

dr Łukasz D. Wróblewski  
Department of European Studies  
Poznań University of Economics and Business  
lukasz.wroblewski@ue.poznan.pl  
ORCID: 0000-0003-3677-043X

## **CROSS-BORDER INTERACTIONS ON THE BENELUX-GERMANY BORDER IN THE LIGHT OF SYNCHRONIZATION ECONOMIC FLUCTUATIONS - ANNEX**

### **Spatial differentiation of business cycle dynamics in the Benelux–Germany borderlands**

Most of the regions studied border directly on a neighbouring country and many are part of functional Euroregions such as the Euregio Maas-Rhine, the Euregio Rijn-Waal and the Grande Région/SaarLorLux. A notable feature is their significant territorial cohesion. The regions under study form a border belt characterised by high population density and infrastructure, and by numerous economic and social links that cross national borders. The study area includes major urban centres such as Aachen, Liège, Maastricht, Luxembourg, Hasselt, Antwerp and Eindhoven, as well as a number of medium-sized and smaller towns, including Heerlen, Turnhout, Sint-Niklaas, Maaseik, Düren, Mönchengladbach, Viersen and Heinsberg.

Aachen is a city in Germany with a population of approximately 252,000 (2023), located directly on the border with Belgium and the Netherlands. It serves as a regional academic and technological centre with strong research and development facilities. Liège in eastern Belgium, with a population of 195,000 (2022), is one of the main economic and cultural centres. Maastricht, the capital of South Limburg in the Netherlands, has a population of around 120,000 and is a key hub of the Maas-Rhine Euroregion. Luxembourg, with a population of around 136,000 (2024), serves as a financial and administrative centre and is home to European institutions. Antwerp, the largest city in the border area under study, with a population of approximately 565,000 and a metropolitan area of over 1.2 million, is Belgium's main seaport and one of the most important in Europe. Eindhoven, with a population of around 249,000, is located in North Brabant and is known for its high-tech industry, including companies such as Philips and DAF. On the German border are Mönchengladbach, Düren, Heinsberg and Viersen, cities with high population density and developed residential, industrial and service functions.

The entire area is characterised by a high population density that significantly exceeds the EU average. It combines compact urban agglomerations with rural areas such as the Ardennes, the Eifel and southern Netherlands. Some suburban and industrial zones cross the border, as is particularly evident around Aachen, Maastricht and Liège.

The region's economy has undergone a significant transformation, shifting from mining and heavy industry in Wallonia and Limburg to a model centred on logistics, advanced services and manufacturing, as well as a cross-border labour market. Antwerp continues to play a pivotal role in trade and maritime transport, while Luxembourg is establishing itself as an international financial centre.

The extensive transport infrastructure is based on a dense network of motorways and rail connections. The Liège–Maastricht–Aachen rail connection, launched in 2024, is an example of growing transport integration, facilitating daily cross-border commuting. The Port of Antwerp is a key hub of the European TEN-T network.

The analysed area is an integral part of the economic core of the European Union thanks to its high concentration of population, capital and infrastructure connections. It operates as a cross-border area that is fully integrated. Therefore, it appears that the spatial and functional diversity of the border regions of the Benelux countries and Germany impacts the course and degree of economic cycle synchronisation.

The analysis reveals significant similarities in the rhythm of economic change, as well as clear differences resulting from the structure of local economies. Generally speaking, most of the analysed regions exhibit a typical sinusoidal market economy cycle, characterised by alternating phases of expansion, slowdown and recovery that follow a relatively regular rhythm. However, the amplitude and intensity of these fluctuations vary significantly depending on the location and economic specialisation of the regions. Regions with a diversified economy, particularly those based on services, administration and education, tend to be more stable, whereas industrial and export-oriented regions tend to react more strongly to global economic shocks.

The rest of this annex discusses the economic cycle in three groups of border regions. First are the German regions, which together form a vast and diverse area with well-documented economic dynamics and a high degree of integration with neighbouring countries' markets. Next, the regions of Belgium and Luxembourg are analysed, where economic cycles are more volatile and the differences between Flanders and Wallonia are particularly noticeable. Finally, the border regions of the Netherlands are discussed. These regions are characterised by high internal synchronisation and relatively mild cycles. This structure enables both similarities and contrasts between countries to be observed, as well as providing a comprehensive view of the spatial diversity of economic dynamics in the Benelux-Germany zone.

