

**BUSINESS CYCLE SYNCHRONISATION AT THE REGIONAL LEVEL:
EVIDENCE FOR THE PORTUGUESE REGIONS**

CORREIA, Leonida

GOUVEIA, Sofia

Abstract

This paper looks at the synchronisation of product per capita in Portuguese regions at a disaggregated level over the period 1988-2010. Furthermore, it examines the volatility of the regional cycles by calculating dispersion measures. As a whole, results indicate that in Portugal, despite the geographical proximity of regions, there are substantial regional asymmetries in the amplitude and degree of association of regional business cycles. The discrepancy in the dynamics of the average correlations of the NUTSIII cycle with the regional (NUTSII) and national cycles supports the existence of a regional border effect.

Keywords: Business cycles; Synchronisation; Portuguese regions

JEL Classification: E32; R11

1. Introduction

The degree of synchronisation in business cycles across regions is influenced, among other factors, by its historical links, economic and trade relations and proximity or cultural affinities. Consequently, a region's growth pattern may be more related to certain regions than to others.

Synchronisation has been an important topic of research in recent decades. The theoretical foundations of business cycle synchronization goes back to the theory of Optimum Currency Areas (OCA), pioneered by Mundell (1961) and later developed by such authors as McKinnon (1963) and Kenen (1969), among others. The OCA theory has extensively analysed the criteria and the costs/benefits associated with participation in a common currency area. In a nutshell, this theory holds that a monetary union will remain stable if the benefits associated with gains in trade and economic growth - as a result of the elimination of exchange rate uncertainty and reduction in transaction costs - outweigh the costs of losing monetary and exchange policies independence.

Over the years, OCA theory has stressed the relevance of synchronisation between member states of a monetary union as a key variable. More specifically, it has been asserted that the closer the degree of cyclical synchronisation, the lower the stabilization costs of giving up an independent monetary policy.

As regards Europe, a growing number of studies have examined whether the euro area qualifies to be an OCA. One line of research in particular has examined whether the deepening of economic integration had generated greater co-movement of business cycles. The basic notion was that the euro area would only be an OCA if there was synchronisation in the business cycles of its member states, i.e. when all were in the same phase of the cycle. The importance of this research supports the well-known critique that a common monetary policy may not be equally beneficial for all countries or regions in the union (*one size does not fit all*) due to the difficulty of dealing with asymmetric shocks (i.e. shocks that are idiosyncratic to regions or countries).

In this context, two opposing views have emerged. On the one hand, Krugman's "specialisation hypothesis" (1993) argues that economic integration leads to concentration of industrial activities by region, due, among other things, to scale

economies, externalities or agglomeration effects. This increasing specialization is likely to convert sector-specific shocks in region-specific ones, which will lead to more asymmetric shocks and widen differences in regional economic cycles. Therefore, this pessimistic perspective argued that business cycles in the euro area, especially at regional level, could become more divergent after the creation of the Economic and Monetary Union (EMU).

The second view is based on the idea that more trade across regions and nations will narrow down the differences between them, since trade barriers will be removed and economies will have more symmetrical fluctuations and these, in turn, will lead to more synchronised cycles. Additionally, the coordination of economic policies also accounts for greater convergence. This is Frankel's and Rose's position (1998), which was followed by others, in what came to be known as the "endogeneity hypothesis". The relevance of this hypothesis is that it considers that OCA criteria could be met *ex-post* under the influence of a single currency and a common monetary policy.

Most of the recent empirical literature on synchronisation in Europe focuses on the national level and has been assessing whether the cycles of the economies in the euro area have become more correlated following the creation of EMU. Other related literature has examined the determinants of cyclical co-movements in economic activity. The results of these two research programs are far from being consensual and have not been very conclusive (De Haan *et al.*, 2008; Giannone *et al.*, 2009). The different results may be explained by diverse sample periods, research methods and countries under study. A firm conclusion is, nevertheless, that euro area countries correlate amongst themselves more than with the rest of the world, despite the emergence of a world business cycle as a consequence of globalization (Marelli, 2007).

Studies examining regional cycles are few and use different methodologies and data sets, making it difficult to compare them. The questions discussed are, for example, how regional disparities relate to the aggregate (national) level of development or how specialized regions are. As far as the latter are concerned, there is a wide consensus that, in certain sectors or activities, regions are more specialised than national economic systems. In this sense, many economists are willing to concede that Krugman's hypothesis of growing sector specialisation is more realistic regionally than nationally (Marelli, 2007). Another important result is that regional growth, especially in what concerns employment, is more synchronized when regions are similar in the industry structures (Belke and Heine, 2006). On the other hand, the importance of the regional dimension to the synchronization of countries has been emphasised by several authors. Barrios and Lucio (2003), for example, claim the dynamics of synchronization at the regional level might influence how national economies adjust to European integration; and others such as Artis *et al.* (2011) find exploring the regional dimension, despite the complications involved, will provide new knowledge.

The effect of European integration in the (as)symmetry of business cycles at the regional level for the European Union (EU) is another issue that has been at the heart of a considerable number of research studies. One of its precursors is Fatás (1997), who found that an increasing correlation of national business cycles in Europe was in line with the decrease of the co-movements between regions. Consequently, the author concludes that the economic significance of national borders has decreased. Subsequent studies, however, have achieved the opposite effect, i.e., they have found that the correlation of

regional cycles with the national cycle remained high over the time, despite the economic integration, pointing to the existence of the so-called border effect.

The concept of the border effect is built on the assumption that regions within the same country tend to have greater correlations because they are more highly integrated. In a widely cited study, Clark and Van Wincoop (2001) compare cyclical correlations in the United States (US) and in EU countries and found there is a stronger border effect in Europe than in the US. Following these authors' methodology, Barrios and de Lucio (2003), emphasising the case of Iberian regions, concluded that this effect had considerably decreased in Europe. This decrease was more pronounced for Spain and Portugal in the years following their integration in the EU. Conversely, the study of Montoya and De Haan (2008) came to support the hypothesis of a border effect that influences the synchronisation. Additionally, in relation to the question whether or not there is a regional cycle in the euro area, the authors concluded that it was difficult to give a definite answer because none of the existing studies used a database which included all regions of the euro area. However, they recognized that the various studies on the subject share a common denominator: the existence of large differences in the regions, although they were not seen as supporting Krugman's specialization hypothesis. More recently, in a work with a wide geographical coverage (280 NUTSII regions of 15 EU countries), Seidschlag and Tondl (2011) found that a greater trade integration had exerted a positive effect on the convergence of regional output growth within the euro area.

