I. SELF-FULFILLMENT DEGREE OF ECONOMIC EXPECTATIONS WITHIN AN INTEGRATED SPACE: THE EUROPEAN UNION CASE STUDY

Emilian DOBRESCU[1]

Abstract

This study empirically analyzed the self-fulfillment degree and unbiasedness of expectation-forming mechanisms in the EU. The analysis used the economic sentiment indicator (ESI) and gross domestic product (GDP). Since annual data would fade out the expectational dynamism and the GDP's monthly series are still missing, the quarterly chain indices (ESIq and IGDPq) were used. Correlation analysis confirmed connections between each EU member state's economic growth and its own and other EU countries' economic sentiment indexes. A large preponderance of causal directionality, ESIq→IGDPq, was identified in a Granger sense. To represent the issue purely, the proposed model excluded IGDPq lagged values (with inherent multicollinearities) and any other leading indicators (which would blur the impact of expectations) from the explanatory variables. Using the seemingly unrelated regression technique, the system (28 equations with 745 coefficients) provided econometrically acceptable results, proving a relatively high self-fulfillment degree of economic expectations at a regionally integrated scale.

Keywords: correlation analysis, economic sentiment index, Granger causality, integrated space, model accuracy, self-fulfillment degree of expectations
JEL Classification: A14, C32, C52

1. Introduction

Three conceptual assumptions lead the present study. The first concerns the heterogeneity of expectations at a microeconomic level (*e.g.*, individuals, households, firms, banks, and institutions). Consequently, the main expectation types were identified - from the so-called naïve forms to the famous rational paradigm. Between these two types, a series of intermediary variants have been signaled (*e.g.*, extrapolative, auto-corrective, and adaptive learning algorithms). Such diversity is not accidental - it comes from the market position of economic agents, synthetically defined by their optional openness and informational capability. One signifies the amplitude of a set of options, which the economic agents could access (as not only simple aspirations but also market resources). The other refers to their

[1] *Romanian Academy, National Institute for Economic Research, Centre for Macroeconomic Modelling.*

potential of accessing and interpreting the information required for the decisional process. Box 1 details the economic expectation-forming mechanism and describes the currently identified main types of economic expectations.

Box 1. Typology of economic expectations

A. The set of decisional choices of operators, characterized by both limited informational capability and optional openness, is inherently narrow - almost pre-determined. In our opinion, the expectation-forming mechanism for such a group comes closest to those consecrated in the literature as naïve (intuitive, myopic, static, and the habitual "rule of thumb"). Kaldor (1934) introduce an early formalization of this mechanism. Citing Henry Schultz and Umberto Ricci from 1930, Kaldor explains this in the context of the cobweb model. Later, important contributions have been offered by Brock and Hommes (1997), Evans and Honkapohja (2001), Branch (2004), Guidolin and Thornton (2008), Lanne *et al*. (2008), Kaihatsu (2009), and Fuster *et al*. (2010).

There is the possibility that some economic agents included in this group do not adhere to simple random-walk predictions, but instead adhere to other types of expectations. Such a probability is nevertheless reduced, since we consider entities with restrained informational capabilities and optional openness.

B. In the typology of economic agents, the opposite scenarios are also present. There are agents which have expanded informational capabilities and optional openness (large-sized companies, banking system, investment funds, consulting agencies, other powerful market gamers, and public institutions). The rational expectation-forming mechanism seems more accurate to such a category of market operators. Founded by Muth (1961), and analytically structured by Lucas (1972) and Sargent and Wallace (1976), the rational expectation-forming mechanism was integrated into mainstream modern macroeconomics. In the last two decades, its cognitive and applicative valences have been subjected to extensive study, including those by Svendsen (1993), Sargent (2000), Sims (2003), Branch (2004), Kaihatsu (2009), Chow (2011), Mlambo (2012), Pfajfar (2012), Assenza *et al*. (2013), Deversi (2014), Ayala and Palacio-Vera (2014), Whelan (2016), Aurissergues (2017), Colasante *et al*. (2017), Martínez-García (2018), Holtemöller and Schult (2018), Hommes (2018), and Cornand and Hubert (2019).

According to this paradigm, expectations correspond to optimal solutions of the given business problems (economic agents do not make systematic mistakes). Such a hypothesis involves two fundamental epistemological pillars: a) there is a perfect model of economy, which is known and correctly applied by the agents, and, b) with this aim, the agents use all relevant information in formulating their predictions.

The history of economic methodology has shown that, as a rule, empirical models are contextually conditioned. They depend on the stage reached in the qualitative investigation of the phenomenon of interest, as well as the available database, and involve econometric techniques. At the same time, concrete applications are considerably influenced by the professional expertise and modeling preferences of users themselves. As a replica to these disputable points of the rational expectation hypothesis, Sims (2010) advances the theory of rational inattention. The last decade of research has also introduced diverse algorithms for the so-called near-rational expectations. Some of the studies in this line of research include Akerlof *et al*. (2000), Beeby *et al*. (2001), Weder (2004), Woodford (2005, 2009), Hassany and Mertens (2011), and Ivashchenko (2014). Important to our analysis is the statement indicating how a significant proportion of economic operators are naturally attracted by this

expectation-forming mechanism, either in its initial strong interpretation, or in its later amended variants.

C. Between the previous groups of economic agents, there is a third, with *sui generis* intermediary status. On one hand, this category of agents has the availability to call more complex - rather than naïve - expectation patterns. On the other hand, only rarely is it predisposed to involve the costly rational one. The extrapolative mechanism - according to which the future perception is configurated, notably depending on experience - is probably most often accessed. The central concept of such a paradigm is represented by the "coefficient of expectation," introduced by Metzler (1941), and defined by Enthoven and Arrow (1956) as the sensitivity of the expectation related to the effectively reached levels of the indicator in cause. This has been implied in the theoretical analyses of market equilibrium in the studies of Enthoven and Arrow (1956), Negishi (1964), and Vega-Redondo (1989), as well as in different empirical applications, as shown by Lansing (2005), Deuskar (2007), Hirshleifer *et al.* (2015), Cozzi and Davenport (2017), and Choi and Mertens (2019).

Our second assumption consists of the functional interdependence of microeconomic expectations, which come from the nature of economic activity as a social phenomenon itself. Complex processes of production, distribution, circulation, and final use for goods and services functionally form a large and complicated graph of interactions among economic agents. Therefore, the different types of economic expectations do not exist in isolation. They intersect and generate a multitude of inter-effects. For example, agents requiring a loan for any investment or current activity adjust their expectations with respect to the banking system's expectations (this is concretized in preexisting credit conditions). Almost every bi- or multilateral economic agreement (commercial, financial, employment-related, etc.) is inconceivable without the reciprocal accommodation of partners' expectations. Extending inter-agent communication represents a powerful vector for disseminating the auto-corrective component of expectation-forming processes. Due to their profound interdependence, the economic expectations are manifested at macro-levels, not as an incoherent conglomerate, but rather as an integrated system. This is true for not only the national level but also the international one. Consequently, a major objective of our search is to empirically check this interdependence at the European Union (EU) scale.

The third essential assumption admits that, as an integrated system, the self-fulfillment degree (unbiasedness) of economic expectations is favorized by i) increasing the weight of their rational type, ii) amplifying the macroeconomic forward guidance, and iii) continuously improving pre-contractual negotiations among the economic agents. Analysis of the self-fulfillment degree of economic expectations within the EU represents our research objective.

The rest of the paper is structured as follows: Section 2 describes the methodology of this research, while Section 3 is focused on database problems. The main results of the empirical analysis are discussed in Section 4. Some concluding remarks, together with further possible targets of the investigation, are presented in Section 5, the final part of the paper.

2. Methodological landmarks

Beginning with a short characterization of the foundations of economic expectations theory, this section examines several measurement and modeling problems.

2.1. When schematizing the discussion of, for example, a certain business problem (from the banal sale/purchase of goods, services, and assets, to the most complex investments or

international agreements), operators g $(j = 1, 2, \dots, G)$ are interested. The problem can be solved in m modalities $(m = 1, 2, \dots, M)$.

A situation wherein all operators approach all possible solutions of a given business problem cannot be *de facto* excluded. In some specific monopolistic markets, this could even be effective, although it is an exception. Under actual conditions, an operator k has access to a part (m_k) of the potential solving modalities. The sub-set $m_k(m_k \leq \mathrm{M})$ is the optional openness of operator k. If m_k is very low - or even 1 (*e.g.*, revenues from the social sources, household production for self-consumption, compulsory public taxes, and other legally imposed obligations) - then it would be more appropriate to consider pseudo-options.

Usually, the degree in which accessible solutions m_k correspond to the optimizing function of operator k is different. The final choice depends on the latitude of the operator in cause to access the relevant data about the given problem, to comparatively analyze its possible solutions, and to identify and adequately apply the discriminating criterion for the final selection. This latitude is the informational capability of the economic agent. The types of expectations are significantly linked with these two characteristics of the economic agents' market positions.

2.2. The differentiation of market operators - depending on their optional openness and informational capabilities - involves a simultaneous presence of several types of expectations within the economy. The heterogeneity hypothesis conceptualizes this circumstance. This hypothesis was developed in the 2000s by Branch (2004), Lanne *et al.* (2008), Kaihatsu (2009), Fuster *et al.* (2010), Lines and Westerhof (2010), Pfajfar (2012), Assenza *et al.* (2013), Deversi (2014), and Hommes (2018). The hypothesis admits that economic agents use different information sets and different models, and also have different capacities for processing information (Pfajfar, 2012).

Hence, it is recognized that as far the optional openness and informational capabilities of economic agents are well-differentiated, the expectation-forming mechanism is inherently heterogeneous. This diversity is discernible in countries with consolidated market systems. It is also understandable for emergent economies, which are characterized by many institutional, technological, managerial, and behavioral transformations. An increasing number of sociological surveys on perceptions and intentions of market gamers (*e.g.*, households, firms, public authorities, and professional or owners' organizations) also confirm this.

It is assumed that the heterogeneity of economic expectations is a datum of contemporaneous economies. In an equal measure, however, it is necessary not to underestimate their deep interdependence, on both the national and international scales. This comes from the nature of economic activity itself, as social labyrinthine gearing. This interdependence ensures that the expectation-forming mechanisms are accompanied by a large informational effort of economic agents, and by their intensive interconnections. To this end, the consolidated market economies developed two important instruments - the macroeconomic policies' guidance and pre-contractual negotiations (Box 2).

