THE ASSET CORRELATION ANALYSIS IN THE CONTEXT OF ECONOMIC CYCLE

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Abstract

Probability of default represents an idiosyncratic element of bank risk profile and accounts for an inability of individual debtor to repay its credit obligation. Idiosyncratic risk however does not address any interaction or dependencies streaming from external economic environment, nor the correlation between individual obligors. Credit risk quantification framework accounts for a systematic element of the risk using a concept of asset correlations and joined probability of default. In this paper we focus on the evolution of asset correlations in time and its dependence on economic cycle while asset correlations are proxied by the pairwise stock returns correlations of publicly traded companies. Our analysis proves that a systematic risk is significantly higher in the period of economic downturn where correlations between obligors more than doubled. The analysis also provides a view of systematic risk and its sensitivity to economic cycle between various regions and economic sectors. These observations can be used by banking institutions in the bank risk management and stress testing framework setup.

Key word: Economic capital, asset correlations, systematic credit risk
JEL classification: G32, G21

1 Introduction

Technical and informational revolution over last decades contributed into the globalization in almost all areas and sectors across the whole world. Globalization undoubtedly contributed to higher economic growth and the increase of life standard in developed world. At the same time these changes resulted into higher interdependency between companies and sectors on global scale. These interdependencies at the same time contributed into the increase of systematic risk, especially in the stress periods. Asset correlation represent a widely used approach how to capture these interdependencies. Asset correlations measure how the asset value of one borrower depends on the asset value of another borrower. Likewise, the correlations could be described as the dependence of the asset value of a borrower on the general state of the economy since all borrowers are linked to each other by this single risk factor.

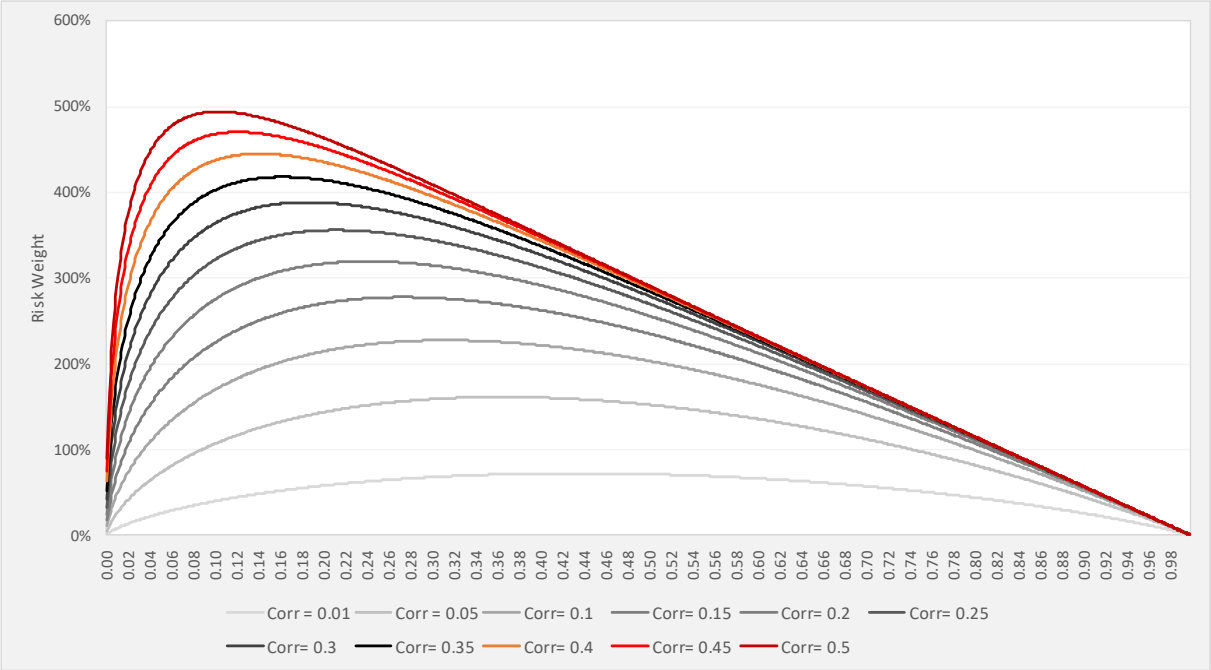
In the article we analyze the systematic risk represented by asset correlations which are derived or proxied by the correlation of company's share price returns using publicly traded companies listed on yahoo finance. In the analysis we focus on the correlation behavior in the time of recession as well as we investigate the difference in correlation between geographical regions and sectors of economy. Consequently, to understand the correlations which could be more specific for Slovak economy and more relevant for Slovak banks, given the lack of data due to the low liquidity of V4 markets, we focus on Central European region which consists of German, Austrian and Swiss financial markets.

