10. DEPENDENT BUSINESS CLIMATE. A NETWORK-BASED ANALYSIS

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Abstract

The relevance of business climate is widely used in various analyses, both scientific and practical. Long histories of such indicators are available on the main data platforms, and a strong interest to develop methodological tools aiming at measuring the market participants' sentiments fed the general accepted paradigm that such indicators could quantify the qualitative side of the market behaviour and enhance the power of economic analyses. This paper applies the network analysis methodology on the series of business climate indicators, as labelled by the Datastream platform. We elaborate on the results obtained from this analysis and provide an analysis of the changes that took place before and after the economic crisis.

Keywords: business climate, dynamic network analysis, minimal spanning tree, survival rate

JEL Classification: M21, F23

I. Introduction

The key issue of our research is to provide an analysis of the relationships among the business climate indicators in different countries. We rely on data for which the Datastream platform applied the label of "climate indicator"[6]. The relevance of the concept of business climate is intrinsically connected to the idea of economic sentiment and is usually taken into account for measurements of the general behaviour of the

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[6] We provide a thorough description of the data in Section III.2.

market participants due to its impact on the future economic development. Ranging from quantifications of the impact on the price of financial assets to measurements of the expected inflation, the concept of business climate influences investment options and even the monetary policy decisions.

Our investigation has the objective to provide a perspective on how this concept is perceived at international level by means of a network analysis employed for national indicators of the general business climate perceptions. We elaborate on the manner in which these indicators are connected for a long period, from 2006 until 2016, and from a dynamic perspective, by monitoring the evolution of the network characteristics.

The remainder of the paper is organized as follows. The following section introduces the main findings and approaches in the specific literature. Section 3 presents the methodology, data and main indicators, while the main empirical results are described in Section 4. Some conclusions are provided in Section 5.

II. Related Research in the Economic Literature

The business climate indicators provide an important class of information regarding the perception of current and further performance of economic activity.

Almost forty years ago, Juhl (1978) questioned the beneficial role of the investment climate indicators for the foreign investors, highlighting the role of political risks and the perspectives of business environment for investment decisions.

With the intention to evaluate whether statistical information is able to mark and anticipate the economic business cycle, Bruno and Malgarini (2002) tried to construct an aggregate composite indicator based on surveys in manufacturing, retail and construction sector, specific to the Italian economy. Using a dynamic factor model, some common data were extracted from these surveys, considered as a composite confidence indicator.

There is a category of research papers that investigate the forecasting power of this type of indicators (survey-based business climate indicators). Hufner and Schroder (2002) tried to understand the forecasting power of the sentiment indicators (the Ifo business expectations, the Purchasing Managers Index, the ZEW Indicator of Economic Sentiment, the European Commission's Economic Sentiment Indicator) in Germany, through the Granger causality tests and using cross correlations. From their analysis it resulted that the Ifo business expectations and the ZEW Indicator of Economic Sentiment have the best forecasting power for the industrial sector. Later, Goggin (2008) discussed in his paper whether business confidence indictors based on surveys in charge of the European Commission may be beneficial for macroeconomic forecasting on short term. The results were mixed, the potential forecasting power of these indicators being small. In the case of consumer survey, the results suggested more statistical relationships between the survey data and the official ones.

Other studies try to identify a leading indicator for an economic sector in a specific region. In this respect, Vanhaelen and Dresse (2000) focused their study on the investigation regarding the possibility that the Belgian industrial confidence indicator may anticipate the Euro Area business cycle. Analysing a set of data from 1985 to July

2000, they derived the conclusion that the turning points in this country significantly led those from the Euro Area starting in 1993.

The financial crisis started in 2008 put much pressure on confidence, with serious results in the economy. Looking at the American and Euro Area markets, Dees and Brinca (2011) concluded that in specific frameworks the consumer confidence index might be considered as a good predictor for consumption.

The link between investor sentiment and stock markets was also taken into account in research studies. Analysing this aspect in four important European countries, Corredor et al. (2013) argue that there is a significant impact of the investor sentiment on the return, although with different intensity across countries. Using the principal component analysis, Finter et al. (2012) design an aggregate sentiment indicator that includes the information transmitted through other several sentiment proxies in order to verify its influence on the local stock market. Although this indicator has no important predictive power for the future returns of German stocks, it seems to have an influence on a smaller category of stocks, namely those stocks that are difficult to arbitrage and evaluate.

