
Comparison on Subannual Seasonality of Building Construction in European Countries

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Abstract:

Purpose: The objective of this study involves the determination of cyclical characteristics that occur on the European construction market.

Design/Methodology/Approach: In the research implementation process, time-frequency analysis was used to identify and analyze cyclicalities in the construction market.

Findings: The results clearly demonstrate the absence of a homogeneous construction market in the investigated countries. The diversity of the European construction market is revealed by the various responses to the periods corresponding to the ups and downs of the economy.

Practical Implications: The present research provides grounds for the clear indication of specific countries and cyclical characteristics on the construction market in them to define guidelines suitable for the identification of adequate scenarios for the development of construction markets in them.

Originality/value: The conclusion derived from the study is associated with the classification of construction markets and identification of various responses of individual markets to the occurrence of macroeconomic or microeconomic stimuli.

Keywords: Housing market, subannual seasonality, time-frequency analysis.

JEL classification: R11, R30, F63.

Paper Type: Research study.

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1. Introduction

The economy, whether regional, national or international, is subject to variability resulting from many macro- and microeconomic factors (Caruso, 2019; Chen and Hung, 2010; Makin, 2019). Modeling of time-frequency variability by examining the direction and magnitude of the impact of these factors is feasible as a result of the application of a variety of techniques of econometric analysis (Borjigin *et al.*, 2018; Chen and Ranciere, 2019; Ghoddusi *et al.*, 2019; Liu *et al.*, 2019). However, regardless of the determinants used to analyze the condition of the economy, precise information about the characteristics of its cyclical variation is very important (Miyazaki, 2009; Sheldon, 2017; Tan and Mathews, 2010). The development of an adequate analytical model, expressed e.g., by the degree of matching between the model and the empirical data, without taking into account the phase of the cycle of the examined phenomenon, may lead to an impractical dimension of the model. At the stage of testing the predictive model, without knowing the phase of the cycle in what the studied phenomenon can significantly decrease its stability. The conclusion from the above is the fact that a high risk of making incorrect market decisions is faced when developing a decision model that does not take into account the characteristics of cyclical fluctuations. This may result in the loss of the company's competitive position on the market, and in extreme cases may determine the success of business. Referring to the economy as a whole, the resulting decision risk may contribute to the loss of either macroeconomic or financial stability of the entire economy.

In this study, the cyclical fluctuations were identified and parameterized in terms of their sub-annual characteristics, which was followed by their interpretation and a comparative analysis of the identified fluctuations. The study was conducted with regard to the construction sector, which forms a significant branch of the economy. One of its main components, i.e. building construction, was included in this production. The study was carried out in 16 European countries. Monthly data from the years 2000-2019 was compiled for the purposes of this study. The number of countries involved in the analysis is imposed by the possibility of accessing suitable data in Eurostat databases.

2. Construction Market – Analysis of Effects on the Economy

An important issue, in particular from the point of view of investment and management activities, is associated with business cycles and their effect on the construction market. When we examine how business cycles affect construction markets, an interesting issue is related to the mutual dependence of the phenomena occurring in both markets. The research conducted in various areas and concerned the American, British and Canadian markets, implies that the American and Canadian markets respond similarly, in contrast to the British market, which in its relations is different from North American housing markets (Chang, 2019). In the subsequent study (Gabrovski and Ortego-Marti, 2019) concerned with the

construction market and cycles occurring on it, the cyclical characteristics of the Beveridge curve were explored. The study demonstrated that the housing market is characterized by well-established cyclical components and the relationship between price volatility has the same direction as the volatility of sales volume, but the opposite direction to the time it takes to sell the property. Another important issue in identifying and predicting the phases of the business cycle on the real estate market is correctly determining the determinants affecting this market. A comprehensive report concerned with the determinants affecting the volatility of the real estate market is offered by Tupenaite at all (Tupenaite *et al.*, 2017).

Another very interesting aspect of research, indirectly dealing with cyclicity, is associated with the problem of the effectiveness of stimulating it through government interventions (Zhou, 2018) and the presentation of how uncertainty of economic policy affects the housing market (Huang *et al.*, 2018). Discussion concerned with the identification of periodic components, including cyclical component in the time series characterizing the construction market, in particular the housing market are explored in other studies (Bengtsson *et al.*, 2018; Devaney and Xiao, 2017; Fan *et al.*, 2019; Gabauer and Gupta, 2020; Liow and Newell, 2016; Yépez, 2018). As we mentioned above, the ability to determine the phase of the cycle of construction market is of particular assistance in determining the development potential of this market. The identification of the phase of the cycle offers the grounds to define the strategy of operation for enterprises operating on the construction market and will allow, in macroeconomic terms, to conduct stable macro-prudential policy. The study (Geipele and Kauškale, 2013) focuses on the process of identifying the main areas related to the effect played by the housing market cycle on the economic development of the whole country (Latvia), with particular emphasis on the economic aspects.