### **The economic cycle in the regions of Germany**

Most of the German border regions surveyed exhibited the typical sinusoidal pattern of a business cycle. GDP fluctuations were relatively small in amplitude and repetitive in nature. However, the intensity of the cycle varied considerably from region to region, with some characterised by exceptionally high volatility and others by considerable stability. Overall, GDP fluctuations centred around the average trend without any permanent drift, which is typical of regular economic cycles.

Between 2005 and 2007, the economies of Germany's border regions transitioned from relatively weak growth to clear recovery. Initially, many regions recorded negative or near-zero growth rates, but by the turn of 2006/2007, most had entered a phase of expansion. Growth was fairly synchronised. A period of marked economic improvement was recorded at around the same time in almost all regions, although the pace varied. In the northwest, Kleve [DEA1B] and Leer [DE94C] recorded the highest positive deviations from the trend (approximately +3%), driven by exports, the food industry and port logistics. Meanwhile, the regions of Euskirchen (DEA28), Trier-Saarburg (DEB25) and Eifelkreis Bitburg-Prüm (DEB23) grew thanks to the machinery, metal and energy industries, benefiting from an influx of investment from the Rhineland and Luxembourg. Meanwhile, Borken [DEA34] and Grafschaft Bentheim [DE94B] experienced a harmonised but milder cycle, associated with medium-sized industrial companies and a stable domestic market. Against this backdrop, Mönchengladbach [DEA15] and Düren [DEA26] experienced moderate but stable growth. Both of these heavily urbanised areas, which are linked to the Rhineland agglomeration, based their development on the public services, education and logistics sectors. In their case, the dynamics were slower, but the cycles were much smoother and less susceptible to shocks.

The global financial crisis of 2008–2009 caused a sharp economic slowdown or recession in most regions. In 2009, almost all of the German regions surveyed experienced negative GDP deviations from the trend. Trier-Saarburg saw the sharpest decline (approx. –3.9%), while the economies of Borken and Grafschaft Bentheim were affected less severely. The amplitude of these fluctuations remained moderate, however, as they were mild and the spread between the pre-crisis peak and trough was relatively small. In some regions, the reaction was delayed. For instance, the lowest values were not reached until 2010 in Kleve [DEA1B],

Heinsberg [DEA29] and Düren [DEA26]. The Mönchengladbach region [DEA15] also experienced a mild recession, as its economy, which is based on administration, educational services and the IT sector, had a stabilising effect, cushioning the decline in exports and industry.

Since 2010, most regions have gradually begun to recover from the recession. This improvement was evident in Borken and Bentheim, for example, where GDP remained close to the trend. As in the previous phase, regions with a more industrial profile, such as Trier-Saarburg, Euskirchen and Bitburg-Prüm, experienced faster growth, benefiting from the recovery in exports. In contrast, urban regions such as Mönchengladbach and Düren experienced stable growth with low volatility, driven mainly by domestic demand. The shallow and short-lived downturn in 2011–2012, linked to the eurozone debt crisis, had little impact. Most regions, particularly those in the west, returned to mild growth as early as 2013. Borken and Bentheim proved resilient once again, as their GDP remained stable and close to the trend. Eifelkreis Bitburg-Prüm (DEB23) and Merzig-Wadern experienced small, frequent GDP fluctuations, which are typical of small, diverse local economies.

