_N^2/σ_y^2 $\times 100$	σ_C^2/σ_y^2 $\times 100$	Total	σ_y^2 $\times 1000$	no. of Regions	optimal weights
1973–1993							
Germany	65.8	21.7	12.5	100	0.83	11	0.21
United Kingdom	13.5	59.2	28.3	100	1.23	11	0.01
France	50.0	12.9	37.1	100	1.15	21	0.23
Italy	33.5	27.2	39.3	100	1.19	20	0.13
Belgium	51.7	24.9	23.5	100	1.04	10	0.14
Netherlands[1]	61.4	6.3	32.3	100	1.77	9	0.29
Large Regions	**44.0**	**29.9**	**26.1**	100	1.02	47	...
Medium Regions	**44.6**	**17.6**	**37.8**	100	1.41	34	
Large EMU Regions[2]	**52.9**	**20.3**	**26.7**	100	0.99	37	
Medium EMU Regions[2]	**46.5**	**16.3**	**37.2**	100	1.38	33	
1980–1993							
Germany	59.5	30.5	10.0	100	0.85	31	0.17
United Kingdom	17.5	74.3	8.2	100	0.99	11	0.02
France	49.9	24.5	25.6	100	1.67	21	0.27
Italy	42.1	34.7	23.3	100	1.57	20	0.16
Belgium	54.5	34.9	10.6	100	1.08	10	0.11
Netherlands[1]	50.8	24.0	25.2	100	2.49	9	0.19
Greece	14.8	62.1	23.1	100	7.12	13	0.00
Spain	47.9	24.8	27.3	100	2.57	18	0.08
Portugal	34.7	51.3	14.0	100	9.80	5	0.01
Large Regions	**46.8**	**36.2**	**16.9**	100	1.42	69	
Medium Regions	**31.9**	**45.6**	**22.5**	100	3.32	68	
Large EMU Regions[3]	**52.9**	**29.0**	**18.1**	100	1.18	56	
Medium EMU Regions[3]	**47.9**	**27.2**	**25.0**	100	2.02	52	

[1] Groningen is excluded.

[2] UK is excluded.

[3] UK, Greece and Portugal are excluded.

For most countries, for both data sets and for the two classes of dimension considered, the common European component explains the bulk of output variance. Exceptions are Greece, Portugal and the UK which show a large nation-specific dynamics, well above 50%.[5] If we exclude the UK, in the first data set the European component is 52.9% for large regions and 46.5% for medium sized regions. Similar figures are obtained for the second data set when Greece,

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[5] For the 1973-93 period, Italy shows an idiosyncratic component which is larger than the European. However, when only data from 1980 are considered, Italy is aligned with the continental model.

Table 2. Average variance explained by the US-wide component, the state component and the local component

State	σ_{US}^2/σ_y^2 $\times 100$	σ_S^2/σ_y^2 $\times 100$	σ_L^2/σ_y^2 $\times 100$	Total	σ_y^2 $\times 1000$	no. of Counties
Connecticut	47.3	44.2	8.5	100	0.86	8
Maine	45.4	22.9	31.7	100	1.63	16
Massachusetts	38.0	47.4	14.6	100	1.05	14
New Hampshire	54.8	36.5	8.7	100	1.53	10
Rhode Island	50.3	35.4	14.3	100	1.21	5
Vermont	62.9	19.7	17.5	100	1.14	14
Delaware	54.9	26.2	18.8	100	1.11	3
Maryland	53.6	18.7	27.8	100	1.43	24
New Jersey	57.0	25.3	17.8	100	0.79	21
New York	45.7	29.2	25.1	100	0.64	62
Pennsylvania	65.5	9.8	24.7	100	0.85	67
Illinois	29.4	45.6	25.0	100	3.43	102
Indiana	50.8	30.0	19.2	100	2.83	92
Michigan	60.8	11.2	27.3	100	1.63	83
Ohio	63.3	11.6	25.1	100	1.36	88
Wisconsin	57.1	15.7	27.3	100	1.30	71
Iowa	43.4	39.6	17.0	100	7.52	99
Kansas	19.2	25.2	55.6	100	15.62	105
Minnesota	44.3	28.1	27.6	100	10.81	87
Missouri	41.2	36.3	22.5	100	4.94	115
Nebraska	27.4	36.7	35.9	100	18.48	93
North Dakota	25.2	55.0	19.8	100	42.99	53
South Dakota	30.3	44.3	25.4	100	18.33	66
Alabama	54.3	9.7	36.0	100	2.12	67
Arkansas	46.7	13.3	40.0	100	5.19	75
Florida	40.0	23.1	36.9	100	2.01	67
Georgia	38.2	18.5	43.3	100	3.38	159
Kentucky	33.9	31.2	34.8	100	2.84	120
Louisiana	22.7	29.8	47.5	100	3.46	64
Mississippi	39.1	20.9	40.0	100	4.74	82
North Carolina	55.2	10.6	34.2	100	2.47	100
South Carolina	51.0	13.4	35.6	100	1.83	46
Tennessee	59.3	10.6	30.0	100	2.35	95
Virginia	51.7	9.9	38.4	100	1.84	105
West Virginia	31.6	32.3	36.1	100	1.83	55
Arizona	44.2	15.0	40.8	100	3.68	14
New Mexico	28.3	16.0	55.7	100	5.57	32
Oklahoma	15.4	29.3	55.3	100	6.31	77
Texas	20.5	10.7	68.8	100	16.55	254
Colorado	21.3	13.4	65.4	100	10.64	63
Idaho	19.6	40.1	39.8	100	5.81	44
Montana	22.5	41.7	35.8	100	15.56	56
Utah	27.7	18.1	54.2	100	3.55	29
Wyoming	17.3	35.9	46.8	100	5.78	23
California	45.1	8.8	46.2	100	2.40	58
Nevada	21.8	31.0	47.2	100	5.18	17
Oregon	34.9	21.3	43.9	100	7.57	36
Washington	28.8	14.3	56.9	100	4.28	39
Large Counties	**51.3**	**27.1**	**21.5**	100	0.93	26
Medium Counties	**54.0**	**20.0**	**26.0**	100	1.25	732
Small Counties	**28.6**	**28.4**	**42.9**	100	8.62	2312

Portugal and the UK are excluded. Note also the enormous variance of Greece and Portugal in the fifth column of Table 1.