On the basis of the research, the authors provided recommendations designed for reducing risk in market activities. The issues related to cyclicity are indirectly addressed in the study by (Balló, 2016), in which the ups and downs of the Hungarian market are explored in an extensive review of the development of the housing market in this country. Market fluctuations are related among others, with macroeconomic indicators and the effect of the economic crisis on their values. Other studies (Minetti and Peng, 2013) explore important issues concerned with restrictions on lending as well as real estate prices and business cycles in emerging markets (on the basis of the example of Argentina). The main evidence derived from the study is that external financial liberalization has a greater effect on prosperity than domestic liberalization, but also alleviates the destabilizing effect of national deregulation.

Given the access to the information regarding parameters of the housing market and information concerning the phase of the market cycle, we can safely invest in this market. Interesting research in the area of investing can be found at work (Badarinza and Ramadorai, 2018). In this paper an attempt is made to assess the extent to which

foreign capital is responsible for variations in housing property prices in global cities such as London and New York, in particular in the condition marked by the economic crisis. The study used large datasets of housing transactions for analysis, and found that international risk strongly affects dwelling prices. The effects are long-term and are associated with both the effects of safe investment in real estate and immigration, which in global cities has a significant effect on the price of housing resources (Badarinza and Ramadorai, 2018).

Other studies concerned with the broadly understood investing in the housing market investigate the viability of investing in various investment options, and explores whether returns on investment in the shares of housing companies follow trends in the stock market. Another study examined the relationship between real estate stocks and private real estate investments (Devaney and Xiao, 2017). The next important research issue was associated with the exploration of the possibilities of diversifying investment portfolios through real estate investment funds (REIT) (La and Mei, 2015; Piao *et al.*, 2016).

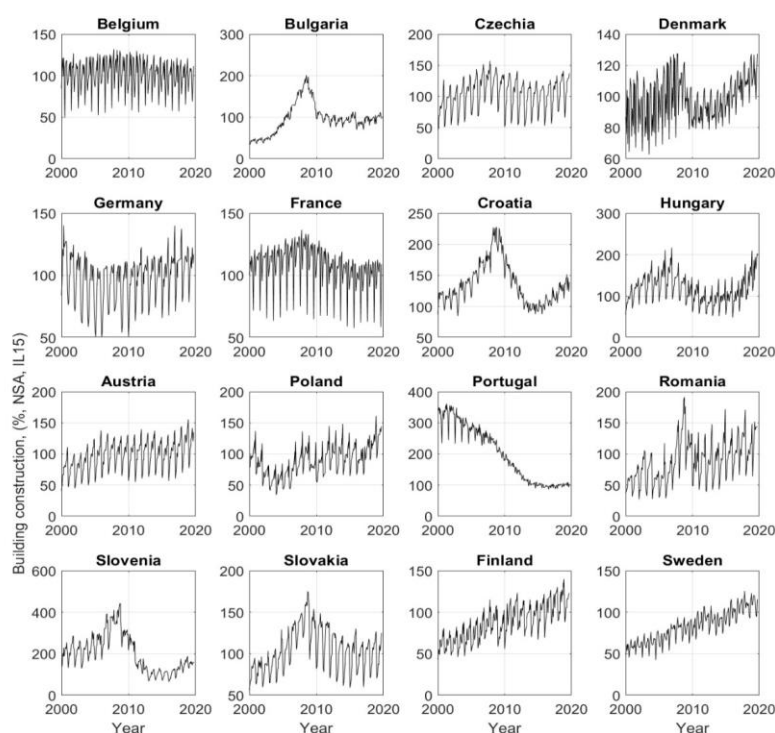
In macroeconomic terms, inflation forms an important determinant that affects investment decisions. The report in the paper by (Taderera and Akinsomi, 2020) attempts to provide an answer to the question regarding investing in commercial real estate as a good security against inflation. Using the vector error correction model (VEC) for coordinated time series, the long-term relationship between property returns and inflation was examined, and whether inflation drives the rate of return on real estate investment. However, we need to bear in mind that investment activities on the market have to be based on the knowledge of the phase of the cycle of this market. This is due to the fact that the phase of the cycle implies its further development, i.e. growth, stagnation or decline.

