spectral density matrix in equation (3) to be time dependent. We assume that the univariate spectra in equation (1) are constant, since we are not interested in the change of the length of the cycle in the first place. We want to use the time dependent cross spectra to derive a time dependent version of the explained variance and the phase shift, which enables us to judge the extent to which the regional business cycles move together over time.

3 Results

The first step in the analysis is to compare the univariate cyclical structure of the regional GDPs in the Centre-North and the Mezzogiorno.[8] Following Canova (1998), we judge the robustness of our results by comparing the outcome for three detrending methods: the difference filter, the Hodrick Prescott filter (Hodrick and Prescott, 1980), and the Baxter-King filter (Baxter and King, 1999) in a slightly modified version (Woitek, 1998). In addition, we also perform a significance test of the share of total variance.[9] The results of this exercise are displayed in Table 1.

[8] The series are annual, at 1990 prices. For the observation period 1951-1993, the data are from Paci and Saba (1998). Based on the data from Svimez (2000), we extended the series to include observations up to 2000.

[9] The distribution of the test statistic is constructed based on 1000 replications of a white-noise process.

Table 1: Italian Regions, Univariate Cyclical Structure

	Cycle Length					
	BKM		HP		D	
	Centre-North	Mezzogiorno	Centre-North	Mezzogiorno	Centre-North	Mezzogiorno
	7.56	5.67	8.59	8.33	8.40	6.86

	Proportion of Total Variance					
	BKM		HP		D	
	Centre-North	Mezzogiorno	Centre-North	Mezzogiorno	Centre-North	Mezzogiorno
7-10 years	0.29***	0.10	0.60***	0.36***	0.20*	0.13
5-7 years	0.18	0.35***	0.08	0.15	0.12	0.17
3-5 years	0.33	0.31	0.15	0.13	0.31	0.26

Notes:
BKM: modified Baxter King filter; HP: Hodrick Prescott filter; D: difference filter.
*/**/***: share of total variance is significant at the 10/5/1 per cent level.

The business cycle in the Centre-Nort region is obviously longer than in the Mezzogiorno. Looking at the proportion of total variance, we find that the long cycle is more prominent in the North than in the South, in the sense that it is robust with respect to the detrending procedure. This result can be explained with the differences in the economic structure: for economies with a dominant agricultural sector, the business cycle is shorter (A'Hearn and Woitek, 2001).[10]

We can go a step further, and present the univariate cyclical structure for all 20 Italian regions. We compare the proportion of variance in the 5 frequency intervals corresponding to the business cycles lengths of 0-∞ years, 7-10 years, 5-7 years, 3-5 years, and 2-3 years. The results (BKM filter) are displayed in Table 2; the 5 columns of this table contain the proportion of total variance in each of the 5 cycle intervals. The result from above is confirmed: for regions in the Mezzogiorno, the longer cycles are less important. However, this picture is not as clear-cut as one would expect.

[10] Another explanation could be a political business cycle in the South of Italy. But although we find a political business cycle in 15 Italian regions (the growth of GDP is significantly higher than the average one year before a regional election, 1970-1990), a dummy measuring the difference of regions in the South with respect to elections turns out to be insignificant.

Table 2: Italian Regions, Univariate Cyclical Structure

	Region	(1)	(2)	(3)
Centre-North	PIE	0.31***	0.12	0.33
	VDA	0.12	0.24**	0.45**
	LOM	0.35***	0.15	0.34
	TAA	0.10	0.27**	0.45**
	VEN	0.14	0.32***	0.27
	FVG	0.15	0.30***	0.34
	LIG	0.10	0.28***	0.29
	EMR	0.25***	0.16	0.39*
	TOS	0.14	0.29**	0.31
	UMB	0.12	0.11	0.51***
	MAR	0.23**	0.18	0.42*
	LAZ	0.18*	0.18	0.34
Mezzogiorno	ABR	0.31***	0.16	0.29
	MOL	0.12	0.20*	0.31
	CAM	0.20**	0.29**	0.22
	PUG	0.08	0.17	0.40*
	BAS	0.06	0.36***	0.29
	CAL	0.07	0.11	0.35
	SIC	0.11	0.37***	0.26
	SAR	0.29***	0.28**	0.15

