UNIVERSITY OF TURKU
Turku School of Economics

Business Cycle Synchronization in the euro area between 1995-2020

An analysis of the similarity of shocks and cycles

Master's thesis in economics

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13.11.2022
Turku

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Subject: Economics
Author: Olli-Pekka Paasivirta
Title: Business Cycle Synchronization in the euro area between 1995-2020
Supervisor: Professor Jouko Vilmunen
Number of pages: 65 pages + appendices 1 page
Date: 13.11.2022

This thesis highlights one of the critical criteria from the optimal currency theory: the similarity of the shocks and business cycles in the euro area. That is relevant because common monetary policy can be suitable to euro area countries only if their business cycles are synchronized enough – in other words, the cycles and shocks should be sufficiently similar in timing and trend.

Two methods are used to examine the issue. The first method, the standard deviation of the output gaps, examines the issue of business cycle convergence. The convergence of the business cycles is an important factor for a monetary union. It means that member states of the monetary union are in the same phase of a cycle at the same time and move at the same pace. Another method, the correlation coefficient, is used to measure the correlation of individual business cycles in comparison with the common euro area cycle. Business cycles of 18 euro area countries are examined. Quarterly GDP data is used and filtered with the Hodrick-Prescott filter. The filter decomposes GDP data into two parts: the business cycle data and GDP trend data.

The results indicate that while the business cycle synchronization has been increasing at the euro area level since the recovery of the financial crisis, the level did not reach the earlier top level at the end of the examined period (Q4 2019). Still, it is significant to note that the overall trend in the chosen period has been towards somewhat strong synchronization – the 2008 crisis and recovery after that is an exception in the large picture, thought the period of mild desynchronization started already in 2000 and continued until the recovery period after the crisis of 2008. There is also evidence, that the amplitudes are lower after the financial crisis than before it.

In addition, an interesting observation in the synchronicity levels is the euro area's feature to have higher synchronicity during downturns, although this relatively mild phenomenon. This is a positive feature concerning the common monetary policy. If the countries of the euro area face a shock of the same magnitude, they all benefit from the same kind of monetary policy. However, the euro area shows differences in the ability to recover; synchronicity levels are lower after recession periods.

In Q4 2019, the euro area was very close to the very strong synchronization levels (0,7). Without the coronavirus pandemic, the euro area could have reached even higher levels in 2020. According to the results, the euro area mostly fulfills the optimal currency area criterion concerning the similarity of business cycles if the threshold for this is a correlation level of 0,5 or even 0,7 with the Kamandulienė-Lydeka scale.

Key words: Euro, business cycles, synchronization

Pro gradu -tutkielma

Oppiaine: Taloustiede
Tekijä: Olli-Pekka Paasivirta
Otsikko: Business Cycle Synchronization in the euro area between 1995-2020
Ohjaaja: Professori Jouko Vilmunen
Sivumäärä: 65 sivua + liitteet 1 sivu
Päivämäärä: 13.11.2022

Tämä tutkielma tarkastelee optimaalisen valuutta-alueen teorian keskeistä kriteeriä, shokkien ja suhdannesyklien samankaltaisuutta euroalueella. Aihe on tärkeä, sillä yhteinen rahapolitiikka voi olla sopivaa kaikille euroalueen maille vain, jos maiden suhdannesyklit ovat riittävän synkronoituneita – toisin sanoen, syklien ja shokkien pitäisi olla riittävän samanlaisia ajoituksen ja trendin osalta.

Tutkielmassa on käytetty kahta metodia aiheen tarkasteluun. Ensimmäisen metodin eli tuotantokuilujen keskihajonnan avulla tarkastellaan suhdannesyklien konvergenssia. Konvergenssi tarkoittaa valuutta-alueen jäsenmaiden suhdannesyklien olevan samassa vaiheessa sykliä samaan aikaan. Toista metodia eli korrelaatiokerrointa on käytetty mittaamaan yksittäisen maan suhdannesyklin ja euroalueen suhdanteen välistä korrelaatiota. Tutkielmassa tarkastellaan 18 euroalueen maan suhdannesyklejä. Neljännesvuosittaista dataa on käytetty, ja se on suodatettu Hodrick-Prescott-suodattimella. Suodatin purkaa BKT-datan kahteen osaan: suhdannesyklidataan ja BKT:n trendiä kuvaavaan dataa.

Tulokset osoittavat, että vaikka suhdannesyklien synkronisaation taso on kasvanut euroalueella finanssikriisin jälkeisestä toipumisesta saakka, edellistä mittausjakson korkeinta taso ei enää saavutettu tarkastellun jakson lopussa (Q42019). Silti on tärkeää huomata, että tarkastellun jakson trendi on edennyt voimistuvan synkronisaation suuntaan – vuoden 2008 kriisin ja sen jälkeisiä tapahtumia voi pitää poikkeuksina kokonaiskuvassa, vaikka heikkenevän synkronisaation trendi alkoi jo 2000-luvun alussa, ja jatkui vuoden 2008 kriisin toipumisperiodin alkuun asti. Tuloksista löytyy myös viitteitä siitä, että amplitudit olisivat madaltuneet finanssikriisin jälkeen verrattuna periodiin ennen sitä.

Tuloksista on myös havaittavissa, että synkronisaation tasot ovat korkeampia matalasuhdanteessa, vaikkakin vain heikosti. Löytö on positiivinen yhteisen rahapolitiikan näkökulmasta. Jos euroalueen maat kohtaavat shokit samalla voimakkuudella, maat hyötyvät silloin samanlaisesta rahapolitiikasta. Tulokset viittaavat kuitenkin myös euroalueella oleviin eroihin palautumiskyvyn osalta; synkronisaation tasot ovat matalammat matalasuhdanteen jälkeisinä ajanjaksoina.

Vuoden 2019 viimeisellä kvartaalilla euroalue oli erittäin lähellä voimakkaan synkronisaation tasoa (0,7). Ilman koronaviruspandemiaa euroalue olisi voinut saavuttaa vielä korkeamman tason vuonna 2020. Tutkielman tulosten mukaan euro alue täyttää pääosin optimaalisen valuutta-alueen kriteerin shokkien ja syklien samankaltaisuuden osalta, jos raja-arvona pidetään korrelaatiotasoa 0,5 tai jopa 0,7 Kamandulienė-Lydeka-mittaristolla.

Avainsanat: Euro, suhdannevaihtelu, synkronisaatio

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1 Introduction

1.1 Background

Currency areas have been an interest of academics for decades. Still, before forming the European Monetary Union (EMU), the topic had been more of a theoretical field of study than empirical. Forming of the EMU, especially the euro's introduction, was an era of new interest for empirical research of monetary areas.

Forming a common monetary and economic union in Europe is an old idea. After World War II, creating the European Coal and Steel Community led to the development of the European Economic Community (EEC) in 1957 and increased economic integration. The first significant plan to build a currency area was introduced in 1970 in the Werner's report. The report was an important initiative in deepening European economic integration because it introduced steps to establish an economic and monetary union in stages. The initiative faced a setback because of global economic shocks; the dollar crisis of 1971 and the oil shock of 1973. The report was put on hold in 1974.

The next step, the European Monetary System (EMS), was introduced in 1979 after the turbulent 1970s, and it lasted until the introduction of the euro in 1999. The EMS was an exchange rate regime set up to foster stability and co-operation in monetary policy in the EEC. Its primary objective was to halt large exchange rate fluctuations in the EEC area and curb inflation. Fluctuations were controlled with Exchange Rate Mechanism (ERM) – national rates were pegged, and only slight deviations were allowed from the European Currency Unit (ECU). ECU was an artificial currency that followed a currency basket of 12 member currencies.

EMS worked well, and in 1988 the European Council (EC) set a target to form the European economic and monetary union in stages. The task of outlining the concrete steps into the new union were set up in the Delor's report. Three steps were completed in 1999, with the last step when all the exchange rates of the 11 member state currencies were pegged irrevocably. The European Central bank (ECB) took responsibility for the common monetary policy. The euro was introduced as accounting money on the 1st of January in 1999 and as physical money on the 1st of January in 2002. The euro area was born.

The EU and, ultimately euro, have been political projects to stabilize and unite the European countries. Still, it is not only that, and the economic perspective has played an

essential role in designing the euro and the monetary union. It was known since the beginning that countries that adopt the euro as their currency should be ready to foster stability in the euro area and ensure that new member states would not be negatively impacted or that their actions would not negatively impact the euro area. The criteria to ensure this was established in the Maastricht Treaty in 1992. The criteria were called the convergence criteria or the Maastricht criteria. The goal of the criteria was to promote convergence in the joining countries before they would join the euro area. Meeting the criteria would mean that these countries could more likely keep pace with the other member countries of the area.

However, Franks et al. (2010) have criticized the original convergence criteria. They argue that criteria are only loosely linked to the actual requirements of a prosperous currency area. According to them, economic theory gives more weight to cyclical convergence as a factor. Cyclical convergence means a situation in which business cycles face the same phases simultaneously or move in synch. In this thesis, this angle is examined in more depth. I argue that the time for researching this topic is good because the euro area countries have over 20-year long time series of their GDP after the introduction of the euro, which ensures a better starting position than what researchers had, for example, in the 2000s. Many key papers concerning the topic are from both sides of the financial crisis.

1.2 Defining terms

The term "euro area" refers to the group of EU member states that have officially adopted the euro. Today the euro area consists of 19 member states. Those countries are depicted in figure 1: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia, and Spain. In 2022 eight members of the European Union are using their national currencies instead of the euro. Those countries are obliged to adopt the euro in the future when they fulfill the criteria – except Denmark, which has negotiated an opt-out. Two of those eight countries, Bulgaria, and Croatia have taken steps toward the euro. Bulgaria has not announced the official adopting date yet, but Croatia will join on the 1st of January 2023. Before joining the area, countries are a part of the Exchange Rate Mechanism (ERM II) process. The ERM II process ensures that fluctuations between the euro area and countries that will adopt the euro are not disrupting the economic stability

in the area. The mechanism also prepares those countries for adopting the euro by converging their cycles towards the common cycle.

Four small countries (Vatican City, Monaco, San Marino, and Andorra) have a monetary agreement with the EU, which means they have adopted the euro, but they do not belong to the EU. They have the right to produce small amounts of euro coins, but they are not allowed to print banknotes. Kosovo and Montenegro have adopted the currency unilaterally – they use the euro as their currency, but they do not have agreements with the EU – this kind of practice has been used in some parts of the Balkans with the German mark before the euro.

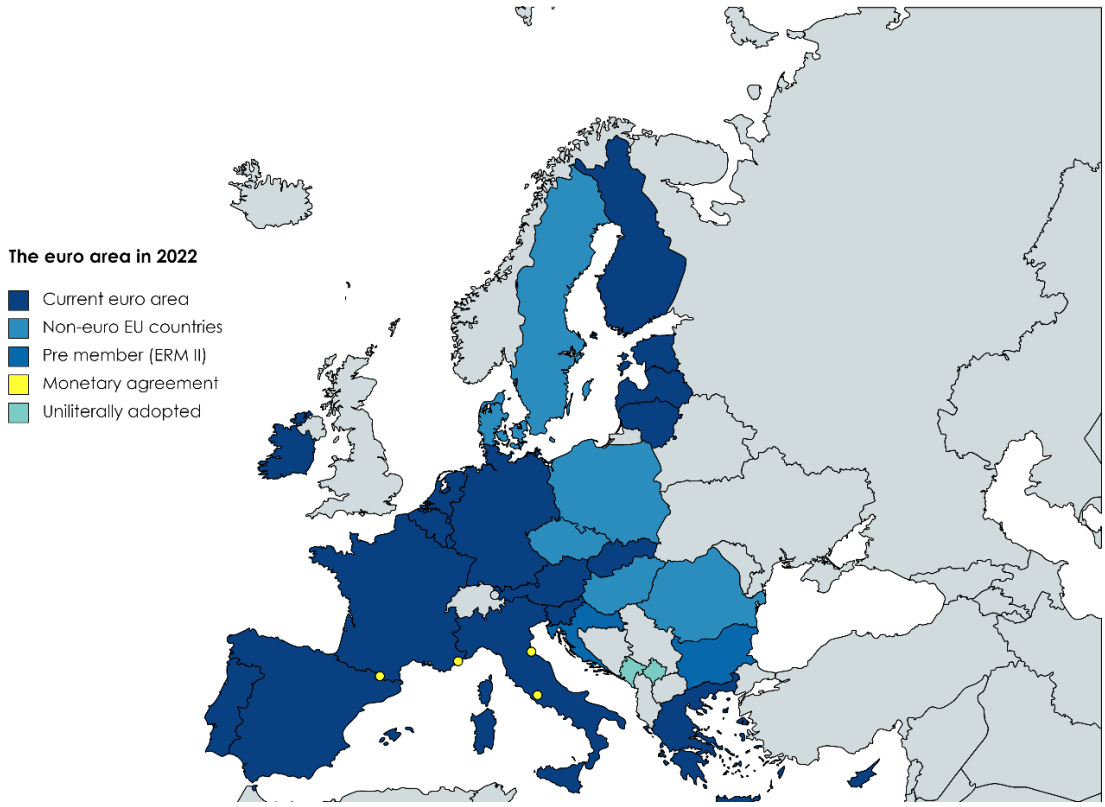

Figure 1: The current euro area in 2022 (author's figure)

The euro area can be assorted differently, and different authors use different systems. Many authors group the EU countries in the research concerning the synchronization of business cycles into "*the core area*" and "*the periphery*." According to Campos and Macchiarelli (2018), it is not clear-cut which group certain countries belong to – some may not fit either of those groups. Countries might also change groups from time to time. In the end, authors' varying decisions concerning data, methods, and thresholds mean

there is a myriad of different classification systems and results. There are no general definitions for these terms. The core is the area that has the most synchronized cycle.

Campos and Macchiarelli (2018) have created their definition because they argue that "*The concepts of core and periphery remain ubiquitous and elusive in the European integration debate.*" Their version of the definition is based on the correlation of supply-side shocks. According to their results, Germany, France, and Austria became part of the core by 1999 – that was also the year the euro was introduced. The next ones to join the core are Belgium in 2000 and Italy and the Netherlands in 2005 and 2007. Their results indicate also that Spain is moving from the periphery to the core. Sweden and Greece, on the other hand, are becoming more peripheral. They name that at least Portugal, Finland, and Ireland are part of the periphery. (Campos and Macchiarelli 2018, 4-8.)