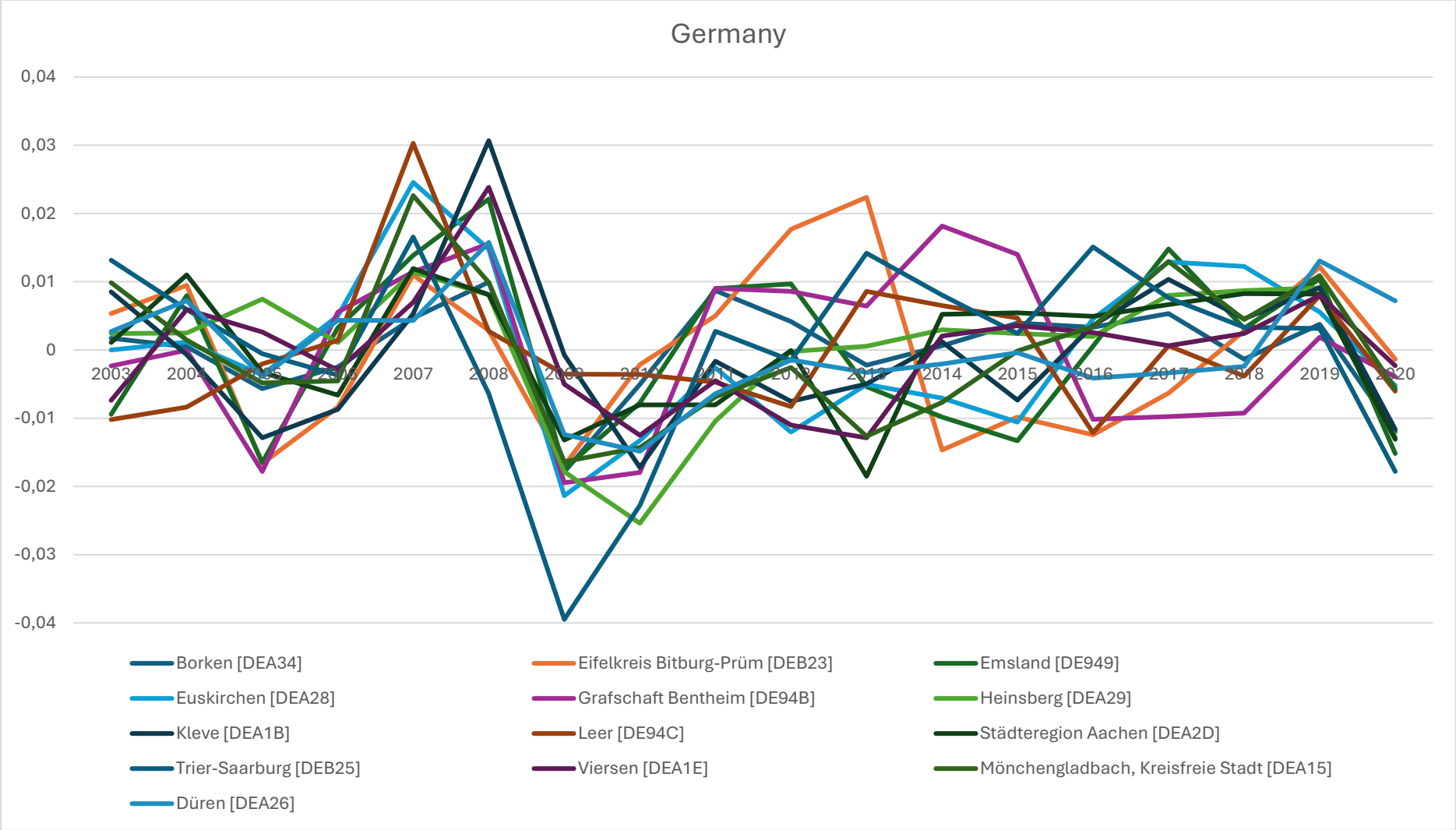
Between 2014 and 2019, the economies of the border regions experienced stable, moderate growth. Euskirchen, Heinsberg, Aachen, Viersen and Düren developed their service sectors, trade and logistics, benefiting from their proximity to the Cologne-Düsseldorf metropolitan area. Emsland [DE949] experienced growth in energy and manufacturing. In the west, the Bitburg-Prüm and Trier-Saarburg regions experienced moderate but stable growth, largely thanks to their cooperation with Luxembourg and the transport sector. Meanwhile, Mönchengladbach experienced a relatively flat cycle, with modest but steady growth and a dominant service sector ensuring resilience to external fluctuations.

The year 2020 saw a severe economic shock caused by the pandemic. GDP declined in all of the German regions analysed, and the response was highly synchronised. The largest decline was recorded in Trier-Saarburg (approximately  $-2\%$ ), followed by smaller declines in Kleve ( $-1.5\%$ ), Leer ( $-1.4\%$ ) and Emsland ( $-1.2\%$ ). Mönchengladbach and Düren were affected to a lesser extent by the pandemic, as the urban service economy cushioned the decline in industrial activity. The recession was short-lived, subsiding in most regions by the second half of the year.

The intensity of cycle fluctuations varied between regions. Overall, the fluctuations in the border regions were moderate in amplitude, though there were a few extreme cases. The largest fluctuations occurred in Eifelkreis Bitburg-Prüm (DEB23) and Trier-Saarburg (DEB25), whose economies, based on industry and agriculture, reacted strongly to economic cycles. By contrast, Borken (DEA34), Grafschaft Bentheim (DE94B), Heinsberg (DEA29), Düren (DEA26) and Mönchengladbach (DEA15) were among the regions with the lowest amplitude, as their service- and public-sector-based economies ensured greater stability of the cycle.

