ISSN 2282-6483

Alma Mater Studiorum - Università di Bologna
DEPARTMENT OF ECONOMICS

Measuring Economic Uncertainty for Poland

Stanisław Bartha
Maria Elena Bontempi

Quaderni - Working Paper DSE N°1178

Measuring Economic Uncertainty for Poland

Stanisław Bartha*
Maria Elena Bontempi§

November 14, 2022

Abstract

Measuring economic uncertainty is challenging, but it is important for policymakers to address it, especially in countries for which there are virtually no uncertainty indices. This article proposes an index of economic uncertainty for Poland, EURQPL, based on Internet searches for specific terms to capture the level of uncertainty perceived by Internet-using economic agents. Compared to Bontempi et al. (2021) who analysed the US and Italy, the change of country, the use of either Polish or English in the definition of queries and the creation of regional indices offer interesting insights. The national index peaks at times commonly considered uncertain, such as the financial crisis and the coronavirus pandemic. Compared to the EURQ for the US and Italy, our index has a significant peak due to the teachers' strike, a shock not reported in the literature. Particularly relevant are the terms related to social security and fiscal policy; uncertainty shocks have persistent effects on unemployment. Besides confirming how successfully Internet searches can be exploited in economic research, we highlight how regional indices can be used to study the impact of uncertainty on local economies.

Keywords: Economic Uncertainty; Uncertainty in Poland; Regional Uncertainty; Native Language and English; Internet Searches; Google Trends.

JEL classification: C23; C41; D22; G32; L10; O30.

*Dep. of Economics, University of Bologna, stanislaw.bartha@studio.unibo.it.
§Corresponding author, Dep. of Economics, University of Bologna, mariaelena.bontempi@unibo.it.

Non-Technical Summary Uncertainty is likely to induce a cautious attitude in households and businesses, perhaps even in economic policy decisions by policymakers. Failure to act could not only slow down or delay economic recovery in the short term, but also undermine the foundations of long-term economic growth. Of course, economic-political uncertainty is composed of many different aspects, varying in importance depending on the country and the period considered. Existing uncertainty indicators are generally based on financial data, or on discrepancies in economic forecasts or on the frequent use of certain terms in newspapers. In all cases, the aspects considered represent a subset of the uncertainty triggers, are filtered by investors, professional forecasters and journalists, and relate to specific countries, such as the US. We propose an index based on Internet searches that is able to represent the perception of uncertainty manifested by all economic agents for a country, Poland, currently at the forefront of receiving Ukrainian refugees. We ask which events most capture Poles' need for more information, what role the language, native or English, plays in defining perceived uncertainty, and in which regions of Poland certain aspects of uncertainty have a significant effect.

1 Introduction

We live in particularly uncertain times. Financial crisis, social and political unrest, climate change and pandemic outbreak are all events that make the future very unpredictable. In her speech on June 13, 2020, the President of the European Central Bank, Christine Lagarde, described the economic situation as "characterised by profound uncertainty" and stressed that "predicting the future has rarely been harder". Increased uncertainty leads to the spread of insecurity among economic agents and prevents rational decision-making. The ability to anticipate trends in uncertainty can be particularly important for policy makers. Such knowledge can be used both to prepare the economy before a crisis and to design recovery programmes afterwards. To quote the ECB president again, "turning uncertainty into confidence" is a condition for "real recovery". For this reason, many researchers devote themselves to measuring economic uncertainty. Quantifying the phenomenon of uncertainty helps to better understand (i) its underlying mechanisms - how it rises and falls; (ii) its impact on the economy - how it affects output and employment, etc.; and finally (iii) the behaviour of economic agents in response to uncertainty shocks.

To construct a relevant measure of uncertainty, it is necessary to define the type of uncertainty of interest and the agents that convey the 'information' about uncertainty signals. First, we focus on economic and policy uncertainy. Second, while most of the available uncertainty measures base on the uncertainty expressed by experts such as managers, professional forecasters or journalists (e.g. Baker et al. 2016; Ozturk and Sheng 2018; Ahir et al. 2018), we intend to measure instead the uncertainty perceived by ordinary people - regular Internet users. Our work is innovative not only because it extensively develops an Internet-based uncertainty index for Poland, but also because we propose a comparison of the index according to the language used for the queries, Polish or English, and regionally disaggregated uncertainty indices, which are relatively unexplored aspects.

Following the approach of Bontempi et al. (2021), we develop the Economic Uncertainty Related Queries index for Poland (EURQPL). Our measure relies on Internet searches and tracks the changes in the interest of Internet users driven by uncertainty. The key idea is that economic agents search for information on selected topics related to uncertainty that are of particular concern to them. The more often and more intensively agents seek these queries on the Internet, the greater uncertainty they express. The advantage of this approach is that it is based on freely accessible data updated in real time[1], does not require the selection of unbiased media, and captures sentiments of millions of users.

According to the Polish Statistical Office's report (GUS 2020), the Internet has become a major source of information for many Poles. The digital society is growing rapidly: the percentage of Polish households with Internet access from home has risen from 41% in 2007 to over 90% in 2020. Only slightly slower has been the increase in the number of individuals using Internet regularly (81% in 2020). Moreover, the Internet proved to be particularly important medium (second after TV) during the 2020 pandemic, as 68.5% of respondents sought information on COVID-19 in this media.

Our research is possible thanks to Google Trends (GT). GT is a freely available website that allows to view trends of any search query from the Google search engine. Its popularity has increased dramatically over the last decade and has been widely used in research work spanning fields such as

[1]The data is even available at a minute frequency.

computer science, medicine, economics and marketing (Ginsberg et al. 2008; Jun et al. 2017; Nuti et al. 2014; Carneiro and Mylonakis 2009). Importantly, GT has been used to predict the results of 2015 Greek Referendum (Mavragani and Tsagarakis 2016), the monthly US unemployment rate (D'Amuri and Marcucci 2017) and car sales and consumer confidence (H. Choi and Varian 2011). Google's worldwide share of Internet traffic in the period 2009-2020 exceeds 92% and in Poland even reaches 98%[2]. Google's dominant position allows all the other search engines to be neglected[3].

Our pool of search terms downloaded from GT contains 148 queries adapted from the list of Bontempi et al. (2021) (which amounts to 184 queries for the US and 136 for Italy), with the caveat that we adjust, add or remove queries so that the list fits better for Polish users. We constructed several EURQPL indices. The "national" index captures the overall uncertainty in Poland. We built two complementary national indices, one based on queries in Polish and the other in English, which measure the uncertainty perceived by Poles and English speakers respectively. This distinction in language might indicate differences in the perception of uncertainty depending, for example, on the level of education of economic agents. In addition, we constructed sixteen regional indices, one for each province. Regional disaggregation could point to differences in perceived uncertainty related to the industrial and cultural context of eah part of Poland.

We find several arguments in support of the usefulness and effectiveness of our indices. Essentially, our EURQPL does indeed speak in periods of particular economic turbulence, e.g. during the financial crisis and due to the 2020 pandemic. Moreover, EURQPL represents a distinctive innovation from the literature in that it captures the uncertainty induced by the 2019 teachers' strike, an event typically ignored by economic measures. The topics related to social security programmes and fiscal policy play a crucial role.

We provide further validation of our indices by running a series of comparisons with other measures of uncertainty for Poland, based on different approaches. We perform three sets of comparisons on a monthly, quarterly and annual yearly frequency, depending on data availability. Specifically, these indices are: based on Internet searches of aggregate categories, forecast-based, based on newspapers, based on economic reports and finally a financial-based index. The variety of methods makes it possible to reveal the heterogeneous nature of each measure in the case of Poland. Our EURQPL shows the highest correlation with the Internet search-based Google Economic Policy Uncertainty, GEPU index (Kupfer and Zorn 2019) and the forecast-based Country Specific Uncertainty, CSU index (Ozturk and Sheng 2018).

Establishing a reliable measure of uncertainty opens up numerous possibilities for econometric analysis. First, we look for a causal relation between uncertainty indices and commonly used leading indicators. We obtain different results depending on the language used to build the EURQPL. The measure in Polish leads movements in business sentiment, while the measure in English leads macroeconomic indicators. Second, we provide evidence of how macroeconomic aggregates evolve in

[2]Stats (2021) provides rich information on search engine market in various countries and for wide period. Available at https://gs.statcounter.com/search-engine-market-share.

[3]Bearing in mind the numbers above and in order to simplify terminology, we will use shorter forms such as 'Internet users' or 'Internet-driven search' while always meaning 'Google search engine users' or 'Google-driven search'. However, there are countries, including Russia and China, where Google does not hold such a dominant position. In Russia and China, Google controls 52% and 9% of the market respectively, which means that data from other search engines, e.g. Yandex and Baidu, must be used.

response to shocks in economic uncertainty. Our analysis uncovers a significant and positive effect of uncertainty on unemployment. Unemployment increases persistently and remains high for two years. At the regional level, we find three to six heterogeneous clusters. Defining the factors responsible for this clustering of regions is difficult and offers opportunities for future research. Our provisional examination indicates reasons such as migration flows, employment in services and agriculture but not the unemployment rate.

This study is organised as follows. Section 2 presents the related economic literature. Section 3 describes our economic uncertainty indices, tests their robustness and compares them with other available measures of uncertainty. Section 4 contains the Granger causality tests between our EURQPL and some leading indicators, uses VAR models to estimate the effect of the uncertainty shock on macroeconomic variables and perform cluster analysis for regional indices. Section 5 concludes.

2 Literature Review

The topic of economic uncertainty is receiving increasing attention in the literature. In this Section, we present papers of fundamental importance for the exploration of the concept of uncertainty. To begin with, it should be noted that many different methodologies have been applied to study uncertainty, such as econometric techniques, text mining, web scraping and surveys, to name a few.

Both theoretical and empirical works have been conducted to assess the impact of uncertainty on the economy. this issue. A common finding of most studies is the counter-cyclicality of uncertainty (Bernanke 1983; Bontempi et al. 2010; Meinen and Roehe 2016; Ahir et al. 2018; Ozturk and Sheng 2018). This conclusion is further supported by Bloom (2009) who shows that investment decreases in response to uncertainty shocks. The author builds a model with a time-varying second moment and estimates it using firm-level data. A simulated macro uncertainty shock produces sharp recession, but this is followed by a rapid recovery. Furthermore, Algharabali and Al-Thaqeb (2019) reveal that firms take precautionary measures during periods of high uncertainty, thereby slowing down investment in production and employment. In particular, firms increase liquidity to hedge against high uncertainty (Demir and Ersan 2017). However, empirical work conducted by Carrière-Swallow and Céspedes (2013) shows substantial heterogeneity across countries. Emerging economies experience a much more severe decline in investment and private consumption and take longer to recover. As pointed out by Ahir et al. (2018), uncertainty is greater in emerging and low-income economies than in advanced countries. The study by Castelnuovo and Tran (2017) reveals a positive and persistent unemployment response to an uncertainty shock in the US, but not significant in Australia. On the other hand, the effect of uncertainty on the Croatian economy is statistically significant, but short-lived and rather weak (Sorić and Lolić 2017).

Uncertainty is also relevant in the social context. For instance, Bazzani et al. (2020) study the decline in fertility in most European countries. They suggest that economic uncertainty has a negative effect on fertility because individuals behave according to uncertainty, based on their narratives of the future and the narratives shared by the society. Kalinowski (2015) examines the uncertainty faced by the poor in the western Polish city of Poznań. The author observes that high job insecurity determines the uncertainty of the respondents' future. Income uncertainty leads to deprivation of needs. The

study by Kula and Ruzik-Sierdzińska (2011) shows that institutional uncertainty is an important factor in retirement decisions. Frequent changes in the welfare system reduce the individual planning horizon and lead people to retire as soon as they meet the eligibility criteria.

As far as empirical work is concerned, one of the most popular proxies for uncertainty is the VIX, which measures stock market volatility and thus focuses on financial uncertainty, used e.g. by Bloom (2009) and Carrière-Swallow and Céspedes (2013). In his paper, Drechsler (2013) argues that uncertainty is strongly reflected in option prices as measured by the VIX, which is a better predictor of excess stock returns than statistical expectations of volatility. The author finds that uncertainty is an important factor influencing the equity premium and the risk-free rate.

On the other hand, uncertainty indices based on newspapers are becoming increasingly popular, especially after the work of Baker et al. (2016) who analysed thousands of newspaper articles in search of specific, words related to uncertainty and constructed the Economic Policy Uncertainty index (EPU). With this measure, they estimated the effect of uncertainty on the economy at both the firm and macro level. In the first case, they found that a shock to policy uncertainty signals higher price volatility, and lower investment and employment. In the second case, shocks to policy uncertainty lead to a decline in investment, output and employment. Initially constructed only for twelve developed and emerging economies, the index is now available for several countries, including Greece (Hardouvelis et al. 2018), the BRIC countries (Demir and Ersan 2017) and Poland (Hołda 2019). Furthermore, Algharabali and Al-Thaqeb (2019) find that a local effect of the EPU spills over to other countries.

While newspaper-based measures treat the media as a reliable source of information on economic uncertainty, Internet search-based indices deal with the perception of uncertainty by web users. This approach was adopted by Dzieliński (2012) and Donadelli (2015) who constructed simple indices based on a few queries (one and three respectively). The former is based on the search volume of the word "economy" and has a negative relationship with future aggregate market returns. The second index of Donadelli (2015) incorporates three policy-related queries ("US stock market", "US politics" and "US Fed"). Uncertainty measured this way leads to a decline in industrial production and an increase in the unemployment rate. Castelnuovo and Tran (2017) increased the number of queries. However, so far the most elaborated index that overcomes word selection bias and verifies the reliability of measures based on Internet searches has been proposed by Bontempi et al. (2021). They constructed their EURQ index using 184 queries for the US and 136 queries for Italy.

As the relevance of economic uncertainty increases, more and more research focuses on emerging markets and Poland. For example, Güney (2019) investigates the impact of economic uncertainty on private investment in Poland. The author uses a GARCH model in which uncertainty is the variance of the unexpected component of the model. In this framework, uncertainties in the real exchange rate, inflation and growth have a negative effect on private investment. In light of these results, the author concludes that macroeconomic stabilisation is crucial for strong investment. Brzozowski and Nehrebecka (2016) adopt a similar approach to study the impact of macroeconomic uncertainty and idiosyncratic shocks on corporate saving. They measure uncertainty as conditional variance in ARCH and GARCH models of inflation, output, capital market rate of return, real GDP and 3-month real interest rate. The estimates show that Polish firms adjust the level of savings and liquidity to the level of macroeconomic uncertainty, and maintain a safety reserve in the form of accumulated savings as

a precaution against idiosyncratic shocks. Finally, Škrinjarić and Orlović (2020) estimate the effects of shocks in the economic policy uncertainty index (EPU) for Central and Eastern European (CEE) markets. They found that Poland is particularly vulnerable to uncertainty shocks in Europe, such as Brexit. Moreover, stock markets in CEE countries are sensitive to changes in the EPU.

Last but not least, we have to list the five uncertainty indices with which we compare our EURQPL index. We already mentioned the first two in Section 1: the GEPU index based on Internet search (Kupfer and Zorn 2019) and the CSU index based on forecasts (Ozturk and Sheng 2018). The other measures are: the Economic Uncertainty index, EU, based on newspapers (Hołda 2019), the World Uncertainty Index, WUI, based on economic reports (Ahir et al. 2018), and finally the Volatility of Stock Prices index, VSP, based on finance (Bank 2021). We provide a detailed presentation of these indices at the end of Section 3.

3 Measuring uncertainty

The Economic Uncertainty Related Queries index for Poland, EURQPL, uses Internet search volumes to measure economic uncertainty. The EURQPL is based on the assumption that economic agents' need for information on certain topics is stimulated by uncertainty. In other words, people search for certain terms on the Internet *because* they associate a certain level of uncertainty with the searched topic and feel insecure about the future. As far as EURQ is concerned, Bontempi et al. (2021) show that searching for answers on the Internet reflects individuals' genuine interest in a certain topic rather than a simple curiosity triggered by the media. The idea of our index is therefore as follows: the greater the interest in certain words or phrases expressed by Internet users, the greater the uncertainty.

In this section, we first explain the procedure for constructing the EURQPL index. This includes selecting terms, exploring the nuances of the Polish language, removing noise and implementing the aggregation technique. Next, we present our national indices for Polish and English queries. For the former, we also examinate several alternative versions. To study heterogeneity between regions, we also construct indices for each province. Finally, we compare the national EURQPL with other measures of uncertainty.

3.1 Selecting the queries

As the reliability of our approach depends fundamentally on the choice of queries, it is necessary that these are complete and accurate. To construct the EURQ index for Poland, we have compiled an extensive list of 148 carefully selected search terms. The construction of the dictionary requires several steps. First, we translate the chosen queries from Bontempi et al. (2021) and adopt those relevant for the Polish case. In addition to direct translation, this step includes changing the names of American/Italian institutions with Polish equivalents or replacing terms referring to legal, monetary, fiscal, etc. systems in the US/Italy with those valid in Poland. For example, we replace the term 'federal reserve' with 'NBP' (Polish Central Bank) or 'national debt' with the Polish version of 'public debt'. Secondly, we look for Poland-specific queries, e.g. the Polish equivalents of 'introduction of the euro' and 'shale gas' are important uncertainty factors. Finally, we eliminate the noise that

accompanies our search terms, as sometimes a query can have multiple meanings and thus refer to other non-economic topics.