When considering the above macro- and micro-circumstances, our proposal is to interpret expectations - even in the heterogeneity hypothesis - as an integrated system with a significant self-fulfilling capacity. This statement does not presuppose agreement of decisions with a certain pre-established reference (as is assumed by the optimal model in rational theorem), but only a pronounced closeness of the real processes to the forerunning expectations.

Box 2. Macroeconomic policies' guidance and pre-contractual negotiations

A. Expectations are not formed in isolation. Hence, all economic agents act in a common business environment (*e.g.*, property regimes, state interventions, banking infrastructures, fiscality, monetary policies, labor legislations, social protection systems, international conjectures, and communication channels). The informational context is substantially influenced by the macroeconomic policies' guidance, with comprehensive characterizations of economic dynamics in the short, medium, or long term. Two archetypes can be distinguished here: Delphic (purely informative) and Odyssean (involving certain commitments of issuers). For the former archetype, we consider analyses and forecasts delivered by international organizations, governments, the banking system, professional publications and centers, owners' organizations, and trade unions, concerning the state and anticipated evolution of the economy (in the largest sense), as well as demographic processes, politico-strategic environments, and climate and health phenomena. The second archetype is achieved, for example, through public budgets, infrastructural investment projects, and research, as well as education, health, social, and other operational programs adopted by local, national, and international institutions.

A special role belongs to the monetary forward guidance, admitted by Bernanke (2020), as well as quantitative easing as a new tool of the monetary policy. Forward guidance or "open mouth operations" (Guthrie and Wright, 2000) entail(s) specifications, followed by macroeconomic targets. Mendes and Murchison (2014) identify three generations of its evolving nature: qualitative (pioneered by the Bank of Japan, through adopting the "zero lower bound" in 1999), time-contingent (implemented in 2009, by the Bank of Canada's commitment toward targeting an overnight rate on longer-term market interest rates by considering the relationship between interest rates, inflation, and unemployment rates), and state-contingent unemployment thresholds (used by the Federal Reserve in 2012, and, subsequently, the Bank of England). More frequently, forward guidance aims to influence the expectations of future interest rates, asset prices, inflation, economic growth, employment, and perceived uncertainty (Eggertsson and Woodford, 2003; Gurkaynak *et al*., 2005; Andersson and Hofmann, 2009; Moessner, 2013; Raskin, 2013; Magill and Quinzii, 2014; Del Negro *et al*., 2015; Smith and Becker, 2015; Andrade and Ferroni, 2016; McKay *et al.,* 2016; Swanson, 2017; Bundick *et al.,* 2019; Hubert and Labondance, 2018; Andrade *et al*., 2019; Coibion *et al*., 2020; Sutherland, 2020). Some studies reveal how various attributes of forward guidance have an influence on forming expectations, of not only the market operators but also the forecasters themselves (Campbell *et al*., 2012; Kool and Thornton, 2015; Coenen *et al*., 2017; Andrade *et al*., 2019; Jain and Sutherland, 2018).

Therefore, macroeconomic forward guidance does not pre-determine the expectations of proper decision makers. Instead, it offers them certain common landmarks, facilitating the relative homogenization of their market options.

B. At the microeconomic level, there are factors with similar roles. The network of technological, commercial, and financial interconnections, in which almost all economic agents are engaged, obliges them to reciprocally accommodate their expectations. An intensive propagation of business expectations among market operators is also signaled (see, *e.g.*, Kukuvec and Oberhofer, 2020, with reference to the EU). The negotiations associated with preparation and conclusion of any bi- or multilateral contract will be expressive from this viewpoint. This process could be named the "collective auto-corrective expectational process."

Sometimes, such a property is called unbiased. Some references to this question may be found in studies on the heterogeneity hypothesis (Grisse, 2009; Kaihatsu, 2009; Assenza *et al*., 2013; Dosi *et al*., 2020) or the business cycle theory (Bilo, 2019).

2.3. This analysis is necessary as a more comprehensive indicator of economic activity. This involves the development of an immense multi-hierarchical graph of inter-connected actions and outcomes of economic agents (individuals, households, firms, banking systems, local and national institutions, and international organizations). There are different modalities to express this large puzzle synthetically. Our study addresses the following binomials:

- The gross domestic product (GDP) as a measure of the outcomes resulting from effective economic activity, and
- The economic sentiment indicator (ESI) representing the proxy of expected outcomes of the economy. As a reference variable (European Commission, 2016, p. 21), the performance of the ESI - which summarizes the attitudes and judgments of many economic actors - should be compared to the GDP growth.

2.4. As the methodology and statistics of the GDP are largely known, we shall focus on the ESI construction. Since the direct measuring of expectations at the macroeconomic level is, euphemistically speaking, a very difficult target (as Brayton *et al*., 1997, referred to such a question), this issue was approached by indirect methods. Most frequently, they involved the sentiment indexes, which approximate the perceived market players' track of the economy. Such an example is ESI, which is estimated for the entire EU, and separately for all the member countries.

By its nature, ESI is a composite indicator, consisting of the weighted average of the balance of replies collected from surveys, addressed to managers and consumers, on their perceptions concerning the state, as well as short-run perspectives of the main fields of economic activity. By aggregating algorithms, ESI is conceived to approximate the expected GDP growth of member countries and the EU as a whole.

Statistical representativeness of the ESI is based on the large number of consulted units. The recently practiced nominal sample sizes comprise more than 221,000 units. Their national distribution is correlated to the demographic dimension and economic heterogeneity of member countries (for details, see European Commission, 2016, p. 4). The response rate is differentiated, representing the euro area level of 62.1% in industry, 60.6% in investment, 56.7% in services, 61.7% in consumers, 50% in retail trade, and 43.8% in construction. When extrapolated at the EU scale, these rates mean an effective sample of more than 126,000 units.

Through the efforts of entities engaged in collecting and processing surveys, a useful publication frequency is ensured. The current surveys are operated monthly, and only certain answers are requested quarterly or biannually.

Usually, the accentuated diversity of the national economies integrated into the EU seriously complicates the data aggregability problem. To solve this problem, the following solutions were promoted: i) use in all countries of the same harmonized questionnaires; ii) determination of the sample size and survey mode, so as to achieve high representativeness of data, including minimal alteration of black noise (irregular fluctuations); iii) the entire option-scales (from three to six), adopted in different surveys and reducible to a similar balance operable scheme; and iv) promotion of a common methodology and timetable for all operations. However, to refrain from ignoring some relevant specificities of national economies, the common ESI questionnaires were completed with some auxiliary annexes.

ESI surveys cover an extended palette of micro and macroeconomic indicators, such as production, export, import, investment, building activity, employment, unemployment, financial situations, selling prices, consumer prices, purchase intentions, saving intentions, companies' profitability, and general (sectoral, national and EU) economic situations (see European Commission, 2020).

The current sectoral weights, in aggregation (industry 40%, services 30%, consumers 20%, retail trade 5%, and construction 5%), considered the "representativeness" of the respective sectors and the tracking performances *vis-à-vis* the GDP growth reference variable (European Commission, 2016, p. 20).

These weights, as with the other aspects of the ESI building, raise understandable questions. We shall come back to some of them in the concluding section of this paper. However, it is clear that our research could only call to a series of ESI, constituted based on an actual methodology that was described previously in brief.

2.5. To test the main objective of this study (macroeconomic self-fulfillment degree of expectations), the modeling approach seems most promising.

2.5.1. Concerning this issue, the literature is far from unitary. Negative opinions are also present. For example, Martináková and Kapounek (2013, p. 2497) affirm that, even if there was a link between the aggregate ESI and the real economic activity, we cannot use this as a leading economic indicator to predict future development. Dimitriou and Pappas (2018, p. 17) also admit that there are poor indications by which confidence indicators lead economic activity.

However, it would be difficult to contest that the main engines of economic life do not act as supernatural forces, but on the contrary, their influences are exerted via the operational decisions of market players, always motivated by their expectations. Being a previous phenomenon, the expectations - if they are correctly measured - are an inevitable precursor of economic dynamics. Similar views are shared by many researchers, such as Mourougane and Roma (2002), Giannone *et al*. (2009), Moon and Lee (2012), Pošta and Pikhart (2012), European Central Bank (2013), Leboeuf and Morel (2014), and Lehmann (2015).

The inclusion of expectations into economic growth models is achievable through different ways. Therefore, national GDPs can only be related to the corresponding national ESIs. The interdependence expectation-forming process is considered in this case only at the national scale, although the international contagion effect cannot be ignored. (Dées and Soares Brinca, 2011, for instance, find evidence of a confidence channel in shock transmission between the USA and the euro area.) It is presumed that, within an integrated regional space, such a phenomenon will be even more intense.

Although, it seems non-intuitive, the current GDP is sometimes related to both current and lagged ESI, as in Biau and D'Elia (2011). Notable modeling attempts refer to the combination of ESI with other indicators (Keeney *et al*., 2012; Van Aarle and Kappler, 2012; Gajewski, 2014; Pareja *et al*., 2018), such as composite purchasing manager index, industrial production, non-energy industrial production, sales of large firms, unemployment, retail sales, credit to non-financial corporations, export, and import. Technically, it would be worth to mention that both the fixed and time-varying coefficients models are used.

2.5.2. To systematize the solutions (some already experimented, others not), in which ESI data are integrable (from different modeling perspectives) into the GDP estimations, the following scheme (Table 1) is useful.

Table 1

Perspectives from which ESI is integrable into GDP estimation

Perspectives	Possible solutions		
Temporal	Current ESI	Lagged ESI	Both
Spatial	National ESI	ESI of other countries	Both
Exogenous	Exclusively ESI	Other variables	Both
Model coefficients	Gixed	Time-varying	Both

Note: ESI=economic sentiment indicator; GDP=gross domestic product.The matrix in Table

1 provides a large variety of disposable variants. As a discriminating criterion of selection, the predictive performance of the resulting model is usually preferred. Our searching optics are slightly different. As was outlined, we aimed to approximate only the self-fulfillment degree of expectations, as such, in each historical context (reflected through a given statistical database). With this target, there was no place for other indicators that could quantitatively blur the ESI impact. The time-varying parameters would also inevitably make the approximation of the searched degree difficult, for the period in cause. Regarding inclusion of the lagged ESI in this model, there are both *pro* and *contra* arguments: near the current value, lags could reveal the auto-corrective adjustments of expectations, but at the same time, may contain some risks of inducing the collinearity effects. For the current application, therefore, we opted for a linear univariate regression, in which *i*, *j* signifies the codes of countries:

$$GDP_i = f(c_0, \sum c_j * ESI_j), \quad (i = \text{fixed}; j = 1, 2, ...28) \tag{1}$$

where: c_0 is the intercept.