In the last column of Table 1 we report the optimal weights computed by our estimation procedure and placed on the national aggregates in order to compute the European common factor. Surprisingly, in both data sets the German aggregate[6] does not have the larger weight, but only the third, coming after both France and the Netherlands. Note also that Greece, Portugal and the UK have very small weights.

Table 2 shows the variance decomposition for the US. The comparison with Europe is striking: the average size of the US-wide component is similar to that of the European component of Table 1 when the UK is excluded (first data set) and when Greece, Portugal and the UK are excluded (second data set). Moreover, the US state component seems to be of the same order of magnitude than the national component in Europe.

Overall, these results indicate that pre-monetary union Europe is already very much "integrated", with a small component of output volatility explained by national shocks.

A more accurate picture can be given by analyzing the dynamic profile of the different components. The problem can be analyzed through the frequency domain representation. Figure 1 shows the average spectra of the three components for Europe (first data set, UK excluded) and the US (medium and large counties). Although, as we have seen, the variances of the output components are similar, the dynamic profiles are very different. There are two main differences between Europe and the US. First, the European common component is very persistent, whereas the US-wide component exhibits a typical business cycle shape, which peaks at a period of around six years. By looking at low frequencies we see that the total long-run variance is similar in Europe and the US, so that the uncertainty about the future income level at, say, ten or twenty years is nearly the same. However—and this is the second difference—while in the US the main bulk of long-run fluctuations is state specific or local, in Europe the long-run variance is mainly common. This implies that European regions have a larger long-run covariance, i.e. larger cospectra near the vertical axis. In other words, European regions have a "common destiny" in the long-run, much more than US counties.

The latter statement needs an important qualification. We are not claiming that European countries have similar income levels, or that they are converging to the same income level. We only observe that permanent changes are strongly correlated across countries. Still, both drift and initial levels, which are not analyzed here, could be rather different, leading to persistent gaps, convergence or even divergence.[7]

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[6] We recall that the German aggregate is not the German GDP, but the optimally weighted average of the GDP's of the German regions.

[7] Note also that we are analyzing total income, as opposed to per-capita income. Different

8

Figure 1. The spectral shape of the three components for Europe and the US
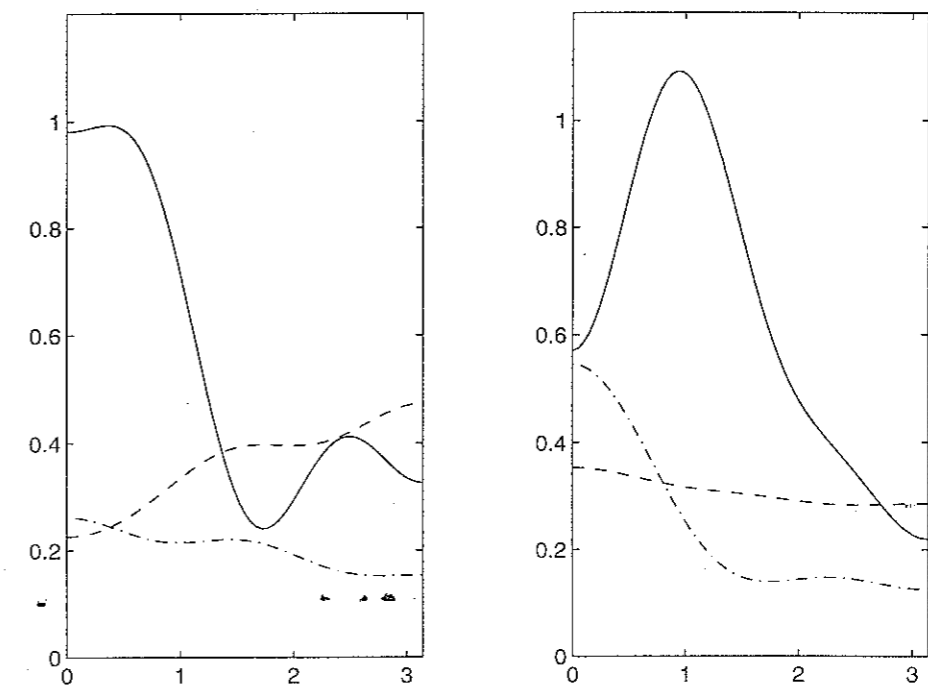
Horizontal axis: frequency; vertical axis: spectral density. Common component: solid line; National (state) component: dotted and dashed line; local component: dotted line. Europe (first data set, UK excluded) is on the left; US (large and medium counties) is on the right.

The analysis disaggregated by country (Figure 2) shows that the UK is the only European nation which, like the US, has a typical business cycle. The other countries confirm the aggregate result of a large European wide component with most of the variance concentrated at low frequency (although Italy has a lot of high frequency variation in the idiosyncratic).

Before we can interpret these results on variance decomposition in terms of degree of integration, we must study the degree of synchronicity and symmetry of the propagation mechanisms of the common shock. If the response functions of the common shock had different signs, the interpretation of a large common component at low frequency would imply that regions are diverging, exactly the opposite of what concluded so far.

A rough measure of symmetry and synchronization is given by the regional distribution of the correlation coefficients. In Figure 3 we report the frequency density distribution of a grid of correlation intervals for European regions (first data set) and US medium and large counties. In both cases, we can see that

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dynamics of total income in the US and Europe could be compensated by migrations, leading to similar dynamics of per-capita income.