In general, our dictionary is composed of queries that capture any event relevant to political, social, legal or financial developments affecting the economy and economic agents. Thus, we include terms that relate to the fiscal system, monetary policy, regulations, national security or political and economic crises.

To better illustrate the process of selecting uncertainty-related queries, we present two cases that explain why the terms 'inflation' and 'Polish army' are relevant to economic uncertainty in Poland. Of course, common intuition suggests that inflation is a source of uncertainty. However, we need to validate this hypothesis before adding the term to the dictionary. To this end, let us compare the actual inflation rate and the volume of Google searches for the Polish word 'inflation'. Figure 1 shows the trend for both measures. It can be seen that both variables often peak in the same months. The volume of searches is highest in months when inflation is particularly high (e.g. just before the financial crisis or in the period 2019-2020), whereas in the period 2014-2016, when Poland was in deflation, interest in the term inflation was much lower, implying that concern about inflation was also low. In 2020, searches peak when the inflation rate exceeds the Central Bank's target of 2.5%. Of course, the level of inflation does not necessarily translate into inflation uncertainty, which is rather the ex ante (second moment) variability of inflation. Nevertheless, given the relatively high (0.4) and statistically significant correlation between the two, we adopt the query. Furthermore, there are no correlated queries that refer to irrelevant (non-economic) topics. Hence, the signal information clearly outweighs the noise.

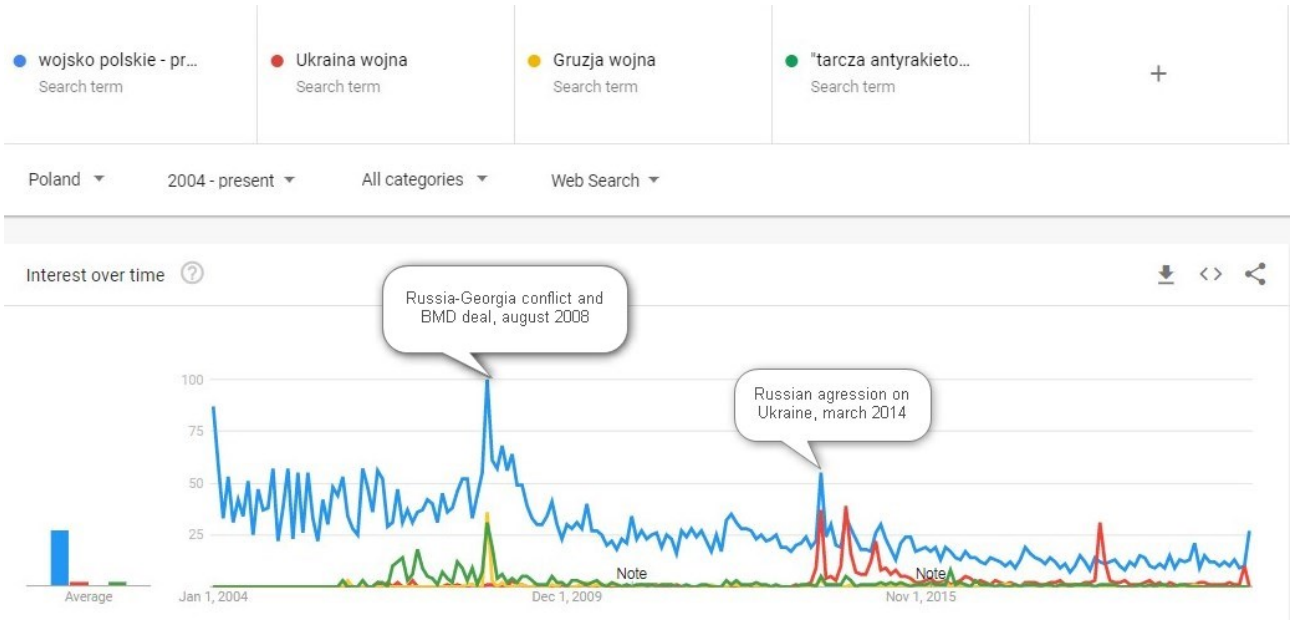
Figure 1: Actual inflation rate and searches for 'inflation' query in Poland.

Notes: Actual inflation rate in Poland (scale on the right) and search volume for 'inflation' query (scale on the left).

Not all queries are as easy as inflation. War is an example. Certainly military conflicts increase uncertainty, yet a simple query 'wojna' (*war*) is too broad and captures interest not only for current conflicts but also for many historical conflicts. Indeed, the volume always drops in the summer months, suggesting that much of the search is induced by students preparing schoolwork. In this case, we try

to overcome the problem of extensive noise by applying an alternative query. Specifically, instead of war, we use the Polish equivalent of 'Polish army'. After removing the noise words from the query, we obtain a reliable term. The Figure 2 shows that interest in the Polish army spiked during the war in Georgia (2008) and the annexation of Crimea (2014)[4]. We can conclude that the search volume of the Polish army captures the uncertainty induced by military conflicts. Furthermore, it can be noted that this type of uncertainty is particularly driven by Russian military expansion.

Figure 2: Screenshot from GT: 'Polish army', 'Ukraine war', 'Georgia war' and 'Ballistic Missile Defence'.



Notes: Search volumes of Polish equivalent for 'Polish army' (in blue), 'Ukraine war' (in red), 'Georgia war' (in yellow) and 'Ballistic Missile Defence' (in green).

Following the logic just presented is a necessary condition for validating our queries. However, there are other conditions that derive from the nature of the language. In particular, we must take into account the fact that there are special characters in the Polish alphabet that could influence our results. Additionally, in some cases we have to decide between the singular and plural form of a term. We adopted a trial-and-error-approach to validate each query, thus obtaining the optimal set of queries. A detailed discussion of word selection and the complete list of queries are given in Appendix **??**.

We are aware that the index may not be robust over time and will need to be updated. New events may occur and the old queries may no longer capture all the uncertainty. An example is the reform of the OFE[5]. It was an important factor of uncertainty, but now that the OFE has been abolished, it is likely to no longer be relevant. On the contrary, the IKE (Individual Pension Account) might play a role in the future and be included in the index. Moreover, the current list of queries may have to be revised in the future to exclude possible noise.

[4]The careful reader will notice that the red peak in November 2018 had a minimal effect on interest in the Polish military. In our view, Poles do not see this event as a threat to Poland's sovereignty and therefore this event does not contribute to the index. In this case it was an exacerbation of the conflict between Ukraine and Russia over the Azov Sea.

[5]The OFE was a pillar of the pension system with a mandatory contribution. The 2014 reform reduced this pillar by lowering the contribution and redirecting it largely to the ZUS (Social Security Institution). In 2019 the OFE was completely abolished.

Finally, we should emphasise that the national index for the whole country may differ substantially when translated regionally. Poland is divided into 16 provinces[6]. As shown in Figure 16 of Appendix C, Polish regions vary considerably in terms of population size. Mazowieckie is the most populated province, with more than 5 million inhabitants, while Opolskie and Lubuskie have just 1 million, which places them at the bottom of the ranking. Consequently, we expect Internet traffic to be higher in regions with a large population. This leads us to conclude that regions such as Mazowieckie, Śląskie, Wielkopolskie and Małopolskie might have a particular contribution to the index. Mazowieckie might have a large weight in our index for another reason. As this is the region where the capital is located, local events may also attract national attention. The results of Mroczek et al. (2014) show that the strongest gravity effects (effects of regional interdependence) are observed in densely populated and rich metropolitan areas such as Warsaw, Poznań, Wrocław, Kraków and Śląskie region. We believe that our index can be concentrated in large urban areas, making peripheral regions weigh less and contribute less.

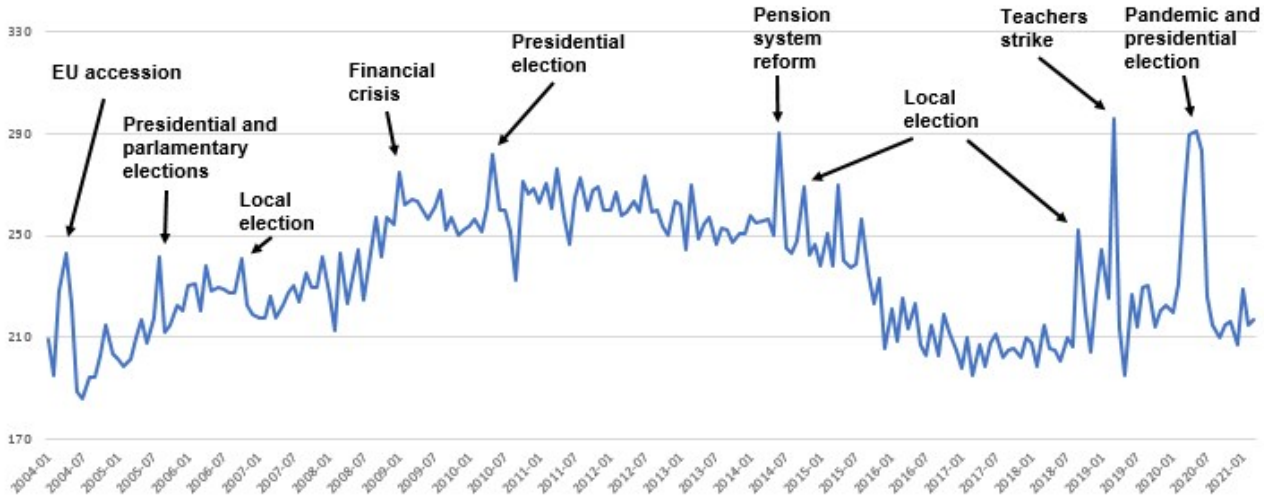
3.2 The national EURQ indices

Our national EURQPL index is displayed in Figure 3. In general, the index jumps during periods commonly described as highly uncertain (financial crisis, pandemic) and due to a number of political events. Looking at the figure, we can see that Poland's accession to the EU was a one-off uncertainty factor. This is logical, as EU membership brought with it major changes in legislation and taxation, a source of great uncertainty for economic agents. Another important event is elections. Local elections seem to play a particularly important role. For example the peak in October 2006 is associated with local elections won by Civic Platform (PO), the opposition party at the time. That victory paved the way for PO's dominant position on the Polish political scene for the next decade. Similarly, the 2014 local elections were a watershed for PO's main opponent, the Law and Justice party (PiS) party. These were controversial elections in two respects. First, the opposition PiS party won the election for the first time after eight years of PO dominance. This triggered a shift in the Polish political scene from the centre to the right: since then, PiS has won almost every election. Secondly, the results were questioned by many as the number of invalid votes was very high, amounting to 9.8% nationwide and in some provinces even reaching 22.3%. The index shows an upward trend from 2007 to 2009 and peaks in February 2009 in response to the financial crisis. The level of uncertainty remains high in the period 2009-2015, which corresponds to the economic slowdown in Poland and Europe. The increase in uncertainty is also due to the rise in unemployment. Therefore, while most uncertainty shocks are temporary, the financial crisis shock has been persistent. In July 2014, the index peaked due to the reform of the pension system. After the 2015 presidential election, uncertainty falls and remains relatively low in 2016-2017. During this period, economic growth accelerates causing the unemployment rate to fall. Moreover, it was an election-free period (however not without political tensions). The index spikes again in October 2018 (local elections) and April 2019 (teachers' strike). The latter event is particularly interesting, as no other index captures this type

[6]They are called *województwa* in Polish. These are: Dolnośląskie, Kujawsko-Pomorskie, Lubelskie, Lubuskie, Łódzkie, Małopolskie, Mazowieckie, Opolskie, Podkarpackie, Podlaskie, Pomorskie, Śląskie, Świętokrzyskie, Warmińsko-Mazurskie, Wielkopolskie and Zachodniopomorskie.

of uncertainty, which even exceeds the uncertainty caused by the 2020 pandemic. We deepened the analysis of this unanticipated uncertainty shock and develop an alternative version of the EURQPL, which is discussed in more detail in this section. Finally, as expected, the EURQPL index peaks jumps in April 2020 when the COVID-19 pandemic begins.

Figure 3: National EURQ index for Poland (EURQPL)

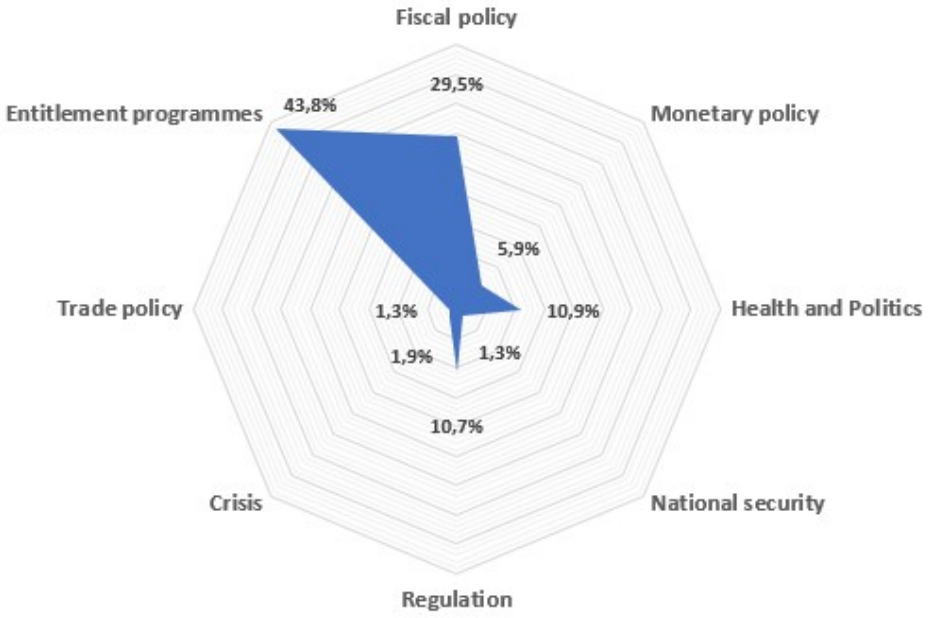


The index proves to be quite robust to dictionary changes. We test its robustness by running the same procedure with the exclusion of each query category at a time (e.g. we exclude the category of fiscal policy and run the code, then we exclude monetary policy, etc.). We find that all of these indices peak at the same periods, albeit with a different amplitude (see Figure 18 and Table 9 in Appendix D for more details). The index is sensitive to the exclusion of queries related to fiscal policy and entitlement programmes. This is in line with our expectations, as terms referring to the tax system, social benefits and unemployment are among those that contribute most to the index. In fact, these two categories account on average for 29.5% and 43.8% of the EURQPL respectively (see Figure 4). In contrast, the categories of national security, crisis and trade policy categories are practically negligible. This decomposition unveils other interesting findings. First, it is the category of entitlement programmes that is mainly responsible for the increase in uncertainty after the financial crisis. Second, the uncertainty caused by health and political queries became more relevant after 2013.

As mentioned above, the spike in April 2019 deserves further explanation. Interestingly, the sudden increase in uncertainty was mainly induced by the teachers' strike. In fact, the corresponding query reached 92% of our benchmark ('ZUS'), becoming the second most searched term (see Table 1). In April 2019, teachers proclaimed a general strike and most of them refused to give regular lessons[7]. Moreover, all this occurred on the very eve of the final examinations, which were in danger of being cancelled. This was a major source of uncertainty: teachers had to decide whether to participate in the strike, parents did not know whether the school would be open to take care of their children

[7]According to Newsweek the scale of the strike was huge. Depending on the region, 69% to 91% of schools joined the strike. In Warsaw alone, the strike affected over 200,000 children. See https://www.newsweek.pl/polska/spoleczenstwo/to-juz-pewne-najwiekszy-strajk-szkol-w-historii-zacznie-sie-w-poniedzialek/8g42r40.

Figure 4: Average contribution of each query category to EURQPL.



Notes: Entitlement programmes and fiscal policy queries account for over 70% of the entire index, while trade policy and national security contribute about 1.3% each.

and, finally, children did not know whether they would be allowed to take the exams. Although all these factors are certainly responsible for a high degree of uncertainty, it is still a surprise that the uncertainty caused by the teachers' strike is greater than that caused by the pandemic.

To elaborate on this, we replaced 'teachers' strike' with the more general 'strike'. The Polish equivalent turns out to have a higher volume than our reference term 'ZUS'. Therefore, we have developed an alternative EURQ-strike index which takes the Polish implementation of 'strike' as the reference query and is shown in Figure 5. This setting gives even more weight to the teachers' strike, whose peak is almost double that of the pandemic. Moreover, the overall level of our index decreases by about 30-50 units at each point, as the new benchmark has a higher value. Such a measure of uncertainty could be influenced by a subjective choice of queries or a lack of relevant queries. For example, our intention is to avoid words like 'COVID-19' or 'coronavirus', as they refer to a specific event. Instead, we would be inclined to use the term 'pandemic' to refer to future virus epidemics as well. In EURQ-strike, the Polish word for strike has a very high volume and therefore has a great impact on the index. However, if we were to add the term 'coronavirus', it would dominate the entire index, making 'strike' much less relevant (when implemented in Polish, the peak of 'strike' is only 15% of the peak of 'coronavirus')[8].

An alternative benchmark query could be the Polish equivalent of 'elections' and we investigate this case further. This alternative index, EURQ-elections, is essentially driven by the election calendar (Figure 5). Almost every peak corresponds to a month in which elections were held. The highest peaks occur during local elections, which suggests that economic agents express more interest in regional elections than in others. One potential explanation could be that Poles consider local elections

[8]In fact, any index we construct in this research would be very small compared to an EURQ-coronavirus (result not reported but available upon request).