In summary, the economic cycles of German border regions between 2003 and 2020 were generally regular and mild, with relatively minor fluctuations. The most cyclical regions, such as Trier-Saarburg and Eifelkreis Bitburg-Prüm, clearly responded to global shocks. Meanwhile, Mönchengladbach, Düren, Borken and Bentheim were among the most stable, with their urban service structures and high sectoral diversification ensuring resilience and a quick return to equilibrium after crises.

Chart 1. Business cycles in the German border regions



Source: own study.

## The business cycle in the Belgian border regions and Luxembourg

The economic cycle of the Belgian regions can be divided into six consecutive phases. All of the regions studied exhibit the classic sinusoidal shape of the economic cycle, albeit with some anomalies. The regions of Flanders generally exhibit a relatively regular cycle, featuring a distinct peak prior to the financial crisis and a slowdown in 2009. By contrast, some Walloon regions (notably Bastogne and Arlon) exhibit more unusual trajectories, reflecting the local economic structure and weaker integration with the national cycle.

Between 2003 and 2007, the Belgian economy was in an expansionary phase. The country's GDP grew by several percentage points per annum, with most regions showing positive deviations from the trend. In the north, Antwerp (BE211), one of Europe's largest petrochemical and port centres, recorded significant growth, with GDP deviations from the trend line reaching over +2%. This growth was undoubtedly driven by maritime logistics, the chemical industry, and the oil industry. In East Flanders, including Ghent (BE234), Dendermonde (BE232), Eeklo (BE233) and Sint-Niklaas (BE236), expansion was supported by logistics, food production, the machinery industry, river transport and links to the port of Ghent. Turnhout (BE213) and Bruges (BE251), with a more diversified structure encompassing printing, logistics, the wood industry and tourism, grew steadily without major fluctuations. In East Flanders and Limburg (i.e. Tongeren [BE223], Hasselt [BE224] and Maaseik [BE225]), the economic situation was positive, driven mainly by logistics, the food industry, and the production of building materials. In Walloon regions such as Liège (BE332), growth was based on metallurgy and mechanical engineering, albeit at a slower pace than in Flanders. By contrast, Bastogne [BE342] and Arlon [BE341], which are more agricultural and tourist-oriented regions, experienced slower growth, but their economies were less vulnerable to external shocks. Verviers [BE335] and the German-speaking community of Eupen [BE336] experienced stable growth thanks to local services, textile production, and mountain tourism.

In 2008–2009, Belgium entered a phase of sharp slowdown. The country's GDP fell by approximately –1.5%, but regional responses varied. Industrial and export-oriented regions such as Antwerp (–1.6%), Liège (–0.3%), Ghent and Sint-Niklaas were hit hardest, as the collapse of global trade translated into a decline in industrial production and port traffic. Hasselt, Tongeren and Maaseik experienced a decline in industrial activity, yet remained relatively stable due to their service sectors. Bruges and Turnhout recorded a mild slowdown, cushioned by tourism and the public sector. An interesting case was Bastogne (BE342), where GDP remained above trend in 2009 (+3.8%), due to the local nature of the economy (agriculture, public services and small-scale trade). Similarly, Arlon (BE341), with an economy dominated by administration and cross-border workers from Luxembourg, weathered the crisis relatively well. In contrast, the declines in the regions of Verviers and Eupen (BE336) were small and mainly affected textile production and processing.

Between 2010 and 2011, the Belgian economy returned to growth of around 2% per annum.

Bastogne and Arlon experienced the most dynamic recovery, benefiting from infrastructure investment, tourism and cross-border services. Meanwhile, Antwerp, Ghent, Tongeren and Hasselt experienced moderate growth driven by exports, logistics and food processing. Liège gradually emerged from recession thanks to the modernisation of the metal industry and the development of precision technologies. Meanwhile, the regions of Verviers and Eupen experienced a revival in the service and mountain tourism sectors, and Bruges and Dendermonde grew thanks to the processing industry and trade.

However, in 2012–2013, Belgium experienced another slowdown linked to the eurozone debt crisis. Antwerp and Ghent entered a phase of stagnation, while Bastogne and Arlon experienced a sharp decline due to reduced domestic investment. Meanwhile, Hasselt, Tongeren and Turnhout recorded minimal growth thanks to public services and the food sector, while Liège remained slightly below the trend. Verviers and Bruges saw a modest slowdown, while Eupen remained relatively stable due to its administration and education sectors. Overall, it was a period of stagnation and increased regional divergence.