As regards the Portuguese case, literature on synchronisation is limited and focuses mainly on its association with the EU countries' cycles. At national level, Gouveia and Correia (2008) showed that Portugal's, Finland's and Greece's cycles were the ones which presented lower correlation with the aggregate cycle of the euro area, besides experiencing greater volatility. However, the association of Portugal with the euro area has increased considerably over time, especially in the second half of the 80s. At a more disaggregated level, using data from five Portuguese NUTSII regions, Barrios and de Lucio (2003) provided evidence that European integration had a positive impact on the cyclical convergence, while Montoya and de Haan (2008) concluded that, in the case of three Portuguese regions, despite an increasing correlation with the euro area cycle, there have been no changes in the degree of association with the national cycle in the regions in question.

As far as we know, no study dealing exclusively with synchronisation in Portuguese regions at a disaggregated level has been so far published. This paper aims to fill this gap by performing an analysis of the dynamics of correlations between cycles in the gross domestic product (GDP) per capita of the Portuguese regions, for the several NUTS, over the period 1988-2010. Moreover, measures of dispersion will be calculated so as to ascertain whether the regional cycles differ in their amplitude.

The remainder of this paper is organized as follows. Section 2 describes the data and methodology. Section 3 presents and discusses the results. Section 4 concludes.

2. Data and methodology

In order to analyse the fluctuations in regional economic activity, we chose as our reference variable the GDP per capita in constant 2000 prices in thousands of euros for the period 1988-2010. The definition of the sample period was constrained by the unavailability of annual data for the regions, at the NUTSIII level, for a period further

back in time. In view of the scarcity of regional data on a quarterly or monthly basis, using annual frequency data seemed to be the natural option.

The following two figures give us a picture of the data.

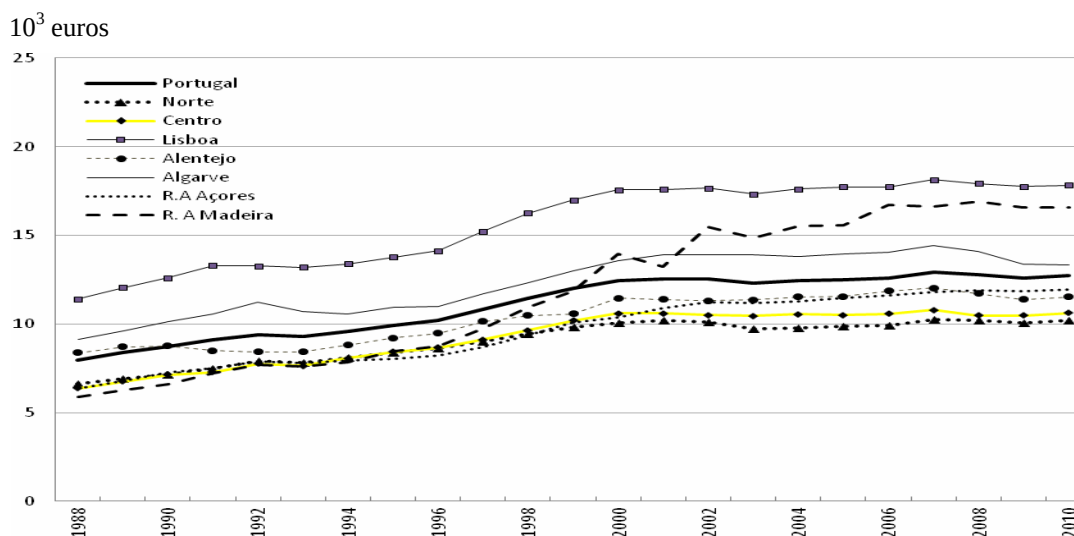


Figure 1: GDP per capita of NUTSII regions, 1988-2010

Figure 1 clearly shows that over the period 1988-2010 *Lisboa*, *Madeira* and *Algarve* reached a product greater than the national average besides there being a convergence of GDP per capita for almost all of the NUTSII regions. This convergence occurred as a result of relatively poorer regions such as *Açores*, *Alentejo*, *Centro* and *Norte* having grown faster, while the initially richer *Algarve* region, has had its advantage reduced. The largest differences occurred in the case of *Lisboa*, which was always very clearly above the national average, and *Madeira*, whose evolution stood out, since the region went from the lowest situation in the beginning to the second highest position in 2010 (positive divergence).

Figure 2 illustrates the great disparity in GDP per capita at the intra-regional (NUTSIII) level.

In *Norte*, *Grande Porto* stands out as the only sub-region with a product which is clearly above the average over the whole period. The sub-region *Entre Douro e Vouga* maintained a performance very close to the *Norte* average, reaching beyond it between 1998 and 2008. The sub-region *Ave* has negatively diverged since 2002, while *Cávado* has approached the average. The remaining four sub-regions are below the regional average, *Tâmega* being the most distant sub-region.

In 2010, four sub-regions in *Centro* - *Pinhal Litoral*, *Baixo Mondego*, *Baixo Vouga* e *Beira Interior Sul* - recorded figures above the average while, the remaining eight sub-regions register values below. Noteworthy is *Pinhal Litoral*, which occupies the highest position, in contrast to *Serra da Estrela* which has the lowest GDP per capita. It should also be noted that *Serra da Estrela* is the poorest sub-region of all Portuguese NUTSIII.

The NUTSIII *Grande Lisboa* has the highest GDP per capita in the *Lisboa* region and is clearly different from all other sub-regions. The process of detachment beyond the

regional average (positive divergence) was more pronounced in the second half of the nineties.