1.3 Research questions

This thesis highlights one of the critical criteria from the optimal currency theory[1]: the similarity of the shocks and business cycles in the euro area. That is relevant because common monetary policy can be suitable to euro area countries only if their business cycles are synchronized enough – in other words, the cycles and shocks should be sufficiently similar in timing and trend. Especially smaller countries might face problematic consequences if they face asymmetric shocks, i.e., economic shocks that hit only their specific industries or regions. Common monetary policy might be very suboptimal during negative asymmetric shocks and hinder their recovery. On the other hand, during positive asymmetric shocks, their economy might overheat due to too loose monetary policy. It would be optimal that all countries would face shocks simultaneously and with the same strength.

The evolution of business cycle movements is also interesting from many points of view. First, it is relevant knowledge to EU-level decision-makers to know if common policies have successfully brought the cycles together and in what order of magnitude. The relevance is that the more synchronized the cycles are, the better the common monetary policy effects (Frankel and Rose 1998). Second, it is important for national decision-makers because they need to know if their national economic policy plan is in

[1] Words "optimal" and "optimum" appear in the literature referring to the same concept. Word "optimal" is slightly more common, and I have used it in this thesis too.

line with the fact that they share their currency with others with the common monetary policy. Their national fiscal policy should be steering the nation in the right direction. The welfare loss is evident if the correction is not made on time. If they do not or cannot act, they know that they need to change the direction or assess the cost-benefit ratio of the membership of the monetary union.

Based on the previous reasoning, the research is conducted to answer the following questions. First, how have the business cycles evolved in the euro area since the introduction of the euro? Second, how similar the shocks and cycles are between different member states? I hypothesize that the synchronization is strongest in the core areas of the euro area, and weaker signs of synchronization can be found in the more minor countries located economically and geographically further from the core areas of the euro area. This hypothesis is based on the reasoning that countries with similar industrial profiles and high levels of mutual trade have more similar cycles. Beyond that, I hypothesize that countries that got worse hit by the financial crisis had deeper falls in their business cycles, and because of that, their cycles are not as synchronized as the cycles of others.

1.4 Structure of the thesis

The structure of this thesis is following. Chapter 2 reviews the theory of central topics handled in this thesis: business cycles, business cycle theories, and optimal currency area theories. That paves the way to go through the most significant results of the former studies. There are different ways of defining a business cycle and many ways to explain why they occur as they do. Optimal currency area theories define the requirements for an optimal currency area and lighten what changes joining a currency union might lead to. In chapter 2, the definition of synchronization as a phenomenon is also introduced. After that, two opposing views of monetary integration and synchronization are examined in light of if forming a monetary union increases the synchronicity of the business cycles of the joining nations.

Chapter 3 handles the topic of synchronization in the eurozone from the perspective of earlier studies. The overview of the studies focuses on the newer studies of the topic, mostly presenting studies published after the 1990s. The most important part of chapter 3 handles how international business cycles and European ones are intertwined. After that, the appearance of anomalies between empirical and theoretical studies is handled shortly.

Chapters 4 and 5 are the empirical parts of this thesis. Chapter 4 presents the chosen methods to examine synchronization patterns in the euro area. There are several ways to measure synchronization, but they all have their problems and shortcomings. The question of synchronization will be studied with two key measures, the correlation coefficient and the dispersion measure (standard deviation of the euro areas countries' output gaps). In chapter 5, results are presented with graphs and analysis. The chosen measures have been used to examine the situation of the whole euro area, but also individual countries.

In chapter 6, conclusions are drawn from the results with possible policy reforms and future ideas for continuing the research on this topic. After calculating the key figures, it is possible to draw conclusions in one direction and ponder what questions raise from the results. It would be especially interesting to find patterns of rising synchronization or desynchronization. Patterns could be found in the business cycles of all countries, country groups, or individual countries.

2 Theory review

2.1 Defining business cycles as a phenomenon

"Destructive acts of God and the wasteful wrath of man often brought acute distress upon communities, but it was only when economic organization assumed its present form that business cycles began to run a regular course." – Wesley C. Mitchell (1960, 169)

Business cycles are cycles of economic activity that usually have steps that recur again and again. They consist of depression, recovery, boom, and slump, depicted in the figure 2. Analyzing the current economic situation through this phenomenon is the foundation of today's economic analysis. Still, the idea of business cycles is relatively new. In the 19th century, economists analyzed the economy without putting too much thought into short-term fluctuations and focused on other areas. In the early 20th century, economist Wesley Mitchell went through a broad collection of data and excluded those movements that could be explained with known theories. His central finding was that business cycles have been quite similar in modern times if the length of the cycles is controlled. That key discovery led to the modern definition of business cycles. (Lucas 1950, 698.)

According to Mitchell and Burns, business cycles are economic fluctuations that appear in nations that have organized their work mainly through enterprises – in other words, mainly in nations that hold some form of capitalism as their economic system. The duration of cycles varies from one to twelve years. (Burns & Mitchell 1946, 5-8.)

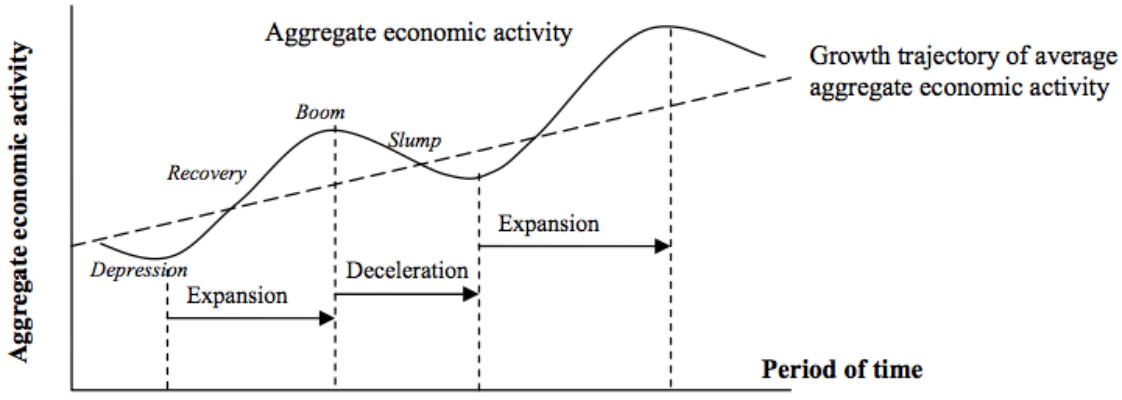

Figure 2: Typical presentation of a business cycle (Adamauskas & Krušinskas, 2012)

Today, the concept of the business cycle has various definitions. Harding and Pagan (2005, 154) suggest the following classification: periodic cycles, serially correlated deviation cycles, and turning point cycles. With periodic cycles, Harding and Pagan refer

to the definition that business cycles are time series of temporary deviations from the trend. Serially correlated deviation cycles are serially correlated deviations of output from the trend. Still, Harding and Pagan argue that this definition by Blinder and Fischer (1981, 227) is too vague to be a serious candidate for a definition of the business cycle. Finally, with the turning point cycles approach, they recognize cycles from the turning points of the particular time series under examination. Harding and Pagan depict the turning points as "*peaks and throughs*" and periods between them as "*expansions and contractions*".

According to Harding and Pagan, business cycles can be examined by using three different time series of GDP:

1. The level of GDP, or $y_t = log(GDP)$
2. The level of GDP subtracted with the permanent component P_t, or $z_t = y_t - P_t$
3. The growth rate of GDP (quarterly or annually), or Δy_t

The first one is considered the classical version of a business cycle, which has been used, for example, in the studies of economist Wesley Mitchell. The second one is a bit trickier because one needs to define a permanent component first. Harding and Pagan criticize the usual way of defining the permanent component as a "*trend*" and the leftover as a "*cycle*," which are often associated with filters such as Hodrick-Prescott and Baxter-King. They argue that a country following a random walk has no transitory component. Consequently, one cannot filter out a trend or a cycle. They argue that such countries do not have a serial correlation with GDP growth rate. Yet, those countries still have business cycles. Because of this, they refer to the "*cycle*" as the growth cycle. The third approach means studying the cycle in the GDP growth rates, which is, according to Harding and Pagan, a special case of the second approach in terms of statistical connections. (Harding & Pagan 2005, 152-153.)

2.2 Business cycle theories

2.2.1 Early theories

Business cycle theories aim to explain economic fluctuations called business cycles. Several schools of thought have different ways of approaching the matter. The first early important theories are Keynesian and monetarist theories. Keynesian point of view was revolutionary in its time. Before the Keynesian revolution, classical economics was based on the idea that supply determines the level of production in the economy. That was

rationalized with Say's Law: aggregate production determines the level of aggregate income, and income not spent on consumption is saved and invested. The logical conclusion is that consumption and investments equal the aggregate level of production and income. In other words, supply creates an equal amount of demand, and the level of aggregate demand is not an interesting variable. (Lutz 2002, 39-43.)

Keynes turned the classical conclusion upside down and argued that aggregate demand is the key determinant in defining the level of production. The basic Keynesian equation is following:

$$Y = C + I + G + (X - M) \qquad (1.)$$

Where Y, C, I, G are real output, private consumption, investments, and government spending, and $(\mathrm{X} - \mathrm{M})$ indicates net imports where X and M indicate exports and imports. When a shock hits the economy and private consumption and investments decrease, the government can apply countercyclical fiscal policy and increase spending to smooth the downturn. Increased public spending will flow to the whole economy and boost growth. If the government does not act, wage stickiness can lead to unemployment and a decreased level of aggregate demand.

Samuelson (1939) extended Keynesian ideas and developed his Multiplier Accelerator Model in this frame. According to the model, economic fluctuations or business cycles form from the interaction of the multiplier and accelerator. The multiplier increases investments when output increases. If the accelerator is not strong enough, investments and income will decline when the economy expands. Investment is the key variable, and its decline initiates a recession. The recession ends only when the level of capital has fallen enough relative to output. In this model, cycles are repetitive and regular, and Burda and Wyplosz argue that due to that and unlikely assumptions, the model does not explain business cycles well enough (Burda & Wyplosz 2001, 339-341).

All in all, the Keynesian models are all about aggregate demand. According to Keynesian theories, insufficient aggregate demand could lead to periods of unemployment. In that kind of situation, Keynesians put their hope on the government, which should stabilize the economy with countercyclical fiscal policies.

The monetarist theory is a counterposition to all that. It emphasizes money as the main source of economic fluctuations. According to Parkin (1996, 414), an increase in the money supply leads to an expansion in a business cycle. On the contrary, a decrease leads to a recession. If the Keynesian theory emphasized aggregate demand, the

monetarist theory brought the supply side back to the discussion. From the viewpoint of business cycle research, the monetarist theory is incomplete because it does not consider, for example, real shocks in the economy.

The monetarist theory is based largely on the quantity theory of money. The theory suggests that the money supply M and velocity of money V equal the price level P times the real GDP Y.

$$MV = PY \tag{2.}$$

Controlling the level of the money supply is the ultimate way to keep the economy stable. Monetarists argue that the long-range level of the money supply does not matter because the price level will find a new equilibrium in the long run. Instead, short-run consequences might harm the economy if the money supply decreases or increases too fast. Expanding the money supply too quickly will stimulate the economy at first, leading to higher inflation later. An increasing level of inflation leads to an increasing level of prices. That is a problem because it distorts the delicate system of price signals – individuals can not recognize if the rise in the price of some product is due to its higher value or rising prices.

According to the monetarist theory, if monetary growth is too slow or even decreasing, there will also be harmful consequences. Slow inflation means that prices are rising slowly. In an economy with sticky wages, wages will rise faster than prices, which means employers' expenses rise faster than their incomes. They need to lay people out – this is a start of an economic downturn in the business cycle. Wages will change in a while, but a downturn is inevitable.

2.2.2 Real business cycle theory

Real business cycle theory (RBC) is one of the key theories concerning business cycles. Its name comes from the idea that economic fluctuations are created when economic agents react to real (not nominal) shocks that hit the economy, for example, changes in technology, import prices, or government purchases – this is the foundation of the theory. In RBC models, the economy is in equilibrium, and economic agents try to reach the optimal state by responding to the shocks. The economy is Walrasian, which means that the responses are always optimal. Romer has summarized the idea well: "*In short, the implication of real-business-cycle models, in their strongest form, is that observed aggregate output movements represent the time-varying Pareto optimum*." This theory's

most notable early developers are at least R. Lucas, E. Prescott, and F. Kydland. (Romer 2019, 194-204.)

One of the key papers on real business cycle models is "*Time to build and aggregate fluctuations*," written by Kydland and Prescott in 1982. In the paper, Kydland and Prescott argue that supply-side shocks, instead of demand shocks, cause business cycles. When the paper was written, the belief was that fluctuations were driven by demand shocks such as a sudden pandemic. That was a powerful argument because the Keynesian theory was based on the thought that nations should smooth out business cycles by increasing or decreasing public spending. If the fluctuations are the economy's optimal responses to supply-side shocks like hurricanes, government intervention could only decrease welfare. (Kydland & Prescott, 1982.)

Lutz (2002) introduces a basic RBC model based on the assumption that economic agents are identical and infinitely living. They work L_t and have free time 1-L_t. They gain utility from both, and the amount is determined by their utility function $u(C_t, 1 - L_t)$. Intertemporal utility from time t has been presented with the following function, which represents the discounted sum of current utilities, where $\beta(0 < \beta < 1)$ is the discount factor:

$$\sum_{\tau=t}^{\infty} \beta^{\tau-t} u(C_\tau, 1 - L_\tau) \qquad (3.)$$

The utility function is continuously differentiable and concave, and it has positive and decreasing marginal utilities. The production function of the output Y, on the other hand, is presented in the following equation:

$$Y_t = \theta_t F(K_t, L_t) \qquad (4.)$$

F is a concave and continuously differentiable variable with positive, decreasing marginal productivities and constant returns to scale in this equation. K stands for capital, which depreciates at the rate $\delta(0 < \delta < 1)$. Because of that, the amount δ of capital stock K_t depreciates between periods t and $t + 1$. θ stands for a supply shock. (Lutz 2002, 90-100.)