The article provides a view on the evolution and sensitivity of systematic risk factors in the period of economic downturn which can be considered as its main contribution. At the same time, we construct a benchmark portfolio which in certain extent reflects Slovak conditions mainly due to the large dependency on German economy. The findings can be consequently considered by banks in the context of its stress test framework and scenarios setup, especially within the Pillar II.

2 Theoretical Background

The concept of idiosyncratic and systematic risk was introduced by Merton and Vasicek and in it has been accepted by Basel Committee within Asymptotic Single Risk Factor approach ASRF, Martin (2013). The borrowers default if they cannot completely meet their obligations at a fixed assessment horizon (e.g. one year) because the value of their assets is lower than the value of their debt. A good example of the presence of systematic element would be the large corporate portfolio where financial conditions of larger firms are interlinked and closely related to the general conditions in the economy. On contrary a typical example of low correlation portfolio is a retail portfolio where the defaults tend to be more idiosyncratic and less dependent on the economic cycle than corporate defaults. The asset correlations also determine the shape of the regulatory risk weight formulas as it is illustrated within Graph 1.

Graph 1 Sector specific correlations



Source: Custom processing according to IRB regulatory risk weight formulas

The increase in asset correlation results in the deformation of the risk weight curve. The curve gets more skewed toward better ratings with higher kurtosis. This shift significantly impacts obligors with good grades and low PDs since the low idiosyncratic risk has been amplified by significant systematic factor, which can result in significant capital implications in the form of an increase in unexpected loss or risk weighted assets.

The concept of unexpected loss can be summarized as follows; Basel Comitee (2005). The mapping function used to derive conditional PDs from average PDs is derived from an adaptation of Merton's 1974 single asset model to credit portfolios. According to Merton's model, borrowers default if they cannot completely meet their obligations at a fixed assessment horizon (e.g. one year) because the value of their assets is lower than the due amount. Merton modelled the value of assets of a borrower as a variable whose value can change over time. He described the change in value of the borrower's assets with a normally distributed random variable. Vasicek in 2002 showed that under certain conditions, Merton's model can naturally be extended to a specific ASRF credit portfolio model. With a view on Merton's and Vasicek's ground work, the Basel Committee decided to adopt the assumptions of a normal distribution for the systematic and idiosyncratic risk factors.

The Unexpected Loss (RWA) can be calculated as follows:

$$Unexpected\ Loss = EAD \times\ LGD\ \times N((1-R)^{-0.5} \times G(PD) + \left(\frac{R}{1-R}\right)^{-0.5} \times G(0.999)) - PD \times LGD \times \left(1 - 1.5 \times b(PD)\right)^{-1} \times (1 + (M - 2.5) \times b(PD) \quad (3)$$

where N represents standard normal distribution, G represents the inverse of the standard normal distribution, R is asset correlation, PD stands for probability of default, LGD is loss given default and EAD represents exposure at the time of default.

3 Objective and methodology

Our main objective is to analyze the changes in systematic risk represented by asset correlations which are derived or proxied by the correlation of company's share price returns using publicly traded companies listed on the yahoo finance. To analyze evolution of asset correlations in time we calculate the average correlation of pairwise stock price returns within the 1 year moving average window using monte carlo simulations.

Düllmann (2008) in his paper differentiates between a direct stock price correlation estimation method which estimates asset correlations directly from equity returns and an indirect and conceptually better-founded method, which requires in the first step to estimate the asset returns from which in the second step asset correlations are estimated.

