Lund University
School of economics and management
Department of Economics

Endogeneity and Specialization Theories of Optimal Currency Areas: A Comparative European Study

Second Year Master Thesis

Author:
Kristoffer Persson

Supervisor:
Fredrik NG Andersson

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Abstract

In this thesis the group of European countries that signed the Maastricht treaty are investigated subject to the endogeneity aspect and the specialization effect of optimal currency areas. The main method used is time series factor analysis for identification of a common European business cycle. To give the analysis a firm basis the USA is compared with European countries during the 1970-2010 period. Furthermore, the group of European countries are analyzed for the 1970-1993 and 1993-2010 periods separately. The results point in the direction of the endogeneity aspect so far being the main aspect effecting the European countries. To further investigate the relationship between an occurrence of regional cycles in the US the Krugman index of specialization is deployed for both the European countries and the USA. This analysis together with the factor analysis implicates that the European countries can expect a future dominance of the specialization effect.

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Chapter 1

Introduction

The European Monetary Union has for a long time been considered as an optimal currency area. Economic events during the last four years have however revitalized this discussion. The financial crisis has had a profound impact on the European monetary union and has made it possible to view the economic evolution from the creation of the union as a full business cycle. The union has also for the first time faced internal problems through the substantial fiscal deficit of some of the member states. This opens the possibility of making a proper effort of measuring the coherence of member states and the occurrence of a common business cycle.

The economic motivation for having a common European currency clinches heavily on the assumption that the EMU is an optimum currency area. Establishing whether the EMU is such an area is therefore very important for a number of reasons. Firstly, it is important for determining the future existence of the union. Secondly, it is important for determining whether the union should be further expanded or not. Thirdly, it gives implications for policy makers when making further decisions about the outline of the union.

Currency areas have for a long time been the target of economic interest. Especially the different pros and cons of them have spurred many questions about when it is optimal to form such unions and under what circumstances it is optimal to have one. This work starts with Mundell (1961) who stated that periodic balance of payment crisis is unavoidable in a system of pegged exchange rates. Moreover, systems of purely flexible exchange rates might be suboptimal in areas who are candidates to be optimum currency areas (OCA). Groups of nations that are candidates to be included into such an area must have high internal and external common factor mobility. McKinnon (1963) continued the analysis further on the concept of optimum currency areas and stressed the importance of intra-industry factor mobility.

Vaubel (1977) contributes to the optimum currency theory by attempting to answer a set of questions regarding the suitability of the EC community (Germany, France, Italy, Netherlands BENELUX, UK, Ireland and Denmark) as an OCA. The research points in the direction of that the contemporary European community is indeed a candidate to be an OCA and that the concept of OCA might be a dynamic one. Melvin (1985) suggests that a currency substitution effect leads to a limitation of central banks ability to Independently control the monetary supply. The main implication of the research is that France, Germany, Italy and the UK are candidates to be an OCA but more for reason of currency substitution than anything else. A public finance perspective on Europe as an OCA is proposed by Canzoneri & Rogers (1990). Their findings suggests that the EC, which is stylized by including Italy and Germany, is likely to be an OCA if as long as they exhibit small valuation and currency conversion costs, low public spending and a high degree of openness.

In addition theories that aim at describing what happens to countries' business cycle synchronization after the inception of a currency union have been developed. Krugman and Venables (1996) develop a model of two imperfectly competitive industries located at different geographical positions. The purpose is to investigate whether the European community might experience agglomeration when entering a common currency area. This purely theoretical analysis points in the direction of agglomeration or specialization. In contrast, Frankel and Rose (1998) investigate the relationship of intra currency union openness and intra industry trade. The main purpose of this is to investigate whether countries with strong trade links tend to have more correlated business cycles. Findings on this type of relationship suggests countries becoming better candidates for OCA membership after the inception of the union. This effect is called the endogeneity aspect of currency unions. The results in question are based on a panel regression for 30 industrialized countries.

Kose et al (2003) attempt to identify world-, region and country specific common business cycles by the means of a dynamic factor model. The research implies that there indeed is an underlying world factor that explains at least some part of all 60 included countries variation. It also implies that regional factors play a role in some parts of the world. Bergman & Jonung (2010) find support for the endogeneity aspect of currency unions when they measure business cycle synchronization in Europe with special focus on the Scandinavian countries. They base their conclusion on two factor model estimations for the Scandinavian currency union and the EMU respectively. In a recent paper Willet et al (2010) analyze the endogeneity aspect of the EMU from a political economy perspective. In this type of analysis focus is put on trade flows, business cycle synchronization and structural reforms. The main method is a simple correlation analysis along with a study of external trade ratios. When this type of analysis is employed the conclusions differ somewhat from for example Bergman and Jonung (2010) in the sense that the endogeneity aspect of the currency union is neither confirmed or denied as the main force effecting the EMU countries after inception.

The aim of this thesis is to shed light upon whether the endogeneity aspect or the specialization effect of optimal currency areas has dominated since the inception of the Maastricht treaty. More generally this means investigating whether the countries who signed the Maastricht treaty and also later joined the EMU are moving towards or away from being an OCA. The reason for including the seven Maastricht years leading up to the inception of the EMU is that the Maastricht treaty forced the signing countries to converge in a number of OCA criteria. The inception of the Maastricht treaty can therefore in some aspects be viewed as the inception of the EMU albeit without the common currency.

The means by which the analysis will be carried out is through time series factor analysis for measuring correlation and existence of common business cycles. This is in contrast to simply measuring the correlation. The reason is that if a set of factors can be singled out and we can conclude convergence then we can conclude both increase in correlation and the presence of one or more underlying common business cycles. These can either represent the total set of countries or a subset of them implying a regional factor. Such results are stronger than only measuring the correlation between countries since countries can be correlated for other reasons than direct economic integration.

Consider for example the case of two countries exporting a large portion of their production to a third country. This might lead to correlation of the business cycle but not necessarily to the existence of a common factor that steers the evolution of the two countries business cycle. Therefore if there indeed exists one or more common business factors it will be possible to draw firmer conclusion about the extent to which countries in the Maastricht countries have integrated co-variant economies. In addition the degree of specialization will be measured through employment of the Krugman Index of Specialization.

The time series factor analysis will span both over time and space. The time dimension will be analyzed by comparing the 1970-1992 period with the Maastricht (1993-2010) period. The space dimension will be analyzed by comparing the Maastricht countries with the US states for the 1970-2010 period. Similarly for the specialization index the US 1970-

2010 period will be compared with the EU 1993-2008 period. The reason for including the US into the analysis is that it is widely regarded as a stable currency area that has been around for many years which implies that it will give the analysis a good basis of comparison.

The uniqueness of this thesis stems mainly from the fact than an attempt is made to measure both business cycle correlation by the means of factor analysis and level of specialization. Also the usage of the 2010 data adds relevance in relation to much research since it includes the recent financial crisis.

The outline is as follows: In Chapter 2 the theoretical framework which this thesis builds upon is outlined. Sub-sectionally in Chapter 3 the analysis starts with a review of the main methods used. This is followed by a presentation of the data as well as a section on how the data was treated before the main method was used. The Results are sub-sectionally presented and analyzed. Finally in Chapter 4 some concluding remarks wrap up the thesis.

Chapter 2

Theory

2.1 Optimal currency area

The theory of optimal currency areas was developed with the Bretton Woods system of fixed exchange rates still operational (Mongelli 2005:608). The man behind the idea, Mundell, sets out to determine if it is optimal for all countries currencies to float freely or if there exists such a concept as an optimal currency area. The optimal currency area as a concept corresponds to a subset of all countries in the world for which a set of conditions are met. Mudell is predominately focused on areas with a common currency where one central bank controls the monetary supply (Mundell 1961:658).

At this point in time the Phillips curve still reigned unquestionably and Mundells primary focus was to determine what size the currency area should have for there not to be frictions of such an amplitude that one central bank would have to accept too large regional inflation and too large regional unemployment at the same time (Mundell 1961:659). He argues that flexible exchange rates are to prefer but only between regions that are optimal currency areas. Countries that are good candidates for a currency area are defined as having:

- High factor mobility
- Price and wage flexibility
- Financial market integration
- Fiscal integration
- High political integration
- Diversification in production and consumption

- High degree of economic openness
- Similarities in inflation

The requirement for high factor mobility stems from the idea that if factor mobility is low then flexible exchange rates fills the function of a compensation mechanism when the relative real factor prices change. If the exchange rate is fixed or indeed there is a currency union then factor mobility needs to be high because of the lack of such a compensation mechanism. Also if the union experiences asymmetries in unemployment then mobility of labor needs to be high in order to dampen effects of intra-regional drops in labor demand. The price and wage flexibility is important from the perspective that when for example two countries are in a currency union and exhibit high unemployment and high inflation then the process of adjustment following the shock that put the countries in that position is made with less cost.

The reason for countries being financially integrated is that it reduces the need for exchange rate adjustments when interest rates differ due to shocks (Mongelli 2005:609). Diversification in production and consumption over all countries ensures that no country is extra vulnerable to any specific types of shocks implying that business cycles will be similar across countries (Mongelli 2005:610). The high degree of openness is mostly thought of as being towards other member countries. Large intra union trade will cause spill over effects synchronizing business cycles (Mongelli 2005:609). The similarities in inflation facilitates that the common central bank can use effective monetary policy and that the terms of trade between the member states remain stable over time which reduces the need for an adjustment mechanism such as a flexible exchange rate (Mongelli 2005:610).

2.2 Specialization

The theory of specialization and OCA's is based on the idea that different countries within the union have different relative advantages for production of different goods. The main idea is that when a currency area is started under such circumstances production will move to countries that has relative advantages for production in different industries. This will lead to specialization of industries relocating such that the industry portfolio of each country becomes less diversified. This will lead to each country becoming more vulnerable to specific shocks implying that a decrease of the homogeneity in the sensitivity of shocks across the area will take place. All in all the theory of specialization suggests that a process of industry specialization will take place when a currency union is started and that this process will lead to less synchronized business cycles which in turn demands that labor mobility is high to avoid within region unbalances in employment and inflation (Mongelli 2005:625).

2.3 Endogeneity of currency areas

In contrast to the theory of specialization the endogeneity aspect of a monetary union claims that when a set of countries enter into a currency union they will become more synchronized. The reason for this is that once they have committed to having one common currency they have informally decided to become long-term partners in trade and political activities. This commitment will facilitate foreign direct investment and reciprocal trade which in turn will cause the business cycle to become more synchronized. This implies that countries need not on forehand have synchronized business cycles for being candidates to enter in to a common currency union. The real process of synchronization starts after the inception of such an endeavor. Under this theory labor mobility does not need to be high, at least no to the same extent as for the specialization theory (Frankel & Rose 1998:1010).

