HOW CYPRUS' ECONOMY COPED WITH THE COVID-19 PANDEMIC

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Abstract: *This paper assesses how Cyprus' economy coped with the Covid-19 pandemic by generating two series of forecasts with wavelet analysis: forecasts using data including the pandemic (from Q4 1997 to Q2 2022) and not including the pandemic (from Q4 1997 to Q3 2019). The difference of their averages is an indicator of the resilience of the economy during the pandemic, the greater the difference, the more resilient the economy. Eurozone and Germany are used as benchmarks: subtracting the Q3 2022 to Q4 2050 GDP growth rate (quarterly and annualized) average forecast of Cyprus obtained with the Q4 1997-Q2 2022 data, +1.62%, by the one obtained with the Q4 1997-Q3 2019 data, +1.47%, the difference is +0.15% whereas with Eurozone the difference is +0.11%, [+0.68% - (+0.57%)] and with Germany the difference is -0.12% [+0.89% - (+1.01%)]. Thus, Cyprus' economy shows a slightly higher resilience (+0.15%) than the Eurozone's (+0.11%) based on Q3 2022-Q4 2050 forecasts and a stronger resilience than Germany's (-0.12%). Moreover, the average of the Q3 2022-Q4 2050 quarterly (annualized) growth rate forecasts of Cyprus is expected to be +1.62% with the Q4 1997-Q2 2022 data whereas it is expected to be only +0.68% for the Eurozone and +0.89% for Germany. Cyprus' economy shows better prospects than the Eurozone's and Germany's economies.*

Keywords: GDP; Wavelet Analysis; Forecasting; Cyprus; Eurozone; Germany

1. Introduction

This paper assesses how Cyprus' economy coped with the Covid-19 pandemic. Cyprus is an island part of the European Union, officially named the Republic of Cyprus. The southern part covering 74% of the area of the island is administered by a Greek population speaking Greek and using the Euro as legal tender. The northern part representing 36% of the island area is administered by Turkish Cypriots. It is named the Turkish Republic of Northern Cyprus, speaking Turkish, and using the Turkish lira as legal tender. Northern Cyprus is still counted by

the international community as part of the Republic of Cyprus. Northern Cyprus' survival depends on Turkish economic support following the implementation in 1994 of an international economic embargo against Northern Cyprus by the European Union and supported by the United Nations (The World Factbook, 2023). In 1974, Turkey invaded Northern Cyprus and has been a state recognized only by Turkey since 1983. In 2023, the Turkish president and the Greek prime minister decided to intensify negotiations aimed at resolving long-standing regional conflicts, including the future settlement of Cyprus which will be based on the creation of two distinct States, a motion currently rejected by the Greek Minister of Foreign Affairs, but which could be implemented in the medium term (Tugwell and Hacaoglu, 2023).

The economy of Cyprus is tiny, ranking 104th in the world in size of GDP equal to 28,408 million USD (2021 estimate, World Bank 2023). The GDP composition by sector of origin is represented by services (85.5% of GDP, 2017 est.), including tourism (source of about 8% to 13% of GDP), industry and agriculture being marginal (respectively 12.5% and 2% of GDP, 2017 estimates). The importance of tourism to the economy must be mentioned since tourism has been hit hard by closures and travel bans during the pandemic. Cyprus' economy is considered as high-income, with a Real GDP per capita equal to $41,700 (2021 est.) ranked 45th in the world.

The following section covers the literature about the impact of the Covid-19 pandemic on the Cypriot economy.

2. Literature Review

Before the Covid-19 pandemic crisis, Cyprus was already hit by a financial crisis in 2012-2013 with a failure of its banking system. At this time, banks in Cyprus, especially Laiki bank, second-largest banking group in Cyprus behind the Bank of Cyprus, 'were exposed to overleveraged local real estate companies, the Greek public debt crisis and a downgrade in the credit rating of Cypriot government bonds by international rating agencies' (Markidou, 2022). Laiki bank was nationalized in 2012. In 2021, the Central Bank of Cyprus filed an application for the liquidation of former Laiki bank (Stockwatch, 2021). In 2013, to avoid a collapse of its financial system, Cyprus was bailed-in by the ECB (European Central Bank), the European

Commission, the Eurogroup, and the International Monetary Fund, offering a financial bail-in of €10 billion. During this bail-in process, banks' shareholders and creditors paid their share of costs. 'No insured deposits of €100,000 or less were affected, although depositors lost 47.5% of all bank deposits above €100,000' (Ekathimerini.com, 2013).

The Covid-19 pandemic started at the end of 2019 and had spread to five continents, killing millions and inducing a global recession. The pandemic quickly caused widespread social and political upheaval, disrupting the lives of the entire society. To limit the spread of the virus, governments put in place unpopular confinements of populations. By February 26, 2023, the global number of Coronavirus Cases was 679,605,591 infected people, 6,797,685 dead among them (Worldometers, 2023). Lockdowns have paralyzed economies globally, resulting in a global recession in 2020. In Cyprus, out of a total population of 1.244 million in 2021, the number of cases and deaths from the Covid-19 pandemic have been 1,328,673 cases and 7,071 deaths by March 2, 2023 (Worldometers, 2023) which represent about 52.1% of the population in terms of cases and 0.10% in terms of deaths. Using the total of 48 European countries as benchmark, the number of cases and deaths from the Covid-19 pandemic have been 246,371,491 cases and 2,017,562 deaths by March 2, 2023, out of a population of 748,845,084 which represent about 32.9% of the population in terms of cases and 0.26% in terms of deaths. It shows that the Cypriot population was 58% more infected by the Covid-19 pandemic than the European population (52.1% versus 32.9%) but was 61% less impacted by death than the European population (0.10% versus 0.26%). The Cypriot population would have seemed less concerned about protecting themselves against the Covid-19 pandemic but more resistant to death than the European population. In fact, Covid-19 exacerbated inequalities, and led to broad social changes (Redbird et al., 2022). Although a small country, Cyprus has not been spared from this phenomenon. To address health inequalities, the Cypriot government implemented the largest health sector reform Cyprus has ever seen (Michail et al., 2021), which became fully operational in 2020. It provided free health care to all citizens, thereby minimizing health inequalities. This measure being inclusive, for the first time in Cyprus, migrants benefited from the same health coverage as all Cypriot citizens (Koutsampelas et al., 2020). Furthermore, the pandemic has intensified income inequality in Cyprus. The government took several measures in 2021,

including the implementation of wage and social protection policies and the application of the Equality Act. The government provided financial assistance in the form of salary compensation to affected employees and unemployed people, including self-employed people, working parents and employees of small businesses and businesses, who had to suspend their activities completely or partially (Republic of Cyprus, 2021). To boost the Cypriot economy during the Covid-19 pandemic, the government implemented a recovery and resilience plan, which amounted to €1.2 billion and 5.2 % of Cyprus' 2019 GDP (Delivorias, 2022). Cyprus has decided to use most of its allocation in grants equivalent to €1.005 billion, including €200.3 million in loans. In 2020, the Council of the European Union has recommended that Cyprus take measures to effectively combat the pandemic, support the economy and the subsequent recovery (EUR-Lex, 2020). The Council considered three factors essential to the recovery process of Cyprus: 1) the first factor was to improve the quality of education and training for the labor market, and to promote a rapid recovery of the labor market; 2) The second factor was to promote an efficient judicial system favorable to investment and business; 3) The third factor was improving the Cypriot health system. In conclusion, Cyprus' recovery and resilience plan was aimed to improve economic growth and create jobs, to boost Cyprus' GDP by 1.1% to 1.8% by 2026, to improve the economy by adding 3,000 citizens into the job market, to rely on spill-over effects accounting for 0.5 percentage points of gross domestic product in 2026 from other Member States, through exports (European Commission, 2020). Furthermore, the IMF (Tuladhar et al., 2021) indicated that the Cypriot economy's dependence on tourism and its high levels of public debt and private sector made it particularly vulnerable to the shock of the pandemic. The IMF suggested three key policies to strengthen the recovery of the Cypriot economy from the effects of the pandemic shock: 1) address lending problems to strengthen bank balance sheets and support credit growth; 2) focus on mitigating the impact of the crisis while maintaining debt sustainability and 3) support the reallocation of resources to strengthen future growth and make it more inclusive. It appears that the recovery plan and sound advice from the IMF have worked well with the Cypriot economy. According to the President of the European Central Bank, Christine Lagarde (Lagarde, 2022), Cyprus showed a strong recovery momentum with a GDP increasing by 5.6% in 2021, reaching its 2019 level. Unemployment was back to pre-pandemic levels of around 6%. Cyprus performed well thanks to the extraordinary policy response from the Eurozone, implementing

