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DIPLOMARBEIT

Titel der Diplomarbeit

„A Convergence Study of Austria, Germany and
Switzerland”

Verfasser

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angestrebter akademischer Grad

Magister der Sozial- und Wirtschaftswissenschaften
(Mag.rer.soc.oec.)

Wien, 2012

Studienkennzahl lt. Studienblatt:
Studienrichtung lt. Studienblatt:
Betreuer

A 140
Diplomstudium Volkswirtschaft
Univ.-Prof. Dipl.-Ing. Dr. Robert Kunst

Acknowledgements

This thesis would not have been possible without the guidance and the help of my advisor Robert Kunst.

Furthermore I want to thank my family without their support and help my study would not have been possible.

Also I don't want to forget my friends that have gone with me through my study life and have had some important inputs to my work. Namely Georg Ecker, Stephan Eger, Alois Engl, Peter Obereigner and Stefan Niederreiter and Moritz Resl.

Table of contents

List of figures	5
List of tables	5
Acronyms and Abbreviations	6
Abstract (English)	7
Abstract (German)	8
Chapter 1	9
1.1. Introduction	9
Chapter 2	10
2.1. Review of the Literature	10
Chapter 3	12
3.1. The Business Cycle	12
3.1.1. Economic activity	13
3.1.2. General description of a business cycle	14
3.1.3. Phases of the cycle	15
3.1.4. Causes for a business cycle	16
3.1.5. Duration of a business cycle	17
Chapter 4	19
4.1. Data	19
4.2. General facts about the trade balance	19
Chapter 5	35
5.1. Empirical Method	35
5.3. Interpretation	37
Chapter 6	38
6.1. Conclusion	38
References	39
Appendix	41
Curriculum Vitae	42

List of figures

Fig. 3.1: A cycle wave	14
Fig. 3.2: Amplitude of a cycle	14
Fig. 3.3: Period of a cycle	15
Fig. 3.4: General business cycle graph	16
Fig. 3.5: Kondratiev wave	18
Fig. 3.5: Business cycle by Schumpeter	18
Fig. 4.1: Imports from Germany (historical)	23
Fig. 4.2: Exports from Germany (historical)	24
Fig. 4.3: Trade with Germany (historical)	24
Fig. 4.4: Trade ratio of Austria (exports)	25
Fig. 4.5: Trade ratio of Austria (imports)	26
Fig. 4.6: Trade ratio of Germany (exports)	26
Fig. 4.7: Trade ratio of Germany (imports)	27
Fig. 4.8: Trade ratio of Switzerland (exports)	27
Fig. 4.9.: Trade ratio of Switzerland (imports)	28
Fig. 4.10: Austria's GDP real	29
Fig. 4.11: Austria's CPI	29
Fig. 4.12: Germany's GDP real	30
Fig. 4.13: Germany's CPI	30
Fig. 4.14: Swiss GDP real	31
Fig. 4.15: Swiss CPI	31
Fig. 4.16: Unemployment rate of Austria	32
Fig. 4.17: Unemployment rate of Germany	33
Fig. 4.18: Unemployment rate of Switzerland	33

List of tables

Table 4.1: The most important trading partners of Austria 2011	21
Table 4.2: The most important trading partners of Germany 2011	21
Table 4.3: The most important trading partners of Switzerland 2010	22
Table: 5.1: Empirical results	36

Acronyms and Abbreviations

CCA	Canonical Correlation Analysis
EFTA	European Free Trade Association
GDP	Gross Domestic Product
CPI	Consumer Price Index
SECO	State Secretariat for Economic Affairs (Switzerland)
IMF	International Monetary Fund
AT	Austria
DE	Germany
CH	Switzerland
G	Governmental spending
I	Investment
C	Sum of Consumption
X	Exports
M	Imports
$(X - M)$	Net Exports

Abstract (English)

This thesis investigates the economic interdependence between Austria and Germany as well as Switzerland and Germany over a thirty year period starting in 1980. The main questions I address are (i) To what degree are these economies interdependent? (ii) Is there a synchronization of the business cycles? (iii) Has the convergence of the business cycles accelerated since Austria has joined the European Union? I therefore give an operational definition of a business cycle and use trade flows, graphs and canonical correlation analysis to identify possible macroeconomic interdependencies and transmissions. The canonical correlation analysis is applied to check for convergence.

My main results are that the economies of both countries (Austria and Switzerland) have been highly synchronized with the German economy over the last thirty years, but no further synchronization took place.

Abstract (German)

Diese Diplomarbeit untersucht die wirtschaftliche Verflechtung Österreichs mit Deutschland genauso wie die der Schweiz mit Deutschland über eine Zeitspanne von dreißig Jahren. Meine Fragestellung ist (i) sind die Volkswirtschaften wirtschaftlich verflochten? (ii) Haben sich die Konjunkturzyklen über die Jahre synchronisiert? (iii) Hat sich die Konvergenz der Konjunkturzyklen beschleunigt seit Österreich der Europäischen Union beigetreten ist? Als Einführung gehe ich auf den Konjunkturzyklus allgemein ein. Des Weiteren untersuche ich die Handelströme der jeweiligen Länder gefolgt von einer graphischen Analyse, sowie einer Kanonischen Korrelationsanalyse. Letztere soll eine etwaige Konvergenz zwischen den Ländern aufzeigen.

Die Ergebnisse zeigen, dass die Konjunkturzyklen der beiden Länder (Österreich und die Schweiz) über die letzten dreißig Jahre schon stark mit der deutschen Wirtschaft synchronisiert sind, aber keine weitere Synchronisation auf dem bereits hohen Niveau stattgefunden hat.

Chapter 1

1.1. Introduction

One objective of the European Union is to tear down trade barriers and to facilitate trade between member states and to establish a common market. As a result one can expect that because of increased trade the individual economies become more interconnected with each other and this could mean that an economy's dependence on other economies increases. So a boom or a recession in one country definitely affects or has influence on the other.

The question I raise is: Does this higher dependence also lead to a synchronization of the business cycles of the economies? Is there a convergence observable over the last years?

My goal is to see if the business cycles of Austria and Germany are synchronized and show co-movement over the last decades. If so, I want to check for an increased synchronization nowadays compared to the 1980s and 90s. A more specific question I try to answer is, if the convergence of the business cycles between Austria and Germany has even accelerated since Austria has joined the EU in 1995. Furthermore I want to investigate, if there is a difference between the Austrian-German synchronization compared to Germany and a non-European Union-member. Therefore I choose Switzerland, because the Swiss economy also is closely related to Germany's economy like Austria's. For both countries Germany is the most important trading partner.

In order to investigate the questions above, I give an overview of the business cycle in general and move on to a graphical and an empirical analysis. The remaining structure of this paper is as follows:

In Chapter 3, I explain the theoretical background of business cycles and provide a literature review.

In Chapter 4, I proceed with a graphical analysis of the data set

In Chapter 5, I conduct a canonical correlation analysis. Chapter 6 concludes.

Chapter 2

2.1. Review of the Literature

There have been done many different studies and papers on the topic of business cycle synchronization after the seminal work of Frankel and Rose (1998)¹. Many different methods have been proposed to measure the effect that trade between two countries could have on the synchronization of their business cycle. Esser (2007)² empirically investigates the influence of bilateral trade on synchronization. He concludes that the results show stronger effects of trade if filtered series are used. On the other hand more objectivity is given by unfiltered series because there is a sensitivity of estimations to different filtering methods.

Binary constructed series show a positive but less intense impact on synchronization. The multivariate analysis shows that countries cluster together when there are strong trade ties between them. Moreover Esser (2007) states that the measured strength, of the effect of more intensive trade between two countries on business cycle synchronization depends on the method used.

As of late, the international business cycle relationships and their stability have been challenged. Helbing and Bayoumi (2003)³ suggest that common shocks are responsible for the increase in cyclical synchronization in the advanced economies after 2000.

Sayek and Selover (2002)⁴ claim that there exist three major theories that are trying to explain international business cycle synchronization and comovements:

The locomotive hypothesis:

This theory explains synchronization by suggesting that business cycles are transmitted most of the time to a smaller economy by capital movements and trade flows. But labour migration, informational flows and technological transfers could also do it.

¹ Frankel, Jeffrey A. and Rose, Andrew K. (1998) "The Endogeneity of the Optimum Currency Area Criteria" *Economic Journal* 108-449, 1009-1025.

² Esser, Andreas (2007) "Trade and Business Cycle Synchronization" Universiteit Maastricht.

³ Helbing, T. and Bayoumi, T (2003) "Are They All in the Same Boat? The 2000-2001 Growth Slowdown and the G-7 Business Cycle Linages", IMF working paper, 03-46.

⁴ Sayek, Selin and Selover, David (2002) "International Interdependence and Business Cycle Transmission between Turkey and the European Union" *Southern Economic Journal*, 69(2), 206-238.

The common shocks hypothesis:

Dellas (1986)⁵ and other researchers explain with the help of real business cycle theory that common shocks like technology shocks or commodity supply shocks are responsible for business cycle synchronization, because they could not find significant proof for the transmission of business cycles.

The mode-locking theory:

Selover and Jensen (1999)⁶ developed this theory of business cycle synchronization, because they did not find the common technology shock theory plausible. According to the mode-locking theory, even only two weakly linked oscillating economies influence each other's oscillation timing in such a way that their business cycle synchronize.

This is really interesting, because it means that even if there is no strong linkage between two economies their business cycles will synchronize over time given that the mode-locking effect will shift the timing of the cycles to more synchronous phases till they reach co-movement.

Another important fact about business cycle synchronization is that during a contraction time world and country specific fluctuations seem to be much more synchronized. Similar dynamics and common timing appear to be characteristics during the economic declines. By contrast, expansions have a tendency towards large idiosyncratic components. This is shown by Canova, Ciccarelli and Ortega (2004)⁷

⁵ Dellas; Harris (1986) „A real model of the world business cycle” *Journal of International Money and Finance* Issue 5:381-94.

⁶ Selover, David D., and Roderick V. Jensen (1999) “‘Mode-locking’ and international business cycle transmission” *Journal of the Japanese and International Economies*, Issue 13:230-53.

⁷ Canova, F., Ciccarelli, M. and Ortega E. (2004) “Similarities and Convergence in G-7 Cycles” Bank of Spain working paper.

Chapter 3

3.1. The Business Cycle

Since the beginning of the 19th century economists have started to realize the importance of business cycles to capture the state of the economy and intensified their research in this economic field. In the 1920s the two pioneers Arthur F. Burns and Wesley C. Mitchell, together with the National Bureau of Economic Research (NBER), began to systematically and chronologically collect economic events and track the development of descriptive statistics to provide better anticipation and predictions of business cycles.

The most common and acknowledged definition of the business cycle is based on Burns and Mitchell:

“Business cycles are a type of fluctuations found in the aggregate economic activity of nations that organize their work mainly in business enterprises: A cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; this sequence of changes is recurrent but not periodic; in duration business cycles vary from more than one year to ten or twelve years; they are not divisible into shorter cycles of similar character with amplitudes approximating their own.”⁸

⁸ Burns, Arthur F. and Wesley C. Mitchell (1946), “Measuring Business Cycles”

3.1.1. Economic activity

Economic activity describes the business situation and business activity of a continent, country or region and shows the overall picture of the economy and is best expressed by ups and downs of the aggregated business processes.