Chapter 3

Analysis

3.1 Method

The main idea behind factor analysis is that one can, from a set of observable variables, find a set of common factors or latent variables. The factors govern the evolution of the observed variables. This implies reducing the dimensions of the set of observable variables $y_{i,t}$ to the a set of factors, $\xi_{k,t}$, such that $k < i$. The model is:

$$y_{i,t} = \alpha + B\xi_{k,t} + \varepsilon_t \tag{3.1}$$

Where $y_{i,t}$ is the set of observable variables for country i and where $\xi_{k,t}$ is the set of k underlying factors or latent variables and B is the factor loadings on $y_{i,t}$. The idiosyncratic error term is represented by ε_t. In this specific case it is assumed that the underlying factors have some sort of dynamics but assumptions about such dynamics are not made. This implies that fewer restrictions are imposed on the model as opposed to alternative methods such as Dynamic Factor Analysis (DFA) where the underlying factors on forehand have to be explicitly modeled. Equation 3.1 is the same as for standard (cross-sectional) factor analysis theory with the very important difference that observations are indexed with time. This imposes some challenges to the model since time-series variables rarely are covariance stationary (Gilbert & Meijer 2005:5).

Time series factor analysis (TSFA) assumes that the time series included in the model are non-stationary integrated of order one so that the series show stationarity in its first differences. In this thesis, all variables used for factor modeling are by definition stationary I(0) so that differencing is not necessary. In this context the only assumption being made for standard maximum likelihood estimation to be possible is that the series ξ_t and ε_t are serially correlated but uncorrelated at t with zero means and constant covariances Γ and Ψ. In this case the means and covariances of the observed series y_t is: $\mu_y = \alpha$ and $\Sigma_y = B\Gamma B' + \Psi$ (Gilber & Meijer 2005:6). Provided that these assumptions hold it is possible to consistently estimate the factor loadings B and the error covariance Ω from the sample covariance through the following equation:

$$\Sigma = B\Gamma B' + \Omega \tag{3.2}$$

Where

$$\Omega = \sum_{t=1}^{T} \frac{\varepsilon_t \varepsilon_t^{'}}{T} \tag{3.3}$$

Here Ω is assumed to be diagonal and is identified if the following restriction is met:

$$(M - k)^2 \geq M + k \tag{3.4}$$

This restriction is known as the Ledermann bound where M stands for the number of observable variables and k stands for the umber of factors. The Ledermann bound indicates how many factors it is possible to estimate from the set of observable variables (Gilbert & Meijer 2005:8). The likelihood estimator for the loadings B and the error covariances Ω is found by minimizing the function (Gilbert & Meijer 2005:9):

$$L = log(det\Sigma) + tr(\Sigma^{-1} S_y) \tag{3.5}$$

The factor scores $\hat{\xi}_t$, that is, the values of the underlying factors can be found by using the Bartlett predictor. This method involves predicting the underlying factors from the set of observed series y_t, estimated loadings $\hat{B}$ and error covariance $\hat{\Omega}$ through the expression (Gilbert & Meijer 2005:12):

$$\hat{\xi}_t^B = (\hat{B}'\hat{\Omega}^{-1}\hat{B})^{-1}\hat{B}'\hat{\Omega}^{-1} y_t \tag{3.6}$$

With estimators for factor loadings, factor correlations, and factor scores in place the model can consistently be estimated. In order to determine the optimal number of factors to include in the model the Consistent Akaike Information Criteria (CAIC) due to Bozdogan (1987) will be used. The consistent AIC builds on the work by Akaike (1973) and is defined as:

$$CAIC = -2log[L(\widehat{\theta})] + K[log(n) + 1] \tag{3.7}$$

The model is selected by minimizing over the estimated CAIC values for different model specifications. Here $L(\widehat{\theta})$ is the log likelihood of the parameter vector and the entire first term describes the lack of fit of the model in question. The second term is a penalty term where more parsimonious models are preferred, here n is the sample size and K is the model size. This measure is designed to avoid overparameterization by extending the penalty term with the sample size as opposed to only the model size using standard AIC (Anderson et al 1998:265). In the context of factor analysis the CAIC is used in combination with the Ledermann bound to determine the optimal number of factors.

3.2 Data

The data that has been used for the TSFA-model is quarterly real-GDP for the European countries from the OECD main economic indicators database. For the US no quarterly GDP data was available for the entire 1970-2010 period on state level so employment data was used as a proxy variable. The data on US employment was collected from the US Bureau of Labor Statistics. For measuring the level of specialization data on yearly industry output from the OECD STAN database was collected for the EU10 and for the US the data was collected from the Bureau of Economic Activity (BEA). The industry data from the OECD STAN database was somewhat more limited than the production data on the entire economy from the OECD main indicators with data only available for the 1993-2008 period. Also the data on Ireland was so scarce that the country was left out in the analysis.

3.2.1 Data treatment

Data on GDP and employment can be viewed as time series of the following composition:

$$Y_t = G_t + C_t + S_t + I_t \tag{3.8}$$

Where G_t is the growth trend or time trend, C_t is the cyclical component, S_t is a seasonal component and I_t is an irregular component. For the European GDP data all series where seasonally adjusted when collected which implies that the seasonal and irregular components had been singled out and removed from the series Y_t. The data on US employment was not seasonally adjusted upon data collection and therefore the X12-ARIMA method of seasonal adjustment[1] was used for the entire dataset (see for example Granger (1978:35)). In order to single out the cyclical component C_t the Hodrick-Prescott (HP) filter due to Hodrick and

[1] The calculations where made using a program supplied by the US Census Bureau

Prescott (1980,1996) was used. The method in question estimates the growth trend by minimizing the sum of the differences between Y_t and G_t. In addition the smoothness of the trend is controlled by a parameter λ. The resulting cyclical component C_t is by definition mean-zero and stationary (Hodrick & Prescott 1996:3).

The HP-filter is a popular way of singling out the cyclical component in the research community especially for business cycle theorists. At the same time some critiques have also been proposed for the method which mainly focuses on 2 points. The first of these points is that the HP-filter is not optimal at the endpoints of a series. This is due to the fact that the series is a symmetric two-sided filter that looses optimality in the end- as well as starting points of a series (Mise et al 2005:58). The second aspect of the critique points at the possibility that it generates spurious cycles that could lead to wrong conclusions about how short-term movements in macroeconomic data relates (Harvey & Jaeger 1993:246). Despite this critique the method has withstood the test of time in a remarkably good way and is likely to be used for the purpose of isolating the cyclical component of a time-series further into the future (Ravn & Uhlig 2002:371).

For the reason of the HP-filter rendering spurious estimates at the endpoints of a dataset the data on real GDP for the European countries and the data on employment for the US was expanded exponentially at all start and end points of the dataset. The data on industry production was limited to manufacturing industries following Midelfart-Knarvik et al (2000) rendering a total of 38 industries for the 9 European countries included in the analysis. For the US data on industry production the definitions are slightly different from the European countries due to different data collecting agencies but a similar restriction as for the European countries was made. Estimation of the time series factor analysis and calculation of the Krugman specialization index is made by use of the R software for statistical computing[[2]][[3]].

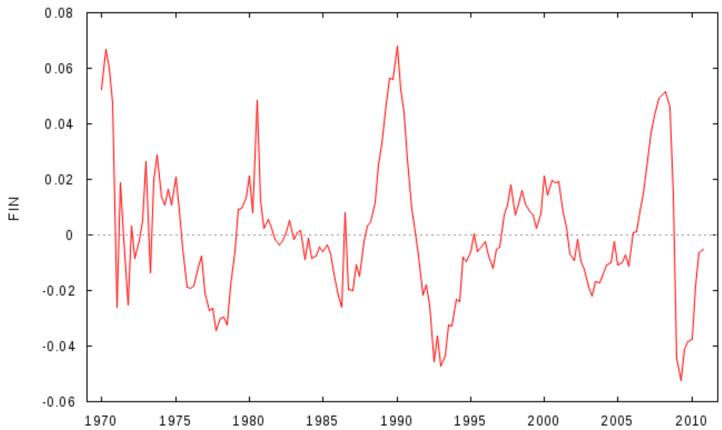
[2]The "tsfa" package supplied by the Comprehensive R Archive Network and created by Paul Gilbert and Eric Meijer was used for estimation of the factor models

[3]For most of the data treatment code was developed by the author in the GNU Regression and Econometrics Library (GRETL). On a further note, the R code developed by the author for estimation and significance testing of the factor models was embedded in GRETL-code

3.2.2 European Business cycles 1970:Q1-2010:Q4

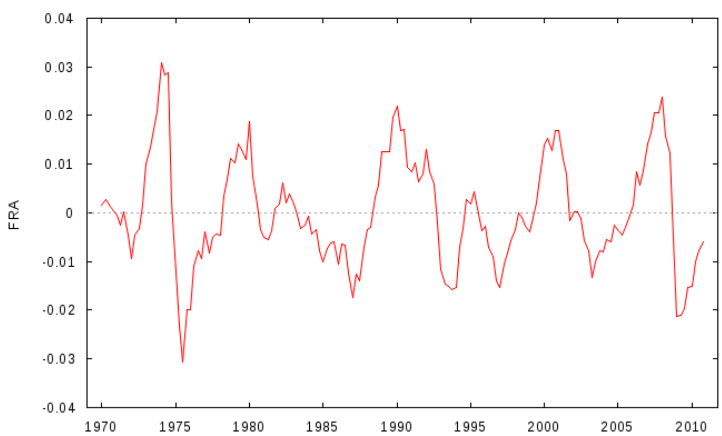
Below the HP-filtered logarithmic real GDP series for the European countries are presented graphically:

Figure 3.1: The Finnish Business Cycle 1970-2010



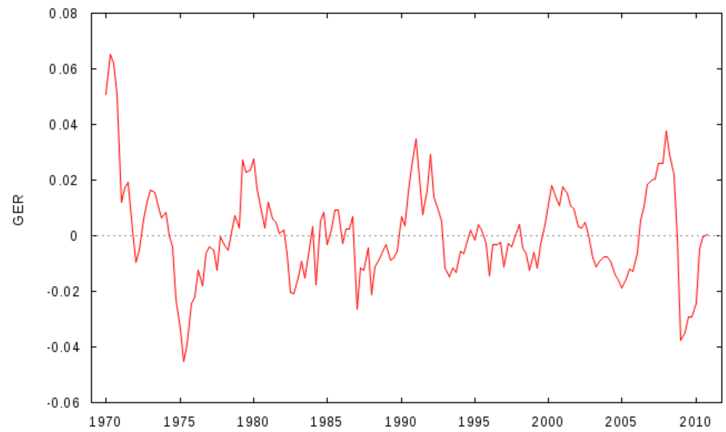
The Finnish business cycle varies in between -0,05 and 0,068 during the period. The volatility in the output gap as measured by the standard deviation is 0,024. The series shows peaks in the output gap at 1970, 1980 ,1990 and 2008. It shows dips at 1978, 1993 and 2008. The last combination of peak and dip is most likely due to the recent financial crisis and its preceding economic boom.