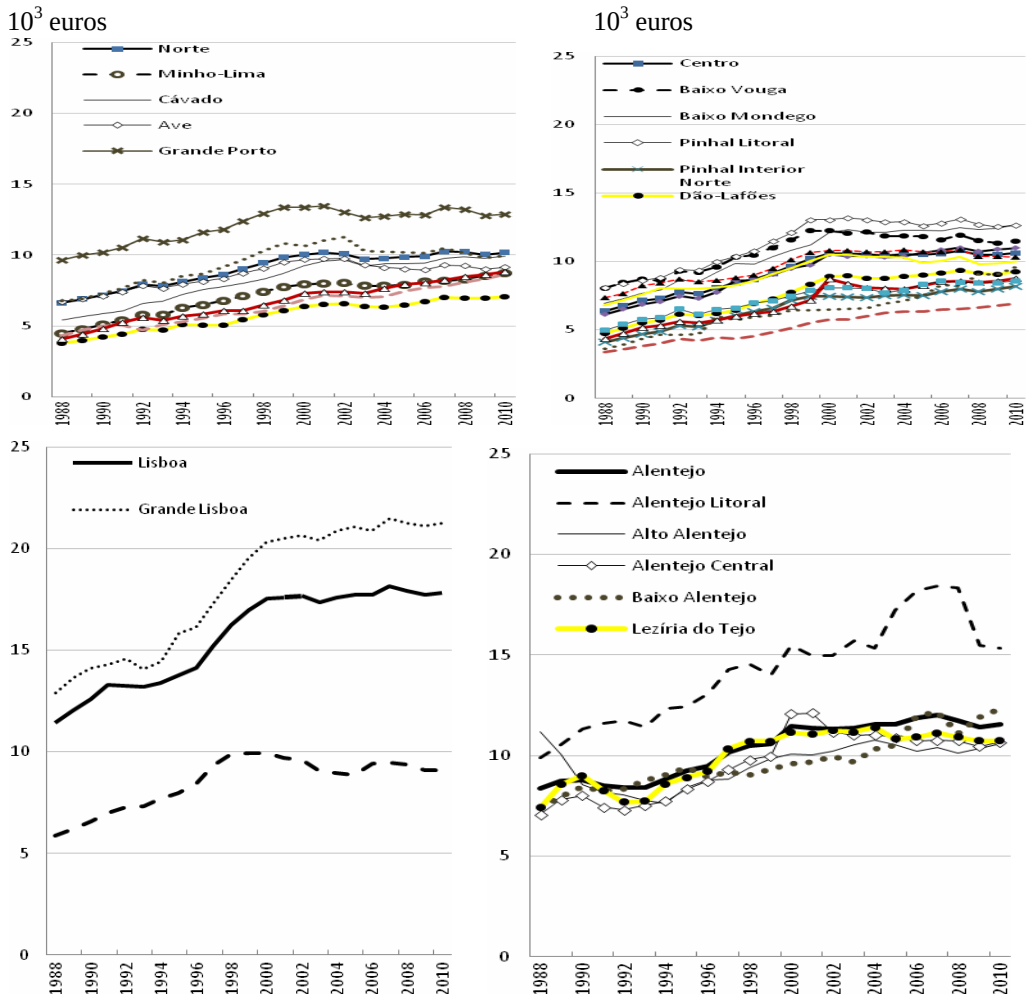


Figure 2: GDP per capita of NUTSIII sub-regions, 1988-2010

As concerns *Alentejo*, *Alentejo Litoral* is the only sub-region with a product clearly above the regional average. The other four sub-regions, despite having diversified dynamics throughout the sample period, are very close to this average in 2010.

Overall, the strongest impression resulting from the analysis of the figures above is that there are large asymmetries in GDP per capita among the Portuguese regions. These findings are in line with other studies, namely Guerreiro's and Caleiro's (2005), showing that, regardless of being a small country, Portugal is characterised by large regional disparities, though, which are clearly discernible in the analysis of such indicators as level of income or unemployment.

In this context, using different concepts and methodologies, several authors have shown that the income is not equally distributed across the Portuguese territory, highlighting a

higher incidence of poverty in rural areas rather than in urban areas (e.g., Rodrigues, 2008). Also Pereira *et al.*(2009) draw the attention to the great heterogeneity in the territory, both in terms of rurality, accessibility and economic context (the latter involving such variables as productivity, income, unemployment rate and purchasing power, among others). Their work suggests the coexistence and juxtaposition of three regional oppositions: north *versus* south; coast *versus* inland; and the archipelago configuration.

In the next step, we proceeded to the identification of the business cycle. In order to do so, we have used the “deviation cycle” concept proposed by Lucas (1977), i.e. the fluctuations in the cyclical component of a variable around its trend. The literature suggests several methods for estimating the cyclical component of a macroeconomic series. However, given that empirical results depend on the specific filter adopted (Canova, 1998), we have applied two techniques so as to make our results robust: the Baxter-King (BK) bandpass filter (Baxter and King, 1999) and the Hodrick-Prescott (HP) filter (Hodrick and Prescott, 1997). In the configuration of the BK filter we have followed the authors’ suggestion that fluctuations be extracted within a specific band between 1.5 and 8 years. In the HP filter, we have used a smoothing parameter of 6.25 ($\lambda = 6.25$), a value proposed in the literature for annual series (e.g, Ravn and Uhlig, 2002). Figure B.1 in Appendix B presents the business cycles of the Portuguese regions calculated according to the BK method.

After having completed the filtering process, we calculated the Spearman’s rank correlation coefficient in order to obtain the degree of synchronisation; this coefficient describes the degree of association between pairs of cycles. It has the advantage of not being sensitive to the possible asymmetry of distributions of the variables or the presence of outliers, thus not requiring the data to be normally distributed (Pestana and Gageiro, 2003). We have begun the study by obtaining the contemporary correlation coefficients between each of the seven NUTSII regions cycles and the national cycle. Then, we have computed the correlations between each of the 27 NUTSIII sub-regions cycles and the respective NUTSII region and the national aggregate cycles. Additionally, in order to examine the evolution of the degree of synchronisation along the sample period, we have calculated rolling correlations using a window of 8 observations, which corresponds to the maximum duration of the typical business cycle. Finally, we have compared the volatility of the regional economic activity using two measures of dispersion: the mean absolute deviation (MAD) and the standard deviation (SD).

3. Results and discussion

In this section we present and discuss the results of the study of synchronization and volatility of regional cycles. Table 1 shows the contemporary correlation coefficients between the cycle of each NUTSII region and the national business cycle. The figures have been obtained by applying the BK and HP filters and are qualitatively similar. This conclusion applies to all other computations performed in this study. Therefore, and because from a theoretical point of view BK filter is preferable (Stock and Watson, 1998), in which follows only BK filtered correlations will be presented and looked into.¹ It is also evident that the degree of synchronisation varies substantially between the NUTSII regions. *Norte*, *Lisboa* and *Algarve* register the highest association while *Alentejo* has the lowest degree of correlation with the Portuguese business cycle.

¹ All results for the HP filter are available from the authors on request.