Table 1: Queries with the largest volume.

English translation	Polish implementation	% of 'ZUS'
Social Security Institution	ZUS‡	100
teachers strike	"strajk nauczycieli"	92
Personal Income Tax	PIT	64
District Job Agency	PUP	61
local election	"wybory samorządowe"	52
Value Added Tax	VAT	34
National Healthcare Fund	NFZ	34
Open Pension Funds	OFE	24
currency exchange rate	"kurs walut"	15
Alternative benchmark queries		
elections	wybory	169
strike	strajk	120

Notes: The second column shows the queries used to construct the index and the first column displays their translation into English. The third column reports the ratio between the highest peak of a query in the row and the highest peak of the 'ZUS' benchmark. The bottom part of the table shows the queries that constitute the benchmark for EURQ-elections and EURQ-strike. (†) The removal of noisy words in the Polish implementation is ignored in the table for clarity. The actual query is: ZUS - pue - logowanie - infolinia - kalkulator - praca - kontakt.

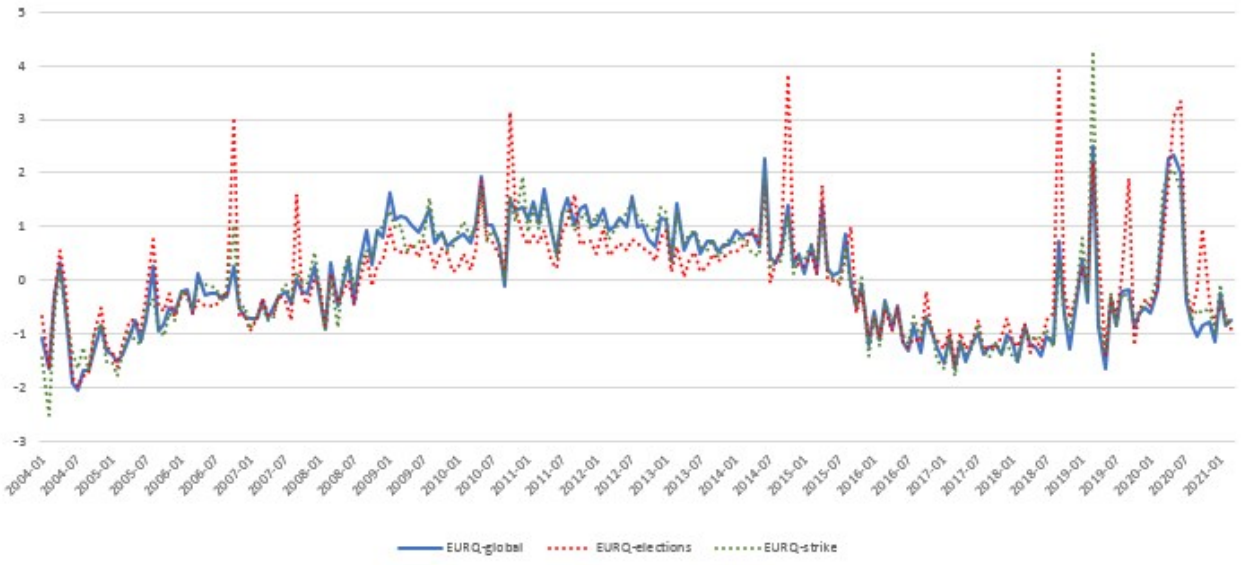
particularly important. However, voter turnout proves the opposite: parliamentary and presidential elections have always had a higher turnout. An alternative reason for this trend is that while national elections can be easily followed through television or radio, this is not the case for regional elections. Only local media and the Internet provide information on the results at the county, municipality or village level. Therefore, people might use the Internet more often to find out the winner. Nevertheless, EURQ-elections is clearly political and includes a lot of non-political information. This index fails to represent economic uncertainty, mainly because the COVID-19 pandemic does not turn out to carry more uncertainty than any normal election.

The three versions of the uncertainty index (EURQPL, EURQ-strike and EURQ-elections) show us several interesting features. First, regarding popular queries, even small changes in a query can lead to large changes in the index. Secondly, the reference query plays a particularly important role. Thirdly, word selection defines the type of uncertainty a researcher is interested in and the weights that are assigned to particular categories. For example, Kupfer and Zorn (2019) assign equal weights to each topic by downloading the volume for each query separately[9]. In this case, the measure is not subject to a strong dependency on any search term. On the contrary, in the EURQPL all queries are scaled with respect to the most popular query, giving great weight to the term with the highest volume.

Next, we extend our analysis to compare measures for Polish and English queries. While our basic index captures the uncertainty expressed by fluent Polish speakers, the extension into English should do so for people who are comfortable with English queries (such people would probably be most foreigners and Poles who can speak the language). We start by translating the list of Polish queries into English and creating the EURQ-ENG index. However, English terms have much lower search

[9]This approach implies that the peaks for both an almost never searched query and a very popular query are equal to 100 and contribute equally to the index.

Figure 5: Comparison of EURQPL, EURQ-elections and EURQ-strike.



Notes: EURQPL based on the full set of queries is EURQ-global in the graph. The indices are standardised to have zero mean and unit standard deviation.

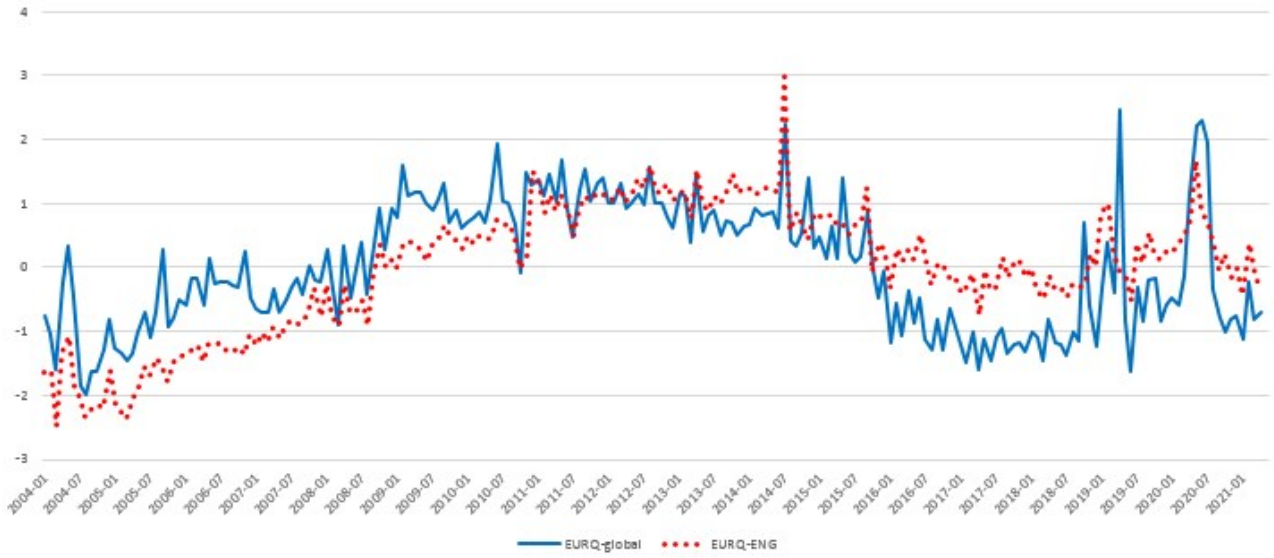
volume than their Polish equivalents and less popular ones have to be excluded due to insufficient volume in Google Trends. Thus, the final dictionary is reduced to 105 queries. Moreover, while most terms are translated, some remain unchanged. This usually occurs in the case of acronyms, e.g. ZUS, NFZ, NBP (Social Security Institute, National Healthcare Fund, Polish Central Bank, respectively). As a result, these terms are given high weights, as other relevant queries are replaced with less popular English equivalents. Nevertheless, Figure 6 shows that both indices exhibit very similar trends and most often peak simultaneously. This is confirmed by the high correlation of 0.7. However, the EURQ-ENG is generally smoother than the EURQPL and has less frequent peaks. Interestingly, the English index is substantially lower than the Polish one until 2010 and since then is usually higher, especially in the period 2015-2019. The highest peak occurs in July 2014 and corresponds to the controversial pension system reform, while the second highest peak, in April 2020, is a response to COVID-19.

We can conclude that the uncertainty, as measured by English queries, has a much lower volatility and is not strongly triggered by domestic political events, such as elections (in fact, of all the indices presented, the EURQ-ENG is the least correlated with the EURQ-elections, see Table 2). On the other hand, it increases in response to the global financial crisis and the coronavirus pandemic. We should pay particular attention to the fact that the 2014 reform caused the biggest jump in the index. The new regulations may have led to a loss of credibility of the pension system, causing many people to worry about their savings. The reform also affected the stock market, because pension funds were important investors in the market.

3.3 The regional EURQPL indices

Taking into account the fact that Polish regions vary substantially in terms of demography, economic performance or structure of the economy, we constructed the EURQPL index for each region

Figure 6: EURQPL indices for Polish and English queries.



Notes: The national EURQPL constructed using Polish queries is EURQ-global in the graph; English queries are used to construct EURQ-ENG. Both indices are standardised to have zero mean and unit standard deviation.

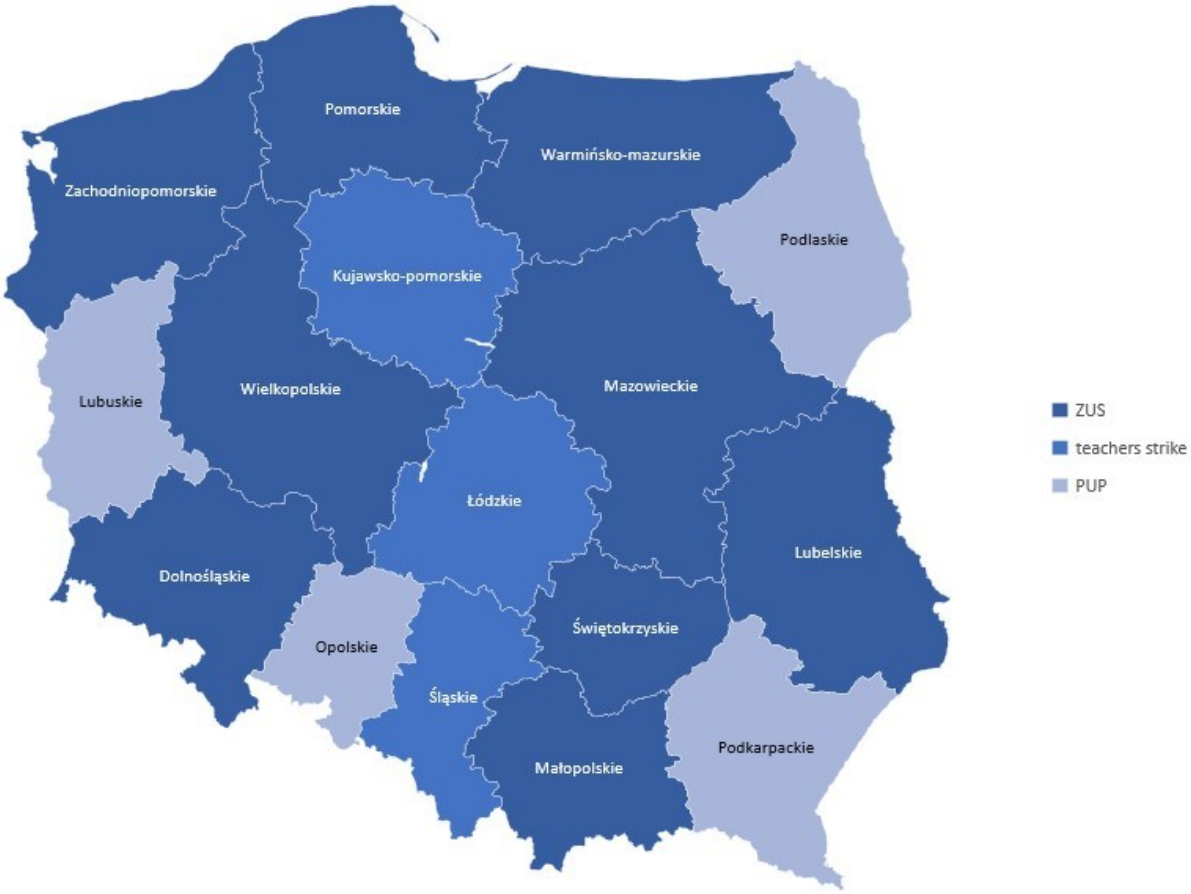
Table 2: Correlation matrix between different EURQPL indices.

	EURQPL	EURQ-strike	EURQ-elections	EURQ-ENG
EURQPL	1.00			
EURQ-strike	0.97*	1.00		
EURQ-elections	0.85*	0.84*	1.00	
EURQ-ENG	0.70*	0.68*	0.54*	1.00

Notes: EURQPL is the national index based on the full list of Polish queries; EURQ-ENG is the national index based on English queries; EURQ-strike and EURQ-elections are alternative measures of EURQPL, constructed using different reference queries. The symbol * denotes a statistical significance of 1%.

separately. To make the regional EURQPLs we employ the same procedure as for the national EURQPL. This is possible thanks to the Google Trends function that allows to analyse search trends also on a regional level. Thus, we use a slightly extended Python code with the option to select one of the regions (e.g. Mazowieckie or Opolskie). Regions can have different reference queries, as in some cases the most searched query at the national level 'ZUS' (Social Security Institution) is not necessarily the most popular locally. 'ZUS' is the benchmark query for nine out of 16 regions, while in three regions in central and southern Poland (Kujawsko-Pomorskie, Łódzkie and Śląskie) the Polish equivalent of 'teachers' strike' obtained the highest volume of all queries and thus forms the benchmark. Finally, in Lubuskie, Podkarpackie, Podlaskie and Opolskie the term 'PUP' (District Employment Agency) outperformed all other queries. The geographical distribution of the benchmark queries is displayed on the map in Figure 7.

Figure 7: The map of benchmark queries for regional EURQPL indices.

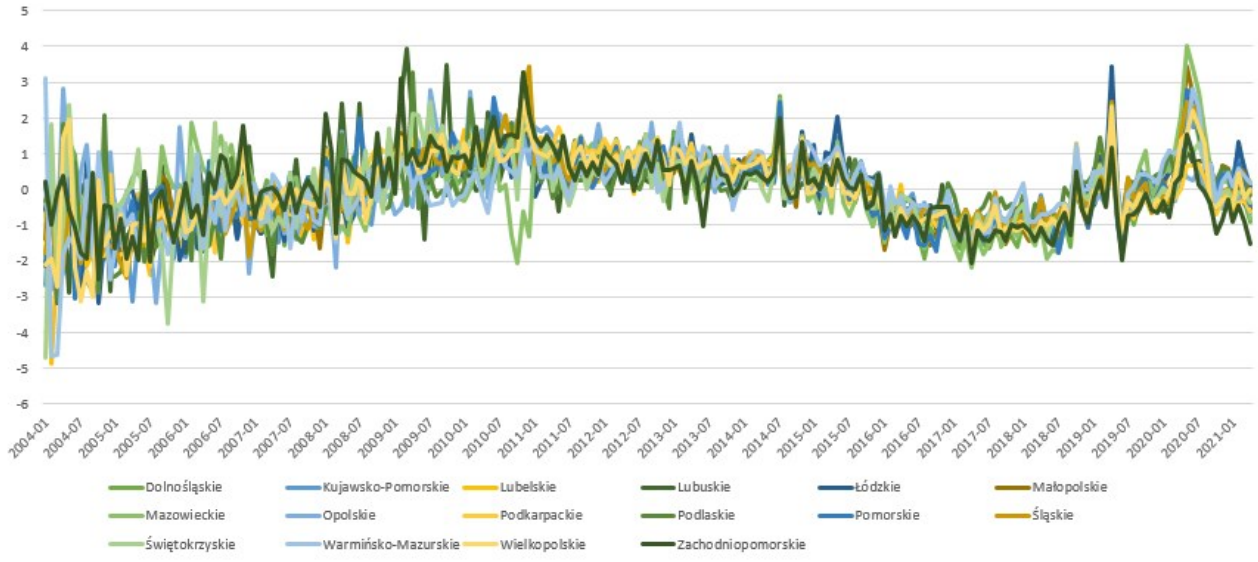


Notes: Nine out of 16 regions (56%) have the same benchmark as EURQPL at national level, 'ZUS' (Social Security Institute). There are three central regions where 'teachers' strike' is the reference query and four border regions with 'PUP' (District Employment Agency) as the benchmark.

The correlation of regional EURQPLs ranges from 0.34 to 0.86 with an average of 0.65 (see Table 10 in Appendix E). The regions with a particularly high correlation are: Dolnośląskie, Kujawsko-Pomorskie, Łódzkie, Małopolskie, Podkarpackie, Pomorskie, Śląskie and Wielkopolskie. In contrast, Mazowieckie, Opolskie and Warmińsko-Mazurskie have less in common with the other regions. All regional indices have a relatively high correlation with the EURQPL (0.62-0.9) and have a similar trajectory (see Figure 8). However, Lubuskie, Podlaskie and Zachodniopomorskie achieved a significantly higher uncertainty index in Q1 2009. A large discrepancy can also be observed in

Q4 2010, when Mazowieckie's index diverges from all others. Both cases can mainly be attributed to large changes in the volume of job-related Internet searches - at the beginning of 2009, the three mentioned regions faced a particularly high unemployment rate. In contrast, the labour market in Mazowieckie seems to have stabilised more quickly than in the other regions. All these differences are in fact confirmed by the min-max band - the amplitude between the smallest and the largest index is particularly evident in the early years and one of the largest gaps between the regions occurs at the end of 2010. Both the indices themselves and the amplitude between them jump again due to the shocks of the teachers' strike and COVID-19. This suggests that greater uncertainty implies greater regional divergence.