Asset correlations are approximated in the first, direct method by pairwise equity correlations, which are estimated from stock returns. Estimating asset correlations directly from equity prices is quite common in empirical studies and can be motivated by the equivalence of using equity and asset values in the limiting case when the length of the time horizon approaches zero. Using equity returns to estimate asset correlations has nevertheless been often criticized because it ignores the leverage in the capital structure. This is, however, considered a minor concern for high-grade borrowers.

The second, "indirect" estimation method consists of two steps. In the first step, the asset values are estimated from stock prices and liabilities and transformed into log-returns. In the second step, the asset correlations are estimated from the asset returns of the first step.

Henneke and Trück (2006) in their paper investigate asset correlations of Small and Medium Enterprises and they point out that neither the level of asset correlation nor the assumed relationship between correlation and probability of default as it is assumed in the Basel capital accord can be observed in the market.

Building on above research in this paper we are primarily interested in the directional change rather than estimating the exact values of asset correlations. Bearing in mind the fact

that we do not have access to balance sheet information we use the first method, described by Düllmann, that derives correlations directly form equity price returns.

Our development sample has been built on a relatively large sample of equity assets where we collected over 6,000 share tickers. These shares were split into segments, according to the geography, USA, Europe, Australia and sector such as Automotive, Construction, Trade etc. Since there was no recession in Australia in 2007 - 2012, the Australian market was included as a benchmark with the expectation of relatively flat overall correlations with less sensitivity to the global economic cycle.

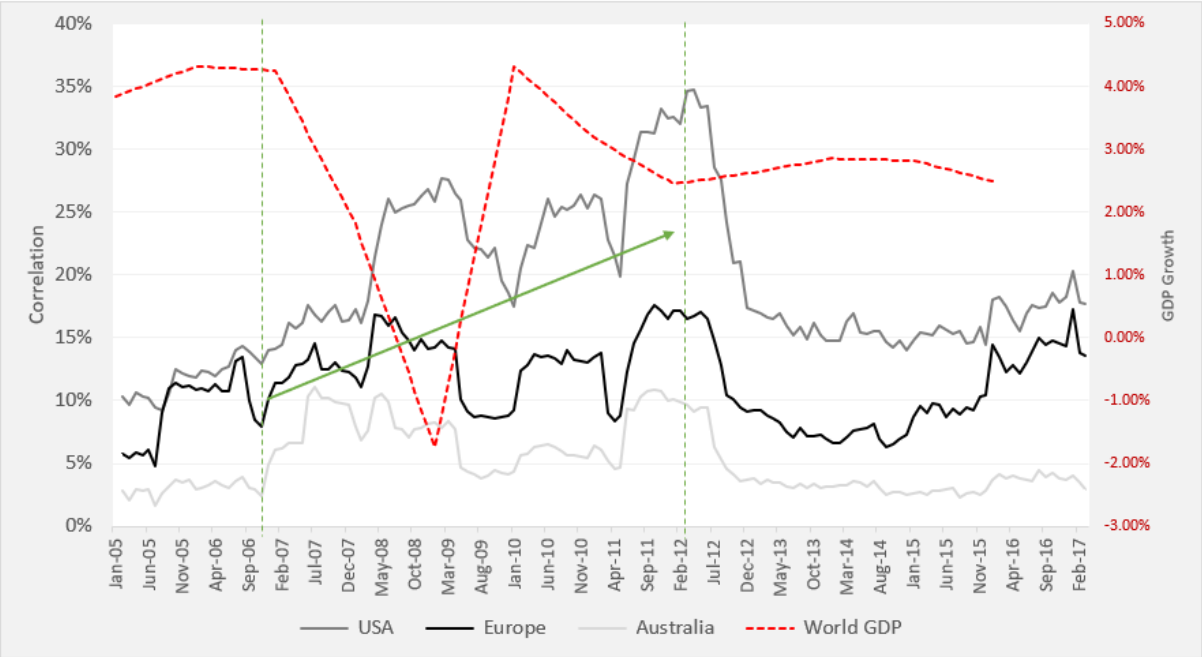
The data has been downloaded from finance.yahoo.com and further process in R where also monte carlo simulations were run.

4 Results and Discussion

In the first part of the analysis we focus on the average pairwise correlations in time and its dependence on economic cycle. Our assumption of higher correlations representing higher systematic risk in the period of crisis has been proved correct.