Notes:
PIE: Piemonte; VDA: Valle D'Aosta; LOM: Lombardia; TAA: Trentino Alto Adige; VEN: Veneto; FVG: Friuli Venezia Giulia; LIG: Liguria; EMR: Emilia Romagna; TOS: Toscana; UMB: Umbria; MAR: Marche; LAZ: Lazio; ABR: Abruzzo; MOL: Molise; CAM: Campania; PUG: Puglia; BAS: Basilicata; CAL: Calabria; SIC: Sicilia; SAR: Sardegna.
Cycle lengths: (1): 7-10 years, (2): 5-7 years, (3): 3-5 years.
*/**/***: share of total variance is significant at the 10/5/1 per cent level.

To gain more insight into the similarities between the regional cycles, we employ cluster analysis, based on the Euclidean distance for each of the 5 columns in Table 2. The resulting dendrograms can be found in Figure 2. The following robust result emerges:[11] Trentino/Alto Adige and Valle D'Aosta

[11] "Robustness" is judged according to whether the result comes trhough under both the

are the most similar regions. Other robust pairs are Friuli/Venezia/Giulia and Toscana, Veneto and Liguria, Emilia Romagna and Marche, and finally, Piemonte and Abruzzo.

On the next level, we find 2 groups of three similar regions: Piemonte, Abruzzo, and Lombardia, and Veneto, Liguria, and Siciliy. These two groups are the core of two large groups of regions which are relatively similar. The first group is Friuli/Venezia/Giulia, Toscana, Veneto, Liguria, Basilicata, and Sicily. The second group consists of Emilia Romagna, Marche, Piemonte, Abruzzo, Lombardia, and Lazio.

If we would want to split Italy into three regions according to the similarity of the business cycle, we would end up with the following groups:[12]

- Group 1: Valle D'Aosta, Trentino/Alto Adige, Veneto, Friuli/Venezia/Giulia, Liguria, Toscana, Campania, Basilicata, Sicily, and Sardegna
- Group 2: Piemonte, Lombardia, Emilia Romagna, Marche, Lazio, Abruzzo
- Group 3: Calabria

Geographical proximity seems to matter, but only to some extent. The clusters based on the univariate characteristics of the business cylce do not divide Italy into two regions in the North and the South.

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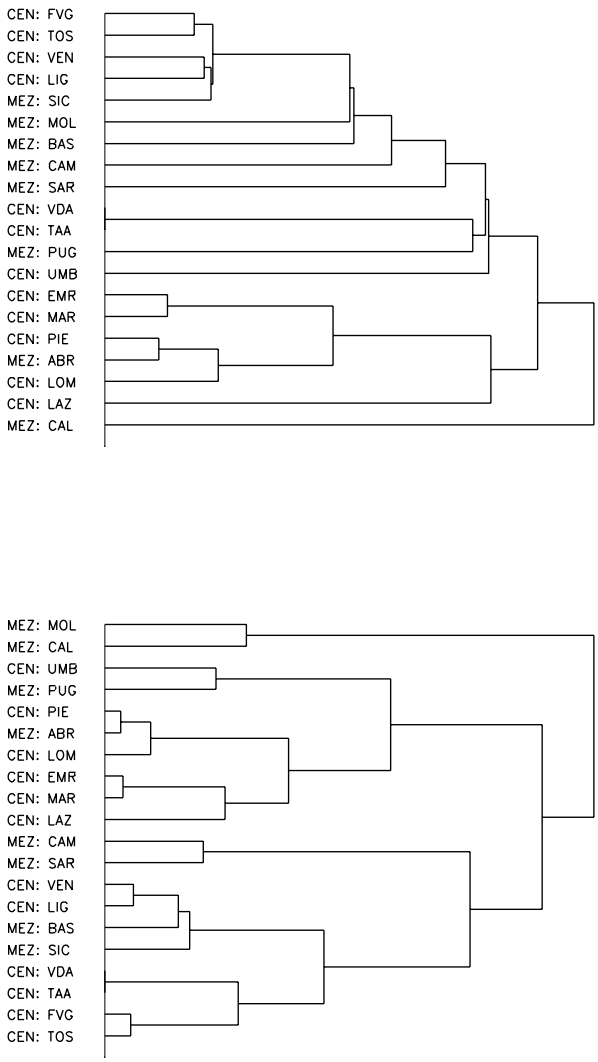
single-link and the complete-link method. For a description of cluster analysis, see e.g. Krzanowski (1990).