9

Figure 2. The spectral shape of the three components for six European countries
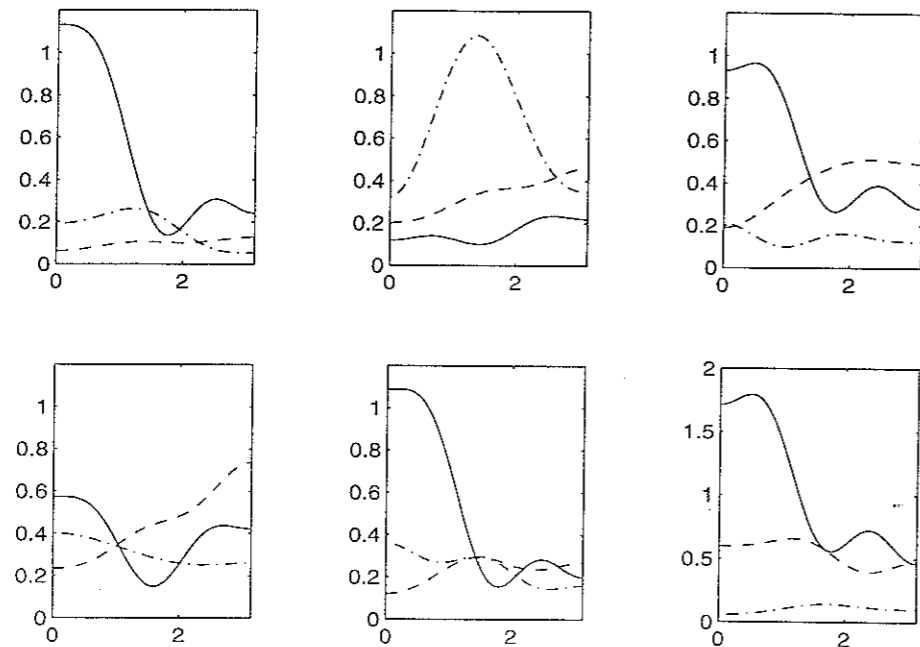
Horizontal axis: frequency; vertical axis: spectral density. Common component: solid line; National (state) component: dotted and dashed line; local component: dotted line. From the left to the right: Germany, UK, France, Italy, Belgium, Nederland (Groningen excluded). Nederland have a different scale on the vertical axis.

most correlation coefficients are positive and large.[8] This confirms the interpretation of variance decomposition results given above, even if we can notice that European regional dynamics is slightly more asymmetric than in the US case.

Finally, to complete the picture on European integration, we want to ask the question of whether regions which are "more European" (larger relative variance of the European component) belong to a particular geographical area. In order to answer this question we shift to the second data set, which is the most complete in terms of number of countries. Figure 4 reports the geographical distribution of variance ratios between European-wide components and total variance. Light gray indicates a small European component while dark gray indicates a large European component.

The Figure shows that, unlike what found by studies based on national data (see e.g. Bayoumi and Eichengreen, 1993. Helg et al, 1995), a core made by the key countries France, Germany and the Benelux does not exist. Dark and light spots are sparse, indicating that almost all countries are partly in and partly out. The only exceptions are Greece and the UK, which are clearly less integrated

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[8] The negative values are accounted for by Sicily, Sardinia, some UK regions and Groningen, the Dutch outlier.

Figure 3. Density distribution of correlations among the common components
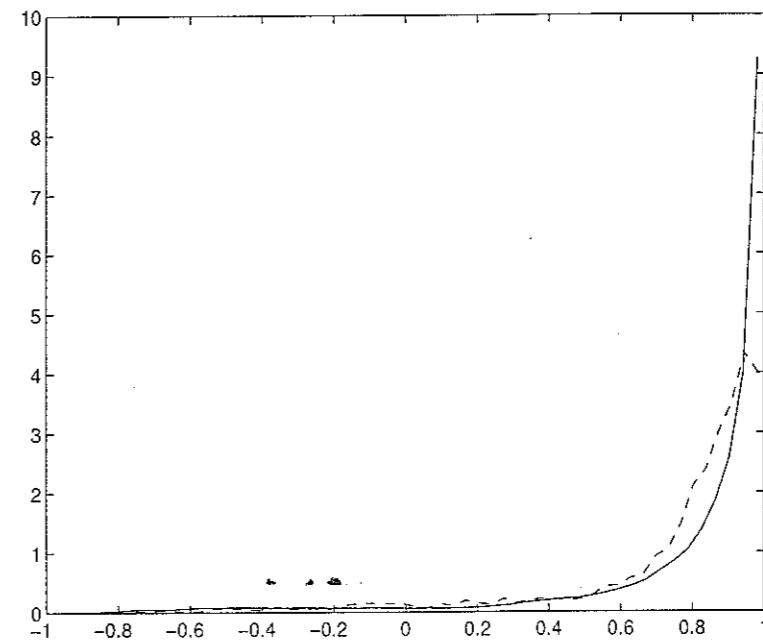
Europe: dashed line; US: solid line.

with the rest of Europe. In general, heterogeneity within nations is at least as large as heterogeneity across nations.

In summary, European regions are already highly integrated and are expected to "move together" in the long-run more than US counties. The common shock exhibits high persistence in Europe and a typical business-cycle shape in the US. If we exclude Greece and the UK, Europe appears a continent of regions rather than nations, as far as output fluctuations are concerned.

Our estimates on the degree of European integration based on output data are in line with what found by Fatás (1997) for unemployment, Fuss (1997) for income per capita and by Viñals and Jimeno (1996) for employment. They contrast, however, with the earlier literature on the optimality of Europe as a currency area (e.g. Bayoumi and Eichengreen, 1993) which obtained lower estimates. Given the variety of methods used in the literature, results are difficult to compare. One likely explanation for the discrepancy of results, however, is the higher level of aggregation at which those studies were conducted.