A longer phase of economic expansion began in 2014. In Antwerp and Ghent, GDP grew by 0.5–0.8%, reflecting stable, diversified development based on the chemical industry, logistics and maritime transport. Liège's economy benefited from the development of technology services and air

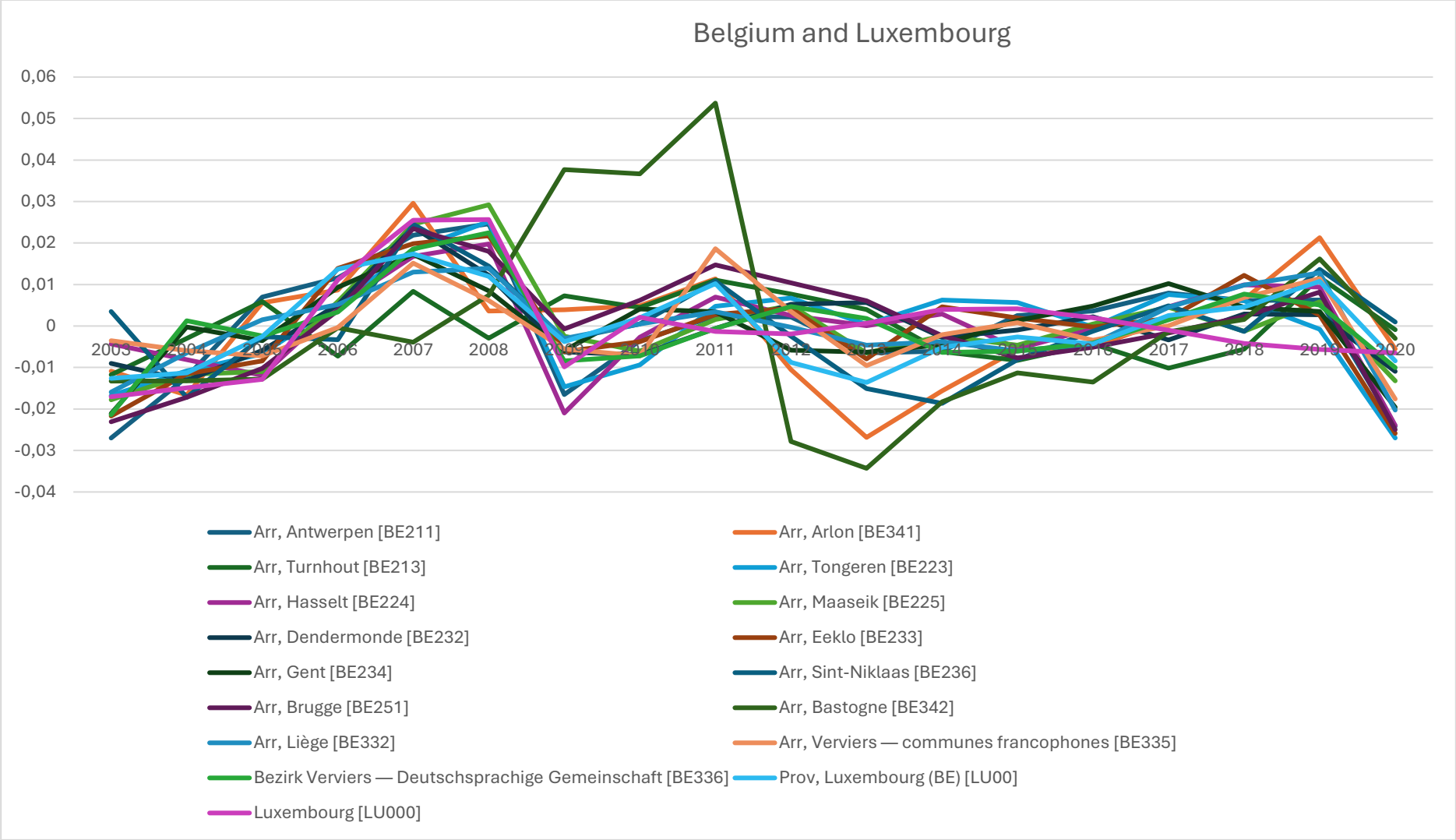
logistics thanks to Bierset Airport. Growth in the Tongeren, Hasselt and Maaseik regions was driven by trade, logistics and agri-food processing, while Turnhout and Bruges benefited from a revival in tourism and the retail sector. Bastogne and Arlon recorded even stronger growth, driven by tourism, agriculture and cross-border services. Meanwhile, growth in Verviers/Eupen was driven by employment in the public sector and small local businesses. It was a period of stability with moderate cyclical fluctuations.