Figure 3.2: The French Business Cycle 1970-2010



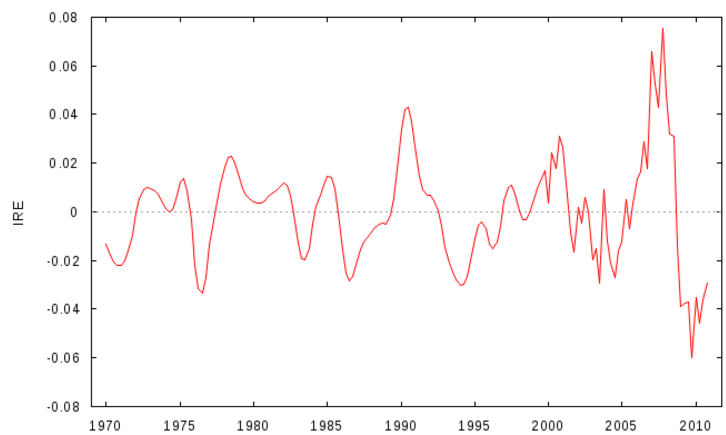
The French business cycle varies in the interval of -0,03 and 0,03 with a standard deviation of 0,011 which is considerably lower than for Finland. The series shows peaks in the output gap at 1974, 1980, 1990, 2000 and around 2007. The main dips occur around 1975, 1987, 1994, 1997, 2003 and 2008. What is remarkable about the French output gap is that the dip around 1975 which coincides with an oil shock of the 1970's is more negative than the one occurring at the time of the recent financial crisis.

Figure 3.3: The German Business Cycle 1970-2010



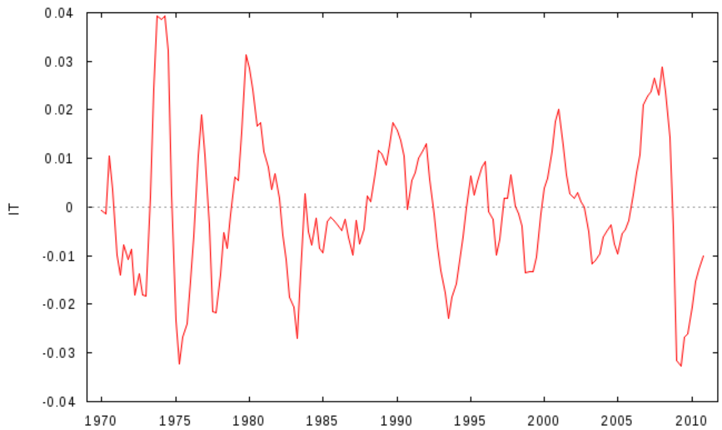
The German business cycle varies between -0,045 and 0,065 with a volatility of 0,017. It shows peaks around 1971, 1979, 1991 and 2007. For Germany as for France the dip caused by the oil shock in the 1970's was more negative than the one caused by the recent financial crisis.

Figure 3.4: The Irish Business Cycle 1970-2010



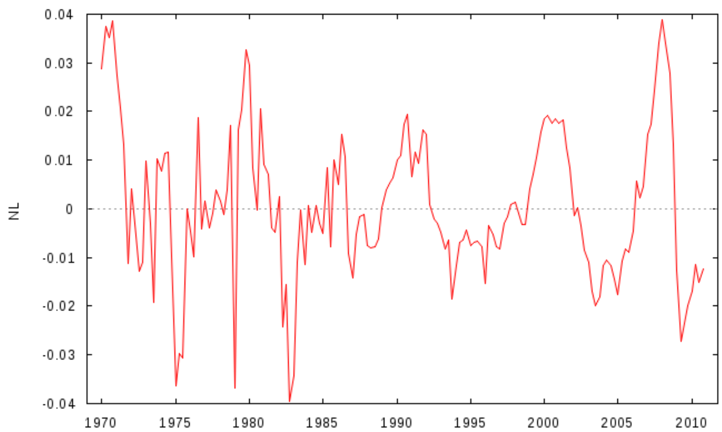
The series describing the Irish business cycle is very smooth for the years 1970-1998 indicating that it might have been exponentially smoothened for the purpose of expanding the dataset. For the same time period the volatility is quite low with the only real peak at 1990. For the post 1998 period one large peak is observed just before the financial crisis where the most substantial dip is observed. Over the entire period the series varies between -0,06 and 0,075 with standard deviation 0,02.

Figure 3.5: The Italian Business Cycle 1970-2010



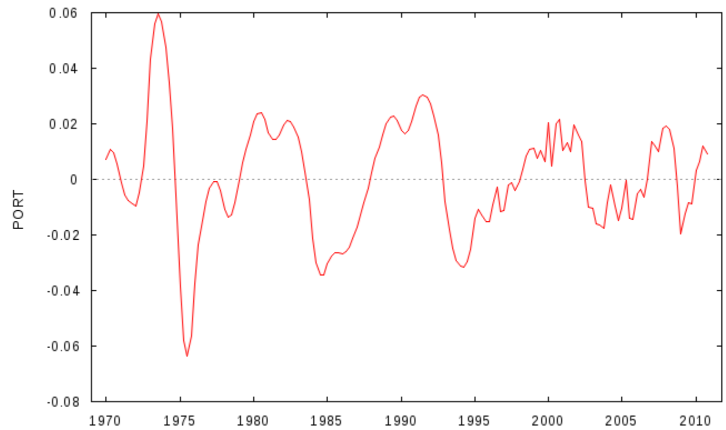
The Italian business cycle varies quite intensively through the period. Major peaks are observed at 1973, 1977, 1979, 1990, 2000 and 2007. Major dips occurred at 1975, 1978, 1987, 1994 and 2008. The series varies between -0,03 and 0,04 with standard deviation 0,015.

Figure 3.6: The Dutch Business Cycle 1970-2010



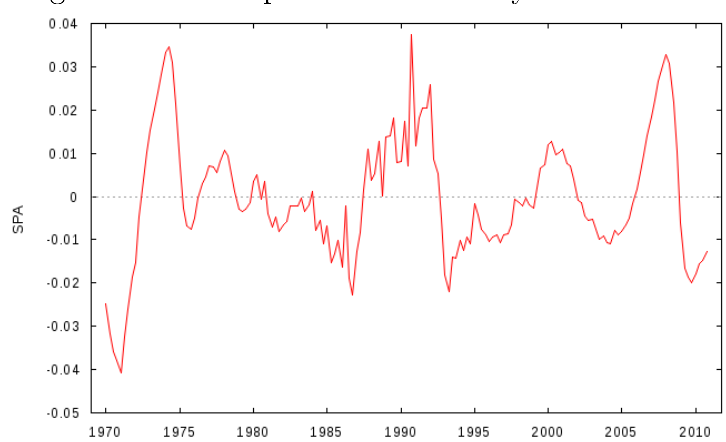
Major fluctuations during the 1970-1985 period characterizes the Dutch business cycle. From 1985-2010 the frequency of peaks and dips is lower with one large peak at 2007 and a correspondingly large dip at 2008.

Figure 3.7: The Portuguese Business Cycle 1970-2010



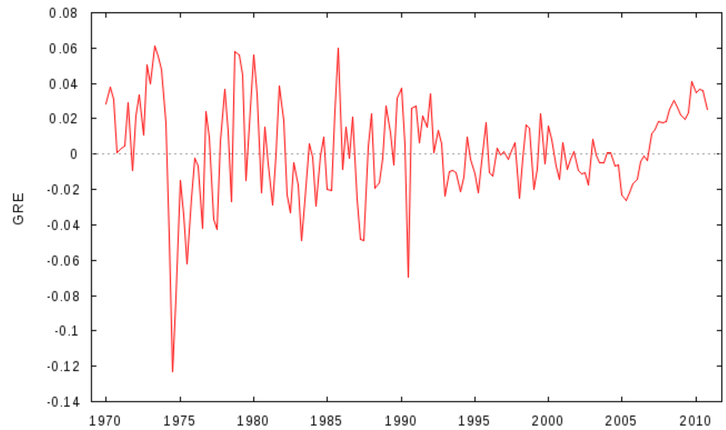
Similarly to the business cycle gap the Portuguese equivalent seems to be exponentially smoothened due to data expansion during the 1970-1998 period. The series seems to be decreasing in volatility with larger peaks and deeper dips as the series moves away from the start of the sample period. The financial crisis does not seem to have an impact on the Portuguese output gap of the same impact as for the rest of European countries. The series shows signs of small peak around 2007 and a corresponding dip around 2008 but the amplitude is quite modest.

Figure 3.8: The Spanish Business Cycle 1970-2010



The shape of the Spanish business cycle is quite different from the other European countries. Major peaks are observed at 1974, 1989 and 2007. Major dips are observed at 1971, 1987, 1992 and 2008. The series varies in the range -0,04 and 0,37 with standard deviation of 0,014.

Figure 3.9: The Greek Business Cycle 1970-2010



The Greek business cycle fluctuates heavily for most of the period. It exhibits a large dip around 1975 and around 1990. What is most interesting about this series is the fact that the financial crisis does not seem to be present at all. This is due to the fact that the HP-filter has estimated the trend component as having a stark negative development for the 2005-2010 period. This leads to estimates of the cyclical component that is above the trend value and therefore positive.

3.3 TSFA-results European countries 1970:Q1-1993:Q3

Calculated CAIC values for the 1970-1993 period model are:

Table 3.1: CAIC-values for the European countries 1970:Q1-1993:Q3

	0	**1**	**2**	**3**	**4**	**5**	**6**
CAIC	276	156	186	219	253	281	306

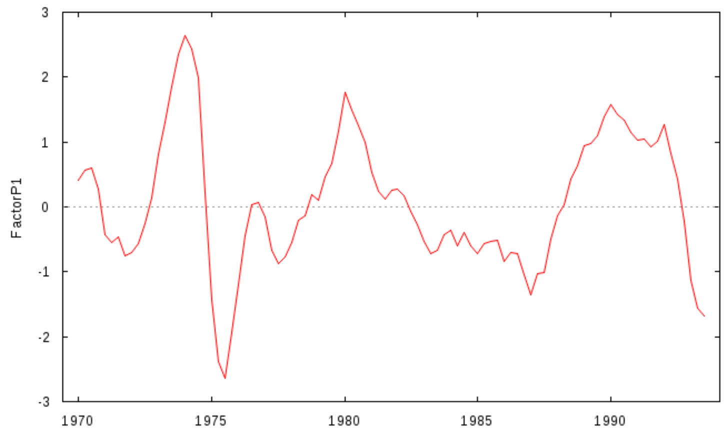
These values suggest that a one factor model should be estimated due to the fact that the smallest CAIC is at one included factor. On the basis of the CAIC analysis a one-factor model is estimated. The results of the estimation are presented in the table below. Positive values of the loadings indicate that the countries have converged during the period . A countries Communality refers to the amount of variance the estimated factor accounts for. The OLS robust standard errors with corresponding significances indicate whether the estimated factor is significant for the different countries. The significance indicators are "***" implying significance on the less than 1% level, "**" indicating significance on less than 5% level and "*" indicating significance on the 10% level.

Table 3.2: TSFA European countries 1970:Q1-1993:Q3

	Loadings	**Communality**	**OLS Std error**	**Significance**
SPA	0,0087	0,3245	0,0012	***
NL	0,0069	0,2079	0,0012	***
PORT	0,0202	0,7370	0,0013	***
IT	0,0128	0,7486	0,0007	***
FIN	0,0134	0,2884	0,0024	***
BEL	0,0106	0,8554	0,0004	***
FRA	0,0102	0,8463	0,0004	***
IRE	0,0058	0,1427	0,0016	***
GER	0,0096	0,2779	0,0015	***
GRE	0,0096	0,0876	0,0041	*

The estimated loadings are all positive which implies that the countries included in the model have had a converging business cycle for the period. Significance tests show a significance on the less than 1-% level for all countries except for Greece where the factor is significant on the 10% level. The original EEC countries (Germany, France, Belgium, The Netherlands and Italy) all have high communalities around 70-80% except for Germany (28%) and the Netherlands (21%). Of the states that joined the EEC in the 80's (Greece, Portugal and Spain) Portugal is the country with the highest communality at 74%. Interestingly Finland who was not a member of the EEC for the entire period has a communality greater than Germany, the Netherlands and Greece. Furthermore there seems to be a strong relationship between the southern European countries and the estimated factor. All of the southern European countries included in the analysis show a higher communality than the rest of the countries with the exception of Greece. The mean communality for the total set of countries was 45%. Below the estimated factor is plotted:

Figure 3.10: The estimated European business cycle 1970:Q1-1993:Q3



The European business cycle shows peaks at 1974, 1980 and 1989. Major dips occur at 1975, 1987 and 1993. The timing of both peaks ands dips agree quite well with the dips and peaks of the individual countries business cycles (see pages 13-17).