3. Data analysis

The evaluation of the interdependence between economic expectations and their self-fulfillment degrees will be empirically studied using the 1995–2019 series of the EU (ante-Brexit format) for the GDP and the aggregate economic sentiment (Eurostat, 2019). Statistical significance is ensured, not only volumetrically (28 countries, covering 22% of the world GDP) but also through casuistry (advanced and emergent market economies, with differentiated levels of development, traditions, and cultural values). Both variables are represented as chain indexes - IGDP and ESI - the comparison referring to the expected and effective economic growth.

3.1. Data problem

To ensure the relevance of this comparison, special care needs to be taken for the frequency data problem. Annual indexes are too aggregate, because they are able to flatten significant episodes of the binomial expectations-reality. Certainly, a better solution would be the monthly data, but officially these are calculated only for the ESI. This situation is converse in the case of an intermediary solution (quarterly pace), for which an IGDP series exists, but not for ESI. Therefore, under these circumstances, we had to choose from the following technical possibilities: i) generate a monthly series of IGDP from existing information on its monthly components, and so compound a monthly model this way; ii) generate the quarterly series of ESI from its monthly levels, resulting in a quarterly model; and iii) operate concomitantly with the available monthly ESI and quarterly IGDP, calling a bridge to equations or other techniques of processing mixed samples. Every variant has some

advantages, raising certain disadvantages at the same time. Their comparative analysis would be worthwhile. For the current study, however, we chose the second solution: transforming monthly ESI into quarterly indexes by a polynomial of the third degree (Box 3).

Box 3. Approximation of the quarterly ESI

A. Denoting by x_1, x_2, and x_3 the corresponding monthly ESIm, and by x the adjusted value for the whole quarter, we compared three procedures (α, β, and γ) for estimating x. Differentiated by the way in which the inertial feature of the expectational process is considered, it follows that we use:

i) Usual arithmetic mean (x_a)

$$x_a=(x_1+x_2+x_3)/3, \quad (2)$$

to obtain the quarterly series $ESIq_\alpha$;

ii) Geometric mean in the form of

$$x_\beta=(x_1*x_2*x_3)\text{^}(1/3), \quad (3)$$

with the solution of

$$x_b=\exp[(\ln(x_1)+\ln(x_2)+\ln(x_3))/3], \quad (4)$$

to obtain the quarterly series $ESIq_\beta$; in the expectational analysis, this method was used by Mariano and Murasawa (2003), followed by Guagliano and Mantovani (2014) and Pareja *et al*. (2018); and

iii) A polynomial of the third degree (x_γ)

$$a*x_\gamma^3+b*x_\gamma^2+c*x_\gamma+d=0, \quad (5a)$$

where: a=1, b=1, c=1, and d=-($x_1^3+x_2^2+x_3^1$). For the solution to the general cubic equation, see the example of Fermat's Last Theorem (2006).

According to the premises of our application (p=2/3, q=7/27-d, and r=1/3), the relationship in Equation (5a) transforms into

$$x= ((7/27\text{-d})/2 + ((7/27\text{-d})\text{^}2/4 + (2/3)\text{^}3/27)\text{^}0.5)\text{^}(1/3) + ((7/27\text{-d})/2\text{-}((7/27\text{-d})\text{^}2/4 + (2/3)\text{^}3/27)\text{^}0.5)\text{^}(1/3)\text{-}1/3. \quad (5b)$$

The resulting series is denoted by $ESIq_\gamma$.

B. The three mentioned procedures were applied as preliminary on the longest series (available in the EU) of the country monthly economic sentiment indexes ($ESIm_p$). For 12 EU member countries (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Spain, and the UK) information regarding the interval of 1985–2019 was published.

For all the enumerated countries, the chain quarterly indexes $ESIq_\alpha$, $ESIq_\beta$, and $ESIq_\gamma$, which were admitted as equals for all months of the respective quarter, were computed. These obtained monthly estimations ($ESIm_\alpha$, $ESIm_\beta$, and $ESIm_\gamma$) were compared to the primary data (ESIm). To this end, there averages (AVm_0, AVm_α, AVm_β, and AVm_γ) and standard deviations ($STDm_0$, $STDm_\alpha$, $STDm_\beta$, and $STDm_\gamma$) were determined, considered to be the main structural characteristics of the used database. The ratios are

$$rAVm_i=AVm_i/AVm_0 \ (i=\alpha, \beta, \gamma), \quad (6)$$

$$rSTDm_i=STDm_i/STDm_0 \ (i=\alpha, \beta, \gamma). \quad (7)$$

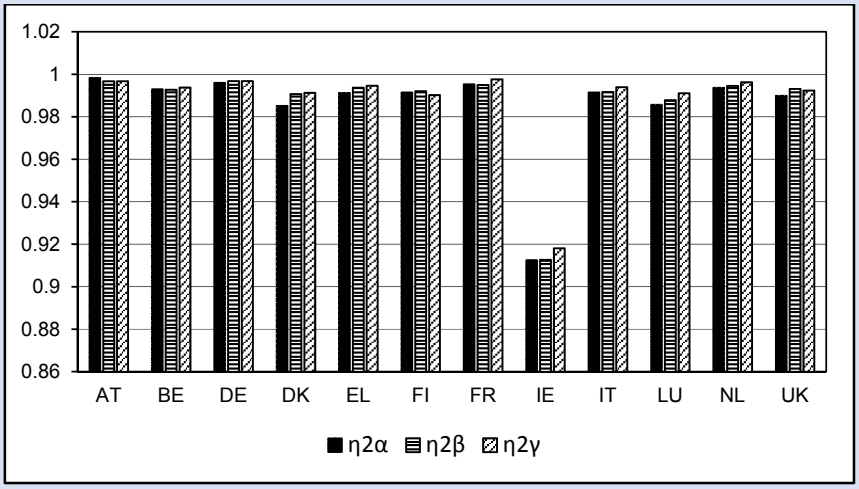
The measure in which the AVM and STDm ratios get closer to unity was adopted as the discriminating criterion in choosing the preferable procedure for quarterly data approximation. Its determination starts from

$\lambda_1=1-|1-rAVm_i|$, (8)

$\lambda_2=1-|1-rSTDm_i|$, (9)

both varying between 0 (total disparity) and 1 (perfect super-position). These are aggregated *(e.g.*, by a simple mean, obtaining a type of the concordance coefficient of estimated monthly series with primary sample [$\eta_i=(\lambda_{1i}+\lambda_{2i})/2$]). Figure 1 displays values of η_i for all 12 countries.

Figure 1. Coefficient of concordancy with the primary sample



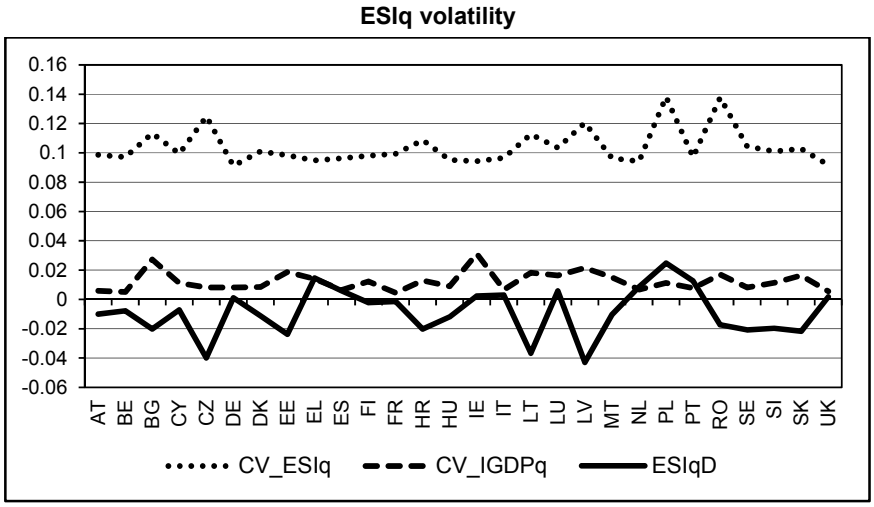
Therefore, all three procedures (α, β, and γ) provided acceptable results. At a small distance, however, the polynomial of the third degree ranks first in eight cases. Consequently, in our empirical study, we use this procedure in approximating the quarterly economic sentiment indexes.

Appendix 1 contains quarterly series IGDPq and ESIq for all 28 ante-Brexit EU members. The lengths per country are differentiated, depending on the moment when the computational methodology of ESI was implemented by the national statistics.

3.2 Descriptive statistics

The descriptive statistics provide two significant properties of the ESIq series. One refers to the volatility degree of ESIq as compared to GDPq. Another refers to the measure in which the ESIq diverts from IGDPq. The first is approximated by the ratio of standard deviations to corresponding means (resulting CV_ESIq and CV_IGDPq), and the second by the difference between the ESIq and IGDPq means (denoted by ESIqD). These curves are provided in Figure 2.

Figure 2



Generally, ESIqD does not stand too far from zero. However, retaining of the economic sentiment index for half the countries (Latvia, Czechia, Lithuania, Estonia, Slovakia, Sweden, Bulgaria, Croatia, Slovenia, Romania, Hungary, Denmark, Malta, and Austria) reveals a rather pessimistic state of economic agents' perceptions of the business track: their mean ESIq is sensibly lower than the mean IGDPq (ESIqD between -0.01 and -0.043). The other 11 countries (Belgium, Cyprus, Finland, France, Germany, the UK, Ireland, Italy, Luxembourg, Spain, and the Netherlands) are in a slightly more balanced situation (ESIqD between -0.0076 and +0.0085). Only three countries (Portugal, Greece, and Poland) register a positive difference, higher than +0.0125.

Instead, the volatility of ESIq is substantially higher than that of IGDPq, which cannot help but induce certain problems in the estimation of expectations' self-fulfillment degree. This gap is imputable, to a high extent, to the frailty of any subjective evaluation. It adds also, in our opinion, a factor of measurement origin. *Grosso modo*, we could distinguish three steps of the expectation-forming mechanism: i) initial business desires and perceptions on business environment; ii) affordable business projects; and iii) well-designed business plans, usually preliminarily agreed with the economic agents' partners. Intuitively, it is reasonable to admit that expectations belonging to the first category are characterized by the highest uncertainty, while contrary, those included in the last category are most probable. Also, the actual ESI methodology does not yet consider this circumstance. Therefore, it would be possible that mixing expectations of different uncertainty degrees induces the volatility of aggregated ESI to be supplementary accentuated, as compared to the GDP (based on more reliable recorded data).