However, in 2020, Belgium's economic cycle was abruptly interrupted by the onset of the global pandemic. The country's GDP fell by approximately  $-6.3\%$ . The regions most affected were industrial and export-oriented areas such as Antwerp ( $-2.4\%$ ), Ghent and Liège ( $-2.0\%$ ), and Tongeren ( $-2.7\%$ ), where restrictions on trade and transport impacted production. Turnhout and Bruges suffered from a decline in tourist traffic. Conversely, regions based on local services and agriculture, such as Arlon, Bastogne, Eupen and Maaseik, proved to be more resilient. The recession was short-lived and synchronous, demonstrating the high degree of synchronisation between regional economic cycles.

The amplitude of economic fluctuations depended on the structure of the economy.

Regions with a diversified industrial and service profile, such as Turnhout, Liège, Ghent and Verviers, experienced the lowest volatility, as their economies combined manufacturing, logistics and the public sector. In contrast, Bastogne and Arlon, which have a smaller economic base and depend heavily on tourism and local services, experienced the greatest fluctuations in economic activity (from  $+5.4\%$  in 2011 to  $-3.4\%$  in 2013). Antwerp and Bruges experienced moderate volatility resulting from cycles in international trade and transport. The stable economies of Hasselt, Maaseik and Tongeren owed their mild cycles to sectoral diversification and strong links with neighbouring countries' markets. In summary, regions with a diversified economic structure are more resilient to external shocks, while peripheral areas with narrow specialisation react much more strongly to changes in the economic cycle. These differences are important for regional policy, indicating that cyclical resilience increases with economic diversification, and that flexibility within local structures is crucial for stability in the event of future crises.

**Chart 2. Business cycles in the Belgian border regions and Luxembourg**



Source: own study.

## The business cycles in the Dutch border regions

Most of the analysed border regions of the Netherlands exhibited a typical sinusoidal business cycle pattern, characterised by moderate amplitude fluctuations and high regional synchronisation. While the rhythm of change remained consistent nationwide, notable differences in scale emerged – the industrial regions in the south exhibited significantly higher volatility, whereas the agricultural and service areas in the north and east displayed greater stability.

Between 2004 and 2007, all of the Dutch border regions experienced positive GDP deviations from the trend. In the south of the country, the industrialised regions of Noord-Brabant, such as West-Noord-Brabant (NL411), Midden-Noord-Brabant (NL412) and Zuidoost-Noord-Brabant (NL414), recorded particularly strong growth. These regions benefited from the export boom in the high-tech industry and the development of logistics and the processing industry. The Limburg regions of Midden-Limburg (NL422) and Zuid-Limburg (NL423) also recorded strong growth thanks to the chemical and pharmaceutical industries, as well as the developing business services sector. In the west, Zeeuwsch-Vlaanderen (NL341), which is strongly linked to the port of Antwerp, grew thanks to the chemicals, logistics and port sectors, while Overig Zeeland (NL342) saw more balanced growth based on tourism, services and the food industry. Growth was positive in eastern regions such as Achterhoek (NL225) and Twente (NL213), although the scale of expansion was smaller due to the more traditional industrial and agricultural profile of the economy. In the north, the regions of Delfzijl en Omgeving (NL112) and Overig Groningen (NL113) benefited from the boom in the chemical and gas energy industries. Meanwhile, the agricultural regions of Oost-Groningen (NL111) and Zuidoost-Drenthe (NL132) experienced slower growth with smaller deviations from the trend.

The slowdown began as early as 2008 and, in 2009, the Dutch economy entered a deep recession. The regions most affected were those with a strong industrial and export orientation, such as Zuidoost-Noord-Brabant (NL414), West-Noord-Brabant (NL411), Midden-Noord-Brabant (NL412), Zeeuwsch-Vlaanderen (NL341) and Midden-Limburg (NL422). [NL422]. The decline in global demand hit the high-tech sector, the chemical industry, and cross-border logistics. The recession was slightly milder in regions such as Noord-Limburg (NL421), Achterhoek (NL225) and Noord-Overijssel (NL211), whose economies are based on SMEs and agriculture. The decline was also noticeable in the northern provinces, such as Delfzijl en Omgeving (NL112) and Overig Groningen (NL113), but this was partially offset by stable energy production and the public and university sectors in Groningen.