fiscal and monetary policies to protect incomes and demand. Nevertheless, following the pandemic, lockdowns were responsible for a lousy restart of supply responsible of 'a global mismatch between increasing demand and short supply, bringing shortages and disruptions of the supply chain' (Lagarde, 2022). Due to an interconnected global economy, this was transmitted to the markets, bringing high inflation reaching 5.6% year-to-year in February 2023 in the euro area (Trading Economics, 2023), with energy inflation above 30%. Cyprus was not spared, with inflation equal to 6.7% year-to-year in February 2023 (Trading Economics, 2023) – due to increasing food and energy prices. The invasion of Ukraine by Russia has created a supply shock for economies around the world that simultaneously drove up inflation and reduced growth. Rising energy and food prices are the result of this supply shock, with Russia being the main energy supplier, and the two warring countries (Ukraine and Russia) accounting for around 30% of world wheat exports, Russia and its ally Belarus producing close to one third of potash in the world, a key component of fertilizer production. The tourism sector in Cyprus was also hit by a reducing number of Russian and Ukrainian tourists representing respectively 27% and 5% of the tourists in Cyprus in 2021.

Furthermore, Cyprus has historically been the focus of foreign direct investment from and to Russia. Professions related to foreign direct investment in Cyprus linked to Russia were also impacted including consultants, lawyers, and accountants. Nonetheless, the Cypriot economy has become stronger and more resilient nowadays following the 2013 banking crisis. Non-performing loans dropped to less than 10% by the end of 2021 from 50% of all loans in 2014. Overall, the Cypriot banking sector is substantially liquid and capitalized.

The final words of this section concern the modeling of wavelet analysis applied to forecasting. The flexibility of wavelet analysis was supported by forecasting in-sample stationary and nonstationary time series (Rostan and Rostan, 2018a). Further articles evaluated how sustainable were the pension system of Spain with wavelet analysis (Rostan et al., 2015) as well as the Saudi pension system (Rostan and Rostan, 2018 b). Forecasting European and Asian populations with wavelet analysis incorporating multiscale principal component analysis to model age groups co-dynamics was the topic of another paper (Rostan and Rostan, 2017); this was also the topic of the article "When will European Muslim population be majority and in which country?" (Rostan and Rostan, 2019). To demonstrate the versatility of wavelet analysis,

it was also applied to fossil fuels prices projections (Rostan and Rostan, 2021b). Finally, wavelet analysis was used to forecast various economies of Spain (Rostan and Rostan, 2018c), Greece (2018d), Austria (2020), the Kingdom of Saudi Arabia (2021a), the Persian Gulf (2022a), Turkey (2022b), the United Kingdom (2022c) and Korea (2023a).
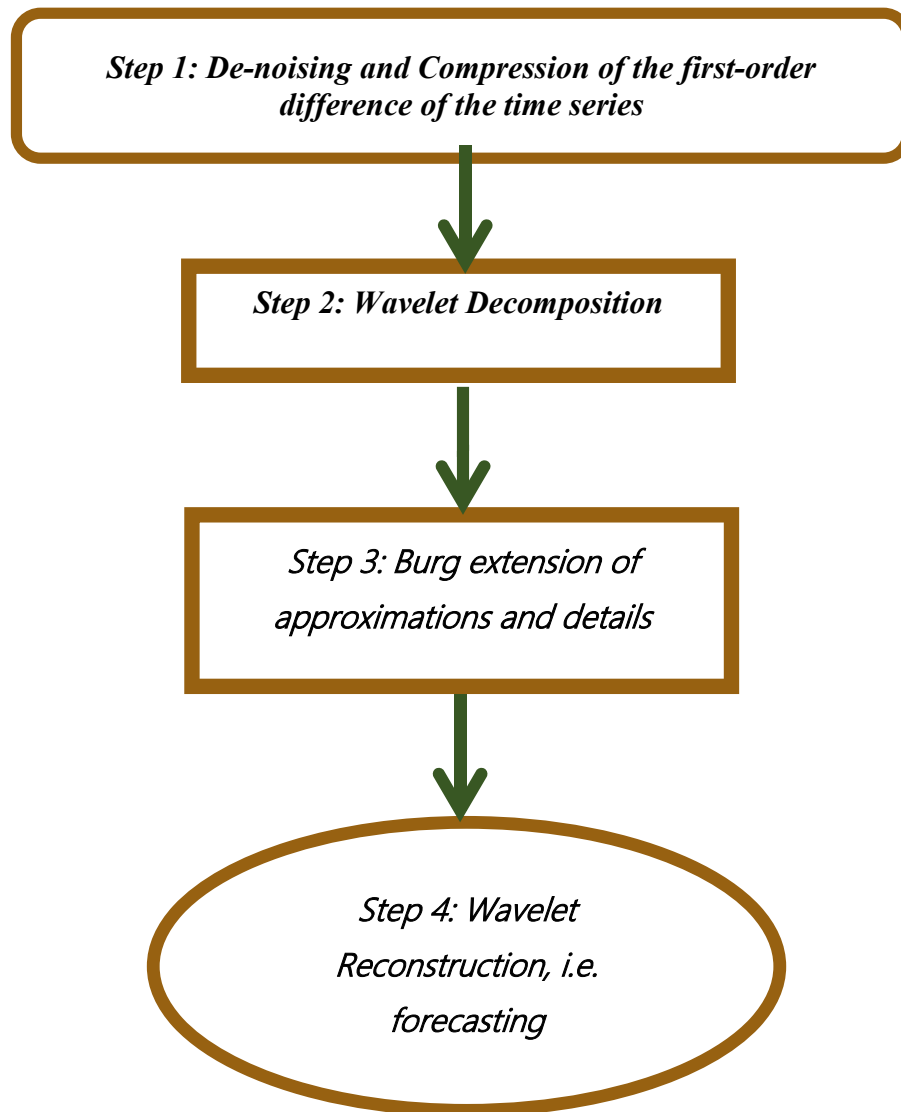
The methodology used in this article is presented in the next section.

3. Methodology

3.1. Overview of the methodology

The present paper assesses how Cyprus' economy coped with the Covid-19 pandemic using its 2050 projections. The idea is to compare Cyprus' Q3 2022 to Q4 2050 Real GDP growth rate forecasts excluding (from Q4 1997 to Q3 2019) and including the pandemic (from Q4 1997 to Q2 2022) by using wavelet analysis. The difference of their averages measures the resilience of the economy during the pandemic, the larger the difference the stronger the resilience. The wavelet analysis forecasting model used in this research follows four steps illustrated in the flowchart below (Figure 1). Detailed methodology is found in Rostan and Rostan (2022c). Q3 2022 to Q4 2050 Real GDP growth rate forecasts of the Eurozone (19 countries including Cyprus) and Germany are used as benchmarks of Cyprus' forecasts.