3.3 Correlation analysis

Useful information may also be obtained from the correlation analysis. The usual algorithm (Galtung–Pearson or standard formula) is applied, first on values for the same moment (contemporaneous correlation) and then in the dependence on lags.

The correlations between IGDPq for each country, and all 28 series of ESIq, are presented in Appendix 2a. Approximately 42% of them are higher than 0.5. Together with the previous class (0.4–0.5), they exceed 58%. This reveals how important the connection of the economic growth with the expectational mechanism is.

To be relevant, the inter-country comparison does not omit the economic importance of the involved partners. The weighting problem is solved using the procedure advanced in Dobrescu (2019). The weights (w_{ij}) of interest will be determined based on

$$w_{ij} = \varphi_i * \varphi_i, \tag{10}$$

where: φ denotes the country shares in the GDP of the EU, and i and j are the codes of countries between which they are calculated. The matrix of weights (w_{ij}) resulting from Equation (10) and the country shares in the EU GDP (2019, current prices) are detailed in Appendix 2b. Applied to the correlations of ESIq-IGDPq, this matrix is shown in Appendix 2c (matrix wEGij). Since the values are weighted, the correlation coefficients become aggregable, which allows us to define the corresponding row and column sums (similar to multipliers from the input-output analysis). Formally,

$$srwe_i = \sum wEG_{ij}\ (i - fixed;\ j = 1, 2, \dots, k), \tag{11a}$$

$$scwe_j = \sum wEG_{ij}\ (j - fixed;\ i = 1, 2, \dots, k), \tag{11b}$$

The row and column sums allow us to identify the main "expectation-offerors" and the main "expectation-receivers." These are the countries with a prominent role in the global interaction of real processes with the expectation-forming mechanism. Depending on the ratio of the cumulated weighted correlation coefficients of EU countries as "offerors" to "receivers," we can distinguish among three groups. The highest ratio (over 1.2) is for Belgium, Germany, Denmark, Ireland, Luxembourg, Malta, Sweden, and Slovakia. Conversely, there are countries with a ratio lower than 0.8: Bulgaria, Cyprus, Czechia, Croatia, Latvia, Romania, and Slovenia. The remaining countries constitute an intermediary group, with a ratio of 0.8–1.2 (Austria, Estonia, Greece, Spain, Finland, France, Hungary, Italy, Lithuania, the Netherlands, Poland, Portugal, and the UK). The interpretation of these differences requires further socio-economic research.

Regarding the ESIq series, autocorrelation with the first lag is consistent and positive, which would justify a possible presence of this lag into modeling specification IGDPq=f(ESIq). We also examine the temporal cross-correlation, as the relationship of ESIq with the GDPq (at the first and second lags). We found the higher order of lags insignificant.

3.4 Stationarity of the analyzed series

In order to check the stationarity of the analyzed series, the series were submitted to the unit root test (Newey–West automatic bandwidth selection and the Bartlett kernel).

As Table 2 confirms, all tests reject the null hypothesis of the unit root process. The standard version of the Granger causality test is, therefore, applicable.

Table 2

Summary of the group unit root test

		***GDPq* (28 cross-sections)**		***ESIq* (28 cross-sections)**		***GDPq+ESIq* (56 cross-sections)**	
Method	Null: unit root	Prob.	Obs.	Prob.	Obs.	Prob.	Obs.
Levin-Lin-Chu t*	Common unit root process	0	2,643	0	2,599	0	5,242
Im-Pesaran-Shin W-stat	Individual unit root process	0	2,643	0	2,599	0	5,242
ADF-Fisher chi-square	Individual unit root process	0	2,643	0	2,599	0	5,242
PP-Fisher chi-square	Individual unit root process	0	2,664	0	2,627	0	5,291

Note: Probabilities for the Fisher tests are computed using an asymptotic chi-square distribution. All further tests assume asymptotic normality. GDP=gross domestic product; ESI=economic sentiment indicator; ADF=augmented Dickey-Fuller; PP=Phillips-Perron.

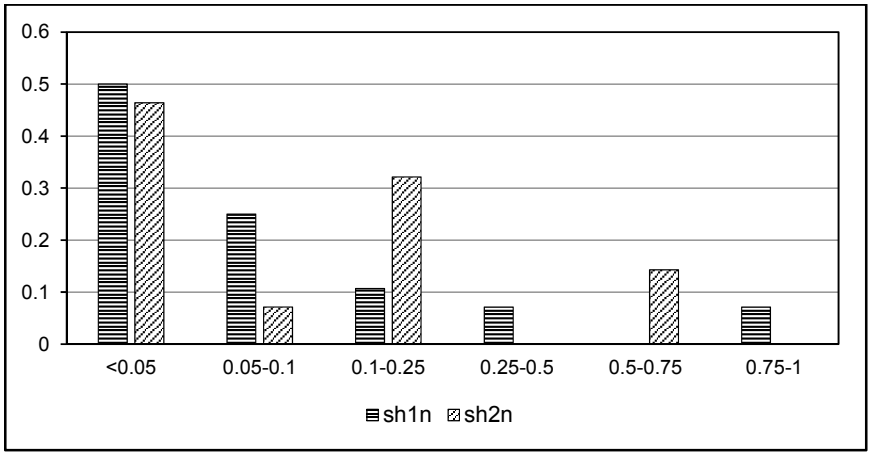
3.5. Granger causality test

The relationships of ESIq↔IGDPq is checked with the Granger causality test for the series with one and two lags. Each of these hypotheses is calculated with 28x28 tests.

Results are classified into six groups, depending on the following thresholds of the null hypothesis probability (iESIq does not Granger cause jIGDPq, in which *i* and *j* are symbols of analyzed EU countries): below 0.05, 0.05–0.1, 0.1–0.25, 0.25–0.5, 0.5–0.75, and 0.75–1. It was considered useful to present separately the national space (for *i=j*) and intra-EU space (*i,j*=AT, BE,…, UK). Figures 3a and 3b describe this distribution as shares (*sh*) of each group in the total number of tests (with suffixes 1 or 2 corresponding to the number of included lags, and *n* or *e* for the national and intra-EU space, respectively).

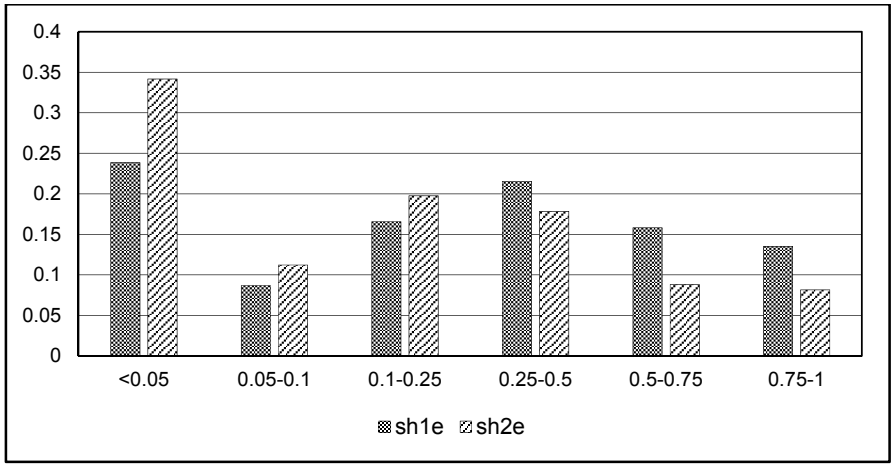
Figure 3a

Granger test for ESIq→IGDPq on national space (shares of group in total tests)



Figuere 3b

Granger test for ESIq→IGDPq on intra-EUI space
(shares of group in total tests)



The shares of groups with low null hypothesis probability (the first three) cumulate more than 85% of the national space and 50%-65% of the intra-EU space. The higher proportion recorded for the national level seems normal, the economic agents being better informed on the evolution of their own economy. Also notice that a possible extension of number of lags (three, for instance) - aside from induced and, thus, interpretative difficulties - would still not improve the mentioned distribution.

4. The modeling approach

The next step is to attempt to assemble the previously deduced quantitative landmarks into a coherent model. Our proposal gravitates around the assumption that the effective economic growth of each country is connected not only to its own ESIq, but also to the ESIq series of other EU members.

4.1. Model specification

The model specification work has attempted to represent the researched problem - the macroeconomic self-fulfillment degree of economic expectations - in a more pure form.

Therefore, the inclusion among explanatory variables of the lagged values of IGDPq was strictly avoided. The economic expectations are formed by considering the previous state of the economy, so that inclusion of any IGDPq lags would generate inevitably unpleasant multicollinearities. Symmetrically, no other leading indicators are added, so that the effect of expectations is not blurred.

The correlation analysis and Granger causality test revealed another useful pillar of the model specification: the international contagion effect of the expectation-forming mechanism is especially strong in an integrated space, such as the EU. To obtain a simpler numerical image of this conclusion, for country *i* the correlation coefficients $IGDPq_i$-$ESIq_j$ and the null hypothesis of the Granger causality test $ESIq_j \rightarrow IGDPq_i$ (*i*=fixed; *j*=1, 2, …, 28) were divided

into two groups: the discriminating criteria being 0.5 in the first case and 0.25 in the second one. It was conventionally admitted that correlation coefficients >0.5, and the null hypothesis probabilities of the Granger causality test <0.25, signified a notable connection of the economic growth in the respective member country, with the expectational process of the entire EU. For IGDPq of each country, *i*, the ESIq (as coefficient of correlation or as cause in Granger sense) of country partners' *j* (including itself) were distributed into four categories (Table 3):

- Observing the threshold for correlation, but not for the Granger test (C category),
- Observing only the threshold for the Granger test (G category),
- Observing concomitantly both the thresholds (B category), and
- Not observing any from the abovementioned thresholds (N category, meaning a weak IGDPq-ESIq relationship).

Therefore, 79% of the outcomes (correlation coefficients and Granger tests) suggest a notable relationship between economic growth of each member country and expectational processes of the whole EU. Consequently, when modeling the IGDPq, the inclusion as predictors of as many as possible ESIq series would be desirable. To extendedly capture the integrating contagion effect, this study uses not only the contemporaneous ESIq values but also the first lags (as in Biau and D'Elia, 2011), as well as the second lags.