3.4 TSFA-results for the European countries 1993:Q4-2010:Q4

Calculated CAIC-values for different model specifications are:

Table 3.3: CAIC-values for the European countries 1993:Q3-2010:Q4

	0	**1**	**2**	**3**	**4**	**5**	**6**
CAIC	466	148	173	205	238	266	288

Once again the CAIC suggests the inclusion of one factor into the model. The 1 factor model gave the following estimates of loadings and communalities:

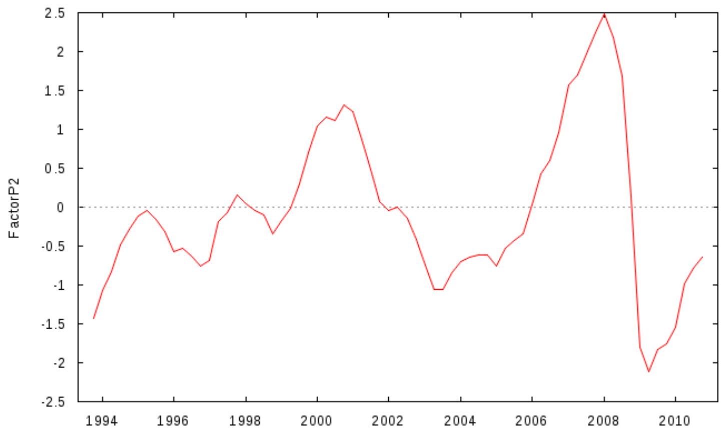
Table 3.4: TSFA model for the European countries 1993:Q4-2010:Q4

	Loadings	**Communality**	**OLS Std error**	**Significance**
SPA	0,0117	0,9040	0,0006	***
NL	0,0139	0,9027	0,0006	***
PORT	0,0091	0,4427	0,0010	***
IT	0,0123	0,8335	0,0006	***
FIN	0,0204	0,8925	0,0007	***
BEL	0,0109	0,8873	0,0004	***
FRA	0,0101	0,9094	0,0003	***
IRE	0,0229	0,7926	0,0016	***
GER	0,0135	0,8584	0,0006	***
GRE	0,0009	0,0033	0,0025	-

The estimated loadings are also for this period all positive indicating convergance among the countries. The communalities are for this period substantially larger for most countries compared to the 1970-1993 period with the exception of Greece. The significanes are once again indicating significance on the less than 1% level for all countries except Greece. Communalities for the statistically significant countries range from around 0,44 (Portugal) to 0,91 (France). We can also see that Portugal has a lower communality for this period (0,44 compared to 0,74).

Ireland has a communality of 0,79 which is a very large increase from the 0,14 estimate for the pre-Maastrich period. The fact that the factor is not significant for Greece is not surprising. Greece had the lowest communality during the pre-Maastrich period and has been effected differently than the other countries by the recent financial crisis. Furthermore Spain shows a noteworthy increase in communality from 32% to 90%. Germany increase their communality by 58% and Finland increase their communality by 60% which are remarkably large increases. All in all the mean communality increased from 37% to 82%. The estimated European business cycle is plotted below:

Figure 3.11: The European estimated business cycle 1993Q4-2010:Q4



The European business cycle exhibits peaks at 2001 and 2007. Dips are observed at 2003 and 2009. The 2009 dip is by far the most dramatic event during the period and is most likely due to the recent financial crisis. The shape of the factor very much resembles that of the individual countries who all where affected in a similar way by the financial crisis except for Greece.

3.5 Analyzing the European case in the time domain

The results from the factor models for the pre- and post-Maastricht periods indicate an increase in the European business cycle correlation. This is due to the fact that communalities are in a broader sense substantially larger for the post-Maastricht period. The estimated factor for the pre-Maastricht period showed large communalities for mainly southern European countries while the post-Maastricht period showed large communalities for countries from both the northern and southern countries. There are however some exceptions such as Portugal for whom the communality decreased for the post-Maastricht period and Greece for whom the estimated factor was not significant. These countries where both hit very hard by the financial crisis which could be the reason for the divergence. Furthermore, the fact that the model selection criteria suggested one underlying factor as the optimal model specification implies that there indeed exists one single underlying factor which is a powerful result. All in all the results point in the direction of the endogeneity effect as being the major factor effecting the countries since the Maastricht treaty.

3.6 TSFA results for US 1970:Q1-2010:Q4

For the US the CAIC suggests an inclusion of 4 factors. This is partially in line with what we could expect and we can here assume that the second third and fourth factors are regional cycles whereas the first one is a national cycle. The significances from the factor model can be found on the preceding page, communalities and loadings can be found in the appendix.

Table 3.5: Factor significances 1970:Q1-2010:Q4

Factor 1	**Factor 2**	**Factor 3**	**Factor 4**
Alabama***	Alabama***	Arizona***	Alaska**
Alaska***	Alaska***	Arkansas***	Arizona**
Arizona***	Arkansas***	Colorado***	Arkansas***
Arkansas***	California***	Connecticut***	California***
California***	Colorado***	Delaware**	Colorado***
Colorado***	Connecticut***	DOC**	Connecticut***
Connecticut***	Delaware***	Florida**	DOC***
Delaware***	DOC*	Hawaii***	Georgia***
DOC***	Florida**	Idaho***	Hawaii***
Florida***	Georgia***	Illinois*	Illinois***
Georgia***	Indiana***	Iowa*	Indiana***
Hawaii***	Iowa**	Kansas***	Iowa***
Idaho***	Kansas*	Kentucky***	Kansas*
Illinois***	Louisiana***	Louisiana***	Kentucky***
Indiana***	Maine***	Maine***	Louisiana***
Iowa***	Maryland***	Massachussetts***	Maryland***
Kansas***	Massachussetts***	Minnesota***	Massachussetts***
Kentucky***	Michigan***	Montana***	Michigan***
Louisiana***	Missouri***	Nebraska***	Minnesota***
Maine***	Nebraska**	Nevada***	Missouri**
Maryland***	Nevada***	NH***	Montana**
Massachussetts***	NH***	NJ***	Nebraska***
Michigan***	NJ***	NM***	Nevada***
Minnesota***	NM***	NY***	NH***
Missouri***	NC***	NC**	NJ**
Montana***	ND***	Ohio***	NM***
Nebraska***	Ohio*	Oklahoma***	NY***
Nevada***	Oklahoma***	Oregon***	Ohio**
NH***	Oregon***	Pennsylvania***	Oklahoma***
NJ***	Pennsylvania***	RI**	Oregon***
NM***	RI***	SD***	Pennsylvania***
NY***	SC***	Tennesee***	RI***
NC***	SD**	Texas***	SC**
ND***	Tennesee***	Utah***	Tennesee***
Ohio***	Texas***	Washington***	Texas***
Oklahoma***	Utah***	Vermont**	Washington***
Oregon***	Washington***	Wisconsin*	Vermont*
Pennsylvania***	Vermont***	Wyoming***	Virginia**
RI***	WV**		Wisconsin***
SC***	Virginia***		Wyoming***
SD***	Wisconsin***		

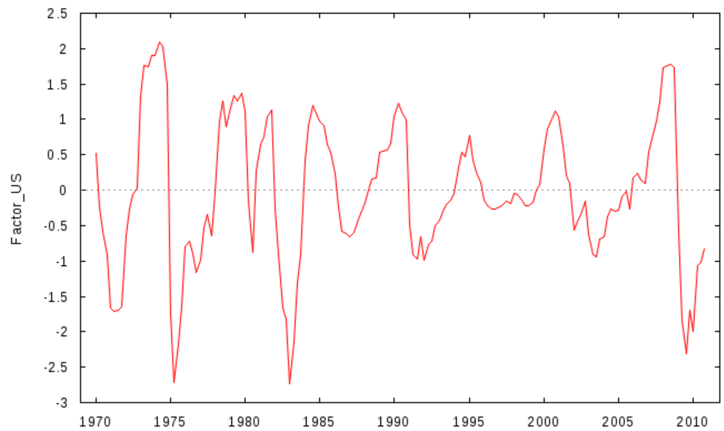
Tennesee*** Texas*** Utah*** Washington*** Vermont*** WV*** Virginia*** Wisconsin*** Wyoming***	Wyoming***		

The estimated loadings show a positive sign for the first factor with the exception of Alaska for which the estimated loading has a negative sign. This suggests that all states except Alaska have converged with the national cycle for the period. For the second third and fourth factors the estimated loadings have mixed signs which indicates mixed convergence and also indicates that some of the factors might be insignificant for some states. In order to further investigate whether some factors are insignificant a significance test was conducted by running an OLS of each observed variable on each estimated factor. The results from the significance tests are that the first factor is significant for all states. The second factor is significant for 42 states, the third factor is significant for 38 states and the fourth for 40 states.

This does not give much information about what the factors represent and therefore it seems more reasonable to look at the communalities. The variance that the respective factors stands for are distributed quite unevenly between factors. From studying the table of variances it becomes clear that the first factor accounts for most of the variation in the observed variables. The cases where the second, third or fourth factor stands more than 10% of the variance are for factor 2: Alaska (23%) Louisiana (18%), Oklahoma (37%), Texas (35%) and Wyoming (50%). These states are all large petroleum and gas producers and their respective economies are therefore likely to be more sensitive to petroleum-specific shocks than the rest of the country.

For the third factor the states with more than 10% explained variance are: Idaho (11%), Kentucky (17%), Montana (11%), Oregon (13%) and Washington (15%). These states are all located in the north west of the country except for Kentucky. In addition to the geographical perspective these states also share industry structure with a large high-tech sector. For the fourth factor the only state for which the factor could explain more than 10% was Hawaii (26%). This indicates that the fourth factor may be an effect of autocorrelation in the underlying factor since it is not plausible to assume that there exist a factor describing only the Hawaiian economy. The first factor managed to account for more than 10% of the variance for all states but Alaska. A graphical representation of the first factor can be viewed below:

Figure 3.12: The estimated US national business cycle 1970:Q1-2010:Q4



The US national business cycle shows peaks at 1974, 1980, 1985, 1990, 1994, 2001 and 2007. Major dips occur at 1971, 1975, 1983, 1987, 1992, 2003 and 2009. The dates of the dips can for example be linked to the oil shocks in the 1970's and 1980's, the terrorist attacks of the early 2000's and finally the recent financial crisis.