III. Methodology and Data Description

III.1 Methodology

In order to reflect the structure of the business climate and to identify the relationships, we constructed a minimal spanning tree. A minimal spanning tree connects all the peaks together using the minimal total weighting for the edges. Many different spanning trees may be derived from one graph, a minimal spanning tree being unique once each edge has a certain weight for a given connected graph. Used very often in the financial markets analysis (Onnela *et al*., 2003), the minimal spanning tree presents the most relevant information and correlations in a very simple structure.

We first calculated the correlation coefficients of business climate indicators using the formula:

$$C_{ij}^{T} = \frac{\sum_{t=1}^{T}(r_{i,t} - \bar{r}_i)(r_{jt} - \bar{r}_j}{\sqrt{\sum_{t=1}^{T}\left(r_{i,t} - \bar{r}_i\right)^2 \sum_{t=1}^{T}\left(r_{j,t} - \bar{r}_j\right)^2}}.$$

Following the work of Mantegna (1999), we converted the correlation to a metric distance (between the economic climate in country i and country j) using the formula:

$$d_{ij} = \sqrt{2\left(1 - C_{ij}^{T}\right)}.$$

Then, we used the distance matrix to produce the minimal spanning tree. The algorithm used by Prim (1957) was adapted. The minimal spanning tree can reduce the number of important links to N-1 for N markets, while the number of possible links is N(N-1)/2. At the same time, it gives the subdominant ultra-metric hierarchical tree, revealing the internal clustering structure and the close-sparse linkages for the business climate.

Hughes (2004) considers that minimal spanning three and the ultra-metric space are similar, the ultra-metric space being a metric space that simultaneously has three properties:

$$d_{ij}^{*} \geq 0, d_{ij}^{*} = 0 \leftrightarrow i = j;$$
$$d_{ij}^{*} = d_{ji}^{*};$$
$$d_{ij}^{*} \leq \max\{d_{ik}^{*}, d_{kj}^{*}\}.$$

By defining the subdominant ultra-metric distance d_{ij}^{*} as the maximum value[7] of any Euclidean distance d_{kl} (single steps moving from i to j in the minimal spanning tree), we constructed the ultra-metric matrix. Without any assumptions, we designed a unique hierarchical structure of the business climate.

The number of edges incident to the market business climate represents, in the minimal spanning tree, the degree of a market, k(i): $k(i) = \sum_{j=1}^{n} a_{ij}$. If the business climate of the country I and country j have an edge in the minimal spanning tree, then $a_{ij} = 1$; or $a_{ij} = 0$ in the rest, for n representing the number of countries.

Sieczka and Holyst (2009) consider that a good measure for market's centrality is betweenness centrality – B(i), calculated as according to the following the formula:

$$B(i) = \frac{2}{N(N-1)} \sum_{(j,l)} \frac{\sigma_{jl(i)}}{\sigma_{jl}}, \qquad j \neq i \neq l.$$

where: $\sigma_{jl(i)}$ represents the shortest line from j to l via I, and the σ_{jl} represents the shortest line from j to l. For the constructed minimal spanning tree in this paper, it was derived a betweenness centrality that reverberate the level to which the other countries' business climate rely on that of country i, the higher value of this indicator accounts for the higher centrality degree of the country i.

Another relevant indicator is the farness that is the sum of distances to the other countries, calculated using the formula:

$Farness\ (i) = \sum_{(i,j)} R_{ij}, i \neq j$. R_{ij} is the smallest distance from i to j in the constructed minimal spanning tree and a lower value of farness (i) implicates that the centralized degree of country i is superior for the entire sample and the connections between country i and the other countries are the nearest.

To calculate time-varying measures we applied a rolling time window. We used 50 observations for each numbering, moving then the sample window with one space. Because we have a data sample for the period covering February 2006 until January 2016, the number of windows is 68.

Returning to the paper of Onnela *et al*. (2003), we analyzed the time-varying correlation distribution using the next indicators:

- Mean, $\overline{C(t)} = \frac{2}{N(N-1)} \sum_{ij} C_{ij}^{T_1}(t)$;
- Variance, $\lambda_2(t) = \frac{2}{N(N-1)} \sum_{ij} \left(C_{ij}^{T_1} - \overline{C^{T_1}(t)}\right)^2$;

[7] $d_{ij}^{*} = max\{d_{ik},\ d_{kl},\ d_{lj}\}$.