Figure 8: The regional EURQPL.



Notes: Each index is based on the same set of queries, but the reference query varies from region to region. The indices are standardised to have zero mean and unit standard deviation.

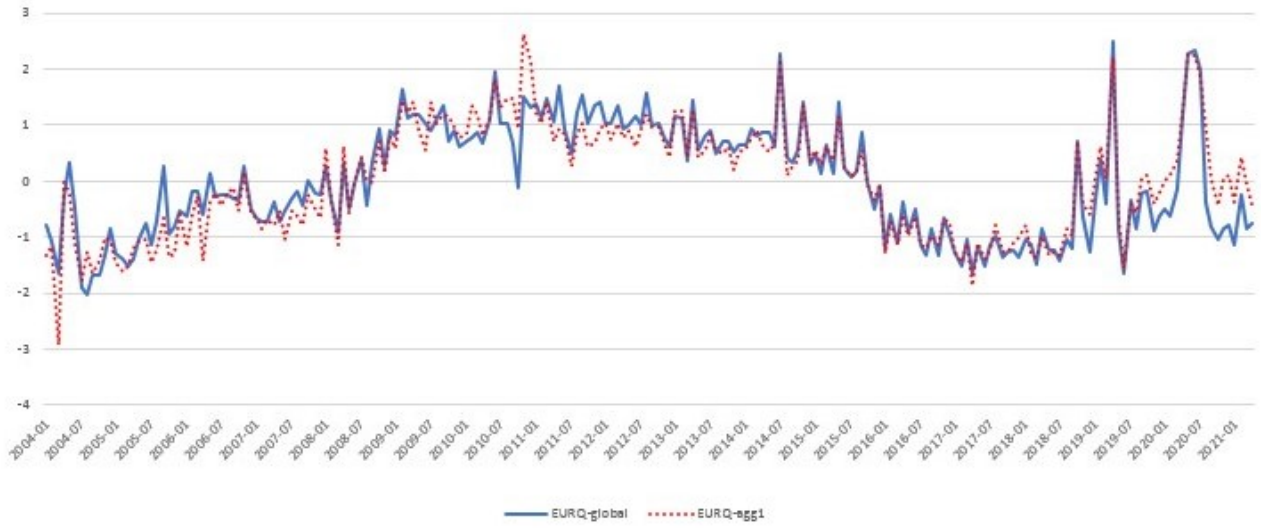
The heterogeneity between Polish regions is not surprising. Several empirical studies, including that of Ciżkowicz et al. (2016), show that there are large disparities in local unemployment rates in Poland, mainly due to local demographics, education and sectoral employment. In this regard, our index exploits the fact that local populations may perceive uncertainty caused by different events and at different times than the national ones. One example is the transition to a zero-emission economy. While most regions may perceive the new policy as an investment opportunity, in Śląskie, a region with a strong coal mining sector, almost all stakeholders see the consequences of the uncertainty induced by the transition as unequivocally negative (Skoczkowski et al. 2020).

Obtaining decentralised EURQPLs leads us to ask whether the combination of all regional indices leads to the same directly constructed national index. To answer this question, we aggregate the regional EURQPLs to obtain a new national index. Simple averaging may seem trivial, as this method of aggregation treats all regions equally and ignores their actual contribution to the national index, but it turns out to be satisfactory[10]. Figure 9 shows the national and aggregate indices. Our aggregated

[10]We actually tested two other aggregation methods that give practically the same result. The first technique is based on a weighted average for the population size of the region (the weights take into account the average population over the period 2004-2019). The second uses a weighted average for the number of Internet users (average 2011-2019). The

index gives practically the same results as the original one. A small deviation in November 2010 refers to local elections.

Figure 9: National and aggregation of regional EURQPLs.



Notes: EURQ-agg1 is obtained by aggregating regional EURQPLs and represents a national alternative index to EURQPL. Both indices are standardised to have zero mean and unit standard deviation.

3.4 Comparison between EURQ and other uncertainty indices for Poland

As pointed out in the Introduction, there are several methods to measure uncertainty. In addition, the definition of the channel through which uncertainty information is disseminated plays a key role and may influence the final results. In this Section, we compare our EURQPL index with five other economic uncertainty indices available for Poland. We have chosen the search-based GEPU (Kupfer and Zorn 2019), the forecast-based CSU (Ozturk and Sheng 2018), the EU (Hołda 2019) based on newspapers, the WUI (Ahir et al. 2018) based on economic reports and the financial VSP (Bank 2021).[11]

The first index, Google Economic Policy Uncertainty (GEPU), takes a similar approach to our EURQPL. The GEPU also uses Google Trends to measure uncertainty, so it considers the interest of Internet users as the way in which economic agents express their insecurity. However, instead of summing up the individual queries, Kupfer and Zorn (2019) select 14 policy-relevant topics and categories[12], each of which is assigned equal weight. The index is available for the period 2004-2021 on a monthly basis.

aggregation technique is irrelevant and all indices are almost identical, with a correlation coefficient close to 1. See Figure **??** in Appendix E for details.

[11]The EURQPL and its alternative versions were downloaded on May 4-11, 2021, while the regional EURQPLs were downloaded on August 5, 2021. The other uncertainty measures were downloaded from institutional and researcher websites (EU, CSU, WUI and VSP) or received directly from the authors (GEPU). For each index we use observations from January 2004 to the most recent date available.

[12]The Google Trends topics and categories capture the volume of many queries at a time. Elections, public debt and insolvency, among others, are the categories selected to construct the GEPU.

The Country Specific Uncertainty (CSU) measures uncertainty based on economists' responses to a survey. To determine the level of uncertainty in the economy, Ozturk and Sheng (2018) use market analysts' forecasts. The CSU consists of two components: common uncertainty, which is the perceived variability of future aggregate shocks, and idiosyncratic uncertainty, understood as disagreement among professional forecasters. The sum of these two decomposed elements produces the index of our interest. The CSU is calculated for each month from June 2007 to October 2017.

The next index is the EU, the Economic Uncertainty index produced by Hołda (2019). This is a newspaper-based measure similar to Baker et al. (2016). In this approach, information on uncertainty is reported by journalists, who are therefore considered to be impartial and professional news providers. Every article from the Polish daily Gazeta Wyborcza[13] which contains a certain set of words related to economic uncertainty[14] is counted. The greater the ratio of the raw count of selected articles to the total number of articles published in a given period, the greater the uncertainty. We obtain the index for each quarter from 2004 to 2018.

Besides the EU, the World Uncertainty Index (WUI) also uses text mining methods. This index is based on the frequency of the word 'uncertainty' (and its variants) used in the Economist Intelligence Unit's quarterly reports for Poland. These reports, compiled by experts and checked in a five-step process, examine the main economic, financial and political trends in a country. The index is obtained by dividing the raw count of selected words by the total number of words in each report. We download the data for the period 2004-2020.

Finally, the Volatility of Stock Prices (VSP) index is the 360-day standard deviation of the performance of the Warsaw Stock Exchange. We select the date from 2004 to the most recent available, 2017.

Table 3 presents the descriptive statistics of the uncertainty indices used in this Section. The level of the values of the uncertainty indices varies considerably, as the indices are measured using different approaches. Note that EURQPL and GEPU have very similar averages, but the standard deviation of GEPU is almost three times that of EURQPL. In fact, the ratio of standard deviation to the mean of the EURQPL is the lowest of all indices.

Table 3: Descriptive statistics for EURQ indices and other measures of uncertainty in Poland.

Index	Description	Periodicity	Source	Corr	Mean	Min	Max	Sd
EURQPL	EURQ in Polish	monthly		1.00	235.1	185.4	295.9	24.4
EURQ-ENG	EURQ in English	monthly		0.71	128.4	76.0	190.7	21.1
EURQ-strike	alternative EURQPL	monthly		0.92	203	151	290	20.6
EURQ-elections	alternative EURQPL	monthly		0.83	150	112	226	19.2
GEPU	Google Trends-based index	monthly	Kupfer and Zorn (2018)	0.41	249.0	57.0	467.0	70.6
CSU	forecast-based index	monthly	Ozturk and Sheng (2018)	0.36	0.48	0.21	1.03	0.18
EU	newspaper-based index	quarterly	Hołda (2019)	0.12	91.3	33.7	184.0	39.2
WUI	economic reports-based index	quarterly	Ahir et al. (2018)	-0.12	0.24	0.00	0.92	0.18
VSP	finance-based index	yearly	World Bank (2021)	0.39	22.4	15.4	38.4	6.3

Notes: Corr is the correlation between each uncertainty index and EURQPL. Mean, Min, Max and Sd represent the mean, minimum, maximum and standard deviation of the various indices.

Given the nature of our data (i.e. the different frequency of observations), we have grouped all six

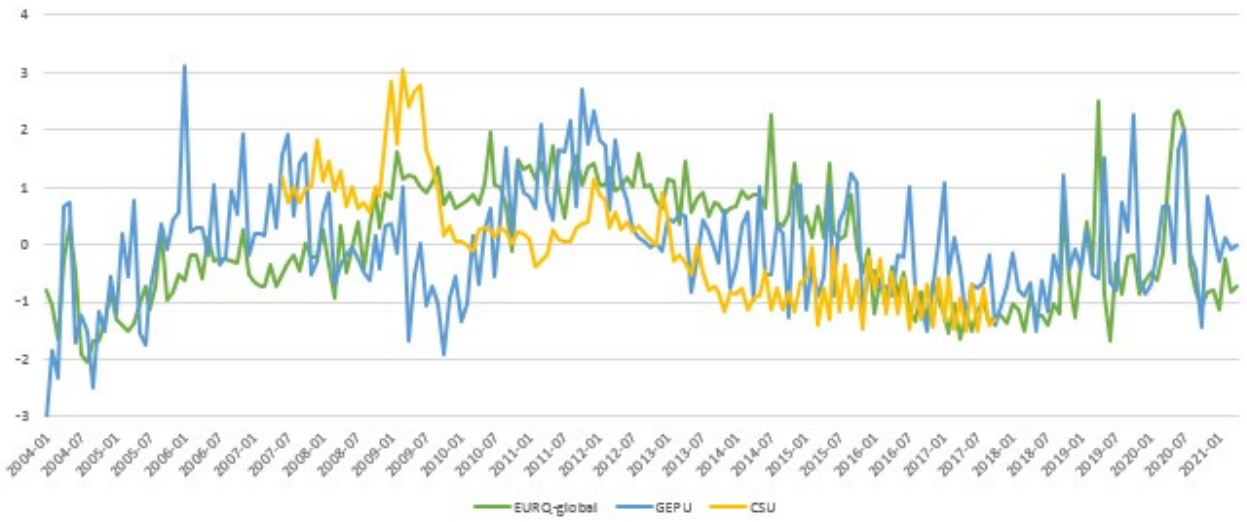
[13]The results are robust to the inclusion of another major Polish newspaper, Rzeczpospolita.

[14]Namely, 'uncertainty', 'uncertain', 'economy' and 'economic'.

measures into three samples of monthly, quarterly and annual aggregation.

The first sample consists of three indices reported monthly: EURQPL, GEPU and CSU. Figure 10 shows a rather high heterogeneity between these measures. Despite the many similarities of EURQPL and GEPU, they exhibit different patterns of development. For instance, the GEPU spikes in response to the crisis of the coalition government in 2006 or during the 2011 and 2019 elections. Moreover, during the period when the financial crisis broke out, the GEPU shows a minimum. Therefore, this index mainly captures the political and budgetary uncertainty of the government and takes high values in election years and due to parliamentary crises. In fact the GEPU is more correlated with the EURQ-elections than the EURQPL (the correlation coefficient is 0.5 and 0.41, respectively). Among these indices, the CSU registers the strongest surge due to the financial crisis, peaking in early 2009. These trends support the idea that economists disagree more about the future development of the economy in a period of crisis. The EURQPL is less correlated with the CSU with a coefficient of 0.36, while the GEPU and CSU are uncorrelated (see Table 12 in Appendix F).

Figure 10: EURQPL, GEPU and CSU indices at monthly frequency.

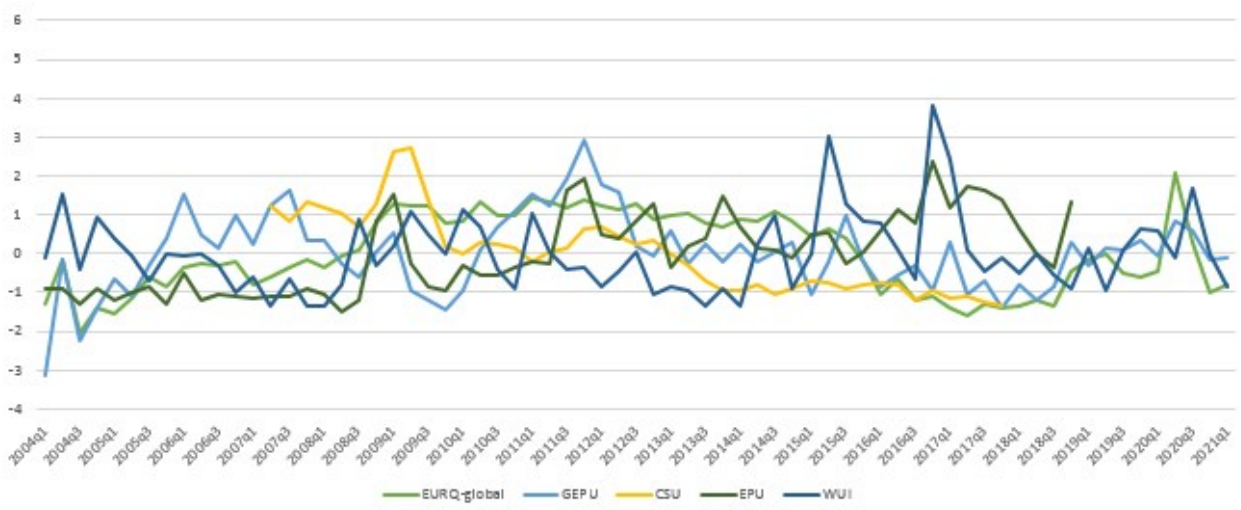


Notes: EURQPL is EURQ-global in the plot. The indices are standardised to have zero mean and unit standard deviation.

The second sample adds the EU and WUI indices, which are reported quarterly. The monthly measures of EURQPL, GEPU and CSU are transformed into quarterly data by computing quarterly averages. The results are presented in Figure 11. It is evident that the transformation leads to smoothing. However, contrary to the GEPU, the EURQPL still peaks in Q2 2020, whereas the behaviour of the CSU does not change substantially. The EU index, which was relatively low before 2008, increases due to the financial crisis. It also surges in response to the European debt crisis, the Brexit referendum and the election of Donald Trump. This demonstrates the significant difference between Internet search and newspaper-based measures. While the EURQPL focuses mainly on domestic uncertainty, the EU index emphasises the role of international events. Journalists pay more attention to global politics and therefore assign more weight to the uncertainty induced by international turmoil. In contrast, regular Internet users feel more uncertain due to domestic events that affect them more directly. Finally, the WUI has the highest short-term peaks among all indices. This measure jumps in Q4 2008 (financial crisis), Q2 2015 (presidential election), Q4 2016 (Brexit, Trump election).

Somewhat surprisingly, the index associates the aforementioned events with much greater uncertainty than the coronavirus pandemic in 2020. In the quarterly representation, EURQPL remains (and is slightly more) correlated with GEPU and CSU. Furthermore, the correlation between CSU and EU is significant (-0.4). All other index pairs are uncorrelated (see Table 13 in Appendix F).

Figure 11: EURQPL, GEPU, CSU, EU and WUI indices at quarterly frequency.



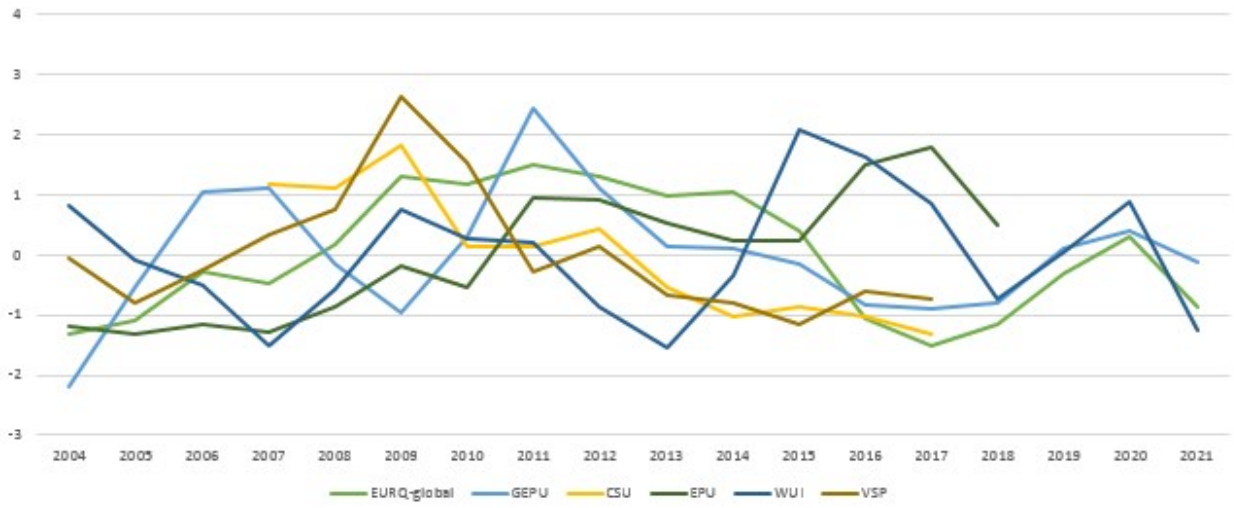
Notes: EURQPL is EURQ-global in the plot. The values for EURQPL, GEPU and CSU are measured as quarterly averages. The indices are standardised to have zero mean and unit standard deviation.

