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The Role of the Euro in Financial Crises: A Comparative Analysis of the Business Cycles between Eurozone and Non-Eurozone Countries

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## 1.1 Zusammenfassung

Diese Masterarbeit bietet eine umfassende Untersuchung der Optimal Currency Area (OCA) – Theorie und ihrer Anwendung auf den Euroraum, indem sie eine kritische Bestandsaufnahme der Literatur mit einer facettenreichen empirischen Bewertung der Synchronisation der Konjunkturzyklen verknüpft. Nachdem die Entwicklung der OCA-Konzepte von Mundells bahnbrechender Arbeit bis zu späteren Erweiterungen nachgezeichnet wurde, analysiert die Studie das institutionelle Gefüge des Euroraums, von den Maastricht-Konvergenzkriterien bis zu den sukzessiven Erweiterungen, und bewertet dessen Übereinstimmung mit klassischen OCA-Indikatoren.

Die empirische Strategie nutzt Kalman-Filter-Dekompositionen des vierteljährlichen BIP-Wachstums für den Euroraum 20 (EA20), länderübergreifende Dispersionsmaße, Leave-one-out-Analysen der Beiträge einzelner Mitgliedstaaten, dynamische Kern-Peripherie-Klassifikationen auf Basis rollierender HP-gefilterter Korrelationen sowie regionale Fallstudien der baltischen, nordischen und südosteuropäischen Beitrittsländer. Die Ergebnisse zeigen eine ausgeprägte strukturelle Abschwächung des Trendwachstums von etwa 2,4 % Ende der 1990er bis 1,4 % bis Q1 2025, begleitet von tiefen Produktionslücken in großen Krisen (–4,2 % in Q1 2009; –10,6 % in Q2 2020) und teilweisen Erholungen unter koordinierter Politik. Vierteljährliche und monatliche Dispersionsmuster zeigen eine Konvergenz Mitte der 1990er, krisenbedingte Divergenz und persistierend erhöhte Nachkrisen-Baselines, wobei gewichtete Maße in etwa halb so groß sind wie ungewichtete Werte. Leave-one-out-Ergebnisse identifizieren traditionelle Kernmitglieder als „Synchronisierer“ im ursprünglichen EA12, deren Einfluss im EA20 gleichmäßiger verteilt ist. Zeitvariierende Kern-Peripherie-Aufteilungen und rollierende Korrelationen verdeutlichen, dass die Angleichung an den Euroraum-Zyklus sich über mehrere Konjunkturzyklen hinweg vollzieht und nicht sofort mit dem Beitritt einsetzt. Fallstudien zu den baltischen Staaten, den nordischen Staaten und Kroatien veranschaulichen graduelle Konvergenzverläufe vor dem Hintergrund idiosynkratischer Schocks.

Drei Hypothesen zur Beziehung zwischen Euroraum-Mitgliedschaft (und Nichtmitgliedschaft) und Synchronisation nach Finanzkrisen und Euro-Einführung wurden deskriptiv getestet. Zwar deuten Tendenzen auf eine moderate Angleichung bei Mitgliedern und unterschiedliche Mitbewegungen bei Nichtmitgliedern hin, formale Inferenz bleibt jedoch aus, sodass die Nullhypothesen nicht verworfen werden können.

Die Arbeit betont die Notwendigkeit weiterer Forschung unter Verwendung ökonometrischer Identifikation, Panel-Daten-Modelle, reichhaltigerer Mikroindikatoren und Echtzeit-Hochfrequenzmetriken, um zu klären, wie Währungsunionen Konvergenz und Resilienz ausbalancieren.

## 1.2 Abstract

This thesis offers a comprehensive investigation of Optimal Currency Area (OCA) theory and its application to the Euro Area, integrating a critical survey of the literature with a multifaceted empirical assessment of business cycle synchronization. After tracing the evolution of OCA concepts from Mundell's seminal work through subsequent extensions, the study examines the Euro Area's institutional design, from the Maastricht convergence criteria to successive enlargements, and evaluates its alignment with classic OCA indicators.

The empirical strategy employs Kalman–filter decompositions of quarterly GDP growth for the Euro Area 20 (EA20), cross–country dispersion measures, leave–one–out analyses of member–state contributions, dynamic core–periphery classifications based on rolling HP–filtered correlations, and regional case studies of the Baltic, Nordic, and Southeastern European entrants. Results show a pronounced structural slowdown in trend growth, from roughly 2.4 % in the late 1990s to 1.4 % by 2025 Q1, alongside deep output gaps in major crises (–4.2 % in 2009 Q1; –10.6 % in 2020 Q2) and partial recoveries under coordinated policy. Quarterly and monthly dispersion patterns reveal mid–1990s convergence, crisis–induced divergence, and persistently elevated post–crisis baselines, with weighted measures approximately half the unweighted values. Leave–one–out findings identify traditional core members as "synchronizers" in the original Euro Area 12 (EA12), whose influence becomes more evenly distributed in the EA20. Time–varying core–periphery splits and rolling correlations highlight that alignment with the euro–area cycle unfolds over multiple business cycles rather than instantly upon accession. Case studies of the Baltics, Nordics, and Croatia illustrate gradual convergence trajectories amid idiosyncratic shocks.

Three hypotheses concerning the relationship between Eurozone membership (and non–membership) and synchronization after financial crises and euro adoption were tested descriptively. While tendencies suggest modest alignment for members and varied co–movement for non–members, formal inference remains elusive, and the null hypotheses cannot be rejected.

The thesis underscores the need for further research employing econometric identification, panel–data models, richer micro–level indicators, and real–time high–frequency metrics to clarify how currency unions balance convergence and resilience.

## 2. Introduction

A critical factor in the stability and the success of the Euro Area is the member states financial integration in the monetary union. A great measurement for this integration is the Business Cycle Synchronization (BCS) – the degree to which member states' economies fluctuate to each other. It is also important for the European Central Bank's (ECB) efficient crisis management intervention through its interest rate policy. However, different countries, depending on various factors, such as economic structure, openness to trade, and stage of integration have varying synchronization patterns overtime compared to the Euro Area (EA) average.

Thus, the research question of this thesis is the following: "How do the indicators of business cycle synchronisation correlate with the EA average over time?" highlighting times of economic shocks, comparing core and peripheral countries of the Euro Area and business cycles synchronization changes for new adopters of the Euro to explore synchronization patterns related to Euro Area membership.

To get a coherent answer to the research question, secondary data was collected from various external sources for analysis and was synthesized through desk research.

This thesis examines Business Cycle Synchronization in the European Union (EU) using both Euro Area and non-Euro Area countries data, analysing the evolution of the synchronization overtime and the factors that drive convergence and divergence using Gross Domestic Product (GDP) and its components and unemployment data. Understanding the Business Cycle Synchronization is crucial not only for assessing the current health of the Euro Area but also for informing potential candidates about the up- and downsides of joining the currency union and whether it is the right time to do so.

High Business Cycle Synchronization, in short, facilitates effective monetary policy, reduces asymmetric shocks effecting the members of an Optimal Currency Area (OCA), and strengthens the resilience of the currency union. However, persistent divergence in economic cycles between economies of the Euro Area has raised concerns about the long-term sustainability of the Euro Area as an optimal currency area for monetary policy intervention. Particularly, the sovereign debt crisis, and the global financial crisis of 2008 have exposed vulnerabilities regarding crisis management through ECB interest rates making the Euro Area not so much of an optimal currency area (Darvas & Szapáry, 2008; Gächter et al., 2012; Ryan & Loughlin, 2018; Hanus & Vácha, 2020; Arčabić et al., 2024)

Peripheral Euro Area countries, Greece, Italy and Spain experienced severe recessions, while other, core Euro Area countries, like Germany remained relatively stable. These disparities complicated the European Central Bank's monetary policy decisions, as recent evidence suggests as well, a "one-size-fits-all"[1] interest rate often proved inadequate (especially short-term) for economies in different phases of business cycle (Arčabić et. al, 2024). In response to this issue, the EU then has promoted structural reforms, greater fiscal coordination, and financial integration to enhance this synchronization (European Council, 2020).

The research measures longitudinal effects of the Business Cycle Synchronization across the Euro Area; analyses how economic integration correlates with convergence cycle patterns and the efficiency of policy interventions designed to enhance synchronization; and lastly it assesses the implications of current Business Cycle Synchronization levels for the Euro Area's future stability and institutional development.

The Euro Area represents one of the most ambitious economic, monetary and political integration projects in modern history, with its member states sharing a common currency, but maintaining diverse financial and economic structures. Since its establishment in 1999, the Euro Area has expanded persistently to include 20 member states of the European Union, fostering deeper financial integration and encouraging trade and investment across Europe. The stability that is provided by the Euro and the Euro Area is not only crucial for its member states but also for the global financial markets, considering the Euro's role as the second most held reserve currency (International Monetary Fund – IMF, n.d.; Ryan & Loughlin, 2018). However, the Euro Area had to overcome significant challenges since its foundation, including sovereign debt crises, asymmetric economic shocks, and different fiscal policies among its member states. These emerging issues have heightened the importance of a robust, well working bank supervision, that ensures financial stability.

The thesis is structured to systematically examine the Business Cycle Synchronization of Euro Area and non-Euro Area countries of the European Union, assessing the Euro Area as an Optimal Currency Area. The analysis begins by uncovering historical and theoretical foundations of the key ideas of monetary integration, then proceeds to evaluate the Euro Area's institutional and economic evolution since foundation, lastly it culminates in empirical testing

[1] The idea refers to the challenge of how a single central bank, the ECB, applies uniform monetary policies across an economically diverse Euro Area, despite their differing cyclical positions and structural characteristics.

of Business Cycle Synchronization trends and their policy relevance using Hodrick-Prescott, Baxter-King, and Kalman filters.

Concerning the build-up of the thesis, the third chapter establishes theoretical framework, tracing the intellectual and historical lineage of currency union theories and their applications in real world settings. Chapter 4 outlines the Maastricht treaty convergence criteria and the Euro Area's institutional framework with special focus on the European Central Bank and the Stability and Growth Pact. It then follows through the Euro Area's expansion from the original 11 members to the current 20, and analyses why some of the EU member states remain reluctant to join the Euro Area. Chapter 5 evaluates the Euro Area as an Optimal Currency Area, contrasting the theoretical ideals with real world performance of the currency union. It discusses the critiques that the Maastricht Treaty has received over the years on nominal convergence over real economic alignment and examines the gap in labour mobility and fiscal risk-sharing. Chapter 6 defines Business Cycle Synchronization and explores its importance for shock absorption in a currency union. It explores key factors that influence the synchronization of cycles (trade, financial integration, fiscal policy) and the endogeneity hypothesis, while analysing pre- and post-adoption effects and crisis impacts. Chapter 7 is about the empirical motivation of the research. It highlights key crises (2008 Global Financial Crisis, European Sovereign Debt Crisis, Crisis of the Covid-19 pandemic and the Crisis caused by the Russian-Ukrainian War) that exposed the Euro Area to asymmetric shocks. It also discovers the latest milestone in the history of Euro Area accession. This frames the urgency of studies around the Business Cycle Synchronization amid debates on fiscal reforms and future enlargement. Chapter 8 synthesizes relevant studies (e.g. Gächter et al. (2012) on core-periphery divides, Darvas & Szapáry (2008) on smaller regional convergence, Crespo-Cuaresma and Fernández-Amador (2013) on quantifying the fiscal and macroeconomic costs of admitting new member states, Hanus & Vácha (2020) on time-scale dependent synchronization, and Arčabić et al. (2024) on how the different methods used for measuring the output gap may yield different results), comparing methods and findings. The literature review reveals a significant research gap spanning from the period between post-2008 Global Financial Crisis studies and the most recent Euro Area accession. This temporal discontinuity in research affects the understanding of the evolution of the Optimal Currency Area dynamics in the Euro Area during expansion phases and it misses the institutional adaptation mechanisms employed by newer members during crisis periods. Chapter 9 details the data sources and justifies the models and methodology used for the empirical research. Chapter 10 presents the empirical results of the

analysis, highlighting how the business cycle synchronization with the EA average has evolved across countries over time. It identifies clusters of highly synchronized economies (e.g., core Euro Area members) and less synchronized outliers (e.g., the Baltic states), and interprets these findings in the context of Optimum Currency Area theory. Chapter 11 discusses broader policy implications, including the potential need for deeper fiscal integration, revisits the endogeneity hypothesis of OCA theory, and assesses the risks and challenges associated with future Euro Area enlargement. Chapter 12 summarizes key findings, answers the research question and acknowledges limitations. Lastly, future research directions are identified.

## 3. Theoretical framework

To get a coherent understanding of the research question above, secondary data was collected from external resources for analysation and synthesis via desk research. Key among these sources is the widely used textbook International Economics: Theory and Policy by Krugman, P. R., Obstfeld, M., and Melitz, M. J., which serves as a core reference in universities across numerous countries worldwide for understanding international economic principles. Additionally, the research builds on the research related to business cycle synchronization, particularly on the work of Darvas, Zs. and Szapáry, G. – Business cycle synchronization in the enlarged EU, Gächter, M., Riedl, A. and Ritzberger-Grünwald, D. – Business Cycle Synchronization in the Euro Area and the Impact of the Financial Crisis, Hanus, L. and Vácha, L. – Growth cycle synchronization of the Visegrad Four and the European Union, and Arčabić, V., Panovska, I., & Tica, J. – Business cycle synchronization and asymmetry in the European Union.

### 3.1 History Prior to the Optimal Currency Areas Theory

Originally, before the concept of the Optimal Currency Areas emerged from Mundell (1961), most countries maintained full control over their financial system, monetary policies and they also operated with their own currencies. Exchange rates to independent countries even to this day fluctuate based on trade, capital in- and outflows, and domestic economic conditions, requiring conversion of currency for international transactions. This system had both its advantages and disadvantages, since it allowed the adjustment of monetary policies on a national level to have a quick response to local shocks, however, international transactions were more costly, and it also induced exchange rate volatility.

The search for a system providing exchange rate stability predates modern monetary unions, as earlier systems already aimed to mitigate economic disruptions caused by the high levels of currency volatility. The classical Gold Standard system (1880-1913) pioneered this effort by pegging the currencies to gold, ensuring fixed exchange rates and promoting international trade (Eichengreen & Temin, 2010). However, the system proved to be excessively rigid, as it required strict monetary discipline and deflationary adjustments during imbalances and hence became unsustainable at the time of and post-World War I, as countries priority at this time lied in domestic recovery instead of gold parity.

In order to address the shortcomings of its predecessor, the Bretton Woods regime (1944-1973) emerged as a more flexible alternative after World War II. It established the gold backed US dollar, as the global reserve currency, with other currencies pegged to it within narrow bands. As a result, currencies included would move in unison, thereby reducing instability created by the exchange rate volatility and facilitating predictable trading and investment flows. The system aimed to combine stability with the countries keeping their policy autonomy, while allowing for occasional devaluations for fundamental imbalances. However, this also meant relinquishing independent control over interest rates, leaving them prone to being exposed to speculative attacks. Moreover, in case of imbalances in either of the economies the entire pegged system could be destabilized. Triggered by US inflation and gold shortages, the system finally collapsed in 1973, which demonstrated the vulnerability of pegged regimes under speculative pressures and conflicting national policies (Krugman et al., 2018, p.683).

The European Economic Community (EEC-6), responded to the failure of the Bretton Woods system by attempting to have a regional exchange rate coordination. The “Snake in the Tunnel” (1972-1979) was an initiative, launched by the Basel Agreement of 1972, where the member states agreed to limit the fluctuations between their currencies within tighter margins than against the dollar (European Parliamentary Research Service, 2015). While the initiative did reduce the intra-European volatility, it still required frequent realignments and was exposed similarly to the Bretton Woods system to speculative attacks. This highlighted challenges in the field of maintaining fixed rates because of the lack of fiscal or political integration.

The results of these experiments culminated in the European Monetary System (1979-1999). It introduced the Exchange Rate Mechanism to stabilize the currencies via adjustable pegs and the European Currency Unit to assist accounting and simplify settlements. The European Currency Unit, however, lacked the legal tender status in contrast to its later successor Euro (European Parliamentary Research Service, 2015). The Exchange Rate Mechanism was

successful at reducing short-term volatility, however, it faced recurring crises, as the semi-fixed structure was vulnerable to fluctuating inflation rates and volatile capital flows. The European Monetary System exposed a crucial factor, the need for deeper economic convergence between the member states. This became a lesson that directly connects to the Optimal Currency Area theory, and which later paved the way for the structure of the Euro Area.

The common theme around the failures of the above-mentioned systems centred around the following dilemma. Fixed exchange rates could enhance the trade and investment the countries, but it requires that countries either surrender their sovereignty (e.g. Gold Standard) or that they engage in robust coordination (e.g. European Monetary System) (Krugman et al., 2018). The framework of the Optimal Currency Areas would later formalize the conditions, under which such trade-offs could be justified.

### 3.2 Theory of Optimal Currency Areas

The collapse of the Gold Standard and the Bretton Woods system underscored the question on the optimal exchange rate systems: Under what circumstances should a nation give up its own monetary sovereignty for a shared currency? Robert Mundell, already prior to the fall of the Bretton Woods system, in his 1961 seminal work sought to find the theoretical answer to this question. He proposes that regions with high level of labour mobility and economic integration could optimally adopt a single currency. This is for the reason that his economic model emphasizes that asymmetric shocks may cause economic disturbances that affect regions unevenly, but that should be mitigated if workers moved freely from affected depressed areas to the booming areas. The shift caused by unemployed people from depressed areas accepting work in prosperous areas would in turn reduce the need for exchange rate adjustment as labour mobility can serve as an effective adjustment mechanism (Mundell, 1961). However, peers in the field later pointed out that Mundell's model assumes an ideal world with high labour mobility, which is often limited in the real world by factors, such as language barriers, cultural differences and regulatory constraints, exposing limitations of this model (Beyer & Smets, 2015, Krugman et al., 2018).

To alleviate the limitation of the Optimal Currency Area model, McKinnon (1963), expanded the criteria by arguing that economic openness determined the viability of a currency union. The research used trade-to-GDP ratio as metric for economic openness. According to the proposed theory, highly open economies benefit more from stable exchange rates with trade

partners, as currency volatility disproportionately disrupts small, trade-dependent markets. Yet, this raised an interesting paradox situation, where openness encourages currency unions, while at the same time it increases exposure to external shocks. This tension was observed later in the Euro Area's peripheral economies (Darvas & Szapáry, 2008).

A third pillar, compromising mechanisms for fiscal risk-sharing was introduced by Kenen (1969), stressing that centralized fiscal mechanisms could absorb the regional shocks, when the previous two, labour mobility and economic openness, proved insufficient. His insight anticipated the Euro Area's Achilles' heel, as the lack of robust fiscal union during the 2008 global financial crisis forced asymmetric adjustments to weaker members of the monetary union (Wächter et al., 2024).

While Mundell, McKinnon, and Kenen focused on adjustments mechanisms on an already working currency union, later research emphasised a fourth pillar, a pre-emptive condition for a currency union's success. Economies with comparably similar structures (e.g. proportional reliance on manufacturing, services, or commodity exports) are less prone to asymmetric shocks, greatly reducing the need for ex-post adjustments.

Frankel & Rose in their endogeneity hypothesis (1998) argue that that currency unions themselves could induce this synchronization overtime by deepening financial ties through intensified trade and increased financial ties. Although this claim remains contested post-2008 global financial crisis showcased divergences in the synchronization levels of the Euro Area.

This last pillar remarkably matters to the Euro Area, as there was a noticeable core-periphery divide between the countries at the time of the 2008 global financial crisis. While the German economy is reliant on its industry and export, this clashes with Greece's tourism-based economy. This creates structural mismatch, for which it is impossible to create monetary policy, that would benefit both economies at times of crisis. Without aligned cycles, monetary policy (e.g. ECB interest rates) inevitably falls flat, as it creates boom in one region and recession in another region (Wächter et al., 2024; Arčabić et al., 2024).

While Frankel & Rose (1998) envisioned a constantly and inevitably improving integration, intra-industry trade and synchronization between the member states, Krugman et al. (2018) warned that currency unions might instead deepen the regional specialization, as in the types of products and services produced, as seen in the Euro Area's industrial core states and the tourism dependent periphery countries. This would be counteractively making shocks more asymmetric, not less (Krugman et al., 2018, p. 699-700).

The theoretical benchmarks (the four pillars) provided a rigorous framework for evaluating later currency unions. Yet, early solutions often lead to unstable halfway solutions instead of full OCA compliance.

### 3.3 Attempts Toward Forming OCAs

Following the precise outlining of the theoretical framework for the OCAs, and as the economic integration between countries deepened, the question arose, whether an introduction of such a common currency would prevail as a benefit for all, and if so, to what extent should countries synchronize their business cycle prior to creating or joining a shared currency and a shared policy framework. Understanding the business cycle synchronization is crucial in evaluating the viability of currency unions and the costs and benefits of a monetary integration.

There have already been attempts even before the Euro to create and sustain shared currencies and test the practical limitations of the OCA theory. While not formal OCAs, monetary unions did exist prior to the Euro Area. Monetary unions from the 19th century of such as the Austro-Hungarian Empire's monetary union between 1867 and 1918 – shared currency, "de facto monetary union", common market, trade policy, legal system, army, foreign policy, and monarch, despite political duality, and not fulfilling the labour mobility. Other European economic formations, although not proper monetary unions include the Scandinavian Monetary Union between 1873 and 1914 – fixing their currencies to gold, circulating currencies freely between the member states although the currencies co-existed, but failing to raise intra-Scandinavian trade and existing without a central bank – and the Latin Monetary Union between 1865 and 1927 – using standardized gold and silver coinage with fixed exchange rates, but existing without shared central bank or fiscal union (Ryan & Loughlin, 2018). These systems had OCA traits, they demonstrated that fixed exchange rates were desired and that they could facilitate trade. However, these monetary arrangements failed to endure beyond the 20th century, owing to the mismatched fiscal policies and external shocks, even more foreshadowing the importance of OCA criteria. A still existing attempt on creating an OCA, is the CFA (franc of Financial Cooperation in Central Africa) created by the former colonies of France in Western Africa in 1945. The CFA zone is, however, argued upon whether it can be considered an optimal currency area. "Indeed, while the CFA zone cannot be qualified as an optimal currency area, its durability over time tends to show that it has been at least sustainable." (Couharde et al., 2020, p.13).

In the late 20th century, developing nations adopted currency boards (e.g. Argentina's 1991 peg to the USD) or dollarization (Ecuador in 2000), often as crisis response rather than optimal integration. These cases revealed a recurring pattern. Without labour mobility, fiscal solidarity, or structural arrangement, rigid currency regimes risked exacerbating economic fragility – a lesson later echoed through the Euro Area's periphery (Carrera, 2004).

Europe's path to monetary union began in the late 20th century, with incremental steps that often mirrored but sometimes contradicted the OCA theory. The Werner Report (1970) proposed a three-phase plan, in a gradually increasing economic policy coordination system for a completed European Monetary Union by 1980. This report envisioned fixed exchange rates, capital mobility, and centralized economic policymaking. "A monetary union implies, internally, the total and irreversible convertibility of currencies, the elimination of margins of fluctuation in rates of exchange, the irrevocable fixing of parity ratios and the total liberation of movements of capital. It may be accompanied by the maintenance of national monetary symbols, but considerations of a psychological and political order militate in favour of the adoption of a single currency which would guarantee the irreversibility of the undertaking." (Werner, 1970, p. 26). Oil crises, political reluctance and lack of pre-emptive convergence at the time led to its failure, highlighting a gap between the OCA ideals and the political realities.

The Delors Report (1989) built on the lessons learnt from the Werner Report and laid the groundwork for the Euro and the European Central Bank. It emphasized parallel progress in monetary integration (e.g. through the ECB) and economic coordination (e.g. through the Stability and Growth Pact), addressing earlier critiques of the lack of a solidified institutional framework, insufficient economic policy coordination and the overly ambitious timetables (Committee for the Study of Economic and Monetary Union, 1989). Yet, it underestimated the need for fiscal risk-sharing (Kenen's criterion), a flaw exposed during the 2008 financial crisis (Krugman et al., 2018).

These attempts, though incomplete, demonstrated that successful monetary unions require both institutional rules (Maastricht criteria) and adaptive mechanisms (banking unions, fiscal backstops).

### 3.4 Benefits and Costs of Currency unions

Before turning to the Euro Area itself, it is necessary to understand, that currency unions represent a fundamental trade-off: they eliminate exchange volatility and enhance economic

integration but require surrendering key policy tools. “The removal of controls greatly reduced member countries’ monetary independence (a consequence of the monetary policy trilemma), but freedom of payments and capital movements within the EU had always been a key element of EU countries’ plan to turn Europe into a unified single market.” (Krugman et al., 2018, p.687). Understanding what benefits and costs monetary unions impose according to the OCA theory really impose on the participating countries is essential to evaluate why nations adopt or resist shared currencies and monetary unions.

### 3.4.1 Advantages of Currency Unions

The theory about benefits and costs has been already thoroughly explored by peers in the field. The primary advantage of a currency union is the elimination of the transaction costs and exchange rate uncertainty, which fosters trade and investment. Despite original scepticism, studies, such as Rose (2000), estimate that currency unions can achieve triple their original trade as intra-union trade largely by reducing exchange rate uncertainty, hedging expenses and pricing complexities. Additionally, unlike fixed exchange rate regimes, which are vulnerable to speculative attacks – as seen during the 1992-1993 ERM crisis – a unified currency eliminates the risk among members and reduces the scope for a crisis like this. While Bartolini and Prati (1998) highlight the fragility of soft target zones, their analysis underscores broader challenges of managing credibility and expectations in non-unified systems, which remain vulnerable to currency crisis.