Table 1: NUTSII cycle correlation with national cycle, 1988-2010

	BK Filter	HP Filter
Norte	0.92***	0.90***
Centro	0.83***	0.87***
Lisboa	0.94***	0.95***
Alentejo	0.50**	0.44**
Algarve	0.90***	0.88***
Região Autónoma dos Açores	0.78***	0.80***
Região Autónoma da Madeira	0.61***	0.67***

Source: Author's own calculations. Note: ** and *** denote significance at the 5% and 1% levels, respectively.

Regarding the amplitude of the NUTSII cycles, we have obtained similar results with the two measures of dispersion, as documented in Table 2.

Table 2: Dispersion measures of the NUTSII cycles, BK filter, 1988-2010

	MAD	SD
Norte	1.13	1.35
Centro	1.08	1.39
Lisboa	1.17	1.47
Alentejo	1.42	1.78
Algarve	1.51	2.00
Região Autónoma dos Açores	1.08	1.39
Região Autónoma da Madeira	2.35	3.13

Source: Author's own calculations.

There are substantial differences in the amplitudes of NUTSII business cycles. The SD and MAD of the cyclical component of GDP per capita in the region with higher volatility (*Madeira*) more than doubles the values observed in regions with lower volatility (*Norte*, *Centro* and *Açores*).

When we look at the contemporary correlation coefficients between each NUTSIII sub-region cycle and the Portuguese and the respective NUTSII region cycles (Table 3), we conclude that the degree of synchronisation varies considerably among NUTSIII sub-regions. Not surprisingly, given its importance in the national aggregate, *Grande Porto* and *Grande Lisboa* present the highest synchronisation (0.9), whereas *Douro*, *Pinhal Interior Sul*, *Alto Alentejo*, *Alentejo Central* and *Baixo Alentejo* cycles are not associated with the national cycle.

At the intra-regional level, the highest values for the correlations with the respective regions are the following: *Ave*, *Grande Porto* and *Entre Douro e Vouga* (0.9) with *Norte*; *Baixo Vouga*, *Baixo Mondego*, *Pinhal Litoral*, *Pinhal Interior Norte* and *Oeste* (0.8) with *Centro*; *Grande Lisboa* (0.8) with *Lisboa*; *Alentejo Central* (0.8) with *Alentejo*. At the

opposite extreme, there come *Douro*, *Pinhal Interior Sul* and *Alto Alentejo* which have decoupling cycles with the region to which they belong.²

Table 3: NUTSIII cycle correlation with national and regional cycles, BK filter, 1988-2010

		Cycle correlations with	
		NUTSI	NUTSII
Norte	Minho-Lima	0.61**	0.67***
	Cávado	0.45**	0.66***
	Ave	0.81***	0.89***
	Grande Porto	0.86***	0.89***
	Tâmega	0.75***	0.83***
	Entre Douro e Vouga	0.74***	0.86***
	Douro	0.13	0.16
	Alto Trás-os-Montes	0.51**	0.55***
Centro	Baixo Vouga	0.68***	0.83***
	Baixo Mondego	0.56***	0.81***
	Pinhal Litoral	0.74***	0.83***
	Pinhal Interior Norte	0.49**	0.79***
	Dão-Lafões	0.78***	0.72***
	Pinhal Interior Sul	0.07	0.13
	Serra da Estrela	0.45**	0.55***
	Beira Interior Norte	0.38*	0.46**
	Beira Interior Sul	0.67***	0.75***
	Cova da Beira	0.65***	0.68***
	Oeste	0.75***	0.79***
	Médio Tejo	0.71***	0.71***
Lisboa	Grande Lisboa	0.86***	0.81***
	Península de Setúbal	0.70***	0.68***
Alentejo	Alentejo Litoral	0.52**	0.50***
	Alto Alentejo	-0.04	0.04
	Alentejo Central	0.26	0.82***
	Baixo Alentejo	0.11	0.40*
	Lezíria do Tejo	0.40*	0.69***

Source: Author's own calculations. Note: *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

² Table C.1 (Appendix C) shows the correlation coefficients between the cyclical components of GDP per capita between region i and region j, at NUTSIII level, over the period analysed. Note that the six lowest correlation coefficients are negative and always include *Alto Alentejo*. This suggests that this particular region has a desynchronised cycle in relation to the cycle of each Portuguese sub-region.

Table 4: Dispersion measures of the NUTSIII cycles, BK filter, 1988-2010

		MAD	SD
Norte	Minho-Lima	0.97	1.23
	Cávado	1.23	1.47
	Ave	1.28	1.53
	Grande Porto	1.29	1.60
	Tâmega	1.62	1.96
	Entre Douro e Vouga	1.76	2.21
	Douro	1.75	2.38
	Alto Trás-os-Montes	1.44	2.01
Centro	Baixo Vouga	1.33	1.61
	Baixo Mondego	1.23	1.65
	Pinhal Litoral	1.12	1.53
	Pinhal Interior Norte	1.30	1.73
	Dão-Lafões	1.43	1.83
	Pinhal Interior Sul	2.39	3.51
	Serra da Estrela	1.31	1.76
	Beira Interior Norte	2.23	3.28
	Beira Interior Sul	1.44	1.91
	Cova da Beira	1.71	2.24
	Oeste	1.39	1.59
	Médio Tejo	1.36	1.75
Lisboa	Grande Lisboa	1.37	1.73
	Península de Setúbal	1.88	2.14
Alentejo	Alentejo Litoral	3.13	3.82
	Alto Alentejo	2.10	2.69
	Alentejo Central	2.51	3.66
	Baixo Alentejo	2.26	2.99
	Lezíria do Tejo	2.54	3.69

Source: Author's own calculations.

The two measures of NUTSIII sub-regions cycles' volatility (table 4) reveal marked differences. The SD of the cyclical component of GDP per capita in sub-regions with higher volatility (*Alentejo Litoral*, *Lezíria do Tejo*, *Alentejo Central*, *Pinhal Interior Sul* and *Beira Interior Norte*) is about three times as much the SD of the region bearing the lower volatility (*Minho-Lima*). The analysis that has been done so far does not demonstrate the evolution in the cyclical association over time. To analyse the dynamics of regional cycles, we have computed the correlations between the cycle of the NUTSII and NUTSIII with the national cycle (figure 3) for rolling periods of 8 years, and the linear trend of sequential correlation. For the sake of simplification, the years mentioned correspond to the midpoint of each period.