The last group, in Figure 12, comprises all available indices, including the VSP, which is an annually reported variable (the yearly values of the other indices are obtained as annual averages of monthly or quarterly data). The VSP and the CSU follow a fairly similar trajectory, with a peak in 2009 and a subsequent decline, and have a high correlation (0.83). The CSU - EU and EURQPL - GEPU pairs also show a relatively high correlation (-0.69 and 0.57, respectively). All other indices show a small and not statistically significant correlation (the complete results are presented in Table 14 in Appendix F).

Overall, several findings emerge from the above analysis. Firstly, our indices exhibit a wide heterogeneity. Most of them are not correlated with each other and behave differently over time. There could be two reasons for these discrepancies. Although all indices intend to measure economic uncertainty, they define it differently, consider different agents and adopt different methodologies. In fact, these indices seem to measure different types of uncertainty. Second, we can distinguish several pairs of indices that share some similarities. The EURQPL-GEPU pair is significantly correlated regardless of the periodicity of the data, as both variables are based on Internet searches and Google Trends. Furthermore, the CSU shows similar patterns to EURQPL, EU (negative correlation) and VSP.

We should not forget that there are several caveats to take into account. Our indices are reliable in their original form, i.e. EURQPL, GEPU and CSU with monthly frequency and EU and WUI with quarterly frequency. By taking averages for each index, we smooth the data and lose some of the variability. Each transformation implies less information, as we no longer observe all the peaks and troughs of an index. Thus, while our results for high-frequency data can be considered reliable, those for aggregated data should be interpreted with caution.

Figure 12: EURQPL, GEPU, CSU, EU, WUI and VSP indices at annual frequency.



Notes: EURQPL is EURQ-global in the plot. Indices with a frequency greater than one year are measured by taking arithmetic averages. The indices are standardised to have zero mean and unit standard deviation.

4 The macroeconomic analysis of EURQ indices

4.1 The macroeconomic variables

The OECD database is the main source of our macro variables, which are: the Composite Leading Indicator (CLI), the Business and Consumer Confidence Indicators (BCI and CCI, respectively), the stock price index, the short-term interest rate, the unemployment rate and industrial production. The OECD indicators are detailed in Appendix G. The stock price index is the average price of shares on the Warsaw Stock Exchange in a given month, while the short-term interest rate represents the rate at which short-term government bonds are issued or traded on the market. The registered unemployment rate is the measure reported by labour agencies and finally, the industrial production indicates the output of firms in the mining, manufacturing and steam sectors, expressed as a percentage of the 2015 reference output. When necessary, the variables were subject to transformations, e.g. we standardised the indices to make them comparable or took the logs of macroeconomic variables. Table 4 presents descriptive statistics such as mean, minimum, maximum and standard deviation for our macroeconomic variables. There are two points to note. Firstly, variables based on the same form have similar statistics, e.g. stock price and industrial production are both measured as indices, and interest and unemployment rates are expressed as percentages in the original form. Secondly, the leading and confidence indicators are also very similar (see Figure 20 in Appendix G for the graphical presentation).

We also use data from the Polish Statistical Office (GUS) to perform computations at the regional level[15]. The decomposed data reveal significant heterogeneity between Polish regions, especially with regard to variables such as employment, wages, type of web searches and population size.

[15]The Polish regions are almost exact equivalents to the NUTS 2 territorial units of the EU (the exception is the Mazowieckie region, which is divided into two units in the NUTS 2 system).

Table 4: Descriptive statistics for macro variables.

Variable	Description	Mean	Min	Max	Sd
Stock price	log of stock price index	4.46	3.75	4.84	0.27
Interest rate	log of one plus short interest rate	0.034	0.002	0.068	0.017
Unemployment	log of one plus unemployment rate	0.107	0.050	0.182	0.036
Industrial production	log of industrial production index	4.47	3.96	4.94	0.26
CLI	Composite Leading Indicator	100.09	94.70	102.40	1.16
BCI	Business Confidence Indicator	100.24	95.70	102.70	1.39
CCI	Consumer Confidence Indicator	100.33	97.90	102.70	1.36

Notes: Mean, Min, Max and Sd represent the mean, minimum, maximum and standard deviation of the various macroeconomic variables. The values of interest rate and unemployment rate have three decimal places, as they have different units than the other macroeconomic variables.

4.2 Leading properties of EURQ indices

In this Section we compare the EURQ index and its variants for Poland with commonly used leading indicators to assess the effectiveness of uncertainty indices in anticipating the business cycle. Indices signalling imminent market fluctuations are particularly valuable for managers and policy makers in understanding short-term developments in the economy. While it is true that Internet searches may anticipate developments in the economy (e.g. increased traffic on apartment-buying platforms may suggest a future price increase in the real estate market), it is equally plausible to think of an example of ex post searches: for instance, after the government adopts a deficit budget, people may be concerned about the state of the public debt and carry out web searches on this topic.

Bontempi et al. (2021) show that their EURQ index for the US is an indicator of ex ante uncertainty. In this Section, we consider whether to classify the EURQ for Poland as a forward looking (ex ante) or backward looking (ex post) index. As a forward-looking indicator, we chose the Composite Leading Indicator (CLI) provided by the OECD. As the CLI aims to signal forthcoming developments (in qualitative terms) in economic activity around its long-term potential level, it can be used to forecast fluctuations in the business cycle. Our logic is as follows: if we can confirm a strong relationship between the EURQ for Poland and the CLI, we can classify our index as an anticipatory indicator.

In addition, we extend the analysis by adding two other OECD indicators, the Business Confidence Index (BCI) and the Consumer Confidence Index (CCI). The BCI is a survey-based index that captures industrial firms' perceptions of the market situation. The CCI, on the other hand, focuses on households' feelings about future developments in their economic situation, showing possible trajectories of change in consumption or savings. Confidence indicators can also offer interesting insights into fluctuations in the economy, as they reveal the sentiment of market participants (however, some economists question the usefulness of the economic sentiment indicator as they find it lags behind the aggregate economic activity, see Martináková and Kapounek 2013).

We construct a 4-variable VAR model to test for the presence of Granger causality between these indices. Our aim is to answer two questions: (1) whether past shocks to the EURQ for Poland cause contemporaneous changes in CLI, BCI or CCI and (2) vice versa, whether past shocks to anticipatory or confidence indicators result in contemporaneous changes in current web searches and, hence, in our EURQ for Poland. A positive response to the first question would imply that Internet searches

are exogenous and that economic agents are interested in specific topics *before* they read economic reports or hear about industrial problems. On the other hand, if it is the EURQ for Poland that is Granger-caused by the other indicators, we could think of a situation in which Internet users search for specific topics *because* they have found out that the economy is facing problems or they have heard about a decline in business or consumer confidence.

The model is expressed by the equation:

$$\begin{bmatrix} z_t \\ x_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \begin{bmatrix} A_{11,1} & A_{12,1} \\ A_{21,1} & A_{22,1} \end{bmatrix} \begin{bmatrix} z_{t-1} \\ x_{t-1} \end{bmatrix} + \ldots + \begin{bmatrix} A_{11,p} & A_{12,p} \\ A_{21,p} & A_{22,p} \end{bmatrix} \begin{bmatrix} z_{t-p} \\ x_{t-p} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \tag{1}$$

where z_t is our uncertainty index, represented by EURQPL or EURQ-ENG, i.e. our index based on Internet searches in Polish or English. The second component of the VAR is the vector $x_t = (cli_t, bci_t, cci_t)'$ containing the leading and confidence indicators. We follow Akaike's Information Criterion (other criteria give the same results) and select three lags for the first estimation. The results are divided into two groups, which we summarise below.

In the first group, we consider the model with the EURQPL for Polish queries. In this case, we find no Granger causality. The lack of such a relationship shows that the Polish index fails to anticipate business cycle developments. The fact that the EURQPL captures the interest of all internet users may be behind the index's failure to lead the CLI. In other words, political events, which typically attract a lot of interest, might have less impact on the economy than expected.

The second set of results is estimated for the EURQ-ENG uncertainty index. Now, shocks to the EURQ-ENG Granger-cause shocks to the CLI, which means that the EURQ-ENG anticipates the leading indicator and thus has predictive power. As the index captures the uncertainty manifested by English speakers, it can better capture the economic sentiments of business professionals, managers and economists among others, who have a greater understanding of economic developments and thus convey important information about the possible future state of the economy.

As shown above, we obtain qualitatively different results for EURQPL and EURQ-ENG. This leads us to a peculiar discrepancy between our EURQs in Polish and English. While the former is the most correlated with the BCI (-0.51) and the least correlated with the CLI (-0.39), the opposite is true for the latter - EURQ-ENG is the least correlated with the CCI (-0.24) and the most correlated with the CLI and BCI (equally -0.43).

4.3 Macroeconomic dynamics of uncertainty

In this section we construct a VAR model and estimate the effects of a shock to uncertainty on other macroeconomic variables. The specification aims to assess the impact of EURQ for Poland on both financial performance and the real economy. We use monthly data for Poland from January 2004 to March 2021. Now, the left-hand side of the equation 1 becomes

$$\begin{bmatrix} z_t \\ x_t \end{bmatrix} = \begin{bmatrix} leurq \\ lshpr \\ lint \\ lunem \\ lip \end{bmatrix} \tag{2}$$

The five-variable model is bases on the Cholesky decomposition with the following ordering: leurq - log of the EURQ index (EURQPL or EURQ-ENG), lshpr - log of the stock price index, lint - log of one plus short interest rates, lunem - log of one plus the registered unemployment rate and lip - log of the industrial production index. The order ranges from fast-moving to slow-moving variables. Such a specification is commonly used in the literature (e.g. Baker et al. 2016; Bontempi et al. 2021)[16] and implies that a shock to uncertainty has an instantaneous (within one month) impact on any other variable, while the uncertainty itself is assumed to be exogenous[17] and thus simultaneously independent of shocks to other variables. The stock market index affects the short-term interest rate. A shock to unemployment affects unemployment and industrial production and, finally, sudden changes in industrial production can affect the other variables only with a certain lag, thus only having an immediate impact on production.

We estimate impulse-response functions in which the impulse is an uncertainty shock followed by a response of each macroeconomic variable. Figure 13 illustrates our results. The shocks to EURQPL and EURQ-ENG have almost the same effect on each variable.

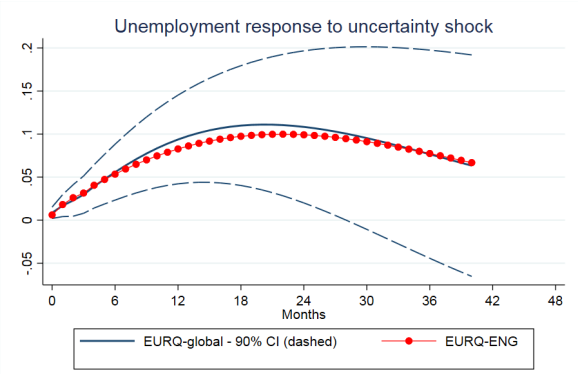
First, we find a very strong, persistent and positive response of the unemployment rate to the uncertainty shock. Induced by the shock to EURQ, the unemployment rate rises steadily for fifteen months, reaches a maximum increase of 0.1% after twenty months and then declines slowly. This is in line with Algharabali and Al-Thaqeb (2019) showing a negative relationship between uncertainty and employment. The effect of EURQ with 90% confidence lasts for at least 28 months, which makes it much more persistent than a typical uncertainty shock (e.g. in Bloom (2009) the effect persists for up to one year). Our findings are somewhat similar to S. Choi and Loungani (2015) who show that sectoral uncertainty has a persistent effect on unemployment with a peak occurring after two years.

Second, industrial production, short-term interest rates and stock prices are not affected by a shock to our measures of uncertainty (confidence intervals always include zero). These results are in line with those of Kupfer and Zorn (2019), but slightly different from those of Bontempi et al. (2021) who find a small and short-run, but significant, effect of the EURQ on manufacturing output in the US and Italy. Although in a very short run Polish industrial production decreases due to the uncertainty shock just as in the US and Italy, the persistence of the shock is much smaller. Our case is therefore different from the one presented by Sorić and Lolić (2017) for the Croatian economy.

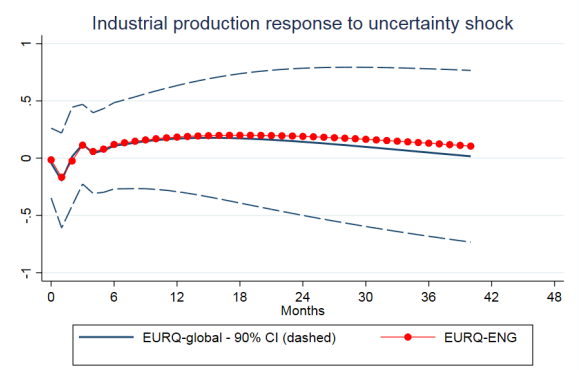
[16] Jurado et al. (2015) and Ozturk and Sheng (2018) also use a similar specification, with the exception of the stock price index (S&P 500 index) which is ordered before the uncertainty measure.

[17] The exogeneity of EURQ could be the subject of further research, as the index is built on unemployment-related queries (such as the unemployment rate or unemployment benefit) and hence could be induced by a shock to unemployment).

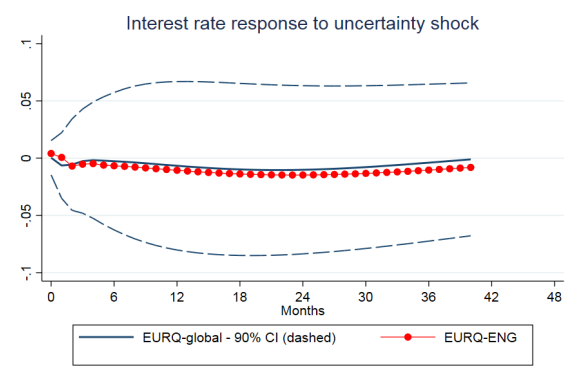
Figure 13: Impulse-response to uncertainty shocks measured by EURQPL and EURQ-ENG.



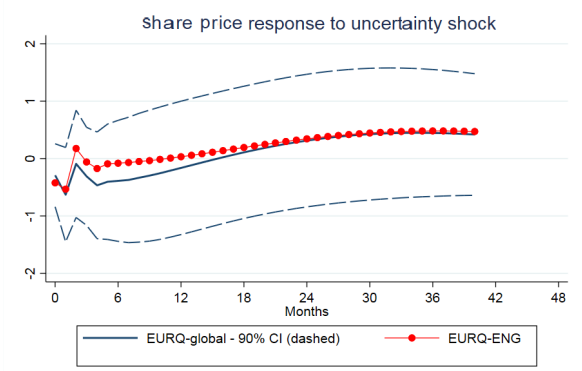
(a) Impulse response of log of unemployment.



(b) Impulse response of log of industrial production.



(c) Impulse response of log of interest rate.



(d) Impulse response of log of share prices.

5 Clustering of regional indices

To begin the study of the relationships between the regions, Figure 8 compares the 16 time series of the EURQPL indices of each region (the regional indices are presented in Section 3.3 and their correlations analysed in Table 10 of Appendix E). These approaches revealed the presence of similarities and heterogeneities in the development patterns among our observations.

To analyse this topic further, we perform cluster analysis. In our case, the use of statistical techniques can reveal new information about Polish regions in relation to uncertainty. In particular, we want to investigate whether and how regions are clustered and find a possible explanation for this.

We start by computing Euclidean distances. This measure assigns greater weights to large differences, thus facilitating the division of data into clusters. Specifically, the distance δ_{ij} tells us how far an object i is from an object j for K variables, where the objects are represented by the regional EURQs and the variables are the months of the time series[18]. The distance is defined as:

$$\delta_{ij} = \sqrt{\sum_{k=1}^{K}(x_{ik} - x_{jk})^2} \tag{3}$$

We obtain a distance matrix for 16 individuals (regions) and 208 variables (months), thus a 16×16 matrix (see Table 16 in Appendix G). Performing the analysis on the non-standardised data yields the largest distance, 1494.8, between Świętokrzyskie and Opolskie indices and the smallest, 212.8, between Pomorskie and Małopolskie.

We use Ward's method, which minimises the loss of information measured as total within-cluster variance. In this approach, at each iteration, the cluster pair with the smallest between-clusters distance is merged. The within sum of squares for the s^{th} cluster is given by the equation

$$W_s = \sum_{k=1}^{K}\sum_{i=1}^{n_k}(x_{iks} - \overline{x}_{ks})^2 \tag{4}$$

and the overall sum of squares is given by $W = \sum_s W_s$. Compared to other clustering methods such us single linkage, complete linkage and centroid, Ward's method gives the best (most informative) results.