Hence, misguided decisions with regard to investments from the point of view of ignorance of the business cycle phase can cause speculative bubbles. The study (Gazzani, 2019) contains detailed analysis of information on speculative bubbles occurring on the construction market that was conducted in terms of its effect on the stability of the economy. Research into the impact of unpredictable economic shocks on the housing market has also been addressed in a study by (Christou *et al.*, 2019). These studies demonstrated that every shock on the market negatively affects all parameters of the housing real estate market. In other studies in the area of emerging unpredictable conditions emerging on the housing market, we can name the studies (Silva *et al.*, 2019) in which the relations between shocks occurring in this market and the dynamics of the development of the mixed market are explored and discussed. Detailed research concerned with determining the impact of economic shocks on the value of aggregate production and the implementation of monetary policy. These studies also showed that the behavior of housing prices is dependent on market shocks, which in turn are orthogonal to business cycles.

3. Study Organization and Discussion

The study process was carried out in several basic research steps. The first step involves the presentation of the time-frequency variability of the analyzed variables (Figure 1), followed by the second step concerned with the analysis of cyclical fluctuations, and a third step that includes a synthetic presentation and summary analysis of the test results. These steps have been implemented to follow the variations in the variable: building construction data. The data was derived from Eurostat database. In the paper the index is neither seasonally adjusted nor calendar adjusted data (NSA). The unit of measures is a percentage changes, the base year is 2015.

Figure 1. Time series of variable building constructions for 2000-2019



Source: Own study

3.1 Analysis of Time-Frequency Analysis

When we perform an analysis of the variability in the area of dwelling construction, we can note that in the case of Sweden there is a continuous increase in the potential in the area of building construction. In the period of expected declines in the potential of this market, i.e. in the early years of the crisis, i.e. in 2007-2008, in the

case of Sweden we can only observe a slowdown in the growth. It can therefore be concluded that the building construction market in Sweden demonstrated immunity to the negative outcomes of the global economic crisis. Also in Finland, the implementation during the building construction variable has similar characteristics to the ones characterized by the Swedish market. The only difference is that on the basis of the analysis of data for Finland, we can note how the global crisis had the negative effect on the dynamics of changes in these market parameters. In 2008, a slowdown and even a slight decrease in the potential of this market could be observed. It should be noted, however, that this market has increased its development potential throughout the entire time frame studied.

When analyzing Slovakia, we can see that the construction market in this country strongly responded to the global economic crisis. This reaction involved a significant decrease in the potential of this market. The resulting crisis-related unfavorable phenomena on the construction market in Slovakia could be observed from 2008 to 2015. From 2015 to the end of the period under review the relative stabilization of this market was faced. This meant neutral market condition in terms of its development. We can also call this state market stagnation. An even more discernible negative reaction to the economic crisis was recorded for the case of Slovenia. Prior to the global economic crisis, the construction market in this country had a four hundred percent greater potential compared to the values recorded in 2015. The reaction of the Slovenian construction market to the global economic crisis was manifested in a rapid decline of its potential. This decrease is observed for the years 2008–2016. This market has revived and has been growing since 2016. However, achieving the potential of this market before 2008 seems unlikely at the moment.

On the other hand, the Romanian construction market in 2000–2020 is characterized by a positive development tendency, with a short-term correction recorded in the period of the global crisis. In the case of Romania, we can note that the correction that took place in 2008–2010, and involved a decrease in the potential of this market, corresponding to a relatively short-term correction. From 2010, the potential of the Romanian construction market has increased year by year.

The conditions on the Portuguese construction market form an interesting case. In the period applied in the study of the market situation, i.e. from 2000 to 2019, it was characterized by a shrinking potential. A sharp decrease in the potential of this market can be observed from 2000 to 2015. For subsequent years, i.e. in the period 2016–2019, this market was in a period of stagnation. It should be noted that the Portuguese residential real estate market significantly lost its potential over the investigated period.

In Poland, the real estate market over the period under consideration has specific time-frequency variability characteristics. Such specific characteristics are manifested by a three-year decrease in the potential of this market. The first decrease

in the dynamics of changes was observed for 2000–2006, followed by the second fall in 2008–2010, and a third one between 2012 and 2016. From the observed characteristics of the variations we can conclude that the Polish construction market is quite volatile and unpredictable.

The Hungarian construction real estate market systematically follows the trends in the global economy. Until 2008, this market is dynamically developing, increasing its potential to record a decline after that period, which lasted until 2013. On the Hungarian market we can see that this market in 2019 has the potential it had before the outbreak of the great crisis.

When we perform an analysis of the Croatian housing market in the area of building construction, we can see how the development trend reflecting activity increased on it before 2008. This activity slowed down after the outbreak of the economic crisis. We should note that the activity of this market in 2015 was characterized by the lowest value and that from that time until the current year this activity demonstrates a clearly upward trend.