Figure 1: Flowchart of the methodology from steps 1 to 4.

Step 1: De-noising and Compression of the first-order difference of the time series

Step 2: Wavelet Decomposition

Step 3: Burg extension of approximations and details

Step 4: Wavelet Reconstruction, i.e. forecasting

3.2. Assessing the forecasting ability of wavelet analysis

The forecasting ability of wavelet analysis is assessed in this section. Wavelet analysis is benchmarked to ARIMA (2,1,1) forecasting model (Box and Jenkins, 1976; Baillie and Bollerslev, 1992; Box et al.; 1994), forecasting 50 in-sample quarters from Q1 2010 to Q2 2022 of the Real GDP of Cyprus obtained with Cyprus' Real GDP data from Q4 1997 to Q4 2009 (49 data), dividing the in-sample almost equally (49/50). To compare the forecasting ability of both models, the Root-Mean-Square Error (RMSE) criteria is applied (forecasts versus historical data), computing the error of forecasting. In this exercise, as illustrated in Figure 2, wavelet analysis forecasting model beats ARIMA (2,1,1) model over 50 quarters with a RMSE equal to 472 versus 819 with ARIMA (2,1,1), almost twice as high.

Figure 2: 50 forecasts from Q1 2010 to Q2 2022 of the Real GDP of Cyprus, Millions of Chained 2010 Euros, Quarterly, Seasonally Adjusted, obtained with Cyprus' Real GDP data from Q4 1997 to Q4 2009 (49 data)
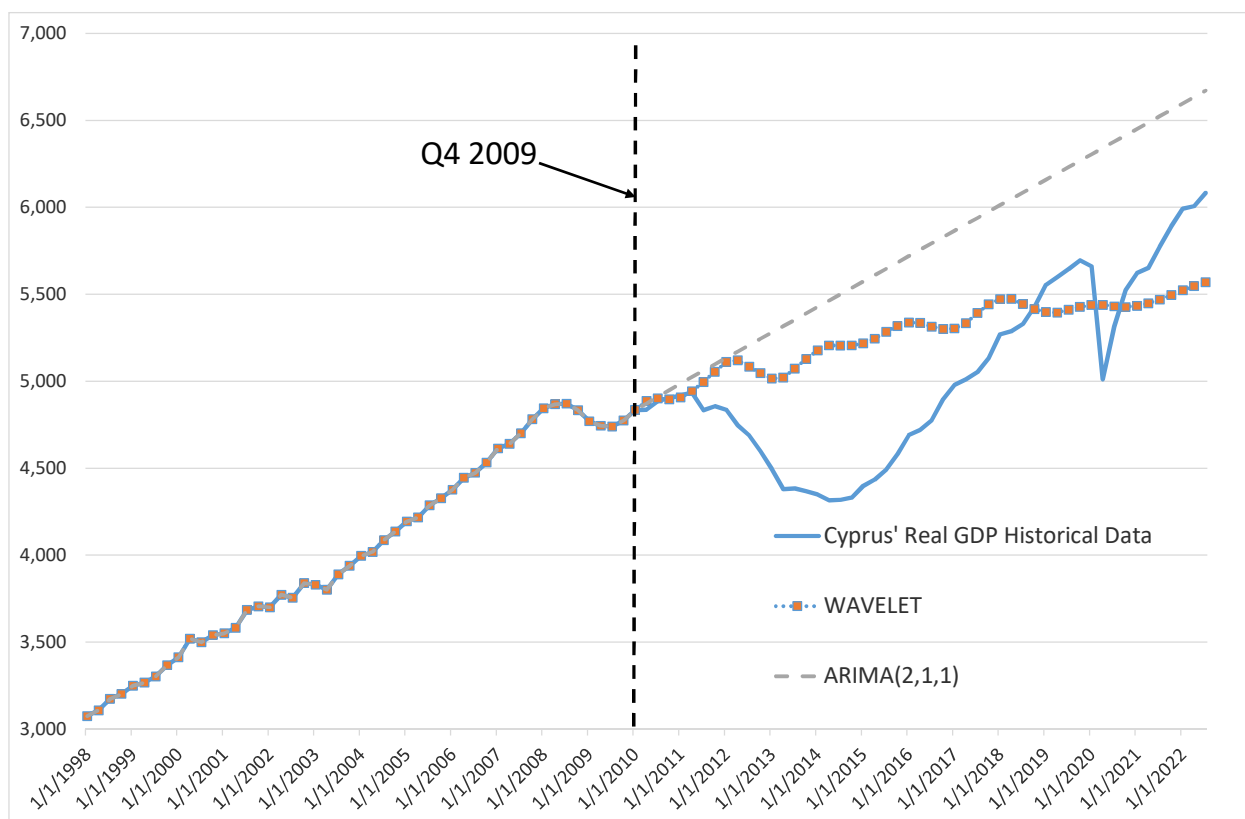
Autoregressive integrated moving average (ARIMA) is a forecasting model extensively used in statistics and econometrics. ARIMA (2,1,1) model is used since it best fits Cyprus' Real GDP data from Q4 1997 to Q4 2009 (49 data). ARMA lags p = 2 and q = 1 are identified with the Bayesian Information Criterion (BIC) applied to the 49 data. For this purpose, several models are estimated with different p and q values. For each estimated model, the loglikelihood objective function value is computed. Then, the loglikelihood value is input to compute the BIC measure of fit which penalizes for complexity. The methodology involving ARIMA model is implemented in Matlab using the econometrics toolbox. To formally identify the ARMA lags, several models are fitted with different lag choices, making the degree of differencing (i.e. the "I" of ARIMA) varying from 0 to 3. All combinations of ARMA(p,q) are fit for p = 1,...,3 and q = 1,...,3 (a total of 9 models per degree of differencing). The loglikelihood objective function and number of coefficients for each fitted model are stored. The BIC is computed for each fitted model. In the BIC matrix, the rows correspond to the AR degree (p) and the columns correspond to the MA degree (q). The optimal value in the BIC matrix is the smallest BIC value (508.8909) obtained with the first order differencing, which explains the choice of the ARIMA(2,1,1) model:

	q		
	509.6706	512.3826	547.5427
p	508.8909	733.9306	715.2085
	734.6537	739.2543	743.7683

Selected model for this exercise: ARIMA(p,d,q) = ARIMA(2,1,1).

3.3. Dealing with structural breaks

This section focuses on structural breaks and how wavelet analysis can handle them. A structural break is an unexpected change over time in the parameters of regression models, which can lead to huge forecast errors and overall model unreliability. The lack of stability of coefficients frequently caused forecast failure, and therefore econometricians must routinely test for structural stability. There is extensive statistics and econometrics literature related to the detection of changes and structural breaks such as Antoch et al. (2019). Lo Cascio (2007) focused on structural breaks and how to handle them with wavelet analysis. During step 2, Wavelet Decomposition and more specifically denoising, the sparsity property of the wavelet transform,

which is its ability to encode a signal in few big coefficients, is the basis for noise reduction techniques by thresholding the wavelet coefficients. These techniques outperform classical linear filtering. The denoising involves a simple way to suppress the noisy part of the signal, called shrinkage in the wavelet domain, an overall reduction in the size of the wavelet coefficients which will reduce coefficients of negligible value to zero. Shrinking the coefficients towards zero has the effect of suppressing the noise while preserving the essential features of the signal. As an illustration of the shrinkage technique, Lo Cascio looked at identifying structural breaks of UK Real GDP from 1873 to 2001, period that has included many policy regime shifts, two world wars and two oil crises, and major legislative and technological changes. Lo Cascio used the denoised annual growth to recover the trend that has been plotted with the UK GDP in levels. Lo Cascio proved the superiority of the wavelet analysis over classical linear filtering to reveal the true structure of the data, including its local irregularities and abrupt changes.