Graph 2 displays the evolution of average pairwise correlations between US, European and Australian share returns which are set into the context of world GDP growth representing the economic cycle.

Graph 2 Average pairwise correlations of US, EU and Australia stock returns

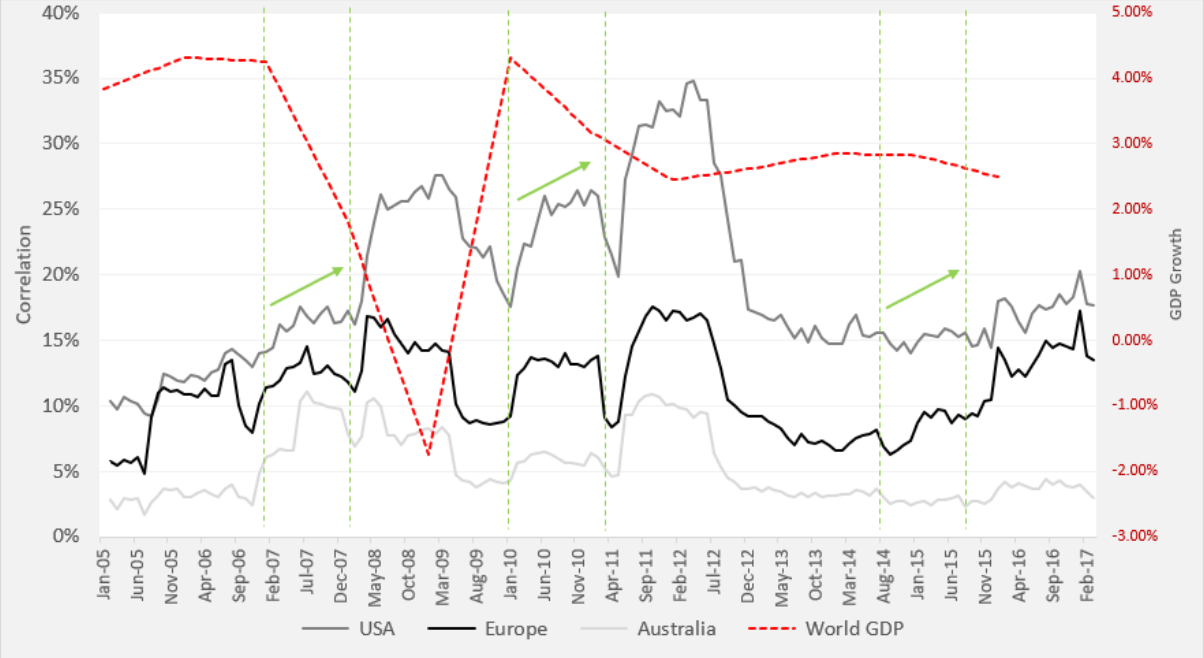


Source: Custom processing according to finance.yahoo.com data

From the chart we can observe a significant increase in average correlations between 2007 and 2012 and consequence reduction afterwards. In the case of US, correlations almost tripled and in EU nearly doubled. The highest systematic risk seems to be present within US market, peaking in February 2012. On contrary the example of Australia shows significantly lower values. These low interdependencies could be caused and at the same time could contribute to the fact that there has been no recession in Australia during the last global downturn.

Analyzing the dependence of economic cycle and average correlations we can observe that has taken approximately one year since the information of economic downturn had been translated into the significant increase in share price returns correlation as it is shown within Graph 3 below.