According to Lutz (2002), RBC theory and models aim to numerically describe observed business cycle movements. RBC models produce time series for output, consumption, and investment, which have very similar statistical properties as the real-time series. The problem with the RBC theory is that it does not explain all business cycle movements in the real world: one could say that it is an empirical failure. According to RBC theory, monetary shocks do not have real effects, but we can strongly argue that, for

example, the Great Depression had multiple effects on society. Romer also argues (2019, 309) that there is little evidence of aggregate technology shocks, which are the main driver of business cycles according to RBC theory.

Lutz points out that there are many extensions to the basic RBC model because it has many problems. He argues that the basic model is inconsistent with empirical research: hours are not volatile enough in the model, and the predicted correlation between real wages and hours is too high. There are also correlation problems between productivity and wages. Lutz argues that the required high wage elasticity of labor supply can be right if the basic model is fixed with labor indivisibilities, home production, government expenditure, or preference shocks. Another expansion he introduces is wage stickiness, an alternative explanation for the volatility of hours worked. Few extensions are focused on multisectoral dynamics, money, and the international economy. (Lutz 2002, 90-100.)

2.3 Optimal currency area theories

2.3.1 Background of optimal currency area theories

The idea of a common European currency has also stirred discussion of the cost-benefit side of an economic and monetary union. It is pointed out in the "*One Market, One Money*" report from the European Commission (1992, 31) that *"there is no ready-to-use theory for assessing the costs and benefits of EMU."* Still, this kind of assessment was needed to make policy decisions. The report assesses that the optimal currency area theory (OCA) provided important early assessment possibilities but is an outdated and narrow framework. According to the report, the question of the EMU is possibly more complex than the OCA question itself. While the theory is criticized and not perfect, it is still a useful tool to approach the question for some parts. On the other hand, the OCA theory has historical value from the EU perspective because it has shaped the discussion on the EMU in the past. Furthermore, the OCA theory has seen some new developments since the 1990s.

The OCA theory concerns the criteria of a common currency area and its benefits and costs. It can also be seen as a tool to analyze the optimality of different exchange rate regimes in different regions. It is a frame that can be used to examine how optimal some currency area would be or is. Beyond that, McKinnon argues before introducing his

version of the OCA theory (1963, 1) that "*the idea of optimality, then, is complex and difficult to quantify precisely, so what follows does not presume to be a logically complete model*." In other words, the OCA theories are not indexes that can give exact numbers but rather a collection of different approaches inspired by Robert Mundell's major paper "*A Theory of Optimum Currency Areas*" (1961).

Mongelli has divided the development of the OCA theory into four phases. In the 1960s and 1970s, "*the pioneering phase*" consisted of establishing the theory and laying grounds for the basic principles of assessment of costs and benefits of monetary union. In the 1970s "*reconciliation phase*" did not lead to major developments but improved the theory and linked it together. In the 1980s and 1990s, the idea of EMU brought new light to development, and a new generation of OCA theories was born. Finally, the 1990s and the forming of the EMU brought the "*empirical phase*" and strong development of empirical methods to assess the optimality criterion. (Mongelli 2002, 1.)

2.3.2 Pioneering theories

According to Mundell, at least four characteristics distinguish optimal currency areas from less optimal entities. First, the industrial structure of an optimal currency area should be broad enough. If an economic shock hits one industry, the whole economy will carry on with the growth of other industries. Small countries would not be able to keep such a broad base of different industries, and they should pay attention to this fact when assessing the benefits of joining a currency union. In addition, the size of the currency area is a significant characteristic for two more reasons. If the currency areas were too small, and there would be lots of them, management and change of different currencies would be too expensive compared to the benefits of larger areas. Small currencies could also be interesting targets for international speculators who could deteriorate the stability of those currencies while chasing profits. (Mundell 1961, 663-664.)

Mundell considers especially factor mobility as a significant criterion for forming an optimal currency area. He argues that if a country with its own currency has two areas, A and B, and the demand for goods shifts from A to B, area A will face unemployment, and the other will face inflation. If there are wage and price rigidities, no labor mobility, and a fixed exchange rate regime, the situation will not stabilize. It will not reach the equilibrium state without some adjustment. The problem will disappear with sufficient labor mobility because workers can move from area A to area B – under that condition,

areas A and B can form an optimal currency area with the same exchange rate. In addition, Mundell was the first person to propose in an academic paper that an optimal currency area could also be a region of which borders would not be confined only to national borders but that they could also be larger or smaller entities. (Mundell 1961, 658-659.)

A couple of years later, McKinnon developed the theory further by distinguishing two different types of factor mobility. He argues that it is meaningful to compare geographical and industrial mobility impacts separately. His definition of geographical mobility is the same as Mundell's (1961), but an improved definition of industrial mobility is his expansion of Mundell's theory. McKinnon argues that different regions have their own industries in which they have specialized. That is why negative shocks can hurt industries in area B but not in area A. In this case, if area B can produce A-type products, the need for factor mobility is not large. If this is not the case, then factor mobility can stabilize the situation, and movement from area B to area A can adjust the situation back to equilibrium without decreasing income in area B. Both Mundell and McKinnon agree that factor movement is an important indicator of whether areas A and B should form a currency area. (McKinnon 1963, 724.)

Kenen (1969) expanded the factor movement argument further six years later. He guides the discussion on occupational mobility: "*When regions are defined by their activities, not geographically or politically, perfect interregional labour mobility requires perfect occupational mobility. And this can only come about when labour is homogenous*" (Kenen 1969, 44). Kenen's argument means that currency areas should be quite small because the composition of the labor force can be very different, even between small countries. This arrangement would pose other significant problems, considering the daily need for currency exchange between different agents that trade commodities. Kenen also raises the question of product diversification. According to Kenen, well-diversified economies can form optimal currency unions more easily and benefit because they are more resilient to asymmetric shocks. On the contrary, less diversified economies face harsh consequences from shocks and need flexible exchange rates to smooth out the effects (Kenen 1969, 44-49). Mundell (1969, 11) criticizes that a world currency would be the best solution according to Kenen's argument because that large currency union would have the most diversified collection of different industries.

I argue that both Kenen (1969) and Mundell (1969) are right, but the need for diversification depends largely on the other features of the currency union, and it is hard to view only one feature per time. For example, suppose a less-diversified economy faces

an economic shock but has a high mobility factor. In that case, the problem is not so significant from the view of the currency area – people can move to an area where jobs are available. Indeed, Ishiyama (1975) poses a problem for every country to evaluate the pros and cons of forming a currency area or entering into one. Ingram (1969) goes even further and argues that the optimality of currency areas might depend more on the political commitment of the member states than on any criteria.

2.3.3 Modern theories

During the 1960s, improving the OCA theory was largely interesting from an academic perspective. At that time, nation-states relied on national currencies, and supranational currency areas were more relevant in academic discussions than in the tables where decisions were made. European Economic Community (EEC) was formed in 1957, and European integration gave fuel to the discussion, but there was still a long road toward the common European currency area.

During the last three decades, the discussion concerning the OCA theory has taken new steps. Tavlas (1993, 1) observed aptly at the beginning of his paper in 1993 that "*the theory of optimum currency areas is back*." Krugman (1993, 18) even observed in the same year: "*It is arguable that the optimum currency area issue ought to be the centerpiece of international monetary economics*." This new interest rises, of course, from the development of a more integrated Europe through the EU and a common currency. Macroeconomics had also developed, and Horvath (2003, 18) observes that the crucial change that was discovered is the claim that the trade-off between inflation and unemployment is not permanent or stable. New theories indicate that monetary integration has more benefits and fewer costs (Tavlas 1993, 682) – one could also argue that so-called traditionalists or classical theorists focused more on the cost side of integration. These new theories are often grouped under the term "new optimal currency area theory," which was first introduced by De Grauwe (1992).

Tavlas (1993) claims that the OCA theory has developed especially in the following areas in the 1990s: expectations formation, the time-inconsistency problem, the analysis of exchange-rate determination, and the theory of uncertainty underlying labor mobility. With the time consistency issue, Tavlas means that certain countries known for devaluating their currency can benefit from "*tying their hands*" or giving their monetary decision power to a new supranational central bank. That is because the markets will

notice that the possibility of high inflation has disappeared. Tavlas also notes that traditional OCA theories include the idea that similar inflation rates are an important pre-condition for joining a currency union, but it should be handled as a desirable outcome. (Tavlas 1993, 664; 673-674.)

New discussions and research around the issue have brought up many topics and viewpoints to develop the theory further. The most notable discussions are, according to Horvath (2003), Tavlas (1993), and Kunroo (2015), at least the following: effectiveness of the monetary policy, discretion vs. credibility, endogeneity vs. specialization hypothesis, and matter of political factors.

The effectiveness of monetary policy discussion is at the center of the new OCA theories. Traditionalists like Corden (1972) argue that joining a currency area will lead to losing the independent monetary policy, leading to high economic costs. While this might be true, newer studies have developed this argument further. Alesina, Barro, and Tenreyro (2002, 7) highlight that the defining variable in measuring the costs of loss of the independent monetary policy is the similarity of shocks and, more specifically, correlation and output variance. The more similarities, the less there are costs imposed on the economy. On the other hand, giving away independence might be good if the central bank's credibility is low.

Tavlas's "*tying their hands*" argument is part of the discretion vs. credibility discussion. Monetary authorities need high credibility so that their announcements and policy changes have the desired effect. If a monetary authority breaks away even once from its policy, it loses a part of its credibility. If that happens once, it can happen again – as a result, markets will lose their trust in the central bank, and inflation expectations will rise. Kydland and Prescott (1977) and Barro and Gordon (1983) are pioneers in this discussion and have studied the topic within one economy.

The endogeneity vs. specialization hypothesis refers to how increased trade between two areas affects the business cycle synchronization of those two economies. On the other hand, increased trade might lead to further specialization different area invest to increase their production on the area in which they have the comparative advantage – this will deviate the business cycles of these areas even more. For example, Krugman (1993b) and Eichgreen (1992) advocate this view. On the other hand, Frankel and Rose (1998, 1012) argue that international business cycle correlations are endogenous. They argue that joining a monetary union increases the synchronization of the business cycles of those countries. That is due to closer trade ties and common monetary policy. That happens

especially if the trade is intra-industrial. Their argument means that a currency area might be optimal ex-post, even if the joining country does not meet the requirements ex-ante. Corsetti and Pesenti (2002, 1) even argue that common monetary policy is self-validating. They suggest that "*when the private sector chooses pricing strategies that are optimal in a monetary union, such strategies make a currency area the optimal monetary regime from the vantage point of the national policymakers as well.*" They argue that business cycles become more correlated even if there are no structural reforms.

Labour markets and mobility have been in the middle of the discussion concerning the OCA theory since the beginning when Mundell (1961) argued that factor mobility is an important variable determining if a country should join a currency area. Bruno and Sachs (1985, 222-232) state that labor market institutions have a crucial role in how economic shocks affect wage and price development in different countries. They point out that especially the level of centralization in wage bargaining has an essential role because countries with highly centralized bargaining tend to be able to contain the rise of wages during supply shocks, and they will be able to recover faster. Unions accept lower wage increases because they know that they lead to higher inflation, which would neutralize the effect of wage increases. On the other hand, countries with an intermediate level of bargaining tend to fare worse because independent unions will not coordinate their bargaining processes. They do not want to end up in a situation where they have negotiated smaller wage increases than other unions. That leads to higher nominal wages and higher inflation. De Grauwe (2003, 75-82) refers to the theories of Bruno and Sachs and argues that countries with different kinds of labor markets and institutions may not be better off at forming a currency area.

To conclude, there are various points of view to define what entity could be described as an optimal currency area – in the end; there is not a single fully accepted definition that does not has its flaws. One of the most used is the one described by Frankel and Rose (1998). According to them, the following four aspects are crucial in defining if an entity is indeed an optimal currency area:

- Labor mobility
- Risk-sharing (f. ex fiscal transfers)
- Similarity of business cycles
- Openness with capital mobility and price and wage flexibility

2.4 Defining synchronization as a phenomenon

The definition of business cycle synchronization is a co-movement of the economic growth rates. On the contrary, co-movement does not mean that the levels of national GDP:s are the same. Additionally, synchronization of business cycles does not mean convergence in growth rates, which refers to the rapprochement of the rates. Synchronization is a commonly used tool or criteria to measure if a similar monetary policy is suitable or even necessary for the countries, such as forming a monetary union. In a monetary union consisting of countries with synchronized business cycles, a common monetary policy can be an effective and working stabilizing macroeconomic mechanism. Suppose one of the countries is hit with an asymmetric shock. In that case, the common monetary policy is likely not optimal for the country in recession. The country should stabilize the situation with fiscal policy or other ways to get back on the same track as the others. For example, in the euro area, countries should use their national fiscal policy or other ways to surpass the problems of the shocks that do not hit the whole eurozone.

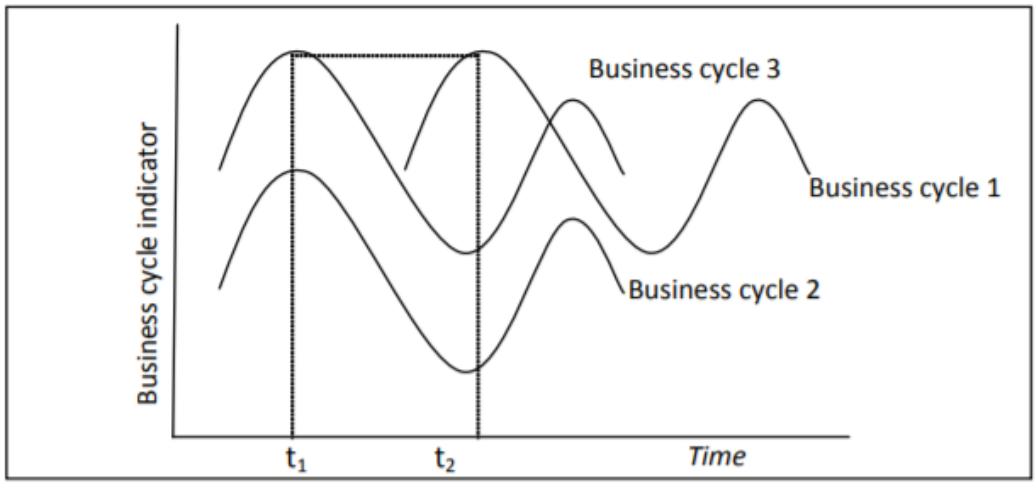

Figure 3: Examples of business cycles (Kamanduliéne & Lydeka 2011, 39)

Business cycle studies have robust terms to describe the correlation between different business cycles. Procyclical, countercyclical, and acyclical are the three most used. If cycle 2 in figure 3 describes the eurozone, cycle 3 can be described as procyclical and cycle 1 countercyclical. An acyclical cycle would be a cycle that has no significant correlation with the examined cycle.