The French building construction market is characterized by relatively low volatility in terms of its dynamic characteristics. However, we can note considerable seasonal fluctuations. A similar situation can be noted with regard to the German construction market. The only difference is that the activity of the German market decreased until 2008. We can be concluded from the graph that the German market after the outbreak of the economic crisis in terms of constructing buildings did not feel its effects.

The Belgian housing market demonstrates similar characteristics to the markets described above, i.e. to the German and French ones. On the one hand, this market is characterized by a considerable amplitude of seasonal fluctuations, while on the other hand, there is no visible impact of the 2008 economic crisis on its potential. The Danish market has different activity characteristics. In this market, the period of the economic crisis is not marked in the statistical data and additionally we can observe a stabilization of the activity of this market after 2008. This stabilization is characterized by a decrease in the amplitude of seasonal fluctuations.

When we perform the analysis of the time-frequency characteristic of the Czech Republic construction market, we can see the logical implementation of its activity, which is clear from the point of view of the economic crisis of 2008.

In the category of building construction, we can note the considerable susceptibility of the Bulgarian construction market to the economic crisis that occurred in 2008. Since 2015, this market has been characterized by invariable developmental potential. It should be noted, however, that this potential is still well below the one recorded in 2008.

The Austrian construction market has a positive development tendency throughout the entire analyzed period, which slightly slowed down during the global crisis. However, we can conclude that this market in 2008 demonstrated resistance to the outcomes of destabilizing factors generated in the economy through the resulting crisis.

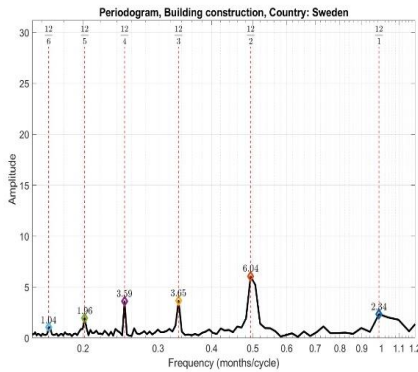
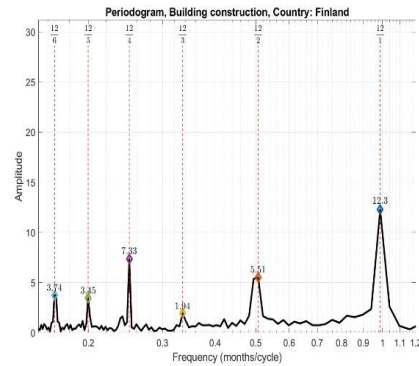
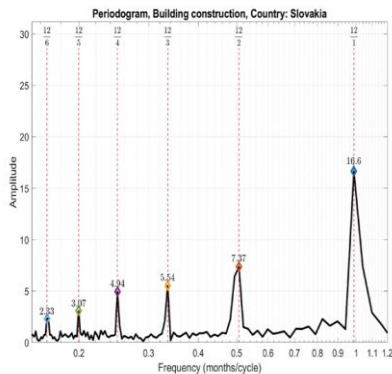
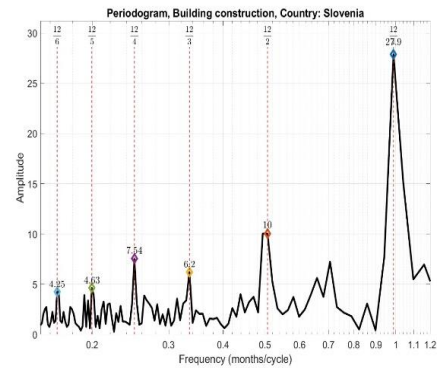
3.2 Analysis of Time-Frequency Analysis Using Fourier Transformation

The following stage of the research involved the identification of active sub-seasonal periodicity corresponding to the variable building constructions. The identification was made using fast Fourier transformation (FFT) and the result of the identified subannual seasonality activities are presented in Figures 2–17. It has been assumed that the presentation of results will be given in the form of periodograms for the variable: building construction for each of the 16 European countries included in the present analysis.

In each of the perdiograms, the number of observed cycles per year (month/cycle) is located on the x axis. The y-axis contains the amplitude of observed activity for the periods detected in the year (month/cycle). These periods were defined as 12/1 (one cycle per year), 12/2 (semi-annual cycle), 12/3 (three cycles per year), 12/4 (quarterly cycle), 12/5 (five cycles per year) and 12/6 (two-month cycle).