Graph 3 Average pairwise correlations in context of recession

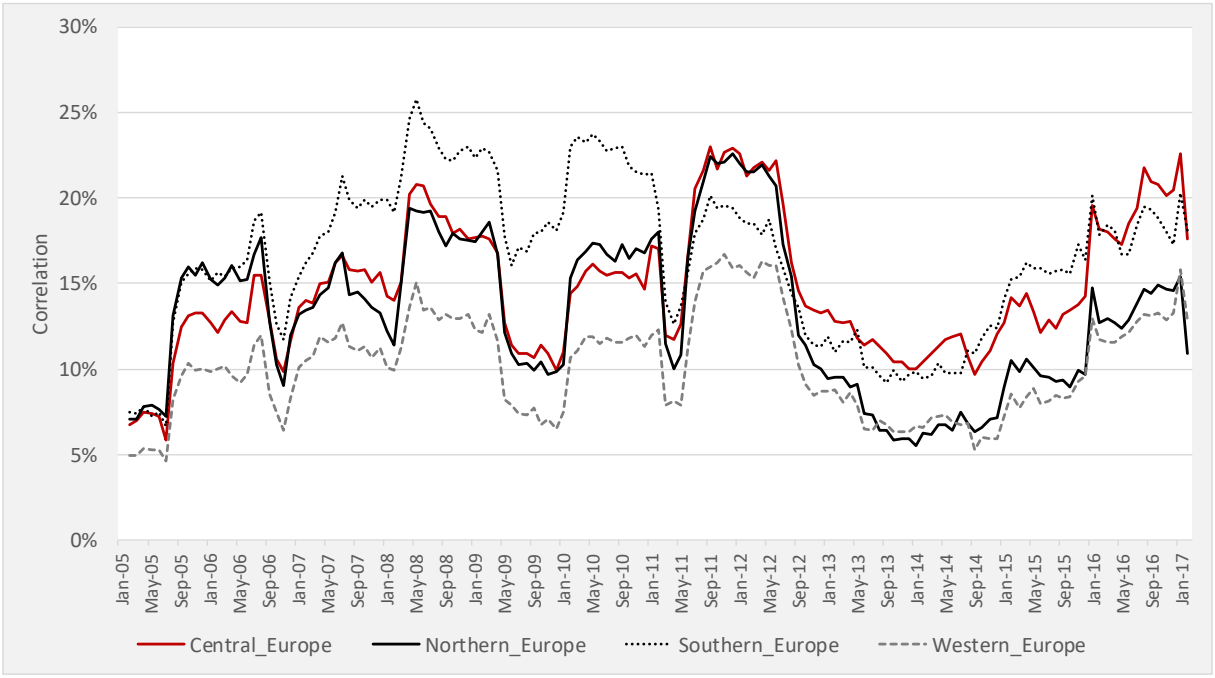


Source: Custom processing according to finance.yahoo.com data

To better understand the correlation structure that would be more relevant for the Slovak economy, we divided our European sample into four main geographical areas, Western Europe, Northern Europe, Central Europe and Southern Europe. The typical split between West and East was not plausible due to the insufficient trading activity and liquidity of Eastern European markets. The geographical decomposition indicates the highest presence of systematic risk factor in Southern Europe whereas in the Western Europe it is the lowest. In

the post crisis period, significant increase can be observed in the Central European region which is primarily driven by the increase in correlations in Germany (Graph 5).

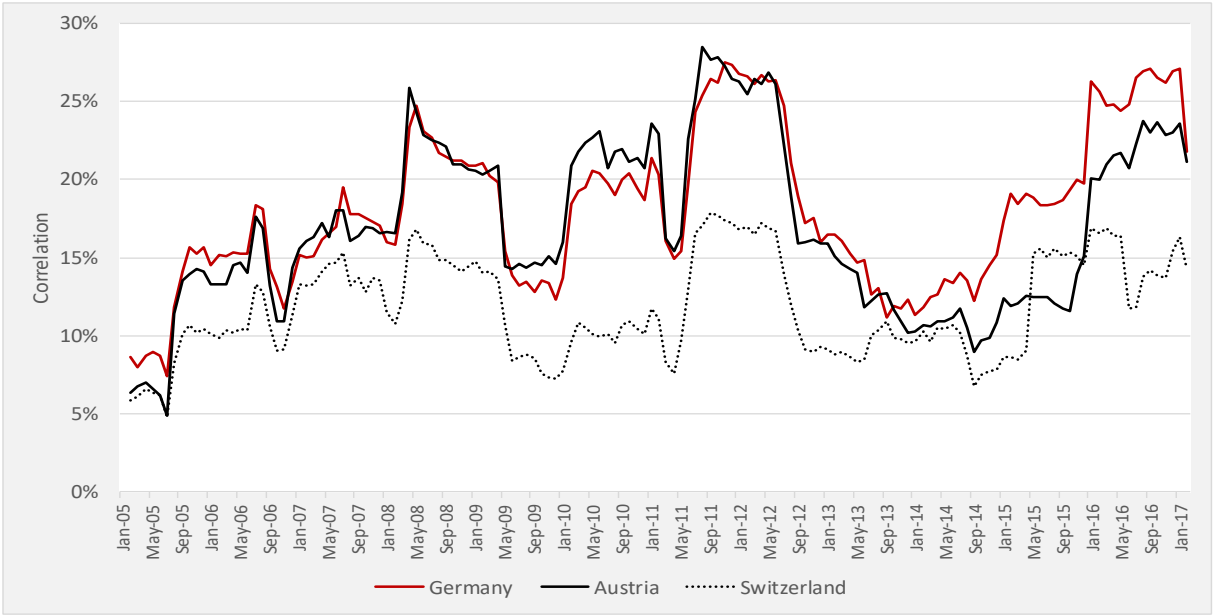
Graph 4 Average pairwise correlations within four main European regions