The years 2010–11 saw a phase of economic recovery. The southern regions of Zuidoost-Noord-Brabant (high-tech industry) and West- and Midden-Noord-Brabant (logistics and manufacturing) experienced the most dynamic growth. In contrast, service and public service regions such as Arnhem/Nijmegen (NL226) and South Limburg (NL423) recorded a more moderate growth rate, as their economies are mainly based on administration, education, and medical services. Consequently, their cycles responded to the national cycle with some delay.

In 2012–13, a second slowdown occurred, linked to the eurozone debt crisis. Once again, the export-oriented regions in the south of the country (Brabant, Limburg and Zeeland) were hit hardest, while those in the east and north (Achterhoek [NL225], Twente [NL213] and Groningen [NL112–113]) were less affected. Agricultural regions such as Noord-Overijssel (NL211) and Zuidoost-Drenthe (NL132) experienced stagnation rather than a marked decline. Meanwhile, Overig Zeeland [NL342] remained relatively stable, benefiting from domestic tourism and the food sector.

After 2013, a longer period of expansion began. The strongest positive deviations were recorded in the industrialised southern regions, such as Zuidoost-Noord-Brabant (NL414), Midden-Limburg (NL422) and West-/Midden-Noord-Brabant (NL411–412), which benefited from the global economic upturn and export growth. Meanwhile, Zeeuwsch-Vlaanderen [NL341] benefited from the revival in maritime trade and the expansion of the Port of Antwerp, and Overig Zeeland [NL342] grew thanks to tourism, agriculture, and local services. Arnhem/Nijmegen (NL226) and Zuid-Limburg (NL423) grew thanks to the development of public, educational and medical services, while Twente (NL213) grew thanks to technological innovation and the IT sector. Growth was also evident in agricultural and peripheral regions, such as Oost-Groningen (NL111), Zuidoost-Drenthe (NL132) and Noord-Overijssel (NL211), albeit to a lesser extent. Exceptions were Delfzijl en Omgeving (NL112), where industrial production slowed down after 2014, and Overig Groningen (NL113), which was affected by a decline in natural gas production.