5.2 The potential output target of the European central bank

National central banks can target that component of the output variance which is common to all regions in a nation but are unable to smooth idiosyncratic

Figure 4. Percentage of output variance explained by the European component
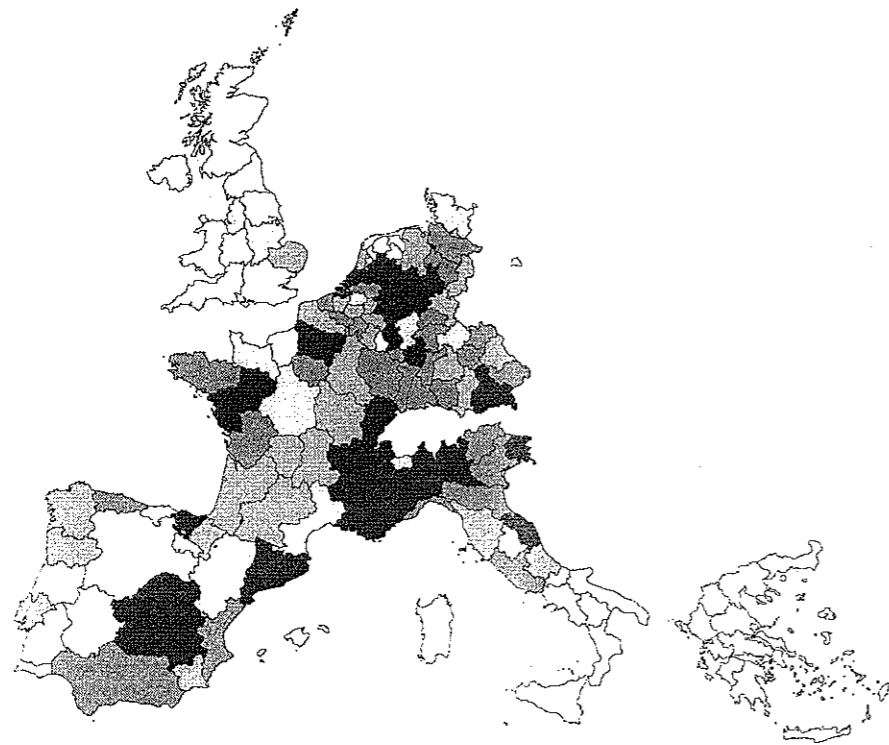
Dark regions have a large European component. Limits for color changes are 0.23, 0.42, 0.58, 0.70.

regional output changes. Similarly, the future European central bank will only be able to target that component of output volatility which is common to all regions of Europe, but it is unable to target nation-specific variance. Moreover, the typical target of monetary policy is the cycle, not long-run volatility. This is not because long-run income stabilization is undesirable, but because monetary policy shocks, having mainly temporary effects on output, cannot be used as a long-run stabilization device. Studies on the reaction functions of monetary policy indicate that central banks react to output gap indicators (Clarida, Gali and Gertler, 1998 and Gerlach and Schnabel. 1998) and this implies smoothing output volatility at cyclical frequencies. Hence a measure of the potential target of the common monetary policy should be defined as the short-run component of the output variance which is neither regional nor nation specific.

In Table 3 we report variance decompositions at different frequencies for Europe (excluding the UK which is not going to participate to the first phase

Table 3. Average long-run, medium-run and short-run variance of in Europe and the US

Period	Common Comp.	National Comp.	Local Comp.	Total	Tot. var. $\times 1000$
European Regions — UK excluded (70 regions)					
> 10 years	17.6	4.5	4.3	26.4	0.31
$5 - 10$ years	13.5	3.9	5.8	23.2	0.33
< 5 years	18.3	9.7	22.4	50.4	0.54
Total	49.5	18.1	32.5	100.0	1.19
US medium and small counties (758 counties)					
> 10 years	12.0	8.4	5.8	26.3	0.29
$5 - 10$ years	17.7	4.8	5.4	27.9	0.26
< 5 years	24.0	7.2	14.7	45.9	0.56
Total	53.7	20.3	26.0	100.0	1.12

of the EMU) and the US. We report average variances for both cycles between five and ten years and cycles of less than five years. Assuming a realistic target to be a cycle of less than five years, we estimate the potential smoothing effect of the common monetary policy to be a variance accounting for 18.3% of the total. Notice that this is less than 50% of the total common component, which is not surprising, since the latter is very persistent. Notice also that this number is lower than in the US. It is interesting to note that, notwithstanding the anti-cyclical monetary policy of the Federal Reserve, the US cyclical variance remains larger than the European one. A counterfactual exercise would be interesting, but it is beyond the scope of this paper.

5.3 The potential insurance role of a fiscal federation

Fiscal policy, like monetary policy, can be used to stabilize aggregate output over time. In addition, however, it has the role of stabilizing local output by acting as an automatic insurance mechanism. Regions which are performing particularly well pay more taxes than regions experiencing temporary slowdowns and receive less benefits.

Abstracting from political economy type of considerations (for a discussi moral hazard problems related to the institution of a fiscal federation, see Persson and Tabellini, 1996), a European-wide insurance mechanism would be more effective than a national one, simply because of size; a fiscal federation can potentially insure both nation specific and purely regional volatility, while a nation can only insure regional variations. Only in the case in which the national component of variance is negligible, a fiscal federation will not have a higher insurable potential than a national insurance system. The size of the national component of output volatility will then tell us how much scope there is for a fiscal federation.

But should we look mainly at long-run fluctuations or short-run fluctuations? While traditional anti cyclical policies, being based on intertemporal income transfers, can only address short-run volatility, a fiscal federation, by

acting through cross-sectional transfers, can in principle reduce both short-run and long-run variance. From Table 3 we can see that national fluctuations account for about 18% of total variance. Hence the scope for a fiscal federation as an insurance mechanism is not negligible. [9]

5.4 Political economy

From the discussion, we can say that the map of potential losers and winners of a federal fiscal policy is given by the geographical distribution of the variance of the nation-specific component over total variance. Were the heterogeneity to be found within nations and not between nations, we may infer that the degree of consensus against a common fiscal policy will not be different than the consensus towards a national fiscal policy. Figure 5 reports the map of the nation-specific variance over total variance.

The map shows clearly that Greece and the UK would benefit more than other countries from fiscal integration. However, once again, if we exclude Greece and the UK, the map of potentially insurable risk is regional, not national. The lighter areas, which represent very low relative national variance, correspond roughly to the dark areas of Figure 3 of regions with the highest relative common variance (the more integrated regions). These regions belong to Northern Italy, part of Germany and France—the corridor of commercial and productive activities of post-Middle Age Europe. The map suggests that potential opposition to a federation will not be larger than existing regional opposition against national federations.