When we perform the analysis of the identified cyclicalities for Sweden, we can see that the effect of sub-annual seasonality is not very visible. The value of amplitude for the semi-annual cycle is less than $A=6$. For Finland, we can note that the most active cycle is formed by the annual cycle ($A=12.3$) followed by the quarterly cycle ($A=7.33$). An interesting course of activity of sub-annual cycles can be noted for the case of Slovakia. In this country, sub-annual cyclicity has a tendency of decreasing activity accompanied by an increase of the cycle frequency.

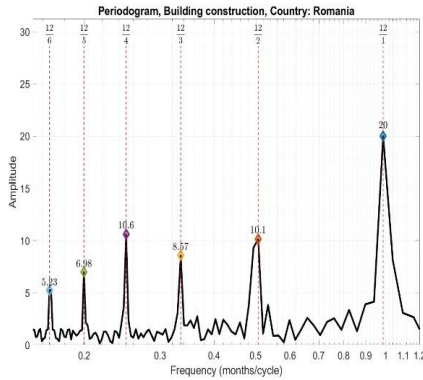
We can see that the annual cycle forms the most active one ($A=16.6$), followed by six-month ($A=7.37$), four-month ($A=5.54$), and quarterly cycles ($A=4.94$), etc. The identification of sub-seasonal seasonality for Slovenia demonstrates that in the branch of building construction, dominant seasonal activity is definitely associated with the annual cycle. The amplitude for this cycle is as high as $A=27.9$.

Figure 2. Periodogram – Sweden**Source:** Own study**Figure 3. Periodogram – Finland****Source:** Own study**Figure 4. Periodogram – Slovakia****Source:** Own study**Figure 5. Periodogram – Slovenia****Source:** Own study

For the case of Hungary, we can identify two leading cycles. The first is the annual cycle ($A=17.2$), whereas the second is the quarterly one ($A=17.5$). In Romania we can note significant sub-seasonal activity that can be identified in terms of four cycles. Annual cycle demonstrated the greatest activity ($A=20$), followed by the quarterly cycle ($A=10.6$), sub-annual ($A=10.1$) and four-month cycles ($A=8.57$). By identifying the activity of seasonal sub-annual cycles in Poland for building construction, we can see that the highest activity can be noted with regard to the annual cycle ($A=12.5$). In this order two sub-cycles are active, i.e. the quarterly cycle ($A=8.95$) and a five-cycle periodicity per year ($A=7.63$).

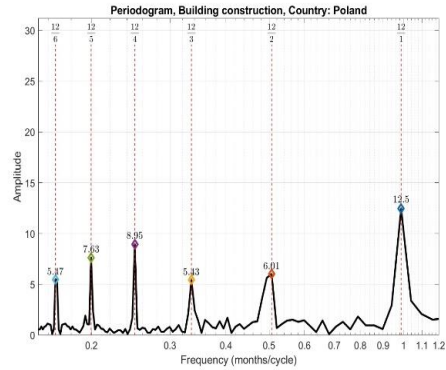
In Austria, on the other hand, cyclical studies of the building construction market the results indicate a single active main cycle and it is an annual cycle ($A=17.5$), and three cycles with comparable activity, i.e. a quarterly cycle ($A=9.23$), a semi-annual cycle ($A=8.93$) and a four-month cycle ($A=8.09$). The cyclicity of the building construction market in Germany has similar characteristics as the sub-annual cyclicity in Poland.