2.5 Monetary integration and synchronization

Does forming a monetary union increase synchronicity of the business cycles of the member nations in the light of economic theory? That is an essential question regarding the topic of this thesis. If the answer is yes, there should be a notable level of business cycle synchronization in the euro area after introducing the common currency area. Two opposing views have emerged in the relevant discussions and studies. The answer is not clear-cut.

Frankel and Rose argue that entering into a currency union might lead to tighter trade ties with other currency union members. Increased trade and coordination of national economic policies will decrease the possibility of asymmetric shocks. In addition, higher cooperation and coordination could reduce the possibility of policy-driven asymmetric shocks such as the sudden rise of trade barriers or even trade wars. National business cycles are affected by this change, and the business cycles will become more similar. Countries might be more likely to satisfy ex-post entry criteria than ex-ante because of the previous arguments. (Frankel and Rose 1998, 21-22.)

On the other hand, Krugman argues that these closer ties might lead to a higher level of specialization in such industries in which those countries have a comparative advantage. That would increase the fragileness of those countries to industry-specific shocks that would not affect the other countries as much. The industry-specific shocks would be more and more country-specific because of the increasing level of specialization. That would lead to higher desynchronization of the cycles and a problematic situation for the central bank and monetary policy. (Krugman 1993b, 241-243.)

I argue that both theories have logical reasoning. Still, I raise questions considering Krugman's theory. While increasing country-specific specialization in a monetary union from a purely efficient perspective would be logical, it could be that many countries do not want to take specialization too far. Countries have incentives to be self-sufficient in case of large-scale catastrophes or changes in the political environment. I argue that Krugman's theory might describe more of a first-best world, but in a second-best world, many countries have such a high level of risk-aversion that they put a lot of effort into avoiding risks. Looking from the outside, that might seem an inefficient way to behave, but this might be completely optimal depending on the country's preferences.

Darvas, Rose, and Szapáry (2005, 18-19) argue that fiscal convergence systematically enhances business cycle synchronization. They have found evidence that countries that have a similar fiscal position have also more closely fluctuating business cycles. In other words, fiscal convergence is associated with more synchronization. They have also found evidence that reduced deficits can increase synchronization.

By looking at the Maastricht criteria and these results, one could argue that the criteria might have moved the euro area closer to being an optimal currency area. The Maastricht criteria encourage the countries that wish to join the euro to cut deficits and have increased fiscal convergence. Countries might have also become better candidates for the eurozone by following the criteria. All in all, there are similarities between the arguments of Mundell and the design of the convergence criteria.

3 Literature review

3.1 A brief overview of earlier studies

Literature on the similarity of shocks and cycles in the euro area is diverse. There have been studies before and after introducing the euro, but there is still little research covering a longer period after the 2008 crisis. The studies differ at least in the following ways: 1) the length of the data sample, 2) methods, 3) chosen countries, and 4) data types. Presumably, the conclusions of earlier studies differ because of those differences, but there might also be other reasons in addition. I have chosen a variety of studies for this chapter to describe as well as possible the current understanding of the scientific community in the question of business cycle synchronization in the euro area. Many studies are the ones that have been cited the most, but some studies have given unique perspectives and conclusions. I have focused on the period preceding the Maastricht treaty (1992) and the period after it.

Massmann and Mitchell (2003, 16-17) argue that the long-run trend for the euro area cycle has been rising since the early 1990s, after the unification of Germany and a period of divergence. They note that their results are encouraging for the operation of the euro area. Altavilla (2004, 894-895) has similar results, and he times the convergence trend to begin also from the 1990s, more precisely around the establishment of the Maastricht Treaty. Hence, he supposes that the synchronization trend results from the monetary and fiscal policy controlled by institutional constraints to the EMU member states. Böwer and Guillemineau (2006) argue that the synchronization cycle started when the single market was created (1993) – according to their study, increasing trade in the single market contributed to synchronization.

However, Camacho, Perez, and Saez (2006, 1687-1689) have examined the data from the 1960s to 2003. According to them, the synchronization of the business cycles of the original euro countries has not increased significantly after the introduction of the euro. The convergence had happened before and stayed at quite the same levels after that. Beyond that, they find that the business cycles of the older euro countries are more linked together than the cycles of the new ones.

Studies by Massmann and Mitchell (2003) and Camacho et al. (2006) are examples of studies using the industrial production index (IPI), which measures production and capacity levels in, for example, manufacturing, mining, and electric industries. It can be

seen as a good proxy for GDP, but it might give different results as the GDP aggregate. First of all, IPI is a monthly index, so it can show short periods of divergence or convergence that are not captured in the quarterly GDP data. It is also more vulnerable to external shocks due to the manufacturing sector's dependency on trade, which can cause bias in comparison to measures based on the economy's broader activity. The use of GDP also enables the possibility to use different components of the GDP measure, making it possible to analyze the sources of change in the synchronization. Gayer (2007, 2-3.)

Gayer's (2007, 19-21) data spans to 2007 – he has similar findings to Camacho et al. (2006). According to Gayer, the level of synchronization has been high since the introduction of the euro but not higher than at the beginning of the 1990s. In 2003, there is a significant decrease, followed by a partial recovery in 2004 and onwards. Gayer points out that this change in 2003 was driven by a few less synchronized countries like Finland and Greece. On the other hand, the upward in synchronization trend after 2003 has been driven by almost all the countries. McCarthy (2006) argues in his commentary on another paper that the diverging trends of the early 2000s might have occurred because of disparities in the sources of growth in the euro area. Germany relied on its export industry, while domestic demand supported Spain and France. It is significant to note that all prior studies have been made before the financial crisis, and their data includes only less than ten years of data after the introduction of the euro.

Preceding studies were made before the 2008 crisis. The following five studies have been made after it and include at least some data after 2008. One of them is a newer study by Gächter, Riedl, and Ritzberger-Grünwald (2012). It includes quarterly GDP data until 2012. Their analysis supports the argument that the correlations of the business cycles decreased during the financial crisis, but not as much as in 2004. All countries faced a decrease in their correlation measure in 2004. That was not the case in 2008. In 2008 few countries took a larger hit from the crash than others, and mainly those countries decreased the overall correlation measure of the euro area. Those countries were the ones that had the worst financial situation before the crisis, for example, Greece. They also note that the trend of the output gaps was contrary to the trend of the correlation measure. In 2004 output gaps were significantly smaller than in 2008. In addition, the study reveals that not all countries recovered from the crisis at the same pace. Countries that had less debt and a better situation overall were the ones that could have had more expansionary policies and recovered faster. On the contrary, countries with a less stable situation faced a vicious cycle, which hindered the recovery significantly. That led to the monetary policy

being too strict for the less stable ones and too loose for the ones that recovered better. (Gächter et al. 2012, 54–56.)

Guerini, Luu, and Napoletano (2019) have used IPI data from 2000 to 2017. Their most compelling argument concerns the synchronization clusters and how they change over time. They argue that due to structural reforms, the polarization between the west and the east has changed during the years to the polarization of the Northern and the Southern Europe, as shown in figure 4. According to them, this is partly the aftermath of the financial crisis. They suggest that policies have effectively integrated eastern countries into the common cycle. However, the threat of asynchronization is still there – especially for the countries that faced the crisis with the hardest toll – in other words, the countries that had significantly increased levels of public debt and other problems. This pattern follows the same path as Gächter et al. (2012), and the conclusion is the same: common policies have not been equally effective in all member states. Second, Guerini et al. argue that the peak in the levels of business cycle synchronization was reached just during the financial crisis. After that, it reached only the levels of the early 2000s. (Guerini et al. 2019, 21-22.)

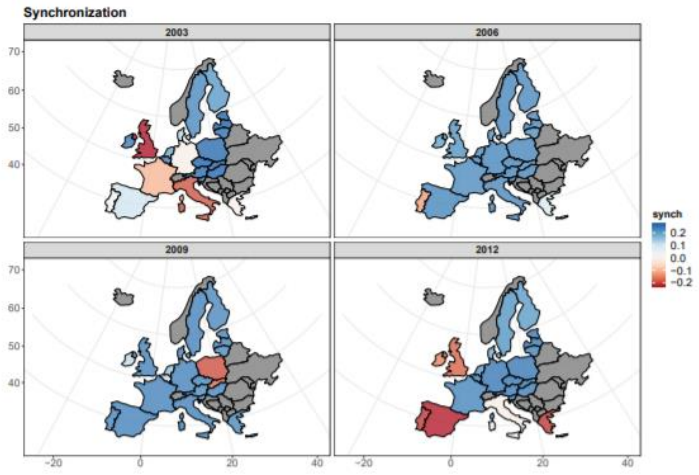

Figure 4: Eigenvector components, corresponding to the correlation of each country with the most relevant factor. (Guerini et al., 2019)

Others too suggest that the effects of joining the EMU have been heterogeneous. Lehwald (2013) compares the common European factor before and after the introduction of the EMU in the first 12 euro area countries. His dynamic factor model suggests that the EMU increased co-movement in the core area and the opposite in the periphery (Spain, Portugal, Greece, and Ireland).

Belke, Domnick, and Gros (2017) approach the topic from a spatial view: they argue that there are two distinct country clusters inside the euro area – core and periphery. According to their analysis, synchronization between these two clusters fell after the financial crisis compared to the period before the crisis and after the introduction of EMU. In addition, the peripheral cluster also lost alignment in comparison with each other. They add that the central problem in the euro area might not be a low synchronization or de-synchronization but different amplitudes of the cycles. Only a high correlation is not a sufficient clue to argue that synchronization in a particular area is high.

Konstantakopoulou and Tsionas (2011) have had the period of 1960 to 2009 under examination. They argue that the core countries are highly synchronized, but the periphery is left behind and shows no sign of synchronization.

Table 1: Summary of the earlier studies and their results. McCarthy (2004) is not included due it is more of a commentary.

Article	Period	Method	Results
Massmann and Mitchell (2003)	1960-2001	An analysis of the distribution of bivariate correlation coefficients	Correlation has risen since the 1990s, and it is statistically positive between all 12 countries pre-year 2001.
Altavilla (2004)	1981-2001	Concordance index and cross-correlation analysis	Business cycle affiliation of the euro area has moved from the US towards the euro area since the 1990s. Monetary policy and fiscal and monetary discipline have increased the euro countries' synchronization levels.
Camacho et al. (2006)	1962-2003	Calculating distances of cycles with VAR-, spectral, dummy, and combined approaches	The business cycles of the euro countries are more closely linked than the business cycles of the newer members. Synchronization of the euro area has increased before the euro and not so much after it.
Böwer and Guillemineau (2006)	1980-2004	Rolling correlations, correlations, and indexes concerning financial flows and trade	The synchronization cycle started when the single market was created – increasing trade in the single market contributed to synchronization.
Gayer (2007)	1983-2005	Rolling correlations, standard deviations of output gaps	Synchronization levels in the euro area have increased since the 1990s, but around 2003, levels faced an abrupt decrease. A rebound and partial recovery happened after 2004.
Konstantakopoulou and Tsionas (2011)	1960-2009	Correlation coefficients, dynamic analysis	A core group of countries is the most synchronized: Germany, France, Belgium, the Netherlands, and Austria. On the other hand, some countries present no synchronization with the rest: Greece, Portugal, Luxembourg, and Finland
Gächter et al. (2012)	2000-2011	Rolling correlations, standard deviations of output gaps	Business cycles faced a period of desynchronization in the 2008 crisis. Some countries recovered faster, but some were left behind.
Lehwald (2013)	1991-2010	Dynamic factor model	There is a trend of synchronization in the core euro area, but not so much in the periphery – the introduction of the euro has fostered imbalances.
Belke et al. (2017)	1999-2015	Correlation coefficients, a standard deviation of the output gap, beta	Core countries faced increased synchronization after 2007. Peripheral countries faced desynchronization regarding the core, non-EMU countries, and among themselves.
Guerini et al. (2019)	2000-2017	Random Matrix Theory approach	Increasing synchronization levels reached their peak in the 2008 crisis. After that, levels have recovered, but only to the levels of the early 2000s. Differences in levels were divided between the east-west axis at the beginning of the 2000s, but they evolved to differences between the south and north after the 2008 crisis.

3.2 Is there a European business cycle?

European development concerning business cycle movements should also be checked through international lenses. If there is business cycle synchronization in the euro area, European cycles should be shifted from the cycles of other countries in the world. There should be a so-called European business cycle. Artis and Zhang (1997) were one of the firsts to examine this issue. They argue, that countries that were members of the ERM moved closer to the German business cycle while moving away from the American cycle during the ERM. They argue that growing trade links between the European countries bolster this. On the other hand, Artis (2005) argues that there is evidence of an emerging global business cycle, which means that patterns in Europe could also be affected by the global pattern of synchronization.

Gayer (2007) finds evidence that the European business cycle synchronization might have increased due to the movements in the global cycle since the 2000s, for example, common global shocks such as internet-boom. Still, there is plenty of evidence that the euro-area synchronization has been distinctly European – the European cycle has been changing between desynchronization and synchronization compared to other areas. Gayer's research does not support the argument that increased synchronization in Europe would be completely by-product of globalization. From the late 1980s to the late 1990s, the synchronization in the euro area was higher than what the global levels were. Global synchronization rose steeply from the mid-1990s, reaching almost European levels, but after that, the European cycles have been significantly closer together than cycles at the global level. (Gayer 2007, 24-26.)

De Grauwe and Yi (2016) argue, too, that correlation of business cycles is smaller outside the euro area. Still, it appears that they often reach correlation levels of 0.6 in the groups of industrialized nations and are quite synchronized. They explain this high level of global synchronization with international trade. Shocks spread across the globe through trade – this leads to idiosyncratic shocks that might spread to other countries and increase synchronization.