– Skewness, $\lambda_3(t) = \frac{2}{N(N-1)} \sum_{i,j} \left(C_{ij}^{T_1}(t) - \overline{C^{T_1}(t)} \right)^3 / \lambda_2^{\frac{3}{2}}(t)$;

– Kurtosis, $\lambda_4(t) = \frac{2}{N(N-1)} \sum_{i,j} \left(C_{ij}^{T_1}(t) - \overline{C^{T_1}(t)} \right)^4 / \lambda_2^2(t)$.

where: $\overline{C(t)}$ represents the average correlation coefficient and $C_{ij}^{T_1}(i,j)$ denotes the correlation between country i and country j in a time frame $[t, t+T_1]$.

In order to analyse the dynamics of the network that is settled at the international level, we monitored the multistep survival ration of the edges, which is an indicator computed as

$$\sigma(t,k) \frac{1}{N-1} |E(t) \cap E(t-1) \dots E(t-k+1) \cap E(t-k)$$

and $\sigma(t,k)$ is the survival ratio of edges in the minimal spanning tree.

III.2 Data Description

For the selected countries, the business climate indicators, their labelling and specific main features are presented in Table 1, together with the institutions responsible for their publications.

Table 1

Indicator Description

Country	Indicator	Description
Germany	IFO BUSINESS CLIMATE INDEX (PAN GERMANY) VOLA	The Ifo Business Climate is calculated by the CESifo Group, consisting in the Center for Economic Studies (CES), the Ifo Institute and the CESifo GmbH (Munich Society for the Promotion of Economic Research). It is a widely observed early indicator for economic development in Germany, based on approx. 7,000 monthly survey responses of firms in manufacturing, construction, wholesaling and retailing, the firms being asked to assess the current business situation and their expectations for the next six months.
Belgium	BUSINESS INDICATOR SURVEY - ECONOMY SADJ	The business survey indicator is published by the National Bank of Belgium. The indicator is calculated each month on the basis of the responses to the business survey among firms in this country. The new method that took effect in April 2009 uses a panel of around 6000 business leaders. The questions mainly concern the assessment of the current situation and expectations for the next three months.
Bulgaria, Cyprus, Latvia, Lithuania, Luxembourg, Romania	IND.: OVERALL - INDL CONF INDICATOR SADJ	Business Confidence is reported by the European Commission.
Chile	BUSINESS CONFIDENCE (BY ICARE) NADJ	The survey is conducted monthly and approximately 600 business executives from manufacturing, mining, construction and trade (private and public companies) are

Country	Indicator	Description
		interviewed, and the weights used in the indicator correspond to the share of these sectors in the GDP. The same units are consulted every time.
Czech Republic	CONFIDENCE INDICATOR: BUSINESS VOLA	The business confidence survey measures the level of optimism of the executives regarding the performance of the economy and the feeling about their organizations' perspectives. The indicator is calculated by the Czech Statistical Office and is a weighted average of seasonally adjusted confidence indicators in industry, construction, trade and in selected services.
Denmark	MANUFACTURING SURVEY: BUSINESS INDICATOR SADJ	The indicator reflecting the business climate is published by Statistics Denmark, and is based on tendency surveys in manufacturing that provide information on the current situation, as well as expectations for the coming three months. Production, employment, new orders, sales prices, investment plans and limits to production are the most important variables used.
Estonia	CONFIDENCE INDICATOR: BUSINESS COMPOSITE SADJ	In Estonia, the Business Climate Indicator measures the current situation of the businesses and its future prospects, being calculated through the estimation of a factor-model. The survey covers 1,810 companies in the country. The questionnaire for the survey concentrates on production trends in recent months, order books, export order books, stocks and production expectations.
Spain, Greece, Austria, Portugal	ECONOMIC SENTIMENT INDICATOR VOLA	The Business Confidence Indicator is reported by the European Commission and measures the current situation of the businesses and future prospects. The survey covers 410 companies. The questionnaire concentrates on production trends in recent months, order books, export order books, stocks and production expectations. Nearly all the questions are characterized by a qualitative nature.
Finland	INDUSTRIAL CONFIDENCE INDICATOR - FINLAND SADJ	The Industrial Confidence Indicator is reported by the European Commission and is a survey measuring the confidence among executives in the manufacturing sector.
France	SURVEY: MANUFACTURING OUTPUT LEVEL - GENERAL OUTLOOK SADJ	INSEE business surveys.
Hungary	GKI BUSINESS CONFIDENCE INDEX SADJ	The GKI Economic Research business confidence index, reported by the GKI Economic Research Co., measures the level of optimism that executives have about the performance of the economy and reflects their organizations' perspectives. GKI approaches 5-6 thousand companies, but 1000-1200 undertakes respond to its questionnaire.
Italy	BUSINESS CONFIDENCE INDICATOR SADJ	The Manufacturing Confidence Index, reported by the ISAE/ISTAT, covers 4,000 Italian companies. The questionnaire concentrates on the current trend of order