Figure 6. Periodogram – Romania



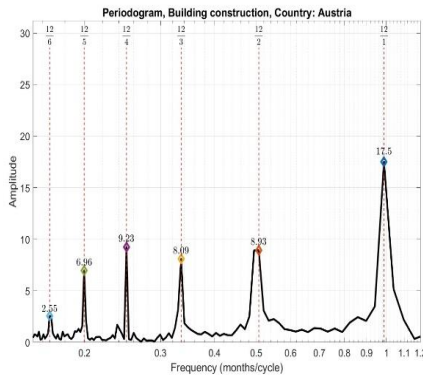
Source: Own study

Figure 7. Periodogram – Poland



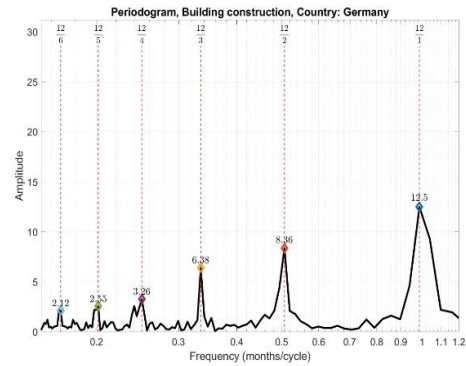
Source: Own study

Figure 8. Periodogram – Austria



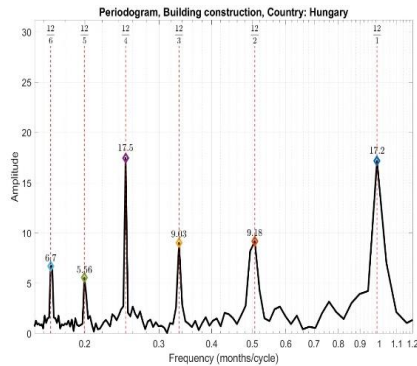
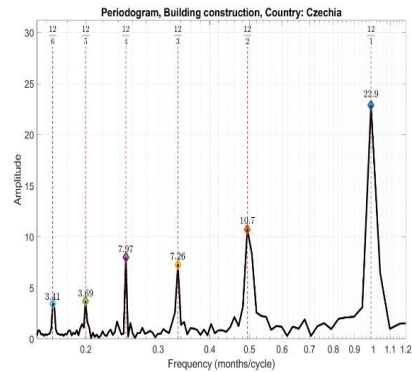
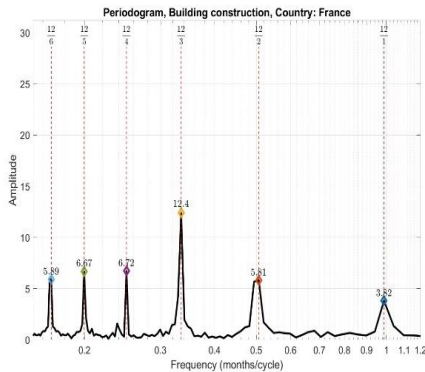
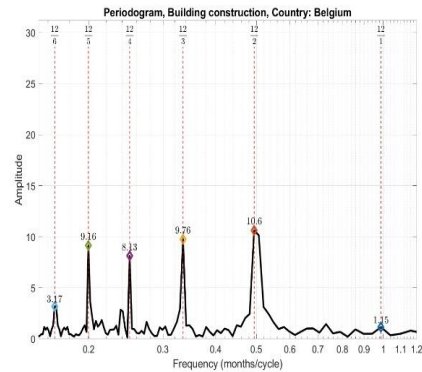
Source: Own study

Figure 9. Periodogram – Germany



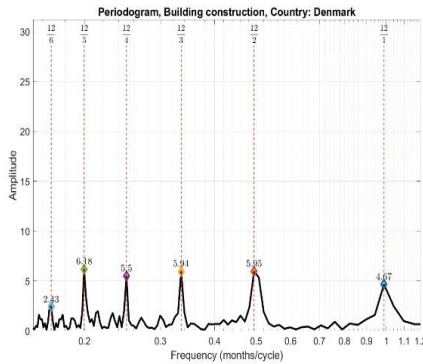
Source: Own study

For the Czech Republic, we can note one cycle with relatively high activity with an amplitude of $A = 22.9$. For countries such as France and Belgium, there is an interesting situation in the area of active cycles. There is no marked active annual cyclicity in these countries. Other cyclic activities of these two countries are characterized by low amplitude fluctuations.

Figure 10. Periodogram – Hungary**Source:** Own study**Figure 11. Periodogram – Czechia****Source:** Own study**Figure 12. Periodogram – France****Source:** Own study**Figure 13. Periodogram – Belgium****Source:** Own study

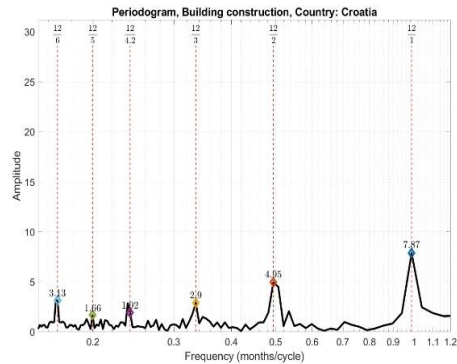
Similarly, building construction markets in Portugal, Croatia, Bulgaria and Denmark are characterized by inconsiderable activity of seasonal sub-cycles. The highest activity can be noted in the case of Portugal for four-month ($A=8.96$), yearly ($A=8.61$) as well as semi-annual sub-periods ($A=7.65$), although in relation to other countries, this activity is moderate. In Bulgaria, the amplitude is $A = 5.66$ (annual cycle), in Croatia $A=7.87$ (annual cycle) and in Denmark $A=6.38$ (five-month cycle).