Table 3

Outcomes of the correlation analysis and the Granger causality test (four categories)

	A	**G**	**B**	**N**		**A**	**G**	**B**	**N**
AT_IGDPq	7	9	8	4	IE_IGDPq	10	3	6	9
BE_IGDPq	7	5	10	6	IT_IGDPq	5	11	9	3
BG_IGDPq	0	22	0	6	LT_IGDPq	0	20	7	1
CY_IGDPq	0	15	2	11	LU_IGDPq	4	12	7	5
CZ_IGDPq	3	11	7	7	LV_IGDPq	3	12	5	8
DE_IGDPq	2	10	15	1	MT_IGDPq	8	3	9	8
DK_IGDPq	2	5	19	2	NL_IGDPq	5	7	13	3
EE_IGDPq	2	12	13	1	PL_IGDPq	1	19	1	7
EL_IGDPq	2	2	1	23	PT_IGDPq	9	7	2	10
ES_IGDPq	11	7	6	4	RO_IGDPq	1	12	0	15
FI_IGDPq	0	17	8	3	SE_IGDPq	1	7	19	1
FR_IGDPq	3	9	14	2	SI_IGDPq	5	9	7	7
HR_IGDPq	0	17	4	7	SK_IGDPq	0	18	10	0
HU_IGDPq	11	7	4	6	UK_IGDPq	7	4	12	5
					Total	102	283	210	161

Regarding the flexibility of the model parameters, we have opted for the fixed coefficients. Our objective is not to get the highest possible accurate economic growth prediction, but first to approximate the macroeconomic self-fulfillment degree of the expectation-forming mechanism. By using a time-varying parameters model, the forecast deviations become imputable, not only to expectations as such, but also to the estimation technique, especially when short statistical series are involved (as in our application).

4.2 Determining IGDPq

In determining IGDPq, there are exclusively ESIq series involved under the fixity of econometric coefficients. Under such restrictions, it would certainly be preferable to involve estimators as the largest possible number of EU countries. However, this choice may not always be possible because of the computational capacity limitations or some regression commitments (*e.g.*, statistical significance). Current specifications contain, for the entire system (28 relationships), 717 ESIq regressors (on average, 25.6 per equation), of which 498 are contemporaneous values, 158 are the first lag, and 42 are the second lag. This distribution considers the prominent impact of current expectations on the economic environment. Each equation also includes an intercept.

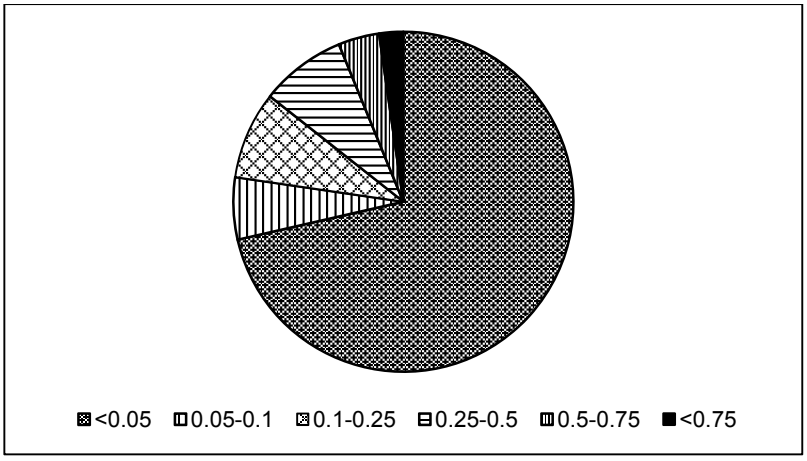
Therefore, the system (named ModEU_IGDPq and presented in Appendix 3) globally comprises 745 coefficients (estimators). It was preliminarily solved by the ordinary least squares. Thereafter, the weighted least squares and seemingly unrelated regression were applied. This study focuses on the seemingly unrelated regression results. Their plausibility was examined econometrically and from the prediction accuracy viewpoint.

4.3 Statistical significance of estimators

Figure 4 presents the null hypothesis probabilities of the t-Student for all coefficients grouped into the classes of <0.05, 0.05–0.1, 0.1–0.25, 0.25–0.5, 0.5–0.75, and 0.75–1.

Figure 4

Distribution (as shares) of the t-Student null hypothesis probabilities for ModEU_IGDPq



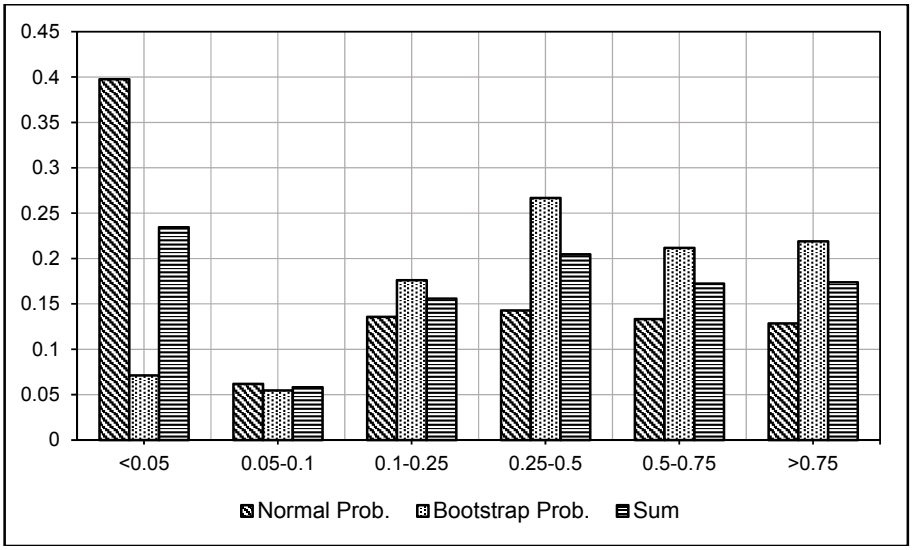
In general, the statistical significance of the estimators is relevant. The weight of the coefficients with a probability of the null hypothesis is lower than 0.05, representing 71.4%. The following two groups sum together 14.2%. To cover as wide as possible a palette of ESIq regressors, a small portion of the coefficients, with probabilities exceeding the usually practiced limits, were however retained. Further studies on modeling specifications could solve the distribution more accurately.

4.4. The BDS test

The results of ModEU_IGDPq were also subject to the BDS test (Brock *et al*., 1996), to check whether the residuals are independent and identically distributed. Many empirical investigations already confirm that this procedure is a powerful analytical tool for identifying the possible deviations of residuals, induced by linear or non-linear dependence (including those of chaotic nature). The probabilities of the null hypothesis, for three variants of the distance epsilon (fraction of pairs, standard deviation, and fraction of range), five embedding dimensions (2, 3, 4, 5, and 6), and both statistical sample and bootstrapped series were calculated. The obtained outcomes (840 probabilities) were classified into six categories, as shown in Figure 5.

Figure 5

BDS null hypothesis probabilities for residuals of ModEU_IGDPq (shares of groups in the number total of tests)



Therefore, over 55% of tests have the probabilities of BDS null hypothesis >0.25. However, one should notice that this weight is a mean of outcomes derived from the sample (40.476%) and from the bootstrapped series (69.76%), the second estimation being more reliable in the case of relatively short statistical series.

4.5. Residual cross-correlations

ModEU_IGDPq has also been examined from the residual cross-correlations perspective. In this case, since only the intensity of correlations is of interest, data were expressed as modules. The autocorrelations were certainly excluded. Approximately 63% of the residual cross-correlations are lower than the threshold of 0.25. Together with the following group (0.25–0.5), this share reaches 90%.

4.6. Predictive accuracy

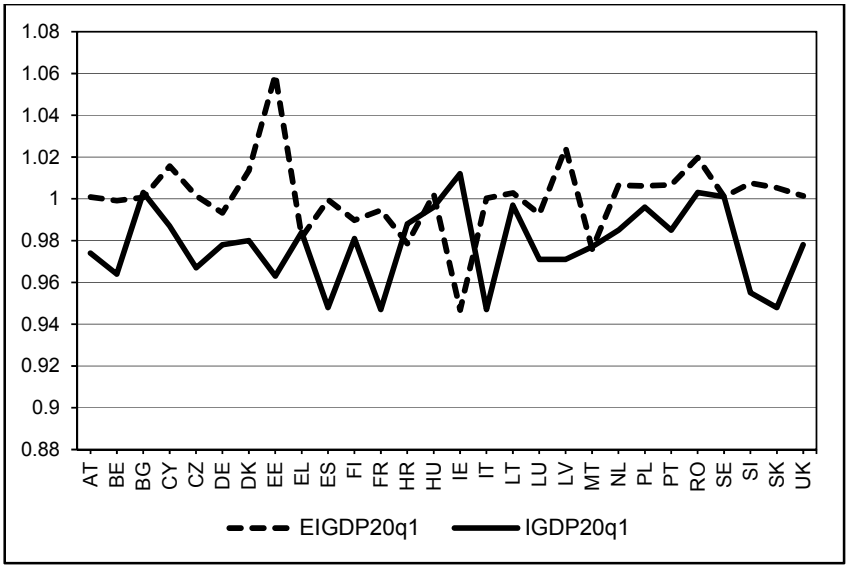
Perhaps the most important criterion of evaluating the relevance of an econometric model is its predictive accuracy. Both in-sample and out-of-sample frameworks will be commented on.

Regarding the first, the coefficient of determination is a simple and unanimously accepted measure. R-squared equations for only two countries (Germany and Ireland) are placed between 70% and 75%. This rises to 75–80% for another two countries (Malta and Croatia). In the case of five countries (Luxembourg, Poland, Portugal, Austria, and Lithuania), this indicator increases to 80–85%. For another 11 countries (Cyprus, Denmark, Italy, Netherland, Greece, Slovakia, Romania, United Kingdom, Sweden, Bulgaria, and Hungary), it was already 85–90%. However, even this level is surpassed by equations concerning eight EU members (Estonia, Finland, Slovenia, Belgium, Czechia, France, Latvia, and Spain). The weighted R^2 amounts to 85%, which means a high average degree of economic expectations' self-fulfillment at the EU scale.

The out-of-sample is also significant. Such an exercise is operated on the first quarter of 2020, an interval marked by not only the usual seasonal fluctuations, but also by hardly predictable factors, such as the serious international commercial conflicts, post-Brexit uncertainties, and especially the beginning of the COVID-19 pandemic. For this quarter, the expected indexes of the GDP simulated by ModEU_IGDPq (EIGDP20q1) and effectively recorded (IGDP20q1) are displayed in Figure 6.