To put these results in perspective of the present paper, wavelet analysis can reveal the true structure of the data in the two samples that were chosen, a sample including the pandemic (from Q4 1997 to Q2 2022) and one not including the pandemic (from Q4 1997 to Q3 2019). It is obvious that the structural break resulting from the external shock of the Covid-19 pandemic has been incorporated in the forecasting of Cyprus' Real GDP generated from the historical data including the pandemic (from Q4 1997 to Q2 2022) but not in the forecasting of Cyprus' Real GDP generated from data not including the pandemic (from Q4 1997 to Q3 2019). This structural break is of course a factor which explains the difference between the two sets of forecasts. But for the two sets of data, shrinkage in the wavelet domain had the effect of suppressing the noise while preserving the essential features of the two signals, meaning that the structural break had a marginal effect on the explanation of the difference between the two sets of forecasts, the main factor being the negative external shock of the Covid-19 pandemic.

3.4.Is wavelet analysis a more suitable choice for the research question?

In the literature of parametric modeling -parametric models allow for a direct interpretation of the data, parameters being used to explain the movements within the different components and being used for forecasting- one school emerges, proponent of the Unobserved

Components Model (UCM, Harvey 1989). The UCM belongs to the class of structural time series models set up in a state space context that takes advantage of the extraordinary flexibility of the recursive algorithms known as the Kalman filter and Fixed Interval Smoother (Pedregal, 2001). UCM is defined in terms of unobserved components with certain behavior attached to each component which then has a direct interpretation (Norwood, 2020). UCM uses previous statistical knowledge of the components and separates components which allow for new elements to be added given knowledge of events. On the flip side, UCM requires low level of previous knowledge of the behavior of the series to begin and evolved UCMs can have issues with stability and convergence if models are incorrectly specified. In the literature of non-parametric modeling of economic time series - non-parametric models placing little to no assumptions on the underlying form of the data- one school among others emerge -others include neural networks, support vector regression, regression trees, Gaussian process, long short-term memory, Gautam and Singh, 2020- another school emerges proponent of wavelet analysis. Examples of the wavelet analysis' followers include Gallegati et al. (2017), who demonstrated that wavelets provide a reliable and straightforward technique for analyzing long waves dynamics in time series exhibiting quite complex patterns such as historical data, by allowing simultaneous estimation of different unobserved components and Rhif et al. (2019) who underlined the ability of wavelet analysis to capture non-stationarity, multiresolution and approximate decorrelation which emerge from wavelet filters. Which school to choose? Unlike UCM, wavelet analysis is a non-parametric model that offers flexibility because it is to place little to no assumptions on the underlying form of the data. Since this article focuses on Real GDP time series where a reduced amount of prior information is assumed, reducing data assumptions may lead to a more unbiased approach (Norwood, 2020). In addition, the trend, seasonality, and cycle are embedded in Real GDP time series which are not directly observable in the data (Harvey and Koopman, 2010) but may be captured with both wavelets and unobserved components model. Fluctuations in economic activity are specifically captured by the cycle. Both models can once more capture this cycle. When hidden periodicities in data are to be associated with cyclical behavior or recurring processes, wavelet analysis and unobserved components model may again reveal these periodicities. In addition, wavelet analysis and unobserved components model aim to portray the features of a time series by assuming that they follow

stochastic processes. In conclusion, there is no clear-cut study in the literature separating wavelet analysis and unobserved component model for forecasting economic time series, although unobserved component model is more fashionable. The authors believe that the wavelet analysis forecasting model is as suitable as its competitors.

3.5. *A remark about the choice of level 2 decomposition / Threshold*

At step 2 "Wavelet decomposition" and step 4 "Wavelet Reconstruction", the authors chose level 2 for wavelet decomposition and reconstruction of the signal *s*.

The selection of the optimal level of decomposition of the forecasting model using the Root-Mean-Square Error (RMSE) criteria comes from the same in-sample GDP dataset as the one used in section "3.2. Assessing the forecasting ability of wavelet analysis". The authors make the level of decomposition varying between 1 to 7, forecasting 50 in-sample quarters from Q1 2010 to Q2 2022 of the Real GDP of Cyprus obtained with Cyprus' Real GDP data from Q4 1997 to Q4 2009 (49 data), dividing the in-sample almost equally (49/50). Levels 1 and 3 return an error message: the model does not converge at these levels with Cyprus' Real GDPs data. With the 2nd level of decomposition obtained from 49 data from Q4 1997 to Q4 2009, the RMSE of the 50 Cyprus' forecasts is equal to 472.03, with the 4th level of decomposition the RMSE is equal to 405.68, with the 5th level of decomposition the RMSE is equal to 405.22 with the 6th level of decomposition the RMSE is equal to 405.1626 and with the 7th level of decomposition the RMSE is equal to 405.1630. It shows that the choice of the 6th level of decomposition for Cyprus should be optimal since the RMSE is minimized at this level. However, at the step of forecasting 115 out-sample quarters from Q3 2022 to Q4 2050 GDP of the quarterly Real GDP of Cyprus, the forecasting model does not converge and return an error message when using the 4, 5, 6 and 7th level of decomposition. The model only generates forecasts with the 2nd level of decomposition. This observation represents a limitation of the wavelet analysis model, which is sensitive to the length of the dataset. Therefore, the 2nd level of decomposition is used in the Results section that follows.

4. Results

This paper assesses how Cyprus' economy coped with the Covid-19 pandemic by generating two series of forecasts with wavelet analysis: forecasts using data not including the pandemic (from Q4 1997 to Q3 2019) and including the pandemic (from Q4 1997 to Q2 2022) and. The difference of their averages measures how resilient is the economy during the pandemic, the greater the difference, the more resilient the economy. Cyprus is benchmarked to the Eurozone and Germany.

Observed quarterly GDP time series of Cyprus are illustrated in Figure 3 from 1/1/1998 to 7/1/2022, as well as the ones of the Eurozone economy (19 countries, not including Croatia which joined in 2023), and Germany. In Q1 2020, Cyprus and the Eurozone have entered recession following pandemic that hit their economies. Because of the choice of the scale, the down and up pattern is not clear for Germany in Figure 3. Since 1998, Cyprus' GDP has grown faster than the Eurozone's GDP showing a steeper slope. After the collapse of both economies in 2020, Cyprus seems to have experienced a faster recovery.