Source: Custom processing according to finance.yahoo.com data

Owing the fact that Slovak economy in open and it is closely correlated with the economic performance of Germany our reference geographical sector is Central Europe which is built of German, Austrian and Swiss capital markets.

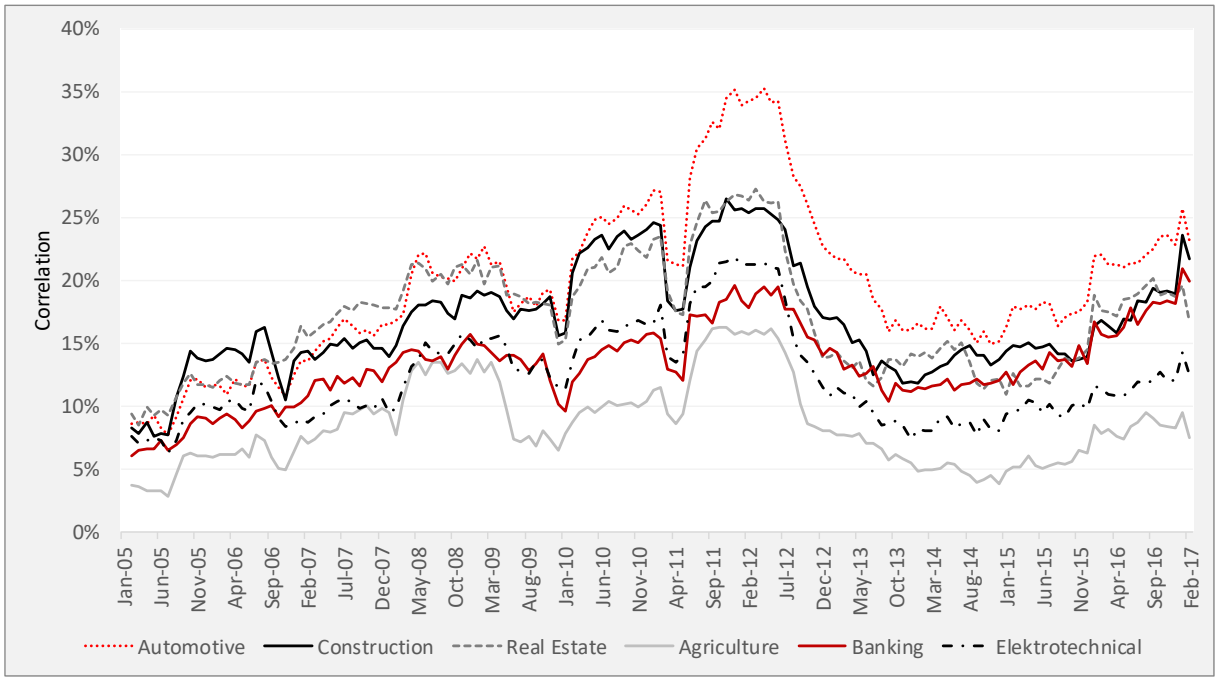
Graph 5 Average pairwise correlations within four main European regions



Source: Custom processing according to finance.yahoo.com data

Once understanding the dynamics between regions and relevant benchmark countries, the sector specific correlation analysis presented on Graph 6 aims to further investigate the presence of systematic factor within the sectors that are most relevant for Slovak economy. The sectoral correlation can play a significant factor in case of banks' exposure concentrations in specific industries.