Figure 6

Expected (EIGDP20q1) and effective (IGDP20q1) index of the gross domestic product during the first quarter 2020



Generally, the model estimations overcome the registered data. This comes from the understandable delay with which the expectational mechanism was adapting to surprisingly

ample shifts, produced in real economies, during this period. This is calculated by the root mean squared relative error (MRSE)

$$MRSE=((1/28)*\sum(1-IGDP/EIGDPq)^2)^{0.5}, \quad (12)$$

which represents 0.0365, although the socio-economic and geo-strategic context of the expectation-forming mechanism was very complex.

5 Conclusion and further research

The presented analysis confirms the strong interdependence of national expectation-forming mechanisms in an integrated space (as with the EU) and the high degree (under these circumstances) of the macroeconomic expectations' self-fulfillment. As an attempt to incorporate these assumptions into a coherent quantitative framework, the model ModEU_IGDPq proved econometrically consistent and pragmatically useful. However, there are many ways through which the investigation of the problems raised in this study could be deepened, beginning with indicators that measure both sides of expectations-real economic activity binomial.

Relative to the global results of economic activity, it would be worth it to extend the research for gradual improvement of GDP methodology, according to the following three suggestions from Stiglitz *et al*. (2009): i) more comprehensive estimation of output quality, especially for high-complexity products (*e.g*., cars, computers, medical and educational services, information and communication technologies, research activities, and financial services; p. 11), a problem also evoked in numerous other studies; ii) counting of the public services at their intrinsic value, not only at input cost (p. 12); and iii) inclusion in the accounted household economic activity of non-monetized goods and services (p. 14). More recently, Hulten and Nakamura (2018, 2020) insist on a better reflection in GDP of information and innovation. However, recent experience shows the necessity to reconsider the importance of goods and services, with vital roles over longer intervals, when the society is confronted with abnormally difficult challenges (*e.g*., natural disasters and medical crises).

Not few are also the ways for improving the expectations' measurement. There were already some problems signaled, concerning the weighting procedure applied in synthetizing the survey information (*e.g*., see Mourougane and Roma, 2002; Sorić *et al*., 2015; Tkacova *et al*., 2017). With reference to ESI, the use of common weights for all countries is a disputable solution: being organized separately, the surveys reflect the importance attributed to different sectors by the public perceptions of each country. In principle, applying the specific national weights cannot be *de plano* excluded, but currently it would be too risky to be adopted without clearly informed differentiation criteria.

Abberger *et al.* (2018) proposes an alternative to the present updating algorithm, considered insufficiently transparent and somehow arbitrary. Certain incoherencies now appear in the ESI reports because of questionnaires mixing the suppliers' and consumers' perceptions. The presence of these views is categorically beneficial (Gelper and Croux, 2009). However, the problem arises when answers coming from both these perspectives are aggregated. The fundamental feature of GDP accounting consists, just in its separate estimation, of the production and revenue methods. Or, in the case of ESI, its global value yields from the summing of suppliers' and consumers' perceptions. It would be useful to examine the possibilities of organizing the surveys' questions and answers in a computational scheme, similar to the Leontief input-output tables. This would ensure a balanced and non-contradictory inclusion in the ESI of expectations concerning the demand and supply sides

of economic activity. The existence of the actual questionnaire's ambiguity among the three steps of expectation-forming mechanisms (initial business intentions, affordable business projects, well-shaped business plans) discussed in our study also remains to be solved.

Possible improvements of the ESI methodology could result from its comparison with other socio-economic survey indicators. For example, the purchasing managers index was included (jointly with the ESI) in certain models (Gajewski, 2014; Pareja *et al*., 2018) with promising results.

Certain questions regarding the aggregative level of models need to be commented on. As in many other studies (*e.g*., Giannone *et al*., 2009), our current study was focused on the aggregated approach of ESI-GDP as a predictive tandem. Certainly, the dis-aggregated approach (consisting of separate estimations of the GDP components, with their subsequent summing) would also be worth investigating. Lehmann (2020), for example, examines this possibility with reference to exports. Important to such a research attempt would be the selection of the GDP components - on the supply or demand side - so as to avoid their incoherent combinations. Dimitriou and Pappas (2018) concentrate their attention on investments and private consumption. According to Kokkinen and Wouters (2016), "Other relevant indicators may be used…such as the industrial production index, deflated real trade and the turnover of services, for which two months' data are available and the third month can be nowcast" (p. 24).

Another modeling problem concerns the frequency of involved indicators. For simplicity, we adopted the same data frequency for both the GDP index and the economic sentiment index. This imposed a preliminary transformation of the monthly ESI data into quarterly ones. It would be interesting to compare the results obtained in this study with those obtainable using different frequency data (quarterly IGDPq and monthly ESIq), in the manner of mixed-data sampling and bridge models. The works of Ghysels *et a*l. (2004), Bruno *et al*. (2005), Clements and Galvão (2006, 2008), Angelini *et al*. (2008), Ferrara *et al*. (2010), Foroni and Marcellino (2013), Castle *et al*. (2013), Bell *et al*. (2014), Schumacher (2014), Reuter (2015), Siliverstovs (2015), Götz and Knetsch (2019), and Wang *et al*. (2019), contain many useful starting landmarks for such an attempt.

Some authors have a view to involve new composite indicators. Tkacova *et al.* (2017, p. 114), for instance, proposes a new composite leading indicator for monitoring and forecasting the German economy. This was conceived based on the analysis of 140 quantitative and qualitative indicators of industry, services, retail, construction, foreign trade, labor market, money aggregates, stock indices, confidence indicators, and consumer expectations. This approach would be interesting for predictive targets. However, it must be used cautiously in the study of macroeconomic self-fulfillment of expectations, which needs a valid possible delimitation of the compared processes - global results of the economy and the preceding expectational mechanism. Therefore, economic expectations remain a generous research issue.

Acknowledgments: The author is thankful to his colleagues G. Georgescu, D. Jula, M. Jula, B. Păuna, and M. Simionescu for their valuable informational and technical suggestions.

References

Abberger, K., Graff, M., Siliverstovs, B., and Sturm, J.E., 2018. Using Rule-Based Updating Procedures to Improve the Performance of Composite Indicators. *Economic Modelling*, 68, pp.127–144.

Akerlof, G.A., Dickens, W.T. and Perry, G.L., 2000. Near-Rational Wage and Price Setting and the Long-Run Phillips Curve. *Brookings Papers on Economic Activity*, 1.

Andersson, M. and Hofmann, B., 2009. Gauging the Effectiveness of Quantitative Forward Guidance: Evidence from Three Inflation Targeters. *ECB Working Paper Series* No. 1098.

Andrade, P. and Ferroni, F., 2016. Delphic and Odyssean Monetary Policy Shocks: Evidence from the Euro-Area. *Discussion Papers in Economics* 12(16), School of Economics University of Surrey. Available at: <https://www.surrey.ac.uk/sites/default/files/delphic-and-odyssean-monetary-policy-shocks-evidence-from-the-euro-area.pdf> [Accessed 18 May 2020].

Andrade, P., Gaballo, G., Mengus, E. and Mojon, B., 2019. Forward Guidance and Heterogeneous Beliefs. *American Economic Journal: Macroeconomics*, 11(3), 1–29.

Angelini, E., Bańbura, M. and Rünstler, G., 2008. Estimating and Forecasting the Euro Area Monthly National Accounts from A Dynamic Factor Model. *European Central Bank, Working Paper Series* No 953.

Assenza, T., Heemeijer, P., Hommes, C. and Massaro, D., 2013. Individual Expectations and Aggregate Macro Behavior. *Tinbergen Institute Discussion Papers* 13-016/II.

Aurissergues, E., 2017. Are Consistent Expectations Better than Rational Expectations?. *Working papers* hal 01558223v2.

Ayala, I.H. and Palacio-Vera, A., 2014.The Rational Expectations Hypothesis: An Assessment from Popper's Philosophy. *Levy Economics Institute of Bard College, Working Paper* No. 786.

Beeby, M.S., Hall, G. and Henry, S.B., 2001. Rational Expectations and Near Rational Alternatives: How Best to Form Expectations. *European Central Bank - Working Paper Series*, Working Paper no. 86.

Bell, V., Co, L.W., Stone, S. and Wallis, G., 2014. Nowcasting UK GDP Growth. *Bank of England - Quarterly Bulletin* 2014/Q1.

Bernanke, B.S., 2020. The New Tools of Monetary Policy. American Economic Association Presidential Address, Brookings Institution. Available at: <https://www.brookings.edu/wp-content/uploads/2019/12/Bernanke_ASSA_lecture.pdf> [Accessed 5 May 2020].

Biau, O. and D'Elia, A., 2011. Is There a Decoupling Between Soft and Hard Data? The Relationship between GDP Growth and the ESI. *Fifth Joint EU/OECD Workshop on Business and Consumer Surveys*. Brussels, 17–18 November 2011. Available at: <https://www.oecd.org/sdd/leading-indicators/49016412.pdf> [Accessed 10 June 2020].

Bilo, S., 2019. Unbiased Expectations and Hayek's Business Cycle Theory. https://dx.doi.org/10.2139/ssrn.2412162

Branch, W., 2004. The Theory of Rationality Heterogenous Expectations: Evidence from Survey Data on Inflation Expectations. *The Economic Journal*, 114, 592–621.

Brayton, F., *et al.*, 1997. The Role of Expectations in the FRB/US Macroeconomic Model. *Federal Reserve Bulletin*, April 1997, pp.227–245.

Brock, W.A., Scheinkman,J.A., Dechert, W.D. and LeBaron, B., 1996. A Test for Independence Based on the Correlation Dimension. *Econometric Reviews*, 15(3), 197-235.

Brock, W.A. and Hommes, C.H., 1997. A Rational Route to Randomness. *Econometrica*, 65(5), 1059–1095.

Bruno, G., Di Fonzo, T., Golinelli, R. and Parigi, G., 2005. Short-Run GDP Forecasting in G7 Countries: Temporal Disaggregation Techniques and Bridge Models. Office for Official Publications of the European Communities, Luxembourg. Available at: <https://ec.europa.eu/eurostat/documents/3888793/5838049/KS-DT-05-027-EN.PDF/8caecb25-bbcd-4cf4-abdc-fcdcfeac33ba>[Accessed 27 June 2020].