Some economic indicators are used for the determination of the economic activity of a country. The most important are:

- GDP (Gross Domestic Product): ...is the sum of all market values of all the produced final goods and services in a defined time period within a country. It is the most important economic indicator.

GDP (Y) is defined as the sum of Consumption (C), Investment (I), Government Spending (G) and Net Exports (X – M).

$$Y = C + I + G + (X - M)$$

- The Unemployment rate: ... is one of the most important economic indicators. It is defined as follows:

$$\text{Unemployment rate} = \text{Unemployed workers} / \text{Total labour force}.$$

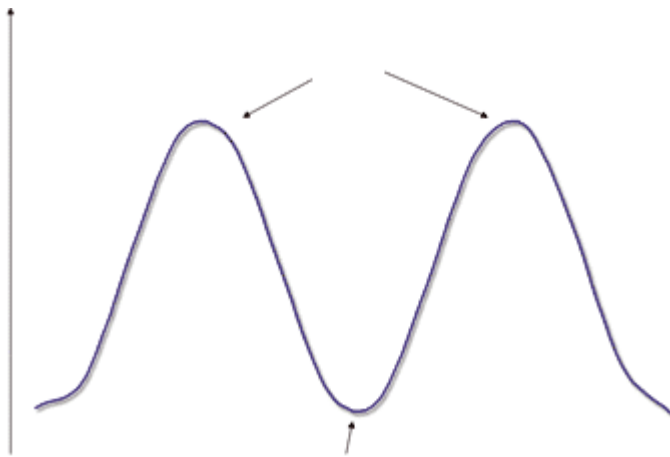
Unemployed workers are defined as people who are currently not working but are able to and want to work for pay.

- Inflation: ... is the percentage of change of the price level over a certain period of time. The price level is given by a basket of a weighted average of prices of commodities, goods and services.
- The Interest rate: ...also called federal funds rate (United States), prime rate or, main refinancing operations rate, is determined by the central bank to control the money and capital market. It has a great influence on the overall refinancing market and the liquidity in the respective currency area.

3.1.2. General description of a business cycle

Figure 3.1 shows two repetitions of cycles. As the length of a cycle usually the distance between two troughs is taken. Sometimes also the peaks are taken as a reference but it is not common and so reliable to use it.

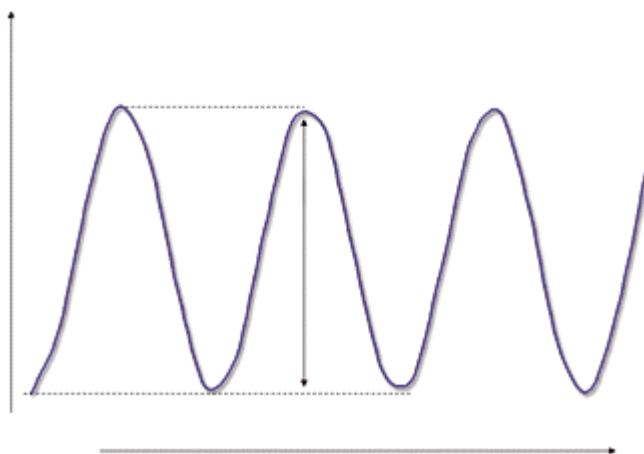
Fig. 3.1: A cycle wave



The x-axis refers to the time and the y-axis to the economy

In figure 3.2 the amplitude of cycles, i.e. the height of a cycle wave is illustrated.

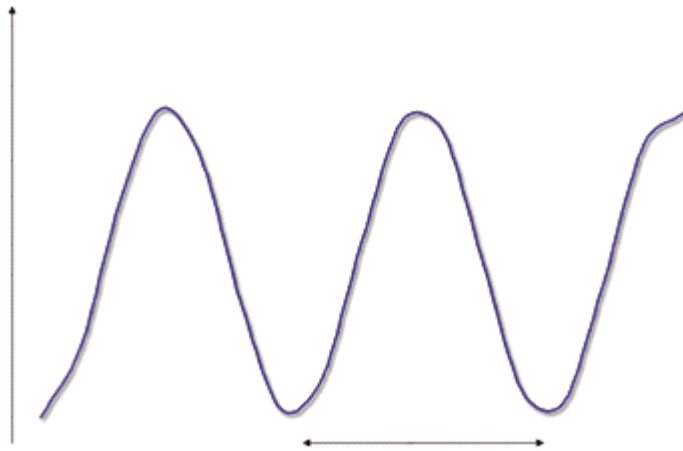
Fig. 3.2: Amplitude of a cycle



The x-axis refers to the time and the y-axis to the economy

The period of a cycle is the time between two troughs (fig. 3.3).

Fig. 3.3: Period of a cycle



The x-axis refers to the time and the y-axis to the economy

3.1.3. Phases of the cycle

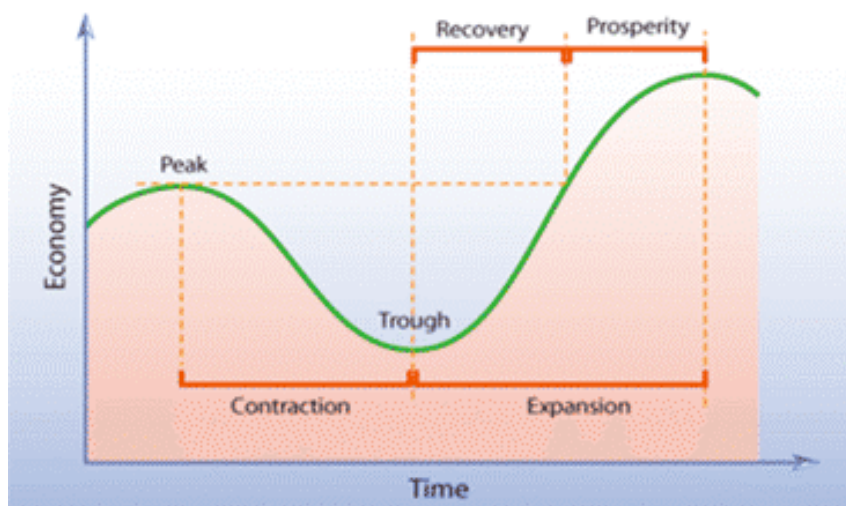
In most cases the business cycle begins with the expansion phase that is characterized by an increasing demand for labour force, commodities, goods and machinery. The positive economic development leads to a higher capacity utilization and full employment. Because of the increasing demand for labour force and goods, wages and prices are getting higher. The demand for goods keeps increasing, which results in an ongoing increase in prices. This economic situation is called economic activity in full swing or Boom and does not end until market saturation is reached. From this point on only a stagnation of the economy is observable, as displayed in figure 3.4.

The GDP still keeps on growing, but not as fast as before. The phase of the recession begins when the GDP does not increase for two consecutive quarters. This period is identified by extensive changes. The Boom slackens. What follows is a decline in prices and wages resulting from a downturn in capacity utilization and a lower demand for labour force. The filled stock of inventory and lesser earnings lead to nearly no new investment. Thus production declines and workers are laid off. In general the economic climate is assessed pessimistic. What follows is an immense downturn in the economy. The unemployment rate goes up, which explains the drop

in demand. A structural crisis occurs and the low point of the business cycle is reached. This phase is called Depression phase. In this period unemployment still rises and prices keep declining, as does the GDP growth.

The transition from one phase to another does not occur abruptly instead it is smooth. Exceptions are exogenous events, like for example the subprime mortgage crisis in 2007.

Fig. 3.4: General business cycle graph



3.1.4. Causes for a business cycle

What are the causes for the appearance of business cycles? We can distinguish between two important factors. These are of exogeneous and endogenous nature.

- Exogenous factors: These factors include higher oil prices, wars, new technologies as well as the discovery of new commodity resources.
- Endogenous factors: One example for an endogenous factor is the overindebtedness of consumers and or producers which at first is a reason for an economic boom but then can cause less consumption and leads the economy into a recession.

3.1.5. Duration of a business cycle

As well as no cycle resembles another the duration of one changes from case to case. It only is possible to roughly classify the type of a business cycle. The main characteristic trait is their duration.

The most common classification of business cycles by periods was done by the Austrian economist Joseph Schumpeter (fig. 3.6). He combined the findings from other known cycles to his version of a business cycle:

- Kitchin inventory cycle

It is used for production and demand planning. In the first phase the production is higher than the actual sales and the stock is going to replenish. As a slower growth in demand is expected the production will be reduced. Kitchin found out that this cycle lasts approximately around 41 months

- Juglar fixed investment cycle

It describes the investments in equipment and manufacturing machines. According to Clément Juglar such a cycle lasts around 9 years.

- Kuznets infrastructural investment cycle

Simon Kuznets found a connection between the demographic process, especially with immigrant inflows respectively outflows and the following construction or building power. The duration is described by 15 to 25 years.

- Kondratiev wave

This cycle is named after their founder the Russian economist Nikolai Kondratieff. An example is shown in fig. 3.5. It can last up to fifty or even sixty years. Unlike the shorter cycles, the existence of this cycle is still in dispute. Generally this cycle is dealing with structural fluctuations, which are a view on business cycles from a broader, i.e. global, perspective, and their impact on economic development over a century.

Fig. 3.5: Kondratiev wave

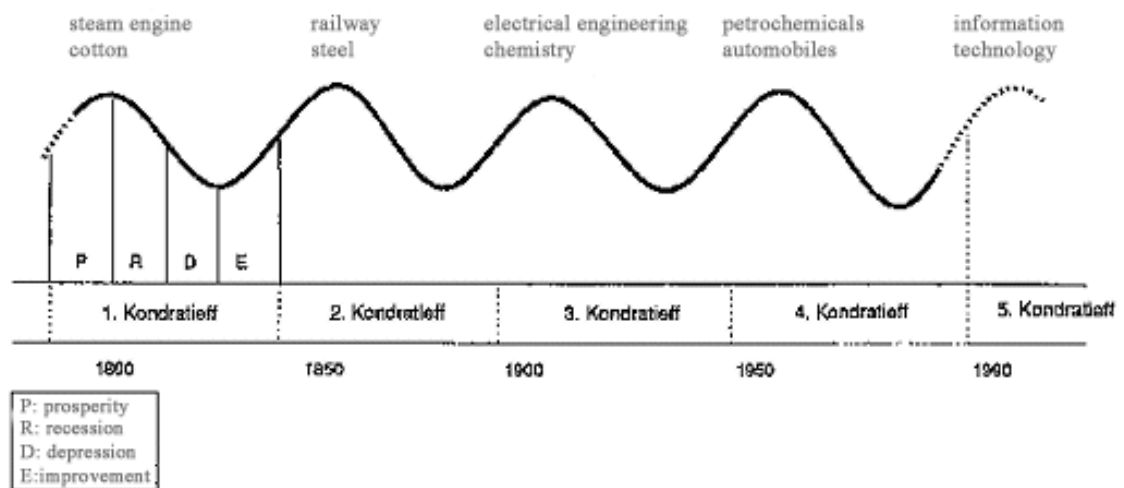
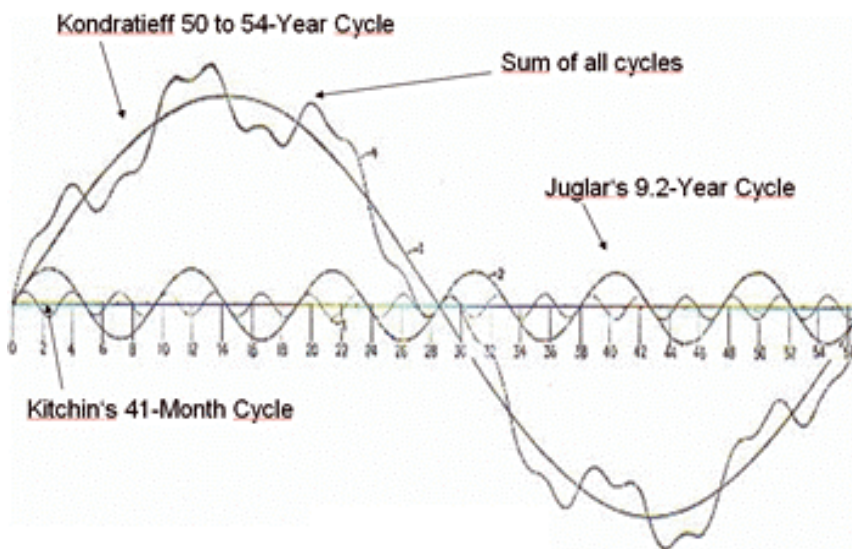