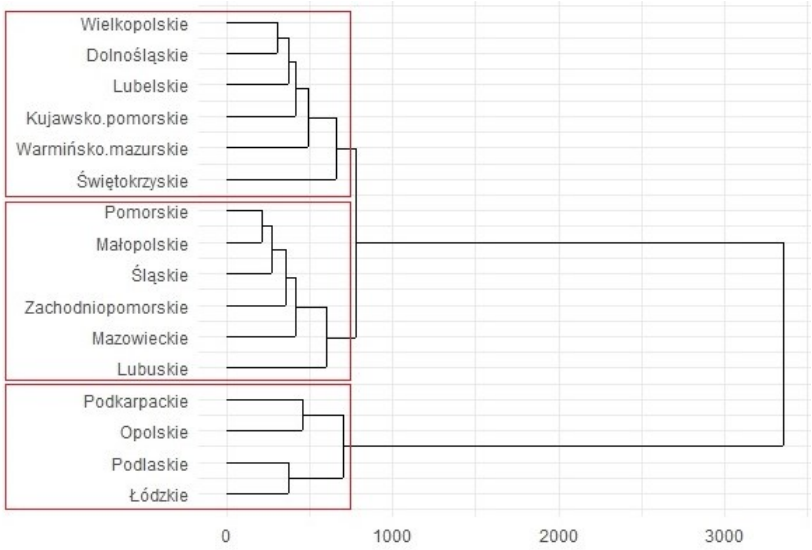
Figure 14 is a dendrogram showing the clustering of our data. Cutting the graph at the distance level 750 gives three clusters: two clusters consist of six regions each and one cluster consists of four regions. However, defining the relationship between the regions within clusters is challenging.

For example, in the first cluster (looking from the bottom of the dendrogram), a common feature of all four regions is a negative net internal migration, i.e. they face a net outflow of population in terms of within-country migration. The second cluster could group regions with relatively high employment in services. Finally, we cannot find a straightforward reason why the regions in the third cluster have such similar patterns of uncertainty. Somewhat surprisingly, in this cluster we have two regions with one of the lowest unemployment rates in the country and four with one of the highest. These results, however, should be interpreted with caution, as there could be other reasons for this

[18]To calculate distances we first transpose the data.

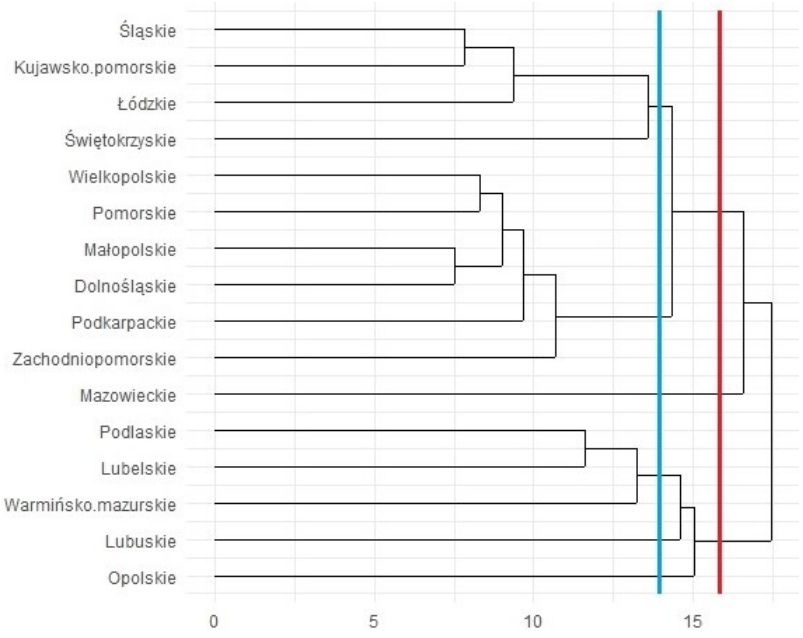
clustering. Furthermore, we do not observe any geographical pattern, as all clusters are distributed over the country.

Figure 14: EURQPL regional clustering dendrogram for Polish non-standardised data.



Red blocks show the three clusters obtained by cutting the graph at the distance of 750.

Figure 15: EURQPL regional clustering dendrogram for Polish standardised data.



The red line cut divides regions into three clusters and the blue line - into six.

In addition to these results, we perform a cluster analysis using standardised data. As expected, the findings are qualitatively different. Now, the greatest distance occurs between Świętokrzyskie and Warmińsko-mazurskie, while the least is between Dolnośląskie and Małopolskie. In contrast to the non-standardised case, in this case the regions are further apart from each other and are grouped with relatively larger values. Again, the choice of the number of clusters is somewhat arbitrary and we can indicate at least two levels into which the dendrogram cut (Figure 15) gives a reasonable split). The

first returns three clusters, the second six (red and blue lines on the graph). We will focus on the latter. In this framework, Lubuskie, Mazowieckie and Opolskie form three separate clusters, which means that they have particularly unique EURQPL patterns, distinct from all the others. The remaining clusters appear to be divided by geographical criteria. There is a cluster of regions from central Poland (four regions), south and west (six regions) and east (three regions). In the last one, which includes the Podlaskie, Lubelskie and Warmińsko-mazurskie regions, high employment in agriculture could also be a common factor. Table 5 summarises all results.

Overall, local disaggregation makes it possible to emphasise the importance of heterogeneity in Poland and provides interesting insights into the dynamics of uncertainty in "local Poland". Indeed, Polish provinces are based on distinct benchmark queries and have peaks of different magnitude and persistence due to the same events, which is reflected in the presence of several clusters.

Table 5: Summary of EURQPL regional clustering.

Data	Total	Cl. 1	Cl. 2	Cl. 3	Single	Possible factors
raw	3	DS, KP, LU, SK, WN, WP	LB, MA, MZ, PM, SL, ZP	LD, OP, PK, PD	-	internal migration, employment in services
standardised	6	LU, PD, WN	DS, MA, PK, PM, WP, ZP	KP, LD, SL, SK	LB, MZ, OP	geography

The analysis on the raw and standardised data produces a different number of clusters and a different grouping of regions. Cl.1-3 (Cluster 1-3) show how the regions are clustered. The column 'Single' shows clusters consisting of only one unit. The region codes are: Dolnośląskie (DS), Kujawsko-Pomorskie (KP), Lubelskie (LU), Lubuskie (LB), Łódzkie (LD), Małopolskie (MA), Mazowieckie (MZ), Opolskie (OP), Podkarpackie (PK), Podlaskie (PD), Pomorskie (PM), Śląskie (SL), Świętokrzyskie (SK), Warmińsko-Mazurskie (WN), Wielkopolskie (WP) and Zachodniopomorskie (ZP).

6 Conclusion

In this research, we have two main purposes. The first is to propose a precise, yet relatively flexible and broad measure of economic uncertainty. In doing so, we intend to capture different dimensions of uncertainty. This is important because nowadays economic processes are becoming increasingly complex and often fall outside the scope of strictly economic disciplines. More complexity and more uncertainty mean greater difficulty in making forecasts.

Consequently, measuring uncertainty is a challenge and requires a lot of attention. We made this attempt by constructing the EURQ (Economic Uncertainty Related Queries) index for Poland. Our concept is bases on the idea of 'empowering' normal people, which we achieve by using Internet users' perceptions of uncertainty. To do this, we turn to Google Trends and follow the popularity of certain search terms related to uncertainty. Shifting the focus from economic experts to ordinary economic agents can be particularly useful for policy makers, who usually pay close attention to how the general public feels about the future. Understanding people's feelings and discomfort can be important knowledge for dealing with social problems. We found that Poles are particularly concerned about the issues of social security, unemployment, taxes, healthcare, elections, civil rights and working conditions.

The use of Google Trends offers several important advantages. It allows trends on the Internet to be freely and timely tracked and its outcomes are easy to interpret. However, the most important feature

is that it provides information on the behaviour of millions of people, which makes indices based on Internet searches much more *inclusive* than other available measures of uncertainty. Although we do not entirely agree with the common saying that 'thousands of people cannot be wrong', we recognise the power of large numbers. To the best of our knowledge, our approach is the first uncertainty measure for Poland that is based on an extensive list of Internet queries. In the future, the index can easily be updated as new periods become available and new substantive queries emerge. As far as the inclusion of new queries is concerned, an updated index can easily be compared with the one constructed in this study. The simplicity of adjusting the index is of paramount importance, as the economy is subject to dynamic changes and only an up-to-date dictionary can successfully measure uncertainty.

Indeed, we discover a number of useful features of our measure. To begin with, the index jumps during periods commonly described as highly uncertain (financial crisis, pandemic), which confirms the reliability of our measure. In addition, we reveal a new uncertainty shock - the teachers' strike - which, as far as we know, has never been reported before in economic studies. Furthermore, a comparison with other available measures of uncertainty measures, such as indices based on searches, forecasts, newspapers, economic reports and finance, reveals a correlation between the EURQPL and the first two.

The second purpose of the study is to assess the effectiveness of our measure in anticipating economic events. To this end, we modelled a VAR framework with inclusion of commonly used leading indicators. This allows us to test for the presence of Granger causality between the selected variables. We obtain clearly different results for the Polish and English versions of the EURQ. The Polish index leads the business confidence indicator, while the English one leads the macroeconomic indicator. These contrasting results open the way for further research in the future. For example, by considering sample indices, in which certain categories of queries are excluded, we could run another VAR model and test which categories are most responsible for the leading characteristics of the two EURQPLs. Our suspicion is that queries related to regulation and trade are important for driving business confidence, while those related to fiscal and monetary policy for anticipating a composite macroeconomic indicator.

With regard to macroeconomic developments, an uncertainty shock produces a strong and persistent increase in unemployment for more than two years. On the other hand, industrial production is not affected at all in the medium and long term, although it decreases in the very short term. This shows that, from the point of view of the majority of Poles, the issue of employment is crucial.

Overall, this research fills in another piece of the puzzle, which is uncertainty. We believe that our study sheds light on the issue of economic uncertainty in Poland.

Lastly, in parallel to our main measure for Poland, we also construct sixteen indices, one for each region. This is a novel approach that can be useful for recognising uncertainty factors that are important at local level. Regional EURQPLs inform us of significant heterogeneity among Polish regions. Indeed, Polish provinces adopt different benchmark queries and have peaks of different magnitude and persistence due to the same events. In the future, regional EURQs may be used to initiate a discussion on the relationship between economic uncertainty and regional development (Gorzelak and Smetkowski 2018), depopulation (Kantor-Pietraga 2014; Runge et al. 2018; Barwińska-Małajowicz and Tecza 2020) and special economic zones (Lichota 2016; Ciżkowicz et al. 2020; Ambroziak and

Dziemianowicz 2021).

7 Acknowledgements

We would like to thank Michele Frigeri, Roberto Golinelli and Matteo Squadrani for very useful discussions on search terms for Poland and for sharing the Python code needed to build the index for Poland.

References

Ahir, H., N. Bloom and D. Furceri (2018), "The World Uncertainty Index", *Stanford Institute for Economic Policy Research*, (No. 19-027),

Algharabali, B. and S. Al-Thaqeb (2019), "Economic policy uncertainty: A literature review", *The Journal of Economic Asymmetries*, 20

Ambroziak, A. A. and W. Dziemianowicz (2021), "The impact of Special Economic Zones on local labour markets in Poland", *Miscellanea Geographica. Regional Studies on Development*, 25(2), pp. 93–98

Baker, S., N. Bloom and S. Davis (2016), "Measuring Economic Policy Uncertainty", *The Quarterly Journal of Economics*, 131(4), pp. 1593–1636

Bank, W. (2021), *Volatility of Stock Price Index for Poland*, https://fred.stlouisfed.org/series/DDSM01PLA066NWDB, retrieved from FRED, Federal Reserve Bank of St. Louis

Barwińska-Małajowicz, A. and K. Tecza (2020), "Regional labour market and depopulation – an assessment of the situation in the Podkarpackie Voivodeship", *Humanities and Social Sciences*, 27(3), pp. 7–20

Bazzani, G., R. Guetto, A. Minello, E. Pirani and D. Vignoli (2020), "A reflection on economic uncertainty and fertility in Europe: The Narrative Framework", *Genus*, 76, pp. 1–27

Bernanke, B. S. (1983), "Irreversibility, uncertainty, and cyclical investment", *The quarterly journal of economics*, 98(1), pp. 85–106

Bloom, N. (2009), "The impact of uncertainty shocks", *Econometrica*, 77(3), pp. 623–685

Bontempi, M. E., M. Frigeri, R. Golinelli and M. Squadrani (2021), "EURQ: A New Web Search-based Uncertainty Index", *Economica*, 88(352), pp. 969–1015

Bontempi, M. E., R. Golinelli and G. Parigi (2010), "Why demand uncertainty curbs investment: Evidence from a panel of Italian manufacturing firms", *Journal of Macroeconomics*, 32(1), pp. 218–238

Brzozowski, M. and N. Nehrebecka (2016), "Wpływ niepewności makroekonomicznej na oszczędności przedsiębiorstw", *Gospodarka Narodowa. The Polish Journal of Economics*, 285(5), pp. 51–69

Carneiro, H. and E. Mylonakis (2009), "Google Trends: A Web-Based Tool for Real-Time Surveillance of Disease Outbreaks", *Clinical infectious diseases: an official publication of the Infectious Diseases Society of America*, 49, pp. 1557–1564

Carrière-Swallow, Y. and L. F. Céspedes (2013), "The impact of uncertainty shocks in emerging economies", *Journal of International Economics*, 90(2), pp. 316–325

Castelnuovo, E. and T. Tran (2017), "Google It Up! A Google Trends-based Uncertainty index for the United States and Australia", *Economics Letters*, 161, pp. 149–153

Choi, H. and H. Varian (2011), "Predicting the Present with Google Trends", *Economic Record*, 88, pp. 2–9

Choi, S. and P. Loungani (2015), "Uncertainty and unemployment: The effects of aggregate and sectoral channels", *Journal of Macroeconomics*, 46, pp. 344–358

Ciżkowicz, P., M. Ciżkowicz, P. Pękała and A. Rzońca (2020), "Why Do Some Special Economic Zones Attract More Firms Than Others? Panel Data Analysis of Polish Special Economic Zones", *Prague Economic Papers*, 30, pp. 61–89

Ciżkowicz, P., M. Kowalczuk and A. Rzońca (2016), "Heterogeneous determinants of local unemployment in Poland", *Post-Communist Economies*, 28(4), pp. 487–519

D'Amuri, F. and J. Marcucci (2017), "The predictive power of Google searches in forecasting US unemployment", *International Journal of Forecasting*, 33, pp. 801–816

Demir, E. and O. Ersan (2017), "Economic policy uncertainty and cash holdings: Evidence from BRIC countries", *Emerging Markets Review*, 33, pp. 189–200

Donadelli, M. (2015), "Google search-based metrics, policy-related uncertainty and macroeconomic conditions", *Applied Economics Letters*, 22(10), pp. 801–807

Drechsler, I. (2013), "Uncertainty, Time-Varying Fear, and Asset Prices", *The Journal of Finance*, 68(5), pp. 1843–1889

Dzieliński, M. (2012), "Measuring Economic Uncertainty and its Impact on the Stock Market", *Finance Research Letters*, 9, pp. 167–175

Ginsberg, J., M. Mohebbi, R. Patel, L. Brammer, M. Smolinski and L. Brilliant (2008), "Detecting Influenza Epidemics Using Search Engine Query Data", *Nature*, 457, pp. 1012–1014

Gorzelak, G. and M. Smetkowski (2018), "Rozwój regionalny, polityka regionalna", Polish, *Raport FOR*

Güney, P. Ö. (2019), "Macroeconomic uncertainty and private investment: the case of Poland", *Uluslararası İktisadi ve İdari İncelemeler Dergisi*, (22), pp. 93–106

GUS (2020), "Społeczeństwo informacyjne w Polsce", *Główny Urzd Statystyczny*

Hardouvelis, G., G. Karalas, D. Karanastasis and P. Samartzis (2018), "Economic Policy Uncertainty, Political Uncertainty and the Greek Economic Crisis", *SSRN Electronic Journal*

Hołda, M. (2019), "Newspaper-based economic uncertainty indices for Poland", *NBP Working Paper*, (No. 310),

Jun, S.-P., H. Yoo and S. Choi (2017), "Ten years of research change using Google Trends: From the perspective of big data utilizations and applications", *Technological Forecasting and Social Change*, 130, pp. 69–87

Jurado, K., S. C. Ludvigson and S. Ng (2015), "Measuring uncertainty", *American Economic Review*, 105(3), pp. 1177–1216

Kalinowski, S. (2015), "Uncertainty-Induced Challenges Faced by Poor Inhabitants of Big Cities: The Case of Poland's Poznań", *Gospodarka Narodowa*, 279, pp. 187–201

Kantor-Pietraga, I. (2014), "Both external and internal factors as an explanation of depopulation of cities on the area of Poland", *Environmental & Socio-economic Studies*, 2(3), pp. 56–64

Kula, G. and A. Ruzik-Sierdzińska (2011), "Institutional uncertainty and retirement decisions in Poland", *University of Warsaw, Faculty of Economic Sciences Working Paper*

Kupfer, A. and J. Zorn (2019), "A Language-Independent Measurement of Economic Policy Uncertainty in Eastern European Countries", *Emerging Markets Finance and Trade*, 56, pp. 1–15