Figure 14. Periodogram – Denmark



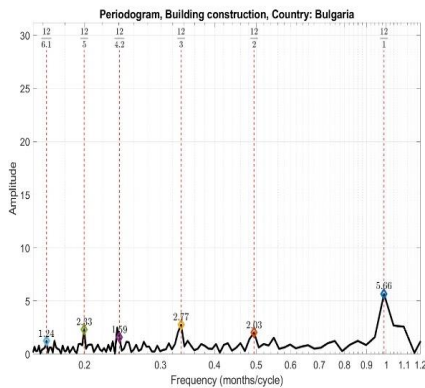
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Figure 15. Periodogram – Croatia



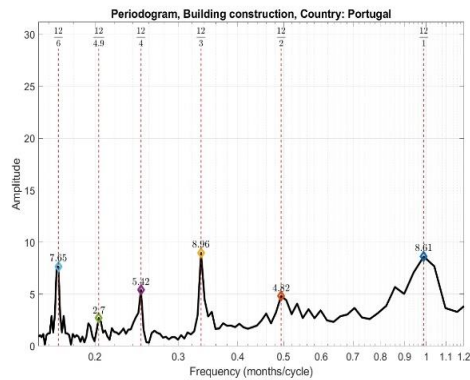
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Figure 16. Periodogram – Bulgaria



Source: Own study

Figure 17. Periodogram – Portugal

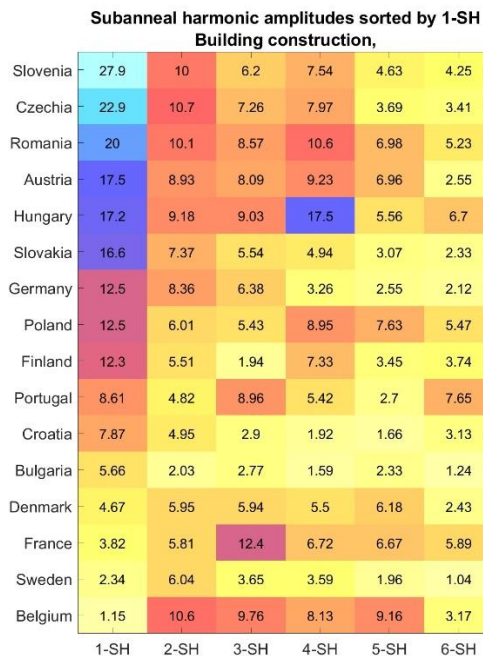
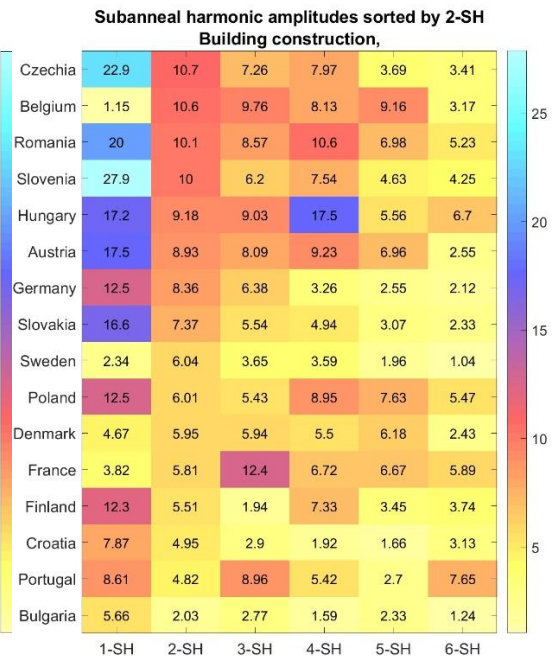


Source: Own study

4. Comparison of Subannual Seasonality of Building Construction

The final stage of the research involved the development of a ranking list for the identified cyclical activity. The ranking of cyclical activities was performed for annual cyclical activity and semi-annual cyclical activity. In Figure 18 we can see that Slovenia as well as the Czech Republic and Romania demonstrate the highest annual cyclical activity. On the other hand, countries characterized by an absence of cyclical annual activity include Belgium, Sweden, France, Denmark, Bulgaria, Croatia and Portugal.

In contrast, Figure 19 contains a list of countries developed in terms of semi-annual cyclical activity. The Czech Republic, Belgium, Romania and Slovenia are the countries with the highest semi-annual cyclical activity. BY contrast, we can note that Bulgaria, Portugal and Croatia are countries with the lowest semi-annual cyclical activity.