Mundell (1961) argues that OCAs offer an effective solution to resolving balance of payments crises. Under independent monetary policies, countries facing external deficits must either allow their currency to depreciate, which risks devaluation, or implement fiscal authority to stabilize external debt and regain external balance (Tanner, 2019). By allowing natural adjustment in case of international trade imbalances, OCAs compensate for constraints caused by the fixed exchange rates and the rigid price and wage levels through fiscal transfers and labour mobility. Labour mobility is especially important because it allows workers to relocate from depressed to expanding regions, smoothing labour–market disparities and acting as an automatic stabilizer in the absence of exchange–rate flexibility (Mundell, 1961). Krugman et al. (2018) identified four reasons as to why the EU countries moved away from the fixed exchange rates towards having a shared currency with shared monetary policy. These include higher degree of market integration, joint response to external economic shocks, free movement of capital, and guarantee on political stability for all participating countries. The methodological

framework serving the intended objectives include eliminating the costs of traders converting from one currency to the other, sharing the monetary policy with nearly equal consideration of all of the member states, aligning economic interest through higher integration, as the degree of net benefits of joining a monetary union also depend on the degree of economic integration. According to (Krugman et al., 2018), the more integrated a country is within the monetary system, the lower the costs and the greater the benefits of participation. This emphasizes how crucial it is to assess a nation's economic structure and degree of integration before agreeing to a currency union.

Even just fixing the currency against another one can be beneficial: "The monetary efficiency gain from joining the fixed exchange rate system equals the joiner's savings from avoiding the uncertainty, confusion, and calculation and transaction costs that arise when exchange rates float." (Krugman et al., 2018, p.693-694). However, the higher the intensity of the trade the country does with another, the higher the benefits of using the same currency will be (McKinnon, 1963; Frankel & Rose, 1998). Furthermore, bilateral trade with a low-inflation country provides distinct economic advantages. "When the economy of the pegging country is well integrated with that of the low-inflation area, however, low domestic inflation is easier to achieve. The reason is that close economic integration leads to international price convergence and therefore lessens the scope for independent variation in the pegging country's price level. This argument provides another reason why high economic integration with a fixed exchange rate area enhances a country's gain from membership." (Krugman et al., 2018, p.695).

According to the theory therefore, a shared currency is superior to fixed exchange rates, because it removes the risk of parity adjustments while deepening the financial integration. However, these benefits assume that member economies can absorb shock without independent monetary policy – a condition that is often unmet in practice.

### 3.4.2 Disadvantages of Currency Unions

Despite all the afore mentioned advantages, OCA membership inevitably generates non-negligible costs of economic and other nature for participating nations in addition to the welfare gains. A country becoming a member of an OCA gives up the ability to have a sole, independent influence over its exchange rate and monetary policy autonomy. These costs will arise observable and quantifiable in magnitude even when regions have low inflation rates. However, they become most apparent at times of crisis. Countries giving up their independent monetary

policy sacrifice their ability to adjust the interest rates; hence they cannot devalue their currency to regain competitiveness during downturns. Countries not being able to adjust their own interest rates or devalue their currency forces them to rely on fiscal policy or internal devaluation (e.g. in the form of wage cuts) which is a painful process seen in Greece and Spain post-2008 (Afonso, 2019; Bilbao-Ubillos, 2022; Frangakis, 2015; Gächter et al., 2012; Tanner, 2019). They are more vulnerable to asymmetrical shocks, have limits in their fiscal stabilizers. In case of imperfect labour mobility constraints, unemployment can persist for longer periods of times in crisis-hit areas, affecting members unevenly. Lastly, surrendering monetary sovereignty may put the country in weaker political position, since they may face public opposition, and their national identity can weaken as a byproduct. "…we find that while the monetary policy misalignment represented by the TRGAP has a statistically significant and negative immediate effect on real GDP growth, this effect becomes statistically insignificant when longer horizons are considered. Third, this negative effect seems to be more pronounced in periphery than in core euro area countries, indicating that the former are more sensitive to monetary policy misalignments than the latter." (Wächter et al., 2024, p.1).

Ultimately, the currency union is justified only, if the benefits (trade integration, crisis resilience, credibility) outweigh the costs (loss of autonomy, shock vulnerability). The Euro Area's mixed performance underscores that success hinges not just on initial conditions but on post adoption reforms as well. Fiscal union, banking integration, and structural convergence are all required to mitigate the inherent risks.

### 3.5 Optimal Currency Area Measurements

While exploring various criteria for measuring Optimal Currency Areas, several key dimensions and ideas emerged. These included the measurement of original pillars of the OCA such as price and wage flexibility, high factor labour market mobility, alongside with a high degree of financial integration, which can function as a form of "private" insurance against asymmetric shocks. Additional factors include the openness of the economy, diversification in production and consumption structures, convergence in inflation rates, stable terms of trade, fiscal integration, political cohesion, and the political willingness to support a currency union. However, many of these criteria are difficult to quantify or compare empirically across countries. Among all these, one particular indicator stands out for its measurability and central importance: business cycle synchronization. It serves as a practical proxy for determining both the potential benefits and costs of joining or remaining in a monetary union, as a higher degree

of synchronization implies fewer adjustment challenges in the absence of independent monetary policy. (Gächter et al., 2012, p.35)

The next chapter examines how the Euro Area institutionalized or overlooked these findings, particularly in the context of the Maastricht Treaty and the subsequent adoption of the Euro, and how these decisions shaped the region's economic integration, stability mechanisms, and response to future financial crises.

# 4. The Euro Area: An Institutional and Economic Overview

## 4.1 The Maastricht Treaty and Euro Adoption

The Euro as a common currency on the continent of Europe is not a novel concept. Previous attempts, as mentioned above like the Werner Report (1970), have envisioned a monetary union over the continent, but political and economic obstacles delayed its realization. The predecessor of the European Union, the European Economic Community already undertook effort in creating a monetary union, which later proved to have laid the groundwork for the creation of the Euro (European Parliamentary Research Service, 2015). The idea already formed in the minds of the leaders of the original member states to commit to and create a common currency that would enhance trade, investment and political cohesion. Finally, the Maastricht Treaty (1992) formalized the path in which the monetary union would be formed. The treaty established a three-stage roadmap toward the Economic and Monetary Union, culminating in the Euro's launch as an electronic currency starting from 1999 and a physical currency from 2002 (European Union, 1992). The treaty also mandated a set of strict rules, so-called convergence criteria, that would ensure stability over the joining regions. To ensure that only economically stable countries adopted the Euro, the Maastricht criteria outlined four key convergence criteria:

1. Price Stability, meaning that the inflation rate of a country must not exceed 1.5 percentage points above the rate of the three best-performing member states of the monetary union.
2. Public Finances, which incorporates that the government deficit must not exceed 3% of the country's GDP, and government debt must not exceed 60% of GDP (or otherwise it should show sufficient progress toward these targets).

3. Exchange Rate Stability, that includes that the country must participate in the Exchange Rate Mechanism (ERM II) for at least two years without severe tensions or devaluation.
4. Long-term Interest Rates or in other terms the nominal long-term interest rate must not be more than 2 percentage points above the rate of the three best-performing member states in terms of price stability (European Union, 1992).

Briefly summarized, the four main criteria are: price stability, sound and sustainable public finances, durability of the convergence, and exchange rate stability. All of these are measurable and remain as the foundational pillars of accession into the Euro Area. These criteria are aimed to prevent asymmetric shocks by ensuring that all the Euro entrants had similar economic fundamentals. Every aspiring member state must fulfil them before joining the Euro Area or show a tendency towards fulfilment as is with the case of public finances (government deficit and debt). However, one critical flaw of the European Monetary Union is that these criteria are not systematically reassessed post-accession, meaning no mechanism ensures continued compliance or even progress towards these set objectives. Post-adoption, fiscal discipline is supposed to be maintained by the Stability and Growth Pact, which monitors and reinforces the 3% deficit and 60% debt rules from the Maastricht convergence criteria (European Commission, n.d.c; European Union, 2016). However, the Stability and Growth Pact lacked strong enforcement mechanisms meaning that violators faced only warnings but no automatic sanctions. This weakness becomes particularly salient during crisis periods, when certain member states significantly underperform relative to the convergence requirements, like how Greece, Italy and Spain, all of which had initially met the criteria but failed to sustain convergence which may have contributed to the severity of their economic challenges during the 2008 Global Financial Crisis (Baerg & Hallerberg, 2016; Fjelstul, 2022). Greece's debt crisis (2010-2015) exposed how fiscal profligacy, and statistical manipulation had been overlooked, forcing painful bailouts and austerity measures (European Commission, 2010; Walker, 2017; Ryan & Loughlin, 2018).

The European Central Bank, established in 1998, became the Euro Area's central monetary authority, tasked with maintaining the price stability within its member states via the use of its interest policy. However, as mentioned already, the "one-size-fits-all" approach of it often clashed with divergent economic conditions across member states. For example, following the introduction of the Euro in the early 2000s, Southern Europe countries experienced credit booms fuelled by low interest rates and increased capital inflows. While Germany benefited from the low rates and subdued domestic demand during this period, Southern economies like

Spain and Greece saw rapid growth in both their private and private borrowing, leading to instability and later to the European Sovereign Crisis (Lane, 2012; Krugman, 2018; Wächter et al., 2024).

The Economic and Monetary Union also lacked fiscal union, meaning no centralized budget or debt mutation (e.g. Eurobonds). This institutional gap forced nations hit by severe crisis to rely on ad-hoc mechanisms like the European Stability Mechanism (ESM), which came with strict austerity conditions (Lane, 2012; Berger et al., 2018).

Although previous studies conducted extensive research on business cycle synchronization of the Euro Area member states, with specific focus on the creation and on the 2008 Global Financial Crisis' effects, Croatia's recent accession to the Euro Area, combined with the economic disruptions caused by the COVID-19 pandemic and the Russian-Ukrainian war offers a new and timely perspective. Unlike earlier entrants, Croatia joined under stricter scrutiny, including countless banking sector reforms and participation in the Banking Union (European Central Bank, 2020a). However, long-term sustainability remains uncertain, as it is still up for debate whether Croatia will maintain financial discipline or whether it will, like Greece, face pressures once the initial enthusiasm fades. The lack of enforcement over the reassessment mechanism for Euro Area members means that future crises could very likely cause expose divergence once again.

### 4.2 Expansion of the Euro Area

As of April 2025, 20 out of the 27 EU member states have adopted the Euro as their official currency. Additionally, four European microstates (Andorra, Monaco, San Marino, and Vatican City) use the Euro under formal agreements, alongside several overseas territories of EU countries. Furthermore, two non-EU member states – Montenegro and Kosovo – also use the Euro, although both unilaterally, without formal agreement, despite having no institutional participation in the Eurozone (Ryan & Loughlin, 2018). It is worth to mention with regards to the Euro that once a country joins the Eurozone, the accession becomes irreversible, as leaving the European Monetary Union without simultaneously leaving the European Union is legally next to impossible at the moment (Athanassiou, 2009). The current 20 member states, forming the Eurozone, all agreed upon not only using the Euro, but also following the same monetary policies outlined by the European Central Bank and surrendering national sovereignty over

interest rates, exchange rates and banking supervision to the ECB's Governing Council under Article 127 of the Treaty of the Functioning of the European Union.

### 4.3 Potential Euro Area Candidates

For a while there were no new joiners to the Euro Area, even though countries who joined the European Union ultimately accepted efforts towards a future accession to the Euro Area. There was a large time gap of 8 years between the last joiner, Croatia, who finally entered the Euro Area on the 1st of January 2023, and the previous, Lithuania, who adopted the Euro on the 1st January 2015, representing the longest interval between accession since the inception of the Euro Area. To date, there are 7 member states of the European Union who are reluctant in adopting the Euro and in joining the Euro Area. These countries are Bulgaria, Czech Republic, Denmark, Hungary, Poland, Romania, and Sweden. Of these countries, only Bulgaria, Denmark and Hungary have ever pegged their currencies against the Euro.

Bulgaria is the only country that has its currency, the Bulgarian Lev, still pegged to the Euro and has taken active steps towards Euro adoption, even as far as to joining the Exchange Rate Mechanism II in July 2020 (European Commission, n.d.b). Ideally, the country would have joined the Euro Area on the 1st of January 2025, however the target date for criteria were not met and so accession has been since delayed due to political and economic (price stability) reasons. Otherwise, Bulgaria fulfilled all the other criteria for joining the Euro Area, which made it a strong potential candidate to be the next country in accession (European Commission, Directorate-General for Communication, 2024a; European Commission, 2024b). Finally, following formal approval by the European Union, the country is scheduled to adopt the euro on 1 January 2026, thereby becoming the twenty-first member of the Euro Area.

The Czech Republic, although not yet in the ERM II, is open in the long-term in the Euro adoption. It is meeting 2 out of 4 of the convergence criteria currently and has a relatively high public support for the Euro adoption. The Czech National Bank is also actively assessing economic alignment with the Euro Area on a yearly basis; however, it has, in December 2023, still advised the Czech government against setting a target date for Euro Area entry (European Commission, 2024b; Czech National Bank, 2025).

Denmark, on the other hand, has opted out via a referendum from using the Euro in 1992, and political consensus on resistance from Euro adoption still remains (The Danish Parliament, 2022; European Commission, 2024b).

Hungary stopped pegging its currency, the Hungarian Forint, against the Euro in 2008 and have not done steps towards Euro adoption ever since (Magyar Nemzeti Bank, 2008). It does not fulfil any of the convergence criteria as of 2024 (European Commission, 2024b).

In Poland, the public support behind the Euro adoption is not high enough (Tilles, 2024) and the country is also not meeting any of the Maastricht limits (European Commission, 2024b).

Romania aimed for Euro adoption earlier in 2014 and 2019 but kept missing the targets. The new target is set for 2029, but Romanian government officials wish to push it even earlier to 2026 (Smarandache, 2023), but this target is unlikely to be met with current inflation and fiscal deficits. It does not meet any of the Maastricht convergence criteria as of 2024 and it would also need entry to the ERM II prior to accession (European Commission, 2024b). However, this country has the highest potential for adoption after Bulgaria's accession in 2026.

Lastly, Sweden is another country similarly to Denmark, that opted out with a referendum and is unlikely to reconsider the choice in the near future (Riksdag, 2023; European Commission, 2024b). Therefore, evidence suggests that after Croatia, Bulgaria will remain the most recent country that has joined the Euro Area for the foreseeable future, given delays and public resistance in other accession instances.

Croatia has undertook significant efforts to reform itself both economically and institutionally to meet the convergence criteria. After having comprehensive understanding of the OCA criteria and the structure of the Euro Area, it is timely to evaluate the Euro Area itself in light of the OCA criteria.

# 5. Evaluating the Euro Area as an OCA

## 5.1 Does the EA Fulfil the OCA Criteria?

The Euro Area's performance as an Optimal Currency Area presents a paradox as it is heavily debated whether the Eurozone fulfils all Optimal Currency Area criteria. While significant progress has been made in economic integration since the Euro's introduction, fundamental gaps remain when it is measured against the classical Optimal Currency Area criteria. As presented in previous chapters, according to Mundell's (1961) work on the foundation of the Optimal Currency Areas, labour mobility hand in hand with price and wage flexibility and financial risk sharing are critical for a successful currency union. Later scholars (McKinnon, 1963; Kenen, 1969) expanded this into a four criteria framework with economic openness and

structural symmetry. This framework can be applied to see whether the Euro Area falls into OCA categorization.

The four criteria first and foremost states that, there needs to be high mobility labour, meaning workers must move freely across different regions of the currency area to offset asymmetric shocks from recessions (Mundell, 1961). This is supported in the EU, even making it one of the founding pillars of the of the single market through the principle of free movement of workers – Article 45 of the Treaty of the Functioning of the European Union. Yet, low mobility levels in the EU remain, when compared to the US, relative to population because of language and cultural barriers (Beyer & Smets, 2015; Krugman et al., 2018 p.702-704). The prices and wages need to be flexible. The wages and prices of a region within the currency area should adjust to economic shocks without causing unemployment (Mundell, 1961). An example for how rigid labour markets became flexible is the case of Southern Europe. Originally strong employment protections and limited wage flexibility was a structural challenge for the Euro Area. However, during the Euro Area crisis, several of these countries undertook internal devaluation by suppressing the wage growth and weakening collective bargain institutions to restore competitiveness (Afonso, 2019).

Second criteria is the economic openness, where the Euro Area presents a mixed picture that both confirms and contradicts McKinnon's criteria. On the positive side, intra-Euro Area trade has remarkably grown in the past two decades from 11% to 23% of GDP since 1993 until 2021 (European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, 2023). However, this surface-level success masks the underlying financial fragmentation, particularly in cross-border bank claims which declined sharply after the 2008 financial crisis. More troubling are the persistent imbalances between the economies of the core and the peripheral economies of the Euro Area (European Central Bank, 2017; Arčabić et al., 2024) with Germany maintaining consistent surpluses while Southern states struggle with deficits. These disparities reveal that trade integration alone cannot compensate for structural economic differences when crisis hits.

Third, the member states should participate in fiscal risk sharing (Kenen, 1969; Krugman et al., 2018). This condition represents perhaps the most glaring institutional gap that the Euro Area is missing. In other functional currency unions, like in the US, centralized fiscal mechanisms are automatically set in place to stabilize regions facing economic shocks through federal automatic stabilizers and targeted transfers. By contrast, it is not satisfied in this extent in the Euro Area, as there is only a small budget that is available for the large-scale fiscal collective,

forcing reliance on ad-hoc crisis measures like the European Stability Mechanism. These mechanisms not only prove to be insufficient, but they also come with politically continuous austerity conditions that often exacerbate economic downturns, like it was seen with Greece and Italy (Krugman et al., 2018). The only large-scale mechanism was limited to the pandemic-era recovery funds of €750 billion that marked the progress towards satisfying mechanisms (European Council, 2020). However, these still fall short to provide the Euro Area with a permanent, automatic stabilizer that the Optimal Currency Area would need because of their temporary nature and limited size. "The current scale of fiscal transfers within the euro zone, however, is by far not sufficient to overcome the radical economic imbalances between its members." (Krugman et al., 2018 p.700).

Lastly, and most importantly, the member economies should be structured in a way that they would react similarly to the external shocks. This is measured based on symmetric business cycles (Mundell, 1961; Frankel & Rose, 1998)[2]. Economic structures across member states remain strikingly divergent. As peers in the field have shown before, during earlier crisis there happened to be divergences from the business cycle as core countries (e.g. Germany) tended to recover much faster than peripheral countries (e.g. Greece) (Gächter et al., 2012; Hanus & Vácha, 2020; Arčabić et al., 2024). This divergence is a possible causality for why the ECB's centralized one-size-fits-all monetary policy inevitably misfires. When it keeps the rates too low for booming economies it is too restricting for overly depressed regions, hence the asymmetry in the rate of recovery.

This comprehensive evaluation reveals that the Euro Area remains as not an optimal currency area. The union has succeeded in creating deep trade integration and price stability but continues to lack adequate mechanisms for easy labour mobilization, overarching strategy for fiscal risk sharing and according to the studies from around the 2008 global financial crisis, it lost control over structural convergence for a few years as well. These institutional gaps force an excessive reliance on the European Central Bank's intervention as a crisis management tool, rather than building up the ideal automatic stabilizers envisioned in the Optimal Currency Area theory. For the Euro Area to fulfil the criteria, deeper reforms in fiscal union, bank integration, and labour market harmonization are imperative.

[2] While one of the first authors to ever use the term were Frankel & Rose (1998), the concept was created by Mundell in his 1961 "A theory of optimum currency areas" economic paper.

## 5.2 Maastricht Criteria vs. OCA Criteria

Although the Euro Area does not fully satisfy the traditional OCA criteria, the Maastricht convergence criteria ensures that at the time of accession the new member states meet nominal benchmarks. While these requirements provide a formal framework for Euro Area accession for the new joiners, they primarily focus on nominal convergence (inflation/price stability, fiscal deficits/sound public finances, exchange rate stability, and long-term interest rates), however, they fail to account for real structural and economic integration or even shock absorption capacity, which are key tenets of the Optimal Currency Area theory. Given that the Euro Area relies solely on these nominal benchmarks' risks at admission, countries remain vulnerable to asymmetric shocks post-adoption. Maastricht's rule-based approach is focused heavily on ex-ante conditionality, gatekeeping through inflation and debt thresholds while the Optimal Currency Area theory applies adjustment-based logic, that is required for ongoing mechanisms to absorb post-entry shocks. As a result, researchers and policy makers have increasingly turned to other measures, more in line with the Optimal Currency Area theory. Among these indicators business cycle synchronization emerges as the most critical metric, as a supplementary scale of readiness, that assesses whether a candidate country's economic fluctuations align closely enough with the Euro Area's core to mitigate the costs of losing their monetary authority. For new joiners, this approach offers a much more nuanced evaluation of their level of integration even within the European Union, but also towards the Euro Area, revealing whether their country has developed deeper trade and financial linkages. This knowledge on cyclical convergence seems especially important prior to formal Euro adoption, but research in the field often lacks following up with evidence on cycles becoming even stronger post adoption.

The Maastricht criteria succeeded in creating a monetary union but failed in fostering an optimal one. By requesting nominal stability instead of real convergence, the Euro Area became highly vulnerable to asymmetric shocks that the Optimal Currency Area warned against. Future reforms must strengthen Optimal Currency Area complaint institutions or revisit entry requirements to induce real economic benchmarks through productivity growth and sectoral diversification.

The next chapter as well as the literature review examines how these design flaws manifested in the Euro Area's Business Cycle Synchronization patterns over time.

## 6. Business Cycle Synchronization – Concept and Importance of Business Cycle Synchronization

The importance of Business Cycle Synchronization has previously been explored in this research. This chapter is dedicated to thoroughly explain the phenomenon and coherently describe its impacts.

Business cycle synchronization refers to the degree to which the economic cycles (expansions and contractions) of two or more countries move in tandem over time. When countries have synchronized business cycles, their economies tend to grow and contract at the same time, experiencing similar fluctuations in key macroeconomic indicators like GDP, unemployment, and inflation (Gächter et al., 2012). Measured through various economic indicators such as Gross Domestic Product growth rates, industrial production, and employment trends, it reflects how similarly economies respond to external shocks and internal monetary policy changes. The theoretical foundation of this concept was developed by Mundel (1961) and has been used by countless researchers in the field so far. There are plenty of methods to measuring it as well, most notably the prior research refers to the work of Hodrick and Prescott (1997) [3], Baxter and King (1999) and wavelet cohesion search based on Hanus and Vácha's (2018) new approach to the model. High synchronization implies that the measured areas experience comparable economic conditions nearly at the same time, while low synchronization measures suggest that the measured areas' economies follow different trajectories. For a currency union that is the Euro Area, the Business Cycle Synchronization is not a mere statistical observation, but in fact a fundamental determinant of stability, influencing the effectiveness of the monetary policies enacted by the ECB and the unions overall resilience to crises.

The importance of the Business Cycle Synchronization stems from the measure's role in identifying the potential for shock absorption (Beyer & Smets, 2015). "Among these properties, the similarity of business cycles features prominently, because if cycles are synchronized, the cost of foregoing the possibility of using counter-cyclical monetary policy is minimized." (Darvas and Szapáry, 2007, p. 2) Before joining a monetary union and a common currency of such, the countries must ensure that the business cycles of the individual countries making up the monetary union are sufficiently synchronized to comfortably retire their separate monetary and exchange rate policy independence. Under idealistic settings, synchronized business cycles

[3] The theory was developed by the authors in 1981; however, the idea was revisited and refined on new available data in 1997.

ensure that a common monetary policy can effectively address economic conditions across the whole economy of the currency area. When cycles of such are aligned within the regions, a single policy rate over all of the regions can stimulate demand during downturns or prevent economic overheating during a boom period without causing disproportionate regional disparities. However, when cycles diverge, the central bank has to face a dilemma, where policies tailored for one region may unevenly disadvantage other particular regions. For instance, during the Euro Area's recovery phase from the 2008 global financial crisis and the European Sovereign crisis, low interest rates supported struggling Southern economies (Wächter et al., 2024). However, in stronger economies, like Germany and the Netherlands, these same ECB policies contributed to rising asset prices, especially in real estate. This tension further explains and illustrates the importance of focusing on the Business Cycle Synchronization as measurement.

Beyond monetary policy, Business Cycle Synchronization further influences financial stability and political cohesion over the region. This phenomenon occurs because regions with synchronized business cycles are better positioned to benefit from common fiscal rules, as their budgetary requirements (such as counter-cyclical stimulus during downturns) will align.

Theoretically, Business Cycle Synchronization is both a precondition and a consequence of currency union success. Traditional Optimal Currency Area theory assumed synchronization would precede adoption of the currency, ensuring that members could share monetary policy without major disruptions. However, endogeneity hypothesis (Frankel & Rose, 1998) suggests that participation in the currency union could gradually strengthen business cycle synchronization by intensifying cross border trade linkages and financial interconnectedness between member states. The Euro Area's mixed record of strong to moderate synchronization among core members but persistent periphery-core gaps indicates that although economic integration promotes cyclical alignment, structural disparities such as industrial composition and labour market flexibility may resist convergence.

Ultimately, Business Cycle Synchronization serves not merely as a technical prerequisite, but as a diagnostic indicator of a currency union's robustness as well. Its presence smooths policy integration, minimizes symmetric adjustment burdens, and reinforces political consensus for deeper integration. Conversely, its absence, as empirically demonstrated by peers researching the Euro Area, leads to fragmentation, suboptimal crisis responses and fundamental doubts about the union's viability.

# 7. Empirical Motivation

## 7.1 Financial Crises and Asymmetric Shocks

The Euro Area's institutional resilience as a monetary union has been repeatedly tested by major crises, each exposing structural vulnerabilities stemming from, among other systemic challenges, incomplete business cycle synchronization and institutional design flaws. Four defining events – the Global Financial Crisis (2008), the Eurozone Sovereign Debt Crisis (2010-2015), the COVID-19 pandemic (2020-2022), and the re-intensified conflict that is the ongoing Russian-Ukrainian War (2022-present) – illustrate how asymmetric shocks test the resilience of monetary unions with inadequate risk-sharing frameworks. These stress events simultaneously highlight importance of the Euro Area's institutional adaptability and the persistent structural deficiencies.