[12] For Umbria, Molise, and Puglia, the results are not robust.

Figure 2: Business Cycle Structure in Italian Regions



Notes:
The upper graphic contains the dendrogram for the single-link method, the lower graphic for the complete-link method.
PIE: Piemonte; VDA: Valle D'Aosta; LOM: Lombardia; TAA: Trentino Alto Adige; VEN: Veneto; FVG: Friuli Venezia Giulia; LIG: Liguria; EMR: Emilia Romagna; TOS: Toscana; UMB: Umbria; MAR: Marche; LAZ: Lazio; ABR: Abruzzo; MOL: Molise; CAM: Campania; PUG: Puglia; BAS: Basilicata; CAL: Calabria; SIC: Sicilia; SAR: Sardegna.

In the next step, we compare the interaction between business cycles in the North and in the Mezzogiorno looking at explained variance. The observation period is 1950-2000. The results are displayed in Figure 3.[13] We show time series of explained variances for the classical business cycle range (i.e. 7-10 and 3-5 years), and for the range in between (5-7 years). As a first result, we see that explained variance in the 5-7 years range is on average higher than for the other cycle lengths. This is not astonishing, given that this range has the most significant results in Table 2. Over time, explained variance decreases, while it increases in the 7-10 years range, a cycle range which is associated with fixed investment. The South catching up with the already post-industrial North could have such an effect.

Explained variance starts at a relatively high level of about 80% in the 50s, but the cycles are out of phase. This changes in the period 1960-65, where the overall measure decreases, but with an increasing in-phase component. In 1960-70, explained variance stays almost constant, with the in-phase component dominating. The period 1970-75 is characterised by a sharp decrease of the in-phase explained variance. After 1975, the overall measure starts to increase again until 1982, with dominating out-of-phase component. The subsequent fall of explained variance until 1985 is accompanied by an increase in the importance of the in-phase component. After 1985, the overall measure increases steadily almost to the level reached in 1960, but the out-of-phase component starts to dominate.

What can be an explanation of the changing nature of the regional cycle transmission?[14] Explained variance seems to be especially high in years where economic policies were adopted which affected the entire country. For

[13]The data were detrended using the modified Baxter-King filter (Woitek, 1998). The results for the other filtering methods show that the outcome is robust.

[14]For the following, see Zamagni (1993) and Rossi and Toniolo (1996).

example, the Italian government tried to overcome structural problems by implementing the Vanoni Plan (1954) and founding the *Cassa del Mezzogiorno* (1950), which could have led to a closer relationship between the regional cycles. The decreasing association in the periods 1970-75 and 1982-85 can be attributed to the impact of the first and second oil crisis. The difference in the structure of the industrial sector, with the state-owned heavy industries in the South, might have triggered different responses to these shocks. The increase in explained variance after 1985 can be interpreted as a consequence of the increasing similarity between the industrial sectors in the two regions (Del Monte and Giannola, 1997). If the industrial sectors become more similar over time, one would expect a increasing relationship between the cycles. Another factor leading to this increase is the diminishing importance of the agricultural sector not only in the North, but also in the South. The agricultural sectors are very different in terms of products and markets; hence, declining agriculture will lead to a closer association.

The change in explained variance describes changes in the association of the regional cycles. Whether the cycles are in phase or not shows the nature of the transmission mechanism. The period before 1978 is characterised by a dominace of in-phase explained variance, while the out-of-phase component dominates after this date, with the exception of a short period around 1987. These fluctuations of the two components can be linked to a change in inter-regional migration as an important component of the transmission mechanism. Migration between the regions decreases over the observation period, although the unemployment differential increases (e.g. Padoa Schioppa, 1991; Faini *et al.*, 1997). Hence, despite the growing similarity between the industrial structure in the South and the North, regional specific shocks like the asymmetric public infrastructure investment (Del Monte and Giannola,

1997, p.105-108) are only transmitted with a lag. The increase in trade between the regions (Del Monte and Giannola, 1997) is obviously to small to compensate for this effect.

Figure 3: Explained Variance