3.3 Anomalies between theory and empirical studies

There are at least two anomalies between economic theory and empirical results concerning business cycle synchronization research. First, real-world levels of synchronization are hard to replicate with macroeconomic models. Backhus (1992) was the first to point out this problem when his open economy versions of real business cycle models failed to reach the levels of real-world synchronization and could not explain it. Later Alpanda and Aysun (2014) found out that open economy DSGE models face the same problem. De Grauwe and Yi (2016) argue that these problems could be solved by introducing exogenic shocks to the models. They add that this would not, of course, be a satisfactory solution because this would mean that the reason for high synchronization would be outside of the current models. Alpanda and Aysun (2014) introduce banks to their model to solve the anomaly between theory and empirical studies. Their simulations have large spill-over effects, which underline the role of frictions in international financial contracts for depicting more accurately the levels of business cycle synchronization across countries. Still, De Grauwe and Yi (2016) argue that too heavy weight is put on the exogenous financial shocks.

De Grauwe and Yi (2016) have built a behavioral model for solving the matter for endogenous reasons. In their model, agents cannot form rational expectations, and instead of that, they use heuristic ways to choose their decisions. In the model, waves of optimism and pessimism follow each other like "*animal spirits*." These waves arise because economic forecasts fulfill themselves and lead to booms and busts. In their two-country model, this creates an endogenous explanation for cross-country synchronization. These animal spirits are their main explaining factor in international business cycle correlation.

According to De Grauwe and Yi, monetary unions matter. They find that synchronization is stronger among the countries that belong to a common currency union. That occurs because central banks impose the common interest rate for all countries belonging to that monetary union – this transmits the animal spirits across the union. In addition, they argue that the degree of synchronization is affected by the strength of the stability policy. When central banks aim to stabilize the output with strong action, they "*tame the animal spirits*" and reduce the propagation dynamics. (De Grauwe & Yi, 2016.)

Another anomaly concerns price variability, which Backus, Kehoe, and Kydland discovered. According to their study, changes in the trade balance are far smaller than what has been found empirically from the US data. Also, investments and working hours

are not as correlated as the theory explains. According to theory, investments and employment should correlate with each other mildly negatively, but data suggests a mild positive correlation. (Backus et al. 1993, 28.)

3.4 Conclusions from the literature

Literature on the similarity of shocks and cycles in the euro area is diverse. The literature agrees on most developments in the synchronization of the euro area business cycles, but there are no conclusive answers to all of the questions. Most of the studies researching this topic have been published after the introduction of the euro and after the financial crisis. Many studies focus on observing these events and their results. Most studies examine the issue with indexes built upon correlations of the cyclical components. Other branches of studies have used, for example, multivariate Markov-switching models and dynamic factor models.

On the whole, studies conclude that there has been a trend of increasing synchronization since the introduction of the euro until the preceding years of the financial crisis. Many studies argue that the trend started far before the introduction of the euro. Massmann and Mitchell (2003) claim that the trend begins in the 1990s, and Altavista (2004) dates the beginning to 1992 of the Maastricht Treaty. Camacho et al. (2006) have the same kind of results, and they argue that most of the synchronization happened before the euro. Gächter et al. (2012) and Guerini et al. (2019) conclude that the trend of synchronization ended a little before the financial crisis, and the same levels have not been reached after that.

Various studies find country clusters from the euro area, and most of them argue that the old euro area countries are more linked together than the new ones (Camacho et al., 2006). Guerini et al. (2019) argue that the formation of the clusters has changed during the new millennium. They argue that due to structural reforms, the polarization between the west and the east has changed during the years to the polarization of the Northern and the Southern Europe. Belke et al. (2017) and Konstantakopolou and Tsionas (2011) also claim that the periphery has been left behind. Konstantakopolou and Tsionas argue that there has been no synchronization for the periphery countries, but only to the core. Common policies have not been equally working for everybody. This surge in synchronization is problematic for the European Union, and it implies that there should be adjustments in local policies to reach the euro area cycle.

Many earlier studies have included only a small batch of countries. Those countries have usually been the ones called today the core area. It is not surprising that these studies find the synchronization to be high and wide-ranging because the so-called periphery is not included in the studies. For example, Massmann and Mitchell (2003) have included only 12 countries in their study. Later studies containing larger amounts of countries have found that there might have been significant spatial differences in the synchronization levels.

Another interesting angle to this topic is to examine how the world cycle has affected the euro area's cycle. Artis (2005) argues that there is evidence of an emerging global business cycle, which means that patterns in Europe could also be affected by the global pattern of synchronization. According to Gayer (2007), this is not the case because the euro area has been significantly more synchronized from the late 1980s to the late 1990s than the global levels have been. After that, the European cycles have been significantly closer together than cycles at the global level. De Grauwe and Yi (2016) agree with Gayer (2007), and they state that the correlation of business cycles is smaller outside the euro area but still somewhat high between industrialized nations.

There are also anomalies between theory and empirical results, questioning whether there is room for improvements, in theory, research methods, or both. One of them is the problem that real-world levels of synchronization are hard to replicate with macroeconomic models.

4 Methods

4.1 Choosing methods

Methodological challenges are versatile in measuring the synchronization of business cycles. The first problem in identifying the magnitude of synchronization is measuring it between countries and groups of countries. Economies' nature to fluctuate has many features; peaks, amplitudes, periods, and phases are needed to account for – these are illustrated in figure 5. When two or more economies interact or are affected by the same external forces, they might synch into the same rhythm – this is called the synchronization of business cycles.

To analyze the optimality of a currency union, one should use adequate methods for measuring synchronization. Kamanduliéne and Lydeka have reviewed the methodological aspects of measuring business cycles, and they list the following tools for the estimation: correlation, concordance, Granger causality, and vector autoregression models (VAR). They argue that although there are many different tools, not one is perfect, and it is hard to argue which one is the best – everything depends on the objective. (Kamandulienė and Lydeka 2011, 40-45.)

Gouveia and Correia (2008, 7) have also examined different methods. They argue that the versatility of the different methods is one of the key explanations for different results in studies focusing on synchronization. They list at least the following methods that have been used in the last decade: coherence and concordance measures based on business cycle dating algorithms, dynamic factor models, dynamic correlations, rolling coefficients, correlation coefficients, and wavelet analysis.

Kamandulienė and Lydeka (2011, 47) argue that the correlation coefficient and concordance are the most widely used methods. In this case, the correlation coefficient measures if cycles have common phases: it describes the similarity of those phases with one value. On the other hand, concordance can refer to the concordance index, such as in Harding and Pagan's study in 2002. This index aims to evaluate how long countries' business cycles are in the same phase. According to Belo (2001, 5-6), these measures can also be used, but they give mostly the same results as correlation-type measures. The statistical approach of the correlation measure smoothens the change in time, and some evidence will be lost. The same happens with the concordance measure – both measures are static and do not consider dynamic changes. Kamanduliéne and Lydeka (2011, 47)

point out that most of the most common tools have the same problem. All in all, Belo (2001, 5-6) argues that using these methods can provide an accurate picture of business cycle synchronization, and they are used widely to measure business cycles.

The fact that the correlation coefficient gives one easily comparable number is a relevant feature because comparing country-specific cycles is needed. It is also a relatively user-friendly tool. I choose it as the method of this thesis for these reasons.

Some other issues need to be considered when choosing the correlation coefficient as a method in business cycle research. Belke et al. (2017) have focused on an important issue in their studies. They point out that measuring the only correlation of the business cycles can be misleading. They argue that while the correlation of the cycles can be 1, the amplitudes of the cycles can be different, like on the left side of figure 5. In other words, the steepness of the other cycle can be much stronger, which means that the economy is soaring up or plummeting down stronger than the other – the elasticity of the other country to react to economic shocks is higher. That means that those two countries need different monetary policies to recover quickly. They argue that while the business cycles of the euro area are highly synchronized, the amplitudes differ a lot. Another method is needed alongside the correlation coefficient. I have chosen a dispersion measure to patch the shortcomings of the correlation coefficient. It is a scale-dependent measure and is less suited to measure synchronization itself but suitable for this task.

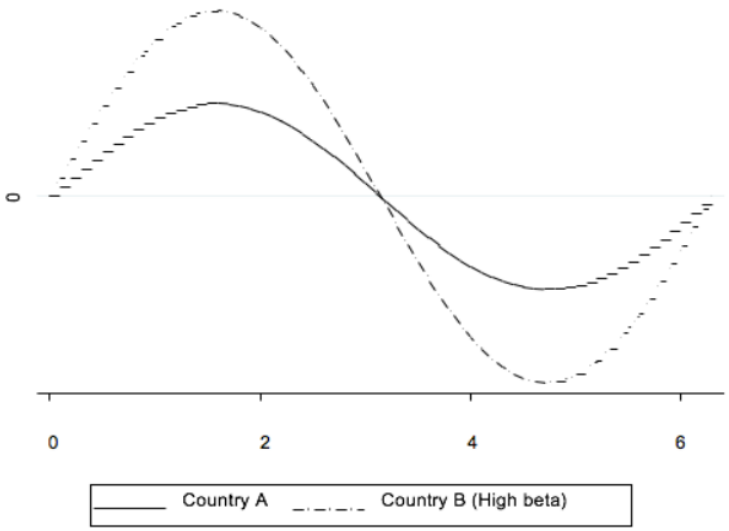

Figure 5: Problems in measuring business cycle synchronization. (Belke et al., 2017)

4.2 Data

The data used in this thesis is part of Eurostat's time series collection (Eurostat 2022). The chosen data covers the quarterly GDP data of chosen countries from Q1 1995 to Q4 2019. That data sample is chosen because it provides quarterly data long enough for this study. Twenty-five years of data is not long for business cycle studies but considering that the euro has been a currency since 1999, the sample is long enough. I have chosen to filter GDP data myself because there is no available quarterly business cycle data.

The selected countries are the original 12 countries that started to use the euro in 1999 (the Netherlands, Belgium, Spain, Ireland, Italy, Luxembourg, Austria, Greece, Portugal, France, Finland, and Germany) and the six others that joined later (Slovenia, Cyprus, Slovakia, Estonia, Latvia, and Lithuania). These countries are depicted in figure 6. Unfortunately, the Maltese data was incomplete, and I did not choose to include it in this thesis

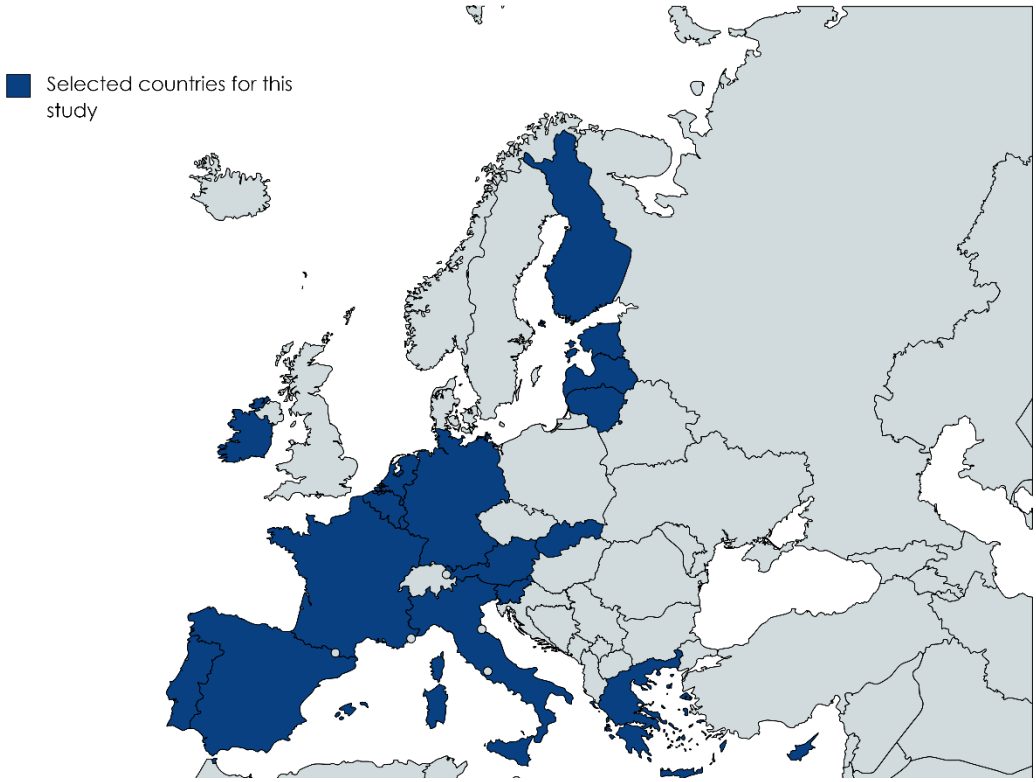

Figure 6: Selected countries for this study (author's figure)

4.3 Business cycles

In this thesis, the Hodrick-Prescott filter (later HP filter) decomposes GDP data into the business cycle and trend movement; figure 7 depicts the result. HP filter is not proven to depict real fluctuations in cycles and trends but is rather a statistical tool. It only approximates the movement of the two parameters: 1) the trend depicts the potential output, and 2) the cycle depicts the output gap as percentage deviations from the trend. Still, it is one of the best and most useful tools to approximate the movements of business cycles. The HP filter is more sensitive to longer-term than shorter-term fluctuations in the data, and smoothness depends on the chosen size of the smoothing parameter. In this thesis, I have used the smoothing parameter $\lambda = 1600$, which is common in business cycle studies when quarterly data is used. A higher value of λ implies a smoother trend and a cycle with more volatility. The filter itself was introduced in 1980 by Hodrick and Prescott (1980), and Belo (2001) formulated it into the following minimization problem. According to Belo, HP-filter defines a trend $\{Y_t^*\}$ from a series $\{Y_t\}$:

$$\min_{\{Y_t^*\}} \sum_{t=1}^{T}(Y_t - Y_t^*)^2 + \lambda \sum_{t=2}^{T-1}[(Y_{t+1}^* - Y_t^*) - (Y_t^* - Y_{t-1}^*)]^2 \qquad (5.)$$