Figure 18. Subannual harmonic amplitudes sorted by 1-SH*Source: Own calculations***Figure 19.** Subannual harmonic amplitudes sorted by 2-SH*Source: Own calculations*

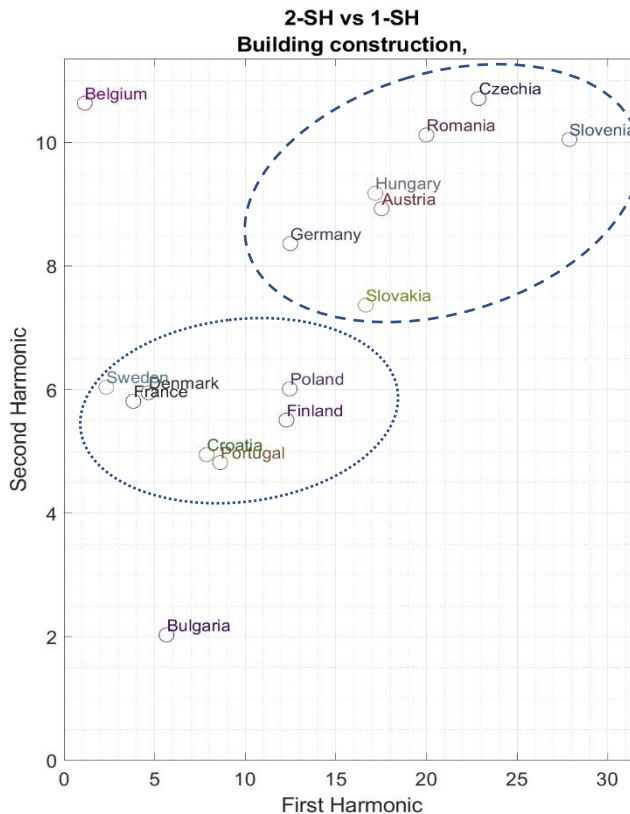
In the summary of the conducted research, Figure 20 was developed to present details of the relations between annual and semi-annual cyclical activities. The purpose of the presentation is to indicate countries characterized by similar levels of cyclicity. The results presented in Figure 20 demonstrate two groups of similar countries that are similar in terms of the activity of annual and semi-annual cycles. The countries with the most active annual and semi-annual cycles include the Czech Republic, Slovenia, Romania, Hungary, Austria, Hungary and Germany. The second group is characterized by moderate annual and annual cyclical activities and includes countries such as Poland, Finland, Croatia, Portugal, France, Sweden and Denmark. Bulgaria is a country with the lowest cyclical activity on an annual and semi-annual basis.

5. Conclusion

In the conclusion we can say that the project objective of the study, which involved the identification and comparison of sub-seasonal seasonality for 16 European countries, has been performed successfully. The realization of the research goal was accomplished by means of several research phases. In the first phases, a diagnostic variable was identified with the purpose of describing the potential of the housing market. Subsequently, an analysis of time-frequency variability was performed for

the examined variable by application of data for 16 European countries. This stage was aimed at a preliminary analysis of the implementation of the temporary variable: building construction and a preliminary analysis of its variability. In the next step of the study, sub-seasonal periodicity was identified. The identification of activity of sub-annual cycles was carried out by means of Fourier transform. A comparative analysis of identified sub-cyclical cycles formed the stage in which the conducted research was summarized.

Figure 20. Scatter chart for identified annual cycles (first harmonic) and semi-annual ones(second harmonic).



Source: Own study.

The major conclusions of the study include the following:

- Cyclicity forms an important component affecting the nature of both time and frequency variability.
- The analysis of time-frequency variability in the conducted research demonstrates that the vast majority of the countries faced the negative impact of the global economic crisis that occurred in 2008.
- Countries such as Bulgaria, Croatia, Slovenia and Slovakia have been

affected considerably by the effects of the economic crisis. The housing market in these countries has not yet made up for lost potential in this market.

- The Portuguese construction market is characterized by a decreasing potential throughout the investigated period. One can hypothesize that this market diminishes its potential annually over the years 2000-2019. The economic crisis enhanced the loss of this potential in 2008-2016.
- The building construction market of such countries as Belgium, Austria, Finland or Sweden has not been affected by the economic crisis. For these countries, we can observe an increase in the potential of the market.
- The identification of sub-annual cyclicity has demonstrated that the characteristics of the cycles observed during the year are various in the individual countries. This diversity is manifested in the number of active sub-cycles and their different frequency.
- We can note that the conducted research offered grounds to state that the activity of cycles for individual countries takes on various intensity.
- The conducted research also explored the details regarding the priority of the activity of annual and semi-annual cycles by country according to their intensity.

It was proven that two groups of countries with similar annual and semi-annual activities can be classified. The first group of countries with the most active sub-cycles includes the Czech Republic, Slovenia, Romania, Hungary, Austria, Germany and Slovakia.

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