If we construct the same map for cyclical frequencies only, we obtain a picture of the regions which will suffer most in terms of output stabilization from federal monetary policy. This map differs only slightly from Figure 5 and therefore we do not report it. The conclusion is that, as expected, the more integrated regions will lose less from the establishment of Europe-wide targets. These regions, on the other hand, have less to gain from the establishment of a fiscal federation.

5.5 Diagnostic checking

At this point, some words should be spent about diagnostic checking. As we have alredy seen, our two European data sets are not very large both in the time and the cross-sectional dimension. Since the estimation procedure is based on

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[9] In Forni and Reichlin (1998b), by analyzing a simple consumption model, we argue that welfare is related to long-run volatility, rather than volatility *per se*. The basic intuition is that consumers may do a lot by themselves, through saving decisions, in order to smooth short-run fluctuations, but are impotent with respect to permanent shocks. As a consequence, policy should concentrate on long-run stabilization rather than short cycles. If this argument is correct, we have to focus mainly on the fraction of long-run volatility (rather than total volatility) accounted for by the national component. This fraction however is very similar to the 18% mentioned before (4.5/26.4, see Table 3, first line), so that the main conclusion does not change.

Figure 5. Variance ratios: national component over total variance
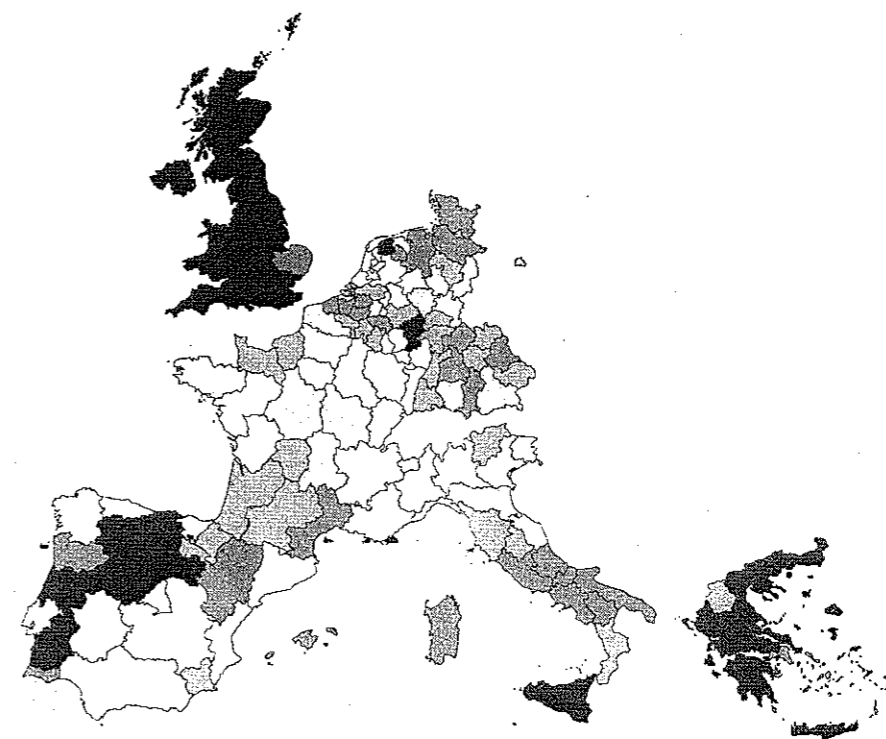
Darker regions have larger variance. Limits for color changes are 0.16, 0.27, 0.37 and 0.56.

the assumption of a large cross-section, one may wander whether in the present case the cross-sectional dimension is large enough to get reliable results.

As shown in Section 3 and Appendix 1, the reciprocal of the larger eigenvalue of the matrix $\Sigma^{-1}\Gamma$ is an estimate of the percentage of idiosyncratic variance which is still present in the optimal weighted average that we use as an approximation to the common factors. The numbers we obtained from estimation are quite comforting. For the first data set the larger percentage of local variance in the national averages is 2.4%,[10] while the percentage of non-European variance in the European average is 6.1%. In the second data set, where more countries are present, the latter figure reduces to 4.1%. The percentage of local variance in the national averages is less than 2% for all nations except Portugal, which has 7.8%.

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[10] Curiously the larger figure is not for the Netherlands, which have only nine regions, but for Italy, which has twenty regions. The smaller percentage is for Germany (0.8%).

6. Methodological notes

The questions studied here, as well as several interesting economic problems, cannot be suitably addressed without modeling a large number of time series. An important feature of the dynamic factor model is that it provides a representation of the dynamic relations among many cross-sectional units which is both flexible and parsimonious. Forni and Reichlin (1996, 1998a) show that, contrary to the common wisdom, estimation of the factor model is quite simple when large cross-sections are involved. By contrast, more popular models such as VARs or panel data models fail either in parsimony or in flexibility. In VAR models the number of parameters to estimate is typically too large with respect to the number of available observations over time. On the other hand, panel data techniques, besides requiring a clearcut *a priori* distinction between 'dependent' and 'independent' variables, entail homogeneity assumptions on the response functions of different units which are severely restrictive when only a few observable explanatory variables are available.

The Panel VARs which have been used to study dynamics for many regions and nations (Blanchard and Katz, 1992, Decressin and Fatás, 1995, Obstfeld and Peri, 1997) while representing an interesting attempt to solve the trade-off, are less flexible than the model employed here. Indeed, the panel VAR model can be seen as a particular case of (1), where the restriction is that regions belonging to the same country have the same propagation mechanism, up to multiplication by a scalar, which must be the same for the national and the European shocks. More precisely, by setting in model (1) $a^{ij}(L) = a^{ij}a^j(L)$, $b^{ij}(L) = a^{ij}b^j(L)$, and $c^{ij}(L) = c^{ij}c^j(L)$ we get

$$y_t^{ij} = a^{ij}f_t^j + c^j(L)l_t^{ij},$$

where $f_t^j = a^j(L)e_t + b^j(L)n_t^j$. By averaging across regions belonging to country j the local components wash out, so that the national average is $y_t^j = a^j f_t^j$, where $a^j = \sum_i a^{ij}/I^j$. Hence

$$y_t^{ij} = \alpha^{ij}y_t^j + c^{ij}c^j(L)l_t^{ij},$$

where $\alpha^{ij} = a^{ij}/a^j$. The Panel VAR strategy consists in first regressing y_t^{ij} on y_t^j and then performing a restricted VAR on the residuals, separately for each nation j. While homogeneity of the response functions, at least to the European shock, is roughly in line with our empirical findings, the assumption that the coefficient a^{ij} is the same for the national and the European shocks seems rather restrictive. More generally, the panel VAR model above fails to distinguish properly between the national and the European component.