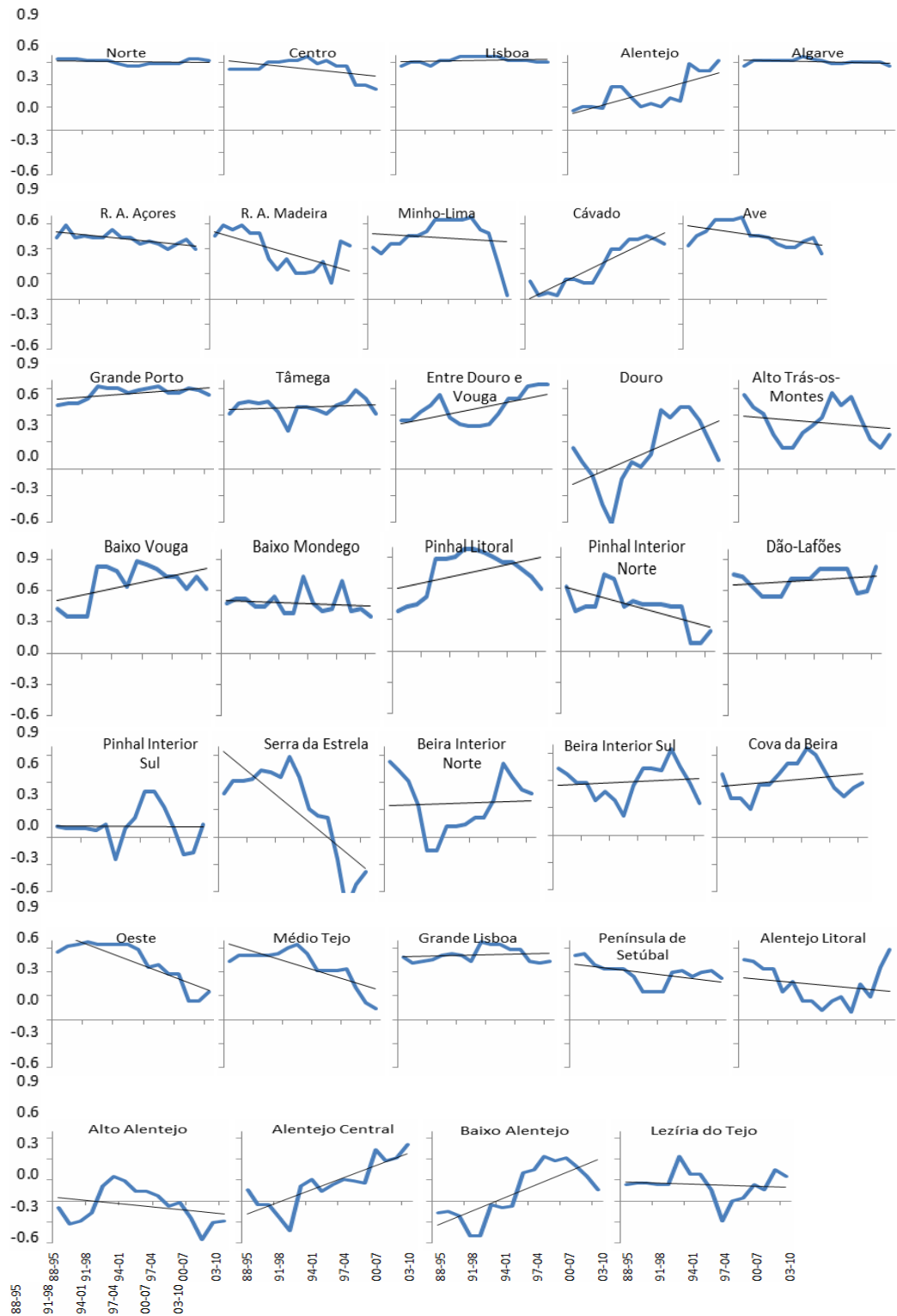


Figure 3: Correlations of the NUTSII and NUTSIII cycles with the national business cycle, 8-year rolling window, BK filter, 1988-2010

The analysis of figure 3 suggests several conclusions. At NUTSII regions level, we highlight the following:

- *Norte*, *Lisboa* and *Algarve* cycles display very high correlations with the national cycle throughout the whole period, keeping a relatively constant trend and values equal to or greater than 0.9;
- *Centro*, *Açores* and *Madeira* constitute a group which is characterised by correlations with a downward trend. However, their evolution is differentiated in the period 1988-2010: *Centro* has high correlations in the early years, but decline sharply after 2000, though; the figures for *Açores* are generally close to the trend, showing no particularly accentuated deviations; *Madeira's* correlations show a remarkable break until the mid 2000s, although recovering onwards.

On the other hand, the rolling correlations for the NUTSIII sub-regions allow us to assert that:

- The group integrating *Cávado*, *Entre Douro e Vouga*, *Douro*, *Baixo Vouga*, *Pinhal Litoral*, *Alentejo Central* and *Baixo Alentejo* displays correlations with a clearly increasing trend; at the opposite extreme, showing a sharply downward trend, are *Pinhal Interior Norte*, *Serra da Estrela*, *Oeste*, *Médio Tejo* and *Alto Alentejo*. In the remaining sub-regions, the trend evolves gradually;
- We highlight the positive cases of *Grande Porto* and *Grande Lisboa* as the sub-regions where the correlations are higher (with an average of around 0.9 and 0.8, respectively) besides there being no major fluctuations around the trend, which is slightly increasing. This contrasts with the desynchronisation behaviour evidenced by *Alto Alentejo* throughout the whole period, always displaying negative or extremely low correlations. Also, *Pinhal Interior*, *Serra da Estrela* and *Lezíria do Tejo* register very low values (between 0.1 and 0.2).