Lichota, W. (2016), "The financial effectiveness of Poland's special economic zones", *Gospodarka Narodowa. The Polish Journal of Economics*, 281(1), pp. 99–130

Martináková, R. and S. Kapounek (2013), "Economic sentiment indicator and its information capability in the Czech Republic", *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 61, pp. 2491–2498

Mavragani, A. and K. Tsagarakis (2016), "YES or NO: Predicting the 2015 GReferendum results using Google Trends", *Technological Forecasting and Social Change*, 109, pp. 1–5

Meinen, P. and O. Roehe (2016), "On measuring uncertainty and its impact on investment: Cross-country evidence from the euro area", *European Economic Review*, 92, pp. 161–179

Mroczek, K., T. Tokarski and M. Trojak (2014), "Gravity Model of the Economic Diversity of Polish Regions", *Gospodarka Narodowa. The Polish Journal of Economics*, 271(3), pp. 5–34

Nuti, S., B. Wayda, I. Ranasinghe, S. Wang, R. Dreyer, S. Chen and K. Murugiah (2014), "The Use of Google Trends in Health Care Research: A Systematic Review", *PLoS ONE*, 9(9),

Opinia, A. R. i (2013), *Polacy a używanie znaków diakrytycznych*, https://www.gazetaprawna.pl/wiadomosci/artykuly/684045,akcja-ratowania-poprawnej-polszczyzny-uzywajmy-a-e-w-sms-ach-i-e-mailach.html, access: 20 April 2021

Ozturk, E. O. and X. S. Sheng (2018), "Measuring global and country-specific uncertainty", *Journal of international money and finance*, 88, pp. 276–295

Runge, A., I. Kantor-Pietraga, J. Runge, R. Krzysztofik and W. Dragan (2018), "Can depopulation create urban sustainability in postindustrial regions? A case from Poland", *Sustainability*, 10(12), pp. 1–18

Skoczkowski, T., S. Bielecki, M. Kochański and K. Korczak (2020), "Climate-change induced uncertainties, risks and opportunities for the coal-based region of Silesia: Stakeholders' perspectives", *Environmental Innovation and Societal Transitions*, 35, pp. 460–481

Škrinjarić, T. and Z. Orlović (2020), "Economic policy uncertainty and stock market spillovers: Case of selected CEE markets", *Mathematics*, 8(7), p. 1077

Sorić, P. and I. Lolić (2017), "Economic uncertainty and its impact on the Croatian economy", *Public Sector Economics*, 41(4), pp. 443–477

Stats, S. G. (2021), *Search Engine Market Share Worldwide*, https://gs.statcounter.com/search-engine-market-share/mobile/poland/\#yearly-2009-2020-bar, access: 20 April 2021

A Appendix

B Terms selection

The key to the reliability of the EURQPL index is the selection of terms that are (i) economically relevant and (ii) relevant to a local user. Furthermore, each language entails additional and unique challenges that need to be carefully studied. For example, Polish is a language that contains diacritical signs that do not exist in the Latin alphabet. Such letters are: *ą ę ó ł ń ś ć ź ż* and could be replaced by the user with characters that require less time and effort: *a e o l n s c z*. Because Google Trends (GT) only shows results with the exact spelling, no errors or deviations are caught. It is therefore important to determine whether Poles use special characters when surfing the Internet. According to a survey by Opinia (2013), 67% of respondents do not use Polish signs in SMS, 48% in chats and 44% in communicators (however, no question on Internet search engines). Although the survey suggests that Polish characters are in decline, GT allows us to better understand the issue. The power of the GT tool is to reveal actual user activity instead of stated activity. A higher volume of one query than the other implies a larger popularity of the former. Examination of such queries indicates that Polish Internet users type words in the correct form more often.

For each term that has at least one Polish sign, we compare the two versions: one in the correct form and the other without special characters. We take a trial-and-error-approach: if each of the two versions has a sufficiently large volume, we keep them both. On the other hand, if one of the two forms has a small volume compared to the other, we remove it from the word pool. For example, we use both versions: 'próg podatkowy' and 'prog podatkowy' (*tax rate*). Although the first is more popular, the other remains relevant. Similarly, we include pairs such as 'płaca minimalna' and 'placa minimalna' (*minimum wage*) or 'gaz łupkowy' and 'gaz lupkowy' (*shale gas*). Terms with Polish letters almost always turn out to have a larger volume and there are cases where words written in an "errata" manner are almost never looked for. Such terms are reduced to a single version, e.g. 'ministerstwo finansów' (*ministry of finance*) or 'nadzór bankowy' (*bank supervision*). The full list of all such cases is reported in Table 6.

Another issue concerning the complexity of word selection is that in Polish, nouns (and adjectives) are subject to declension[19]. This means that the same noun (or adjective) can take different forms depending on the sentence structure. While in English, the word 'economy' will take the same form regardless of how it is used in a sentence (e.g. 'thriving economy', 'the problem with the economy is...', 'foreign investment would help the economy', 'we have improved the economy' or 'we don't have to worry about the economy'). In contrast, the Polish equivalent 'gospodarka' would remain unchanged only in the first case and in the subsequent cases would change to 'gospodarki', 'gospodarce', 'gospodarkę' and 'gospodarką' respectively. This example shows the complexity of creating a language-based index. It is particularly important for news-based indices, such as that of Hołda (2019). Searching for specific words in an article or newspaper requires a certain amount of flexibility, and in this case the use of an asterisk (e.g. gospodark*) allows the different declensions of the word to be identified. However, declension should not be a problem in an Internet search-based

[19] As in other Slavic languages, German, Finnish, Hungarian, Latin and many others. Source: Wikipedia.

Table 6: List of queries containing Polish characters.

Terms with and without Polish signs	Terms with only Polish signs
"próg podatkowy" + "prog podatkowy"	"ministerstwo finansów"
"budżet państwa" + "budzet panstwa"	"luzowanie ilościowe"
"deficyt budżetowy" + "deficyt budzetowy"	"strefa zakazu lotów"
"dług publiczny" + "dlug publiczny"	amerykańskie wojska w polsce
"urząd skarbowy" + "urzad skarbowy"	"nadzór bankowy"
"podaż pieniądza" + "podaz pieniadza"	"kredyt bez zaświadczeń"
adam glapiński + adam glapinski - żona	umowy śmieciowe - co
"trybunał konstytucyjny" + "trybunal konstytucyjny" - co	trybunał sprawiedliwości unii europejskiej
"płaca minimalna" + "placa minimalna"	"inspekcja ochrony środowiska"
"układ zbiorowy" + "uklad zbiorowy"	"zabezpieczenie społeczne"
"urząd patentowy" + "urzad patentowy"	"gwarancja dla młodzieży"
upadłość + upadlosc	"bezwarunkowy dochód podstawowy"
"protokół z Kioto" + "protokol z Kioto"	"światowa organizacja handlu"
"gaz łupkowy" + "gaz lupkowy" - wikipedia	
zasiłek + zasilek	
"ubezpieczenie społeczne" + "ubezpieczenie spoleczne"	
"urząd pracy" + "urzad pracy"	
dopłata + doplata	
dopłaty + doplaty	
cło + clo	

Notes: The first column shows cases where two versions of a query are applied, one with Polish signs and the other without. The second column contains terms for which only the version with Polish signs is applied.

index. Typically, Internet users type the nominative (basic) form of a word, unless the phrase requires declension. An extensive query list should be able to capture most of these cases. Of course, the index may not take some phrases into account and thus underestimate uncertainty but they are expected to have a small volume and thus a minimal impact on the final result.

Commonly in all languages, some terms can be searched in both singular and plural forms. We check each option and keep both if they present different trends and peaks and thus different information. For example, we used both 'próg podatkowy' (*tax rate*) and 'progi podatkowe' (*tax rates*) as they capture differences between regions. The first query is more popular in the first half of the provinces, while the plural term is more popular in the other half. Sometimes the singular term refers to a different topic than the plural term. For example, 'dopłata' (sing.: *payment, subsidy*) refers to a subsidy for housing or rent, while 'dopłaty' (pl.: *subsidies*) refers mainly to subsidies to farmers.

The EURQ index for Poland is mainly based on the adoption and translation of the terms in Bontempi et al. (2021). In addition, we adapt the list to the reality of Poland. This procedure allows us to obtain 148 queries grouped in eight categories.

Table 7: List of queries in Polish used to construct national and regional EURQPL.

Fiscal policy			
1.	"progi podatkowe"	10.	administracja publiczna - praca
2.	"próg podatkowy" + "prog podatkowy"	11.	"deficyt budżetowy" + "deficyt budzetowy"
3.	"kwota wolna od podatku"	12.	"dług publiczny" + "dlug publiczny"
4.	podatek	13.	"obligacje skarbowe"
5.	podatki	14.	"ministerstwo finansów"
6.	opodatkowanie	15.	"urząd skarbowy" + "urzad skarbowy"
7.	opodatkowany	16.	pit

8.	“wydatki publiczne”	17.	cit
9.	“budżet państwa” + “budzet panstwa”	18.	vat
Monetary policy			
19.	nbp	30.	“Bank of Japan”
20.	“podaż pieniądza” + “podaz pieniadza”	31.	“Bank of China”
21.	“operacje otwartego rynku”	32.	fed - fedex - ex - up - cup - metoda
22.	“luzowanie ilościowe”	33.	stopy procentowe ebc
23.	“polityka monetarna”	34.	“stawka POLONIA”
24.	“stopa procentowa”	35.	“mario draghi”
25.	rpp	36.	adam glapiński + adam glapinski - żona
26.	“bank centralny”	37.	marek belka - rak - choroba
27.	EBC - brakes - tarcze - klocki	38.	inflacja
28.	Bundesbank	39.	christine lagarde
29.	“Bank of America”	40.	“wprowadzenie euro”
Healthcare and politics			
41.	nfz	46.	referendum
42.	refundacja	47.	strajk
43.	“programy lekowe”	48.	protest
44.	wybory	49.	“trybunał konstytucyjny” + “trybunal konstytucyjny” - co
45.	reforma	50.	afera - fryzjera - watergate - radio
National security			
51.	terroryzm - definicja - co	55.	“konflikt zbrojny”
52.	“wojna z terroryzmem”	56.	“misje wojskowe”
53.	“strefa zakazu lotów”	57.	NATO - co
54.	wojsko polskie - praca - forum - stopnie	58.	amerykańskie wojska w polsce
Regulation			
59.	“stress testy banków”	82.	uokik - kontakt
60.	“fundusz gwarancyjny”	83.	trybunał sprawiedliwości unii europejskiej
61.	“nadzór bankowy”	84.	“znak towarowy”
62.	KNF	85.	“urząd patentowy” + “urzad patentowy”
63.	“bail in”	86.	“prawo patentowe”
64.	“przeniesienie kredytu”	87.	upadłość + upadlosc
65.	“kredyt bez zaświadczeń”	88.	bankructwo
66.	“kredyt we frankach”	89.	“pozew zbiorowy”
67.	“instrumenty pochodne”	90.	“protokół z Kioto” + “protokol z Kioto”
68.	nik - logowanie - buty - nike - praca - collection	91.	“porozumienie paryskie”
69.	cba - praca - disco	92.	“handel emisjami”
70.	“prawo mieszkaniowe”	93.	“polityka energetyczna”
71.	narkotyki prawo	94.	“gaz łupkowy” + “gaz lupkowy” - wikipedia
72.	“płaca minimalna” + “placa minimalna”	95.	ustawa oze
73.	umowy śmieciowe - co	96.	“inspekcja ochrony środowiska”
74.	“układ zbiorowy” + “uklad zbiorowy”	97.	“ustawa antysmogowa”
75.	nadgodziny	98.	“prawa autorskie”
76.	“odprawa emerytalna”	99.	OFE
77.	odprawa z pracy	100.	“wiek emerytalny”
78.	prawo pracy - studia - szkolenia - radca - prawnik - porady	101.	prywatyzacja
79.	“prawo konkurencji”	102.	restrukturyzacja
80.	“nieuczciwa konkurencja”	103.	dyrektywa UE
81.	antitrust		
Foreign sovereign debt and crisis			
104.	kryzys walutowy	109.	“kryzys finansowy”
105.	dewaluacja	110.	“kryzys w rosji”
106.	rewaluacja	111.	“kryzys azjatycki”
107.	kryzys euro	112.	kurs walut
108.	“kryzys w strefie euro”		
Entitlement programmes			
113.	zus - pue - logowanie - infolinia - kontakt - kalkulator - praca	126.	odliczenie vat
114.	“welfare state”	127.	“ubezpieczenie zdrowotne”
115.	bezrobocie	128.	“ubezpieczenie chorobowe”
116.	zasiłek + zasilek	129.	“bezwarunkowy dochód podstawowy”
117.	“ubezpieczenie społeczne” + “ubezpieczenie spoleczne”	130.	renta
118.	“zabezpieczenie społeczne”	131.	dofinansowanie

119.	“urząd pracy” + “urzad pracy”	132.	dotacje
120.	pup	133.	subwencja
121.	“gwarancja dla młodzieży”	134.	dopłata + doplata
122.	“ulga podatkowa”	135.	dopłaty + doplaty
123.	“ulga na dziecko”	136.	rekompensata - synonim
124.	“500 plus”	137.	odszkodowanie
125.	“odliczenie od podatku”		
Trade policy			
138.	cło + clo	144.	polityka handlowa
139.	akcyza	145.	“runda urugwajska”
140.	subsydia	146.	“runda z dohy”
141.	wto	147.	embargo
142.	“światowa organizacja handlu”	148.	Schengen
143.	umowa handlowa - krzyżówka		

Table 8: List of queries in English used to construct EURQ_ENG.

1.	“tax rates”	53.	“labour law”
2.	“tax rate”	54.	antitrust
3.	taxes - meiou - death	55.	UOKIK - kontakt
4.	taxation	56.	“Court of Justice of the European Union”
5.	government spending	57.	trademark
6.	“public administration”	58.	“patent office”
7.	budget deficit	59.	insolvency
8.	“public debt”	60.	bankruptcy
9.	“government bonds”	61.	“class action”
10.	ministry of finance	62.	“Kyoto protocol”
11.	“tax office”	63.	“Paris agreement”
12.	PIT	64.	“shale gas”
13.	CIT	65.	OFE
14.	VAT	66.	“retirement age”
15.	NBP	67.	privatisation
16.	“money supply”	68.	restructuring
17.	“quantitative easing”	69.	EU law
18.	“monetary policy”	70.	devaluation
19.	“interest rate” + “interest rates”	71.	revaluation
20.	RPP	72.	euro crisis
21.	“central bank”	73.	“financial crisis”
22.	ECB - pacanów	74.	“exchange rate”
23.	NIK - logowanie - buty - nike - praca - collection	75.	ZUS - pue - logowanie - infolinia - kontakt - kalkulator - praca
24.	Bundesbank	76.	“welfare state”
25.	“Bank of America”	77.	unemployment
26.	“Bank of Japan”	78.	“unemployment benefit”
27.	“Bank of China”	79.	“maternity leave”
28.	fed - fedex - ex - up - cup - metoda	80.	child benefit
29.	“Mario Draghi”	81.	“social insurance”
30.	Adam Glapiński + Adam Glapinski - żona	82.	“social security”
31.	Marek Belka - rak - choroba	83.	“job agency”
32.	inflation	84.	PUP
33.	“Christine Lagarde”	85.	“tax credit”
34.	NFZ	86.	“500 plus”
35.	refund - steam - gog - game - ryanair - sisters	87.	“tax deduction”
36.	election	88.	“health insurance”
37.	reform - bogen	89.	“basic income”
38.	referendum	90.	funding - crowd
39.	“teachers strike”	91.	grant aid
40.	protest	92.	subvention
41.	“constitutional court”	93.	allowance - baggage - po
42.	terrorism	94.	compensation - flight - lag
43.	“war on terror”	95.	indemnity - double
44.	Polish army - museum	96.	tariff

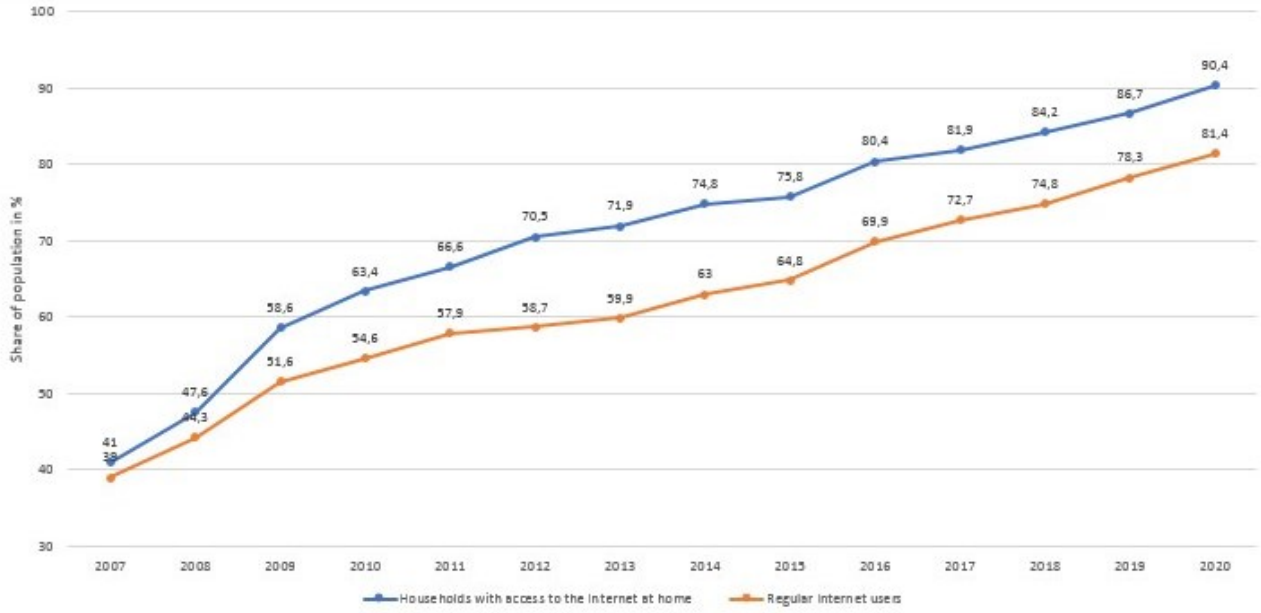
45.	NATO - co	97.	subsidy
46.	“US troops in poland”	98.	subsidies
47.	KNF	99.	WTO
48.	“bail in”	100.	“world trade organization”
49.	derivatives	101.	“trade agreement”
50.	CBA - praca - disco	102.	trade policy
51.	“minimum wage”	103.	embargo
52.	overtime - cash	104.	common market

C Descriptive statistics

Figure 16: Polish provinces and population size in 2019.