Country	Indicator	Description
		books, production and inventories, short-term forecasts on order books, production, prices and the general economic situation.
Korea (South)	BOK BUSINESS SVY: BUSINESS CONDITIONS-ALL INDS, FORECAST NADJ	This concept indicator reflects the general state of the economy as it relates to businesses. It can include broad economy-wide conditions or specific economic conditions of a particular industry. It is a business survey that includes 2,500 companies, being undertaken from 10th to 25th of the month.
Mexico	BUSINESS TENDENCY SVY: MFG. BUSINESS CONFIDENCE INDEX NADJ	The Manufacturing Business Confidence Index, calculated by the Banco de Mexico, measures the executives' sentiment on the current situation of their firms. The Index is based on questions regarding: business climate for the next months; the current financial and economic environment relative to previous periods; the expectations for the next months; employment expectations for the next months and the current scenario to invest.
Mozam-bique	BUSINESS CLIMATE INDICATOR NADJ	The Economic Climate Indicator (ECI), calculated by Instituto Nacional De Estatistica, measures the level of optimism that executives have about current and expected developments in production, sales, employment, inventories, etc. The indicator is based on a sample of around 850 companies from the main sectors of the country's economy.
Nether-lands	CBS MFG. SVY.: PRODUCER CONFIDENCE INDEX SADJ	Statistics Netherlands publishes the producer confidence survey that covers 1,700 manufacturing companies. The survey covers three elements: evaluation of their order positions, their stocks of finished products in the month under review and the anticipated economic activity for the next three months.
New Zealand	NBNZ BUSINESS SURVEY: BUSINESS CONFIDENCE VOLN	Business Confidence is reported by the ANZ Bank New Zealand, being designed to provide business opinions regarding the expected prospects for their business and for the economy overall. The survey covers around 700 respondents.
Poland	MANUFACTURING SECTOR: BUSINESS CLIMATE INDEX NADJ	Business Confidence is reported by the Central Statistical Office of Poland (GUS) and is based on a survey of 3,500 companies. The business tendency questionnaires concentrate on the basic features of the economic situation in industry.
Slovenia	BUSINESS SURVEY - CONFIDENCE IND. IIN MANUFACT. SADJ	Business Confidence is reported by the Statistical Office of the Republic of Slovenia and measures the level of optimism that executives have about the performance of the economy and about their organizations' perspectives.
Switzer-land	KOF INDUSTRY SURVEY: BUSINESS CLIMATE SADJ	Is calculated by the KOF Swiss Economic Institute (acronym for the German word "Konjunkturforschungsstelle", which means business cycle research institute).

Country	Indicator	Description
Slovakia	IND. CONFID. INDICATOR SADJ	Statistical Office publishes the industrial confidence indicator that measures the level of optimism that companies have about the performance of the economy and how they feel about their organizations' perspectives. This indicator is a composite indicator calculated as an arithmetic average of balances of the demand, stock of finished goods and the expected production.
Thailand	BUSINESS SENTIMENTS - ACTUAL NADJ	The Business Sentiment Index (BSI), calculated by Bank of Thailand, measures the expectations of entrepreneurs regarding current business performance, orders, employment, production, costs and investment. The survey covers a sample of around 1,500 entrepreneurs.
Turkey	BUSINESS CONFIDENCE INDICATOR NADJ	Business Confidence is reported by the Central Bank of the Republic of Turkey. The Business Tendency Survey collect the opinions of senior managers on the recent past, current situation and their expectations regarding the future course of business environment in the manufacturing industry.
United States	ISM PURCHASING MANAGERS INDEX (MFG SURVEY) SADJ	Business Confidence is reported by the Institute for Supply Management. It is based on data compiled from purchasing and supply executives nationwide. Survey responses reflect the change, if any, in the current month compared to the previous month.