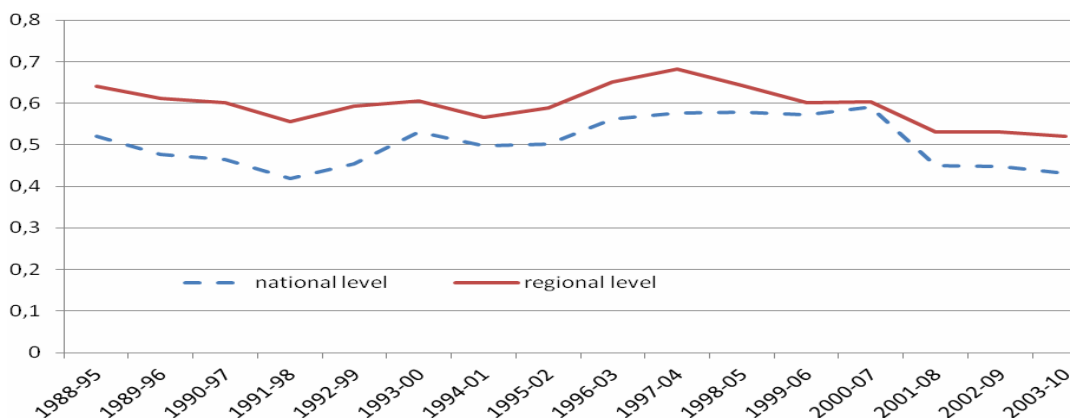


Figure 4: Average correlation of the NUTSIII cycle with regional and national business cycles

Figure 4 shows the average correlation coefficient for all NUTSIII cycle with the national and regional reference cycles, for rolling periods of eight years. It becomes clear that the average correlation of the NUTSIII cycle with the national cycle experienced a substantial increase in the second half of the 90s and declined in the first decade of this century. The dynamics of the average correlations of NUTSIII with the cycle of the

respective region is similar. However, and despite a narrowing of the difference in the second half of the nineties, the degree of synchronisation at the regional level remains higher than with the national cycle, suggesting the existence of a border effect specific to the region that seems to have become more pronounced in recent years.

A qualitatively compatible result was obtained by Panteladis and Tsiapa (2011) for the Greek NUTSIII regions, in the period 1980-2008. Using a similar methodology, the authors also concluded that there is a regional border effect.

4. Conclusions

Business cycle synchronisation has been an important topic of research in recent decades. However, the literature has been more abundant at the national rather than at the regional level.

With our empirical research we wish to make a contribution towards filling this gap for Portugal, examining the correlations of business cycles in the Portuguese NUTSIII level disaggregated regions, covering a period of 23 years, from 1988 to 2010. Also, we have evaluated the volatility of regional cycles by calculating measures of dispersion.

The results from the synchronisation and volatility analysis have revealed substantial assymetries in the product per capita cycles of the Portuguese NUTSII and NUTSIII regions.

The correlations with the national business cycle indicate that, at the regional level, the major differences are between *Alentejo*, which has the lowest degree of correlation, and the group formed by *Norte*, *Lisboa* and *Algarve*, which displays the highest association. In the case of sub-regions, *Grande Porto* and *Grande Lisboa* have the strongest correlations, unlike *Douro*, *Pinhal Interior Sul*, *Alto Alentejo*, *Alentejo Central* and *Baixo Alentejo* which present decoupling cycles relative to the national cycle.

At the intra-regional level there is also a large asymmetry. The highest values for correlations with the regions to which they belong are displayed by *Ave*, *Grande Porto* and *Entre Douro e Vouga* with *Norte*; by *Baixo Vouga*, *Baixo Mondego*, *Pinhal Litoral*, *Pinhal Interior Norte* and *Oeste* with *Centro*; by *Grande Lisboa* with *Lisboa*; and by *Alentejo Central* with *Alentejo*. On the opposite extreme are *Douro*, *Pinhal Interior Sul* and *Alto Alentejo*, which display dissynchronised cycles relative to the region to which they belong.

As concerns business cycles dispersion, *Norte*, *Centro* and *Açores* are the regions that record the lowest volatility, contrary to *Madeira* which has the highest cyclic dispersion. At the sub-regions level, *Minho-Lima* stands out for having the lowest volatility unlike the group consisting of *Alentejo Litoral*, *Lezíria do Tejo*, *Alentejo Central*, *Pinhal Interior Sul* and *Beira Interior Norte*, which show the highest values.

Moreover, the analysis of the dynamics of synchronisation for rolling periods of eight years revealed disparities in the evolution of the trend of the regional cycles. In particular, the comparison of the dynamics of average correlations between the NUTSIII cycle with the regional and national cycles showed that, although the difference narrowed down in the second half of the nineties, the degree of synchronisation at the regional level remains higher than at national level. This discrepancy has increased in recent years. These findings support the hypothesis that there is a border effect specific to the region.

In conclusion, results indicate that in Portugal, despite the geographical proximity of regions, there are significant regional differences in the degree and pattern of the business cycle synchronisation. This may have important implications regarding the effectiveness

of regional economic policies, especially those intended to reduce inequalities in the economic growth across regions.

Finally, we wish to point out that this study opens the way to interesting topics for further research. A potential extension might be to determine the sources of the differences between regional cycles. The convergence/divergence among Portuguese regions might also be looked at so as to ascertain whether it has been influenced by the European integration process and, particularly, by the creation of EMU.

References

- Artis, J., C. Dreger and K. Kholodilin (2011), *Common and spatial drivers in regional business cycles*. The Manchester School, 79, 1035-1044.
- Barrios, S. and J. de Lucio (2003), *Economic Integration and Regional Business Cycles: Evidence from the Iberian regions*. Oxford Bulletin of Economics and Statistics, 65, 497-515.
- Baxter M. e R. King (1999), *Measuring Business Cycles: Approximate Band-Pass Filters for Economic Time Series*. The Review of Economics and Statistics, 81, 575-593.
- Belke, A. and J. Heine (2006), *Specialisation patterns and the synchronicity of regional employment cycles in Europe*. International Economics and Economic Policy, 3, 91-104.
- Canova, F. (1998), *Detrending and Business Cycle Facts*. Journal of Monetary Economics, 41, 475-512.
- Clark, T. and E. Van Wincoop (2001), *Borders and Business Cycles*. Journal of International Economics, 55, 59-85.
- De Haan, J., R. Inklaar and R. Jong-A-Pin (2008), *Will business cycles in the euro area converge? A critical survey of empirical research*. Journal of Economic Surveys, 22, 234-273.
- Fatás, A. (1997), *EMU: Countries or regions? Lessons from the EMS experience*. European Economic Review, 41, 743-751.
- Frankel J. and A. Rose (1998), *The Endogeneity of the Optimum Currency Area Criteria*. Economic Journal, 108, 1009-1025.
- Giannone, D., M. Lenza and L. Reichlin (2009), *Business Cycles in the Euro Area*. ECB Working Paper Series 1010.
- Gouveia S. and L. Correia (2008), *Business cycle synchronisation in the euro area: the case of small countries*. International Economics and Economic Policy, 5, 103-121.
- Guerreiro, G. and A. Caleiro, (2005), *Quão distantes estão as regiões Portuguesas? Uma aplicação de escalonamento multidimensional*. Revista Portuguesa de Estudos Regionais, 8, 47-59.
- Hodrick, R. and E. Prescott (1997), *Postwar U.S. Business Cycles: An Empirical Investigation*. Journal of Money Credit and Banking, 29, 1-16.
- Kenen P. (1969), *The Theory of Optimum Currency Areas: An Eclectic View*, Monetary Problems of the International Economy, R. Mundell e A. Swoboda (eds), University of Chicago Press, Chicago, 41-60.