The **2008 Global Financial Crisis** originated from the U.S. subprime mortgage markets, transmitted unevenly across the Euro Area (Gächter et al., 2012). Although all members faced recession, banking sector vulnerabilities determined the severity of the national downturns. Ireland and Spain, with their overleveraged real estate markets, suffered severe downturns with GDP contractions exceeding 10%, while Germany's export driven economy demonstrated resilience and was able to recover by 2010. The divergence originated from financial fragmentation (national regulators underestimated the cross-border exposures, e.g. German banks' holdings in securitized U.S. debt) and absence of centralized banking resolution framework forcing taxpayers bore the bailout costs in many cases, most notably in Ireland's €64 million recapitalization (International Monetary Fund, 2016).

The **Eurozone Sovereign Debt Crisis** functioned as a real stress test of the incomplete architecture. It demonstrated how institutional gaps transformed a national fiscal crisis into a systematic threat. What began as a Greek fiscal crisis was able to metastasize into an existential threat to the Euro Area due to three key components. There were three structural deficiencies proved to be particularly crucial. The lack of a sovereign backstop (until the ECB's belated 2012 intervention), bank-sovereign doom loop (national banks held domestic bonds, tying bank stability to sovereign credit risk, and finally pro-cyclical austerity (mandated budget cuts deepened recessions – Greek GDP fell by 25% between 2007-2013 – Frangakis, 2015). The crisis revealed the cost of low levels of synchronization. While core economies such as Germany and the Netherlands achieved relatively rapid recoveries, the peripheral economies of

the Euro Area endured a decade of stagnation. Critically, this period acted as a catalyser for major institutional innovations, including the ESM and the Banking Union, yet it left financial integration incomplete.

The **COVID-19 Pandemic** represented a unique economic shock that initially produced a wave of synchronized contractions over the Euro Area, with aggregate GDP declining by 6.8% in 2020 (Eurostat, 2021). The policy broke new ground through the European Central Bank's €1.85 trillion Pandemic Emergency Purchase Programme (PEPP) and the establishment of the NewGenerationEU recovery fund, demonstrating unprecedented monetary-fiscal coordination at a supranational level (European Central Bank, 2020b; European Council, 2020). Despite these factors, by 2022, significantly distinct recovery patterns became observable among the member states. Economies with excessive reliance on the tourism sector (most notably Greece and Portugal) experienced prolonged sluggishness in their recovery due to persistent disruptions in global travel patterns. Conversely, manufacturing- and export-oriented economies like Germany, initially rebounded faster only to face supply chain bottlenecks. This result emphasizes a critical lesson. Even in the face of nominally symmetric shocks, the absence of continuous, coordinated policy support can result fundamentally asymmetric recoveries within a monetary union. There can exist an extent to which business cycles of member countries are truly aligned both leading up to and following such shocks, and this alignment can differ between longstanding members and new joiner countries.

The **Russian-Ukrainian War** is a conflict that triggered a seismic shift in energy markets, with natural gas prices reaching a peak of 800% above pre-war levels in 2022 (McGeever, 2022). The Euro Area's energy-importing economies were disproportionately impacted by this shock, which once again revealed structural weaknesses among its member states. Germany's energy dependent industrial sector was put under pressure following the cutoff of Russian gas supplies, while Southern European economies displayed greater resilience owing to their lower energy intensity.

While the topic regarding business cycle synchronization was extensively researched and of significant interest prior to the 2010s, there were only a handful of studies published in recent years. However, the most recent large-scale crises being the Russian-Ukrainian war, preceded by the COVID-19 crisis, and Croatia's accession have revitalized the topic's relevance, as these external and internal factors disrupted the status quo. Therefore, these crisis situations – following the methodological models used for the evaluation of the 2008 Global Financial Crisis and the European Sovereign Debt Crisis – deserve a re-evaluation in light of new data

and perspectives so the EU's response mechanisms to the post COVID-19 economic shocks and the consequences of the Russian-Ukrainian war can be better understood.

These mentioned four which are recent but very different shocks and only the 2008 Financial Crisis and the European sovereign debt crisis are well researched in the field Business Cycle Synchronization. The other two shocks only became researchable recently, since the effects of these crises can only be reliably analysed after a year has passed. (Gächter et al., 2012) Hence, data can only be taken from previous periods for correct assumptions. Since the Covid-19 officially started in 2019 in Europe, and the Russian-Ukrainian war only started in 2022, these just became observable recently after the 1-year mark, defined by the HP and BK filters' end-point bias, has passed. Moreover, Croatia has just joined the EU on the 1st of January 2023, meaning that research for the first year after accession also became available in early 2025.

### 7.2 Political and Economic Milestones

The Euro Area's evolution has been marked by critical circumstances that reveal both its adaptability and resistance to challenges. Three recent developments illustrated how political and economic forces continuously redefine the currency union's boundaries and its governance. Croatia's euro adaptation, ongoing fiscal rule reforms and growing enlargement procedures all highlight the tensions between deepening integration and maintaining stability in an increasingly heterogeneous monetary area.

Croatia's recent Euro adaptation is a perfect example of a test case for the reformed convergence. The last country before Croatia to join the Euro Area was Lithuania in 2015, still during the European Sovereign Debt Crisis, making this entry the first post-crisis enlargement incorporating the lessons learned from past mistakes. Unlike previous joiners, like Greece, Croatia met all the Maastricht criteria without data manipulation. The heightened transparency is thanks to the newly adopted ERM II stability and the banking reforms (Walker, 2017; European Central Bank, 2020a). Accession time public opinion was overall very positive, around 54% supported the adoption according to the surveys (European Commission, 2023a). Initial data shows improved sovereign borrowing costs, but the business cycle synchronization is yet to be researched prior to this paper. Croatia's technical readiness does not guarantee smooth real economy transitions, which, if true may suggest caution for future candidates.

The EU's Stability and Growth Pact is now undergoing a substantial reform since its inception in 1997. The proposed changes, scheduled to take place between 2023 and 2025, seek to

introduce a much greater flexibility while maintaining its financial sustainability. A key innovation is the differentiation of debt reduction paths, granting high-debt countries such as Italy and Greece extend adjustment periods of four to seven years, compared to the current three-year mandate. Meanwhile, low-debt countries like Germany will also face the softer constraints, allowing them the fiscal space to invest large amounts into green solutions and defence priorities (European Central Bank, 2025).

The EU is also pressing on a momentum for expansion, with Ukraine, Moldova, Türkiye, Georgia and Western Balkan countries actively pursuing entry to the European Union while Romania and Bulgaria are making efforts for accession to the Euro Area (European Commission 2023b; European Commission, 2024b). While this enlargement presents geopolitical and economic opportunities, it also raises critical challenges for the European Union and the Euro Area. It poses the question; do candidate countries have the fundamentals required for stable integration? Additionally, the geopolitical considerations – such as Ukraine's membership – can be a risk of repeating past mistakes, notably similarly to that of Greece's premature Euro Area entry with improper, insufficient economic convergence.

Institutional capacity is another pressing issue. The ECB's monetary policy has been already heavily criticized as the "one-size-fits-all" approach already had issues supporting the current members, additional member states would only add on to the strain. This led to a deepening divide within the EU. Some would support further integration prior to further extension of the union, while others believe that an enlargement of such would only act as a catalyst for deeper integration.

Together these debates over the fiscal reform and the enlargement highlight the complex challenges the EU is facing in its ongoing struggle to keep its stability balanced, within an increasingly complex geopolitical landscape. As the EU navigates structural shifts in global power dynamics, energy security concerns, and military conflicts near its borders, the policy decisions made in the coming years will be critical, shaping not only the Euro Area's resilience, but also its political cohesion in an era of rising global uncertainty.

## 8. Literature Review

The study of the business cycle synchronization has generated a rich body of empirical research about the Euro Area, with scholars employing diverse methodologies to conduct their research on the convergence patterns of the members, regional disparities, and the impact of the 2008

Global Financial Crisis. Five pivotal contributions to the topic by Gächter et al. (2012), Darvas & Szapáry (2008), Hanus & Vácha (2020), Crespo-Cuaresma and Fernández-Amador (2013), and Arčabić et al. (2024) offer distinct, yet complementary insights into the synchronization dynamics of the Euro Area, each reveal critical lesson about the currency union's strengths and vulnerabilities.

Firstly, analysing the research by Gächter et al. (2012) provides a foundational analysis for the core-periphery differences in the respective countries' synchronization trends. "The extent of synchronization of national business cycles is a widespread indicator for gauging whether individual countries are indeed ready to adopt a common currency." (Gächter et al., 2012 p.33). This study tries to see which of the two outcomes was more likely to happen to countries due to the 2008 Global Financial Crisis. Did the post-2008 divergence between Euro Area core and periphery members reflect on the persistent trade and fiscal imbalances, therefore reinforcing the asymmetry, or did the crisis induced monetary adjustments slowly but eventually restore or even improve the levels of synchronization? The paper implements empirical data based on the Eurostat's online database on GDP growth between 2000 and 2011 on the member states of the European Union then uses industrial output as a complementary data on the same set of states to ensure the robustness of the findings as well as to see which sectors are most lined up and which sectors differ widely amongst the states.

Their research uses Hodrick-Prescott filtering method taken from the many available filtering methods from the literature including Hodrick-Prescott, Baxter-King, Christiano-Fitzgerald Band-Pass Filter, Phase Average Trend, centred moving average. The filters chosen for this research are explained later in the chapter of methodology, for measuring the effects of the crisis, as the different filtering methods can lead to more precise measurement in various aspects: "Empirical inference about individual Eurozone business cycles is found to be sensitive to the measure of the business cycle considered." (Massmann and Mitchell, 2003). Their research uses the output gap as its main measurement. This is a process in which a trend is extracted from the time series that can be interpreted as potential output. The cyclical component, known as the output gap, is then obtained by subtracting potential output from the original variable and is thus serves as an estimate of the output gap or in other words how far the economy is operating from its potential. At first output gap is measured, then the direction of that is added, lastly the research focuses on the which of the individual countries have contributed most to the desynchronization. The empirics confirm the desynchronization of business cycle due to the financial crisis. "The argumentation is as follows: If the potential

members of a monetary union are subject to symmetric economic shocks, the benefits of a common currency exceed the cost of relinquishing a national autonomous monetary policy" (Gächter et al., 2012 p.33). This criterion however is controversial because as mentioned previously, the Optimal Currency Area's endogeneity is questionable as countries joining the monetary union are more likely to meet preset requirement after the accession as trading within the monetary union is highly induced and building better connections strengthens the business partnerships within the countries, making the synchronization of these states closer. Yet, this remains to be "an appropriate measurement helping the economic policy makers take appropriate action in corrective action" (Gächter et al., 2012 p.33). The research cites multiple previous studies indicating that the convergence is growing since the introduction of the Euro however, these studies either do not show steady growth or tend to be non-conclusive. Neither observes a specific coherent European business cycle (Camacho, 2006; Darvas & Szapáry, 2008), however the studies also focus on fairly short time series spanning only 5-12 years since the formation of the Euro Area and put larger focus on post-formation time. This 5-12 years' time period is even less when considering the end of the sample effect (high uncertainty at both ends of the sample quarters, making 3-4 quarters of the sample nearly impossible to include in the data sample), making the meaningful data this research practically use of 3-10 years after the Euro Area formation (Orphanides & van Norden, 2002). Countries with higher GDP are assigned higher weight in the weighted standard deviation, used as a dispersion measure. More data became available since; hence this assumption can be re-examined, properly processing the long-term effects of the 2008 Global Financial Crisis. Similarly to data availability then, only short-term effects of the pandemic, the Russian-Ukrainian War and Croatia joining can be examined based on the data available however, long-term effects can be visualized of the European Sovereign Debt Crisis.

From their empirical analysis it clearly shows that both weighted and unweighted standard deviation already started rising in 2007 even before global financial crisis. The dispersion of the business cycle synchronization is strongly driven by Estonia, in the case of unweighted GPD dispersion, not being a Euro Area member yet and by Slovakia, being a recent joiner to the Euro Area. Compared to the high GDP appropriate weights of Germany, France, Italy and Spain, Greece has a very minor (2.4%) weight but an extraordinarily high inclusion cost (Gächter et al., 2012). The research concludes that "Countries with less debt were able to successfully wield an expansionary fiscal policy to effect a change in trend, whereas the more heavily indebted countries had considerably less room for manoeuvre, thus slipping ever deeper into the crisis.

These countries were additionally handicapped by structural weaknesses such as tax evasion, low competitiveness and real estate bubbles, which slowed the recovery in these countries even more." (Gächter et al., 2012 p.55) Crucially, the study reveals that the Euro's first decade mased underlying divergence, which only became apparent under stress.

How do these earlier findings hold up more than a decade later? Now that there is access to over twice as much data and the Euro Area has experienced a series of significant events – including financial crises, institutional reforms, and geopolitical shocks – could these have had heavy influence on the degree of business cycle synchronization?

The study by Darvas & Szapáry (2008) shifts the focus to the Central and Easter European area of the European Union. By the time of the study, only 10 new member countries have joined the European union in addition to the original 7 members. Research is focused on convergence of the countries at the time of the foundation of the Euro Area and the new additions up until 2008. The paper argues that the Maastricht Treaty and the Stability and Growth Pact diminished the likelihood of a fiscal policy, becoming a source of shocks, thereby moving the Euro Area entrants closer to being an Optimal Currency Area. Similarly to previous papers, it takes GDP and industrial production, and, as an addition, it takes major expenditures and sectoral components as well to assess synchronization. 5 measures are taken into account, these are correlation, leads/lags, volatility of the cycles, persistence and impulse-response (Darvas & Szapáry, 2008, p.5-6). Correlation between the business cycle of the individual European Union member states is examined over 5-year long non-overlapping periods already from 1983, until 2002. OECD data is used; however, many countries only have data after 1993. The countries are then classified into core and periphery areas based on the strength of their co-movement with the Euro Area. The study also measures leads and lags in cycles to identify whether countries precede or follow the broader Euro Area trends. Additionally, volatility of the cycles is assessed by comparing the squared deviation from the Euro Area mean, effectively normalizing volatility levels for consistent comparison. Persistence as a measurement means how long lasting the effects in the member states "Some shocks could have longer-term effects while others might diminish sooner, and some economies could react to a given shock differently than the other … We do not formulate any normative statement on whether a "high" or a "low" persistence is better, we are simply interested in whether persistence is similar across countries." (Darvas & Szapáry, 2008, p. 6).

Crespo-Cuaresma and Fernández-Amador (2013) highlight the advantages of using a wavelet approach, for detecting the specific core-periphery division in business cycles. They assume

that it has great potential for future studies, however instead they concentrate on another important measurement, namely the costs of including a country in an optimal currency area. To do that, the research examines the convergence of national cycle fluctuations. To extract the trend, cycle and irregular components of each country's GDP series, they employ a different model than prior pioneers. The model, that the study uses is based on the Harvey and Jaeger (1993) state space model within the Kalman-filter framework (Kalman, 1961).

This methodology builds heavily upon the Hodrick-Prescott filter's bandpass properties but adds three key advantages in the face of explicit modelling of the trend as a random walk with drift, implicit specification of the cycle's frequency band, filtering out both low and high frequency movements and lastly, it uses likelihood-based signal-extraction procedure.

To measure the synchronization, both the weighted and unweighted cross-country standard deviation of the smoothed cyclical component, alongside with a series of weighted co-movement indicators are calculated. The results show statistically significant convergence of medium- and long-run cycles over time. The dispersion of core EMU members with that of a hypothetical enlarged EMU (anticipating Bulgaria's accession in 2026 and Romania's potential later entry) is further compared, finding a clear European-centric cycle up until 2004, and immediately after a shift towards a global-level cycle approaching the global financial crisis. The study also tests for inflation stabilization within the groups. Crespo-Cuaresma and Fernández-Amador (2013) conclude that OCA membership benefits must outweigh adjustment costs and stress the need for fiscal constraints to prevent free–rider behaviour, while acknowledging that their model does not capture all welfare gains, particularly those arising.

Hanus & Vácha (2020) introduced a methodological innovation compared to previous research methodologies used in the field. By applying wavelet analysis to the Business Cycle Synchronization, it became possible to assess the synchronization across different time horizons. Unlike the traditionally used filters that have the issue of assuming constant cyclicality, this approach captures how cohesion within the region varies between short-run fluctuations of 1-2 years and longer business cycles of 5-8 years using the wavelet method, originally used for determining meteorology patterns. Their results revealed that during the late 2000's and early 2010's the Eurozone's synchronization was highly time-scale dependent. This means that while members all across the continent were tightly aligned in their medium-term cycles, which they account to monetary policy and trade, short-term cohesion is more fragile and is significantly weaker, particularly during the main time frame the research focuses on, the European Sovereign Debt Crisis. The finding challenges the notion of uniform convergence,

suggesting that Euro Area's stability hinges on managing multiple cyclical frequencies (short, medium, long) at the same time.

In their 2024 study, Arčabić, Panovska, and Tica examine the degree of business cycle synchronization in the European Union among member states between 1975 and 2022. They propose that unlike previous findings, the estimated output gaps show large differences based on the methods used. For this purpose, they employ simple averaging and weighted averaging as well as the Hodrick-Prescott filtering method. This approach allows them to assess the robustness of synchronization measures and the impact of different modelling choices on the interpretation of economic convergence within the EU. The study reveals that the synchronization is highly sensitive to the choice of empirical models employed. Importantly, the averaged output gaps do respond to the historical recession periods, confirming the presence of business cycle synchronization non-linearities in many, especially in the peripheral, EU economies. The research examines the pre-COVID period, giving extra interest to measuring the economic activity of Ireland. Key takeaway is also the fact that "there is no evidence of uniform synchronization across all members and that substantial care should be exercised when designing "one-size-fits-all" policies". (Arčabić et al., 2024, p. 33)

## 9. Methodology and Anticipated results

The research uses two separate aggregates for the empirical analysis. The Euro Area 12 (EA12) and the Euro Area 20 (EA20) are used to see the differences created between the original members of the Euro Area and the expanded aggregate.

The Euro Area 12, that the research focuses on therefore includes the original joiners to the union with Austria (AT), Belgium (BE), Finland (FI), France (FR), Germany (DE), Greece (GR, joined before the physical creation of the Euro), Ireland (IE), Italy (IT), Luxembourg (LU), Netherlands (NL), Portugal (PT), and Spain (ES), while the Euro Area 20 aggregate includes Croatia (HR), Cyprus (CY), Estonia (EE), Latvia (LV), Lithuania (LT), Malta (MT), Slovakia (SK), and Slovenia (SI) added to the original EA12 aggregate.

As the United Kingdom left the European Union in early 2020 data for them is excluded from the table as it would lead to high amounts of unexplained correlation between member countries before and after their exit from the union. The UK was also exempted from data reconciliation ever since.

To get a coherent answer to the following research question: “How do the indicators of business cycle synchronisation correlate with the EA average over time?” this research examines the correlation between business cycle synchronization indicators and Eurozone members and non-members. For this the following hypotheses are formed:

The first hypothesis of the research is that there is significant positive correlation between Eurozone membership and the indicators of business cycle synchronization after financial crises, to discover whether it is advantageous to join the Eurozone. The respective null hypothesis is that there is no significant correlation between Eurozone membership and the indicators of business cycle synchronization after financial crises. Meanwhile, the second hypothesis is that there is a significant low (either positive or negative) correlation between the non-Eurozone countries and the indicators of business cycle synchronization after financial crises. Here, the corresponding null hypothesis is that there is no significant correlation between the non-Eurozone countries and the indicators of business cycle synchronization after financial crises. The third hypothesis is that there is significant positive correlation between Euro Area membership and the indicators of business cycle synchronization after the Euro adoption. The corresponding null hypothesis is that there is no significant positive correlation between Euro Area membership and the indicators of business cycle synchronization after Euro adoption.

The aim of this thesis is to examine Euro Area and non-Euro Area countries’ business cycles in times of financial crisis and assess the advantages and drawbacks of a unified / shared currency during economic downturns. Specifically, the study will compare the rates of business cycle synchronization recovery between Eurozone and non-Eurozone economies. Understanding the dynamics of Business Cycle Synchronization for the whole region of the Euro Area requires a robust empirical framework capable of isolating the short-term cyclical fluctuations from the long-term trends, while accounting for the unique challenges posed by economic crises and structural divergence. To assess the Business Cycle Synchronization in the Euro Area, this study initially applied three complimentary filtering techniques, namely Hodrick-Prescott (HP), Baxter-King (BK) and Kalman-filter, in order to isolate and extract such cyclical components from macroeconomic time series. A systematic comparison showed that the cyclical estimates produced by each method differed only marginally in both magnitude and timing. Consequently, the HP filter was adopted as the principal extraction tool for the bulk of the analysis, with the Kalman filter reserved for charts where direct comparison with prior studies is possible. The BK filter was excluded from the final charts due to its negligible divergence from the HP and Kalman results.

Building on these filtered series, rolling window analysis is implemented, to capture the time-varying dynamics of co-movements between countries, thereby identifying periods of convergence against periods of divergence in the synchronization. Furthermore, dynamic correlation coefficients are calculated over these rolling windows, providing a flexible and intuitive measure to account for structural breaks, economic crises, and regime shifts. Altogether, this is done to ensure comprehensive and reliable results, using these tested filtering methods to capture both evolution and the underlying drivers (unemployment rate, industry development) of synchronization across the Euro Area member and candidate countries. Using multi-method approach robustness of the results is ensured against the different limitations that the any single used filter has on its own while providing a comprehensive view of the synchronization dynamics of the Euro Area member and candidate countries.

The relevant literature utilizes the indicators such as Gross Domestic Product, Industrial Production, Unemployment Levels, Export and Import Levels, Consumption, Investment and Service Levels, and tries to identify turning points in the data. The analysis of this thesis makes use of quarterly real GDP, and its components', growth rates, sectoral growth rates (excluding construction) and unemployment rates for all 20 Euro Area members and 7 candidate countries when available[4]. The construction sector was excluded from the analysis, as the cyclicality of this sector would distort the comparability of the data across countries and time, particularly since there is a significant reduction of construction activity during winter months. The data used for the analysis is taken from the Eurostat data base and from the OECD data base when available for cross checking the data source. Taking the data from only Eurostat data base ensures transparency within the analysed countries, as the methodology for taking the data is the same in all the cases. Comparability with previous research is also ensured as peers in the field also prioritized these data sources. The data is quarterly and is spanning from 1995 until 2024, however this primary dataset is customized based on the mentioned end-of-sample effects.

Given the volatility inherent in economic time series, particularly during the examined time series including multiple crises, preprocessing steps are essential to ensure meaningful results.

Cyclical component is extracted from the data series using the three above-mentioned methods. Hodrick-Prescott filter is the standard tool used by most of the peers (e.g. Darvas & Szapáry, 2008; Gächter et al., 2012).

[4] more on the availability in the appendix

$$\min_{\{y_t^T\}_{t=1}^T} \{\sum_{t=1}^{T}(y_t - y_t^T)^2 + \lambda \sum_{t=2}^{T-1}[(y_{t+1}^T - y_t^T) - (y_t^T - y_{t-1}^T)]^2\}$$

This filter is used in standard macroeconomic research, and it applies a soothing parameter (λ - lambda) set to 1600 for quarterly data, offering a baseline measure for cyclical fluctuations. The filter decomposes a time series into a trend component and a cyclical component ($y_t^C = y_t - y_t^T$) (Hodrick & Prescott, 1997). While it is widely used in research, it has several limitations. The HP filter has a well-documented issue regarding its end points, as it becomes all the more sensitive towards the final 2-3 quarters of the examined sample.

For greater precision in isolating cycle frequencies, the Baxter-King bandpass can be utilized.

$$y_t^C = \sum_{j=-k}^{k} a_j * y_{t-j}$$

Configuration for this can be set between 6-32 quarters to capture medium-term business cycle frequency fluctuations. The largest benefit of using this filter is that it has an explicit focus on cyclical frequencies that enhances comparability between countries. Although, this method, similarly to HP filter has its limitation at the endpoints. The weights are defined by the $a_j$ component, while the leads and lags are given by setting the k as 12 for annual data (Baxter & King, 1999; Darvas & Szapáry, 2008).

Kalman:

This model specifically decomposes the GDP in the following way:

$$y_{it} = \tau_{it} + c_{it} + \varepsilon_{it}, \varepsilon_{it} \sim NID(0, \sigma_{\varepsilon^y}^2)$$

where

$$\tau_{it} = \tau_{it-1} + \beta_{it-1} + \varepsilon_{it}^{\tau}, \varepsilon_{it} \sim NID(0, \sigma_{\varepsilon^\tau}^2)$$

(trend with random–walk and drift),

and $c_{it}$ is a cyclical component confined to business–cycle frequencies, and $\varepsilon_{it}$ captures irregular shocks.

For each filtered series, rolling window correlations are applied of 1 and 2 years between core and periphery cycles. Core countries and peripheral countries are defined based on classifications from existing literature and categorized accordingly, however, in case the original data or the analysis suggests that a different grouping is more appropriate, then countries may be re-categorized. Dynamic Factor Models – estimates common Euro Area factor

are measured against country-specific deviations. Robustness checks are carried out using alternative filters (HP/BK/Kalman) and alternative data sources recommended by peers. Crisis periods are targeted for in-depth analysis, as the key focus is on recovery.

All computations are implemented and carried out by the statistical software, R, leveraging specialized packages such as “mFilter” for HP and BK decomposition. Code transparency and reproducibility are prioritized, with full scripts archived alongside the results, that can be found as part of the appendix. The multifaceted approach not only strengthens these findings through different methods but also ensures that the received results are policy-relevant, clarifies whether the post-crisis reforms have genuinely improved synchronization or simply masked ongoing divergency trends. By combining traditional and advanced techniques, the methodology provides a nuanced, empirically grounded foundation for assessing the Euro Area’s evolution towards functioning an Optimal Currency Area.