Note: SADJ - Seasonally adjusted, NADJ - Not seasonally adjusted, VOLA - Volumes, seasonally adjusted, VOLN - Volumes, not seasonally adjusted.

IV. Main Results

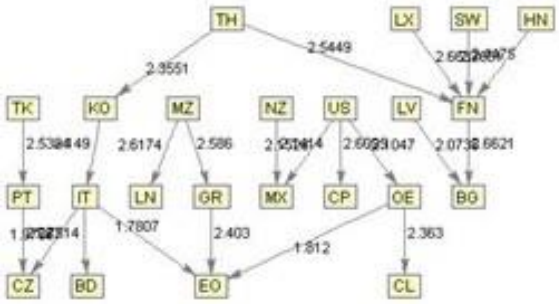
In order to develop a thorough representation of the complex structure of the economic sentiment as a whole for all the countries in our analysis, we built a minimal spanning tree for all the indicators in our chosen set of countries. This allows us to develop an analysis about how the perceptions on the economic dynamics are connected at global level, for all the countries on which we could obtain information about these indicators. This investigation goes on with a representation of the hierarchical structure of these indicators and a description of the evolution of this structure as time passes.

The first part of our analysis consists in the construction of a minimal spanning tree that allows us to see the economic sentiment at the global level using the distance matrix. Figure 1 presents a minimal spanning tree with 32 edges, out of which 23 are part of at least one connection. We notice a connection between Thailand, on the one hand, and Korea and Finland on the other hand, as well as a clear connection between Italy, on one hand, and the Czech Republic, Germany and Estonia, on the other hand. From the same perspective, the US is connected with Mexico, Cyprus and Austria, while the economic sentiment in Finland seems to be dependent on the economic perceptions from Luxembourg, Switzerland and Hungary. The independent countries seem to be Bulgaria, Denmark, Spain, France, Netherlands, Poland, Romania, Slovenia and Slovakia.

We should note that this analysis is performed for the whole sample starting in early 2006 until January 2016, so it is a span of approximately 10 years and it holds the variability structure associated with 120 months of data and a rather different manner to quantify the economic sentiment.

Figure 1

Minimal Spanning Tree for the Full Sample

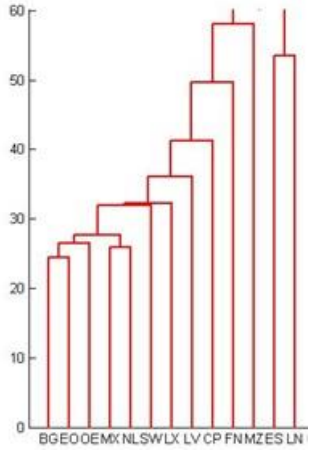


Given this analysis, a clustering analysis was also considered to be useful for our investigation. Figure 2 presents a hierarchical structure that is associated with the minimal spanning tree computed on the basis of correlations between the changes in the values of the various indicators used to measure the economic sentiment.

We should note that, over the whole sample, we can identify a cluster of sentiment indicators, consisting of Belgium, Estonia, Austria and Mexico and the Netherlands. On the other hand, a small cluster consisting of Spain and Lithuania takes shape at the right side of the cluster. An important element is the fact that 17 countries are not considered as part of any group and they are rather independent or the economic sentiment in these countries is not generally consistent with the dynamics of such indicators in the other countries in our analysis.

Figure 2

Hierarchical Architecture Associated with the Minimal Spanning Tree



Coming back to the analysis of the minimum spanning tree, we rebuilt the investigation for two samples: one that took place approximately before the general outburst of the global financial crisis (i.e. from February 2006 to the end of 2008) and another one after the crisis (i.e. from January 2009 to January 2016).