Fig. 3.6: Business cycle by Schumpeter



Another business cycle that should be mentioned is the so-called seasonal fluctuation. Such cycles are rather short and last at most for one year. They result from an economy that depends on seasonal features. Examples are economies in touristic areas or construction. Winter tourism reduces the unemployment rate or even leads to over-employment and pushes consumption during the cold months whereas during summer tourists and seasonal workers leave the region.

Chapter 4

4.1. Data

What data to consider is fairly disputed, because GDP constitutes the broadest possible output variable. Thus it provides a more complete view than just looking at part of its components.

The data set I work with to check for convergence of the business cycles between Austria and Germany and in comparison Switzerland and Germany contains the following variables. First of all and most important is the Gross Domestic Product. Furthermore I use the unemployment rate, the inflation rate and trade data, to be more precise it is amount of imports and exports between both countries and the whole world which is covered by monthly and quarterly data.

The data set is balanced meaning that there is no missing data for the selected variables and quarters.

The sources for the data are the official statistics of the Austrian, German and Swiss statistic offices for all variables.

My statistical analysis includes (i) descriptive statistics and time series graphs, (ii) statistics on trading partners and trade shares and (iii) canonical correlation analysis.

4.2. General facts about the trade balance

Austria and Germany

Due to their common history, both economies are closely related not only regarding trade but also regarding direct investments and the service sector. For example, Germany is the biggest investor in Austria. Traditionally for Austria the export country number one is Germany, but its ratio decreased from 39 per cent in the year 1993 to 32 per cent in the year 2012. A reason for the decline could be the entry of Austria into the European Union 1995, when other nations started to import more goods from Austria.

But not only is Germany the most important export market for Austria, more than two fifths of all imports originate from Germany. For Germany a small country like Austria does not play such a huge role like vice versa, but still it is remarkable that for Germany Austria is ranked 9th regarding imports and 7th biggest exporting market according to the data from the year 2011.

Switzerland and Germany

No other economy in the world has such an intense economic relationship with Switzerland than the Federal Republic of Germany. Germany is the largest trading partner of Switzerland. The benefit of this close integration occurs not only in Switzerland but also Germany. For example, Germany's market leader in the Swiss Import Market: A third of all imports of Switzerland come from Germany. That's more than the imports from Italy, France, the USA and the Netherlands combined. The 7.8 million inhabitants of Switzerland buy about half as much of German products as the more than 300 million Americans. The volume of trade (imports and exports) in 2009 due to the crisis broke sharply and amounted to 90.8 billion, representing a decrease of 16.3% over 2008. Since the end of 2009, bilateral trade has, however, recovered. Germany has regularly a trade surplus on Switzerland (2010: CHF 19.3 billion)⁹.

⁹ See Homepage: Eidgenössisches Departement für auswärtige Angelegenheiten

Table 4.1: The most important trading partners of Austria 2011

Country	Imports in %	Country	Exports in %
Germany	38.2	Germany	31.2
Italy	6.5	Italy	7.7
Switzerland	5.4	United States	5.3
China	4.9	Switzerland	4.9
Czech Republic	3.7	France	4.1
United States	2.9	Czech Republic	3.9
France	2.9	Hungary	3.1
Netherlands	2.8	United Kingdom	2.9
Hungary	2.8	Poland	2.8
Russia	2.5	Russia	2.4
Slovakia	2.5	China	2.4
Poland	1.9	Slovakia	2.0

Source: Statistik Austria (2012)

The columns 'imports in %' and 'exports in %' show the fraction of each trading partner compared to total imports of Austria.

Table 4.2: The most important trading partners of Germany 2011

Country	Imports in %	Country	Exports in %
Netherlands	9.1	France	9.6
China	8.8	United States	7.0
France	7.3	Netherlands	6.5
United States	5.3	United Kingdom	6.2
Italy	5.3	China	6.1
United Kingdom	4.9	Italy	5.8
Russia	4.5	Austria	5.4
Belgium	4.2	Switzerland	4.5
Austria	4.1	Belgium	4.4
Switzerland	4.1	Poland	4.1

Source: Statistisches Bundesamt Wiesbaden (2012)

The columns 'imports in %' and 'exports in %' show the fraction of each trading partner compared to total imports of Germany.

Table 4.3: The most important trading partners of Switzerland 2010

Country	Imports in %	Country	Exports in %
Germany	33.7	Germany	20.3
Italy	10.7	United States	10.6
France	9.0	Italy	8.3
United States	5.6	France	8.1
Netherlands	4.8	United Kingdom	6.2
Austria	4.5	China	3.9
United Kingdom	4.0	Japan	3.5
China	3.5	Austria	3.4
Spain	2.8	Spain	3.3
Japan	2.1	Netherlands	3.0

Source: Eidgenössische Zollverwaltung (2012)

The columns 'imports in %' and 'exports in %' show the fraction of each trading partner compared to total imports of Switzerland.

Tables 4.1 to 4.3 display the most important trading partners of Austria, Germany and Switzerland. As expected for the two smaller economies (Austria and Switzerland) their most important trading partner clearly is Germany. Especially for Austria Germany is by far the largest trading partner. To be more precise the fraction of Austria's imports from Germany mount up to more than a third (38.2%) of all imports. The amount exceeds nearly six times the import volume from the second largest trading partner (Italy, 6.5%).

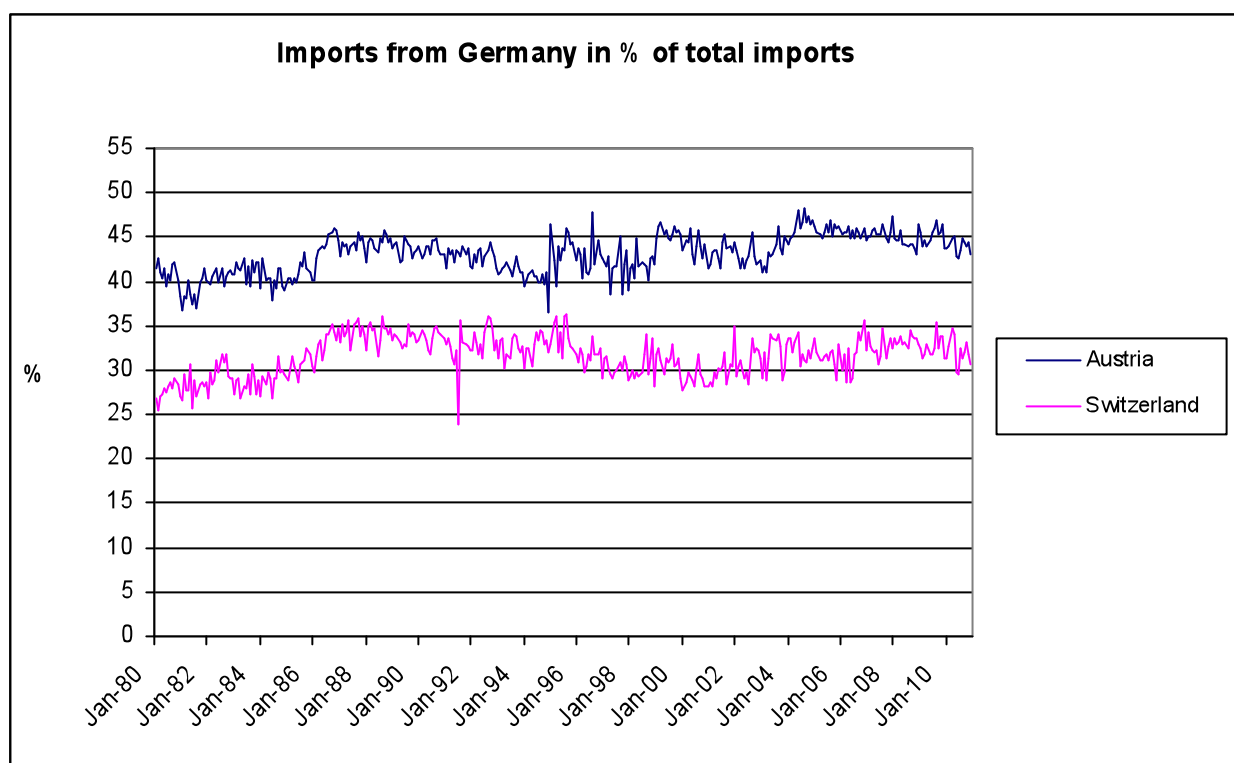
When we take a look at Austria's exports they depict a very similar picture. The amount of exports to Germany is close to a third of all exports (31.2%) and again it is more than four times as high as to the second largest country (Italy 7.7%).

The numbers show a similar picture for Switzerland. The imports from Germany also add up to a third (33.7%) of all imports and are more than three times the amount from second largest trading partner (Italy, 10.7%). On the export side one fifth of all exports (20.3%) go to Germany, again twice the amount of the second largest partner (United States, 10.6%).

From the German point of view both countries Austria and Switzerland belong to the ten most important trading partners. Austria's and Switzerland's share of German imports are 4.1% for both and are ranked 9th and 10th. 5.4% of Germany's exports go to Austria and 4.5% go to Switzerland which rank them 7th and 8th.