In their research, Darvas and Szapáry (2012) found that Hungary, Poland, and Slovenia have achieved higher degree of synchronization for GDP, industry and exports but not for consumption and services. This is a relevant finding, since it shows that not all the time do countries need to be in the same monetary union or use the same currency to achieve this, but it can however be a prerequisite for that. Since the research, Slovenia did already implement the use of the Euro for the country, while Hungary and Poland refrained from using it. The research does not detail how Croatia, a country that has just recently implemented the Euro, came close in the business cycle synchronization. However, it does detail, that the Baltic states, which previously had high synchronization with Russia, afterwards desynchronized and their level of synchronization was far below the European average. Since then, Baltic state countries (Estonia, Latvia, Lithuania) adopted the Euro. It also raises the question how early to the introduction of the Euro and by how much they had to achieve business cycle synchronization.

This research contributes to the existing literature by providing a comparative analysis of the Eurozone and the surrounding non-Eurozone countries across multiple crises. It assesses whether the Euro mitigates the severity of crises or if non-Euro using nations benefit more from having independent monetary policies. The findings will have practical implications for countries such as Hungary, and Poland, who are considering Euro adoption, and will also offer a retrospective evaluation to Croatia’s decision to join the Eurozone.

## 10. Empirical Analysis

After normalizing the GDP data for the available countries of the Eurostat, first, the Hodrick-Prescott filter is applied to receive the cyclicality separated from the trend. The cyclicality is then correlated for the countries with the Euro Area values[5]. The correlation is taken for 1 and 2-year rolling averages. The shorter time span of 1 year shows higher volatility, than the 2 years. The core and peripheral countries were separated based on their co-movement by Darvas and Szapáry (2008) already. Their core group consisted of Austria, Belgium, France, Germany, Italy, and the Netherlands, based on their high levels of synchronization while their periphery was made up of Finland, Ireland, Portugal, and Spain with their lower synchronization levels. Their research had a separate group of "EMU outs", hosting Denmark, Sweden and the UK and three Central and Eastern European clusters with Hungary, Poland and Slovenia being strongly synchronized with the Euro Area and the Czech Republic and Slovakia being mildly synchronized and the Baltic states, just leaving the Soviet Union at the beginning of their timeseries, not synchronized at all. Their observed data frame was between 1993 and 2002.

Recreating their findings do lead to high synchronization between the core countries and lower correlation between the GDP growth of periphery Euro Area countries between their main examined time frame. The introduction of the Euro can clearly be seen as the synchronization of these core countries are desynchronized between 1998-Q4 and 1999-Q3. Peripheral countries are less synchronized during this time frame, although, Spain tends more towards being a core member of the Euro Area, however this can be due to the fact that their research does not specify whether they included only the original Euro Area 11 countries or the whole of the European Union. EMU outs have a co-movement with each other, but only moderately with the Euro Area. Central and Easter Europe shows little to moderate, only time-to-time co-movement with the rest of the European Union. This coincides with the earlier findings.

Unlike Darvas and Szapáry, this research takes the individual countries filtered cycles and correlates them to both the original EU12, and the EU20 (current state after Croatia's accession) so see how the relevant trends change compared to each other depending on the number of countries considered as the Euro Area's core. Comparison with the European Union (27 current member countries) is also provided to widen the scope of the research.

[5] The Euro Area here means an expanding group, originally just the GDP of the first 11 Euro Area countries are taken, however, later it is expanded as more and more countries adopted the Euro.

The first major occurrence that this research wants to highlight is in fact the 2008 Global Financial Crisis. As mentioned before, Gächter et al. also observed this period, with the help of Hodrick-Prescott filter, and output gaps. They used Euro Area 17 aggregated data for their research, instead of the original Euro Area 12 countries aggregated data. However, the recreated correlations and output gaps line up perfectly with their findings.

### 10.1 Aggregate Cyclical and Trend Dynamics of the EA20

Graph 1 presents a decomposed quarterly GDP growth for the EA20 aggregate. The cycle and trend components were decomposed for this using the Kalman-filter. The trend component of the EA20 GDP reveals a clear structural deceleration over the thirty-year span. Between 1995 Q2 and 2007 Q4, the aggregate trend index fluctuated around 2.3% – 2.6%, reflecting robust potential output growth. The onset of the Global Financial Crisis in late 2008 precipitated a marked downward shift: by 2010 Q1, the trend index had fallen to approximately 1.8%, a level it would not sustainably surpass until the mid-2010s. A modest rebound between 2012 and 2019 – peaking near 2.0% output – was interrupted by the COVID-19 pandemic, after which the trend component plunged to 1.4% by 2025 Q1. The post-pandemic trough is the lowest trend value in the series, and it coincides with a period when factors often cited in the literature, aging demographics, subdued investment, and slowing productivity growth, are particularly pronounced.

Cyclical fluctuations around the trend illustrate the euro area's episodic vulnerabilities and resilience. The late-2000s recession drove the aggregate cycle to –4.2% in 2009 Q1, underscoring the severity of the Global Financial Crisis in contracting actual output below potential. Although, during expansions in 2010 and 2011 lifted the cycle back toward neutrality, under sovereign-debt strained times in 2011 and 2012 volatility was reintroduced, with negative deviations of roughly -1.0% in several quarters. The COVID-19 shock produced an unprecedented cyclical downturn, as the cycle index hit -10.6% in 2020 Q2 – which is more than twice the magnitude of the Global Financial Crisis trough. During the period of coordinated fiscal stimulus and expanded monetary accommodation, the cycle recovered from its trough to 1.6% by 2021 Q2; from late 2021 onward, it gradually decelerated to 0.6% in 2025 Q1, indicating an almost closed output gap with some lingering slack.

An increasingly asymmetric growth profile emerges when trend and cycle trajectories are compared. Pre-2008, positive cycles reinforced high trend growth, creating virtuous expansions. Post-Global Financial Crisis, however, cyclical recoveries seldom restored trend momentum to its former highs, with might be suggesting lasting "scarring" effects on labour markets and capital stock. The exceptional depth and rapid rebound of the 2020 cycle may point to both the economic shock's magnitude and the effectiveness of the taken policy interventions. However, the resulting retreat in trend growth suggests that short-term stabilization alone has limited efficacy at reversing the overall structural slowdown.

From a policy standpoint, the sustained decline in the EA20 trend growth demands a renewed emphasis on supply-side reforms. EU initiatives in fields of digitalization, green investment, and labour-market modernization are regularly discussed in the literature by peers as means of restoring the potential output levels. Also, the significant cyclical swings that were observed in 2008 – 2009 and 2019 – 2020 reinforce the importance of building up pre-emptive fiscal buffers and setting flexible monetary frameworks that are capable of swift activation. The lack of renewed trend growth in combination with strong cyclical rebounds is consistent with the idea that specific structural measures could improve long-term resilience and that counter-cyclical policies may not be enough on their own.

Overall, the decomposition of EA20 GDP highlights a dual challenge for the euro area: halting the downward drift of structural growth while maintaining the capacity to withstand, absorb and even reverse deep cyclical shocks.

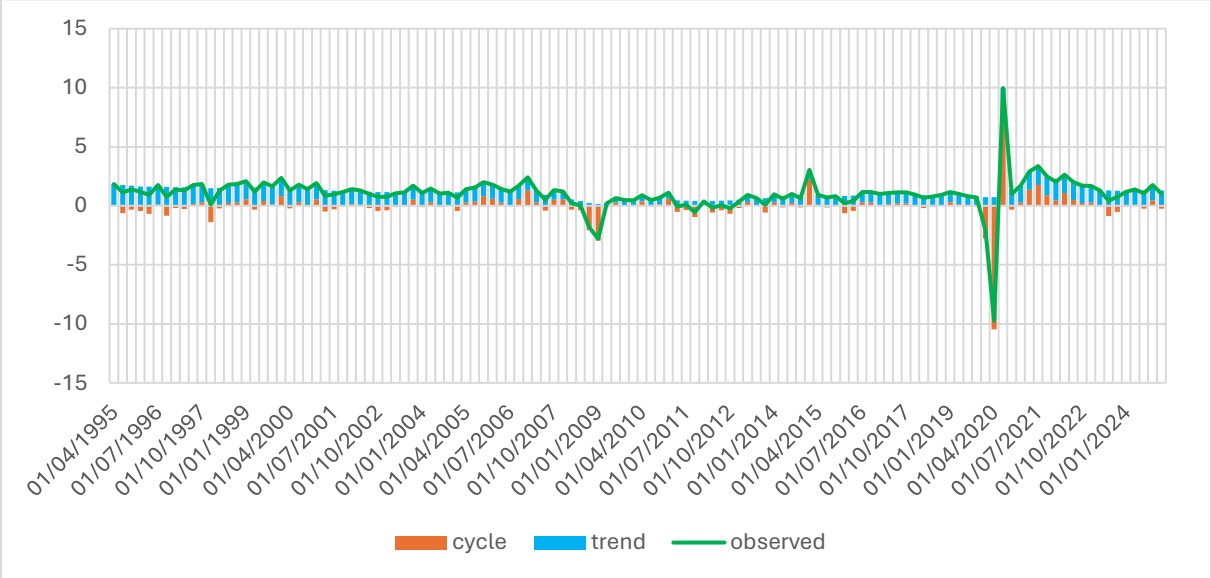



Chart 1 – Decomposed Quarterly GDP growth for the EA20

Graph 2 examines the evolution of cross-country dispersion in GDP fluctuations across the EA20 aggregate starting from 1995 up until the first quarter of 2025. Dispersion is measured by the standard deviation of quarterly deviations from each country's trend ("unweighted_sd_trend") and of cyclical deviations around that trend ("unweighted_sd"), with parallel series weighted by country GDP shares ("weighted_sd" and "weighted_sd_trend"). While higher dispersion signals rising heterogeneity in EA member-state performance, lower dispersion indicates a growing synchronicity.

Over the examined thirty-year span, unweighted cyclical dispersion averaged around 3.3% in the mid-1990s but it then declined to about 2.5% in the early 2000s. This downward path reflects an increasing co-movement which coincides with the Euro's adaptation (1999) and the onset of a unified monetary policy framework. In comparison, trend dispersion remained more stable, averaging near 3.1% early on, before decreasing to 2.2% by 2000. Weighting by GDP consistently reduces the dispersion of both the cycles and the trends, sometimes even halving these spreads: weighted cyclical SD hovered near 2.2% in the late 1990s and fell to 0.7% by 2000, while the weighted trend SD decreased from 2.0% down to 0.9% over the same period. These weighted trends underscored that larger economies were substantially more synchronized than smaller members.

The 2008 Global Financial Crisis generated a dramatic widening of dispersion. Unweighted cyclical standard deviation surged from 2.1% in 2006 to a peak of 5.5% in 2008. There is a sudden drop in the Q1 2009 unweighted cyclical standard deviation, reflecting a brief period of unusually tight synchronization, when virtually every EA20 country's output gap reached similar depths, before dispersion widened again as the recovery proceeded. Even trend dispersion increased slightly from 3.1% to 3.7%, reflecting that some countries' structural trajectories diverged during the downturn. Weighted measures exhibited similar but muted peaks: cyclical standard deviation rose from 0.8% to 1.7%, and trend standard deviation increased slightly from 1.1% to 1.3%. These patterns reveal that both large and small EA20 members experienced a sudden, pronounced, though uneven, downturns and recoveries.

Following the crisis, dispersion receded but never fully returned to pre-2007 lows. By 2011 and 2012, unweighted cyclical standard deviation stabilized around 2.1%–2.2%, and weighted cyclical standard deviation at 0.8–0.9%, reflecting ongoing heterogeneity during the sovereign-debt turmoil. Trend dispersion remained elevated around 2.8% (unweighted) and 1.3% (weighted). The modest decline in dispersion during 2013–19 suggests partial convergence of business cycles, even as structural growth divergences persisted.

The COVID-19 shock again amplified cross-country differences, but to a lesser degree than the Global Financial Crisis did. Unweighted cyclical standard deviation jumped from 1.1% in 2017 to 1.8% in 2019 and came to a peak at 3.3% in throughout the pandemic's first year, before receding to 2.2% which level it keeps currently with lower swings than before. Weighted cyclical standard deviation climbed from 0.7% to 3.2% in 2020 but dipped to 1.1% thereafter. In 2020, trend-dispersion measures increased – unweighted from 1.6% to 1.9% and weighted from 1.1% to 1.3%. Long-run growth trajectories varied across countries, and national fiscal and health responses differed. By 2022 and 2023, dispersion declined but remained above late-2000s lows.

A striking feature is the persistence of weighted dispersion at about half the unweighted figures throughout both crisis and non-crisis episodes. This asymmetry coincides with the dominant role of large economies in shaping euro-area dynamics and implies that synchronization is materially greater when smaller countries' idiosyncrasies carry less weight. Conversely, the unweighted series highlight the full breadth of heterogeneity, with the COVID-19 shock being the only episode where weighted and unweighted trend dispersions reach similarly elevated peaks.

These cyclical and trend SD values might seem like small differences in isolation, however even a "single digit" SD implies real-world GDP-gap swings large enough to drive sharply different policy needs, as while one country may be overheating by +2pp, another might remain -3pp below the trend. In sum, these percentage-point changes in standard deviation, though numerically modest, in real terms, corresponds to meaningful shifts in how closely EA economies move together or diverge apart from each other.

For this reason, from a policy perspective, these dispersion dynamics carry important implications. Periods of elevated dispersion like 2008 to 2009, 2011 to 2012, and 2020 – coincide with episodes of financial stress or asymmetric shocks, during which uniform monetary policy may prove less effective and fiscal coordination more critical as implied by the peers at previous crisis studies. Post-crisis baseline dispersion has stayed at elevated levels alongside a mix of structural imbalances. Reforms already under way in the EMU to include improvements in labour-market flexibility, steps toward banking-union completion, and targeted productivity investments in lagging regions. Keeping key buffers, like the European Stability Mechanism and Next Generation EU, in place helps to moderate possible future divergences across member states.

Overall, the EA20 has experienced large swings in cross-country dispersion for both cyclical shifts and long-run growth trends, coinciding with major economic shocks. Unweighted dispersion points to persistent divergence among the smaller member states, whereas weighted measures indicate moderate heterogeneity concentrated among larger economies. Strengthening the institutional frameworks and deepening policy coordination still remain essential to reduce future dispersion and promote a more cohesive euro-area economy.

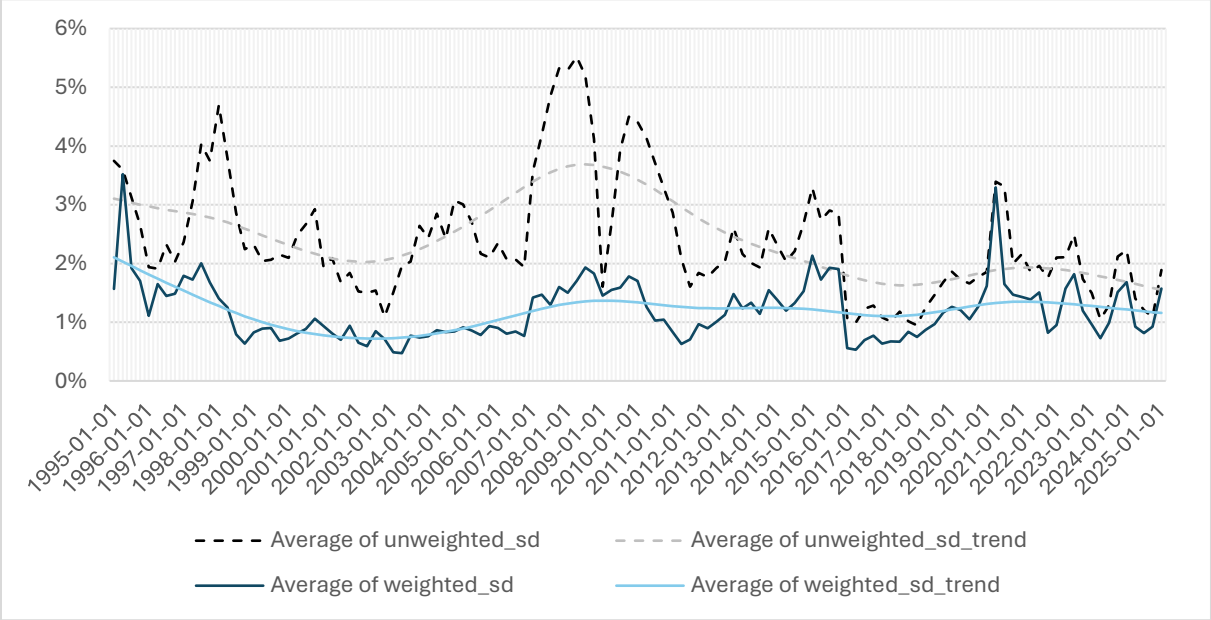



Chart 2 – Cross-sectional dispersion of normalized GDP cycles: weighted vs. unweighted perspectives

One criticism often received in the field of business cycle analysis is that many of the previous studies would not account for proper robustness checks, as there is only quarterly data available on GDP, which is not frequent enough to ensure for robustness, however, based on Gächter et al. (2012), there is a simple way to account for this issue. According to peers, the GDP and its industrial component's data are very similar, but the higher frequency makes the industrial data an accepted crosscheck.

Chart 3 presents a robustness check of the EA20 dispersion patterns using monthly industrial production data from January 1995 through May 2025. Just as in the quarterly GDP analysis, each country's industrial index was decomposed into trend and cycle components and then the cross–country dispersion was calculated as the standard deviation of monthly cyclical deviations ("unweighted_sd") and of trend deviations ("unweighted_sd_trend"), together with GDP–share weighted counterparts ("weighted_sd" and "weighted_sd_trend"). These four

series track how synchronously or divergently the industrial sectors of the twenty euro–area economies have moved over thirty years.

Over the full sample, the grand total averages confirm broad alignment with the GDP–based trends, however not with cyclicality: unweighted cyclical dispersion stands at 2.9%, and weighted cyclical dispersion at 2.6%. Trend dispersion mirrors these figures, with unweighted and weighted series both averaging around 2.9% and 2.6%, respectively. These averages closely mirror the GDP-derived figures. The industrial production in the EA20 displays cross-country heterogeneity at a monthly frequency comparable to that of aggregate GDP on a quarterly basis. Higher volatility reflects the increased data frequency, and the narrow gap between weighted and unweighted standard deviations of cycles and trends stems from the larger smoothing parameter, 14400 rather than 1600, in the Hodrick–Prescott filter, which, in turn, heightens its sensitivity.

In the mid–1990s, monthly industrial dispersion began at a moderate level as unweighted cyclical SD was 2.6% in January 1995, while weighted SD was 2.2%. Over the next five years, dispersion drifted upward, reaching an unweighted cyclical average of 2.9% in 2000, and trend dispersion climbed from 1.7% to roughly 2.8% unweighted. The initial rise in dispersion occurred in the run-up to the euro's introduction and coincided with global business-cycle swings, without clear evidence of a structural break.

Between 2000 and 2007, monthly industrial dispersion settled into a steady range: unweighted cyclical SD hovered between 2.5% and 3.8% with an average of 2.7%, while weighted cyclical SD stayed near 2.6 % to 3.3% with an average of 2.4%. Trend dispersion similarly fluctuated in narrow bands. These levels suggest that, in normal times, industrial output co–movement was neither exceptionally tight nor wildly divergent, and that weighting by GDP quarterly, the cross–country spread did reduce significantly.

The 2008 Global Financial Crisis produced a sharp spike: unweighted cyclical SD jumped from about 2.6% in Q1 2007 to 3.8% by Q4 2008. The trend dispersion widened along with the cycle, rising from 3.8% to 4% unweighted over the period. Weighted measures were more muted but still notable: weighted cyclical SD climbed from 3.1% to 3.6%, and weighted trend SD from 3.5% to 3.6%, underscoring that both major economies and smaller members experienced pronounced industrial volatility.

After 2009, dispersion receded slightly but did not return to pre–crisis lows immediately. From 2010 through 2019, unweighted cyclical SD averaged around 2.7%, and weighted SD near

2.5%, while trend dispersion held at 2.9% for unweighted and 2.6% for weighted. In 2011–12, dispersion remained elevated during the sovereign-debt period, and industrial cycles remained somewhat uneven even in a low–growth environment.

The COVID–19 pandemic generated the largest monthly surge in industrial divergence. Unweighted cyclical SD leapt to 12% in April 2020, more than double its Global Financial Crisis peak, and hovered above 7% throughout the first year of the pandemic. Weighted cyclical SD rose to 11.5% in April 2020 before pulling back to around 4% by mid-2021. Trend dispersion increased as well, unweighted from 3.7% to 4.1%, and weighted from 3.5% to 3.9% percent, around the lockdown and policy-support period, when structural conditions varied widely across countries.

By 2022–23, industrial dispersion had returned toward its longer–run range, both unweighted and weighted cyclical SD eased back to roughly 3.4%, yet with this, cycles remained above the lows of the mid–2000s. Trend dispersion similarly receded but did not fall below 3% for either unweighted or weighted, indicating a new, higher baseline of divergence in industrial performance.

A persistent feature across all episodes is that weighted dispersion tracks unweighted levels at about 90 percent, far closer than in GDP, where weighting often halved dispersion. Large economies display notable industrial idiosyncrasies, while small-country effects are relatively muted. The unweighted series continue to reflect the full spectrum of heterogeneity, especially during acute shocks, with extreme swings, deep plunges or rapid rebounds, evident among certain countries.

The precise level of dispersion depends on whether the industries are weighted by size, but the underlying story, of a steady increase in dispersion punctuated by cyclical peaks, remains unchanged. Finally, the extraordinary correlation levels between weighted and unweighted measures suggests that analysts, similarly to that of the quarterly GDP data, can truly choose whichever is more convenient without fear of missing the essential dynamics.

This robustness check confirms that the dispersion dynamics identified in quarterly GDP – mid-1990s convergence, sharp widening at major crises, and elevated post-crisis baselines – are not evidence of frequency or aggregation. Instead, they are replicated, and indeed magnified, in monthly industrial data. For policymakers, this can offer to reinforce the case for combining broad monetary and fiscal tools with targeted sectoral interventions to cushion asymmetric shocks and foster a more homogeneous recovery across the euro area.

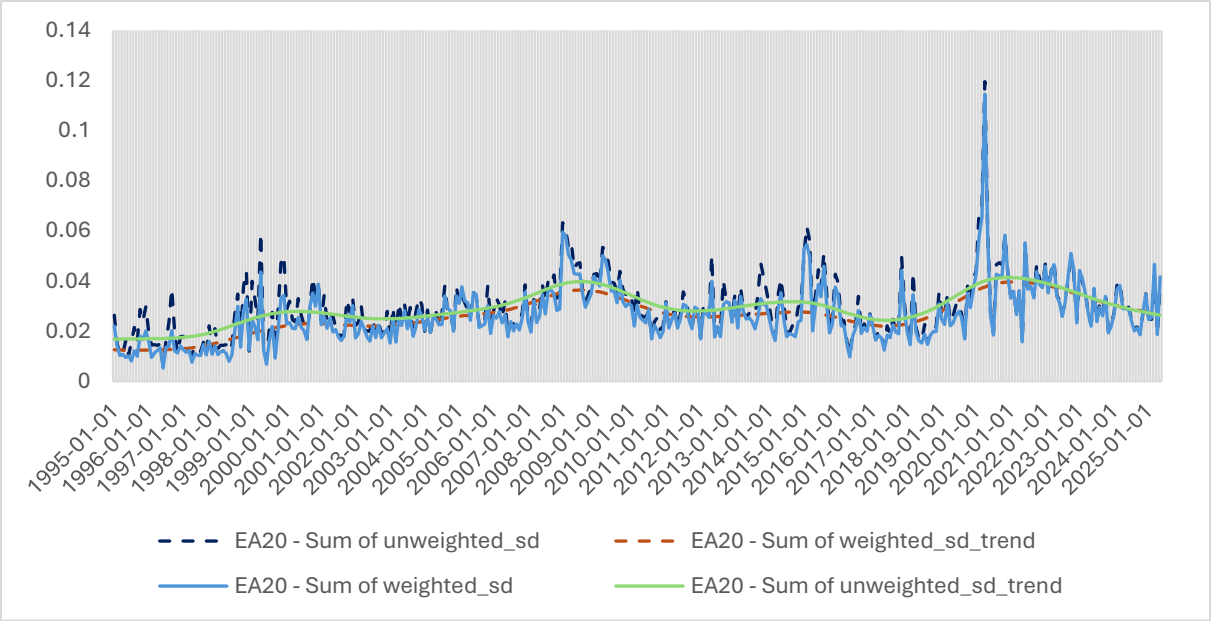



Chart 3 – Cross sectional dispersion of normalized GDP cycles: weighted vs. unweighted perspectives

10.2 Country-Level Leave-One-Out and Business-Cycle Analysis

Leave-one-out analysis of Euro Area dispersion reveals how individual members states shape the union's business-cycle volatility. Chart 4 examines two aggregate panels, the original Euro Area 12 compared to the enlarged Euro Area 20, over 30 years with five distinct phases: pre-EMU convergence (1995–1998), the early euro era (1999–2007), the financial and sovereign debt crisis (2008–2012), recovery and enlargement (2013–2018), and the COVID shock and aftermath (2019–2025). For each country, the percentage change in the weighted standard deviation of normalized GDP growth was calculated when that specific country is excluded. These leave-one-out impacts are summarized by their phase-averaged means and volatilities, allowing for the classification of economies as high-impact "synchronizers," medium-impact "mixed movers," or low-impact "idiosyncratics." The paired graphs for countries common to both EA12 and EA20, and the single-panel graphs for later joiners, illustrate these dynamics visually.

In EA12, five core members emerge as high-impact synchronizers. Austria, Belgium, France, Germany, and the Netherlands each raise aggregate dispersion by over three percent on average when dropped, with relatively low quarter-to-quarter volatility. Their synchronized business

cycles consistently anchor the EA12 average, so omitting them widens the dispersion around the mean. In the paired graphs, the leave-one-out series for these countries track closely across the EA12 side, underscoring their central role in driving the original euro-area cohesion.