For the first period of our investigation, we notice that Greece was connected to Latvia, the Czech Republic, Cyprus and Estonia; the US seems to have generated the business climate in Estonia, Lithuania, Bulgaria, Mexico and Portugal, while Sweden had the power to impact Portugal, Romania and Finland.

After the crisis started, the connections had a different disposal, with eight countries that were independent (they neither generated nor were impacted by the economic conditions in other countries), the US impacted Austria and, indirectly, Estonia, Hungary, New Zealand, Mozambique, and Lithuania, while Thailand has generating impact for Cyprus, Korea and Finland. If some of the connections seem to keep a similar pattern, there are others that have the strength to generate the structure identified in Figure 1, where we noticed a large number of independent countries for the whole sample.

Figure 3

Minimal Spanning Tree for the Sample February 2006 – December 2008

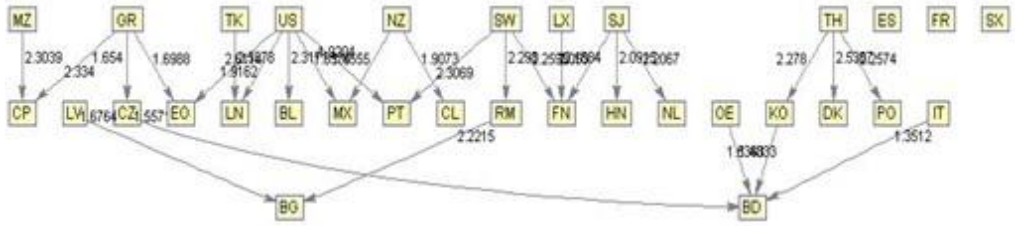
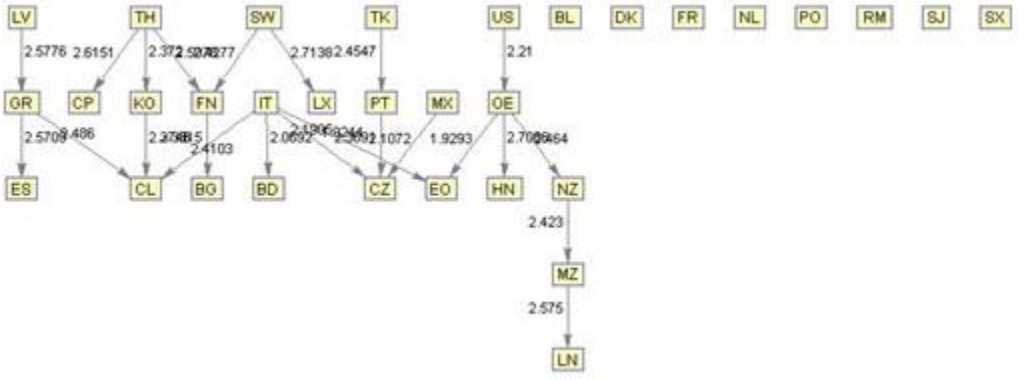


Figure 4

Minimal Spanning Tree for the Sample January 2009 – January 2016

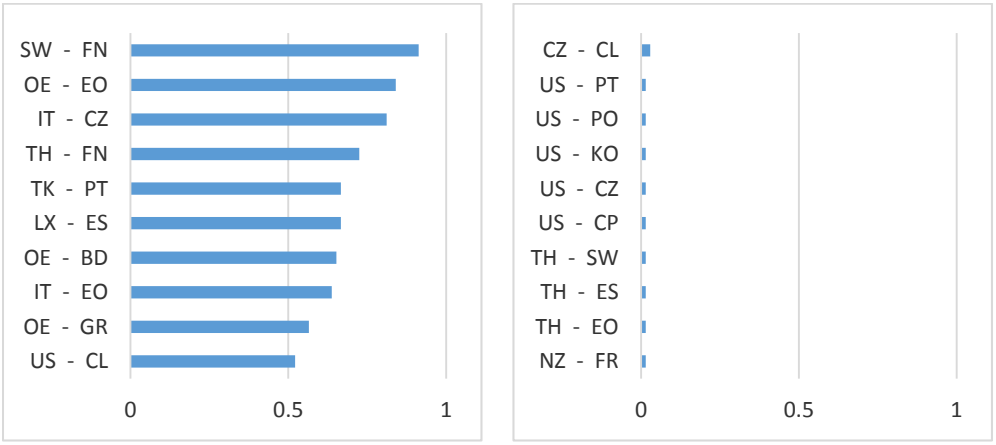


Figures 5 and 6 present the frequency of the connections in descending order, so that we may analyze the robustness of these connections among the countries in our