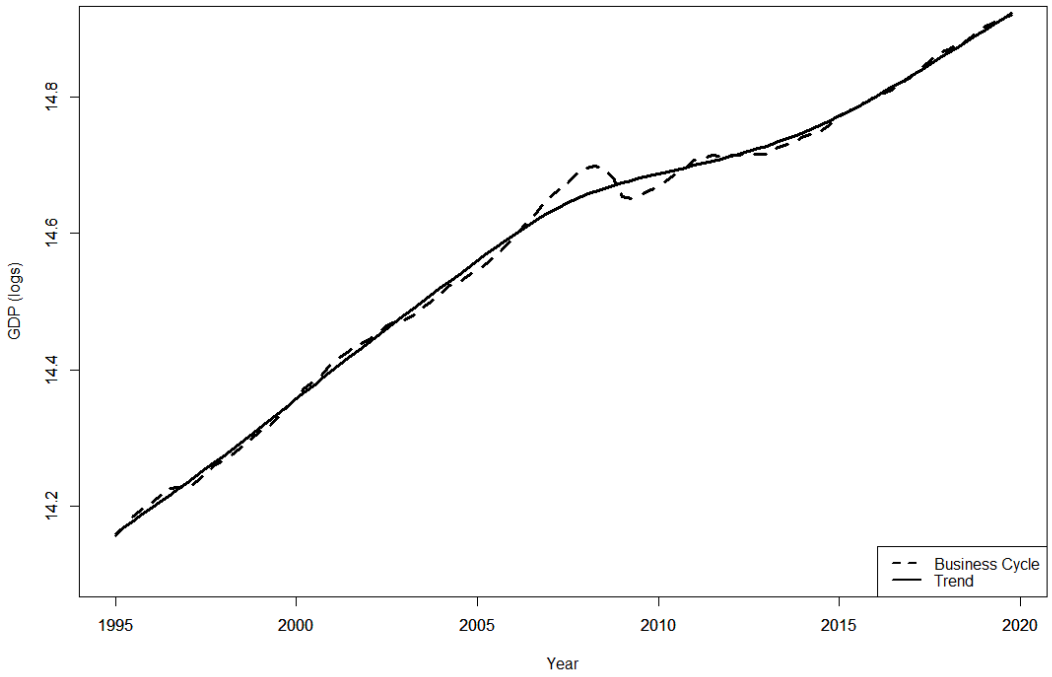

Figure 7: Decomposed cycle and trend of the euro area 1995-2020 (author's calculations)

HP filter has some problematic features due to its nature as a statistical tool. It is bound to make flawed approximations in the starting and ending points of the chosen data. Therefore, end and starting points should not be given too much weight when analyzing the data. Second, it cannot detect when output is below the potential level for the long term or even permanently. These situations might occur if a country or area faces a period of weak growth. In this situation, the HP filter would give flawed approximations of the cycle and underestimate the level of the output gap. (Belo 2001, 3-4.)

4.4 Dispersion measure

The convergence of the business cycles is an important factor for a monetary union. It means that member states of the monetary union are in the same phase of a cycle at the same time and move at the same pace. Convergence can be measured with various tools in macroeconomic research, for example, with a standard deviation of the output gaps. The standard deviation of the output gaps depicts how much the output gap data deviates from its mean. It is calculated by taking the square root out of its variance. The higher numbers the measure gives, the higher the deviation is. In the following formula, x_i displays the value of the i:th data point, $\bar{x}$ is the mean value, and n is the data points in the data set.

Output gap defines how far an economy is from its potential production – the number can be positive or negative. The euro area output gaps were calculated by subtracting the trend from the cyclical component of the GDP. In this occasion, the logarithm of the GDP estimate works as the "trend" and the logarithm of the filtered GDP series as "cyclical component"

I have used the same kind of rolling window function as with the correlation coefficient – however, a 2-year window appeared to capture a sufficient amount of information without noise, whereas in the case of the correlation coefficient a longer window was needed.

$$\sqrt{\frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{(n-1)}} \qquad (6.)$$

Dispersion will be close to zero when economies have a similar output gap, which means a high level of convergence (Gayer 2007, 5). The closer the dispersion measure is zero, the better common monetary policy benefits all member states and the closer the cycles cluster to each other. However, Gayer (2007, 3) notes that this measure is scale dependent. It captures the degree of convergence well, but it is less optimal to determine if cycles have common periodicity or phases – it also disregards possible changes in amplitude. Gayer recommends a correlation coefficient, which provides adequate information on that issue.

4.5 Correlation coefficient

A correlation coefficient is one of the most used methods to measure business cycle synchronization. It can measure if cycles have common phases and give values that describe the similarity of those phases. The correlation coefficient can be measured with fixed-length windows that provide a continuous picture of the development of the correlation over time. The problematic part is choosing how long these rolling windows are. Longer windows can give a more accurate picture of the synchronization, and they can smooth out smaller, less significant changes that occur in shorter periods. On the other hand, too long windows can smooth out even the relevant medium-term changes.

I have chosen a 6-year rolling window for this study because it shows the large picture well without smoothing out all the smaller differences. A 6-year window is also a better choice than the longer ones because the length of the data is limited. In addition, Gayer (2007, 4) points out that:*" If the window is shorter than the mean length of the cycle itself, small phase shifts between otherwise identical cycles can lead to systematic, but artificial drops in the association measure at the turning points of the cycles*". Figure 8 shows the differences between the chosen length of a window. It is important to note that all three curves start from the year 1995 although the length of the window is different. This is because the used function uses less data at the beginning of the curves – in other words, they have been calculated with a shorter window.

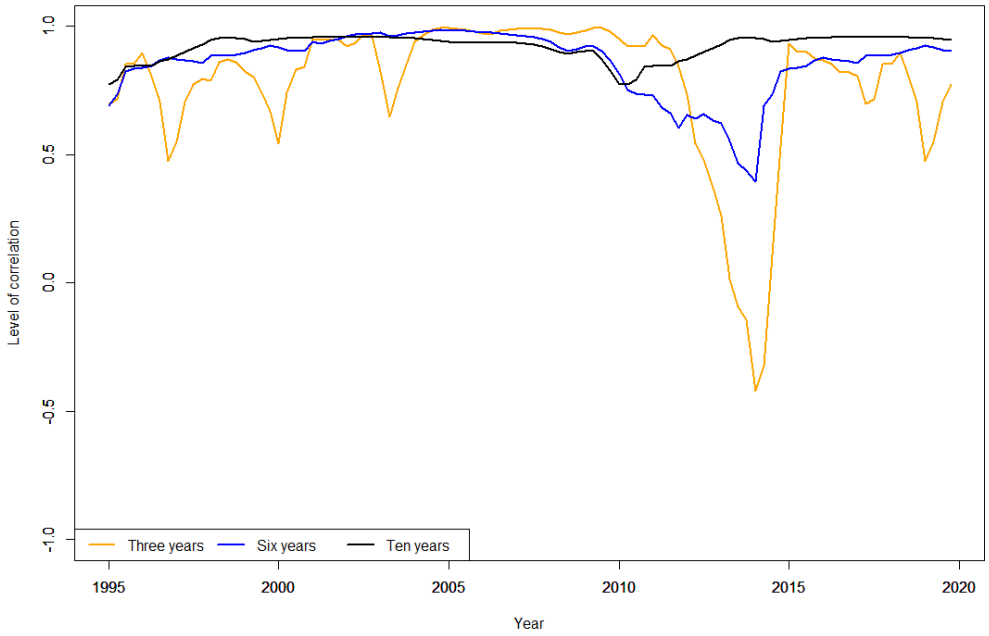

Figure 8: An example of how choosing the length of the window effects

The correlation coefficient refers to Pearson's correlation, which is stated below. It measures linear dependency between two variables. The coefficient has values between 1 and -1, with value 1 being an absolute correlation and -1 being an absolute negative correlation. The correlation coefficient is calculated by dividing the covariance by the variables' standard deviations. On the left side of the formula, r_{xy} is the correlation coefficient itself. On the other side, n expresses the amount of x_i and y_i, and $\bar{x}$ and $\bar{y}$ are the averages of the variables x and y.

$$r_{xy} = \frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2 \sum_{i=1}^{n}(y_i-\bar{y})^2}} \quad (7.)$$

But what level of synchronization can be considered strong or weak? Kamanduliéne and Lydeka (2011) have built an indicator to measure the strength of the measured synchronization, which can be seen in figure 9. Negative levels imply that the level of synchronization is inverse, and there is an inverse relationship. On the other hand, the larger the number, the stronger synchronization – the results near the value of 1,0 mean a very strong level of synchronization.

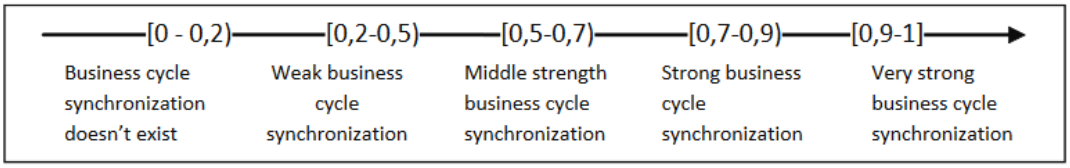

Figure 9: Levels of business cycle synchronization (Kamanduliéne & Lydeka, 2011)

5 Results

5.1 Overview

Since the forming of the EMU, the euro area has officially faced three recession periods, according to Eurostat (2020). The first and second ones were the financial crisis from Q1 2008 to Q2 2009 and from Q3 2011 to Q1 2013. The third one was the beginning of the coronavirus pandemic in Q4 2019. These periods can be spotted clearly in figure 10, which depicts the common business cycle of the euro area countries between 1995 and 2020. The recession of the early 2000s can also be spotted; it lasted from Q4 2000 to Q2 2003 (Gayer 2007, 10). The slowdown at the beginning of the figure is not officially a recession.

The 2008 crisis stands out clearly from the cycle, and it is one of the most important periods to examine from the future figures. Observing the common business cycle is important because it depicts the large picture of the financial situation in the area. Although countries can face recessions alone, they are usually triggered by events reflected in a larger area.

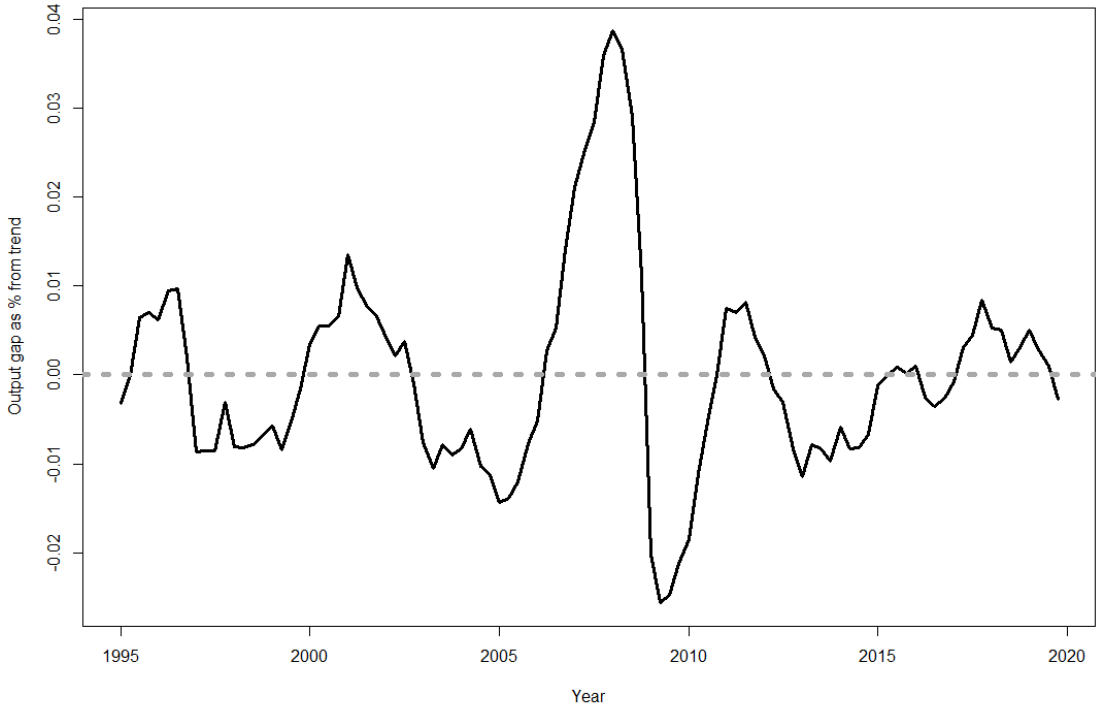

Figure 10: Common business cycle of the euro area countries 1995-2020 (author's calculations)

5.2 Dispersion results

This section evaluates dispersion rates of output gaps in the euro area from Q1 1995 to Q4 2019. The standard deviation of output gaps is used in this thesis to indicate the trend of economic convergence in the euro area. A low standard deviation means that the economy is near its potential output. On the other hand, a high dispersion rate means that the economy faces a boom or bust and has a large positive or negative output gap. When focusing on the dispersion rate of the whole euro area, a low dispersion rate means that the overall area is facing a low dispersion rate on the average – although there might be countries that deviate from the average.

Figure 11 presents two different lines that illustrate how the standard deviation of the output gap has fluctuated – in other words, these are the dispersion rates of two different areas. The black line presents the overall euro area dispersion rate, while the blue is the dispersion rate of the four largest economies: Germany, France, Spain, and Italy. We can see from these graphs that the average level of dispersion was between around 0,02 and 0,04 percentage points of GDP in 1995-2005, but at significantly lower levels after the financial crisis. The dispersion has also reached historically low levels just before and after the crisis.

When the dispersion measure is closer to zero, most of the euro area member states face similar output gaps, which could indicate a high level of convergence. It is important to note that the lower level of dispersion after the financial crisis does not necessarily mean that business cycles are in the same phase. The lower level can also mean that the amplitudes of the cycles are generally lower. Still, they might point in a different direction – other countries might be facing a small recovery and others mild recession. In this case, a smaller dispersion rate would not mean a higher synchronization level. Many conclusions cannot be drawn only from these results – we need to compare them to correlation values first.

Changing levels of convergence can be linked with business cycle movements - this can also be seen when comparing figures 10 and 11. The level of convergence increased in the downturn of the early 2000s and recession periods of Q1 2008 to Q2 2009 and Q3 2011 to Q1 2013. Figure 11 also shows the difference between the dispersion rate of the 19 euro area countries and the four largest economies measured with GDP. The dispersion levels of the four largest are a bit lower in both periods around the financial crisis but reach quite similar levels in the crisis period. That might mean that larger economies have

a smaller standard deviation of their output gaps. Reasons for this might be multiple, but part of the reason is that larger economies' cycles are usually more stable due to their size and a variety of industries – they are not so vulnerable to common or idiosyncratic shocks. They also usually have large markets within their borders.