3.7 Analyzing the European case in the space domain

The factor analysis results for the US 1970-2010 period are in contrast to the results for the European countries. The way in which this materializes is mainly through the fact that there appears to exist regional factors in the US economy. This result speaks for the specialization effect of optimal currency areas since the second and third underlying factors can be viewed as representing industry specific states. This implies that a stable currency union exhibits a certain degree of specialization which leads to regional business cycle phenomenons. For the European countries this means that there is likely to be an increasing specialization effect that will make some regions less correlated with the main common factor or business cycle.

3.8 Krugman index of specialization

In order to investigate if a specialization process is already taking place among the European countries the Krugman index of specialization will be deployed. The index takes a value between 0 and 2 where 0 represents complete equality between countries and 2 represents complete inequality of industry structure. This implies that a currency area with low degree of specialization will display values close to zero and and one that has a high degree of specialization will display values close to 2. The index is constructed as follows:

$$K_i(t) = \sum_k abs(v_i^k(t) - \overline{v}_i^k) \tag{3.9}$$

Where:

$$v_i \equiv x_i^k(t) / \sum_k x_i^k(t) \tag{3.10}$$

Here x_i^k is the output of country i in industry k. Furthermore:

$$\overline{v}_i^k \equiv \sum_{i \neq j} x_i^k(t) / \sum_k \sum_{i \neq j} x_i^k(t) \tag{3.11}$$

So that equation (3.8) measures the sum over all industries k of the absolute deviance of country i's production from all other countries. (Midelfart-Knarvik et al 2000). The index was calculated for EU countries except Ireland for the 1993-2008 period and gave the following results:

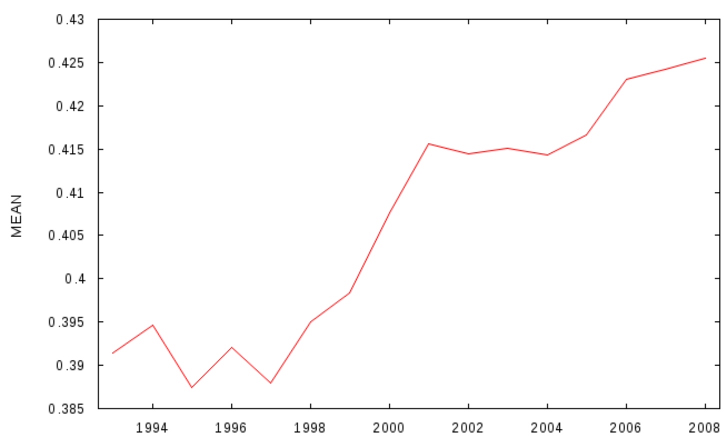
Table 3.6: Specialization levels for the European countries 1993-2008

	BEL	**FIN**	**FRA**	**GER**	**ITA**	**NL**	**PORT**	**SPA**	**GRE**	**MEAN**	**VAR**
1993	0,30	0,46	0,18	0,35	0,29	0,44	0,59	0,27	0,68	0,39	0,027
1994	0,31	0,47	0,17	0,31	0,30	0,43	0,57	0,25	0,68	0,39	0,027
1995	0,32	0,55	0,16	0,30	0,31	0,43	0,53	0,24	0,69	0,39	0,028
1996	0,32	0,54	0,18	0,30	0,30	0,43	0,53	0,24	0,66	0,39	0,026
1997	0,33	0,57	0,18	0,30	0,31	0,42	0,51	0,25	0,69	0,40	0,028
1998	0,32	0,61	0,18	0,30	0,31	0,40	0,52	0,24	0,71	0,40	0,032
1999	0,31	0,64	0,19	0,32	0,31	0,42	0,52	0,24	0,71	0,41	0,033
2000	0,33	0,68	0,19	0,33	0,32	0,44	0,50	0,24	0,70	0,42	0,033
2001	0,33	0,63	0,20	0,34	0,34	0,45	0,51	0,23	0,70	0,41	0,030
2002	0,35	0,63	0,20	0,35	0,34	0,47	0,51	0,23	0,65	0,42	0,026
2003	0,36	0,62	0,20	0,36	0,35	0,47	0,49	0,23	0,64	0,41	0,024
2004	0,37	0,63	0,20	0,37	0,34	0,48	0,48	0,25	0,63	0,42	0,023
2005	0,41	0,64	0,21	0,38	0,34	0,50	0,47	0,24	0,61	0,42	0,022
2006	0,43	0,62	0,21	0,37	0,34	0,51	0,46	0,24	0,63	0,42	0,023
2007	0,45	0,62	0,22	0,38	0,33	0,53	0,44	0,23	0,63	0,43	0,022
2008	0,47	0,59	0,23	0,40	0,32	0,55	0,42	0,24	0,62	0,43	0,021
	0,36	0,60	0,19	0,34	0,32	0,46	0,50	0,24	0,66	0,41	0,027

For most of the countries the index value has increased since 1993. The exceptions are Portugal, Spain and Greece who started at higher index values (0,59, 0,27 and 0,68 respectively) than at the end pf the period (0,5, 0,24 and 0,66 respectively). The fact the level of specialization for both Portugal and Greece has decreased during the period is in contrast to the results from the factor analysis and suggests that the reason of the divergence of these countries lies outside the specialization and/or endogeneity aspects of optimal currency areas.

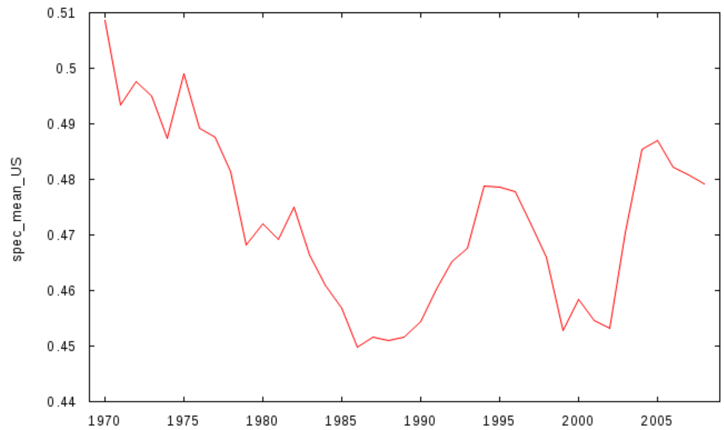
Interestingly the two countries with the lowest degree of mean specialization, Spain (0,24) and France (0,19) are also the countries who have the highest communalities in the factor analysis for the 1993-2010 period. This result confirms the general theory of specialization. In contrast Finland who has the second largest mean level of specialization also has the fourth largest communality in the factor analysis. This result is not confirmatory of the specialization effect. Furthermore Finland has had the largest increase in specialization during the period, a result that on its own speaks for the general theory of specialization. All in all the results from the Krugman index of specialization are ambiguous with respect to confirming the general theory of specialization. The mean series has increased for the period starting at 0,356 and ending at 0,405. The variance has been quite stable for the period. Below the mean series is plotted:

Figure 3.13: Mean level of specialization European countries 1993-2008



From studying the graph of the mean series it becomes clear that the European countries have experienced a modest increase in specialization for the 1993-2008 period. The mean value of specialization was quite stable for the first 4 years but has afterwards increased. All in all the mean value of specialization increased with approximately 5% during the period. For the US the 39 by 51 table analog to the EU table above is omitted but can be found in the appendix. The mean value of specialization for the 1970-2008 period was 0,4727 with average variance of 0,0486. Below the mean series of specialization is plotted:

Figure 3.14: Mean specialization US 1970-2008



The graph above does not show any clear sign of trending in any specific way with the exception of 1970-1985 period where the average level of specialization decreased from around 0,51 to 0,45. After this the series has fluctuated a bit but shows no sign of trending in any specific direction. This suggests that the US specialization process has leveled out which confirms that the US is a stable currency area. The fact that the US has a mean value of specialization that is quite close to the value for the European countries is somewhat contradictory to the presence of regional factors.

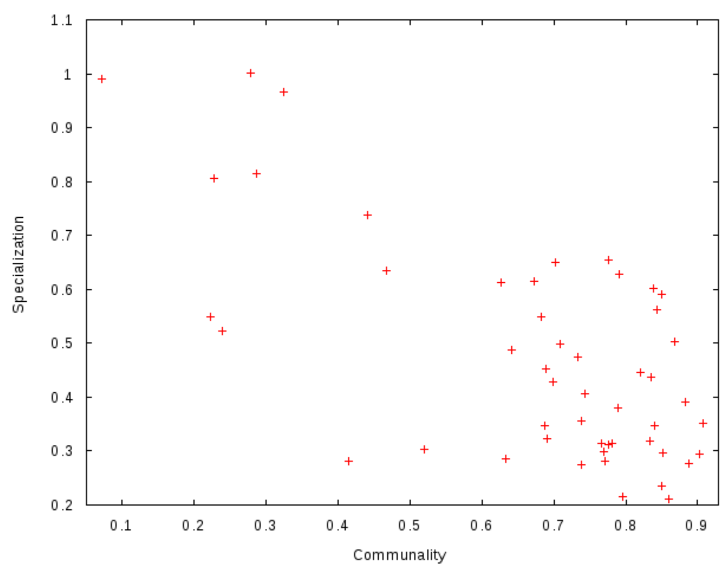
This phenomenon can be explained by studying the variance (0,027 for the European countries and 0,0486 for the US). The lager variance for the US implicates that some states have levels of specialization which are quite distanced from the mean. The most obvious cases of this in the direction of high degree of specialization are Alaska (0,9913), District of Columbia (1,0002), Hawaii (0,9667), Louisiana (0,8154) and Wyoming (0,8050). On a closer look these states are also highly correlated with the second and third estimated factors from the time series factor analysis. To further illustrate the relationship between regional factor and specialization a compilation of regional factor correlated states and their respective deviation from the US mean of specialization is presented below:

Table 3.7: Deviations from mean level of specialization

Factor 2	**Mean deviation**	**Factor 3**	**Mean deviation**
Alaska	0,519	**Idaho**	0,076
Louisiana	0,343	**Kentucky**	-0,170
Oklahoma	-0,191	**Montana**	0,161
Texas	-0,187	**Oregon**	0,155
Wyoming	0,332	**Washington**	0,178
Average dev	0,163	**Average dev**	0,080

From the table above it becomes clear that those states for which the second and third factor could explain a large part of the variance are on average more specialized than the country as a whole. This implies that the specialization has an impact on the business cycle synchronization mostly through the variance of member states/countries degree of specialization. The level of specialization is in this case not differing as much as the variance and herein lies the key to the analysis. Obviously one can not say that the average level of specialization is non-important but in cases where the average level of specialization are similar, the variance of the degree of specialization is crucial for the degree of business cycle synchronization and the presence of regional or industry-specific cycles. From the US data it is also possible to find more general support for the specialization effect. Below the observed mean level of specialization and communality of the estimated national US cycle are plotted for all 50 states:

Figure 3.15: US specialization and communality of national cycle



The relationship between level of specialization and communality of the national cycle presented in the graph above seems to be negative. Most states are located in the bottom right corner of the graph. Most of these observations are states with a combination of low level of specialization and high level of communality. The states who are located in the top left corner all have combinations of large level of specialization and low communalities. The correlation between the variables is found to be equal to -0,67. The graph further shows how a higher variance of specialization leads to a less homogeneous level of business cycle synchronization. The analysis of the US specialization in combination with the factor analysis carried out are unequivocal: a specialization process has taken place in the US and the process in question is likely to have leveled out.