A second cluster is the so-called “medium-impact mixed movers”, which includes Finland, Italy, Portugal, and Spain. Their average leave-one-out impacts on EA12 range between one and three percent, yet these effects fluctuate substantially across regimes. For instance, Italy and Portugal show pronounced negative troughs during the sovereign debt crisis, indicating that their cycles at times diverged from the union norm and, when removed, actually compressed dispersion. The EA12 graphs for Finland and Spain display these swings clearly, with peaks in the crisis years and dampened effects in the early-euro and recovery phases.

The third group of low-impact idiosyncratics in EA12 comprise Greece, Ireland, and Luxembourg. All three exhibit negative average impacts, often in double digits, so excluding them shrinks the overall dispersion. This pattern reflects idiosyncratic growth patterns or higher variance that contrast sharply with the EA12 average. On their dedicated graphs, their leave-one-out series bounce around zero and frequently dip below, signalling that these small or structurally distinct economies counterbalance the union’s synchronized core.

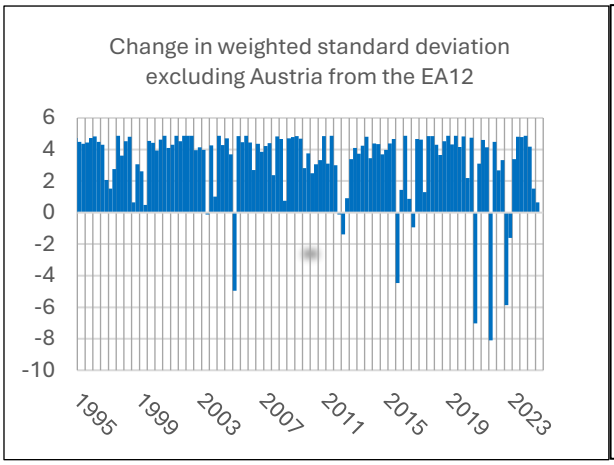
When the sample is extended to the EA20, enlargement dilutes any single country’s pull on dispersion. No member surpasses the three-percent threshold in the larger panel, and Germany’s average impact reverses sign to –18.8%. The eight new entrants – Croatia, Cyprus, Estonia, Latvia, Lithuania, Malta, Slovakia, and Slovenia – join Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain. Together, they form a broad medium-impact group with mean leave-one-out impacts around 2%. The new entrants single-panel graphs show modest, idiosyncratic contributions that vary little across phases.

A distinct low-impact cluster in EA20 contains France, Germany, Ireland, Italy, and Spain. Excluding any of these core economies marginally reduces dispersion, with phase-averaged means between –1.9% and –18.0%. The EA20 graphs for France and Germany highlight the stark reversal from EA12: these economies, prior being central synchronizers, become dampeners in the enlarged union. This change in dynamics underscores how adding diverse members reshapes the reference group’s centre, often placing large, synchronized cycles on the periphery of the new mean.

Contrasting the two panels shows that EA12 high-impact synchronizers contribute almost constantly, while EA20 lacks any dominant members. In the enlarged Euro Area, individual contributions are more evenly distributed, resulting in a flatter dispersion profile. Medium-impact mixed movers hold similar ranks in both panels, though their share is slightly lower in the larger EA20 grouping. Mixed movers' volatility is higher during crisis periods and muted during more stable phases.

Period-by-period inspection reveals regime dependence. Pre-EMU convergence and the early euro era see stronger high-impact effects in EA12, whereas the financial crisis illustrates idiosyncratic behaviour among mixed movers. Post-2013 recovery re-elevates synchronizers before enlargement again diffuses their pull. The COVID shock triggers temporary spikes in mixed-mover impacts across both aggregates.

In sum, the leave-one-out clustering provides a coherent taxonomy of Euro Area members. Core synchronizers in EA12 consistently widen dispersion when excluded, reflecting their pivotal role in the union-wide cycles. Medium-impact mixed movers introduce some conditional volatility, with crisis-linked divergences. Idiosyncratic dampeners offset overall spread, especially in EA20 where enlargement neutralizes individual dominance. These insights, supported by paired and single-panel graphs, enrich the understanding of how membership composition shapes business-cycle dispersion in a multi-country monetary union.


Change in weighted standard deviation
excluding Austria from the EA12
6
4
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-2
-4
-6
-8
-10
1995
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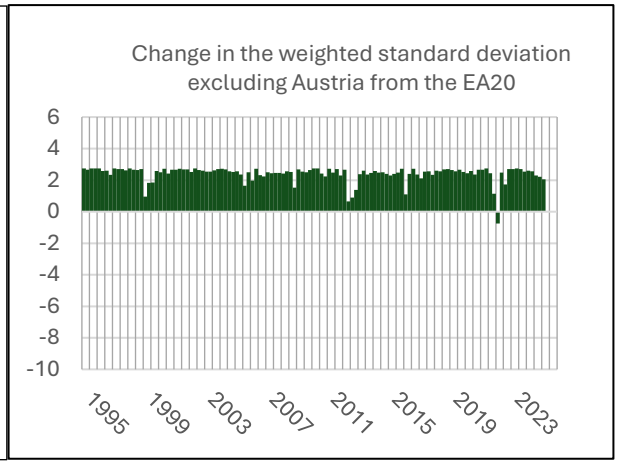
2015
2019
2023


Change in the weighted standard deviation
excluding Austria from the EA20
6
4
2
0
-2
-4
-6
-8
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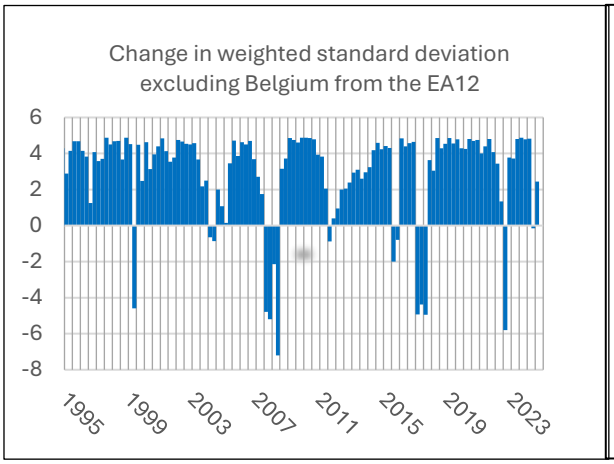
Change in weighted standard deviation
excluding Belgium from the EA12
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-4
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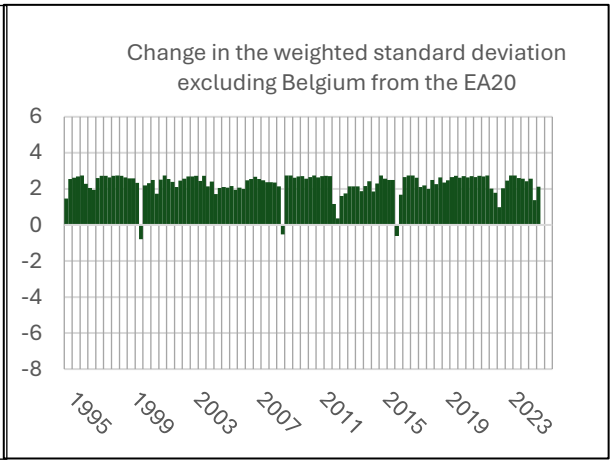
Change in the weighted standard deviation
excluding Belgium from the EA20
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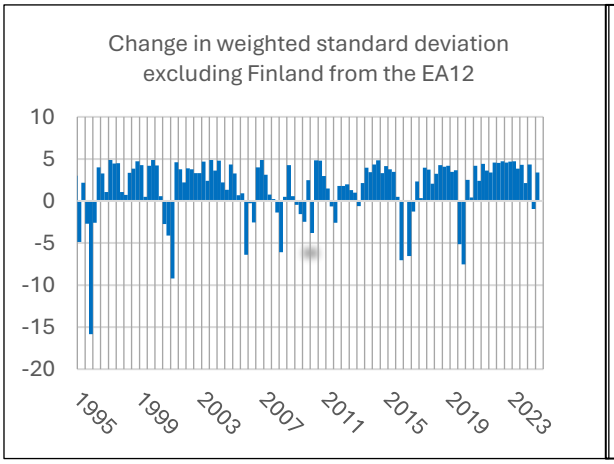
Change in weighted standard deviation
excluding Finland from the EA12
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-20
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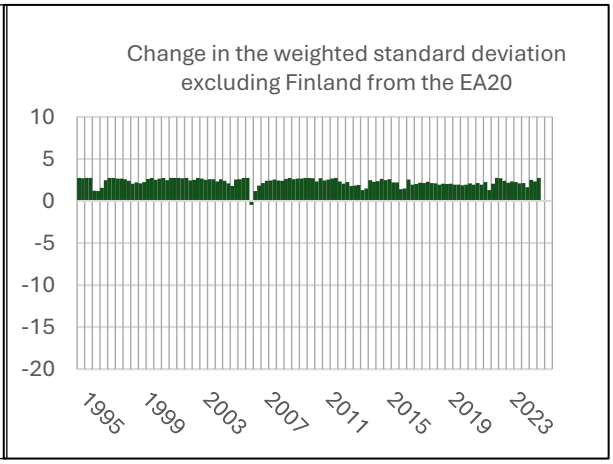
Change in the weighted standard deviation
excluding Finland from the EA20
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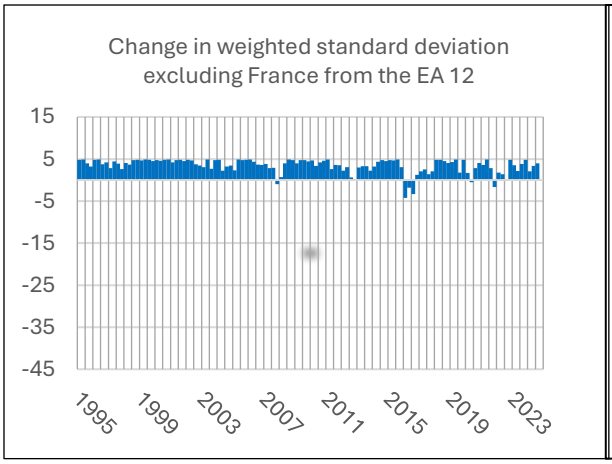
Change in weighted standard deviation
excluding France from the EA 12
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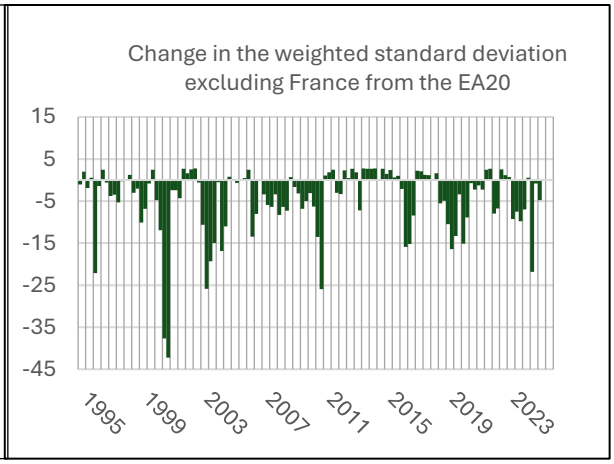
Change in the weighted standard deviation
excluding France from the EA20
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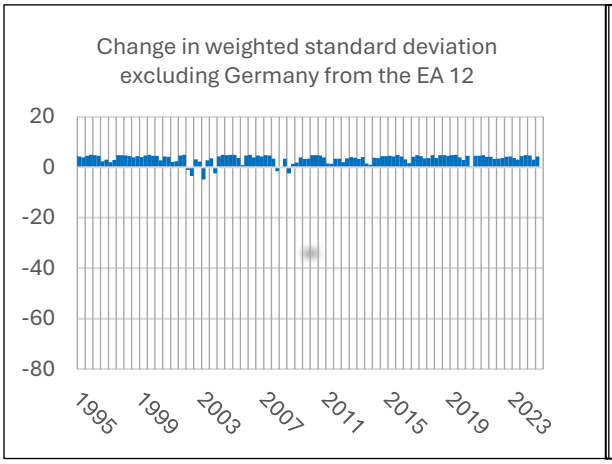
Change in weighted standard deviation
excluding Germany from the EA 12
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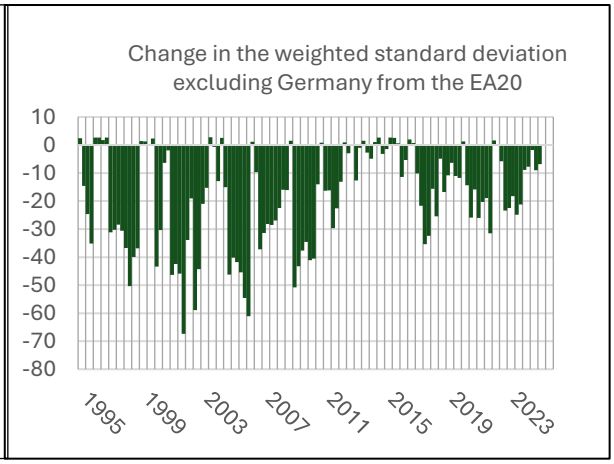
Change in the weighted standard deviation
excluding Germany from the EA20
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-10
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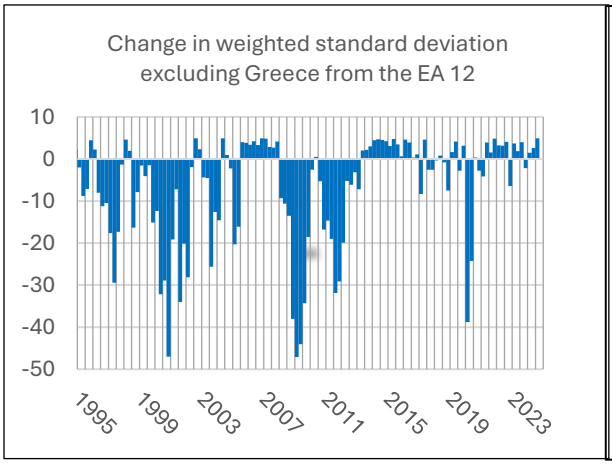
Change in weighted standard deviation
excluding Greece from the EA 12
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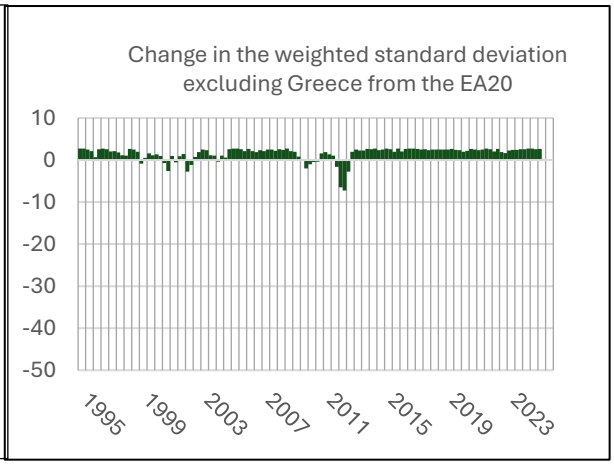
Change in the weighted standard deviation
excluding Greece from the EA20
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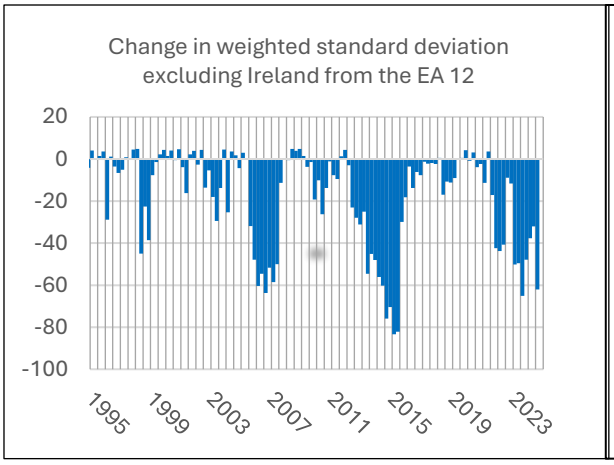
Change in weighted standard deviation excluding Ireland from the EA 12
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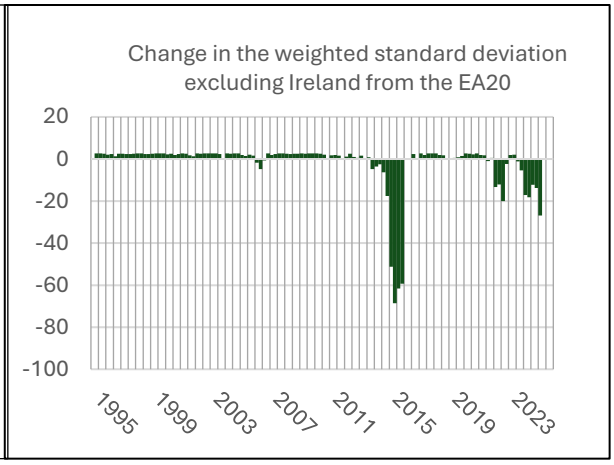
Change in the weighted standard deviation excluding Ireland from the EA20
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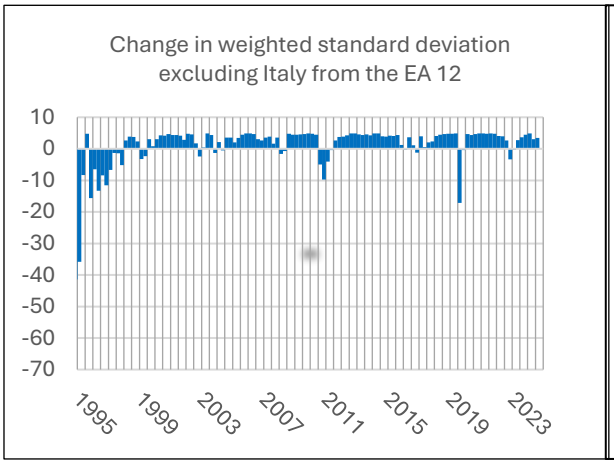
Change in weighted standard deviation excluding Italy from the EA 12
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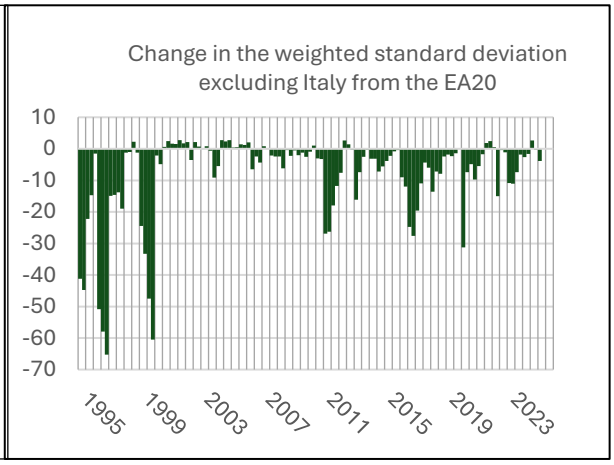
Change in the weighted standard deviation excluding Italy from the EA20
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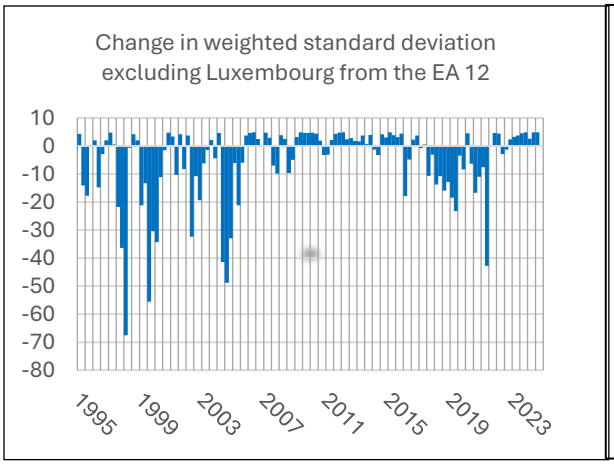
Change in weighted standard deviation excluding Luxembourg from the EA 12
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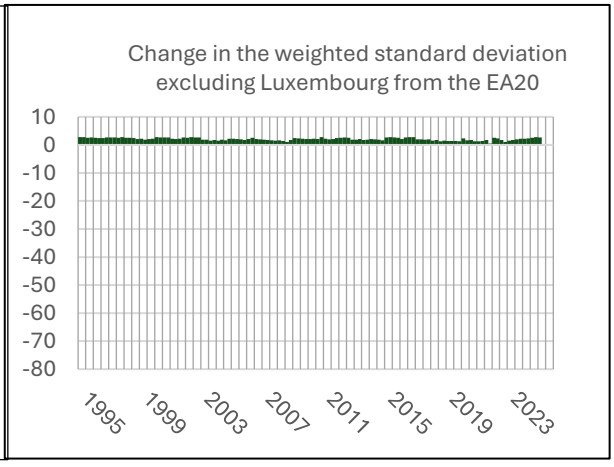
Change in the weighted standard deviation excluding Luxembourg from the EA20
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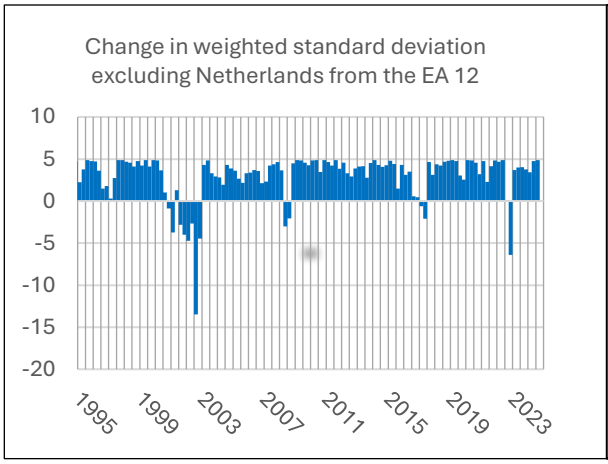
Change in weighted standard deviation
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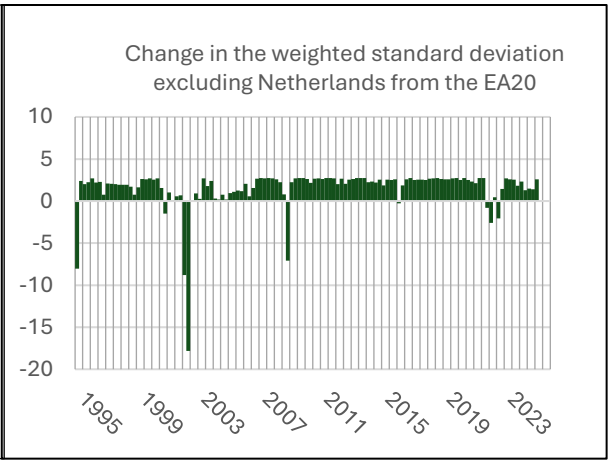
Change in the weighted standard deviation
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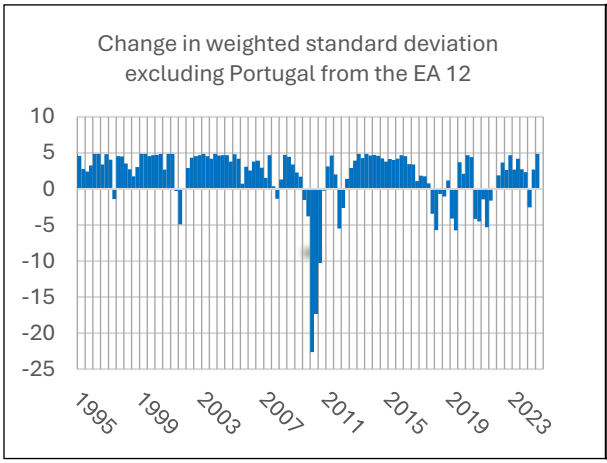
Change in weighted standard deviation
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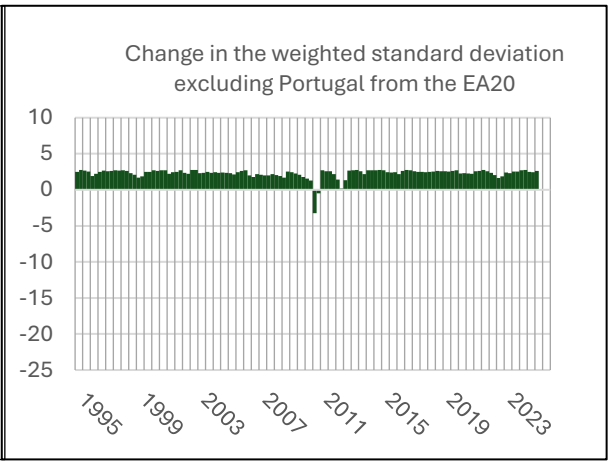
Change in the weighted standard deviation
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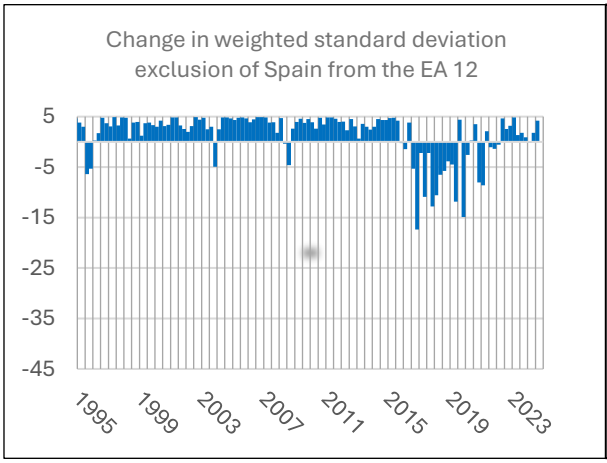
Change in weighted standard deviation
exclusion of Spain from the EA 12
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-15
-25
-35
-45
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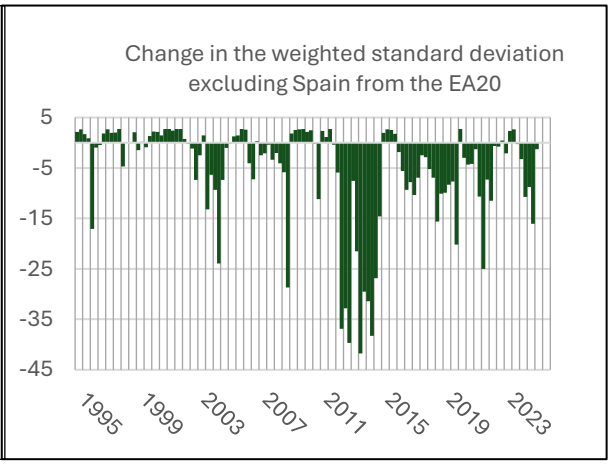
2023