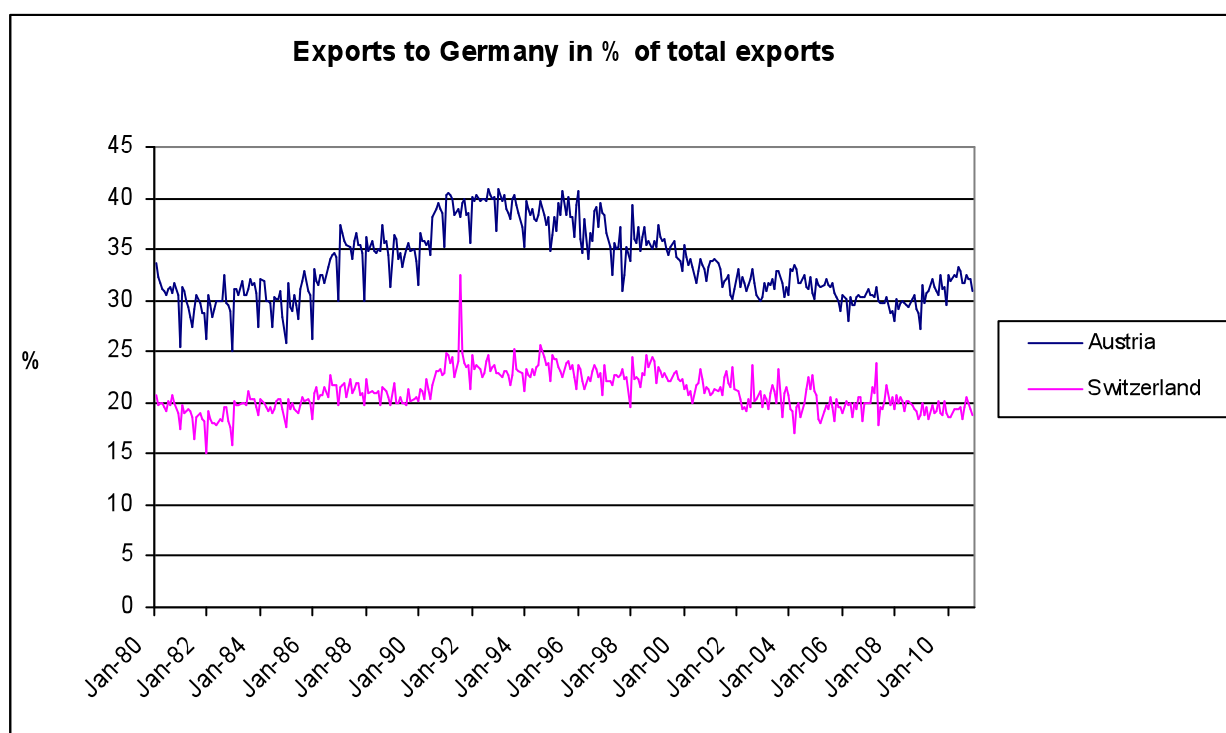
Frankel and Rose's (1998) results show a clear positive effect of trade on business cycle synchronization. So the following graphs show the fraction of German products of all imports, exports and total trade in both countries in comparison over the period 1980 to 2010.

Fig. 4.1: Imports from Germany (historical)



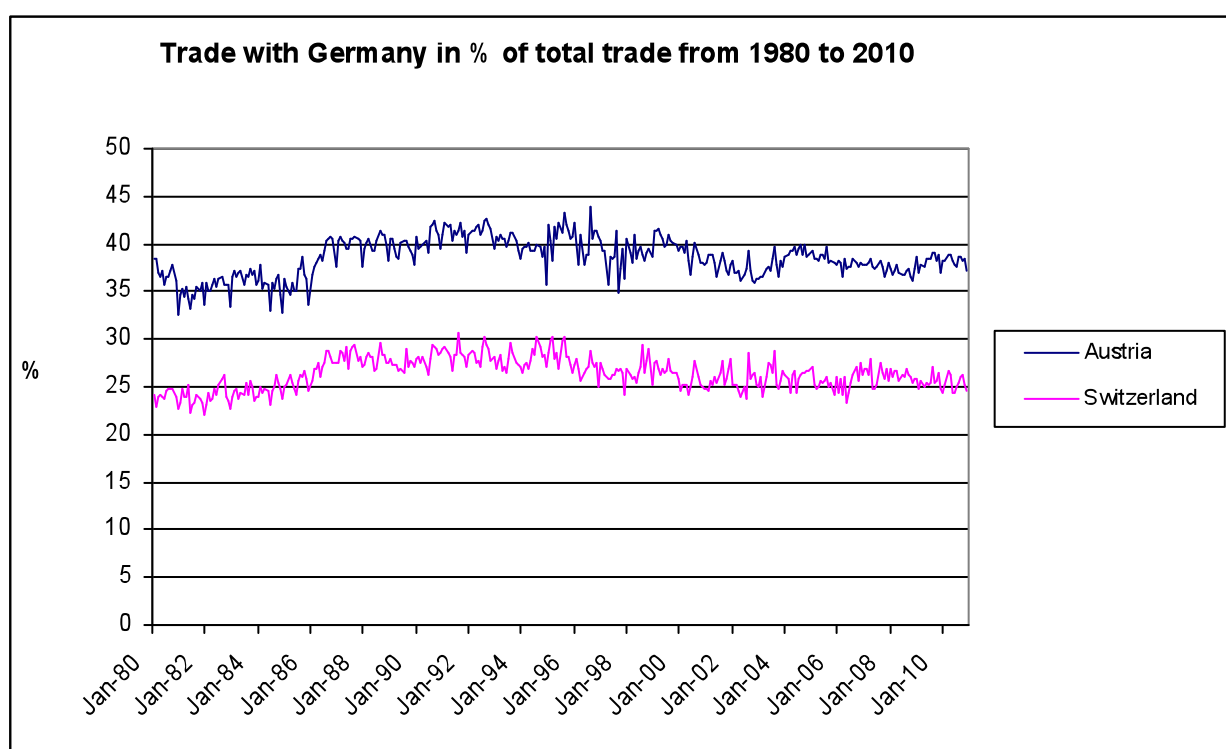
source: IMF (2012)

Fig. 4.2: Exports from Germany (historical)



source: IMF (2012)

Fig. 4.3: Trade with Germany (historical)



source: IMF (2012)

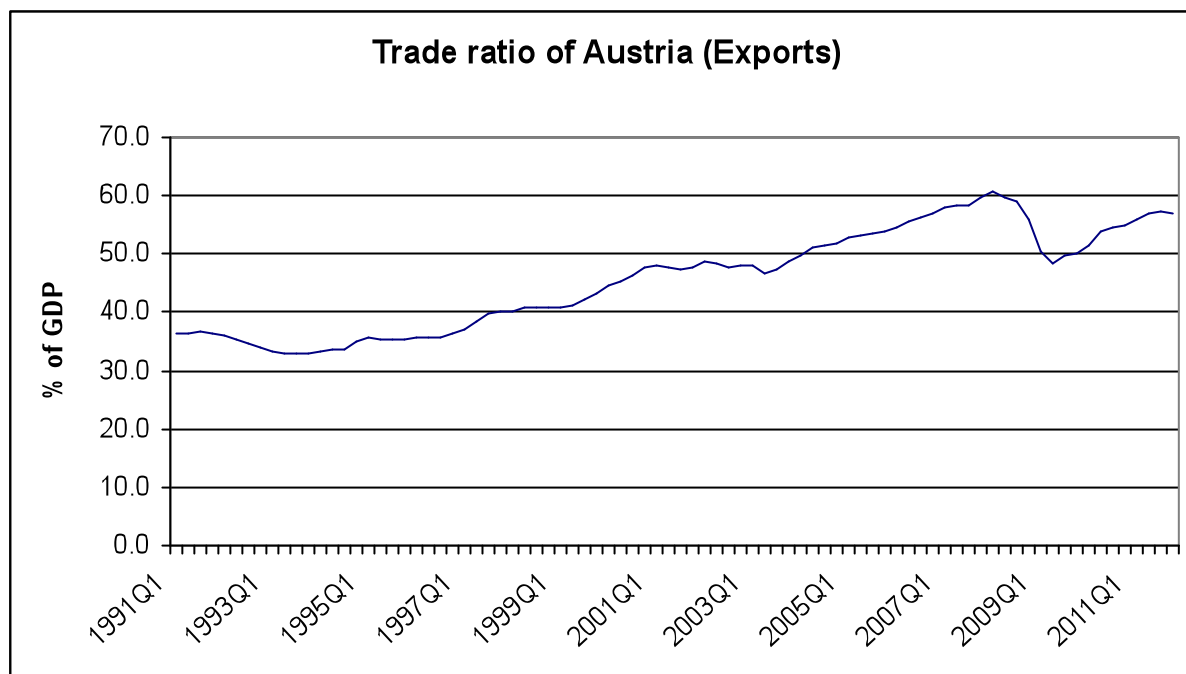
As we can see the trend of the trade ratio with Germany is very similar for Austria and Switzerland. After an increase in the mid 1980s there is a slight decline observable for both countries from the early 1990s up till 2010.

The differences in the development of the import ratio and the export ratio are interesting. While the import ratio slightly increases for Austria, for Switzerland it stays pretty much the same over time (slight divergence starting in 1995). The export ratios show a different pattern. The percentage rates increase till both reach their turning point in the early 1990s. There is visible co-movement over time in which the increase and decrease for Austria is more intense.

Regarding the imports from Germany in percentage of GDP, there is a slight divergence after 1995 between Austria and Switzerland as mentioned above.

Furthermore, note that no business cycles are observable regarding trade between the countries, which could mean that business cycles have no influence because all three economies have a strong co-movement in their business cycle.

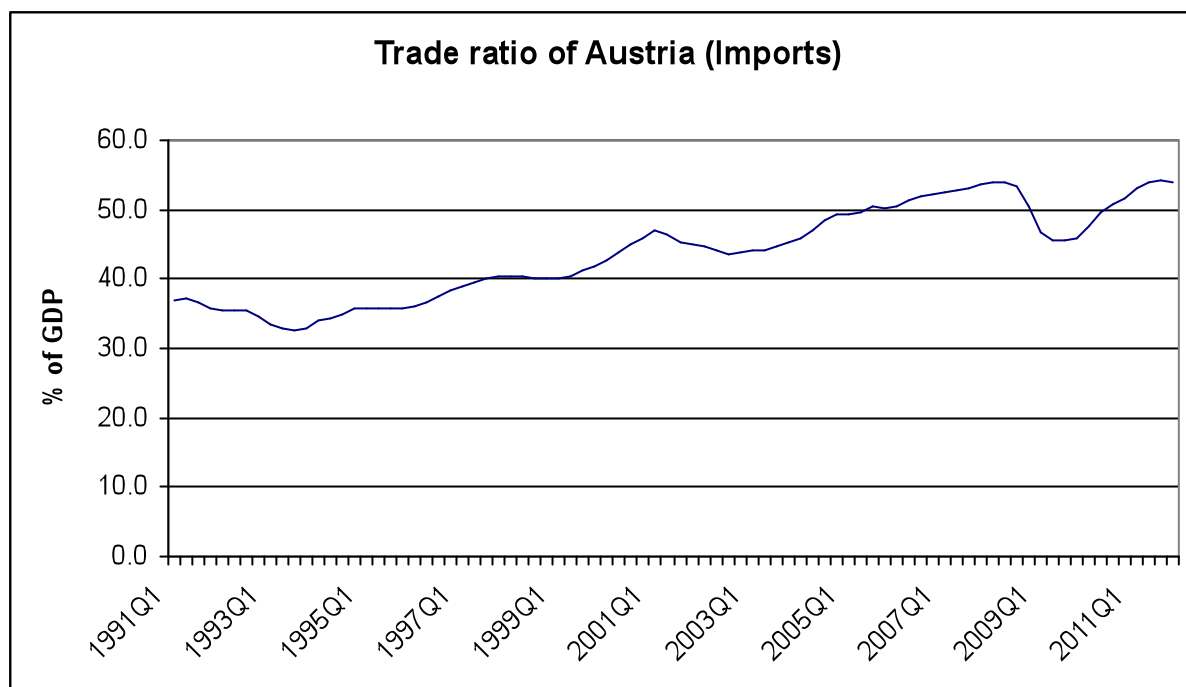
Fig. 4.4: Trade ratio of Austria (exports)