Bundick, B., Herriford, T. and Smith, A.L. 2019. Forward Guidance, Monetary Policy Uncertainty, and the Term Premium. Federal Reserve Bank of Kansas City, *Research Working Paper* 17-07.

Campbell, J., Evans, C.L., Fisher, J. and Justiniano, A., 2012. Macroeconomic Effects of Federal Reserve Forward Guidance. *Brookings Papers on Economic Activity*. Available at: <https://www.brookings.edu/wp-content/uploads/2012/03/2012a_Evans.pdf> [Accessed 15 May 2020].

Castle, J.L., Hendry, D.F. and Kitov, O.I., 2013. Forecasting and Nowcasting Macroeconomic Variables: A Methodological Overview. *University of Oxford, Working Paper* Number 674.

Choi, J.J. and Mertens, T.M., 2019. *Extrapolative Expectations and the Equity Premium*, SSRN. https://dx.doi.org/10.2139/ssrn.3462056.

Chow, G.C., 2011. Usefulness of Adaptive and Rational Expectations in Economics. CEPS *Working Paper* No. 221. Available at: <https://www.princeton.edu/~ceps/workingpapers/221chow.pdf> [Accessed 28 Nov. 2019].

Clements, M.P. and Galvão, A.B., 2006. *Macroeconomic Forecasting with Mixed Frequency Data: Forecasting Us Output Growth and Inflation*, SSRN. https://dx.doi.org/10.2139/ssrn.878445.

Clements, M.P. and Galvão, A.B., 2008. Macroeconomic Forecasting with Mixed-Frequency Data: Forecasting Output Growth in the United States. *Journal of Business and Economic Statistics*, 26(4), pp.546–554.

Coenen, G., *et al.*, 2017. Communication of Monetary Policy in Unconventional Times. *ECB Working Paper* 2080.

Coibion, O., Georgarakos, D., Gorodnichenko, Y. and Weber, W., 2020. Forward Guidance and Household Expectations. *NBER Working Paper Series*, Working Paper 26778.

Colasante, A., Palestrini, A., Russo, A. and Gallegati, M., 2017. Adaptive Expectations versus Rational Expectations: Evidence from the Lab. *International Journal of Forecasting*, 33(4), pp.988–1006.

Cornand, C. and Hubert, P., 2019. On the External Validity of Experimental Inflation Forecasts: A Comparison with Five Categories of Field Expectations. *WP* 1821, halshs-01890770v2.

Cozzi, G. and Davenport, M., 017.Extrapolative Expectations and Capital Flows during Convergence. *MPRA Paper* No. 79517.

Dées, S. and Soares Brinca, P., 2011. Consumer Confidence as Predictor of Consumption Spending – Evidence for the US and the Euro Area. *ECB Working paper* No.1349.

Del Negro, M., Giannoni, M. and Patterson, C., 2015. The Forward Guidance Puzzle. *Federal Reserve Bank of New York, Staff Report* No. 574.

Deuskar, P., 2007. Extrapolative Expectations: Implications for Volatility and Liquidity. *AFA 2007 Chicago Meetings Paper*. http://dx.doi.org/10.2139/ssrn.891539.

Deversi, M., 2014. Do Macroeconomic Shocks Affect Intuitive Inflation Forecasting? An Experimental Investigation. *Ruhr Economic Papers*, No. 528.

Dimitriou, D. and Pappas, A., 2018. Do Confidence Indicators Lead Economic Activity? *The Case of Greece. Hellenic Fiscal Council, Working Paper*. Available at: <https://www.hfisc.gr/sites/default/files/working_paper.pdf> [Accessed 24 June 2020].

Dobrescu, E., 2019. A Note on Estimating the Importance of Interactions among Economic Entities. *Amfiteatru Economic,* 21(52), pp.671–681.

Dobrescu, E., 2019. The New Version (2018) of the Romanian Macromodel - The Sectoral Module. *Romanian Journal of Economic Forecasting,* 22(2), pp.5-31.

Dosi, G., *et al.*, 2020. Rational Heuristics? Expectations and Behaviors in Evolving Economies with Heterogenous Interacting Agents. *NBER Working Paper Series*, Working Paper 26922.

Eftimoski, D., 2019. Improving Short-Term Forecasting of Macedonian GDP: Comparing the Factor Model with the Macroeconomic Structural Equation Model. *Romanian Journal of Economic Forecasting,* 22(2), pp.32-53.

Eggertsson, G. and Woodford, M., 2003. The Zero Bound on Interest Rates and Optimal Monetary Policy. *Brookings Papers on Economic Activity*, No. 1.

Enthoven, A.C. and Arrow, K.J., 1956. A Theorem on Expectations and the Stability of Equilibrium. *Econometrica*, 24(3), pp.288–293.

European Central Bank, 2013. *Confidence Indicators and Economic Developments.* European Central Bank Monthly Bulletin, January, pp.45–58.

European Commission, 2016. *The Joint Harmonised EU Programme of Business and Consumer Surveys-User Guide*. Directorate-General for Economic and Financial Affairs, Brussels. Available at: <https://ec.europa.eu/economy_finance/db_indicators/surveys/documents/bcs_user_guide_en.pdf> [Accessed 9 June 2020].

European Commission, 2020. *Business and consumer surveys. Regular harmonized surveys conducted by the Directorate General for Economic and Financial Affairs for different sectors of the economies in the European Union (EU) and in the applicant countries*. Available at: <https://ec.europa.eu/info/business-economy-euro/indicators-statistics/economic-databases/business-and-consumer-surveys_en> [Accessed 9 June 2020].

Eurostat, 2019. *Economic Sentiment Indicator (ESI).* Available at: <https://ec.europa.eu/info/business-economy-euro/indicators-statistics/economic-databases/business-and-consumer-surveys/download-business-and-consumer-survey-data/time-series_en#economic-sentiment-indicator-esi> [Accessed 15 Dec. 2019].

Evans, G.W. and Honkapohja, S., 2001. Expectations and the Stability Problem for Optimal Monetary Policies. In: N.J. Smelser and P.B. Baltes, eds. 2001.

International Encyclopedia of the Social & Behavioral Sciences. Elsevier Science Ltd., United States. pp.5060–5067.

Fermat's Last Theorem, 2017. [online] Available at: <https://math.mit.edu/classes/18.783/2017/LectureNotes26.pdf> [Accessed 27 Aug. 2020].

Ferrara, L., Guegan, D. and Rakotomarolahy, P., 2010. GDP Nowcasting with Ragged-Edge Data: A Semi-Parametric Modeling. *Journal of Forecasting*, 29(1–2), pp.186–199.

Foroni, C. Marcellino, and M., 2013. A Survey of Econometric Methods for Mixed Frequency Data. *Norges Bank Research, Working Paper* 2013/06.

Fuster, A., Laibson, D. and Mendel, B., 2010. Natural Expectations and Macroeconomic Fluctuations. *Journal of Economic Perspectives*, 24(4), 67–84.

Gajewski, P., 2014. Nowcasting Quarterly GDP Dynamics in the Euro Area – The Role of Sentiment Indicators. *Comparative Economic Research*, 17(2), pp.1-19. https://doi.org/10.2478/cer-2014-0011.

Gelper, S. and Croux, C., 2020. On the Construction of the European Economic Sentiment Indicator. *Oxford Bulletin of Economics,* 72(1), pp.47-62. https://doi.org/10.1111/j.1468-0084.2009.00574.x.

Ghysels, E., Santa-Clara, P. and Valkanov, R., 2004. The MIDAS Touch: Mixed Data Sampling Regression Models. *CIRANO – Centre Interuniversitaire de Recherche en Analise des Organisations, Scientific Series* 2004s-20. Available at: <https://cirano.qc.ca/files/publications/2004s-20.pdf> [Accessed 18 July 2020].

Giannone, D., Reichlin, L. and Simonelli, S., 2009. Nowcasting Euro Area Economic Activity in Real-Time: The Role of Confidence Indicator. Centre for Studies in Economics and Finance, *Working paper* 240.

Götz, T. and Knetsch, T.A., 2019. Google Data in Bridge Equation Models for German GDP. *International Journal of Forecasting*, 35(1), pp.45–66.

Grisse, C., 2009. *Are Expectations About Economic Activity Self-Fulfilling? An Empirical Test.* New York: Federal Reserve Bank of New York. Available at: <http://www.socialpolitik.ovgu.de/sozialpolitik_media/papers/grisse_christian_uid94_pid60.pdf> [Accessed 6 Oct. 2019].

Guagliano, C. and Mantovani, C., 2014. Real-Time Evaluation of GDP in Some Eurozone Countries. Consob, *Working Paper* 77.

Guidolin, M. and Thornton, D.L., 2008. Predictions of Short-Term Rates and the Expectations Hypothesis of the Term Structure of Interest Rates. *European Central Bank, Working Paper Series* No. 977.

Gurkaynak, R.S., Sack, B. and Swanson, E.T., 2005. Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements. *International Journal of Central Banking*, 1(1), pp.55–93.

Guthrie, G. and Wright, J., 2000. Open Mouth Operations. *Journal of Monetary Economics*, 46(2), pp.489–516.

Hassany, T.A. and Mertens, T.M., 2016. The Social Cost of Near-Rational Investment. *Federal Reserve Bank of San Francisco Working Paper* 2016-16.

Hirshleifer, D., Li, J. and Yu, J., 2015. Asset Pricing in Production Economies with Extrapolative Expectations. *Journal of Monetary Economics*, 76, pp.87-106.

Holtemöller, O. Schult, and C., 2018. Expectation Formation, Financial Frictions, and Forecasting Performance of Dynamic Stochastic General Equilibrium Models. *Halle Institute for Economic Research (IWH), IWH Discussion Papers* No. 15/2018.

Hommes, C., 2018. Behavioral & Experimental Macroeconomics and Policy Analysis: A Complex Systems Approach. *European Central Bank, Working Paper Series* No 2201.

Hubert, P. and Labondance, F., 2018. The Effect of ECB Forward Guidance on the Term Structure of Interest Rates. *International Journal of Central Banking*, 14(5), pp.193–222.

Hulten, C. and Nakamura, L., 2018. Accounting for Growth in the Age of the Internet: The Importance of Output-Saving Technical Change. *NBER Working Paper* 23315.

Hulten, C. and Nakamura, L., 2020. Expanded GDP for Welfare Measurement in the 21st Century. *FRB of Philadelphia, Working Paper* No. 20-10.

Ivashchenko, S., 2014. Near-Rational Expectations: How Far Are Surveys from Rationality?. *European University at St. Petersburg, Department of Economics, Working Paper Series* Ec-06/14.