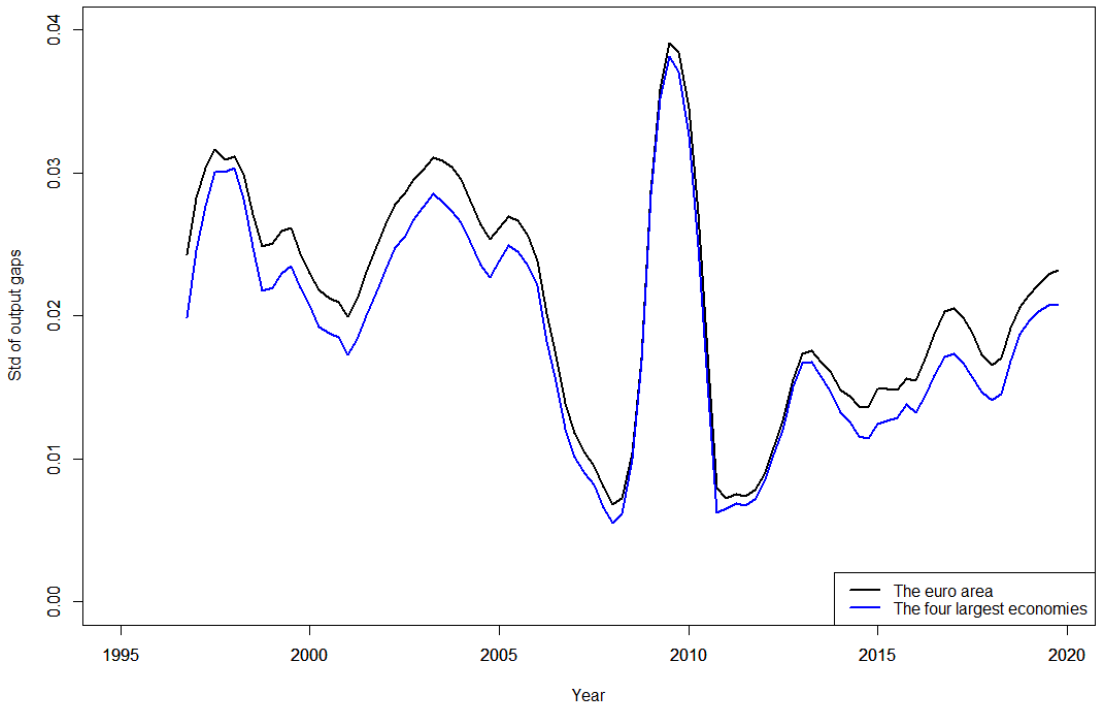

Figure 11: Standard deviation of the euro area's output gaps, 1995-2020 (author's calculations)

Moving on, figure 12 presents country-specific levels of dispersion in the euro area. From this graph, we can see how large output gaps different countries have had during each period. Core countries and periphery can be separated partly according to their graphs. Figure 12 is in line with figure 11 because smaller economies have higher dispersion rates than larger ones – for example, the Baltics. Before the country-specific evaluations, it is important to note that many of these countries have joined the euro area in different periods.

Slovakia, Ireland, and the Baltics stand out clearly with large dispersion rates. The case of the Baltics is interesting because after they joined the euro area in the 2010s, their rates decreased significantly. Estonia was the first to join in 2011. Slovakia's rates have the same trend – it joined the euro area in 2009.

All the other countries have had a higher average level of dispersion before the 2008 crisis, but not Ireland. Ireland reached low rates between 2007 and 2012, but its rate soared after that. Ireland is the only country in the chosen group with a significantly increased rate after joining the euro area, which they did in 1999.

Core countries like Germany, France, Belgium, and the Netherlands have low rates, but on the other hand, larger periphery states such as Spain are at almost the same levels, at least after the financial crisis. Luxembourg can be seen as an exception because it is a small country with a highly concentrated financial sector.

The financial crisis stands out clearly from the graphs. It is interesting to note that Greece has one of the smallest output gaps in the middle of the crisis. The Baltics, Luxembourg, and Slovakia have the largest gaps, and the rest have similar ones. Many countries have a decreasing average dispersion rate trend, with Ireland as the only exception. Ireland's large dispersion numbers might partly be the result of its nature as a home country for many international businesses in Europe.

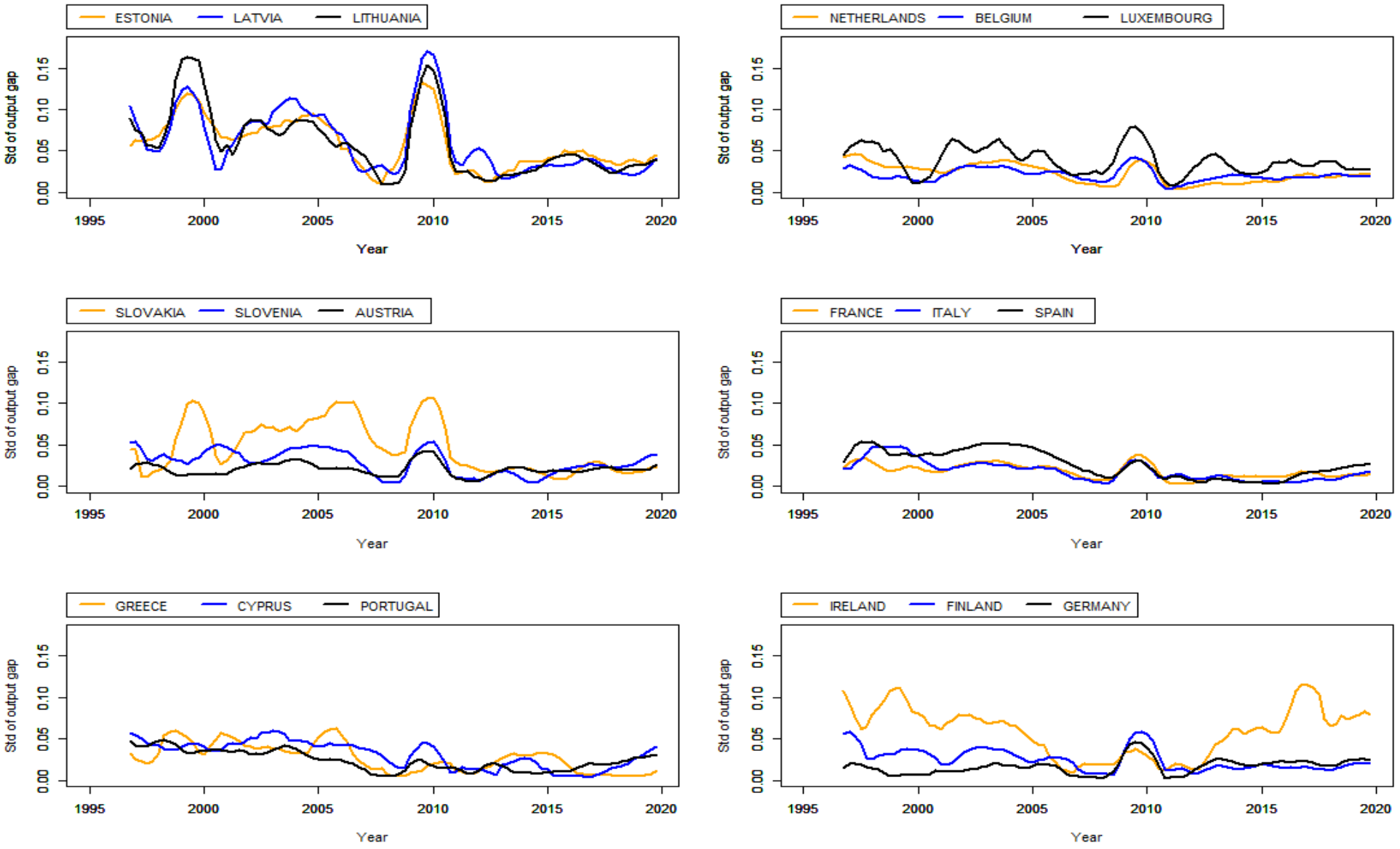

Figure 12: Standard deviation of individual countries' output gaps (author's calculations)

5.3 Correlation results

This section evaluates the trends of the business cycle correlation in the euro area from Q1 1995 to Q4 2019. Figure 13 describes the euro area mean correlations with GDP-weighted and unweighted versions. One can spot three trends. First is the rising correlation trend from the 1990s to 2002, when the correlation peaked in 2002-2003. After that, the trend is downward until 2011-2012, where the trend takes an upward path again until the end of the whole time series.

Again, if one compares the results with the euro area business cycle, one can spot some links between them, though not as clearly as with the dispersion measure. If one looks at the recession periods of the early 2002s and Q1 2008 to Q2 2009, and Q3 2011 to Q1 2013, one can spot that these periods have a slightly higher correlation than those around them. What is more interesting is that a downward trend follows all these periods. That means that countries have faced recessions with higher synchronicity than recovery periods. That is a good thing and a bad thing. It is good that countries have had a higher correlation during recession periods because a similar monetary policy is more appropriate for them – this helps to get out of a recession. The bad thing is that countries have not had the same ability to recover, which poses problems to the central bank's monetary policy. That might be a vicious cycle: if only one or a few countries have not recovered while the others have, the central bank does not have other options than to raise the interest rates. That makes it harder for those countries that are still recovering to continue because higher interest rates are cooling their economy.

In the period chosen for this thesis, there are two periods when the average level of correlation has been consistently increasing, 1995-2003 and 2014-2019. A rise in the average correlation could be evidence of an increasing level of synchronization. But it could also be evidence of the widening distribution of the correlation coefficients. In figure 14 can be seen that this is not the case. Almost all countries see their correlation rising in the first period, but this is not the case in the second wave of increasing correlation from 2015 onwards. A group of countries drives higher average levels of synchronization, but all of them are not at the same pace.

Overall, in the weighted data, the average levels of correlation are middle strength but not strong in the whole period of 1999-2019. According to Kamanduliéne and Lydeka (2011), a correlation over 0,7 means strong synchronization, and a level over 0,9 means a very strong correlation. Strong levels were reached only for a moment at the beginning

of the 2000s. On the other hand, middle strength levels bottomed after the 2008 crisis and the European debt crisis. After the recovery from the financial crisis, the 0,7 level was reached again around 2016-2017, 8 years after the crisis. The first half of the 2010s was not a strong period for synchronization levels.

What comes to data in figure 13 that is not weighted, we can see a clear difference. Because the data is weighted with each country's GDP, unweighted data represents smaller countries as relatively stronger. We can see that the average correlation level is lower when the weighing has not been done. Beyond that, downward and upward trends are steeper, and the trends spotted in weighted data are stronger in unweighted data. That means that smaller countries are relatively less synchronized than larger countries. Smaller countries might have also felt economic shocks and fluctuations stronger than larger countries. According to unweighted data, synchronization had even weak levels in 2014-2015. That is due to some smaller countries (f.ex, Greece) having even negative levels of correlation at that time. According to only this graph, there is not much evidence of increased synchronization after the introduction of the euro.

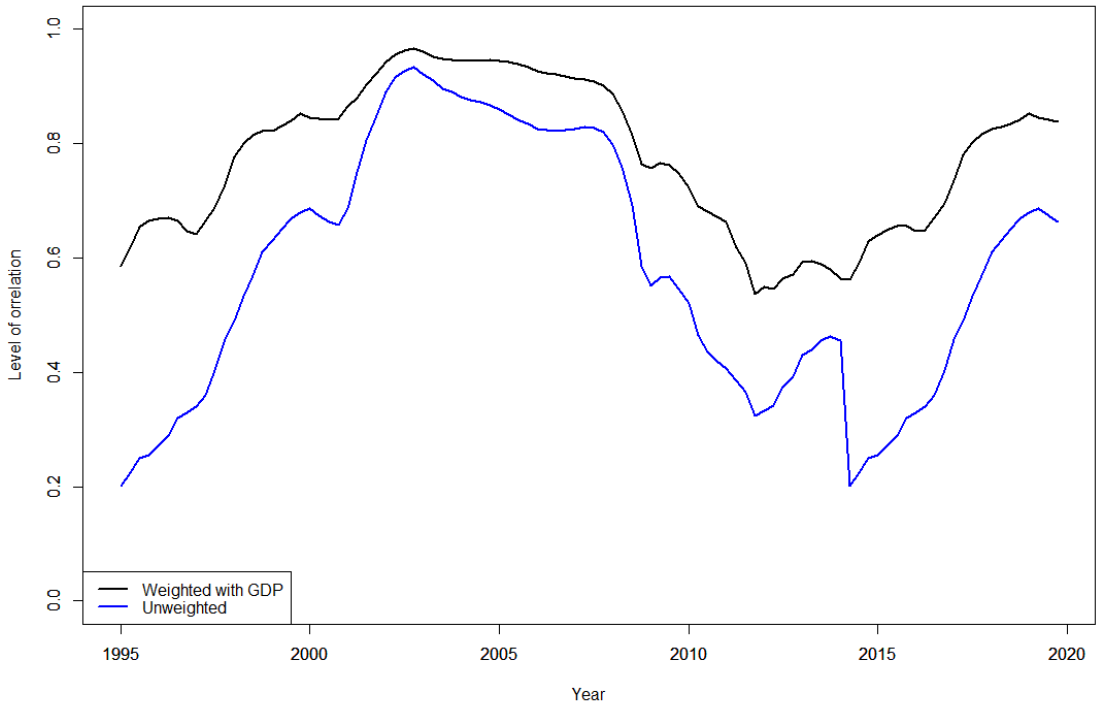

Figure 13: Mean level of business cycle correlation in the euro area 1995-2019 (author's calculations)

Moving on, figure 14 presents individual country correlations. With this kind of specific data, we can spot which countries form country groups and might have their own direction. There are at least a few country groups that we can spot from the data. First, the largest economies have the highest overall correlations. These economies are Germany, France, Italy, and Spain. At least Austria, the Netherlands, and Belgium follow this group with similar shaped correlation levels. That is no coincidence because five of these seven countries formed the European Coal and Steel Community after World War II with Luxembourg. France, Germany, Netherlands, and Belgium have the same-shaped downward gentle bump beginning from the 2008 crisis but reach very strong correlation levels overall. Even their deepest levels can be kept mostly as rather well correlated with the euro area cycle. It is important to note that Italy faces a steep downward bump after 2014, which lasts for a couple of years. The reason for this is probably that Italy was in a far graver situation during the period of the euro crisis.