3.9 Analyzing the full picture

When combining both the factor analysis and the specialization analysis above it becomes clear that the endogeneity aspect has been the dominating effect since 1993 for the European countries. The results that from the factor analysis seemed to contradict this i.e. the lower degree of Portuguese communality and the lack of significance in the Greek case are clearly not due to a specialization effect. For these cases it is more likely that other factors have caused the divergence. One possible explanation is the soaring fiscal deficits of these countries during the latter part of the last decade which have further affected the amplitude of the recent financial crisis. The results from the US factor analysis together with the subsequent specialization analysis suggests that the European countries can expect the degree of specialization of individual countries to increase in the future. This result points in the direction of an expected future dominance of the specialization effect.

Chapter 4

Conclusions

In this thesis the endogeneity and specialization aspects of optimal currency areas have been evaluated. This has been done for the purpose of investigating which of the effects that has dominated for a set of European countries since the inception of the Maastricht treaty in 1993. The currency areas which have been compared is the group of European countries who signed the Maastricht treaty in 1992 and subsequently joined the EMU and the USA. The results of the factor analysis suggests that there exists one single factor or business cycle that explains much of the variation of the individual European countries business cycles. Furthermore, the factor analysis suggested that the European countries have become more synchronized since the Maastricht treaty. Simultaneously for the 1993-2008 period the average level of specialization has increased with a modest 5%.

These results were compared with the US for which the factor analysis resulted in 4 factors being estimated. The first is argued to be a national cycle, the second a petroleum industry specific cycle and the third a regional north western cycle while the fourth factor being recurrence of the first factor. The specialization analysis showed that the average US level of specialization was quite close to the European countries albeit with a higher variance. The higher variance was argued to be the reason for the presence of the non-national cycles in the factor analysis.

In the background of the analysis of the full picture it is possible to conclude that the endogeneity aspect of optimal currency areas has been the dominating effect for the European countries since the inception of the Maastricht treaty. It is however also possible to conclude that the most likely future development is that the specialization effect will play a more dominant role. This implies that the European countries are likely to experience some divergence from the optimal currency area criteria until the specialization process levels out.

An interesting extension of the research would be to investigate to what extent the increase in the European business cycle synchronization is due to an increase in the correlation of a possibly global business cycle. This would contribute to making the analysis of the European business cycle correlation more exact.

Chapter 5

Appendix

Table 5.1: Communalities US 1970-2010

	Factor 1	**Factor 2**	**Factor 3**	**Factor 4**	**Total**
Alabama	0,9030209	0,0109077	0,0006696	0,0011253	0,9157235
Alaska	0,0806698	0,2344754	0,0004851	0,0324530	0,3480833
Arizona	0,8538954	0,0000211	0,0232273	0,0042282	0,8813720
Arkansas	0,7878965	0,0491275	0,0110297	0,0231698	0,8712235
California	0,8444216	0,0105376	0,0031900	0,0340959	0,8922451
Colorado	0,8001428	0,0327851	0,0070563	0,0088078	0,8487919
Connecticut	0,8014071	0,0053666	0,0574407	0,0603007	0,9245152
Delaware	0,5073134	0,0174051	0,0270862	0,0030739	0,5548786
DOC	0,3030103	0,0091463	0,0199256	0,0426108	0,3746930
Florida	0,7872716	0,0058389	0,0137813	0,0003142	0,8072060
Georgia	0,8837736	0,0228517	0,0002879	0,0201491	0,9270624
Hawaii	0,3645972	0,0038700	0,0487400	0,2562522	0,6734593
Idaho	0,7083138	0,0026105	0,1138142	0,0018925	0,8266310
Illinois	0,8089738	0,0007780	0,0072081	0,0281719	0,8451317
Indiana	0,8524756	0,0326663	0,0002148	0,0322263	0,9175830
Iowa	0,7984734	0,0078900	0,0034301	0,0106043	0,8203977
Kansas	0,7059470	0,0052008	0,0349791	0,0064994	0,7526262
Kentucky	0,5210521	0,0004491	0,1662843	0,0393454	0,7271309
Louisiana	0,3195708	0,1754119	0,0166623	0,0672783	0,5789234
Maine	0,6566115	0,0885902	0,0712255	0,0017363	0,8181635
Maryland	0,7640794	0,0102067	0,0004826	0,0914380	0,8662067
Massachussetts	0,7584631	0,0306740	0,0779658	0,0165997	0,8837026
Michigan	0,8082433	0,0207609	0,0047890	0,0389537	0,8727468
Minnesota	0,8667256	0,0001448	0,0097864	0,0238140	0,9004708
Missouri	0,8750530	0,0107640	0,0003990	0,0051838	0,8913998
Montana	0,5083310	0,0064473	0,1056753	0,0296938	0,6501473
Nebraska	0,7195240	0,0086971	0,0107331	0,0114462	0,7504004
Nevada	0,7093168	0,0116689	0,0683562	0,0125522	0,8018941
NH	0,7463842	0,0764182	0,0348510	0,0262449	0,8838984
NJ	0,8443376	0,0302522	0,0488637	0,0027578	0,9262112
NM	0,6901750	0,0307982	0,0555929	0,0810910	0,8576571
NY	0,7947625	0,0000624	0,0613213	0,0294348	0,8855810
NC	0,8641889	0,0420608	0,0019271	0,0031527	0,9113295
ND	0,2615205	0,0308941	0,0069421	0,0148582	0,3142149
Ohio	0,9166015	0,0009182	0,0055203	0,0038968	0,9269368
Oklahoma	0,4186681	0,3654191	0,0459109	0,0071843	0,8371825
Oregon	0,8073487	0,0075411	0,1337857	0,0038755	0,9525511
Pennsylvania	0,8731011	0,0029149	0,0286545	0,0147729	0,9194434
RI	0,7159975	0,0568303	0,0078194	0,0781646	0,8588118
SC	0,8589676	0,0284727	0,0000638	0,0070147	0,8945189
SD	0,6766230	0,0080329	0,0602636	0,0000264	0,7449459
Tennesee	0,9027241	0,0307688	0,0079722	0,0232633	0,9647284
Texas	0,6364201	0,3460229	0,0066337	0,0032488	0,9923254
Utah	0,7505174	0,0678316	0,0354653	0,0000160	0,8538303
Washington	0,7233140	0,0058411	0,1549942	0,0328077	0,9169570
Vermont	0,7465941	0,0330058	0,0125974	0,0058178	0,7980151

WV	0,2425728	0,0140615	0,0000027	0,0006307	0,2572677
Virginia	0,8494209	0,0339184	0,0000485	0,0054730	0,8888608
Wisconsin	0,9206087	0,0039468	0,0027481	0,0082953	0,9355990
Wyoming	0,2337766	0,4966216	0,0085213	0,0187487	0,7576683

Table 5.2: Estimated Loadings US 1970-2010

	Factor 1	**Factor 2**	**Factor 3**	**Factor 4**
Alabama	0,008535	-0,000921	-0,000223	-0,000282
Alaska	-0,005605	0,009386	-0,000416	0,003328
Arizona	0,012537	-0,000061	0,001980	0,000826
Arkansas	0,008553	-0,002098	0,000969	-0,001373
California	0,008515	0,000934	0,000501	0,001602
Colorado	0,009141	0,001817	0,000822	-0,000898
Connecticut	0,008070	-0,000649	-0,002069	0,002072
Delaware	0,006178	-0,001124	0,001367	-0,000450
DOC	0,003365	0,000574	0,000826	0,001181
Florida	0,011448	-0,000968	0,001450	-0,000214
Georgia	0,010303	-0,001627	0,000178	-0,001456
Hawaii	0,004101	0,000415	0,001436	0,003218
Idaho	0,009746	0,000581	0,003740	-0,000472
Illinois	0,007729	0,000235	-0,000698	0,001350
Indiana	0,011015	-0,002118	-0,000167	-0,002005
Iowa	0,007273	-0,000710	0,000456	0,000785
Kansas	0,007161	0,000604	0,001526	-0,000643
Kentucky	0,008124	-0,000234	-0,004394	0,002090
Louisiana	0,006046	0,004399	0,001322	-0,002597
Maine	0,006905	-0,002491	-0,002178	-0,000332
Maryland	0,006745	-0,000766	-0,000162	0,002184
Massachussetts	0,008418	-0,001663	-0,002584	0,001166
Michigan	0,011724	-0,001845	0,000864	-0,002409
Minnesota	0,008254	-0,000105	0,000840	0,001281
Missouri	0,007974	-0,000869	0,000163	-0,000574
Montana	0,006003	-0,000664	0,002621	-0,001358
Nebraska	0,006415	0,000693	0,000750	0,000757
Nevada	0,011596	0,001461	0,003447	0,001444
NH	0,010640	-0,003344	-0,002201	-0,001868
NJ	0,007012	-0,001304	-0,001615	0,000375
NM	0,006281	0,001303	0,001707	-0,002015
NY	0,005974	0,000052	-0,001589	0,001076
NC	0,010206	-0,002212	-0,000461	-0,000577
ND	0,002795	0,000944	0,000436	0,000624
Ohio	0,009584	-0,000298	-0,000712	0,000585
Oklahoma	0,005474	0,005023	-0,001736	-0,000671
Oregon	0,010393	-0,000987	0,004051	0,000674
Pennsylvania	0,006653	0,000378	-0,001154	0,000810
RI	0,009400	-0,002601	-0,000941	-0,002907
SC	0,010946	-0,001957	-0,000090	-0,000926
SD	0,006386	-0,000683	0,001825	-0,000037

Tennesee	0,010378	-0,001882	-0,000934	-0,001559
Texas	0,007191	0,005208	-0,000703	-0,000481
Utah	0,008126	0,002399	0,001691	0,000035
Washington	0,007837	0,000692	0,003473	0,001562
Vermont	0,007555	-0,001560	-0,000940	-0,000624
WV	0,006263	0,001481	0,000020	-0,000299
Virginia	0,007525	-0,001477	-0,000054	0,000565
Wisconsin	0,008443	-0,000543	0,000442	0,000750
Wyoming	0,006719	0,009619	-0,001228	-0,001781