The x-axis refers to the time and the y-axis to percentage of the GDP

source: Eurostat (quarterly seasonally adjusted trade data)

Fig. 4.5: Trade ratio of Austria (imports)



The x-axis refers to the time and the y-axis to percentage of the GDP

source: Eurostat (quarterly seasonally adjusted trade data)

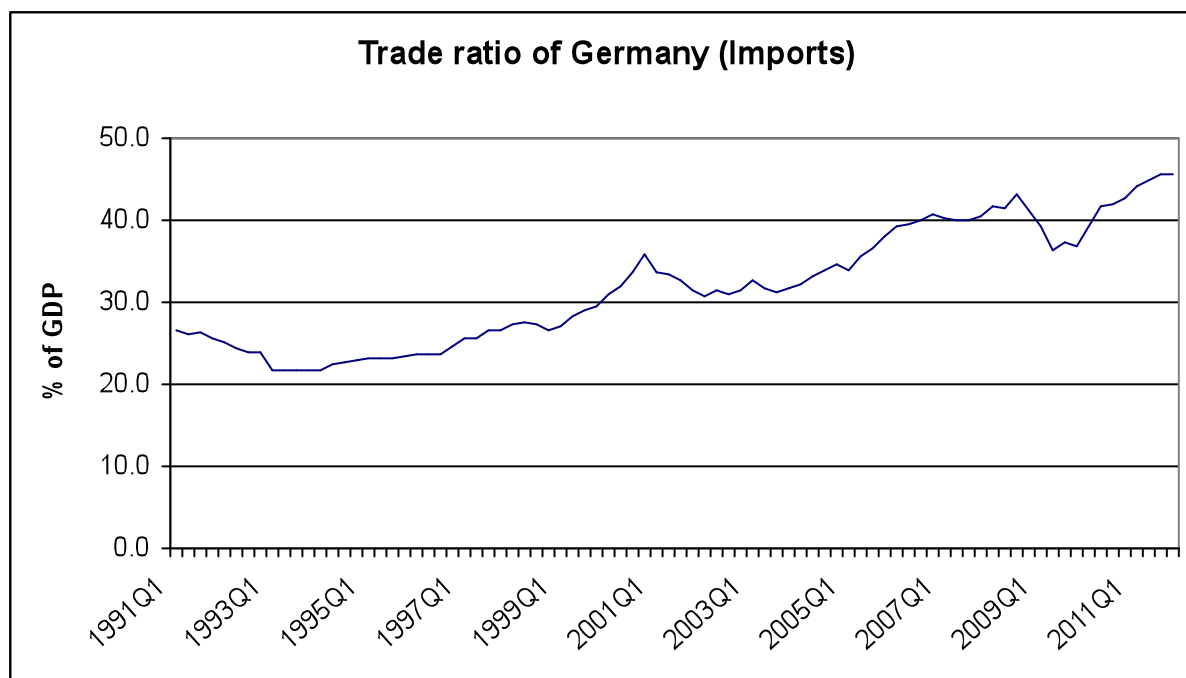
Fig. 4.6: Trade ratio of Germany (exports)



The x-axis refers to the time and the y-axis to percentage of the GDP

source: Eurostat (quarterly seasonally adjusted trade data)

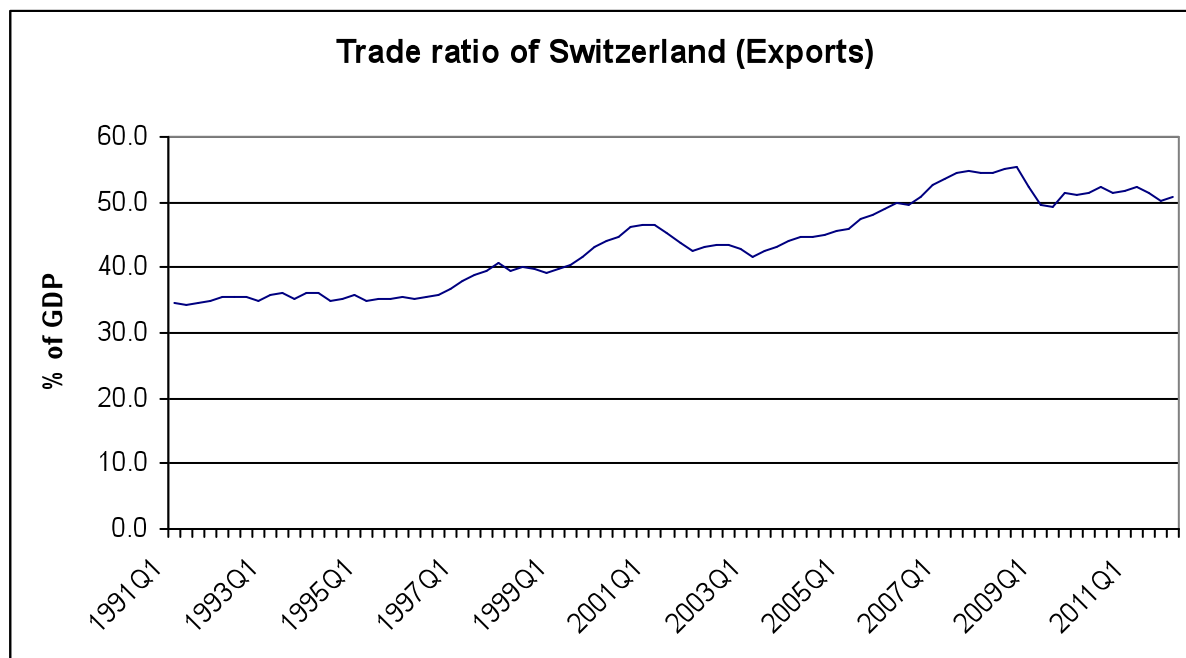
Fig. 4.7: Trade ratio of Germany (imports)



The x-axis refers to the time and the y-axis to percentage of the GDP

source: Eurostat (quarterly seasonally adjusted trade data)

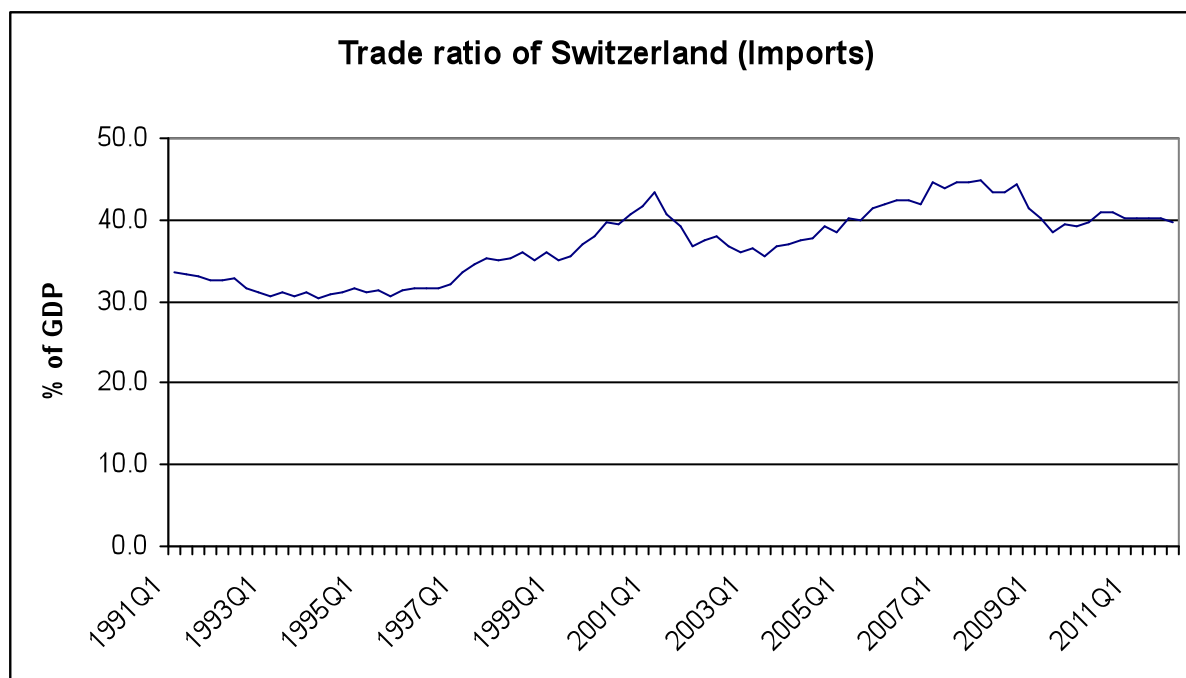
Fig. 4.8: Trade ratio of Switzerland (exports)



The x-axis refers to the time and the y-axis to percentage of the GDP

source: Eurostat (quarterly seasonally adjusted trade data)

Fig. 4.9.: Trade ratio of Switzerland (imports)



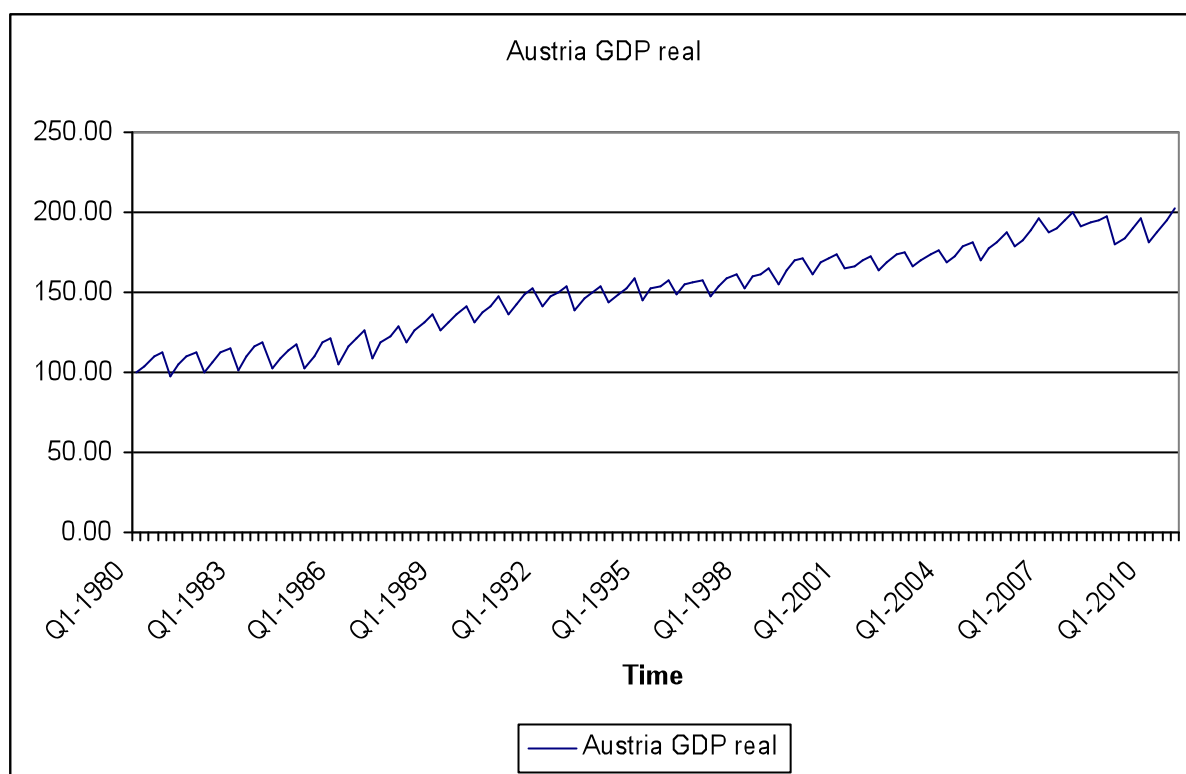
The x-axis refers to the time and the y-axis to percentage of the GDP

source: Eurostat (quarterly seasonally adjusted trade data)