Greece is its own case in comparison with the others. It seems that it has reached high levels of correlation only in 2003 and 2012-2013. Greece has an even correlation level of nearly -1, which indicates a negative correlation. Greece is a complete outlier.

The Baltic countries form a rather coherent group of countries. Their level of correlation grew persistently until 2002 when it reached nearly 1. Correlation stays at these levels until the financial crisis, and after that, it stays at around -0,5 until 2017, when a new steep rise happens – although Latvia's rise starts earlier and is less steep. One can notice a small upward bump in 2013, the same as in Finland. Finland's correlation pattern is quite similar to Baltic Countries', but it has stayed overall at higher levels.

If we look again at the recession periods of the early 2002s and Q1 2008 to Q2 2009, and Q3 2011 to Q1 2013, we can notice country-specific differences. The financial crisis was not a large de-synchronizing event in many countries, but the later period after it was. We can see that many countries kept quite a high level of correlation with the euro area cycle in 2008, except for Spain, Greece, Portugal, and countries from Eastern Europe. That might indicate that these countries faced the crisis at a different pace – it is not a surprise that just these countries have had different patterns because especially Spain, Greece, and Portugal were those countries that were in the largest trouble due to their high levels of debt. Greece is the most unfortunate example of them all.

The 1990s were also an eventful time for European countries due to the unification of Germany and the collapse of the Soviet Union. There were also financial crises at the time, for example, in Sweden and Finland. The recession periods in certain countries at

the beginning of the 1990s might have led to decreasing trend of correlation, but that changed later, which can also be seen in the data of this thesis.

What is more interesting is that the largest changes in the whole graph happen after the financial crisis. Many countries face even negative correlation in comparison with the euro area cycle. Greece, The Baltics, and Slovenia have a long negative period, followed by a little less negative period in Ireland, Italy, and Slovakia, and a smaller but steep bump in Luxembourg's cycle. That might be because those different countries recovered from the crisis at a different pace. Duvall and Elmeskov (2006) argue that structural rigidities can hinder recovery from recession. That might be one reason for these countries' slower recovery. Until this day, Greece has not reached even positive levels of correlation.

Further structural reforms could be in place to enhance the euro area's ability to narrow the distribution of adjustment speed. That could enhance the EU's ability to recover from economic shocks faster and better. One reason could also be a lack of fiscal support for the economy because a significant part of public revenues goes to paying interest and debt.

Something interesting happens in the curves of a few countries in 2014 – the reason for this might be that most of the EU countries faced a decrease in their GDP – it was a time of debt issues too. That year, Slovenia, Italy, and Greece faced an abrupt fall in their correlation levels. On the other hand, the curves of Germany, France, Luxembourg, and Ireland start to grow. Figure 13 depicts that the unweighted curve faces the fall, but the weighted curve goes in a different direction. That is the same case as in the financial crisis: the more vulnerable countries see their economy falling faster, and thus their correlation also falls. Most countries have a rising correlation level at the end of the observed period. Most countries reach at least a positive correlation level of 0,5, with Greece and Slovenia as exceptions.

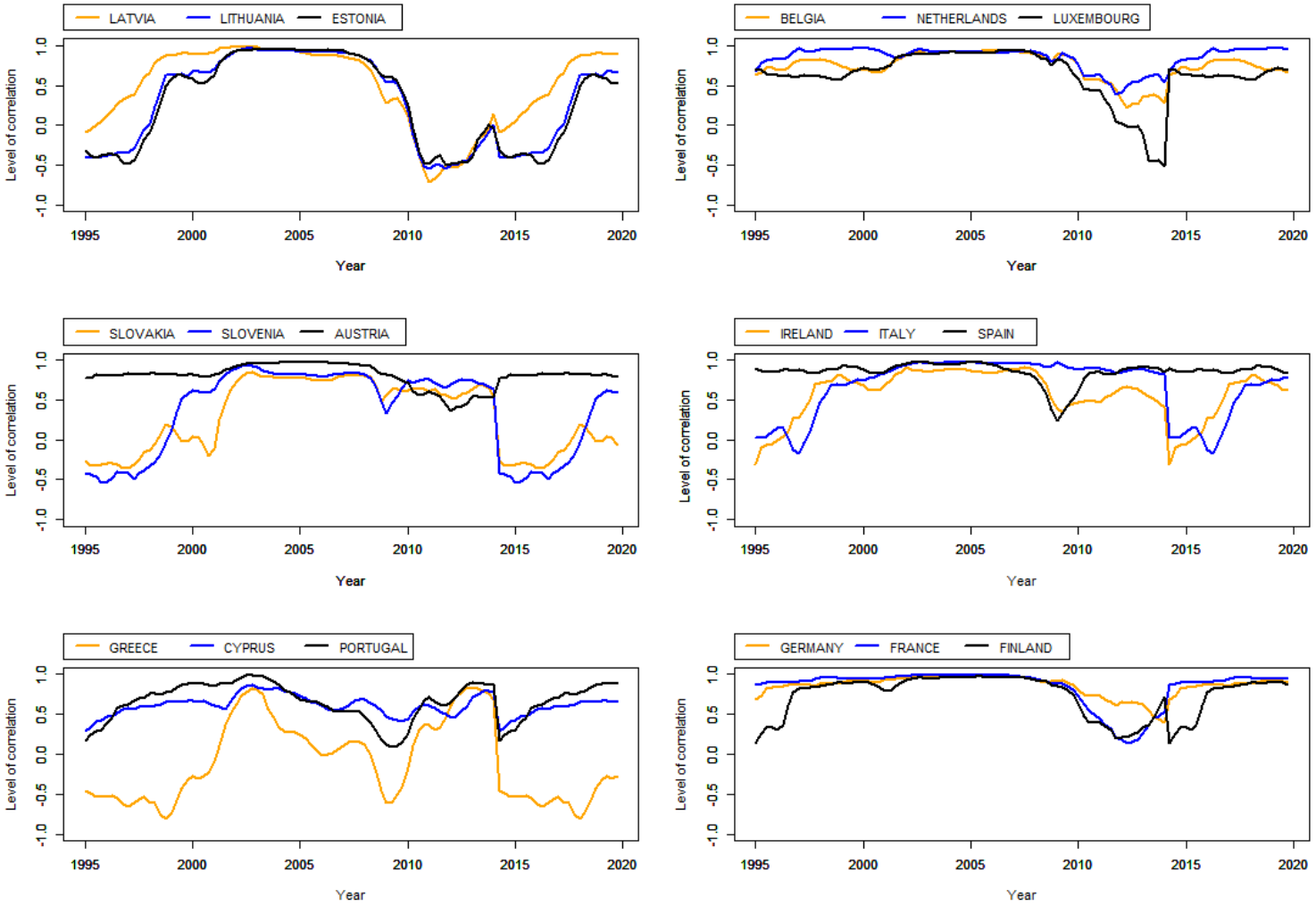

Figure 14: Individual countries' business cycles correlations with a 6-year window (author's calculations)

5.4 Summary of the results

The euro area has faced powerful events during its existence. These events can be pointed out in the GDP growth data, the dispersion measure, and the correlation coefficient graphs. The financial crisis was an unexpected event that changed the euro area's economic situation and decreased synchronization for years. Still, after the crisis, the area has recovered and seen years of increasing levels of synchronization. The level has almost reached the pre-crisis levels. Overall, the average level of correlation has been strong, except for the 2008 crisis and the short periods around it. It is important to note that decreasing correlation started years before the crisis, although as a milder trend at first. Before that, the euro area reached even very strong numbers between 2000-2005, having almost a correlation of 0,9-1.

The euro area has also seen decreasing levels in the dispersion measure since the beginning, although the 2008 crisis is a deviation from the trend. However, the observed trend might not necessarily mean that euro countries' cycles are increasingly at the same pace but that amplitudes have decreased, which means that fluctuations are less vigorous today. All countries except Ireland have had somewhat similar levels of dispersion after the 2008 crisis.

The results indicate that the member states have had higher overall synchronicity during downturns of the economy. This is an important measurement because, in an optimal currency area, the shocks are common, and the central bank can adjust its monetary policy according to the situation. If the characteristics of the shocks would be more idiosyncratic, that would be a problem for the common monetary policy.

However, the results also indicate differences in the abilities of different countries to recover from economic downturns. This argument is based on the observation that the overall correlation levels of the euro area countries face the largest falls in the aftermath of the downturns. Many countries that have shown a poorer ability for recovery have often suffered the most from the 2008 crisis, with Greece as an obvious example. Differences in the pace of the recovery are a problem for common monetary policy.

Duval and Elmeskov (2006) have argued that smaller and more open economies have a better ability to recover from crises faster because they can accommodate endogenously through changes in competitiveness – in other words, they can pass reforms faster and more efficiently. On the other hand, larger countries are slower to make large reforms and might have a slower recovery speed. My results are not fully aligned with their argument

– many smaller countries have had slower recovery processes than larger ones. On the other hand, other reasons might explain this difference. Many of these smaller countries are the ones that had increased levels of debt after the crisis, and this has limited their ability to recover. There might also be additional reasons, such as political and institutional ones.

There are also loose country groups that can be spotted from the data. Central European countries show mostly stronger levels of correlation overall, and the so-called periphery deviates a lot. As a rule of thumb, larger and more stable countries face smaller deviations than smaller and more vulnerable countries.

6 Conclusions

This thesis focuses on business cycle synchronization in the euro area from the perspective of the similarity of shocks and cycles. The similarity of shocks and cycles is one of the key conditions for optimal currency areas and thus is a relevant perspective for this topic. In the empirical part of this study, I have studied this topic with two relevant tools: the correlation coefficient of the business cycles and the standard deviation of the euro area output gaps. These tools can identify the levels and changes in the synchronization of the euro area business cycles. I have examined how the cycles have developed and how similarly the shocks have affected different countries.

According to the earlier studies, there has been a rising level of business cycle synchronization in the euro area since the 1960s or at least from the 1990s. Of course, short-term deviations have happened from time to time in between. After the introduction of the euro, there have been some deviations too. The level of correlation dropped before the 2008 crisis and has not reached the highest earlier levels since. In addition, countries have had differences in their abilities to recover from a crisis. Some authors have argued that the polarization between the west and the east has changed during the years to the polarization of the Northern and the Southern Europe. Some even argue that the periphery has not faced synchronization during the 2000s.

I have studied the problem by observing the correlation and dispersion rates from the country-specific and the euro area levels. By observing single countries' cycles and other variables, I have spotted which countries have influenced the common synchronization levels and in which direction. The question of a different pace of recovery has also occurred after the 2008 crisis. When many countries faced a decrease in their GDP:s, especially peripheral countries recovered slower. This observation signs that there is still room for structural reforms in the euro area. These reforms should develop the countries' resilience to recover from the negative shocks faster, and because of that bring the cluster of cycles faster than before. That would make it possible for more countries to enjoy the benefits of monetary policy appropriate for them.

According to my results, the synchronization level in the euro area was already at high levels when the euro was introduced, and the trend of synchronization started before, probably before the examined period of 1995-2020. After the peak of 2003, a trend of mild de-synchronization started and lasted until the recovery period of the 2008 crisis. My results indicate that while the business cycle synchronization has been increasing at

the euro area level since the recovery of the financial crisis, the level did not reach the earlier top level in Q4 2019. Still, it is significant to note that the overall trend in the chosen period has been towards somewhat strong synchronization – the 2008 crisis and recovery after that is an exception in the large picture. There is also evidence, that the amplitudes are lower after the financial crisis than before it.

In addition, an interesting observation in the synchronicity levels is the euro area's feature to have higher synchronicity during downturns, although this is sometimes a relatively mild phenomenon. This is a positive feature concerning the common monetary policy. If the countries of the euro area face shocks with the same magnitude, they all benefit from the same kind of monetary policy. If there would be a lot of idiosyncratic shocks, those countries facing the shocks differently would gain extra challenges from the suboptimal monetary policy.

But why has the euro area not reached as high levels of synchronization as before? According to country-specific data, some countries drag the overall correlation level down. Economies have been growing at different rates. The currency area has not worked as well for everyone. Still, it is important to note, that the EU and the euro area faced many economic and non-economic domestic and foreign policy-related problems in the 2010s, such as increasing debt levels in many countries. These problems should be addressed with more determination. Interest expenses of debt will be a serious problem for indebted countries, which weakens their ability for fiscal support.

Shared EU-level debt could be one way to solve part of the current problems, as well as building EU-level ways to collect common funds – this is sometimes called "*EU's own resources*." However, the ultimate responsibility for the stability of the euro area is in the end in hands of the individual countries – no number of common structures can help, if the individual fiscal policy is reckless. In summary, in designing supporting mechanisms, attention should be paid also to incentives of the individual countries, so that the moral hazards could be avoided. One thing is sure: there will be crises also in the future, and resilience is needed to prepare for them. Crises have halted economic integration within the euro area before, and preparedness at the member state and the EU level mitigates future effects on the integration.

In Q4 2019, the euro area was very close to the very strong synchronization levels. Without the coronavirus pandemic, the euro area could have reached even higher levels in 2020. It will be interesting to see how synchronization developed during and after the

pandemic when the confirmed data is published. According to my results, the euro area mostly fulfills the optimal currency area criterion concerning the similarity of business cycles if the threshold for this is a correlation level of 0,5 or even 0,7 with the Kamanduliené-Lydeka scale. There are some country-specific exceptions to this, such as Greece, but it is early to say their future direction. Correlation is not alone a sufficient measure to come to this conclusion, but also dispersion measure supports the argument. Dispersion levels have mostly decreased in all countries after a bulge in 2008-2010, with Ireland as the most significant exception.

In the future, there are many ways to examine the topic even further. First, GDP can be divided into parts, so this kind of research could focus on which parts have been central in the euro area in synchronization development. Global perspective could also be taken as a path because the more globalized the world, the more cycles, and shocks of other countries affect the euro area. Another path could be observing the countries around the euro area; are there countries that could benefit from joining the area, and how close their cycles are with the euro area's cycle. Further research should, of course, aim to find more relevant policy options for the EU and its member states.

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Appendices

Appendix 1: GDP LN