Table 5.3: Krugman index of specialization USA

	Alabama	**Alaska**	**Arizona**	**Arkansas**	**California**	**Colorado**	**Connecticut**
1970	0,50	0,93	0,53	0,34	0,30	0,33	0,43
1971	0,47	0,90	0,52	0,32	0,28	0,30	0,38
1972	0,47	0,89	0,55	0,30	0,28	0,30	0,37
1973	0,46	0,86	0,53	0,29	0,27	0,29	0,39
1974	0,46	0,71	0,47	0,33	0,28	0,27	0,38
1975	0,48	0,87	0,54	0,32	0,28	0,32	0,41
1976	0,47	0,98	0,49	0,29	0,27	0,31	0,38
1977	0,44	1,03	0,50	0,29	0,27	0,30	0,39
1978	0,42	0,97	0,50	0,28	0,26	0,30	0,39
1979	0,43	0,96	0,49	0,29	0,28	0,30	0,39
1980	0,42	1,01	0,49	0,29	0,28	0,31	0,38
1981	0,44	0,91	0,49	0,30	0,33	0,33	0,38
1982	0,42	0,94	0,54	0,29	0,34	0,32	0,40
1983	0,42	1,01	0,51	0,28	0,33	0,32	0,40
1984	0,40	0,98	0,45	0,24	0,35	0,30	0,38
1985	0,41	0,94	0,47	0,21	0,36	0,31	0,38
1986	0,37	0,94	0,53	0,26	0,34	0,32	0,37
1987	0,37	0,96	0,53	0,28	0,34	0,31	0,35
1988	0,43	0,90	0,50	0,31	0,34	0,28	0,34
1989	0,39	0,94	0,53	0,32	0,33	0,28	0,36
1990	0,38	0,99	0,54	0,31	0,34	0,28	0,35
1991	0,39	1,00	0,60	0,29	0,32	0,32	0,38
1992	0,40	1,01	0,62	0,31	0,30	0,30	0,33
1993	0,39	0,97	0,63	0,32	0,29	0,33	0,31
1994	0,43	1,00	0,64	0,36	0,34	0,36	0,31
1995	0,40	1,00	0,66	0,33	0,34	0,35	0,31
1996	0,39	1,01	0,67	0,34	0,35	0,31	0,33
1997	0,37	1,10	0,75	0,29	0,37	0,35	0,43
1998	0,35	1,18	0,76	0,27	0,38	0,32	0,43
1999	0,30	1,11	0,77	0,28	0,39	0,32	0,40
2000	0,33	1,09	0,72	0,32	0,41	0,35	0,39
2001	0,31	1,07	0,79	0,32	0,35	0,29	0,45
2002	0,27	1,06	0,80	0,36	0,35	0,35	0,38
2003	0,26	1,08	0,86	0,40	0,30	0,33	0,41
2004	0,27	1,08	0,78	0,40	0,26	0,34	0,38
2005	0,31	1,04	0,73	0,40	0,29	0,29	0,40
2006	0,34	1,08	0,72	0,38	0,28	0,33	0,38
2007	0,32	1,06	0,65	0,34	0,28	0,34	0,38
2008	0,39	1,10	0,64	0,36	0,38	0,25	0,40
Mean	0,39	0,99	0,60	0,31	0,32	0,31	0,38

	Delaware	DOC	Florida	Georgia	Hawaii	Idaho	Illinois
1970	0,78	1,21	0,34	0,55	1,05	0,58	0,25
1971	0,78	1,24	0,33	0,57	0,95	0,61	0,26
1972	0,80	1,29	0,34	0,60	1,02	0,58	0,25
1973	0,86	1,28	0,34	0,62	1,03	0,56	0,25
1974	0,82	1,21	0,39	0,59	1,06	0,65	0,24
1975	0,79	1,25	0,39	0,57	1,02	0,63	0,24
1976	0,81	1,26	0,36	0,54	1,08	0,59	0,24
1977	0,80	1,28	0,35	0,55	1,09	0,56	0,24
1978	0,81	1,29	0,31	0,56	1,10	0,55	0,22
1979	0,84	1,29	0,26	0,57	1,09	0,48	0,21
1980	0,82	1,29	0,26	0,57	1,10	0,47	0,22
1981	0,83	1,27	0,22	0,55	1,07	0,55	0,20
1982	0,82	1,29	0,23	0,50	1,08	0,54	0,21
1983	0,84	1,28	0,22	0,49	1,12	0,56	0,22
1984	0,83	1,25	0,27	0,47	1,10	0,55	0,20
1985	0,85	1,12	0,24	0,42	1,07	0,54	0,20
1986	0,83	1,09	0,20	0,41	1,00	0,49	0,22
1987	0,83	1,12	0,22	0,46	0,98	0,40	0,19
1988	0,80	1,10	0,23	0,46	1,02	0,44	0,18
1989	0,85	1,11	0,22	0,46	0,94	0,39	0,19
1990	0,83	1,10	0,22	0,46	0,93	0,37	0,18
1991	0,75	1,18	0,23	0,46	0,94	0,40	0,17
1992	0,70	1,16	0,24	0,46	0,90	0,49	0,17
1993	0,72	1,15	0,23	0,45	0,93	0,54	0,21
1994	0,78	1,14	0,22	0,48	0,94	0,68	0,19
1995	0,84	1,03	0,24	0,47	1,01	0,59	0,18
1996	0,81	1,04	0,22	0,47	1,02	0,60	0,18
1997	0,60	0,61	0,26	0,47	0,88	0,46	0,20
1998	0,48	0,62	0,23	0,52	0,86	0,47	0,21
1999	0,52	0,46	0,24	0,49	0,87	0,45	0,22
2000	0,62	0,49	0,26	0,49	0,83	0,54	0,23
2001	0,58	0,61	0,26	0,46	0,81	0,50	0,24
2002	0,54	0,46	0,26	0,46	0,86	0,56	0,22
2003	0,56	0,47	0,27	0,47	0,92	0,60	0,23
2004	0,66	0,49	0,32	0,52	0,89	0,76	0,21
2005	0,65	0,56	0,37	0,54	0,80	0,80	0,21
2006	0,60	0,57	0,39	0,50	0,78	0,61	0,24
2007	0,61	0,71	0,43	0,48	0,77	0,62	0,24
2008	0,55	0,68	0,36	0,46	0,81	0,64	0,28
Mean	0,74	1,00	0,28	0,50	0,97	0,55	0,22

	Indiana	Iowa	Kansas	Kentucky	Louisiana	Maine	Maryland
1970	0,32	0,36	0,35	0,41	0,74	0,72	0,31
1971	0,36	0,32	0,32	0,40	0,75	0,67	0,29
1972	0,36	0,31	0,31	0,36	0,76	0,75	0,28
1973	0,37	0,32	0,32	0,34	0,73	0,75	0,25
1974	0,34	0,32	0,33	0,30	0,77	0,75	0,28
1975	0,36	0,33	0,34	0,28	0,76	0,77	0,28
1976	0,36	0,32	0,32	0,31	0,78	0,76	0,23
1977	0,36	0,33	0,29	0,33	0,76	0,76	0,24
1978	0,36	0,36	0,30	0,30	0,81	0,72	0,22
1979	0,34	0,35	0,32	0,30	0,77	0,70	0,23
1980	0,36	0,35	0,34	0,30	0,74	0,71	0,25
1981	0,34	0,31	0,33	0,32	0,66	0,67	0,27
1982	0,32	0,29	0,37	0,33	0,73	0,66	0,27
1983	0,32	0,27	0,33	0,31	0,73	0,59	0,29
1984	0,28	0,26	0,36	0,26	0,72	0,61	0,29
1985	0,30	0,24	0,36	0,28	0,79	0,57	0,30
1986	0,29	0,29	0,36	0,26	0,79	0,54	0,27
1987	0,28	0,28	0,37	0,26	0,87	0,59	0,25
1988	0,31	0,26	0,33	0,24	0,89	0,58	0,27
1989	0,30	0,30	0,34	0,25	0,87	0,57	0,27
1990	0,28	0,27	0,33	0,28	0,84	0,52	0,26
1991	0,33	0,25	0,34	0,28	0,80	0,52	0,27
1992	0,33	0,24	0,36	0,24	0,82	0,55	0,30
1993	0,35	0,23	0,36	0,24	0,85	0,58	0,27
1994	0,36	0,24	0,36	0,28	0,91	0,65	0,29
1995	0,38	0,24	0,37	0,31	0,84	0,61	0,30
1996	0,37	0,23	0,40	0,32	0,84	0,56	0,32
1997	0,34	0,32	0,37	0,33	0,80	0,61	0,25
1998	0,33	0,30	0,37	0,33	0,76	0,65	0,25
1999	0,35	0,30	0,37	0,34	0,82	0,64	0,29
2000	0,37	0,32	0,40	0,28	0,79	0,60	0,30
2001	0,38	0,30	0,39	0,28	0,72	0,52	0,30
2002	0,38	0,30	0,37	0,27	0,77	0,55	0,26
2003	0,41	0,33	0,33	0,32	0,91	0,49	0,27
2004	0,39	0,30	0,38	0,34	0,96	0,48	0,24
2005	0,39	0,34	0,25	0,32	1,08	0,46	0,27
2006	0,37	0,32	0,32	0,31	1,03	0,49	0,29
2007	0,37	0,33	0,36	0,29	0,93	0,52	0,36
2008	0,36	0,35	0,38	0,30	0,91	0,51	0,30
Mean	0,35	0,30	0,35	0,30	0,82	0,61	0,27

	Massachussetts	Michigan	Minnesota	Missouri	Montana	Nebraska
1970	0,30	0,75	0,43	0,22	0,73	0,38
1971	0,29	0,71	0,39	0,23	0,74	0,35
1972	0,31	0,72	0,40	0,22	0,72	0,37
1973	0,32	0,66	0,40	0,22	0,73	0,39
1974	0,35	0,65	0,34	0,20	0,66	0,41
1975	0,35	0,72	0,36	0,22	0,69	0,40
1976	0,36	0,71	0,31	0,25	0,71	0,32
1977	0,37	0,69	0,32	0,25	0,70	0,31
1978	0,38	0,66	0,31	0,22	0,64	0,29
1979	0,38	0,62	0,30	0,21	0,61	0,29
1980	0,39	0,66	0,30	0,22	0,60	0,29
1981	0,40	0,67	0,30	0,21	0,61	0,30
1982	0,43	0,73	0,34	0,18	0,61	0,30
1983	0,40	0,70	0,33	0,23	0,61	0,29
1984	0,41	0,69	0,32	0,16	0,62	0,33
1985	0,41	0,70	0,34	0,19	0,64	0,34
1986	0,44	0,67	0,31	0,20	0,72	0,28
1987	0,43	0,64	0,32	0,22	0,67	0,27
1988	0,44	0,60	0,30	0,22	0,68	0,32
1989	0,45	0,56	0,28	0,28	0,61	0,32
1990	0,43	0,55	0,25	0,29	0,60	0,29
1991	0,41	0,56	0,25	0,28	0,62	0,29
1992	0,39	0,60	0,25	0,26	0,62	0,33
1993	0,37	0,64	0,24	0,25	0,60	0,31
1994	0,40	0,59	0,25	0,30	0,58	0,33
1995	0,38	0,60	0,25	0,30	0,59	0,27
1996	0,37	0,58	0,24	0,32	0,58	0,26
1997	0,41	0,64	0,24	0,25	0,61	0,32
1998	0,42	0,63	0,27	0,25	0,60	0,30
1999	0,41	0,64	0,25	0,23	0,49	0,30
2000	0,44	0,68	0,24	0,23	0,47	0,32
2001	0,48	0,69	0,25	0,21	0,46	0,35
2002	0,46	0,68	0,24	0,22	0,49	0,32
2003	0,50	0,71	0,29	0,21	0,61	0,32
2004	0,50	0,68	0,28	0,24	0,66	0,29
2005	0,48	0,70	0,29	0,23	0,66	0,33
2006	0,44	0,62	0,27	0,24	0,71	0,35
2007	0,45	0,66	0,28	0,26	0,80	0,35
2008	0,45	0,60	0,27	0,30	0,69	0,37
Mean	0,41	0,65	0,30	0,24	0,63	0,32