sample. The frequency of these connections was computed by using samples of 50 months and moving the window for 68 periods until the end of the whole sample. We estimated the frequency with which we were able to observe each connection for the entire sample in our investigation. As shown in Figure 5, the connection between Sweden and Finland is the one that manifested most frequently in the samples that we analyzed, while the connection between New Zealand and France appeared most seldom in these samples.

Figure 5

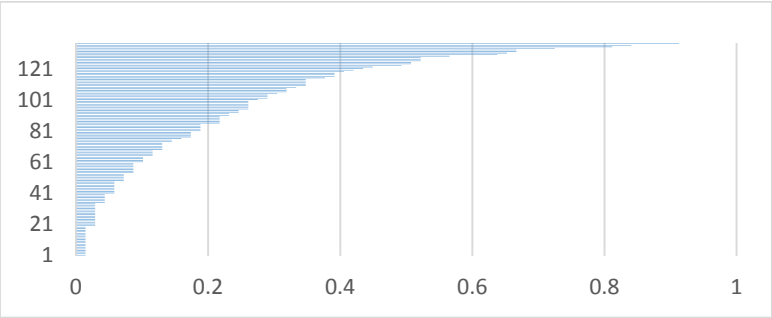
Frequency of the Connections in the Minimum Spanning Tree for the Full Sample – The First 10 Connections and the Last 10 Connections



The fact that none of the connections is 1 implies that during the period between February 2006 and January 2016 the relationships among the business climates in the countries from our sample are not constant, their evolution revealing the manner in which the perceptions concerning the business climate is likely to be dependent on the dynamics of economic conditions and the behavior of market participants. This phenomenon is depicted in Figure 6, where we may have a picture of the frequency of all the possible connections for all the pairs of countries in our analysis.

Figure 6

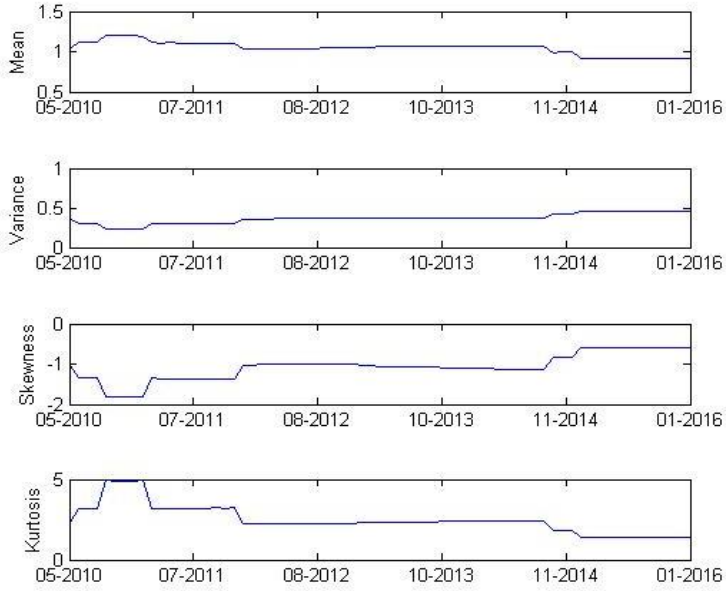
Frequency of the Connections in the Minimum Spanning Tree for the Full Sample – All the Possible Connections



As mentioned in the methodology section, the network analysis is based on the transformation of the correlation matrix into the minimum spanning tree. Since the values of these correlations constitute the root of the network analysis, a representation of their dynamics is important for understanding how the connections are evolving. The tool used for this analysis is the representation of their dynamic distribution, i.e. the movement of the four central moments of their distribution for each sample that we employed in our analysis. Figure 7 depicts the dynamics of the mean, standard deviation, skewness and kurtosis of the correlation coefficients across the moving samples.