When we take a look at the trade ratios, both Austria and Germany had a trade ratio of 30% to 40% during the early and mid 1990s, whereas Germany's trade ratio was between 20% and 30% during the whole 1990s. So it is clearly visible that for all three of them trade became more important over time. That of course suggests that their economy is more dependent on foreign economies and their markets, which results in a higher correlation of those markets. While having a rough trade balance at the beginning of the 1990s all three of them seem to have developed a trade surplus in these last twenty years. Germany's and Switzerland's exports account for close to 50% of their GDP whereas Austria's exports account for nearly 60% of its GDP. This suggests that all three of them are very export-oriented. Again this leads to a higher dependence on their trading partner's economy.

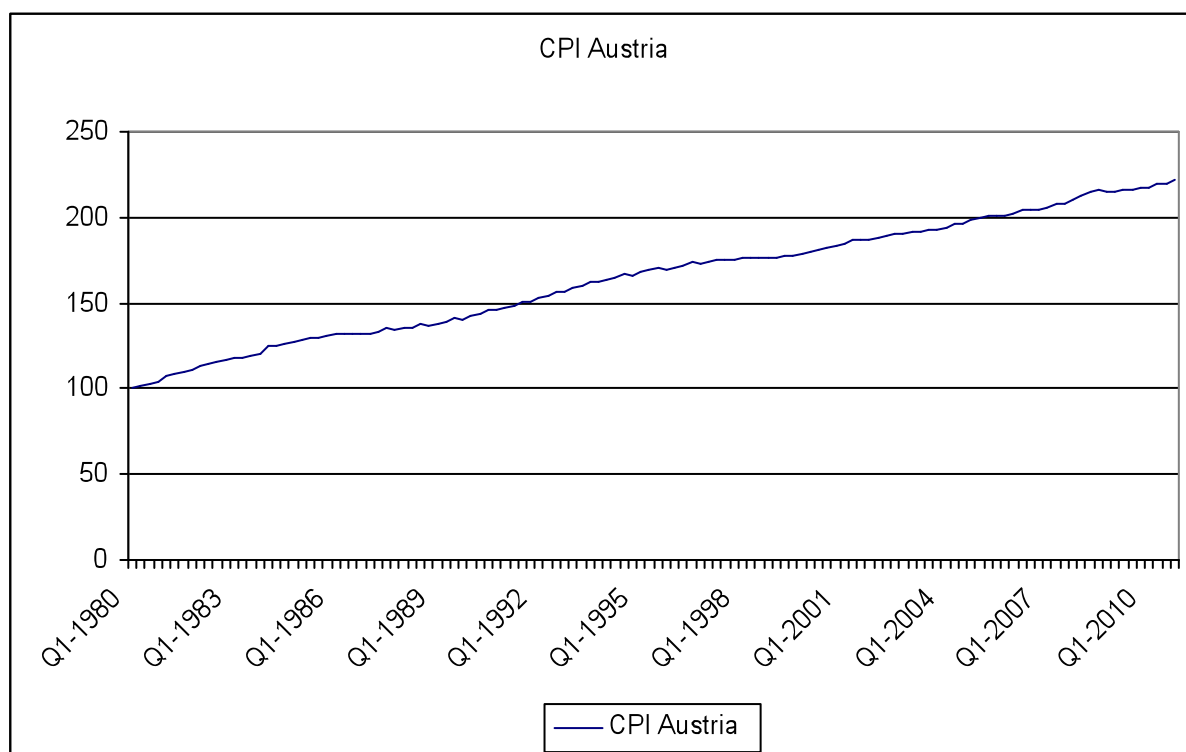
Additionally, note that these figures show the huge impact of a crisis has on the trade ratio of an economy. It appears that trade responds very sensitively to an economic crisis.