Change in the weighted standard deviation
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-35
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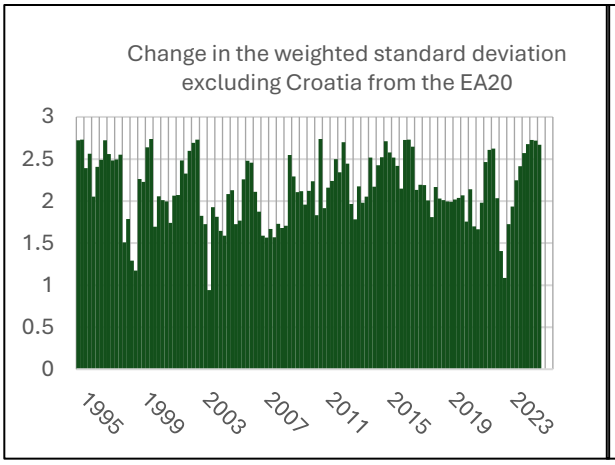
Change in the weighted standard deviation excluding Croatia from the EA20
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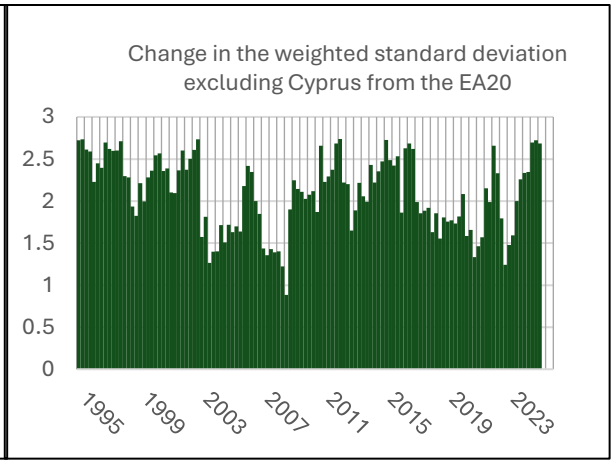
2
1.5
1
0.5
0
1995
1999
2003
2007
2011
2015
2019
2023


Change in the weighted standard deviation excluding Cyprus from the EA20
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1
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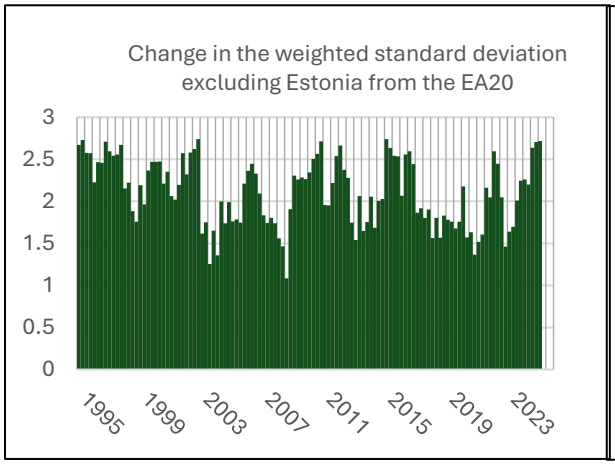
2023


Change in the weighted standard deviation excluding Estonia from the EA20
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1
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1995
1999
2003
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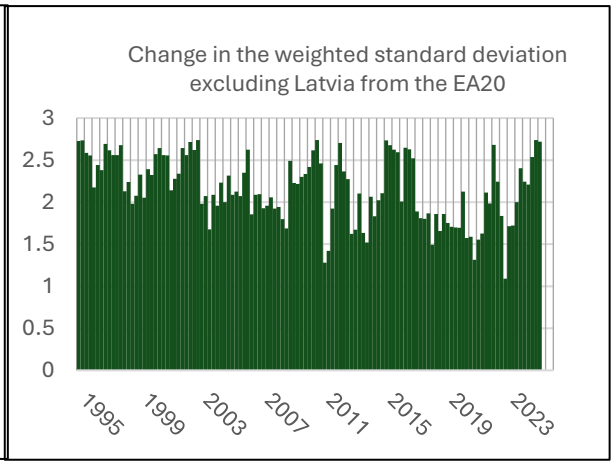
2019
2023


Change in the weighted standard deviation excluding Latvia from the EA20
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1
0.5
0
1995
1999
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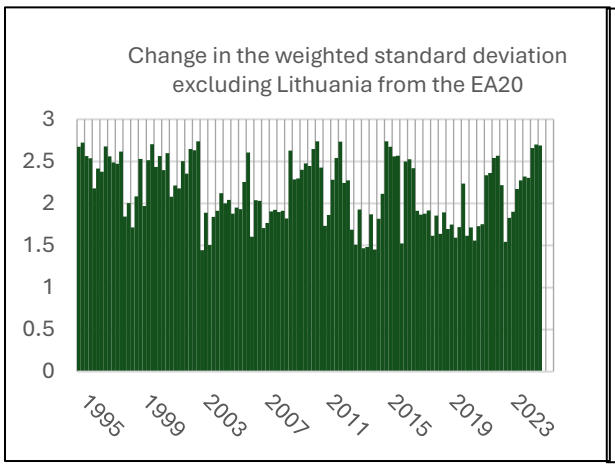
2019
2023


Change in the weighted standard deviation excluding Lithuania from the EA20
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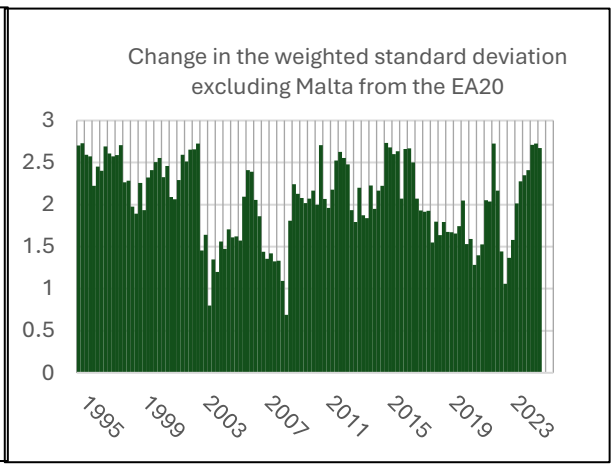
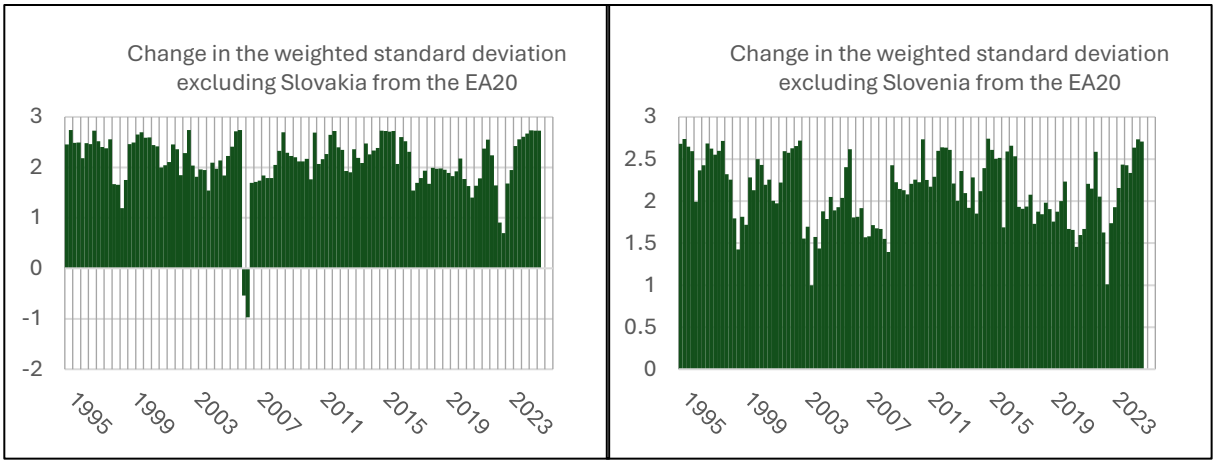
2.5
2
1.5
1
0.5
0
1995
1999
2003
2007
2011
2015
2019
2023


Change in the weighted standard deviation excluding Malta from the EA20
3
2.5
2
1.5
1
0.5
0
1995
1999
2003
2007
2011
2015
2019
2023




Charts 4.1-4.32 – Dispersion changes of GDP Cycles – Leave-One-Out analysis using all EA20 countries, compared with EA12 when possible (weighted vs unweighted graphs)

Table 1 represents the means, standard deviations, minimum and maximum points of the business cycles of individual countries separating them across the 5 defined periods, while the graphs of Chart 5.1-5.4 present only the 5th period as a timeseries. Dynamic integration within the Euro–Area transcends any static classification. By leveraging the one–year moving average of HP–filtered correlations between each EA20 economy and the aggregate Euro–Area output gap, the labels of "Core," "Semi–core," and "Peripheral" can be recast around the lived experience of business–cycle synchronization. Instead of presuming, like previous research, that Austria, France, Germany, Italy, and the Netherlands, always inhabit "Core" status, a period–by–period quartile split of mean correlations uncovers a far more nuanced narrative. In particular, this rolling average view validates the intuition that some countries temporarily break into the core or fall back toward the periphery.

During the 1995–1998 convergence run–up to the euro, the top quarter of economies in terms of mean correlation comprised Spain, France, Sweden, the Netherlands, Germany, Italy, Denmark, and Switzerland. Spain and Sweden, often thought of as periphery and EMU–out respectively, were at the forefront in their responsiveness to the emerging Euro–Area cycle. In contrast, Malta, Hungary, Slovakia, Ireland, Poland, and Portugal registered the lowest mean correlations and occupied the bottom quartile. Between those extremes sat a diverse group, including Austria, Belgium, Bulgaria, and the Czech Republic, with moderate co–movement. The peers often refer to mixed success of structural reforms and pre-EMU convergence criteria during this period.

The early euro era, spanning 1999 through 2007, witnessed an unprecedented broadening of the Core. Here, the Netherlands, Germany, Italy, France, Spain, Finland, Austria, and Latvia formed the top quartile. At the time the Euro Area began to be propelled by a uniform monetary policy, integrated financial markets, and benign global conditions. Southern Europe, Spain and Italy, elevated to Core status alongside a Baltic newcomer, Latvia. Meanwhile, Greece and Slovakia slipped into the bottom quartile, perhaps foreshadowing their later crisis vulnerabilities. Ireland and Portugal, which had exhibited moderate co–movement before the time of the euro, found themselves squarely in the middle.

The crisis of the 2008 – 2012 financial and sovereign–debt crisis tested the durability of these alignments. Once again, the highest mean correlations clustered Italy, Germany, France, Belgium, the Czech Republic, the Netherlands, Spain, and Sweden. Notably, the Czech Republic, an EMU-out, momentarily achieved Core–like synchronization, advancing its mean correlation above many traditional euro members. Conversely, Malta and Latvia slumped into the bottom quartile. Ireland, despite its infamous banking collapse, hovered in the middle group.

Recovery and enlargement, from 2013 to 2018, reshaped the Core once more. Germany, France, Italy, Spain, Malta, the Czech Republic, Portugal, and the Netherlands now comprised the top quartile of mean correlations. On the other hand, Norway, Denmark, Sweden, Romania, and Switzerland occupied the bottom quartile, meaning, some non-euro members and some new–member states struggled to fully integrate their business cycles despite the broader recovery. Greece and Ireland, though still grappling with high indebtedness, moved into semi–core territory, signalling modest synchronization gains.

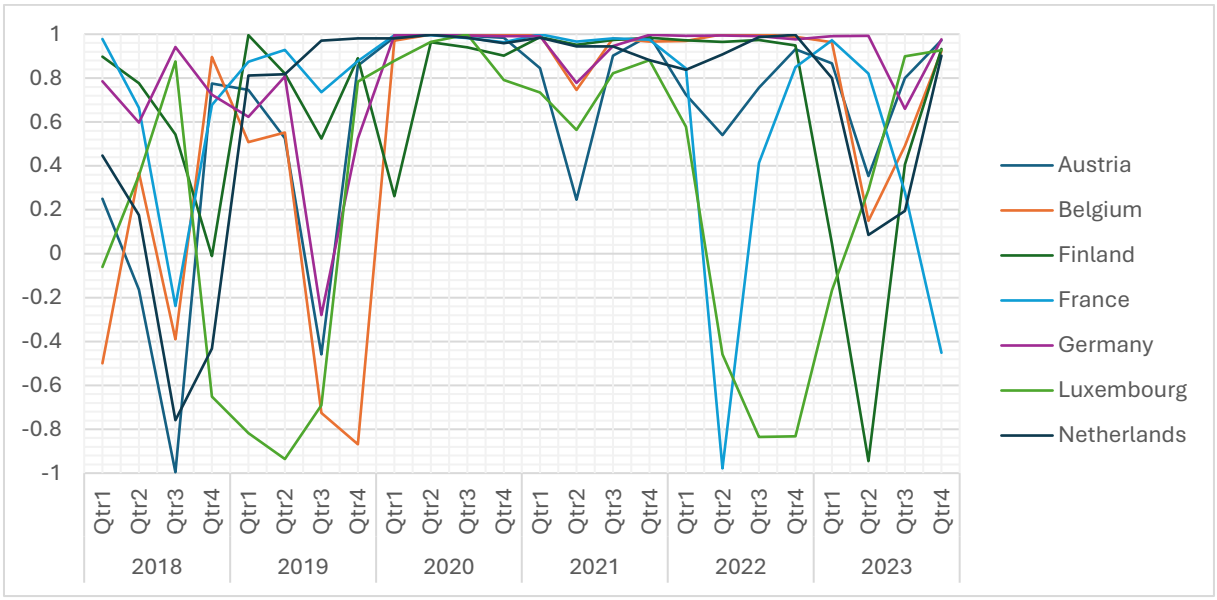
Finally, the COVID shock and its aftermath between 2019 and 2024 changed the groups slightly again. The period's Core included Italy, the Czech Republic, Germany, Austria, Greece, the Netherlands, Portugal, and Spain. Greece's ascent into the top quartile marks a remarkable turnaround from its precipitous crisis dip. In contrast, Malta, Luxembourg, and Ireland reverted to the bottom quartile. Countries like Sweden, Denmark, and Switzerland, also fell into the peripheral grouping, meaning, they were less synchronized with the Euro Area business cycles during this time.

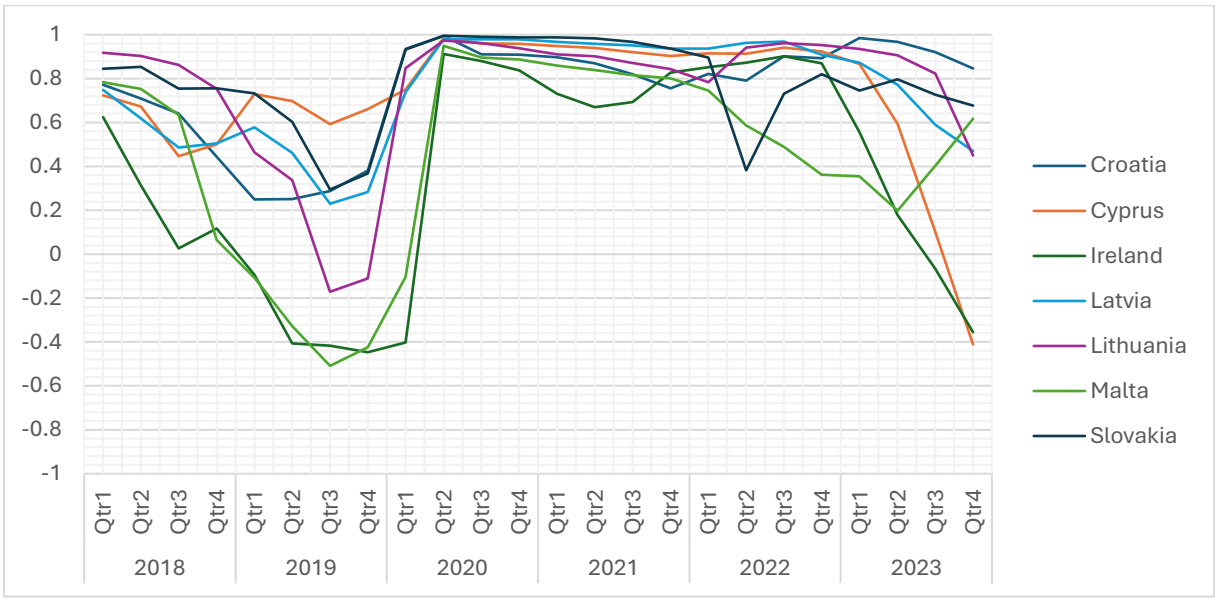
Time–varying recategorization shows that "Core" status shifts over time for many member states. Southern Europe's Core membership appears primarily in benign periods; the Czech Republic records brief elevations during crisis episodes; and small open economies such as Malta and Luxembourg exhibit recurrent volatility. Convergence discussions reference

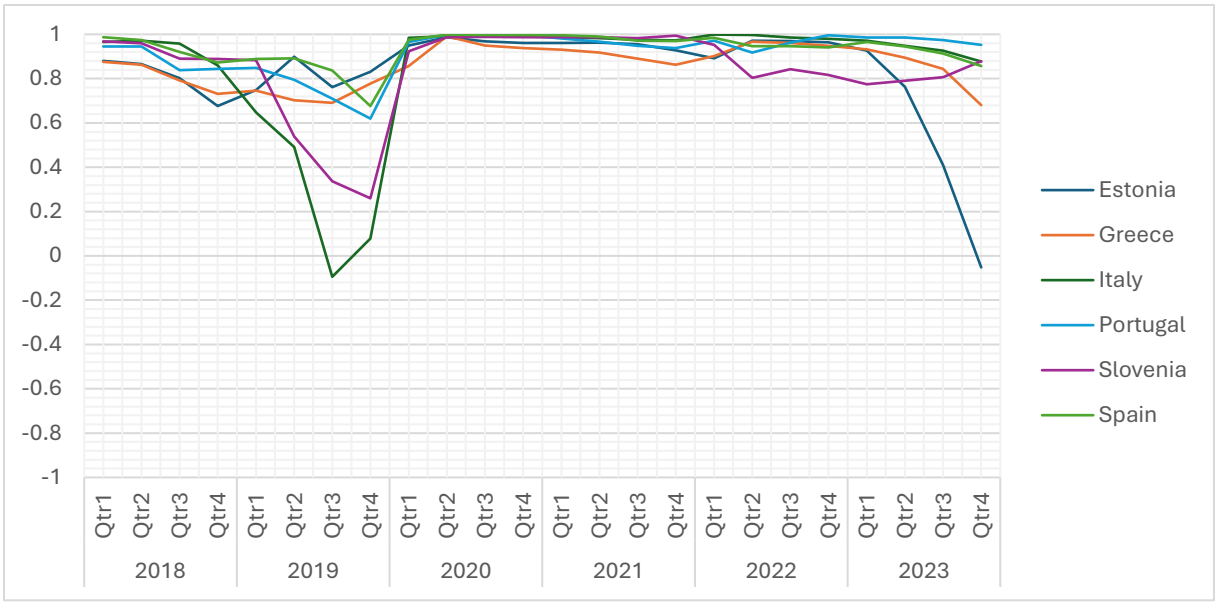
structural reforms, countercyclical fiscal buffers, and deeper financial union alongside common monetary policy. Real-time synchronization monitoring supports adjustment of support mechanisms – targeted conditional transfers or union-wide backstops – for economies near Core thresholds. Nuanced, data-driven stewardship aligns with objectives of deeper monetary-union integration across all members.