Figure 3: Real GDPs Quarterly time series, Millions of Chained 2010 Euros from Q4 1997 to Q2 2022, Seasonally Adjusted for Cyprus (right axis) versus Euro area (19 countries) and Germany, (left axis).
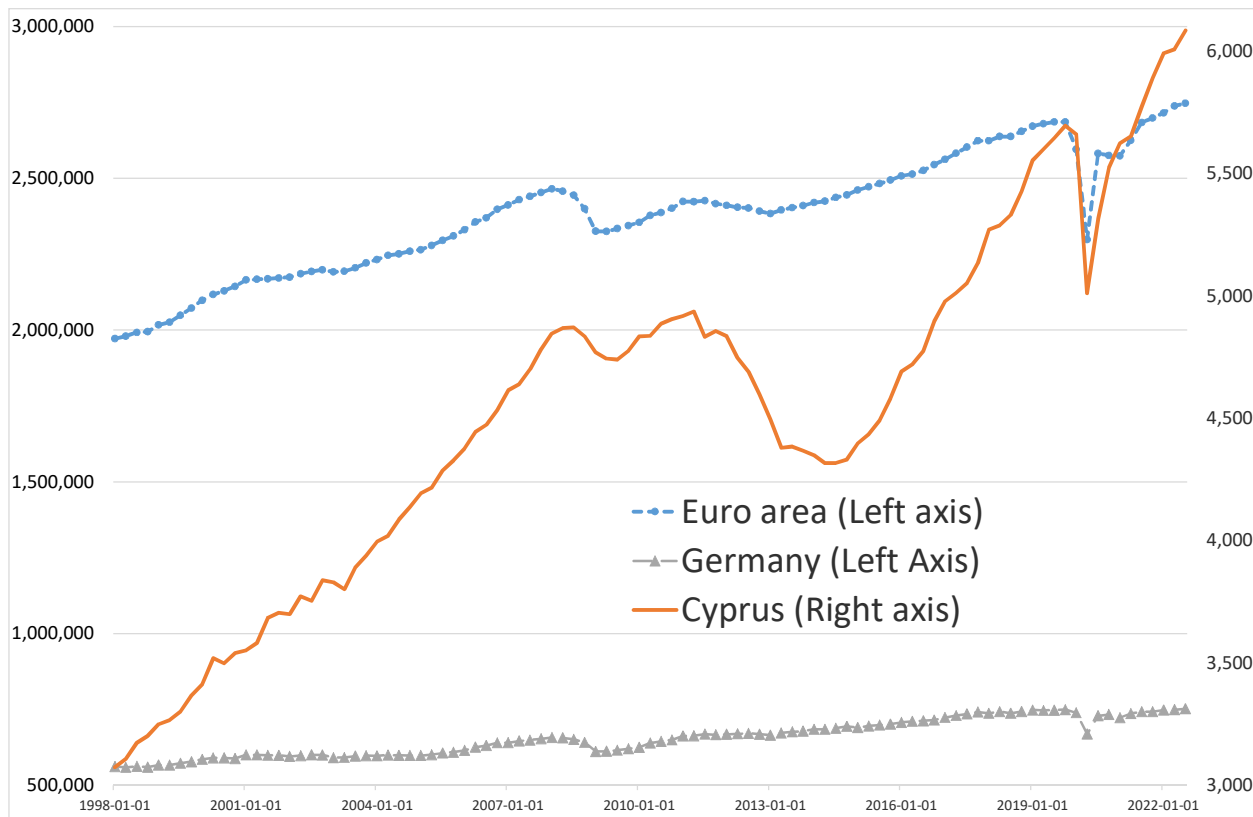
Sources: Own production by the authors. Gross Domestic Product for Eurozone (19 countries) [https://fred.stlouisfed.org/series/CLVMNACSCAB1GQEA19], Germany [https://fred.stlouisfed.org/series/CLVMNACSCAB1GQDE] and Cyprus [https://fred.stlouisfed.org/series/CLVMNACSCAB1GQCY], retrieved from FRED, Federal Reserve Bank of St. Louis

Real GDP growth rate (quarterly and annualized) time series of Cyprus, the Eurozone economy (19 countries), and Germany are illustrated in Figure 4 from Q4 1997 to Q2 2022.

Figure 4: Quarterly Real GDP growth rate (annualized) time series from Q1 1998 to Q2 2022 of Cyprus, the Eurozone economy (19 countries), and Germany.
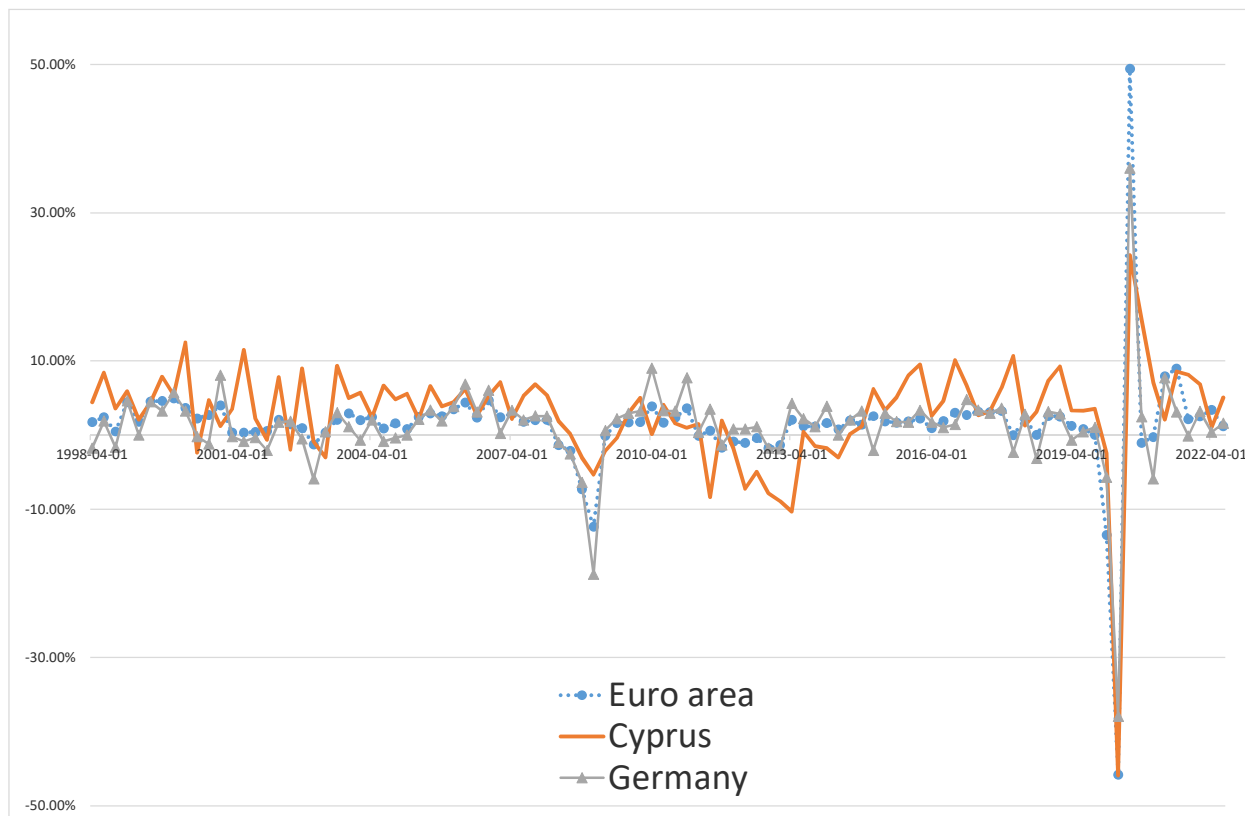
Sources: Own production by the authors and Real GDPs retrieved from FRED. Refer to sources of Figure 3.

Cyprus' growth rate in Figure 4 is most of the time above the ones of the Eurozone (19 countries) and Germany between Q1 1998 and Q3 2019. Between Q4 1997 and Q3 2019, Cyprus had an average quarterly growth rate (annualized) of +2.87% versus +1.43% for the Eurozone and +1.34% for Germany. Figure 5 zooms in on Figure 4 between the third quarter of 2019 and the second quarter of 2022.