Fig. 4.10: Austria's GDP real



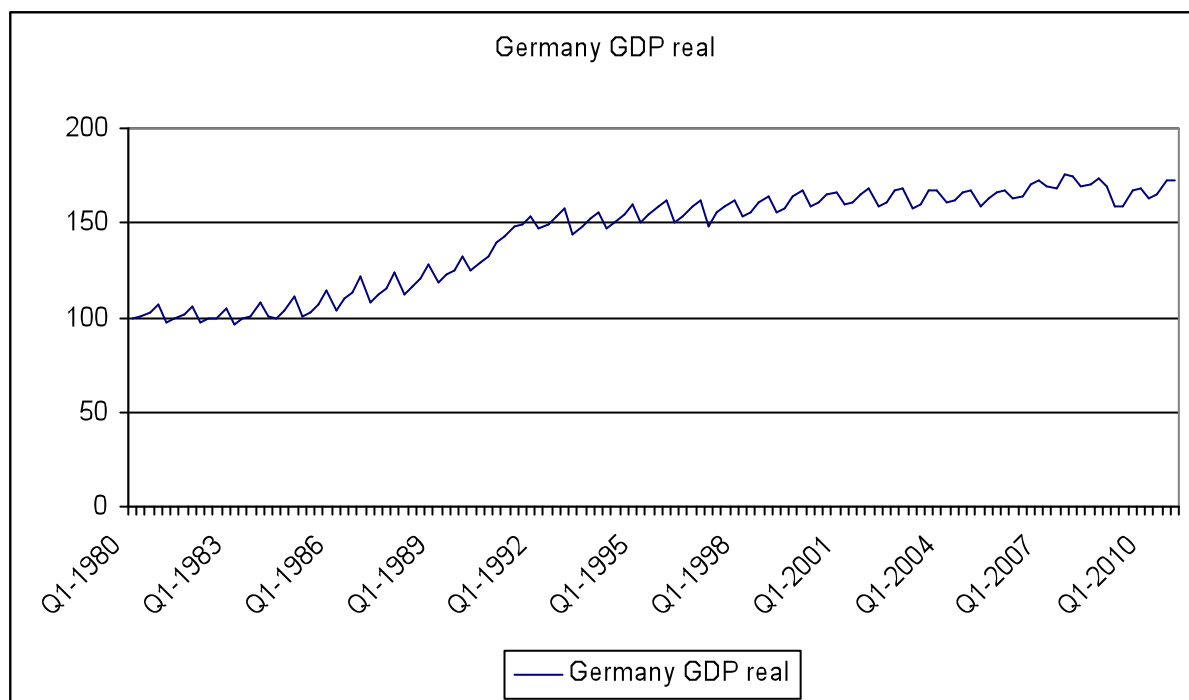
source: IMF, 2012

Fig. 4.11: Austria's CPI



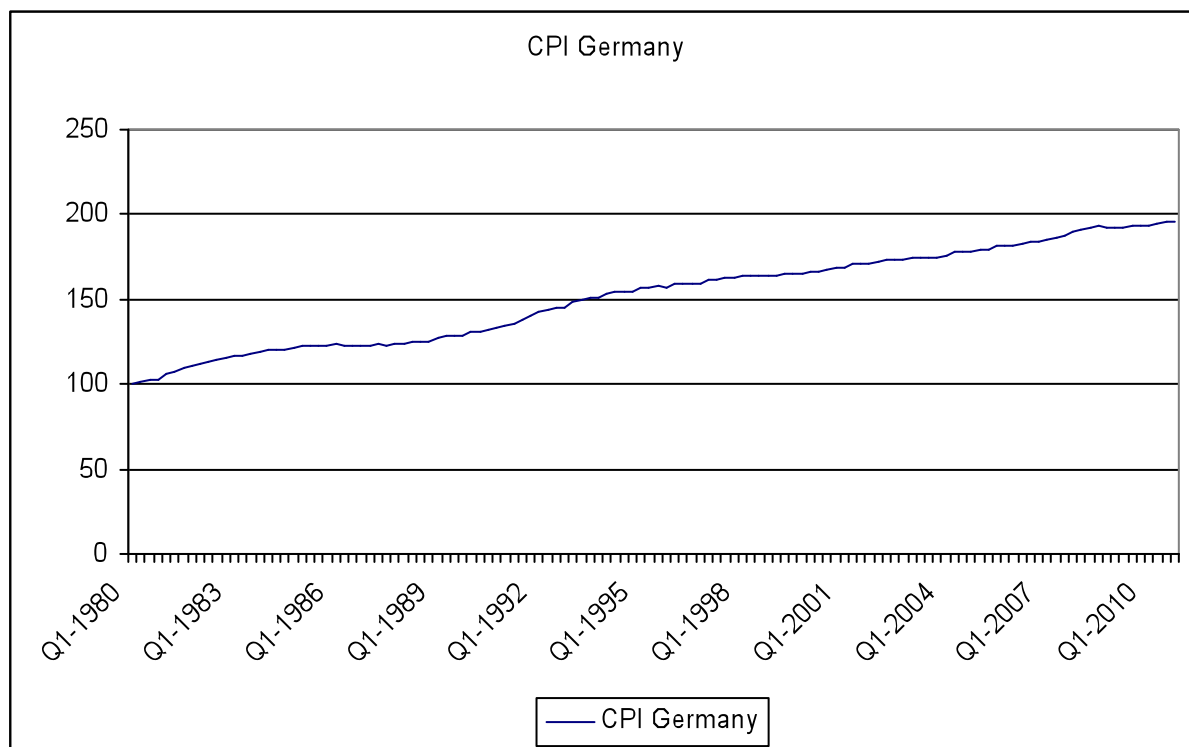
source: IMF, 2012

Fig. 4.12: Germany's GDP real



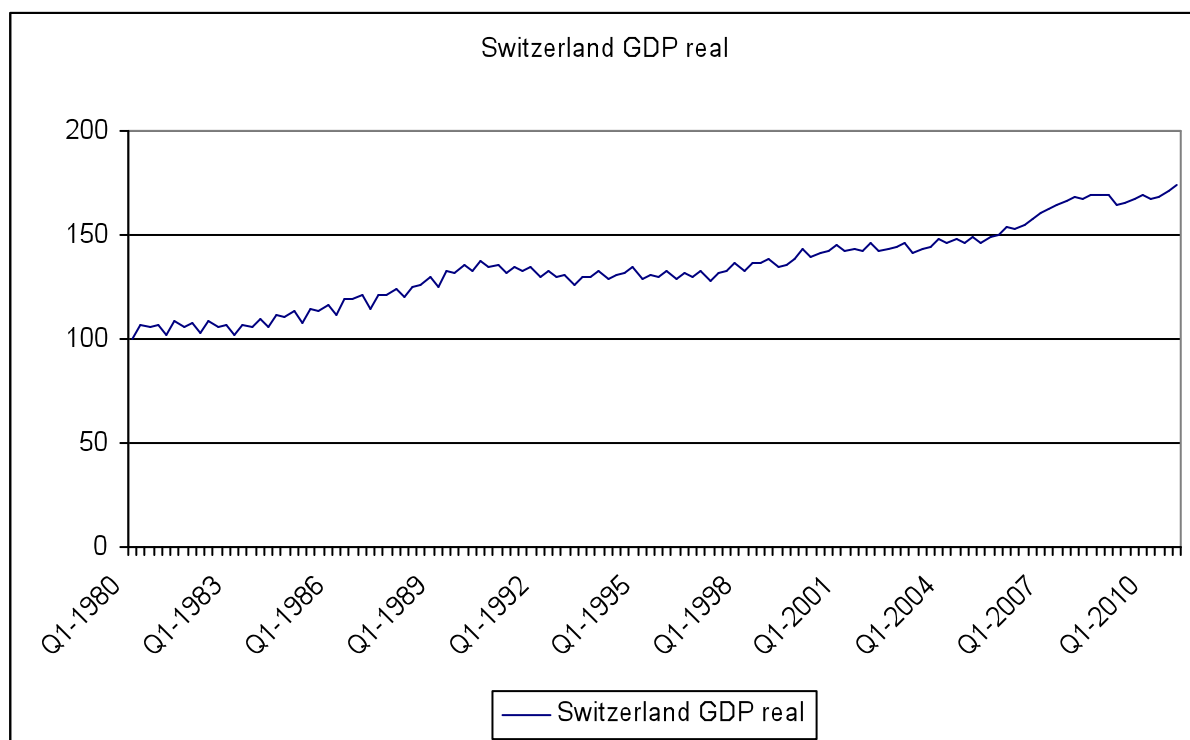
source: Statistisches Bundesamt Wiesbaden (2012)

Fig. 4.13: Germany's CPI



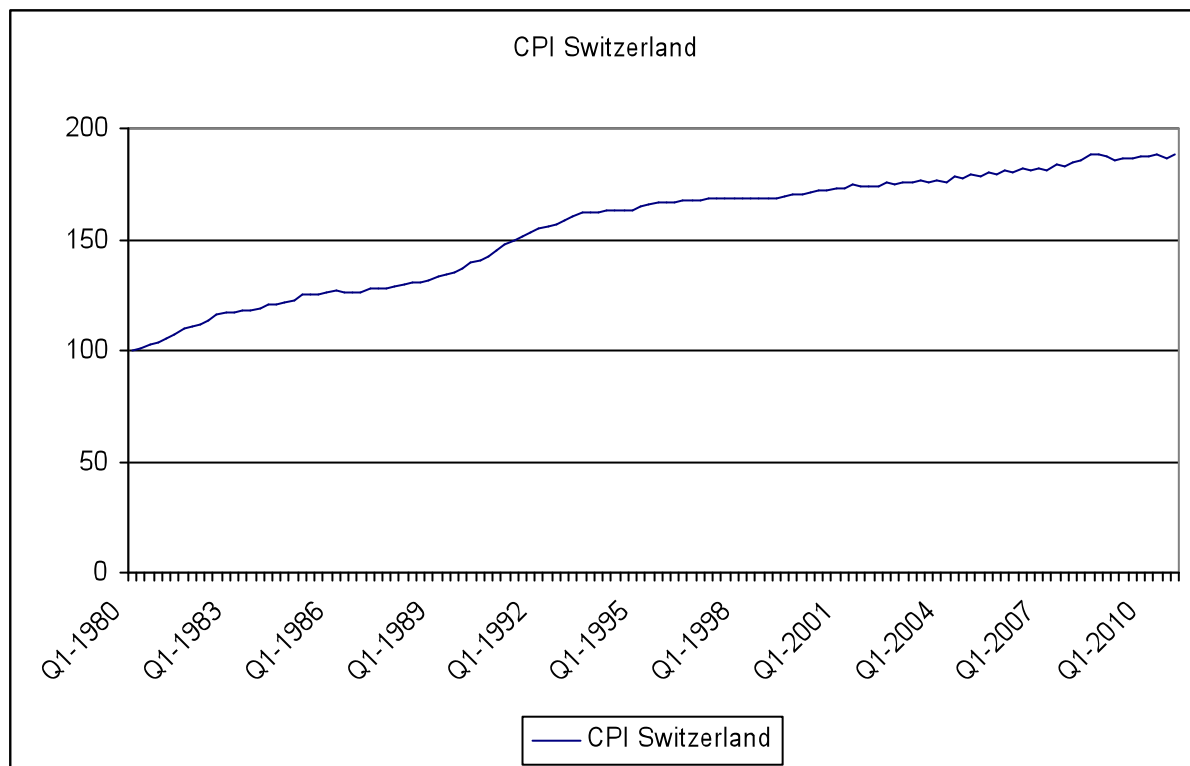
source: Statistisches Bundesamt Wiesbaden (2012)

Fig. 4.14: Swiss GDP real



source: Schweizer Staatssekretariat für Wirtschaft (SECO), 2012:

Fig. 4.15: Swiss CPI

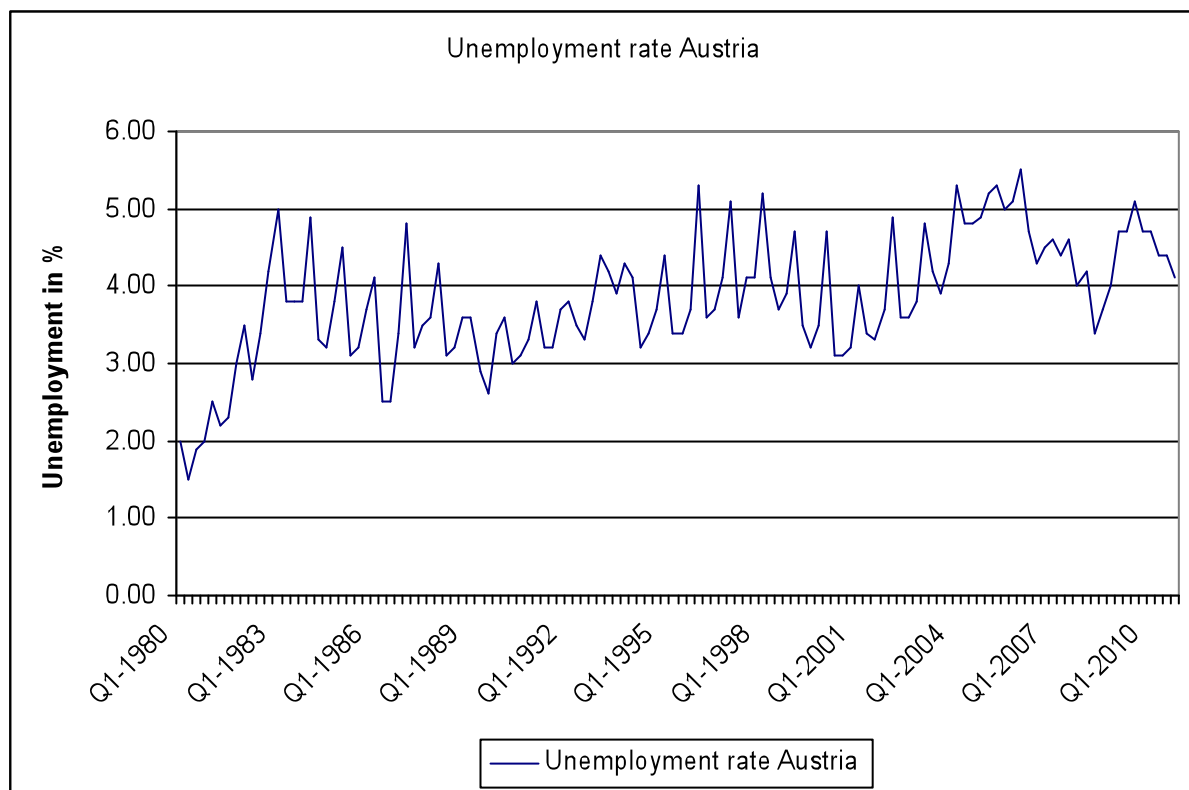


source: Schweizer Staatssekretariat für Wirtschaft (SECO), 2012

In these figures we can observe the business cycles of each country. Especially in the GDP figures we can observe the different phases of a business cycle. All three of them seem to have a strong growth period beginning in the late 80s, again in the late 90s and the last boom phase lasted from 2004 to 2008, when the subprime mortgage crisis that transformed into a financial crisis hit them. So regarding the GDP and its growth it appears that they have very similar growth phases.

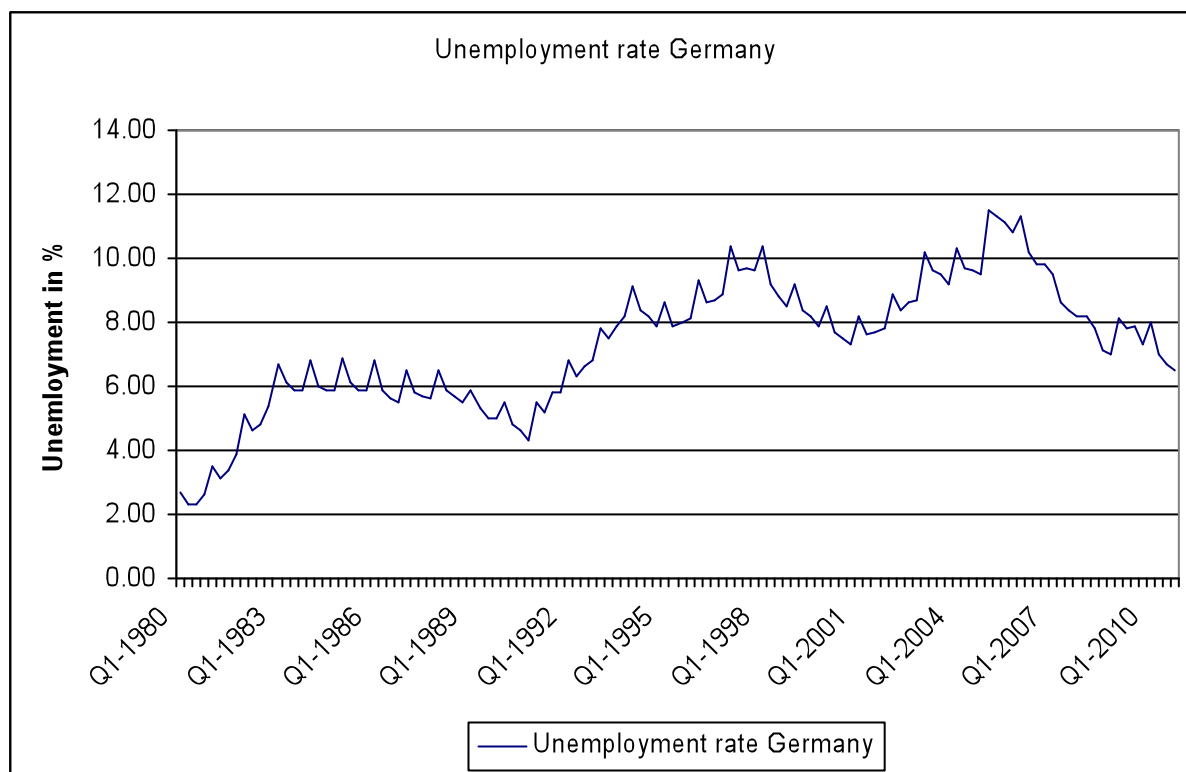
When we take a look at the Consumer Price Index (CPI) of each country it displays a similar picture: A higher inflation in the early 1980s as well as in the early 1990s. For all three the CPI approximately doubled in the last thirty years.