The dynamic factor framework provides a notion of comovements which is very natural. As explained in Section 2, the percentage of variance accounted for by the common component is a measure of comovement which emerges naturally from the common-idiosyncratic representation of factor models. This notion

of comovement is different from what has been proposed by the literature on common trends (Stock and Watson, 1988), common features (Engle and Kozicky, 1993) and common cycles (Vahid and Engle, 1993). The example below may help to clarify this point. Consider the following very simple dynamic specification of model (1), with only two regions and zero national component:

$$\Delta y_t^1 = ae_t + (1 - bL)l_t^1$$
$$\Delta y_t^2 = ae_t + (1 - bL)l_t^2.$$

The two regions do not have either common trends or common cycles, since the first difference of the linear combination $z_t = y_t^1 - \alpha y_t^2$ is

$$\Delta z_t = (1 - \alpha)ae_t + (1 - bL)(l_t^1 - \alpha l_t^2),$$

which do not have a unit root in the Wold representation (unless $b = 1$ and $\alpha = 1$) and is not serially uncorrelated (unless $b = 0$). Nevertheless, if a is large, the two processes comove strongly according to the measure proposed above. Indeed, their correlation may be arbitrarily close to unity (both at long-run and cyclical frequencies), depending on the size of a.

The example also shows that the concepts of common trends and common cycles are not particularly useful in order to get a measure of comovement between the GDP growth rates of a set of regions or nations. The main reason is that cointegration tests, as well as tests on common features, can only provide a binary result: either the regions comove perfectly or not. For instance, cointegration gives a unambiguous result on the strength of long-run comovements only if all regions are pairwise cointegrated. This condition is rather strong; in practice, it will be never satisfied by a large set of regions, leaving us with no useful indications about the relevant problem.[11]

7. Summary and Conclusion

This paper proposes a method to study synchronization of output fluctuations at different levels of aggregation and compares estimates for European regions and US counties. For all regions we estimate the relative variance of a dynamic component generated by a European-wide shock, its dynamic profile and the pattern of its cross-regional correlations.

We find that Europe is as much integrated as the US. Integration is measured by the relative variance of a European-wide (US-wide) component with respect to the total variance of output growth. The disaggregated analysis confirms this fact for all countries except for the UK and Greece. We also find a European core formed by regions with a large common component. The boundaries of the core, however, are not national so that all nations are partly inside

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[11] For a more detailed discussion on cointegration and long-run comovement see Croux, Forni and Reichlin (1998).

and partly outside the core. In general, we find that the national dimension in Europe is not very important: what matters is the European component and a purely local component.

We propose a measure of the potential output stabilization target of the future European central bank as the percentage of total variance accounted for by short-run Europe-wide fluctuations. We find the potential target to be about 18% of total variance against a 24% in the US case. The smaller scope for federal monetary policy in Europe is explained by the higher level of persistence of the European common shocks with respect to US wide shocks.

Further, we measure the variance stabilization role of a European fiscal federation (in addition to what is already stabilized by existing national systems) as the percentage of total variance accounted for by national short-run fluctuations. This is estimated to be around 18% of total variance. Therefore, the ensemble of federal policies for stabilization have a non-negligible potential target of about 40%.

18

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19

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APPENDIX 1

The optimal weighting procedure

Let us focus the attention on a single nation, so that, dropping the index j, model (1) becomes

$$y_t^i = E_t^i + N_t^i + \mathcal{L}_t^i = C_t^i + \mathcal{L}_t^i,$$

where the common component C_t^i is orthogonal to the local idiosyncratic component $\mathcal{L}_t^i$. Now let us indicate with Σ the covariance matrix of the vector of the idiosyncratic components $\mathcal{L}_t = (\mathcal{L}_t^1 \cdots \mathcal{L}_t^I)$ and with Γ the covariance matrix of the vector of the variables $Y_t = (y_t^1 \cdots y_t^I)$. We are looking for the I-dimensional vector w minimizing the ratio $\text{var}(w'\mathcal{L}_t)/\text{var}(w'Y_t)$, or, equivalently, the function

$$\log(w'\Gamma w) - \log(w'\Sigma w).$$

This function is homogeneous of degree zero in w, so that it reaches an interior maximum in $R^I - 0$ (0 being the null vector) on a ray through the origin satisfying the first order condition

$$\frac{2\Gamma w}{w'\Gamma w} - \frac{2\Sigma w}{w'\Sigma w} = 0.$$

Assuming the invertibility of Σ, this is equivalent to

$$\Sigma^{-1}\Gamma w = \frac{w'\Gamma w}{w'\Sigma w}w.$$

Imposing the latter condition, in turn, is equivalent to imposing

$$\Sigma^{-1}\Gamma w = \lambda w \qquad (2)$$

for some scalar λ and some $w \neq 0$. This is because a couple λ, w satisfying (2) must fulfill $\lambda = w'\Gamma w/w'\Sigma w$.

Hence the first order condition is satisfied by, and only by, the eigenvectors of $\Sigma^{-1}\Gamma$; moreover, the eigenvalues λ are the reciprocals of the objective function $\text{var}(w'\mathcal{L}_t)/\text{var}(w'Y_t)$ evaluated at the corresponding eigenvectors. It follows that the solution of the above programming problem must be given by the eigenvector corresponding to the maximum latent root of $\Sigma^{-1}\Gamma$. Moreover, the reciprocal of the maximum latent root is an estimate of the percentage of the idiosyncratic variance in the optimal linear combination $w'Y_t$ and can be used for diagnostic checking.