Figure 7

The First Four Central Moments of the Distribution of the Correlation Coefficients



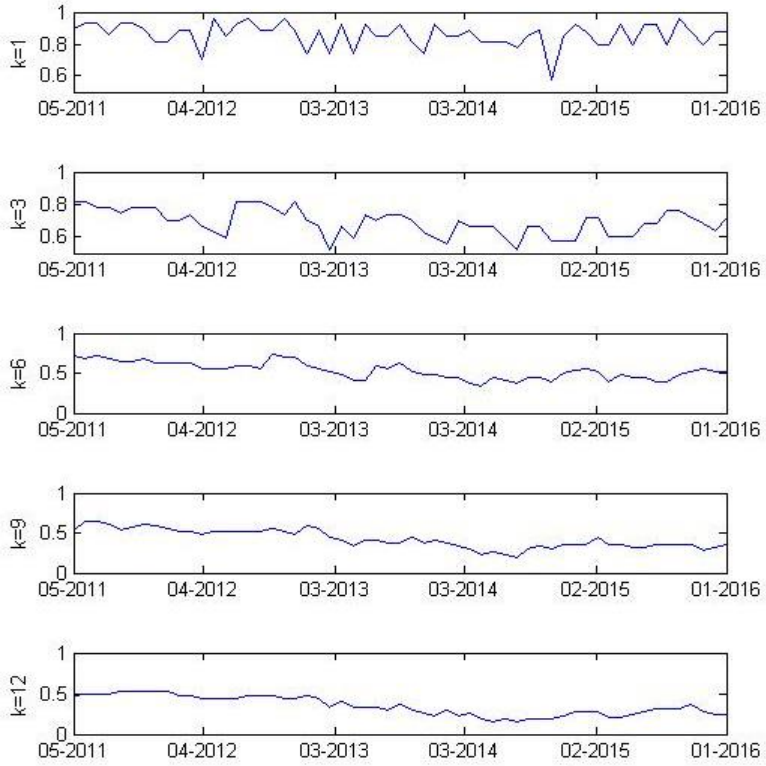
We notice that the mean values are slowly decreasing from 2010 until the end of the sample, with a regime shift at the beginning of 2011 and another reduction at the end of 2015. However, this reduction in the average level of correlations is not statistically significant, as the variance shows a small increase as time passes, which renders lower significance for the level of the trend.

The skewness is negative for the whole sample, with a slight increase towards the end of the sample. Such negative skewness shows that the negative correlations are larger in absolute value with respect to the positive correlations.

Another important feature of the dynamic distribution of the correlation coefficients is the fact that kurtosis is higher than 3 at the beginning of the sample, which means that these coefficients used to have large tails in 2010 and the beginning of 2011 and a rather normal distribution towards the end of the sample, with a rather constant level during 2015 and at the beginning of 2016.

Figure 8

The Evolution of Survival Ratio for Different Steps



As mentioned in the methodology section, we also computed the stability of the system of business climate indicators for all the countries in our analysis in a time-varying

manner. Given this construction of the indicators in our analysis, the more rolling windows we include in the computation of the survival ratio, the more comprehensive is the analysis of the robustness of the minimum spanning tree calculated in our dynamic investigation. Figure 8 shows the evolution of stability when the number of steps included in the analysis are 1, 3, 6, 9 and 12 months. The mean value of the survival ratio diminishes as we increase the number of steps, which shows that, on average, the existence of a connection tends to disappear on long term. We notice a reduction in the survival ratio at the beginning of 2013, a minimal level occurred at the end of 2014 and, in general, we observe that the value of this ratio increases slowly by the end of the sample.

V. Conclusions

Our paper provides an analysis of the network of business climate perceptions for a sample of 32 countries, based on data obtained from Datastream and relying on the default label of business climate ascribed to this data. The indicators used for this analysis have monthly frequency. Section III.2 contains a thorough presentation of their meaning.

The use of a network methodology to investigate these connections relies on the computation of the correlation matrix and its transformation into a minimal spanning tree. We perform this analysis both in a static manner, for the whole sample from February 2006 to January 2016, and in a dynamic way, by calculating the minimal spanning tree for a rolling window of 50 months.

Our results showed that the network increased stability by the end of the sample, the average level of correlations is smaller in this period and the network connections are changing during the financial crisis. These findings could be useful for future analyses on the factors that are likely to explain the evolution of the general economic conditions.

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