Fig. 4.16: Unemployment rate of Austria



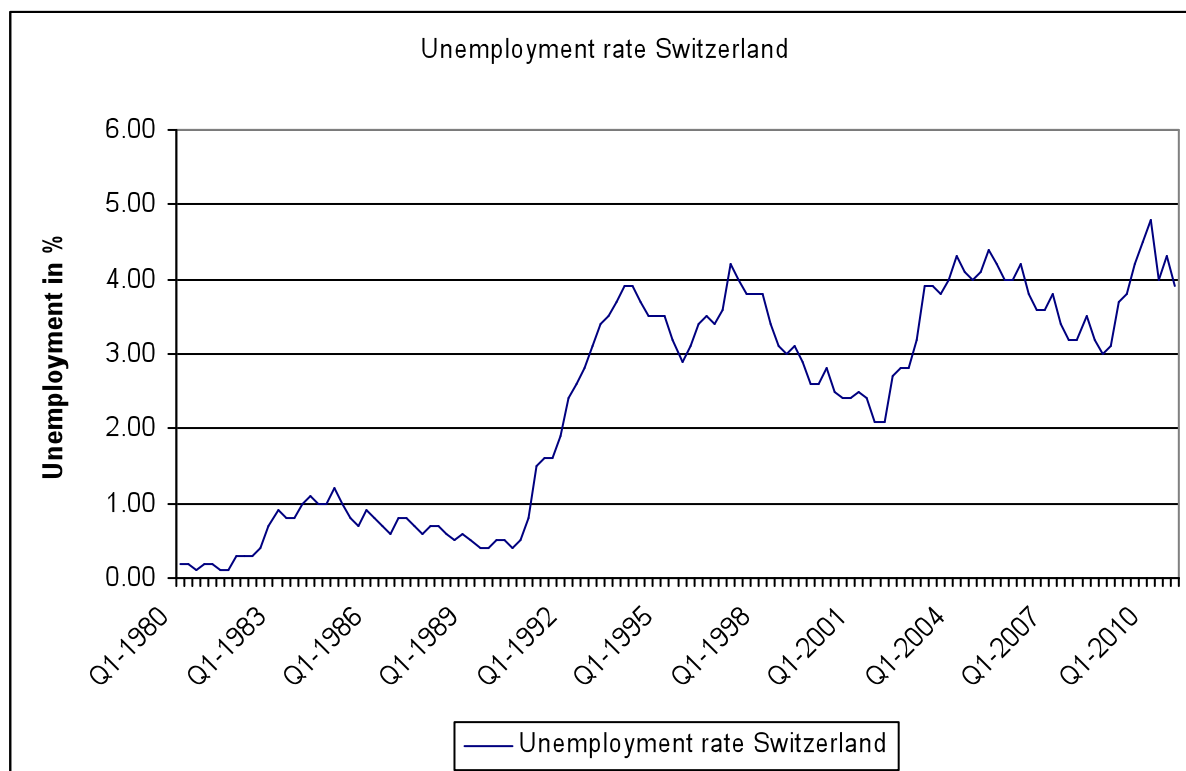
source: Eurostat (2012)

Fig. 4.17: Unemployment rate of Germany



source: Eurostat 2012

Fig. 4.18: Unemployment rate of Switzerland



source: Eurostat 2012

The unemployment rate is very good to observe within the business cycles. When the economy starts to grow again you can see a clear decline in the unemployment rate and vice versa. According to this data we can say that there have been four cycles since 1980. In all three countries the unemployment rate increased in the early 1980s from a very low level that could never be reached again afterwards. Another strong increase appeared a decade later in the early 1990s, but this time Austria seemed to be able to avoid an increase as strong as the other economies. A really astonishing feature is the enormous increase of the unemployment of Switzerland during the early 1990s, from less than 0.5% up to nearly 4%. It octuplicated within three years.

It looks like as if, with each new cycle the unemployment rate spikes even higher. There is a clearly observable trend that points to even higher unemployment numbers on average in the future.

Another interesting aspect of these figures is that in Austria the unemployment rate has very high seasonal fluctuation, but these seem to wane after 2004.

Chapter 5

5.1. Empirical Method

For my empirical method I am using the Canonical correlation analysis (CCA).

Canonical correlation analysis is a method to assess the relationship between two sets of variables. It was developed by Hotelling in 1935⁽¹⁰⁾ and is part of multivariate statistics to analyse this correlation.

When we have two sets of variables, $\mathbf{X} = (x_1, x_2, \dots, x_p)$ and $\mathbf{Y} = (y_1, y_2, \dots, y_q)$, we look for linear combinations of $\mathbf{X}$ and $\mathbf{Y}$ so that the correlation between the linear combinations is as high as possible.

$$F_x = u_1^T X_1 + u_2^T X_2 + \dots + u_p^T X_p = u^T X$$

$$F_y = v_1^T Y_1 + v_2^T Y_2 + \dots + v_p^T Y_p = v^T Y$$

Now we are looking for those vectors $u \in \mathbb{R}^p$ and $v \in \mathbb{R}^q$ that maximize the correlation of F_X and F_Y .

$$(u, v) = \arg \max_{u, v} |Corr(u^T X, v^T Y)|$$

The resulting variables $A = u^T X$ and $B = v^T Y$ are then called the canonical variates. The correlations between successively extracted canonical variates are smaller and smaller.

It is customary to report the largest correlation.

If they are highly correlated the coefficients are near 1. If this is applied over a number of periods in time and the coefficients change, for example that they come closer to 1 that shows evidence for convergence.

For my analysis I use the following variables: differenced real GDP, differenced CPI and the unemployment rate.

I applied the Canonical Correlation Analysis in five year steps to see if the correlation coefficient changes over time.

¹⁰ H. Hotelling (1936), "Relations between two sets of variates", *Biometrika*, 28:321–377

5.2. Results

The results are shown in table 5.1.

Table: 5.1: Empirical results

Canonical correlation coefficients	AT/DE:	CH/DE:
1980q1-1984q4	0.9504	0.9342
1985q1-1989q4	0.9498	0.9608
1990q1-1994q4	0.8902	0.9830
1995q1-1999q4	0.9788	0.9079
2000q1-2004q4	0.9614	0.9731
2005q1-2009q4	0.9362	0.8417

The results show that the business cycles of both countries (Austria and Switzerland) have been highly correlated since the beginning of the 1980s. Although one can see some fluctuations over different periods the correlation always remains high. The results do not seem to show a higher correlation nowadays compared to the 1980s or 1990s.

In 1995, when Austria became a member of the European Union, the CCA statistics rise to almost 98%, while the correlation between Switzerland and Germany decreases from 98% to 90%. However, as the next cycle from 2000 to 2004 shows, this effect was not prolonged in the long run. In this period, synchronization was very high again with values of 96% and 97% for Austria/Germany and Switzerland/Germany, respectively.

Only in the last section, there seems to be a more significant drop in convergence between Switzerland and Germany, while the correlation stays higher between Austria and Germany.

5.3. Interpretation

First of all it is to say that the economies of both countries (Austria and Switzerland) have already been pretty synchronized with the German economy at the beginning of my observation period and that this has not changed over the last thirty years, as the results display. Because of that it is hard to show that two very synchronized economies converged even closer.

The fluctuations, which seem a bit high in the first moment, still remain on very high synchronized level through out the whole period.

And they could be explained by different political agendas in certain periods, especially during crises.

One shortcoming of the result is that the data set could be too short to see a long run trend.

Another point is, because of trade treaties already established in earlier years synchronization has already taken place. For example, membership in EFTA (European Free Trade Association) (1960) and later on in 1999, Switzerland concluded a set of bilateral agreements with the European Union.

Another reason for no further synchronization, which is supported by Austria's exports to Germany in percentage of total exports data, could be a shift of the focus area. I.e. Austria's economy has started to shift their focus on Central and Eastern European countries (CEE) since the fall of the Iron Curtain and especially since the EU enlargement in 2005. Austria became one of the biggest investors in the new member states of the EU, the Balkan states and Turkey. Nevertheless Germany remains the most important trading partner for Austria.

Chapter 6

6.1. Conclusion

To sum up, the data supports the hypothesis that the Austrian and German economy are strongly interconnected, and a similar result holds for the Swiss and German economy. Their business cycles are highly correlated. Surprisingly, they seem to have been already as highly synchronized in the 1980s as they are now. Of course the two smaller countries depend more on the bigger German economy than vice versa.

However I could not find any proof that supports the hypothesis that the business cycles converged over the last thirty years. Trade data shows all three of them became more dependent on foreign trade, but the importance of the German economy for the two smaller countries did not increase. As trade ties grew stronger with Germany it seems they also did so with other countries.

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Eurostat database

Staatssekretariat für Wirtschaft SECO (Schweiz)

Statistisches Bundesamt Wiesbaden

Eidgenössische Zollverwaltung

Statistik Austria

International Monetary Fund

Appendix

Curriculum Vitae

Personal information

First name(s) / Surname(s) **Stephan Geisberger**

Nationality Austrian

Date of birth 04 December 1985

Gender Male

Education and training

Dates September 1992 - June 1996

Principal subjects / occupational skills covered Elementary school

Name and type of organisation providing education and training Volksschule Wartberg an der Krems (Elementary school)
4552 Wartberg an der Krems (Austria)

Dates September 1996 - June 2004

Title of qualification awarded Matura

Principal subjects / occupational skills covered Secondary School

Name and type of organisation providing education and training BRG/BORG Kirchdorf (Gymnasium)
4560 Kirchdorf an der Krems (Austria)

Level in national or international classification higher education entrance qualification

Dates September 2004 - May 2005

Military service Austrian Armed Forces
4560 Kirchdorf an der Krems (Austria)

Dates October 2005 →

Principal subjects / occupational skills covered Economics

Name and type of organisation providing education and training University of Vienna
Universitätsring 1, 1010 Vienna (Austria)

Personal skills and competences

Mother tongue(s) German

Other language skills English, French

Computer skills MS Office