Figure 5: Real GDP growth rate (quarterly and annualized) from Q2 2019 to Q2 2022 of Cyprus, the Euro area (19 countries), and Germany.
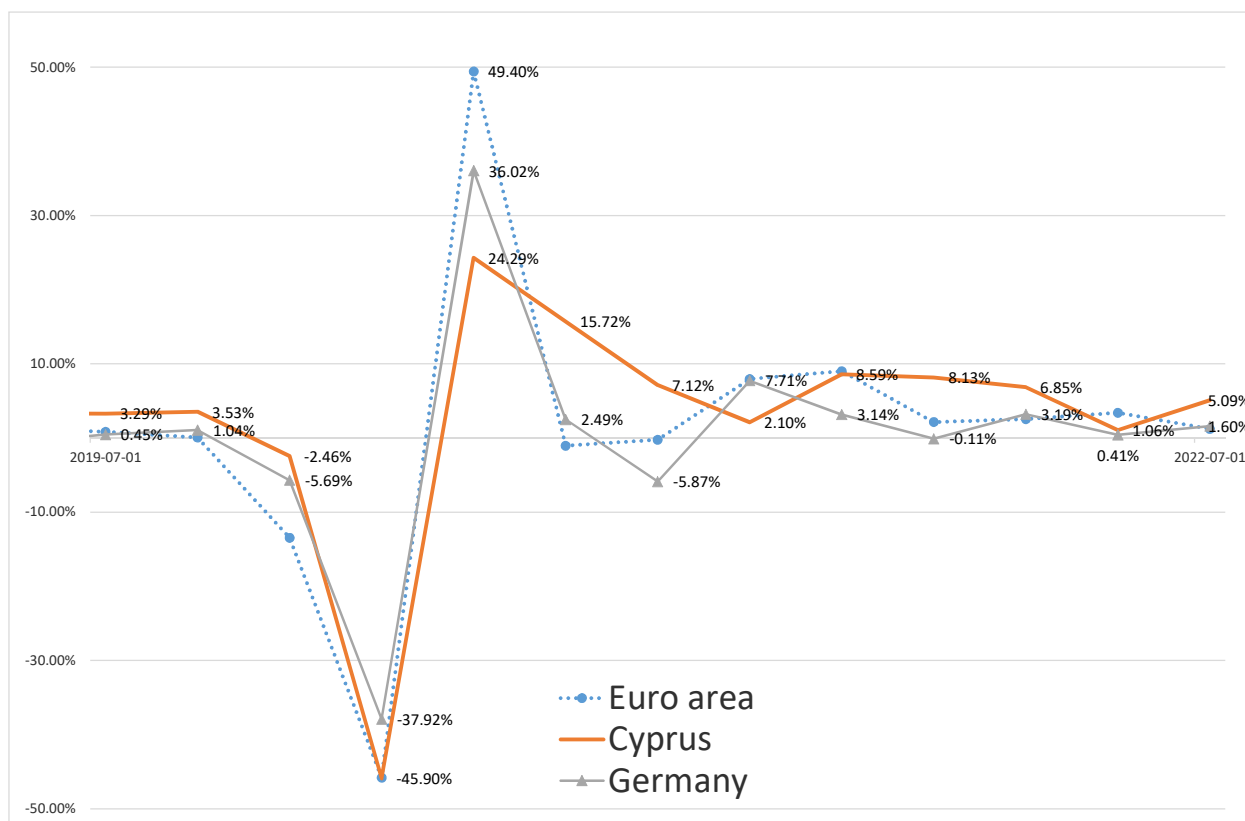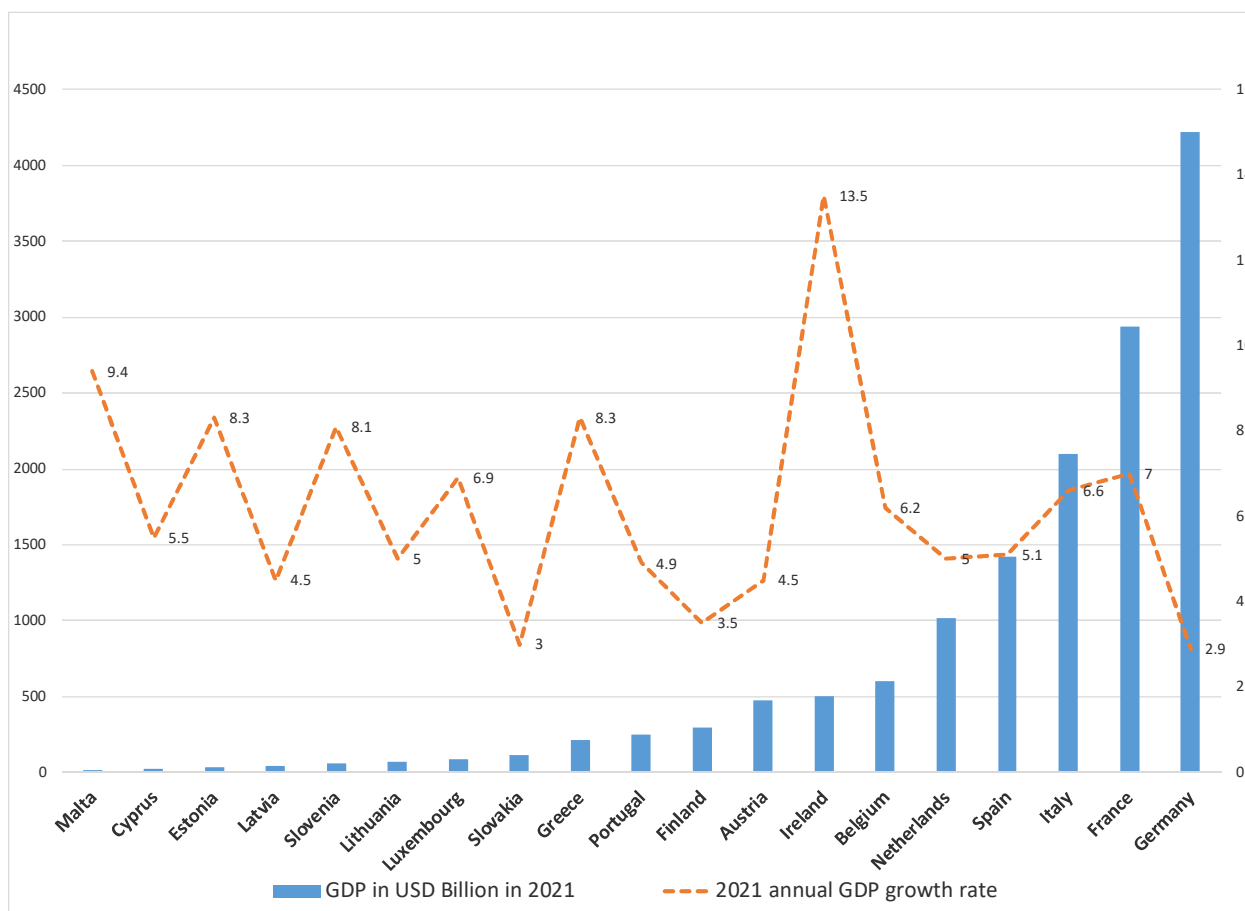

Sources: Own production by the authors and Real GDPs retrieved from FRED. Refer to sources of Figure 3.

Figure 5 shows that at the beginning of the pandemic in the fourth quarter of 2019, the 3 economies started a decline of their quarterly annualized growth rate (-5.69% for Germany, -13.46% for the Eurozone and -2.46% for Cyprus), which extended in Q1 2020 (-37.92% for Germany, -45.80% for the Eurozone and -45.90% for Cyprus), then the 3 economies rebounded in Q2 2020 (+36.02% for Germany, +49.40% for the Eurozone and +24.29% for Cyprus). During the Covid-19 pandemic, between the fourth quarter of 2019 and the second quarter of 2022, the growth rate of Cyprus was most of the time above the one of the Eurozone (19 countries) and Germany with an average of +2.78% in Cyprus versus +1.37% in the Eurozone and +0.45% in Germany. This situation reproduces the relationship of the 3 economies from Q1 1998 to Q3 2019. To bring some perspective to this observation, it is relevant to mention that, in 2021, Euro

area's GDP (including 19 countries) was roughly 523 times bigger than Cyprus', Cyprus' GDP representing about 0.19% of the Euro area's GDP and Germany's GDP was about 152 times the size of Cyprus' in 2021, Cyprus' GDP representing about 0.65% of Germany's GDP. Based on Figure 6, the growth of the Euro area's economies varied between members in 2021: Cyprus' GDP growth rate was +5.5% when the Eurozone's was +6.22% and Germany's (the Euro area leader in size of GDP) was +2.9% (Statista, 2022). In addition, Figure 6 shows that, in 2021, in times of pandemic, small economies had on average greater growth rates than large economies of the Euro area.