If Σ is diagonal, as it is assumed here, equation (2) have a simple interpretation. Since

$$\Gamma w = \begin{pmatrix} \text{cov}(y_t^1, w'y_t) \\ \vdots \\ \text{cov}(y_t^I, w'y_t) \end{pmatrix},$$

equation (2) reduces to

$$\frac{\text{cov}(y_t^i, w'y_t)}{\text{var}(\mathcal{L}_t^i)} = \lambda w^i, \qquad i = 1, \ldots, I$$

i.e. the weight of region i must be larger, the larger is the covariance of region i with the aggregate and the smaller is the variance of the idiosyncratic component.

Note also that in the particular case of perfectly correlated common components, i.e. $C_t^i = a^i C_t$, w is proportional to $a^i/\text{var}(\mathcal{L}_t^i)$, which clearly shows that 'weights' are not necessarily positive.

APPENDIX 2

The estimation procedure

The complete estimation procedure is in five steps.

Step 1 We washed out the local components by computing, for each nation j, the linear combination

$$y_t^j = \sum_{i=1}^{I^j} w^{ij} y_t^{ij},$$

where the coefficients w^{ij} are those minimising the ratio of the variance of the local component over the total, as explained above. Hence

$$y_t^j \approx a^j(L)e_t + b^j(L)n_t^j = E_t^j + N_t^j,$$

where $a^j(L) = \sum_{i=1}^{I^j} w^{ij} a^{ij}(L)$ and $b^j(L) = \sum_{i=1}^{I^j} w^{ij} b^{ij}(L)$.

Step 2 We eliminated the national components by computing the linear combination

$$y_t = \sum_{j=1}^{J} w^j y_t^j,$$

where the w^j's are chosen again to minimize the ratio between the non-common variance to the variance of y_t. Then

$$y_t \approx a(L)e_t,$$

where $a(L) = \sum_{j=1}^{J} w^j a^j(L)$.

Step 3 Assuming equality in the above relation, along with invertibility of $a(L)$, we can write e_t, and therefore E_t^j, as a linear combination of the present and the past of y_t, so that

$$y_t^j = \alpha^j(L)y_t + N_t^j.$$

We estimated the above equations by OLS, with $\alpha^j(L)$ specified as a second order polynomial.[12] These auxiliary regressions are needed in Step 5 in order to disentangle the national and the European component.

Step 4 A similar reasoning leads to the relation

$$y_t^{ij} = \alpha^{ij}(L)y_t + \beta^{ij}(L)y_t^j + \mathcal{L}_t^{ij}.$$

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[12] In principle $a(L)$ can be non-invertible toward the past. In order to allow for roots smaller than unity in modulus we have to specify $\alpha^j(L)$ as a bilateral operator (for a discussion on this point see Forni and Reichlin 1996). We tried different specifications for the $\alpha^j(L)$, including both leads and lags of y_t, but we found that a two-lags specification could not be rejected by the F-test.

We estimated the above regression equations by OLS. Also in this case we found that a second-order specification for both $\alpha^{ij}(L)$ and $\beta^{ij}(L)$ was good. In this way we got an estimate for the local components $\mathcal{L}_t^{ij}$.

Step 5 By substituting for y_t^j in the above relations we see that

$$E_t^{ij} = \alpha^{ij}(L)y_t + \beta^{ij}(L)\alpha^j(L)y_t$$
$$N_t^{ij} = \beta^{ij}(L)N_t^j = y_t^{ij} - E_t^{ij} - \mathcal{L}_t^{ij}.$$

This provides estimates for E_t^{ij} and N_t^{ij}.

A complete estimation of the parameters of (1) is beyond our aims. However, estimates for $a^{ij}(L)$ and $b^{ij}(L)$ could in principle be obtained by estimating $a(L)$ (by univariate ARMA modelling of y_t) and $b^j(L)$ (by univariate modelling of the N_t^j's) and using the relations

$$a^{ij}(L) = \left(\alpha^{ij}(L) + \beta^{ij}(L)\alpha^j(L)\right) a(L)$$
$$b^{ij}(L) = \beta^{ij}(L)b^j(L).$$

24

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44. Carlo Alberto Magni [1989] "Reputazione e credibilità di una minaccia in un gioco bargaining", pp. 56

45. Giovanni Mottura [1989] "Agricoltura familiare e sistema agroalimentare in Italia", pp. 84

46. Mario Forni [1989] "Trend, Cycle and 'Fortuitous cancellation': a Note on a Paper by Nelson and Plosser", pp. 4

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48. Roberto Golinelli [1989] "Note sulla struttura e sull'impiego dei modelli macroeconometrici", pp. 21

49. Marco Lippi [1989] "A Shorte Note on Cointegration and Aggregation", pp. 11

50. Gian Paolo Caselli e Gabriele Pastrello [1989] "The Linkage between Tertiary and Industrial Sector in the Italian Economy: 1951-1988. From an External Dependence to an International One", pp. 40

51. Gabriele Pastrello [1989] "Francois quesnay: dal Tableau Zig-zag al Tableau Formule: una ricostruzione", pp. 48

52. Paolo Silvestri [1989] "Il bilancio dello stato", pp. 34

53. Tim Mason [1990] "Tre seminari di storia sociale contemporanea", pp. 26

54. Michele Lalla [1990] "The Aggregate Escape Rate Analysed throught the Queueing Model", pp. 23

55. Paolo Silvestri [1990] "Sull'autonomia finanziaria dell'università", pp. 11

56. Paola Bertolini, Enrico Giovannetti [1990] "Uno studio di 'filiera' nell'agroindustria. Il caso del Parmigiano Reggiano", pp. 164

57. Paolo Bosi, Roberto Golinelli, Anna Stagni [1990] "Effetti macroeconomici, settoriali e distributivi dell'armonizzazione dell'IVA", pp. 24

58. Michele Lalla [1990] "Modelling Employment Spells from Emilia Labour Force Data", pp. 18

59. Andrea Ginzburg [1990] "Politica Nazionale e commercio internazionale", pp. 22

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61. Gian Paolo Caselli e Gabriele Pastrello [1990] "The service sector in planned economies. Past experiences and future prospectives", pp. 32