Notes: Darker colour indicates larger population.

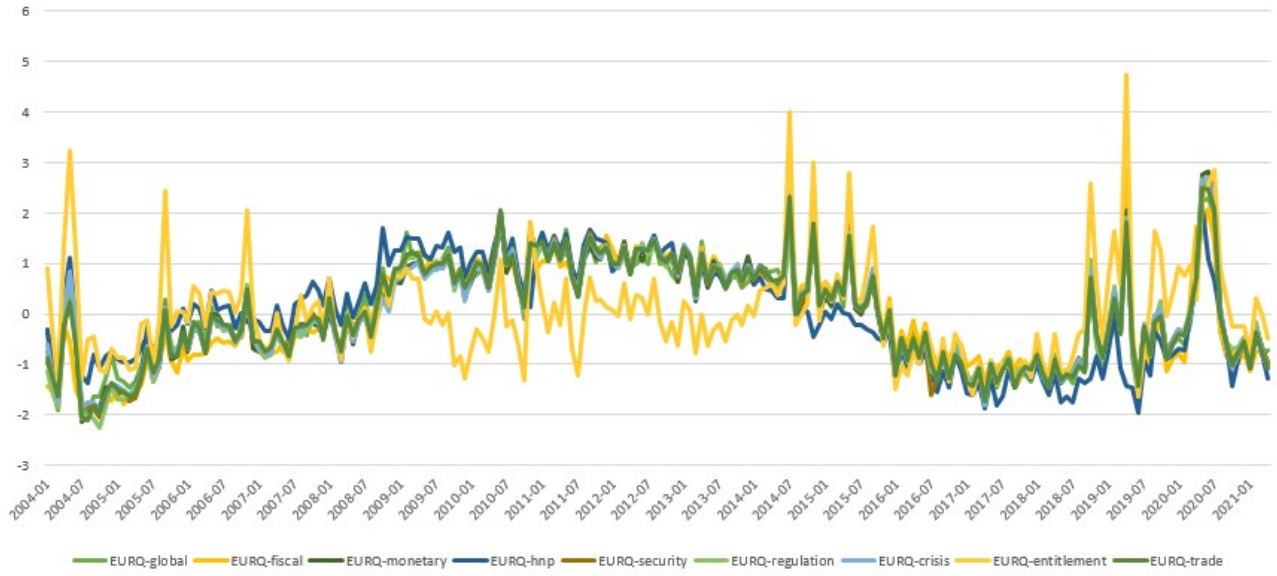
Figure 17: Households' access to the Internet and Internet users over 2007-2020 in Poland.



Notes: Over the last 13 years the number of people using the Internet more than doubled.

D Robustness checks

Figure 18: Robustness check on EURQ for Poland.



Notes: Each series represents an index with the exclusion of one of eight categories: fiscal policy, monetary policy, healthcare and politics, national security, regulation, economic crisis, entitlement programmes and trade policy. For example, EURQ-fiscal is an index without any queries related to fiscal policy. In the case of the exclusion of the entitlement programmes category, the term 'ZUS' (the benchmark) is retained in the list of queries. All indices are standardised to have zero mean and unit standard deviation.

Table 9: Correlation matrix between national EURQPL and EURQPL for categories.

	EURQ-national	EURQ-fiscal	EURQ-monetary	EURQ-hnp	EURQ-security	EURQ-regulation	EURQ-crisis	EURQ-entitlement	EURQ-trade
EURQ-national	1.00								
EURQ-fiscal	0.95*	1.00							
EURQ-monetary	0.97*	0.95*	1.00						
EURQ-hnp	0.86*	0.79*	0.84*	1.00					
EURQ-security	0.97*	0.96*	0.99*	0.85*	1.00				
EURQ-regulation	0.97*	0.96*	0.99*	0.83*	0.99*	1.00			
EURQ-crisis	0.97*	0.95*	0.99*	0.84*	0.99*	0.99*	1.00		
EURQ-entitlement	0.60*	0.51*	0.63*	0.36*	0.61*	0.61*	0.63*	1.00	
EURQ-trade	0.98*	0.96*	0.99*	0.86*	1.00*	0.99*	0.99*	0.60*	1.00

Notes: The symbol * denotes a 5% statistical significance.

E Regional EURQPL indices

Table 10: Correlation matrix between regional EURQPL indices.

	DS	KP	LU	LB	LD	MA	MZ	OP	PK	PD	PM	SL	SK	WN	WP	ZP
DS	1.00															
KP	0.69*	1.00														
LU	0.75*	0.72*	1.00													
LB	0.64*	0.62*	0.61*	1.00												
LD	0.70*	0.78*	0.68*	0.54*	1.00											
MA	0.86*	0.78*	0.71*	0.66*	0.80*	1.00										
MZ	0.67*	0.50*	0.50*	0.42*	0.58*	0.70*	1.00									
OP	0.63*	0.50*	0.63*	0.45*	0.52*	0.55*	0.38*	1.00								
PK	0.80*	0.75*	0.73*	0.68*	0.73*	0.81*	0.45*	0.64*	1.00							
PD	0.65*	0.63*	0.67*	0.53*	0.65*	0.65*	0.36*	0.47*	0.60*	1.00						
PM	0.80*	0.76*	0.74*	0.63*	0.75*	0.85*	0.56*	0.59*	0.78*	0.63*	1.00					
SL	0.80*	0.85*	0.76*	0.62*	0.83*	0.85*	0.49*	0.57*	0.84*	0.70*	0.82*	1.00				
SK	0.65*	0.63*	0.55*	0.50*	0.67*	0.70*	0.46*	0.49*	0.65*	0.52*	0.64*	0.66*	1.00			
WN	0.56*	0.60*	0.65*	0.47*	0.60*	0.55*	0.46*	0.45*	0.55*	0.55*	0.62*	0.65*	0.34*	1.00		
WP	0.84*	0.76*	0.77*	0.61*	0.71*	0.82*	0.58*	0.64*	0.80*	0.63*	0.83*	0.82*	0.67*	0.62*	1.00	
ZP	0.78*	0.61*	0.66*	0.65*	0.59*	0.77*	0.49*	0.57*	0.76*	0.53*	0.77*	0.71*	0.58*	0.44*	0.74*	1.00

Notes: The 16 regions are: : Dolnośląskie (DS), Kujawsko-Pomorskie (KP), Lubelskie (LU), Lubuskie (LB), Łódzkie (LD), Małopolskie (MA), Mazowieckie (MZ), Opolskie (OP), Podkarpackie (PK), Podlaskie (PD), Pomorskie (PM), Śląskie (SL), Świętokrzyskie (SK), Warmińsko-Mazurskie (WN), Wielkopolskie (WP) and Zachodniopomorskie (ZP).

F Comparison of uncertainty measures

Table 12: Correlation matrix between EURQPL, GEPU and CSU at monthly frequency.

	EURQPL	GEPU	CSU
EURQPL	1.00		
GEPU	0.41*	1.00	
CSU	0.36*	0.16	1.00

Notes: The symbol * denotes a 5% statistical significance.

Figure 19: Regional EURQPL aggregated to a country-level index.

Notes: EURQPL indices aggregated using three techniques: EURQ-agg1 (simple average of 16 regional EURQPLs where each of them has the same weight), EURQ-agg2 (weighted average for the average population size of each region over the period 2004-2019) and EURQ-agg3 (weighted average for the average population of Internet users in each region over the period 2011-2019). The indices are standardised to have zero mean and unit standard deviation.

Table 11: Weights for the aggregated EURQPL indices.

Region	**Weights by population**	**Weights by Internet users**
Dolnośląskie	0.076	0.077
Kujawsko-Pomorskie	0.054	0.054
Lubelskie	0.056	0.050
Lubuskie	0.026	0.026
Łódzkie	0.066	0.064
Małopolskie	0.087	0.087
Mazowieckie	0.138	0.147
Opolskie	0.026	0.027
Podkarpackie	0.055	0.052
Podlaskie	0.031	0.030
Pomorskie	0.059	0.064
Śląskie	0.120	0.121
Świętokrzyskie	0.033	0.030
Warmińsko-Mazurskie	0.037	0.037
Wielkopolskie	0.090	0.088
Zachodniopomorskie	0.044	0.046

Notes: Weights by population and by Internet users are used to construct EURQ-agg2 and EURQ-agg3, respectively.

Table 13: Correlation matrix between EURQPL, GEPU, CSU, EPU and WUI at quarterly frequency.

	EURQPL	GEPU	CSU	EU	WUI
EURQPL	1.00				
GEPU	0.51*	1.00			
CSU	0.41*	0.24	1.00		
EU	0.12	0.10	-0.40*	1.00	
WUI	-0.12	-0.17	-0.22	0.17	1.00

Notes: The symbol * denotes a 5% statistical significance.

Table 14: Correlation matrix between EURQPL, GEPU, CSU, EPU, WUI and VSP at annual frequency.

	EURQPL	GEPU	CSU	EU	WUI	VSP
EURQPL	1.00					
GEPU	0.57*	1.00				
CSU	0.37	0.21	1.00			
EU	0.09	0.06	-0.69*	1.00		
WUI	-0.26	-0.20	-0.38	0.29	1.00	
VSP	0.39	-0.06	0.83*	-0.29	-0.09	1.00

Notes: The symbol * denotes a 5% statistical significance.

G EURQ indices and leading indicators

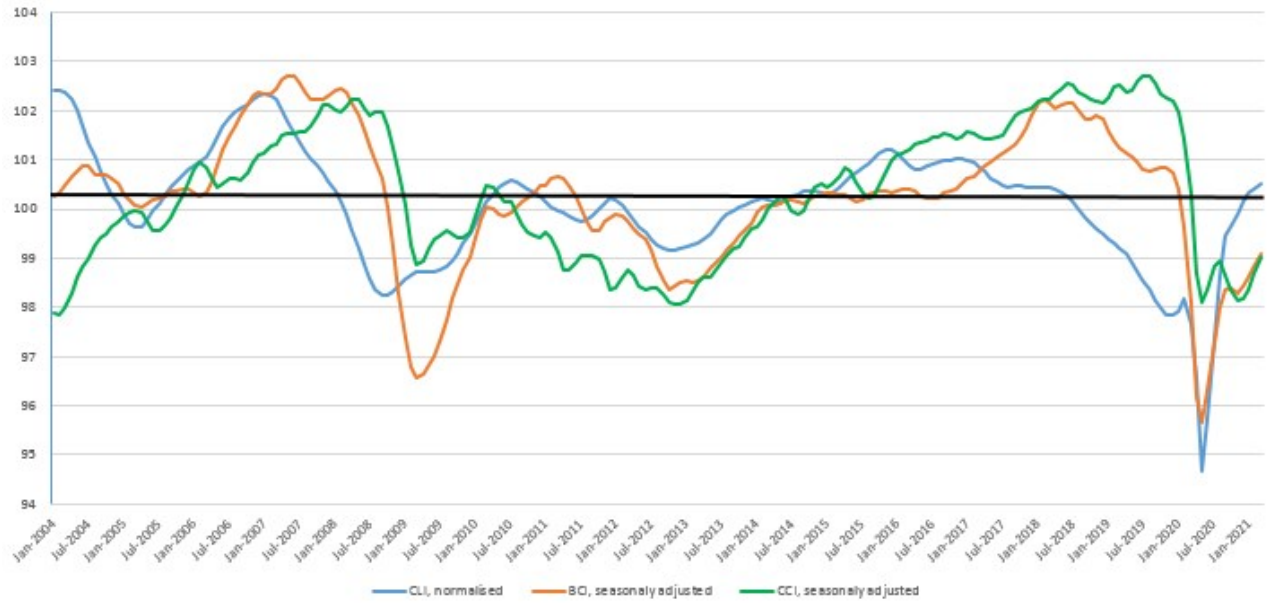
The Composite Leading Indicator (CLI) is an index to monitor qualitative changes in the business cycle. The objective of the concept is to approximate the output gap, i.e. the difference between actual economic activity and potential output. The index fluctuates around 100 points, meaning that a score above 100 occurs when the economy is growing, while values below 100 suggest that the economy is sluggish. Interpreting the peaks and troughs of the index allows one to make predictions about future developments in the business cycle. Such peaks imply that the economy will slow down in the future, while troughs suggest the opposite. The CLI is based on the aggregation of several macro variables that vary from country to country. In the case of Poland these are: real effective exchange rates, 3-month WIBOR (Warsaw Interbank Offered Rate), manufacturing production, job vacancies and coal production. According to the OECD, the turning points of the CLI occur on average 4 to 8 months before the turning points of the real economy variables.

The Business Confidence Indicator (BCI) is a survey-based indicator of trends in production, orders and inventories of the finished goods in the industrial sector. It signals trends in the economic activity of industrial firms and makes it possible to forecast changes in the output. An indicator above 100 signals a boost in business confidence about the expansion of production.

The Consumer Confidence Indicator (CCI) provides information on the economic situation of households and their capacity to consume and save. The indicator incorporates the responses of households to a survey on their expected financial situation, their sentiment on the general economic

situation, unemployment and savings capability. An indicator above 100 suggests an optimistic attitude towards future developments in the economy and could mean that households might be willing to increase consumption in the next 12 months. A score below 100 suggests the opposite situation, where economic agents are more cautious about spending, holding back consumption and more inclined to save.

Figure 20: Leading and confidence indicators: CLI, BCI and CCI.



Notes: The CLI is normalised, the BCI and the CCI are standardised to have a long-term average of 100 and seasonally adjusted.

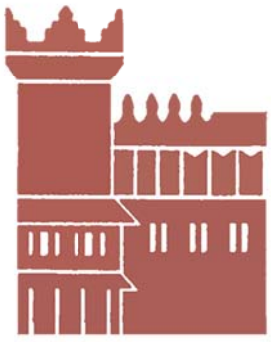
Table 15: Correlation matrix for national EURQ (in Polish and English) and leading and confidence indicators CLI, BCI and CCI.

	EURQPL	EURQ-ENG
CLI	-0.39	-0.43
BCI	-0.51	-0.43
CCI	-0.46	-0.24

Table 16: Matrix of Euclidean distances between regional EURQPL indices in the non-standardised dataset.

	DS	KP	LU	LB	LD	MA	MZ	OP	PK	PD	PM	SL	SK	WN	WP	ZP
Dolnośląskie	0.0															
Kujawsko-Pomorskie	432.7	0.0														
Lubelskie	379.0	388.8	0.0													
Lubuskie	656.2	552.9	584.6	0.0												
Łódzkie	882.5	698.8	766.9	595.4	0.0											
Małopolskie	456.2	375.9	438.0	438.6	482.4	0.0										
Mazowieckie	417.2	448.9	461.0	565.8	634.4	295.9	0.0									
Opolskie	1445.1	1285.6	1305.7	1069.1	710.1	1075.5	1217.4	0.0								
Podkarpackie	1230.1	1049.1	1099.7	834.4	492.1	843.8	1025.5	453.2	0.0							
Podlaskie	1074.4	905.3	941.1	729.4	369.6	694.6	851.7	596.5	434.4	0.0						
Pomorskie	447.2	365.0	404.5	462.9	536.4	212.8	348.2	1107.4	886.6	739.1	0.0					
Śląskie	453.0	305.9	393.9	478.5	539.7	246.1	414.6	1127.7	884.9	745.6	262.9	0.0				
Świętokrzyskie	477.4	535.8	571.7	766.8	941.0	598.4	612.6	1494.8	1278.5	1140.9	597.7	581.5	0.0			
Warmińsko-Mazurskie	486.0	448.4	425.1	614.3	725.7	455.7	441.7	1279.3	1079.9	906.7	419.2	419.5	682.9	0.0		
Wielkopolskie	305.0	340.9	336.5	565.6	734.8	355.0	390.1	1287.8	1070.4	928.3	320.3	329.7	493.2	419.9	0.0	
Zachodniopomorskie	417.7	437.0	429.1	479.3	641.8	299.6	395.9	1172.8	951.1	826.0	296.5	350.9	592.7	502.9	352.0	0.0

Notes: The largest and the smallest distances are marked in red.



Alma Mater Studiorum - Università di Bologna
DEPARTMENT OF ECONOMICS

Strada Maggiore 45
40125 Bologna - Italy
Tel. +39 051 2092604
Fax +39 051 2092664
http://www.dse.unibo.it