- Krugman, P. (1993), *Lessons from Massachusetts for EMU*, Adjustment and Growth in the European Union, F. Torres e F. Giavazzi (eds), Cambridge University Press, 241-260.
- Lucas, R. (1977), *Understanding Business Cycles*. Carnegie Rochester Conference Series on Public Policy, 7-29.
- Marelli, E. (2007), *Specialisation and Convergence of European Regions*. The European Journal of Comparative Economics, 4, 149-178.
- McKinnon, R. (1963), *Optimum Currency Areas*. The American Economic Review, 53, 717-25.
- Montoya, L. and J. De Haan (2008), *Regional business cycle synchronization in Europe?*, International Economics and Economic Policy, 5, 123-137.
- Mundell, R. (1961), *A Theory of Optimum Currency Areas*. The American Economic Review, 51, 657-65.
- Panteladis, I. and M. Tsiapa (2011), *Business Cycle Synchronization in the Greek Regions*. Journal of Urban and Regional Analysis, 3 (2): 143-158.
- Pereira, E., J. Pereirinha and J. Passos (2009), *Desenvolvimento de Índices de Caracterização do território para o estudo da pobreza Rural em Portugal Continental*. Revista Portuguesa de Estudos Regionais, 21, 7-35.
- Pestana M. and J. Gageiro (2003), *Análise de dados para Ciências Sociais: A Complementaridade do SPSS*. Edições Sílabo, Lisboa.
- Ravn, M. and H. Uhlig (2002), *On Adjusting the HP-Filter for the Frequency of Observations*. The Review of Economics and Statistics, 84, 371-376.
- Rodrigues, C. (2008), *Distribuição do Rendimento, Desigualdade e Pobreza: Portugal nos anos 90*. Coleção Económicas - 2.ª Série, Livraria Almedina, Coimbra.
- Siedschlag, I. and G.Tondl (2010), *Regional output growth synchronisation with the Euro area*. Empirica, 38, 203-221.
- Stock, J. and M. Watson (1998), *Business Cycle Flutuations in U. S. Macroeconomics Time Series*. NBER 6528.

APPENDIX A

Table A.1: List of regions and respective codes

NUTSI	Code	NUTSII	Code	NUTSIII	Code
Portugal	PT				
		Norte	NO		
				Minho-Lima	MI
				Cávado	CA
				Ave	AV
				Grande Porto	GP
				Tâmega	TA
				Entre Douro e Vouga	ED
				Douro	DO
				Alto Trás-os-Montes	TM
		Centro	CE		
				Baixo Vouga	BV
				Baixo Mondego	BM
				Pinhal Litoral	PL
				Pinhal Interior Norte	PN
				Dão-Lafões	DL
				Pinhal Interior Sul	PS
				Serra da Estrela	SE
				Beira Interior Norte	BN
				Beira Interior Sul	BS
				Cova da Beira	CB
				Oeste	OE
				Médio Tejo	MT
		Lisboa	LI		
				Grande Lisboa	LIS
				Península de Setúbal	SET
		Alentejo	AJ		
				Alentejo Litoral	AJL
				Alto Alentejo	AJA
				Alentejo Central	AJC
				Baixo Alentejo	AJB
				Lezíria do Tejo	LEZ
		Algarve	AG		
		Açores	AR		
		Madeira	MA		