| | 1995-1998 | | | | 1999-2007 | | | | 2008-2012 | | | | 2013-2018 | | | | 2019-2024 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Min | Max | Mean | SD | Min | Max | Mean | SD | Min | Max | Mean | SD | Min | Max | Mean | SD | Min | Max |
| Austria | 0.174173 | 0.636183 | -0.73595 | 0.899088 | 0.466906 | 0.508692 | -0.9325 | 0.996962 | 0.489338 | 0.663142 | -0.89123 | 0.988454 | 0.180866 | 0.633663 | -0.99571 | 0.993313 | 0.76252 | 0.332246 | -0.45937 | 0.997453 |
| Belgium | 0.234835 | 0.639968 | -0.66698 | 0.98936 | 0.341685 | 0.649321 | -0.98963 | 0.986062 | 0.720498 | 0.434053 | -0.67087 | 0.989015 | 0.025572 | 0.679948 | -0.99824 | 0.967761 | 0.721195 | 0.51654 | -0.8683 | 0.999719 |
| Bulgaria | 0.27323 | 0.525039 | -0.67299 | 0.96217 | 0.108259 | 0.65697 | -0.99006 | 0.98841 | 0.362985 | 0.659366 | -0.90612 | 0.997625 | 0.14087 | 0.639079 | -0.99033 | 0.983141 | 0.592564 | 0.452854 | -0.4411 | 0.99467 |
| Croatia | -0.24905 | 0.497598 | -0.78486 | 0.805059 | 0.223433 | 0.620732 | -0.96913 | 0.9954 | 0.279548 | 0.532077 | -0.67859 | 0.980206 | 0.062165 | 0.605764 | -0.8995 | 0.990818 | 0.665832 | 0.360915 | -0.22589 | 0.99632 |
| Cyprus | -0.21779 | 0.570263 | -0.97604 | 0.645407 | 0.241473 | 0.662515 | -0.97976 | 0.993847 | 0.642308 | 0.540049 | -0.87849 | 0.994233 | 0.241939 | 0.465088 | -0.62334 | 0.978917 | 0.585592 | 0.454934 | -0.87154 | 0.9908 |
| Czechia | -0.05791 | 0.568575 | -0.86535 | 0.973007 | 0.097041 | 0.693466 | -0.98595 | 0.993514 | 0.702634 | 0.373325 | -0.37457 | 0.995899 | 0.384178 | 0.642737 | -0.98714 | 0.977318 | 0.88448 | 0.133403 | 0.465009 | 0.998581 |
| Denmark | 0.395975 | 0.480076 | -0.75588 | 0.921233 | 0.216337 | 0.670801 | -0.97024 | 0.984819 | 0.348375 | 0.718135 | -0.96736 | 0.983116 | -0.05344 | 0.711372 | -0.96749 | 0.985844 | 0.272841 | 0.860158 | -0.96056 | 0.999717 |
| Estonia | 0.117685 | 0.411165 | -0.57299 | 0.710502 | 0.195733 | 0.632577 | -0.95573 | 0.986993 | 0.25335 | 0.741667 | -0.99766 | 0.991122 | 0.251454 | 0.694767 | -0.9345 | 0.993014 | 0.694937 | 0.527579 | -0.86886 | 0.997833 |
| Finland | 0.086086 | 0.570631 | -0.71988 | 0.82924 | 0.493837 | 0.518085 | -0.80805 | 0.99627 | 0.528524 | 0.675132 | -0.85215 | 0.995399 | 0.354075 | 0.665959 | -0.93615 | 0.978063 | 0.744706 | 0.440491 | -0.94501 | 0.995815 |
| France | 0.507849 | 0.536457 | -0.49695 | 0.986486 | 0.67655 | 0.424955 | -0.27321 | 0.99888 | 0.793869 | 0.45228 | -0.60676 | 0.999952 | 0.548286 | 0.498313 | -0.78539 | 0.998795 | 0.73685 | 0.486691 | -0.97814 | 0.999831 |
| Germany | 0.435763 | 0.497219 | -0.40481 | 0.995953 | 0.805793 | 0.32378 | -0.69814 | 0.999611 | 0.909221 | 0.144042 | 0.506771 | 0.997781 | 0.604975 | 0.513476 | -0.7681 | 0.995213 | 0.864136 | 0.279359 | -0.27966 | 0.998471 |
| Greece | 0.138711 | 0.693142 | -0.79304 | 0.841422 | 0.072154 | 0.689484 | -0.99123 | 0.992571 | 0.185198 | 0.792837 | -0.99649 | 0.980963 | 0.229846 | 0.573596 | -0.94119 | 0.967719 | 0.763598 | 0.261318 | -0.14613 | 0.991034 |
| Hungary | -0.53386 | 0.496336 | -0.98713 | 0.418186 | -0.0999 | 0.642801 | -0.9875 | 0.984599 | 0.46049 | 0.602438 | -0.78053 | 0.976949 | 0.249706 | 0.573579 | -0.88333 | 0.999121 | 0.63173 | 0.566835 | -0.99034 | 0.995066 |
| Ireland | -0.4002 | 0.637228 | -0.99176 | 0.876164 | 0.361128 | 0.596902 | -0.81978 | 0.998922 | 0.480055 | 0.542898 | -0.81482 | 0.955547 | 0.341386 | 0.640701 | -0.82108 | 0.976004 | 0.358199 | 0.687834 | -0.99393 | 0.997957 |
| Italy | 0.415539 | 0.535067 | -0.78439 | 0.989728 | 0.745094 | 0.363327 | -0.74957 | 0.996524 | 0.973158 | 0.026423 | 0.91196 | 0.995868 | 0.550447 | 0.488123 | -0.28006 | 0.998235 | 0.913352 | 0.143956 | 0.376378 | 0.999878 |
| Latvia | -0.24701 | 0.512907 | -0.96164 | 0.462706 | 0.432899 | 0.621585 | -0.9197 | 0.999447 | 0.141715 | 0.819782 | -0.95002 | 0.997247 | 0.103859 | 0.488359 | -0.63412 | 0.857453 | 0.579155 | 0.47227 | -0.46035 | 0.998935 |
| Lithuania | -0.31811 | 0.505186 | -0.9228 | 0.479628 | 0.160629 | 0.68535 | -0.98893 | 0.995909 | 0.414372 | 0.637046 | -0.65787 | 0.994922 | 0.222232 | 0.687043 | -0.9022 | 0.994166 | 0.680026 | 0.428971 | -0.37468 | 0.997809 |
| Luxembou | 0.073244 | 0.670765 | -0.82217 | 0.998488 | 0.19862 | 0.654611 | -0.99243 | 0.996886 | 0.609345 | 0.438773 | -0.69425 | 0.998486 | 0.120518 | 0.636935 | -0.81372 | 0.997601 | 0.2511 | 0.703786 | -0.93566 | 0.998983 |
| Malta | -0.59202 | 0.437753 | -0.98349 | 0.543978 | 0.065227 | 0.659415 | -0.94229 | 0.957102 | 0.288551 | 0.642172 | -0.97723 | 0.996332 | 0.450687 | 0.58858 | -0.94548 | 0.993224 | 0.03879 | 0.700719 | -0.96869 | 0.972587 |
| Netherlan | 0.477113 | 0.638538 | -0.76138 | 0.973677 | 0.816406 | 0.263667 | -0.12201 | 0.997846 | 0.703456 | 0.445357 | -0.76218 | 0.99941 | 0.343424 | 0.510783 | -0.75867 | 0.992458 | 0.808305 | 0.251364 | 0.086021 | 0.997322 |
| Norway | -0.21919 | 0.635717 | -0.95983 | 0.931573 | 0.191749 | 0.707179 | -0.88165 | 0.995238 | 0.377071 | 0.700667 | -0.86676 | 0.974163 | -0.37085 | 0.483785 | -0.99336 | 0.937726 | 0.275976 | 0.761694 | -0.98849 | 0.996648 |
| Poland | -0.44861 | 0.476552 | -0.888 | 0.705083 | 0.240568 | 0.638403 | -0.92173 | 0.977327 | 0.569642 | 0.562625 | -0.81565 | 0.994155 | 0.222481 | 0.558618 | -0.9458 | 0.98576 | 0.442049 | 0.628138 | -0.93869 | 0.996206 |
| Portugal | -0.37265 | 0.42348 | -0.8881 | 0.253606 | 0.399615 | 0.619471 | -0.90633 | 0.993606 | 0.67702 | 0.529497 | -0.75388 | 0.998455 | 0.371669 | 0.615455 | -0.82722 | 0.992858 | 0.746736 | 0.404495 | -0.68898 | 0.999586 |
| Romania | -0.05464 | 0.673357 | -0.99047 | 0.965933 | 0.317476 | 0.664935 | -0.99602 | 0.985557 | 0.35682 | 0.568927 | -0.82961 | 0.973127 | 0.04011 | 0.59244 | -0.96904 | 0.900515 | 0.323121 | 0.674194 | -0.69556 | 0.999922 |
| Serbia | -0.07282 | 0.509316 | -0.85567 | 0.65099 | 0.139663 | 0.760204 | -0.99659 | 0.991808 | 0.316608 | 0.716488 | -0.85034 | 0.981365 | -0.16849 | 0.560988 | -0.93731 | 0.821392 | 0.419314 | 0.649026 | -0.96201 | 0.998624 |
| Slovakia | -0.51569 | 0.468046 | -0.99376 | 0.40181 | 0.072661 | 0.667973 | -0.96899 | 0.999993 | 0.340926 | 0.742756 | -0.90243 | 0.999394 | 0.370263 | 0.591372 | -0.7923 | 0.998881 | 0.561859 | 0.547081 | -0.92871 | 0.997951 |
| Slovenia | -0.22879 | 0.367455 | -0.74148 | 0.401116 | 0.1683 | 0.700864 | -0.99984 | 0.990744 | 0.696055 | 0.45852 | -0.75182 | 0.995889 | 0.33573 | 0.611338 | -0.87712 | 0.990665 | 0.648372 | 0.446298 | -0.34804 | 0.995934 |
| Spain | 0.669675 | 0.527754 | -0.56785 | 0.994436 | 0.574349 | 0.454731 | -0.50779 | 0.997064 | 0.76047 | 0.378216 | -0.56719 | 0.995654 | 0.578176 | 0.520154 | -0.37096 | 0.998637 | 0.706777 | 0.447544 | -0.50421 | 0.998456 |
| Sweden | 0.495938 | 0.481986 | -0.63006 | 0.982245 | 0.122049 | 0.674399 | -0.95823 | 0.992322 | 0.564297 | 0.506094 | -0.69073 | 0.997351 | 0.022822 | 0.502856 | -0.92563 | 0.77639 | 0.208725 | 0.623567 | -0.96935 | 0.96425 |
| Switzerlan | 0.404656 | 0.497045 | -0.59146 | 0.97569 | 0.214615 | 0.711062 | -0.98873 | 0.967417 | 0.603222 | 0.302539 | -0.00576 | 0.97847 | -0.09378 | 0.695216 | -0.96887 | 0.995158 | 0.305019 | 0.675767 | -0.98605 | 0.995557 |
| Grand Tot | 0.012405 | 0.136508 | -0.23152 | 0.168467 | 0.302012 | 0.299674 | -0.15543 | 0.788219 | 0.518304 | 0.26104 | 0.09536 | 0.960417 | 0.222039 | 0.235702 | -0.20776 | 0.698425 | 0.572929 | 0.250052 | 0.160408 | 0.985111 |

Table 1 – Rolling Correlations of National Business Cycles with the Euro Area enlargement, summary period-by-period





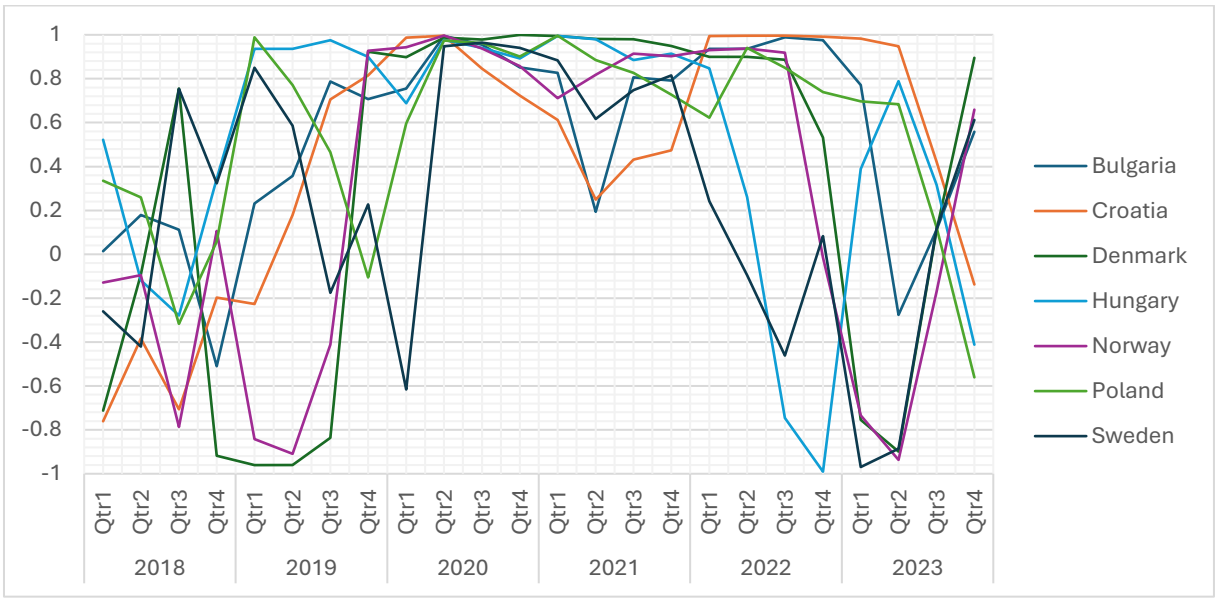




Chart 5.1-5.4 – Rolling Correlations of National Business Cycles with the Euro Area (core vs enlargement)

## 10.3 Regional Business-Cycle Profiles of Post-2008 Entrants

While peers have suggested breaking down regions to capture business cycles at different scales, this approach has yet to be empirically tested. Chart 6.1 presents the time-series of business–cycle movements for the Euro Area's latest 3 members, aligned with their region and regional adaptation periods.

### 10.3.1 Lithuania and Lativa's accession

Although the Baltic states entered the European Union in 2004, they did not join the Euro Area until later, Latvia in 2014 and Lithuania in 2015. To evaluate how their cycles converged with the broader Euro Area, HP-filtering was applied to the EA-20 series around each country's euro–adoption date with 2-year rolling correlation. Between 2013 and 2018, Latvia's and Lithuania's GDP and unemployment cycles unfolded over medium-term swings of roughly two years as they converged with Nordic and Baltic peers following euro-area accession. A two-year rolling correlation smooths out short-lived noise and aligns neatly with these full expansion-and-contraction phases.

The Baltic countries display both common regional patterns and unique national dynamics. Even with considerable economic differences among them, a gradual convergence toward the Euro Area's cycle is observable over time.

From 2013 to 2018, Finland shows the strongest and most stable positive correlation with the Euro Area 20 business cycle, reaching peaks above 0.95. Latvia, Estonia and Lithuania follows with high positive links (around 0.6 to 0.8). Sweden and Norway, neither being Euro Area members, do not closely follow its business cycles. The literature generally theorizes that the longer a country is a member of a monetary union, the more aligned its business cycle becomes with that of the union, which is coinciding with the graph.

Finland generally lagged behind the cycle, while Estonia starts out very well synchronized, just 2 years after its own accession to the Euro Area, but its business cycle synchronization falls immediately after the observed period begins, and so does the business cycle for the rest of the Baltics at the same period. Hence, it cannot be said that just the Euro adoption caused such an immediate negative effect for Estonia, unlike previous theories which suggested that immediately after Euro adoption, countries experience a sharp drop with their business cycle synchronization. Similar patterns are true, in 2014 for Latvia and 2015 for Lithuania's accession. Although as peers have shown, for Estonia, pre accession business cycle synchronization levels were high, the same cannot be said for Latvia (2014) and Lithuania (2015). The Baltics were initially following different cycles but with time and deeper Euro Area integration, their synchronization with EA19 improved in later years, which is especially visible in their post-Euro adoption period.

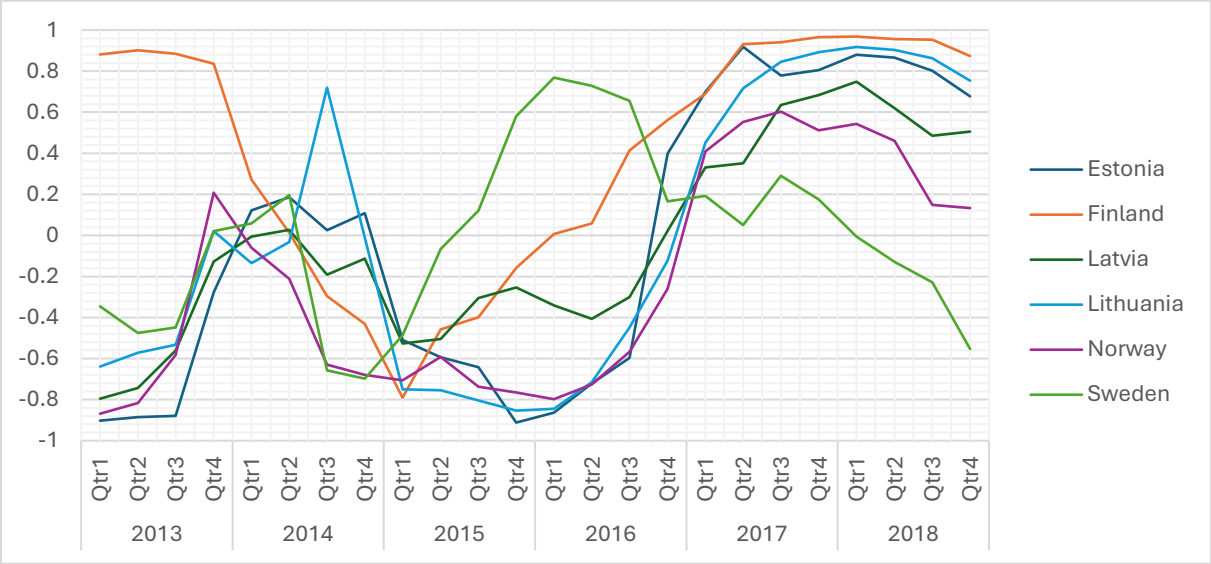



Chart 6.1 – GDP Rolling correlations – Baltics & Nordics against Euro Area 20 (2013-2018) – 2 Year moving average

Chart 6.2 shows the GDP output gap of the Baltics and Nordics against the Euro Area 20 with a 2-year moving average. The output gap describes how far actual GDP deviates from its potential, signalling whether an economy is running below capacity (slack) or above it (overheating). By tracking these gaps across countries and over time, a clear snapshot of cyclical strength is gained, which helps central banks and governments calibrate interest-rate moves, design fiscal support or restraint, and anticipate inflationary or deflationary pressures. In this framework, the Baltic and Nordic states' output-gap deviations serve as a theoretical measure of the welfare loss they would experience under a common monetary policy, whereby the European Central Bank sets its key interest rates on the basis of Euro-area wide conditions rather than individual national cycles. This graph shows a theoretical case Between 2013 and 2018, the six economies' HP-filtered output gaps trace an at first decreasing then increasing business-cycle curve: an average surplus of about 2.3% in 2013 turns into a gradual decline, tipping into a deep trough of roughly –1.8% by 2016 and then rebounds to a moderate 1.4% by 2018. In the early phase, Norway and the Baltic states drove the upswing, Norway's gap exceeded 9% in Q1 2013 while Estonia, Latvia and Lithuania, being part of the Euro Area, all had surpluses between 1.5% and 2.5%, before Norway dipped below –8.5% in late 2015 and even below –11.1% in Q1 2016. That same downturn saw the Baltics slide into mild contraction, dragging the group average ever lower. From mid-2016 onward, Finland and Sweden served as an anchor, remaining near zero and dampening the overall volatility for the group, but by 2017

they have the highest output gap, as Sweden's gap approached 1.7% and Finland's reached above 0.7% by year-end. The synchronized uplift reached its peak in 2018, when Latvia and Estonia posted the largest surpluses (2.4% and 2.0%), Norway rebounded to 3.3% and the overall average settled at 1.4%, reflecting both the shared cycle and the distinct national dynamics that shaped downturns and recoveries across Northern Europe.

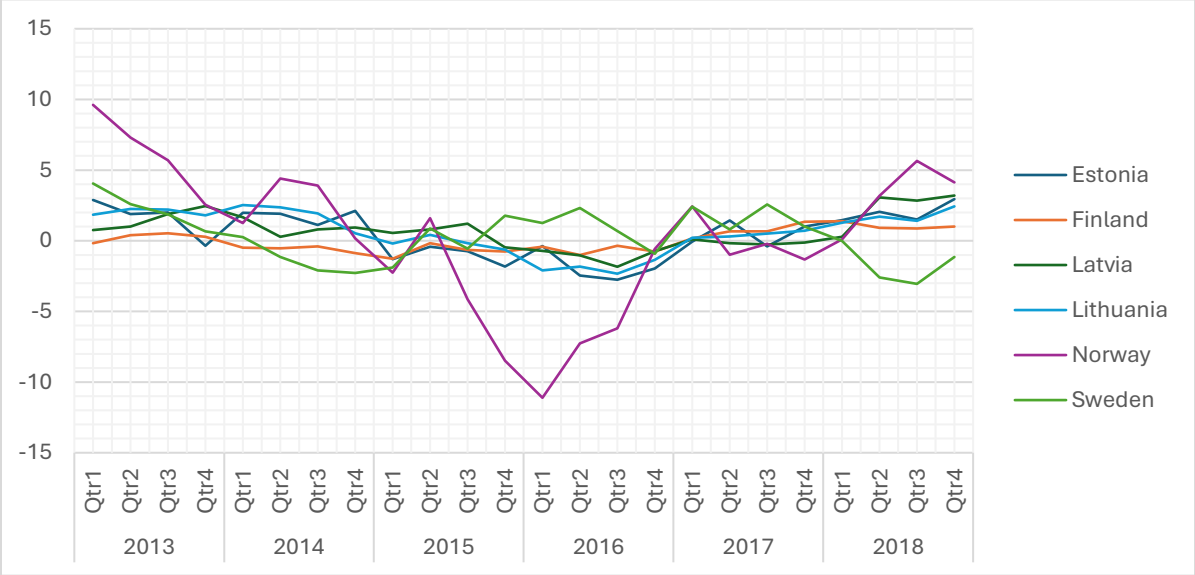



Chart 6.2 – GDP Output gap – Baltics & Nordics against Euro Area 20 (2013-2018) – Quarter by quarter changes

As other scholars have noted, unemployment can act as a crucial adjustment mechanism for countries in a shared currency area to weather and reset recessions. Graph 6.3 shows the unemployment cycle rolling correlations in the Baltics and Nordics. Between 2013 and 2018, Northern Europe's unemployment cycles exhibit moderate synchronization with the Euro Area unemployment cycles, with the six-country average rolling correlation hovering around 0.35. Finland and Sweden consistently lead this co-movement, around 0.39 to 0.51, Lithuania follows in the middle about 0.66, and Estonia and Latvia starting at roughly 0.21 to gradually converge toward regional norms. Early in the period, quarterly swings keep the correlations uneven, but by late 2018 all six economies align tightly, peaking above 0.62, signalling a maturing, shared cycle in unemployment dynamics in the region.

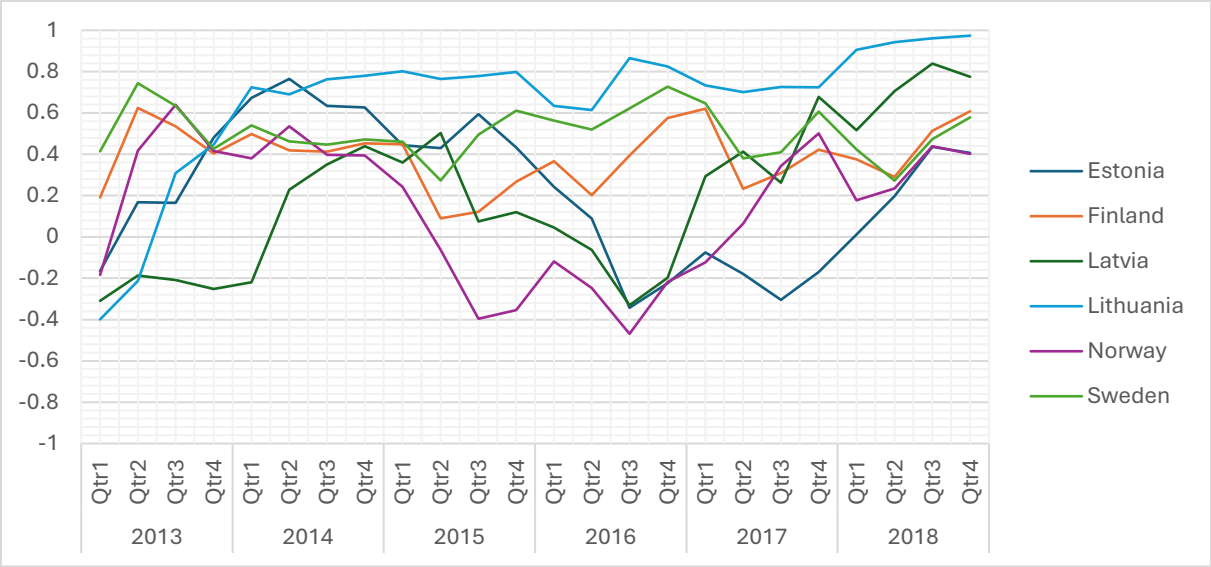



Chart 6.3 – Unemployment rolling correlations – Baltics and Nordics against Euro Area 20 (2013-2018) – 2 Year moving average

Chart 6.4 shows the unemployment output gaps of the Nordics and Baltics. Between 2013 and 2017, Northern Europe's unemployment gaps swing dramatically, averaging at a deep –4.5% slack in 2013–14, narrowing to roughly –0.9% in 2015, turning into a positive 3.1% tightening in 2016 and then drifting back to a slight –0.5% slack by 2017. Beneath this regional arc lie stark national contrasts: Norway's unemployment gap is positive in most quarters, signalling higher unemployment than the Euro–area average, while the three Baltic states almost always display negative gaps, indicating tighter labour markets. Sweden and Finland, by contrast, hover much closer to zero: they oscillate between slight positive and negative deviations rather than consistently sitting on one side of the cycle. Quarterly extremes, from Estonia's –16.8% trough in Q2 2013 to Finland's positive 24% peak in Q2 2015 and a cluster of 6% readings in early 2016, highlight how idiosyncratic shocks and policy shifts are associated with divergent labour-market cycles even amid a shared regional rhythm.

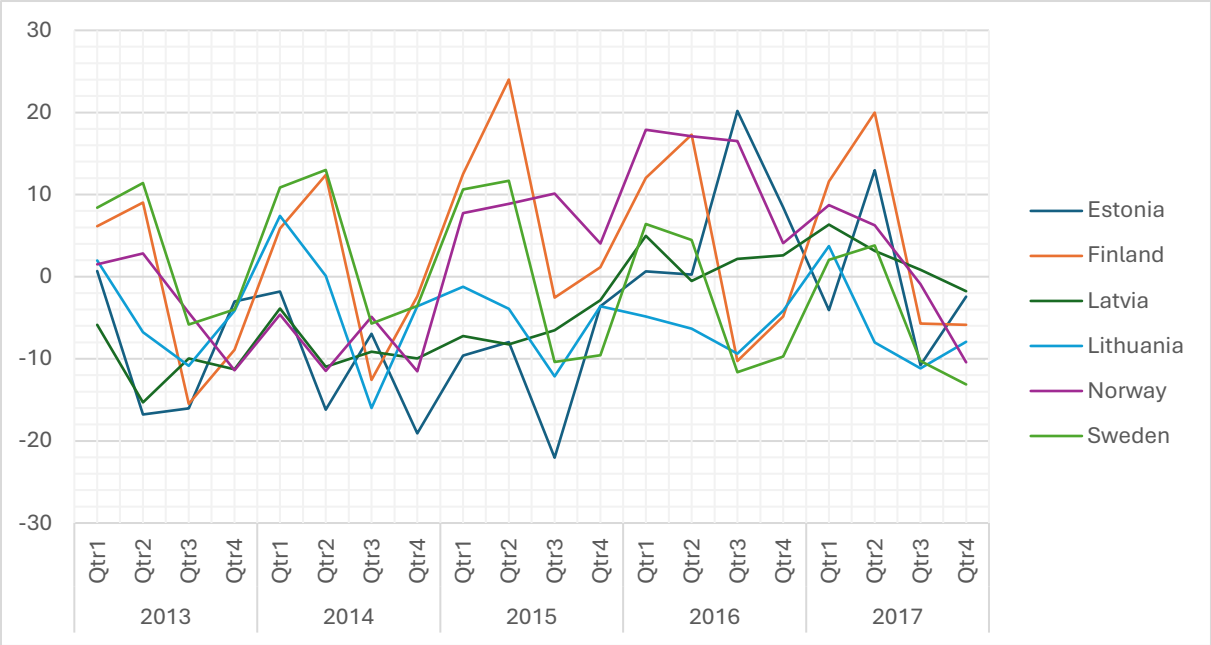



Chart 6.4 – Unemployment output gap – Baltics & Nordics against Euro Area 20 (2013-2018) – Quarter by quarter changes

Across 2013–2018, the "four lenses" on Northern Europe's macro cycles paint a coherent yet nuanced picture: Euro-area accession has driven a clear trend toward synchronized business cycles and unemployment dynamics, but country- and region–specific as well as other factors still shape each economy's path. Finland, Lithuania and Sweden emerge as the most closely aligned with the Euro-area core, posting the highest rolling correlations in both GDP and unemployment, while the rest of the Baltic states start from lower co-movements but steadily converge. Norway, though outside the Euro Area, shows the largest cyclical swings of all six economies. Its HP-filtered output gap moves from a surplus in 2013 through a deep contraction in 2016 to mild overheating by 2018, while its unemployment gap alternates between pronounced slack and tightening with unusually high volatility. Unemployment correlations with the Euro Area increase from moderate to strong by late 2018, mirroring the output-gap resurgence, yet quarterly extremes in both series illustrate how idiosyncratic shocks and structural differences coincide with a broadly shared cycle.

### 10.3.2 Croatia's accession

From 2020 to 2024, Croatia and its neighbouring economies saw COVID-driven shocks compress peaks and troughs into much shorter spans, with output gaps and labour-market

responses playing out within a single year. A one-year rolling window therefore captures those rapid, pandemic-induced cycle shifts far more responsively.

Chart 7.1 presents one–year rolling correlations of Croatia's GDP cycle with those of Hungary, Italy, Romania, Slovakia and Slovenia, using an HP filter centered around Croatia's euro–adoption date. In the pre–adoption period of 2020–2022, at first, Croatia's cycle moved almost in par with Italy and Slovakia, their yearly correlations hovered above 0.95, while Hungary and Slovenia closely followed at roughly 0.91. The COVID–19 shock's aftermath period in 2021 shattered the co–movement of countries: Croatia's average synchrony plummeted to 0.44 and reached a quarterly trough of 0.25 in Q2. There seems to be a short-lived robust recovery in 2022 that restored near–perfect alignment of 0.995 of Italy and strong co–movement of Romania with the EA20, even as Hungary experienced a brief negative correlation amid asymmetric shocks. Following euro adoption, Croatia, Italy and Slovenia correlations initially spiked above 0.90, but mid–2023 correlations for Hungary and Slovakia fell briefly below zero, producing an annual average of 0.54 in the region. By late 2024, however, bilateral correlations rebounded again above 0.97 across all peers and the regional average rose to 0.75, coinciding with the theoretical proposition that longer tenure in a monetary union gradually deepens business–cycle synchronization. Nevertheless, the countries in the region show volatile co-movement trends with the EA20 aggregate.