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63. Andrea Ginzburg [1990] "Debito pubblico, teorie monetarie e tradizione civica nell'Inghilterra del Settecento", pp. 30

64. Mario Forni [1990] "Incertezza, informazione e mercati assicurativi: una rassegna", pp. 37

65. Mario Forni [1990] "Misspecification in Dynamic Models", pp. 19

66. Gian Paolo Caselli e Gabriele Pastrello [1990] "Service Sector Growth in CPE's: An Unsolved Dilemma", pp. 28

67. Paola Bertolini [1990] "La situazione agro-alimentare nei paesi ad economia avanzata", pp. 20

68. Paola Bertolini [1990] "Sistema agro-alimentare in Emilia Romagna ed occupazione", pp. 65

69. Enrico Giovannetti [1990] "Efficienza ed innovazione: il modello "fondi e flussi" applicato ad una filiera agro-industriale", pp. 38

70. Margherita Russo [1990] "Cambiamento tecnico e distretto industriale: una verifica empirica", pp. 115

71. Margherita Russo [1990] "Distretti industriali in teoria e in pratica: una raccolta di saggi", pp. 119

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75. Enrico Giovannetti [1990] "Crisi e mercato del lavoro in un distretto industriale: il bacino delle ceramiche. Sez I", pp. 150

76. Enrico Giovannetti [1990] " Crisi e mercato del lavoro in un distretto industriale: il bacino delle ceramiche. Sez. II", pp. 145

78. Antonietta Bassetti e Costanza Torricelli [1990] "Una riqualificazione dell'approccio bargaining alla selezioni di portafoglio", pp. 4

77. Antonietta Bassetti e Costanza Torricelli [1990] "Il portafoglio ottimo come soluzione di un gioco bargaining", pp. 15

79. Mario Forni [1990] "Una nota sull'errore di aggregazione", pp. 6

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102. Gian Paolo Caselli and Gabriele Pastrello [1994] "Polish recovery form the slump to an old dilemma", pp. 20

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104. Giovanni Bonifati [1994] "Progresso tecnico, investimenti e capacità produttiva", pp. 30

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120. Mario Forni e Lucrezia Reichlin [1995] "Dynamic common factors in large cross-section" pp. 17

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123. Giovanni Bonifati [1995] "Cambiamento tecnico e crescita endogena: una valutazione critica delle ipotesi del modello di Romer" pp. 21

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126. Barbara Pistoresi e Marcello D'Amato [1995] "Co-movements in European real outputs" pp. 20

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133. Carlo Alberto Magni [1996] "Un esempio di investimento industriale con interazione competitiva e avversione al rischio" pp. 20

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137. David Avra Lane, Irene Poli, Michele Lalla, Alberto Roverato [1996] "Lezioni di probabilità e inferenza statistica - Esercizi svolti - " pp. 302

138. Barbara Pistoresi [1996] "Is an Aggregate Error Correction Model Representative of Disaggregate Behaviours? An example" pp. 24

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157. Paolo Silvestri, Giuseppe Catalano [1996] "Le risorse del sistema universitario italiano: finanziamento e governo" pp. 400

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188. Fabio Canova e Eva Ortega [1997] "Testing Calibrated General Equilibrium Model" pp 34

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202. Paola Bertolini [1997] "European Union Agricultural Policy: Problems and Perspectives" pp18

203. Stefano Bordoni [1997] "Supporti Informatici per la Ricerca delle soluzioni di Problemi Decisionali" pp30

204. Carlo Alberto Magni [1997] "Paradossi, Inverosimiglianze e Contraddizioni del Van: Operazioni Aleatorie" pp10

205. Carlo Alberto Magni [1997] "Tir, Roe e Van: Distorsioni linguistiche e Cognitive nella Valutazione degli Investimenti" pp 17

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211. Carlo Albero Magni [1997] "Critica alla definizione classica di investimento: un approccio sistemico" pp17

212. Alberto Roverato [1997] "Asymptotic prior to posterior analysis for graphical gaussian models" pp.8

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214. Gian Paolo Caselli e Franca Manghi [1997] "La transizione da piano a mercato e il modello di Ising" pp15

215. Tindara Addabbo [1998] "Lavoro non pagato e reddito esteso: un'applicazione alle famiglie italiane in cui entrambi i coniugi sono lavoratori dipendenti" pp 54

216. Tindara Addabbo [1998] "Probabilità di occupazione e aspettative individuali" pp 36

217. Lara Magnani [1998] "Transazioni, contratti e organizzazioni: una chiave di lettura della teoria economica dell'organizzazione pp 39

218. Michele Lalla, Rosella Molinari e Maria Grazia Modena [1998] "La progressione delle carriere: i percorsi in cardiologia" pp 46

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221. Antonio Ribba [1998] "Granger-causality and exogeneity in cointegrated Var models" pp 5

222. Luigi Brighi e Marcello D'Amato [1998] "Optimal Procurement in Multiproduct Monopoly" pp 25

223. Paolo Bosi, Maria Cecilia Guerra e Paolo Silvestri [1998] "La spesa sociale nel comune Modena" Rapporto intermedio pp 37

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241. Christophe Croux, Mario Forni e Lucrezia Reichlin [1998] "A Measure of Comovement for Economic Indicators: Theory and Empirics"pp 23.

242. Carlo Alberto Magni [1998] "Note sparse sul dilemma del prigioniero (e non solo) pp 13

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246. Luigi Brighi [1998] "Demand and generalized monotonicity" pp 21

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248. Tommaso Minerva, Sandra Paterlini e Irene Poli [1998] "A Genetic Algorithm for predictive Neural Network Design (GANND). A Financial Application" pp 12.

249. Gian Paolo Caselli Maurizio Battini [1998] "The Changing Distribution of Earnings in Poland from 1989 to 1996 pp. 9.

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251. Lara Magnani [1998] "Un'analisi del distretto industriale fondata sulla moderna teoria economica dell'organizzazione" pp. 46