Figure 6: Annual GDP growth rate in % in 2021 (right axis) and Annual GDP in USD billion (left axis) of the 19 Eurozone's members including Cyprus' economy in 2021.

Sources: Own production by the authors. Annual GDP of European countries retrieved from https://tradingeconomics.com/country-list/gdp?continent=europe 2021 and annual GDP growth rates retrieved from https://www.statista.com/statistics/686147/gdp- growth-europe/

4.1. Q3 2022 to Q4 2050 forecasts of Cyprus and the Eurozone Real GDP growth rates (quarterly and annualized).

Figure 7 shows 114 quarterly forecasts from Q3 2022 to Q4 2050 obtained with wavelet analysis of Cyprus and the Eurozone Real GDP growth rates (quarterly and annualized).

Figure 7: 114 forecasts from Q3 2022 to Q4 2050 obtained with wavelet analysis of Cyprus and the Eurozone GDP growth rates (quarterly and annualized)
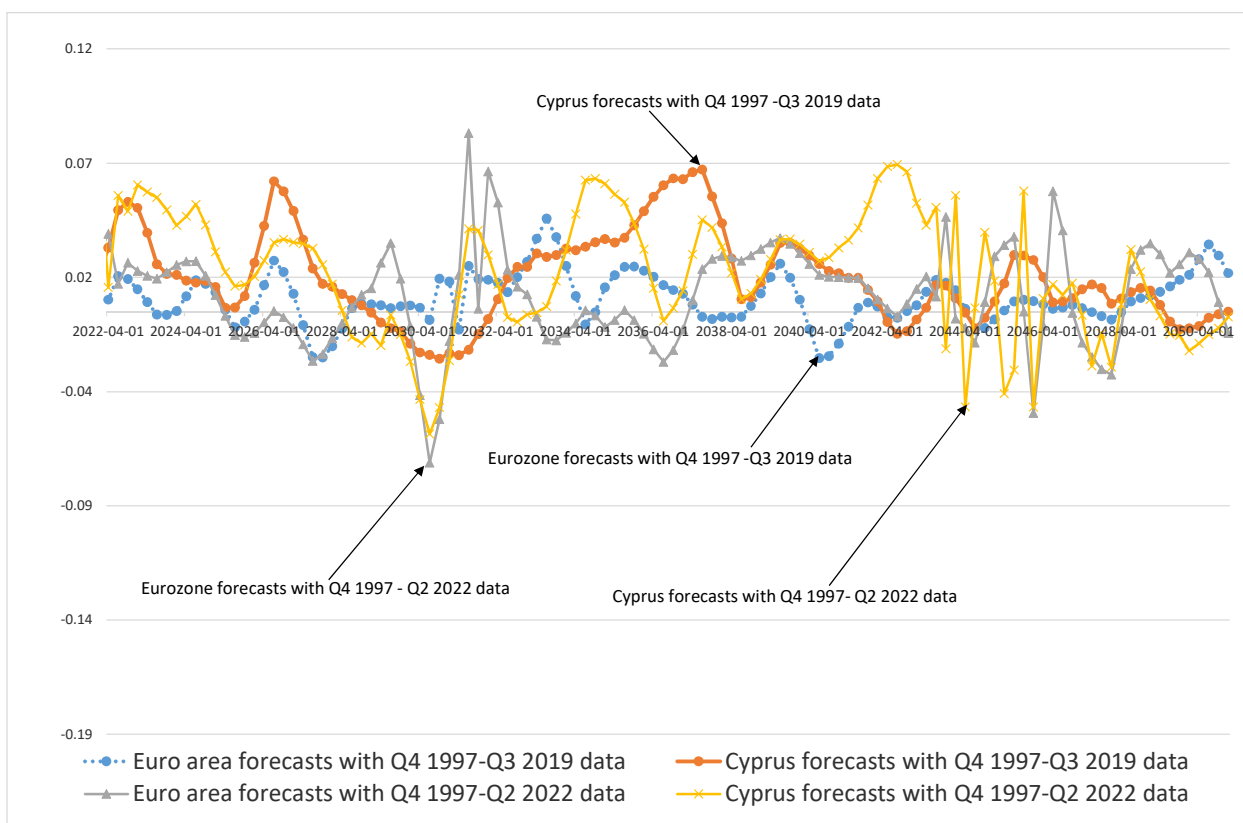
Source: Authors' own production with the software Matlab.

From Q3 2022-Q4 2050 114 forecasts, forecasts of Cyprus are more optimistic than the Eurozone, with an average growth rate (quarterly and annualized) of +1.47% for Cyprus, forecasts generated with the Q4 1997-Q3 2019 data versus +1.62% for Cyprus with the forecasts

generated with Q4 1997-Q2 2022 data. Eurozone's forecasts have an average growth rate of +0.57% with Q4 1997-Q3 2019 data versus +0.68% with Q4 1997-Q2 2022 data.

In addition, Germany being the largest economy of the Eurozone, has an average quarterly growth rate forecast of +1.01% with Q4 1997-Q3 2019 data versus +0.89% with Q4 1997-Q2 2022 data. It shows that, Cyprus (+1.62% with the pandemic data versus +1.47% without the pandemic data) and the Eurozone (+0.68% versus +0.57%) benefited from the pandemic when Germany's economy was hurt by the pandemic (+0.89% versus +1.01%). As represented in Figure 6, small economies of the Euro area had in 2021, on average, a higher GDP growth rate than the larger economies of the Euro area. The forecasts of the 2050 growth rates in this paper confirm that a small economy like Cyprus has been more resilient toward the pandemic and has a better outlook than the largest economy of the Eurozone, Germany.

4.2. Q3 2022 to Q4 2050 quarterly Real GDPs Forecasts of Cyprus, Germany and the Eurozone

Figure 8 illustrates 114 quarterly Real GDP forecasts with wavelet analysis of Cyprus, Germany, and the Euro area from Q3 2022 to Q4 2050. Figure 3 shows a rebound of the 3 economies in Q2 2020, +24.29% in Cyprus, +49.40% in the Eurozone and +36.02% in Germany, following a cataclysmic fall in Q1 2020, -45.90% in Cyprus, -45.80% in the Eurozone and -37.92% in Germany. This observation may explain the fact that the 2050 projections of the 3 economies show a positive trend, wavelet analysis forecasting model being more sensitive to latest data. In addition, as explained in section 4.1., the pandemic benefited to Cyprus' and the Eurozone's economies, but Germany's economy has been hurt, its Q32022-Q4 2050 projections obtained with data including the pandemic being consistently below the ones obtained with data not including the pandemic. In section 4.3., the resilience of the 3 economies towards the pandemic is formally assessed.