	Nevada	NH	NJ	NM	NY	NC	ND	Ohio
1970	0,52	0,48	0,29	0,40	0,36	0,82	0,71	0,37
1971	0,42	0,44	0,31	0,38	0,36	0,78	0,68	0,38
1972	0,41	0,45	0,32	0,41	0,35	0,78	0,57	0,38
1973	0,41	0,42	0,33	0,41	0,34	0,77	0,59	0,38
1974	0,45	0,39	0,33	0,40	0,35	0,76	0,47	0,38
1975	0,44	0,40	0,36	0,39	0,34	0,74	0,51	0,36
1976	0,37	0,40	0,35	0,35	0,34	0,70	0,59	0,37
1977	0,35	0,44	0,37	0,34	0,34	0,70	0,54	0,37
1978	0,37	0,45	0,32	0,37	0,34	0,66	0,53	0,35
1979	0,36	0,45	0,29	0,29	0,32	0,64	0,54	0,32
1980	0,35	0,44	0,29	0,29	0,33	0,64	0,58	0,32
1981	0,35	0,45	0,33	0,32	0,33	0,62	0,61	0,30
1982	0,36	0,42	0,35	0,34	0,33	0,61	0,59	0,35
1983	0,35	0,46	0,33	0,30	0,34	0,56	0,62	0,34
1984	0,35	0,47	0,36	0,39	0,31	0,53	0,59	0,35
1985	0,34	0,47	0,38	0,42	0,33	0,52	0,57	0,34
1986	0,31	0,46	0,41	0,41	0,34	0,55	0,52	0,34
1987	0,33	0,45	0,39	0,38	0,33	0,54	0,44	0,34
1988	0,39	0,47	0,42	0,40	0,32	0,51	0,44	0,35
1989	0,38	0,43	0,45	0,43	0,32	0,52	0,45	0,32
1990	0,37	0,43	0,48	0,84	0,31	0,54	0,43	0,31
1991	0,40	0,46	0,49	0,92	0,32	0,55	0,38	0,34
1992	0,42	0,42	0,53	0,97	0,33	0,52	0,43	0,35
1993	0,46	0,45	0,53	1,01	0,35	0,52	0,44	0,34
1994	0,41	0,51	0,57	0,96	0,32	0,48	0,50	0,35
1995	0,41	0,52	0,63	0,95	0,34	0,51	0,49	0,32
1996	0,41	0,48	0,62	0,99	0,33	0,48	0,50	0,33
1997	0,45	0,57	0,60	1,03	0,26	0,52	0,55	0,38
1998	0,42	0,57	0,57	0,89	0,23	0,56	0,57	0,39
1999	0,38	0,47	0,59	0,91	0,25	0,53	0,57	0,37
2000	0,38	0,48	0,58	0,84	0,28	0,57	0,54	0,38
2001	0,36	0,45	0,58	0,69	0,24	0,59	0,45	0,34
2002	0,41	0,52	0,54	0,65	0,26	0,62	0,48	0,33
2003	0,48	0,53	0,54	0,79	0,28	0,61	0,48	0,35
2004	0,64	0,57	0,52	0,96	0,30	0,56	0,47	0,37
2005	0,66	0,56	0,50	0,92	0,28	0,54	0,54	0,38
2006	0,64	0,57	0,53	0,89	0,34	0,45	0,52	0,35
2007	0,70	0,57	0,52	0,73	0,29	0,47	0,46	0,34
2008	0,70	0,56	0,53	0,66	0,27	0,48	0,48	0,36
Mean	0,43	0,48	0,45	0,62	0,31	0,59	0,52	0,35

	Oklahoma	Oregon	Pennsylvania	RI	SC	SD	Tennesee
1970	0,28	0,61	0,23	0,37	0,77	0,64	0,39
1971	0,29	0,63	0,22	0,35	0,78	0,50	0,38
1972	0,26	0,68	0,22	0,36	0,78	0,50	0,38
1973	0,28	0,64	0,26	0,37	0,75	0,52	0,36
1974	0,30	0,58	0,28	0,43	0,70	0,51	0,39
1975	0,27	0,64	0,24	0,46	0,72	0,49	0,36
1976	0,26	0,66	0,19	0,44	0,70	0,44	0,38
1977	0,29	0,67	0,19	0,42	0,69	0,42	0,37
1978	0,26	0,64	0,19	0,43	0,68	0,45	0,35
1979	0,29	0,57	0,19	0,43	0,67	0,42	0,37
1980	0,31	0,52	0,18	0,45	0,68	0,43	0,38
1981	0,30	0,51	0,14	0,45	0,68	0,45	0,39
1982	0,29	0,58	0,15	0,44	0,65	0,45	0,34
1983	0,31	0,55	0,16	0,41	0,61	0,47	0,27
1984	0,30	0,54	0,15	0,48	0,61	0,41	0,32
1985	0,27	0,57	0,17	0,45	0,61	0,38	0,28
1986	0,26	0,53	0,15	0,47	0,56	0,43	0,26
1987	0,29	0,51	0,13	0,48	0,56	0,40	0,25
1988	0,27	0,52	0,13	0,48	0,57	0,40	0,26
1989	0,31	0,48	0,15	0,52	0,55	0,41	0,27
1990	0,28	0,46	0,17	0,50	0,57	0,42	0,27
1991	0,25	0,51	0,21	0,49	0,59	0,47	0,23
1992	0,21	0,59	0,20	0,46	0,56	0,58	0,24
1993	0,21	0,54	0,22	0,44	0,55	0,50	0,24
1994	0,24	0,59	0,17	0,45	0,55	0,55	0,23
1995	0,22	0,77	0,18	0,43	0,53	0,52	0,22
1996	0,21	0,75	0,21	0,42	0,51	0,51	0,23
1997	0,25	0,64	0,25	0,45	0,46	0,52	0,19
1998	0,31	0,66	0,25	0,45	0,45	0,51	0,18
1999	0,27	0,60	0,27	0,47	0,45	0,49	0,18
2000	0,26	0,60	0,27	0,46	0,46	0,59	0,18
2001	0,31	0,58	0,34	0,53	0,42	0,56	0,13
2002	0,35	0,61	0,34	0,52	0,35	0,70	0,16
2003	0,29	0,69	0,33	0,46	0,39	0,52	0,21
2004	0,33	0,82	0,24	0,57	0,35	0,54	0,19
2005	0,32	0,79	0,23	0,51	0,38	0,52	0,24
2006	0,32	0,87	0,20	0,45	0,38	0,50	0,26
2007	0,36	0,89	0,21	0,47	0,33	0,48	0,22
2008	0,34	0,88	0,19	0,46	0,34	0,47	0,23
Mean	0,28	0,63	0,21	0,45	0,56	0,49	0,28

	Texas	Utah	Washington	Vermont	WV	Virginia	Wisconsin	Wyoming
1970	0,377	0,471	0,676	0,476	0,511	0,531	0,307	0,742
1971	0,322	0,467	0,685	0,427	0,530	0,524	0,296	0,798
1972	0,341	0,436	0,721	0,434	0,554	0,549	0,304	0,796
1973	0,320	0,416	0,718	0,454	0,543	0,541	0,313	0,809
1974	0,361	0,400	0,706	0,543	0,477	0,495	0,325	0,809
1975	0,390	0,389	0,709	0,572	0,532	0,551	0,326	0,821
1976	0,328	0,363	0,680	0,506	0,548	0,513	0,319	0,870
1977	0,318	0,380	0,686	0,549	0,531	0,484	0,315	0,830
1978	0,334	0,349	0,665	0,552	0,508	0,484	0,334	0,921
1979	0,271	0,340	0,642	0,510	0,497	0,504	0,323	0,884
1980	0,273	0,340	0,664	0,522	0,528	0,509	0,317	0,838
1981	0,245	0,368	0,698	0,506	0,564	0,487	0,309	0,790
1982	0,285	0,386	0,683	0,506	0,593	0,473	0,303	0,779
1983	0,247	0,379	0,643	0,457	0,618	0,453	0,261	0,749
1984	0,248	0,442	0,661	0,426	0,652	0,402	0,254	0,714
1985	0,258	0,373	0,678	0,453	0,622	0,383	0,261	0,733
1986	0,292	0,302	0,695	0,497	0,598	0,349	0,279	0,677
1987	0,315	0,325	0,668	0,561	0,643	0,351	0,284	0,827
1988	0,294	0,313	0,673	0,568	0,604	0,354	0,273	0,772
1989	0,270	0,321	0,706	0,616	0,597	0,351	0,294	0,708
1990	0,188	0,323	0,771	0,587	0,601	0,334	0,290	0,768
1991	0,181	0,289	0,772	0,576	0,618	0,344	0,263	0,740
1992	0,186	0,300	0,736	0,553	0,648	0,367	0,251	0,725
1993	0,234	0,294	0,706	0,527	0,675	0,363	0,257	0,749
1994	0,219	0,318	0,610	0,436	0,718	0,381	0,244	0,710
1995	0,201	0,282	0,646	0,418	0,684	0,398	0,244	0,869
1996	0,207	0,279	0,629	0,483	0,663	0,394	0,246	0,879
1997	0,329	0,336	0,575	0,425	0,613	0,452	0,326	0,768
1998	0,302	0,338	0,553	0,425	0,584	0,427	0,307	0,820
1999	0,247	0,338	0,577	0,352	0,582	0,498	0,279	0,729
2000	0,213	0,339	0,558	0,350	0,504	0,502	0,277	0,791
2001	0,255	0,306	0,600	0,530	0,461	0,481	0,292	0,870
2002	0,231	0,325	0,546	0,560	0,429	0,466	0,260	0,763
2003	0,277	0,317	0,562	0,546	0,433	0,424	0,314	0,843
2004	0,402	0,352	0,557	0,536	0,382	0,379	0,314	0,837
2005	0,345	0,388	0,514	0,558	0,385	0,391	0,306	0,866
2006	0,352	0,434	0,571	0,509	0,404	0,402	0,311	0,923
2007	0,386	0,408	0,576	0,465	0,384	0,353	0,327	0,936
2008	0,278	0,394	0,651	0,493	0,415	0,398	0,345	0,944
Mean	0,2853	0,3569	0,6504	0,4991	0,5497	0,4370	0,2936	0,8050

	Mean	Variance
1970	0,509	0,049
1971	0,493	0,049
1972	0,498	0,053
1973	0,495	0,052
1974	0,487	0,045
1975	0,499	0,048
1976	0,489	0,055
1977	0,488	0,056
1978	0,481	0,057
1979	0,468	0,055
1980	0,472	0,055
1981	0,469	0,052
1982	0,475	0,053
1983	0,466	0,055
1984	0,461	0,052
1985	0,457	0,048
1986	0,450	0,046
1987	0,452	0,049
1988	0,451	0,047
1989	0,452	0,045
1990	0,454	0,050
1991	0,460	0,053
1992	0,465	0,053
1993	0,468	0,053
1994	0,479	0,054
1995	0,479	0,056
1996	0,478	0,056
1997	0,472	0,042
1998	0,466	0,042
1999	0,453	0,040
2000	0,458	0,037
2001	0,455	0,037
2002	0,453	0,036
2003	0,470	0,042
2004	0,485	0,048
2005	0,487	0,047
2006	0,482	0,044
2007	0,481	0,042
2008	0,479	0,041
Mean	0,4727	0,0486

Chapter 6

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