Jain, M. and Sutherland, C.S., 2018. How Do Central Bank Projections and Forward Guidance Influence Private-Sector Forecasts?. *Bank of Canada Staff Working Paper* 2018-2.

Kaihatsu, S., 2009. *Self-Fulfilling Inflation Inertia under Model Uncertainty*. Available through: SSRN website. https://dx.doi.org/10.2139/ssrn.1400502.

Kaldor, N., 1934. Classificatory Note on the Determinateness of Equilibrium. *The Review of Economic Studies,* 1(2), pp.122-136. https://doi.org/10.2307/2967618.

Keeney, M., Kennedy, B. and Liebermann, J., 2012. The Value of Hard and Soft Data for Short-Term Forecasting of GDP. *Economic Letters Series*, 11/EL/12, Central Bank of Ireland.

Kokkinen, A. and Wouters, H., 2012.Euro Area and European Union GDP Flash Estimates at 30 days. *The 34th General Conference of the International Association for Research in Income and Wealth (IARIW)*. Dresden, August 21–27, 2016. Available at: <http://www.iariw.org/dresden/kokkinen.pdf> [Accessed 9 June 2020].

Kool, C.J.M. and Thornton, D.L., 2015. How Effective Is Central Bank Forward Guidance?. Federal Reserve Bank of St. Louis Review, Fourth Quarter, 97(4), pp.303–22.

Kukuvec, A. and Oberhofer, H., 2015. The Propagation of Business Expectations within the European Union. *CESifo Working Paper* No. 8198.

Lanne, M., Arto, L. and Jani, L., 2019. *A Naïve Sticky Information Model of Households' Inflation Expectations. MPRA Paper* No. 8663.

Lansing, K.J., 2008. Lock-In of Extrapolative Expectations in an Asset Pricing Model. *Federal Reserve Bank of San Francisco, Working Paper* 2004-06, 2005.

Leboeuf, M. and Morel, L., 2014. Forecasting Short-Term Real GDP Growth in the Euro Area and Japan Using Unrestricted MIDAS Regressions. *Bank of Canada Discussion Paper* 2014-3.

Lehmann, R., 2015. Survey-based indicators vs. hard data: What improves export forecasts in Europe?. Ifo Institute – Leibniz Institute for Economic Research at the University of Munich, *Working Paper* No. 196.

Lehmann R., 2020. Forecasting Exports Across Europe: What are the Superior Survey Indicators?. *Empirical Economics*, (2020). https://doi.org/10.1007/s00181-020-01838-y.

Lines, M. and Westerhof, F., 2010. Inflation Expectations and Macroeconomic Dynamics: The Case of Rational versus Extrapolative Expectations. *Journal of Economic Dynamics & Control*, 34, pp.246–257.

Lucas, R.E. Jr., 1972. Expectations and the Neutrality of Money. *Journal of Economic Theory*, 4(2), pp.103-124.

Magill, M. and Quinzii, M., 2014. Term Structure and Forward Guidance as Instruments of Monetary Policy. *Economic Theory*, 56, pp.1–32.

Mariano, R.S. and Murasawa, Y., 2003. A New Coincident Index of Business Cycles based on Monthly and Quarterly Series. *Journal of Applied Economics*, 18(4), pp.427–443.

Martináková, R. and Kapounek, S., 2013. Economic Sentiment Indicator and Its Information Capability in the Czech Republic. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 61(7), pp.2491-2498.

Martínez-García, E., 2018. Finite-Order VAR Representation of Linear Rational Expectations Models: With Some Lessons for Monetary Policy. Federal Reserve Bank of Dallas - Globalization Institute, *Working Paper* 285.

McKay, A., Nakamura, E. and Steinsson, J., 2016. The Power of Forward Guidance Revisited. *American Economic Review*, 106(10), pp.3133–3158.

Mendes, R. and Murchison, S., 2014. Should Forward Guidance Be Backward-Looking?. *Bank of Canada Review*, Autumn 2014, pp.12–22.

Metzler, L.A., 1941. he Nature and Stability of Inventory Cycles. *The Review of Economics and Statistics*, 23(3), pp.113–129.

Mlambo, L., 2012. Adaptive and Rational Expectations Hypotheses: Reviewing the Critiques. *Journal of Economic Behaviour*, 2, pp.3–15.

Moessner, R., 2013. Effects of Explicit FOMC Policy Rate Guidance on Interest Rate Expectations. *Economics Letters*, 121(2), 170–173.

Moon, H. and Lee, J., 2012. Forecast Evaluation of Economic Sentiment Indicator for the Korean Economy. *The 6th Irving Fisher Committee Conference, BIS*. Basel, Switzerland, August 2012. Available at: <https://www.bis.org/ifc/events/6ifcconf/moonlee.pdf> [Accessed 9 June 2020].

Mourougane, A. and Roma, M., 2002. Can Confidence Indicators Be Useful to Predict Short Term Real GDP Growth?. *European Central Bank, Working Paper Series*, Working Paper No. 133.

Muth, J.F., 2002. Rational Expectations and the Theory of Price Movements. *Econometrica*, 29(3), pp.315–335.

Negishi, T., 1964. Stability and Rationality of Extrapolative Expectations. *Econometrica*, 32(4), pp.649–651.

Pareja, A.A, *et al.,* 2018. A Short-Term Forecasting Model for the Spanish Economy: GDP and Its Demand Components. Banco de España, *Documentos Ocasionales*, N.º 1801.

Pfajfar, D., 2012. Formation of Rationally Heterogeneous Expectations. *CentER Discussion Paper*, Vol. 2012-083. https://dx.doi.org/10.2139/ssrn.2165199.

Pošta, V., and Pikhart, Z., 2012. The Use of the Sentiment Economic Indicator for GDP Short-Term Forecasting: Evidence from EU Economies. *Statistika*, 49(1), pp.41–55.

Raskin, M., 2013. The Effects of the Federal Reserve's Date-Based Forward Guidance. Divisions of Research & Statistics and Monetary Affairs Federal Reserve Board, Washington, D.C., *Finance and Economics Discussion Series* 2013-37. Available at: <https://www.federalreserve.gov/pubs/feds/2013/201337/201337pap.pdf> [Accessed 17 May 2020].

Reuter, A., 2015. Bridge Models for Now- and Short-term Forecasting Euro-area GDP Growth and Evaluation of Forecasts. *International Workshop on Short-Term Statistics*. Beijing, 18-20 May 2015,. Available at: <https://unstats.un.org/unsd/nationalaccount/workshops/2015/Beijing/S62-EC.pdf> [Accessed 27 June 2020].

Sargent, T.J., 2000. Rational Expectations. *The Concise Encyclopedia of Economics*, 1st edition, The Library of Economics and Liberty. Available at: <https://www.econlib.org/library/Enc/RationalExpectations.html> [Accessed 6 Nov. 2019].

Sargent, T.J. and Wallace, N., 1976. Rational Expectations and the Theory of Economic Policy. *Journal of Monetary Economics*, 2(2), pp.169–183.

Schumacher, C. 2014. MIDAS and Bridge Equations. *Discussion Paper - Deutsche Bundesbank No 26*. Available at: <https://www.econstor.eu/bitstream/10419/104623/1/805459545.pdf> [Accessed 25 June 2020].

Siliverstovs, B., 2015. Short-Term Forecasting with Mixed-Frequency Data: A MIDASSO Approach. *KOF Swiss Economic Institute, Working Paper* No. 375.

Sims, C.A., 2003. Implications of Rational Inattention. *Journal of Monetary Economics*, 50(3), pp.665–690.

Sims, C.A., 2010. Rational Inattention and Monetary Economics. In: B.M. Friedman and M. Woodford, eds. *Handbook of Monetary Economics*, 3, pp.155–181. Amsterdam: North Holland.

Smith, A.L. and Becker, T., 2015. Has Forward Guidance Been Effective?. *Economic Review - Federal Reserve Bank of Kansas City,* 100(Third Quarter), pp.57–78.

Sorić, P., Lolić, I. and Čižmešija, M., 2015. European Economic Sentiment Indicator: An Empirical Reappraisal. *EFZG Working Paper Series* No. 15-05.

Stiglitz, J.E., Sen, A. and Fitoussi, J.P., 2009. *Report by the Commission on the Measurement of Economic Performance and Social Progress*, CMEPSP, Paris.

Sutherland, C.S., 2020. *Forward Guidance and Expectation Formation: Cross-Country Evidence from Survey Data*. Bank of Canada, Monetary Policy Analysis and Research Division, Ottawa, 2020.

Svendsen, I., 1993. *Empirical Tests of the Formation of Expectations - A Survey of Methods and Results.* Statistics Norway, Oslo. Available at: <https://www.ssb.no/a/histstat/sos/sos_083.pdf> [Accessed 6 Nov. 2019].

Swanson, E.T., 2017. Measuring the Effects of Federal Reserve Forward Guidance and Asset Purchases on Financial Markets. *National Bureau of Economic Research, Working Paper* No. 23311.

Tkacova, A., Gavurova, B. and Behun, M., 2017. The Composite Lading Indicator for German Business Cycle. *Journal of Competitiveness*, 9(4), pp.114–133.

Van Aarle, B. and Kappler, M., 2012. Economic Sentiment Shocks and Fluctuations in Economic Activity in the Euro Area and the USA. *Intereconomics*, 47(1), pp.44–51.

Vega-Redondo, F., 1989. Extrapolative Expectations and Market Stability. *International Economic Review*, 30(3), pp.513–517.

Wang, X., Dong, J., Xiao, Z. and He, G., 2019. A novel spatial mixed frequency forecasting model with application to Chinese regional GDP. *Romanian Journal of Economic Forecasting*, 22(2), pp. 54-77.

Weder M., 2004. Near-Rational Expectations in Animal Spirits Models of Aggregate Fluctuations. *Economic Modelling*, 21(2), pp.249–265.

Whelan, K., 2016. MA Advanced Macroeconomics: Solving Models with Rational Expectations. [online] Available at: <https://www.karlwhelan.com/MAMacro/part6.pdf> [Accessed 25 Nov. 2019].

Woodford, M., 2005. Robustly Optimal Monetary Policy with Near Rational Expectations. *NBER Working Paper* No. 11896.

Woodford, M., 2009. Robustly Optimal Monetary Policy with Near-Rational Expectations. [online] Available at: <http://www.columbia.edu/~mw2230/robust_AER_final.pdf> [Accessed 9 Feb. 2020]