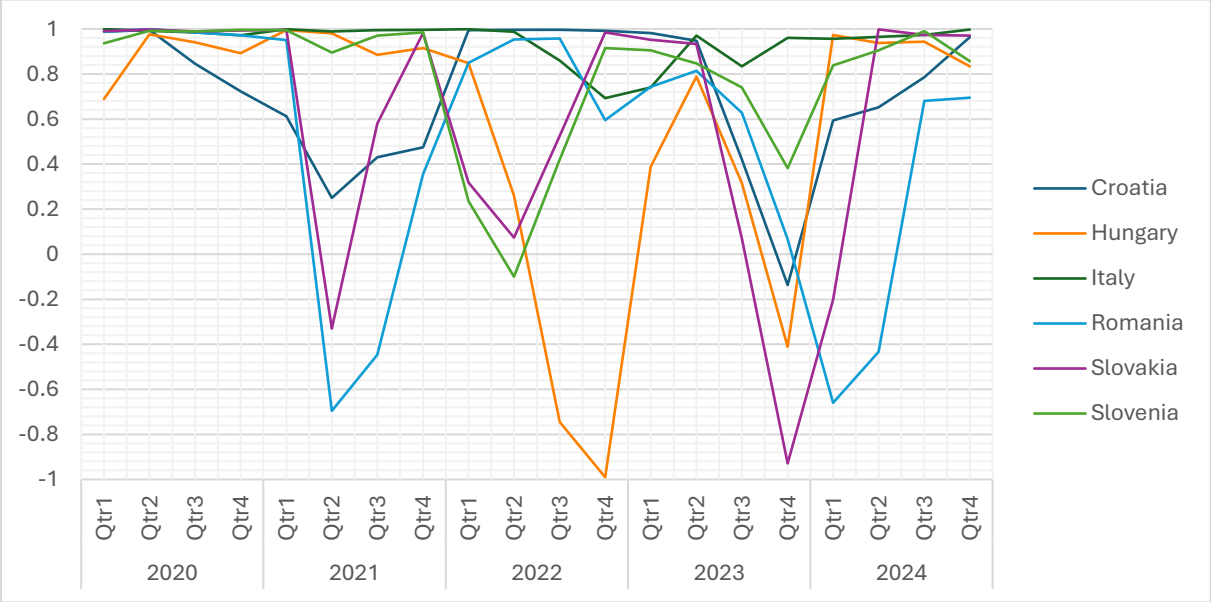



Chart 7.1 – GDP Rolling Correlations – Croatia and its region against the EA20 (2020-2024) – 1 Year moving average

Chart 7.2 presents the GDP output gaps of Croatia and its region from 2020 through 2024, illustrating how actual GDP deviates from potential output and signals slack or overheating across the region. In 2020 the six economies ran deeply below capacity, with a group–average gap of –6.7% highlighted by a catastrophic Q2 trough of –13.9% (Croatia –16.4%, Italy –16.1%), before easing to –5.4% by year–end, which coincides with the close downs of the pandemic. The post–pandemic rebound in 2021 still left the region in notable slack, average gap of –3.6%, even as Croatia narrowed its shortfall from –7.4% in Q2 to –3.7% by Q4 and Italy recovered toward zero. By 2022 slack had almost evaporated: the group average tightened to –1.0%, Italy became the first to reach a sustained positive gap (peaking at 1.4% in Q4), and Hungary even overshot into positive 2.0% in Q1 before returning to –5.4% in Q4. That momentum gave way to widespread overheating in 2023, when the regional average leapt to 3.1%, driven by Hungary's 6.5% peak in Q2, Slovenia's 4.3% and Croatia's 3.7%, while Italy and Romania both maintained surpluses above 2%. By 2024 the upswing was slowing: the average gap fell to 1.1%, with surpluses above 2.3% in Q1 and 1.7% in Q2 giving way to only 0.6% in Q3 and essentially balanced at a near-neutral 0% in Q4. This full cycle, from deep slack through rapid normalization to broad overheating and back toward equilibrium, unfolded under a uniform monetary policy environment alongside coordinated fiscal and macroprudential measures to address inflationary pressures.

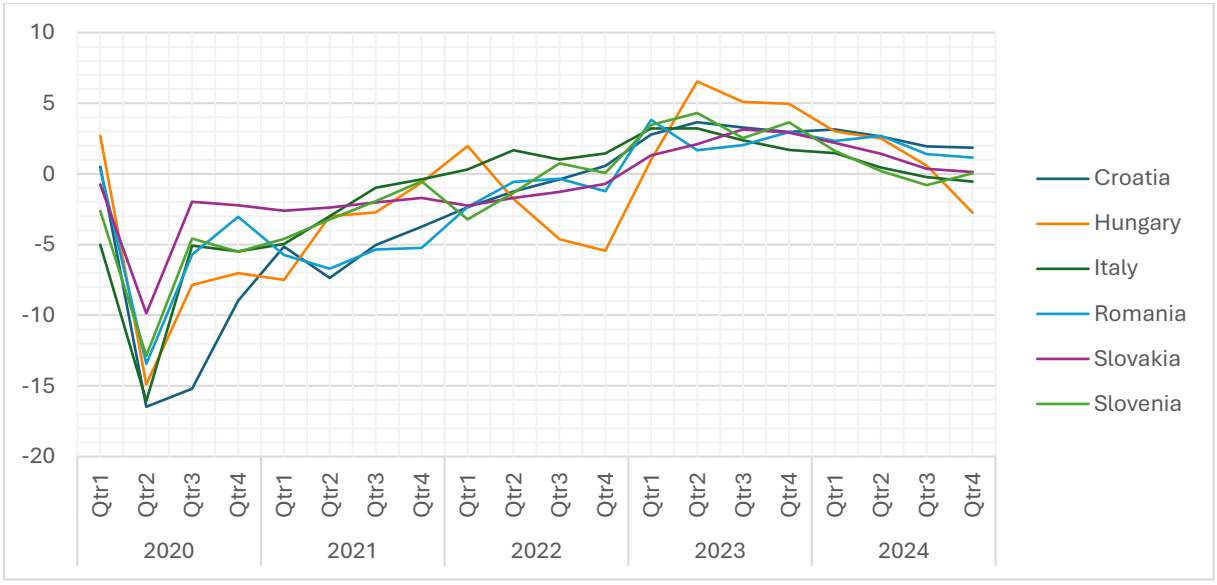



Chart 7.2 – GDP Output Gap – Croatia and its region against the EA20 (2021-2023) – Quarter by quarter

Graph 7.3 shows the one–year rolling correlations of unemployment–cycle fluctuations for the same region against the Euro-Area benchmark from 2020 through 2024. In 2020 these six economies exhibited moderate co-movement, averaging a correlation of 0.57 as this time pandemic–driven job losses unfolded in parallel, with Croatia's cycle at 0.74, Romania at 0.67 and Italy at 0.58. The annual average surged to 0.75. Correlations peaked in Q1 2021 above 0.83 across the group and remained elevated through the end of that year. In 2022 alignment held broadly strong, average of 0.72, despite Romania's brief Q1 dip to 0.04 and Hungary's jump to nearly 0.96 in Q2. 2023 saw a marked weakening to an average of 0.50, Croatia fell to just 0.10 in Q1 and Slovenia to 0.05, while Hungary and Italy sustained higher links above 0.70, highlighting uneven recoveries. By 2024, the downward trend continued with an average of 0.31. Croatia, Hungary and Italy displayed correlations between 0.30 and 0.85, whereas Romania and Slovenia showed lagging or slightly negative correlations. Labour-market cycles in Southeastern Europe remain in the process of convergence rather than fully synchronized.

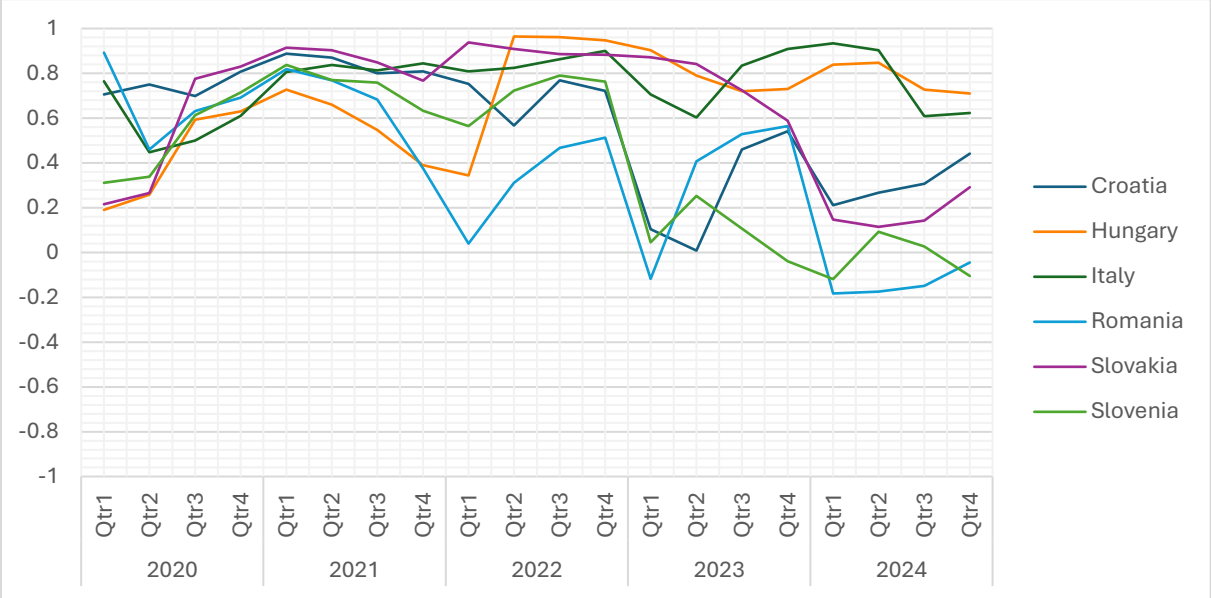



Chart 7.3 – Unemployment rolling correlations – Croatia and its region against the EA20 (2021-2023) – 1 Year moving average

Chart 7.4 shows the unemployment output gaps of the same region from 2020 through 2024, illustrating the deviation of actual unemployment from its long–run trend under a common monetary regime. In 2020 the region's labour market swung from mild tightness in Q1 (–6.5%) to pandemic–induced slack of 2.1% in Q2, before yawning further to 8.7% in Q3 and peaking at 11.6% in Q4, yielding an annual average gap of 3.95%. The acute shock of 2021 drove

average slack to 9.21%, as Croatia and Romania vaulted above 20% in Q1, then gradually eased to 2.1% by Q3 and 4.3% by Q4. In 2022 cyclical slack all but disappeared, the annual average narrowed to 1.40%, even recording mild tightening in Q2 (–0.82%) and Q3 (–0.95%) before settling at 1.8% in Q4. The post–pandemic rebound in 2023 produced moderate overheating compared to the EA20 with an average gap of 1.80%, but pronounced quarterly volatility, from 7.3% in Q1 to –2.6% in Q2 and near–neutral in Q3, underscored divergent national recoveries. By 2024 the region inched into marginal tightening, posting a slight negative average gap of –0.31% even as quarter–to–quarter swings persisted, from 2.6% slack in Q1 to –5.7% in Q2 and back toward equilibrium by year–end, highlighting that despite shared monetary policy, idiosyncratic sectoral shocks continue to drive uneven labour–market cycles across Southeastern Europe.

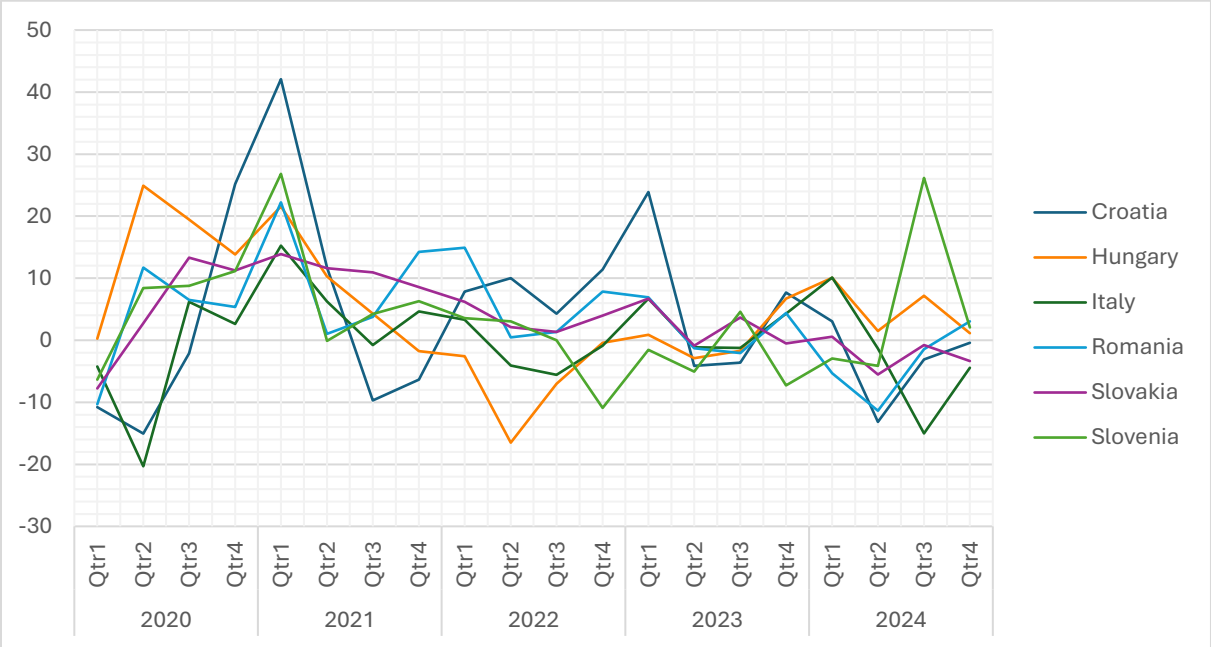



Chart 7.4 – Unemployment Output gap – Croatia and its region against the EA20 (2020-2024)

Across 2020–2024, these observed four complementary indicators of Southeastern Europe's macro–cycles, business–cycle correlations, GDP output gaps, unemployment–cycle correlations and unemployment output gaps, reveal a coherent yet richly textured convergence story under the euro. One–year rolling correlations of GDP show Croatia and Slovakia moving in near–perfect tandem with Italy and each other in 2020, falling to troughs around 0.25 in mid-2021 at the height of the pandemic, then re-synchronizing sharply after Croatia joined the euro in January 2023, even as ties with Hungary, Romania and Slovenia remained more episodic.

HP-filtered GDP output gaps trace a slack-to-overheating curve: from an average shortfall of –6.7% in 2020 (with Q2 troughs near –14%), through –3.6% in 2021 and near equilibrium in 2022 (–0.95%), to broad-based overheating of 3.1% in 2023, before moderating to 1.1% by late 2024. Unemployment–cycle correlations climbed from a moderate 0.57 in 2020 to peaks above 0.75 in 2021–22, reflecting coordinated labour-market interventions, then receded to 0.50 in 2023 and 0.31 by 2024 as recovery paths diverged. Meanwhile, unemployment output gaps ranged from mild slack (average 3.95% in 2020) to extreme surplus gaps of 9.2% in 2021 (Croatia alone surged over 40% in Q1), tightened almost to equilibrium in 2022 (1.4%), overheated again in 2023 (1.8%), and edged into slight tightening (–0.3%) by 2024. Taken together, these four perspectives illustrate both sustained alignment and periodic divergence in the region's convergence path.

## 11. Discussion of the findings

The decomposed quarterly GDP growth of the EA20, obtained via Kalman–filter extraction, describes a pronounced deceleration of potential output alongside episodic but severe cyclical shocks. From 1995 Q2 through 2007 Q4, the trend component remained anchored between 2.3% and 2.6%, a period marked by structural expansion. The Global Financial Crisis corresponds with a shift: trend growth fell to 1.8% by 2010 Q1 and stayed below former levels until the mid-2010s. Although a modest recovery raised potential growth toward 2.0% by 2019, the COVID-19 downturn brought it to 1.4% by 2025 Q1, the series' lowest point, consistent with aging demographics, subdued investment, and slowing productivity. Cyclical deviations show vulnerabilities and resilience: a –4.2% output gap in 2009 Q1 was followed by a –10.6% trough in 2020 Q2. Coordinated fiscal and monetary measures coincide with a recovery to a 1.6% positive gap by 2021 Q2, then moderation to 0.6% slack by 2025 Q1.

Cross-country dispersion of normalized GDP cycles, shown in Chart 2, presents long-run convergence before divergence at major crises. Unweighted cyclical standard deviation declined from about 3.3% in the mid-1990s to 2.5% by 2000, coinciding with the euro's introduction and harmonized monetary policy. Weighted measures, emphasizing larger economies, reduced dispersion by nearly half. The 2008 crisis produced a spike in unweighted dispersion to 5.5%, while weighted dispersion rose to 1.7%. Although dispersion receded during the sovereign-debt period, it did not return to pre-2007 levels. The COVID-19 episode coincided with another widening, unweighted cyclical dispersion peaked near 3.3%, before

settling around 2.2% by late 2021. Throughout, weighted dispersion remained roughly half the unweighted level.

Chart 3 applies the same HP-filtering framework to monthly industrial production as a robustness check. Using a higher smoothing parameter for monthly frequency, unweighted cyclical dispersion averaged 2.9% from 1995 to 2025, while weighted dispersion averaged 2.6%. The 2008 crisis raised unweighted dispersion to 3.8%; the pandemic induced a monthly high of 12.0% in April 2020. By 2023, dispersion receded to around 3.4%. The close alignment between weighted and unweighted series suggests that industrial volatility in large economies weighs nearly as heavily as that in smaller members. These outcomes replicate mid-1990s convergence, crisis-induced divergence, and elevated post-crisis baselines independently of data frequency.

Chart 4's leave-one-out analysis examines country-level contributions to dispersion in both EA12 and EA20 panels. Within EA12, Austria, Belgium, France, Germany, and the Netherlands emerge as high-impact "synchronizers," each associated with more than a 3% increase in dispersion when excluded. Finland, Italy, Portugal, and Spain comprise medium-impact "mixed movers," whose conditional effects sometimes narrow dispersion during crises. Greece, Ireland, and Luxembourg act as low-impact "idiosyncratics", whose omission reduces variability. Enlargement to EA20 corresponds with a dilution of individual influences: no country surpasses the 3% threshold, and Germany's exclusion is linked to a slight reduction in dispersion. The eight new entrants exhibit medium-impact contributions, indicating that union expansion reshapes overall cohesion.

Dynamic core–periphery classification, based on rolling one-year HP-filtered correlations, shows that "Core" membership shifts across the five phases of pre-EMU convergence (1995–1998), early euro era (1999–2007), financial and sovereign-debt crisis (2008–2012), recovery and enlargement (2013–2018), and the COVID-19 shock plus aftermath (2019–2024). Chart 5's quartile splits indicate Spain and Sweden leading the convergence run-up, Southern Europe and Latvia joining the Core in the early euro era, the Czech Republic attaining Core-like synchronization during the crisis, and Greece re-emerging into the top quartile during the COVID-19 period.

Regional profiles of Nordics and Baltics (Charts 6.1–6.4) suggest that euro-area accession aligns business cycles over multi-year horizons but not instantaneously. Two-year rolling correlations of GDP cycles for Finland, Estonia, Latvia, and Lithuania against the EA20 cycle

range from strong co-movement (Finnish peaks above 0.95) to gradual convergence among the Baltics. Output gaps trace a shift from a 2.3% surplus in 2013 to a –1.8% trough in 2016 and a 1.4% surplus by 2018. Unemployment-cycle correlations rise from around 0.35 to above 0.62 by late 2018, while unemployment gaps oscillate markedly, from –16.8% in Q2 2013 to 24.0% in Q2 2015.

Croatia's euro adoption cycle (2020–2024), examined via one-year rolling windows (Charts 7.1–7.4), displays rapid pandemic-era fluctuations. Pre-adoption GDP-cycle correlations with Italy and Slovakia exceeded 0.95, fell to 0.25 in Q2 2021, and rebounded above 0.97 by late 2024. GDP output gaps moved from a –16.4% trough in Q2 2020 through a 3.1% overheating peak in 2023 to near-equilibrium by Q4 2024. Unemployment-cycle correlations peaked above 0.83 in early 2021 before receding to 0.31 by 2024, while unemployment gaps swung from an 11.6% surplus in Q4 2020 to –0.3% tightening by 2024.

Together, these aggregate dynamics, cross-country dispersion, member-level impacts, and regional profiles, suggest a euro area characterized by both alignment and divergence. Trend growth has shifted downward even as countercyclical interventions moderate extremes. Individual members alternate between synchronizer and dampener roles, and post-accession convergence unfolds over multiple business cycles.

Policy considerations are worth for the Euro Area to include targeted supply-side reforms in digitalization, green transition, and labour-market flexibility, alongside adaptive fiscal buffers and monetary frameworks capable of responding swiftly to asymmetric shocks. A balanced approach may support higher cohesion and resilience within the monetary union and therefore benefit the Euro Area as a whole.

## 12. Conclusions

This research has undertaken a comprehensive exploration of Optimal Currency Area (OCA) theory and its application to the Euro Area, combining a critical review of the theoretical foundations, an institutional and economic overview, and a detailed empirical assessment of business–cycle synchronization. After tracing the evolution from the pre–OCA debates through Mundell, McKinnon, and Kenen, the mechanics of currency unions, the trade–offs they entail, and the metrics used to assess their viability was further examined. Anchoring this framework in the Euro Area's institutional architecture, from the Maastricht Treaty's convergence criteria

to successive enlargements, enabled a nuanced evaluation of whether the Eurozone conforms to OCA requirements and how it compares to alternative candidate regions.

The empirical investigation introduced four complementary lenses on synchronization dynamics. First, Kalman–filter decomposition of EA20 quarterly GDP revealed a clear structural slowdown: trend growth receded from roughly 2.4 % in the late 1990s to 1.4 % by 2025 Q1, while cyclical shocks, peaking at –10.6 % of potential output in 2020 Q2, underscored both vulnerability and resilience under common monetary policy. Second, cross–country dispersion measures showed mid–1990s convergence, crisis–induced divergence, and elevated post–crisis baselines, with weighted standard deviations consistently about half their unweighted counterparts. Third, leave–one–out analysis highlighted how core members such as Germany and France acted as "synchronizers" in EA12, only to have their influence diluted in the EA20. Finally, dynamic core–periphery classifications and regional case studies of the Baltics, Nordics, and Southeastern Europe (Croatia) illustrated that synchronization unfolds over multiple business cycles rather than instantaneously upon accession.

These findings inform three central hypotheses. The first hypothesis posited significant positive correlation between Eurozone membership and synchronization indicators after financial crises. While time–series patterns suggest that existing members exhibited tighter cycle alignment in certain post–crisis phases, the absence of formal significance testing precludes definitive rejection of the null hypothesis. Consequently, it must be accepted as limitation of the thesis that no statistically robust link has been demonstrated, even as descriptive tendencies indicate modest convergence. The second hypothesis conjectured a significant low (either positive or negative) correlation for non–Eurozone countries. Again, the data reveal heterogeneous patterns, some non–members exhibit rising synchronization over time, while others remain idiosyncratic, without providing a basis for rejecting the null. The third hypothesis anticipated significant positive correlation between Euro Area membership and synchronization indicators following euro adoption. New entrants like the Baltic states and Croatia show gradual increases in cycle correlation and narrowing of output–gap deviations, but the lack of formal inference means that this relationship at conventional confidence levels cannot be confirmed. Thus, for all three hypotheses, the null scenarios stand, reflecting the limitations of untested time–series analysis.

Several caveats temper these conclusions. First, reliance on Kalman–filter and HP–filter decompositions, while yielding rich cyclical and trend insights, does not substitute for econometric models designed to deliver statistical inference. Second, cross–country dispersion

and rolling–correlation metrics capture synchronization but do not isolate causality or control for potential confounders such as fiscal transfers, structural reform progress, or external demand shocks. Third, data frequency and filter parameter choices influence the measured magnitudes of dispersion and correlations, introducing sensitivity that warrants robustness across alternative specifications.

Looking forward, further research is essential to deepen understanding of currency–union dynamics. Panel–data regressions or difference–in–differences approaches could isolate the impact of Eurozone membership on synchronization while accounting for country–specific effects and global shocks. Incorporating micro–level indicators, labour–mobility flows, firm–level investment, sectoral trade linkages, would clarify the transmission mechanisms behind convergence. Exploration of fiscal-union dimensions, including the role of the European Stability Mechanism and NextGenerationEU disbursements, could illuminate how transfers and mutual-insurance arrangements affect co–movement. Finally, extending the analysis to real–time data, high-frequency financial and sentiment indicators, may capture the evolving interplay between monetary policy and regional business cycles in an era of digitalization and green transition.

In sum, this research has mapped the contours of business–cycle synchronization in the Euro Area, providing a detailed descriptive account across multiple analytical dimensions. Although it cannot offer statistically definitive proof of the benefits or drawbacks of Eurozone membership, it lays a foundation for more rigorous empirical inquiry. That future work must build on these insights, deploying causal identification strategies and richer datasets to assess how monetary unions can balance convergence with resilience, and guide policymakers in designing institutions that foster both.

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