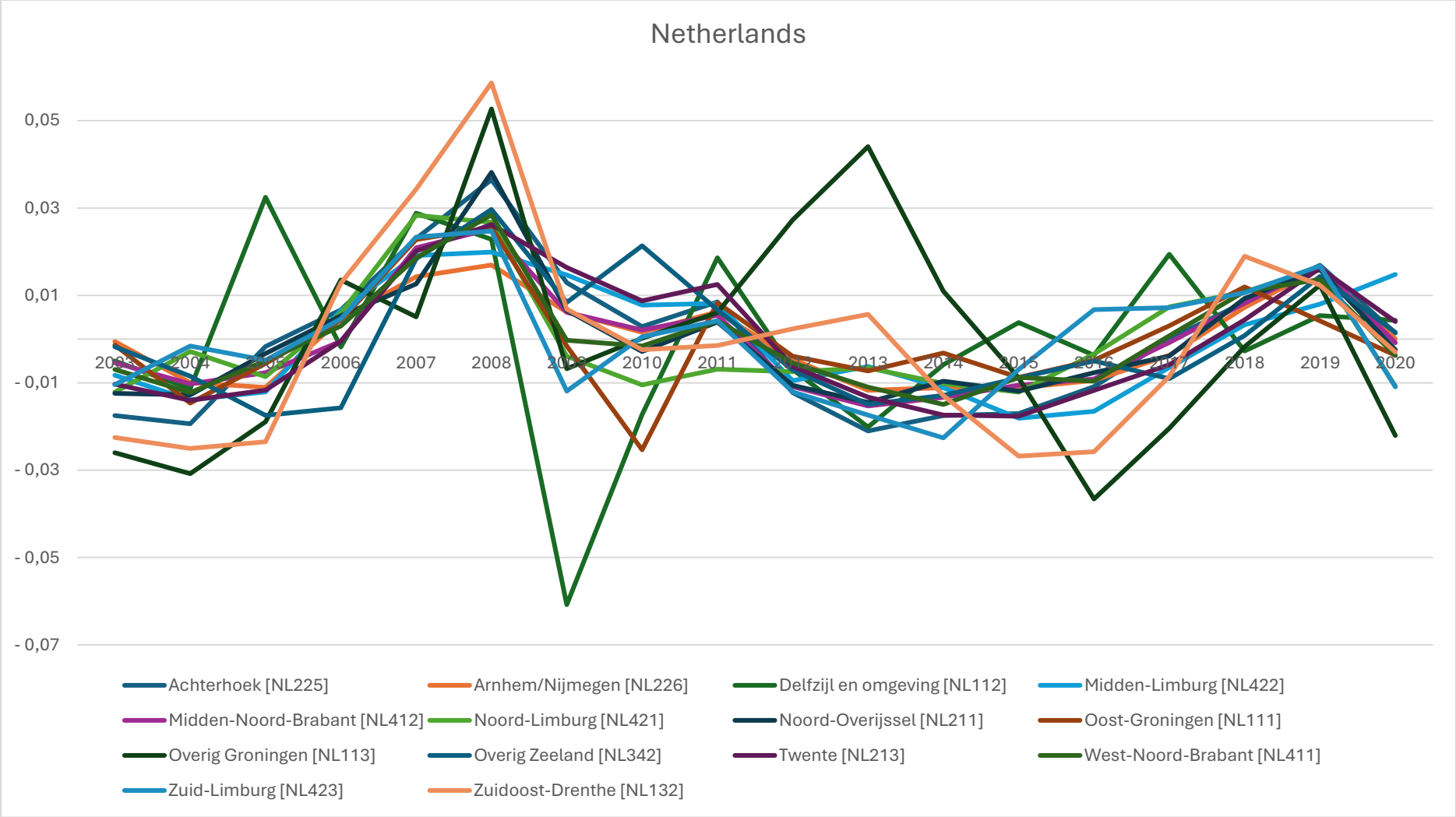
At the beginning of 2020, the economic cycle was abruptly interrupted by the onset of the global pandemic. All of the analysed regions, including the industrial south and the agricultural north and east, experienced a simultaneous decline in economic activity. The sharpest decline affected Zuidoost-Noord-Brabant (NL414) (export industry), Zeeuwsch-Vlaanderen (NL341) (logistics and ports), and Zuid-Limburg (NL423) (services and tourism). The agricultural regions of Noord-Overijssel (NL211), Zuidoost-Drenthe (NL132) and Achterhoek (NL225) experienced a slightly milder decline in GDP, as their economies are less sensitive to cyclical fluctuations. The recession was highly synchronous.

However, the volatility of economic cycles between regions in the Netherlands varied significantly.

Zeeland experienced the greatest fluctuations, with GDP growth exceeding +5% relative to the trend at the peak of the expansion in 2007, before falling by around -4.5% in 2009 and rebounding by more than +3% in 2010. Limburg also experienced similarly high volatility, with GDP falling by around -4% in 2009 and rebounding quickly but not sustainably. Groningen was also exceptionally volatile, with its gas economy causing strong fluctuations. Following a decline of around -4% in 2009, there was an increase of +9% in 2010, followed by a further decline of around -6% in 2014 due to production cuts. Smaller amplitude fluctuations ( $\pm 2-3\%$ ) were observed in the agricultural and service regions of Overijssel, Achterhoek, Drenthe, and Arnhem/Nijmegen, where the economic cycles were milder. In the north, Oost-Groningen (NL111) and Delfzijl en Omgeving (NL112) experienced a delayed and smoothed cycle; the trough occurred in 2009 and, from 2011 onwards, their trajectory aligned with that of the rest of the country. Northern Holland (Noord-Nederland) experienced an unusual local slowdown in 2014-2015 (approx. -3% year on year) as a result of restrictions on gas extraction in Groningen. Overig Groningen (NL113) also stood out with an irregular cycle and weaker synchronisation with the rest of the country.

The economic cycles of the Dutch border regions were broadly synchronised between 2003 and 2020, although their amplitude varied significantly. The largest fluctuations were observed in the industrialised and port regions of the south (Zeeland, Brabant and Limburg), while the agricultural and service areas of the north and east (Overijssel, Achterhoek and Drenthe) remained relatively stable. This diversity reflects structural differences in the Dutch economy. Regions with a high share of export-oriented industry and logistics tend to react more strongly to global cycles, whereas regions based on agriculture and public services tend to be more resilient to external shocks.

**Chart 3. Business cycles in the Dutch border regions**



Source: own study