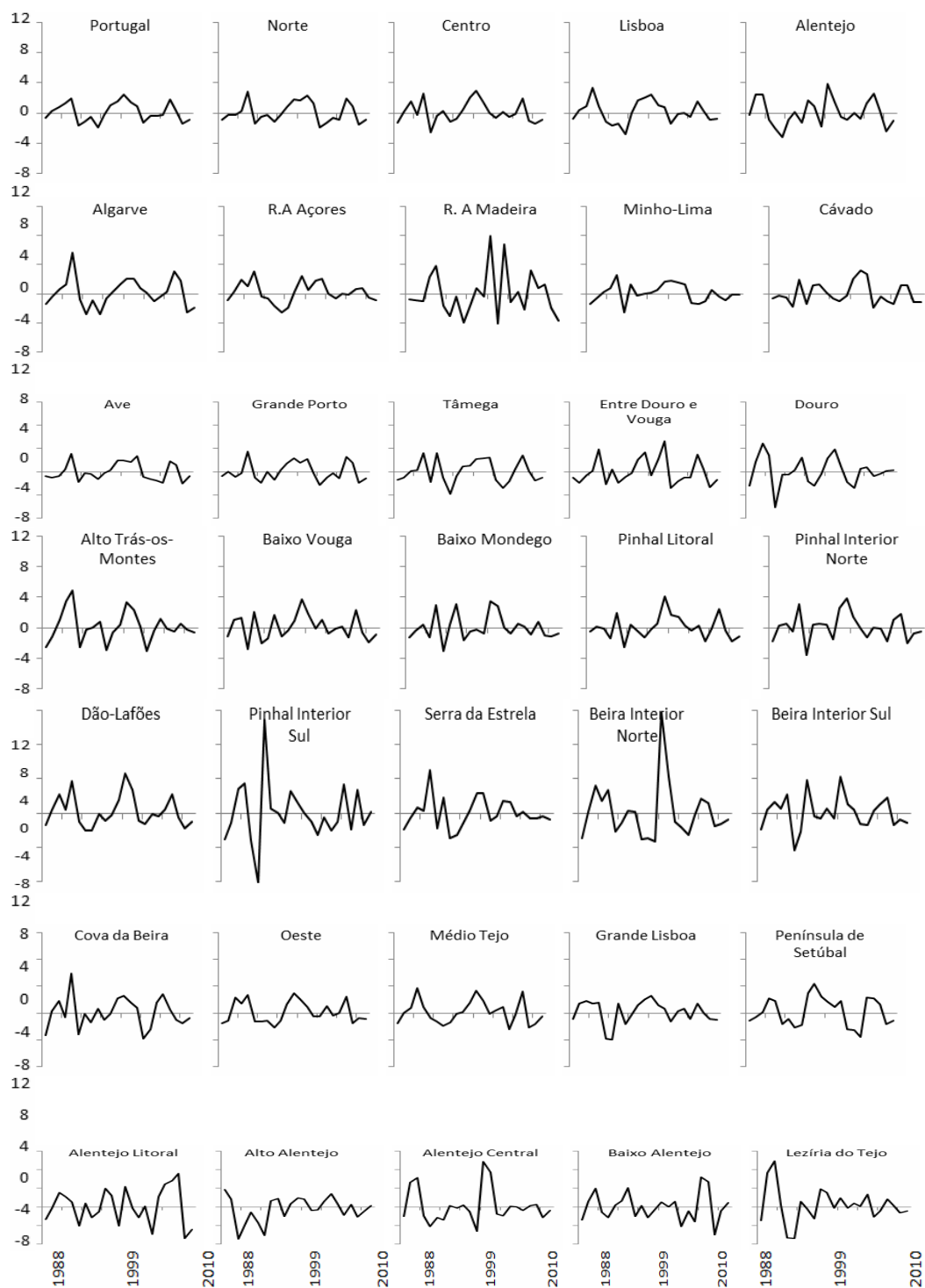
APPENDIX B

Figure B.1: Business cycle of Portuguese regions, 1988-2010

APPENDIX C

TableC.1: Bilateral correlation of NUTSIII sub-regions business cycles

	MI	CA	AV	GP	TA	ED	DO	TM	BV	BM	PL	PN	DL
MI	1.00												
CA	0.43	1.00											
AV	0.64	0.64	1.00										
GP	0.38	0.55	0.77	1.00									
TA	0.78	0.52	0.81	0.56	1.00								
ED	0.69	0.55	0.83	0.67	0.81	1.00							
DO	0.31	0.17	- 0.03	- 0.06	0.04	0.03	1.00						
TM	0.59	0.44	0.40	0.35	0.36	0.47	0.54	1.00					
BV	0.31	0.58	0.60	0.72	0.44	0.44	- 0.02	0.26	1.00				
BM	0.39	0.65	0.51	0.48	0.53	0.34	0.02	0.34	0.74	1.00			
PL	0.60	0.60	0.72	0.62	0.77	0.68	- 0.15	0.18	0.71	0.66	1.0 0		
PN	0.57	0.25	0.36	0.32	0.51	0.36	0.00	0.27	0.60	0.50	0.7 0	1.00	
DL	0.50	0.30	0.45	0.59	0.42	0.50	0.33	0.59	0.52	0.38	0.5 7	0.54	1.0 0
PS	0.34	- 0.13	0.03	- 0.15	0.22	0.14	0.43	0.27	- 0.13	- 0.03	0.0 4	0.32	0.0 6
SE	0.50	0.01	0.35	0.08	0.47	0.31	- 0.15	0.31	0.28	0.35	0.5 4	0.54	0.4 0
BN	0.40	0.36	0.18	0.16	0.36	0.15	0.64	0.67	0.21	0.45	0.1 5	0.33	0.5 6
BS	0.53	0.38	0.43	0.54	0.50	0.36	0.41	0.54	0.62	0.63	0.4 3	0.62	0.6 3
CB	0.74	0.42	0.42	0.44	0.60	0.61	0.43	0.68	0.53	0.44	0.5 6	0.60	0.7 6
OE	0.49	0.04	0.46	0.47	0.50	0.44	0.00	0.41	0.57	0.51	0.5 9	0.63	0.7 0
MT	0.49	0.14	0.56	0.44	0.51	0.42	0.09	0.25	0.40	0.39	0.6 4	0.54	0.7 5
LIS	0.43	0.41	0.61	0.77	0.47	0.44	0.21	0.49	0.82	0.62	0.5 9	0.56	0.7 1
SE T	0.61	0.11	0.61	0.59	0.71	0.72	0.00	0.10	0.28	0.07	0.5 8	0.39	0.4 6
AJL	0.27	0.10	0.36	0.38	0.48	0.44	0.15	0.25	0.22	0.24	0.3 1	0.25	0.4 5
AJ A	- 0.25	0.14	- 0.07	0.09	- 0.34	- 0.23	- 0.19	- 0.19	0.35	0.09	0.1 3	0.19	0.0 1
AJ C	- 0.10	0.34	0.07	0.28	- 0.05	- 0.05	0.47	0.14	0.34	0.42	0.1 1	- 0.02	0.3 5
AJ B	0.22	0.22	0.02	- 0.02	0.35	0.04	0.36	- 0.06	0.20	0.34	0.2 7	0.32	0.0 9
LE Z	0.16	0.15	0.30	0.21	0.27	0.20	0.13	- 0.13	0.35	0.40	0.4 6	0.25	0.2 6

	PS	SE	BN	BS	CB	OE	MT	LIS	SET	AJL	AJ A	AJ C	AJ B	LE Z
MI														
CA														
AV														
GP														
TA														
ED														
DO														
TM														
BV														
BM														
PL														
PN														
DL														
PS	1.00													
SE	0.22	1.00												
BN	0.19	0.09	1.00											
BS	0.14	0.14	0.74	1.00										
CB	0.22	0.41	0.60	0.67	1.00									
OE	0.05	0.68	0.31	0.58	0.56	1.00								
MT	0.01	0.55	0.32	0.45	0.40	0.78	1.0 0							
LIS	0.04	0.36	0.39	0.75	0.57	0.72	0.5 9 0	1.0 0						
SE T	0.22	0.26	0.02	0.38	0.48	0.44	0.4 9	0.4 2	1.00					
AJ L	0.39	0.19	0.37	0.47	0.42	0.25	0.2 3	0.3 2	0.54	1.00				
AJ A	- 0.30	- 0.10	- 0.23	- 0.01	- 0.10	- 0.01	0.0 1	0.1 7	- 0.29	- 0.39	1.00			
AJ C	0.12	- 0.30	0.43	0.44	0.16	- 0.02	0.1 1	0.3 4	- 0.02	0.42	0.07	1.0 0		
AJ B	0.17	- 0.05	0.39	0.38	0.30	0.12	0.1 7	0.1 7	0.23	0.09	- 0.22	0.2 6	1.0 0	
LE Z	0.30	0.30	- 0.01	0.22	0.08	0.26	0.4 3	0.4 0	0.37	0.39	- 0.08	0.5 1	0.3 2	1.0 0