Figure 8: Historical data and quarterly forecasts with wavelet analysis from Q3 2022 to Q4 2050 of Cyprus, Germany, and Eurozone GDPs (annualized), Millions of Chained 2010 Euros, Quarterly, Seasonally Adjusted
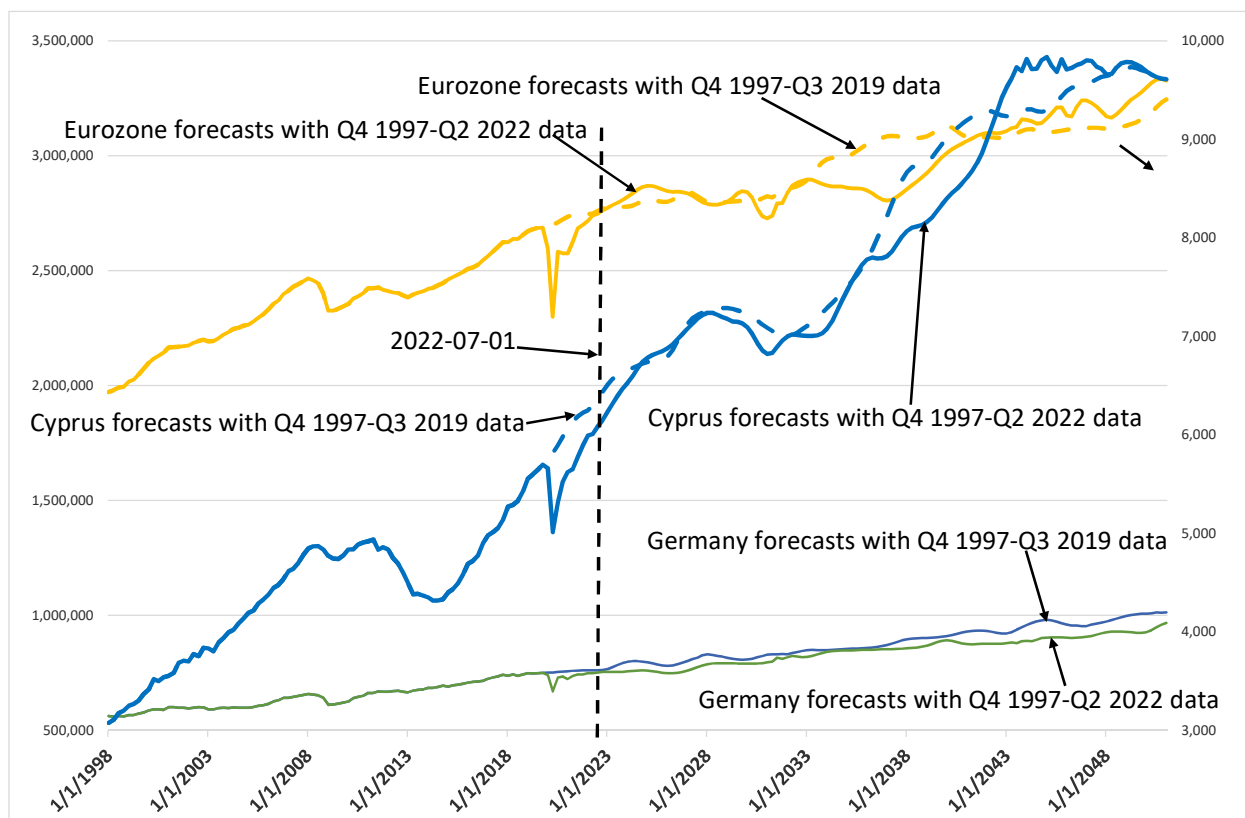
 Source: Authors' own elaboration using Matlab.

4.3. Assessing the resilience of Cyprus' Economy after the Covid-19 Pandemic

This research assesses how Cyprus' economy coped with the Covid-19 pandemic by generating two series of forecasts with wavelet analysis: forecasts using data including the pandemic (from Q4 1997 to Q2 2022) and not including the pandemic (from Q4 1997 to Q3 2019). The computation of the difference of their averages is an indicator of the resilience of the economy during the pandemic, the greater the difference, the more resilient the economy. Eurozone and Germany are used as benchmarks: subtracting the Q3 2022-Q4 2050 GDP growth rate (quarterly and annualized) average forecast of Cyprus obtained with the Q4 1997-Q2 2022 data, +1.62%, by the one obtained with the Q4 1997-Q3 2019 data, +1.47%, the difference is +0.15% whereas with Eurozone the difference is +0.11%, [+0.68% - (+0.57%)] and with

Germany the difference is -0.12% [+0.89% - (+1.01%)]. Thus, Cyprus' economy shows a slightly higher resilience (+0.15%) than the Eurozone's (+0.11%) based on Q3 2022-Q4 2050 forecasts and a stronger resilience than Germany's (-0.12%). Moreover, the average of the Q3 2022-Q4 2050 quarterly (annualized) growth rate forecasts of Cyprus is expected to be +1.62% with the Q4 1997-Q2 2022 data whereas it is expected to be only +0.68% for the Eurozone and +0.89% for Germany. Cyprus' economy shows better prospects than the Eurozone's and Germany's economies.

5. Conclusion and Discussion

This paper assesses how Cyprus' economy coped with the Covid-19 pandemic by generating two series of forecasts with wavelet analysis: one using data including the pandemic (from Q4 1997 to Q2 2022) and another one not including the pandemic (from Q4 1997 to Q3 2019). The difference of their averages is an indicator of the resilience of the economy during the pandemic, the greater the difference, the more resilient the economy. Benchmarks of Cyprus are the Eurozone and Germany. During the Covid-19 pandemic, between Q4 2019 and Q2 2022, the Real GDP growth rate (quarterly and annualized) of Cyprus was most of the time above the one of the Eurozone (19 countries) and Germany with an average growth rate of +2.78% for Cyprus versus +1.37% for the Eurozone and +0.45% for Germany (refer to Figure 5). This observation respects the hierarchy of average growth rates of the 3 economies from Q1 1998 to Q3 2019 (+2.87% for Cyprus versus +1.43% for the Eurozone and +1.34% for Germany). To formally evaluate how Cyprus' economy coped with the Covid-19 pandemic, two series of forecasts were obtained: forecasts using data including the pandemic (from Q4 1997 to Q2 2022) and not including the pandemic (from Q4 1997 to Q3 2019). The difference of their averages is an indicator of the resilience of the economy during the pandemic, the bigger the difference the better the resilience. Eurozone and Germany are used as benchmarks: subtracting the average forecasted Q3 2022-Q4 2050 GDP growth rate (quarterly and annualized) of Cyprus generated from the Q4 1997-Q2 2022 data, +1.62%, by the one generated from the Q4 1997-Q3 2019 data, +1.47%, the difference is +0.15% whereas with Eurozone the difference is +0.11%, [+0.68% - (+0.57%)] and with Germany the difference is -0.12% [+0.89% - (+1.01%)]. Thus, Cyprus' economy shows a slightly higher resilience (+0.15%) than the Eurozone's (+0.11%) based on

Q3 2022-Q4 2050 forecasts and a stronger resilience than Germany's (-0.12%). Moreover, the average of the Q3 2022-Q4 2050 quarterly (annualized) growth rate forecasts of Cyprus is +1.62% with the Q4 1997-Q2 2022 data whereas it is only +0.68% for the Eurozone and +0.89% for Germany. Cyprus' economy shows better prospects than the Eurozone's and Germany's economies.

The last words of this paper are taken from Mrs. Christine Lagarde, during a conference organized in Nicosia (Lagarde, 2022). "When you set out on your journey to Ithaca, pray that the road is long, full of adventure, full of knowledge" (from a famous poem "Ithaca" of Cavafy, 1911). Cavafy's poetry illustrates the tale of Cyprus nowadays, a tale filled with adventure, much hardship, that means to say the 1974 Turkish invasion and the shameful resulting divide of Cyprus, the accession of Cyprus to the European Union in 2004, the adoption of Euro currency in 2008, the banking crisis in 2013 and the steady annual growth of Cyprus' economy by about 6% between 2015 and 2019. The Cypriot population has managed to face all the difficulties, gain knowledge and come out stronger and more resilient each time. This observation applies to the pandemic crisis which was another example of such obstacles endured and overcome by Cypriot people.

Additional research may deal with other economic indicators of Cyprus to identify weaknesses and strengths of the Cyprus economy and how to enhance them.

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