Graph 6 Sector specific correlations



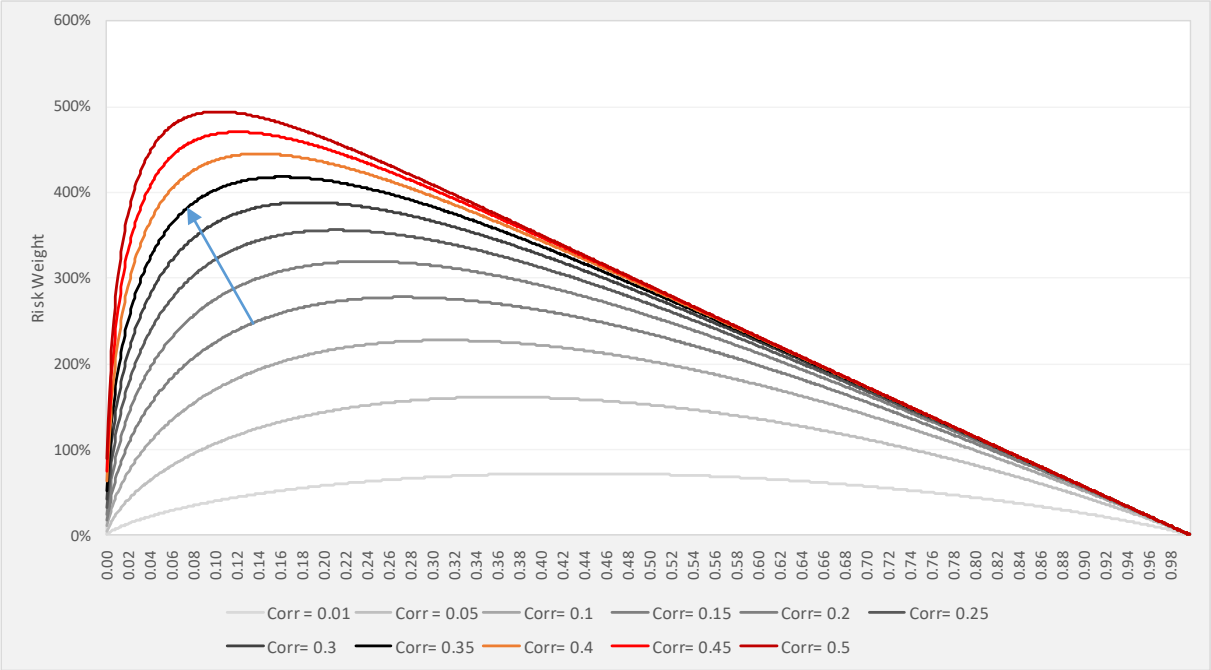
Source: Custom processing according to finance.yahoo.com data

Graph 6 displays a time series of sector specific correlations that are most relevant for the Slovak economy and the Slovak financial sector. The industries with greatest level of systematic risk are Automotive, Construction and Real Estate. Given the fact that the Slovak Economy is mostly built around these industries, this observation is rather alarming, and it is stressing the importance of economy diversification and systematic risk mitigation.

The Basel regulation predefines asset class specific values of asset correlations. In the nonretail and corporate asset class the asset correlation is a function of probability of default ranging from 12 to 24 %. These correlations are applied uniformly across different nonretail sectors. The increase in correlations in crisis period represents an increase of systematic risk which should be adequately captured within bank's stress testing framework.

Graph 7 displays a sensitivity of IRB Risk weight function to various levels of asset correlations.

Graph 7 Sector specific correlations



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The increase in asset correlation results in the deformation of the risk weight curve. The curve gets more skewed toward better ratings with higher kurtosis. This shift significantly impacts obligors with good grades and low PDs since the low idiosyncratic risk has been amplified by significant systematic factor, which can result in significant capital implications.

This shift is exceptionally dangerous for Automotive industry where we can observe the average correlation increasing from 15% to its peak of 35% in July 2017.

Conclusion

In the paper we analyzed asset correlations and its dependence on economic cycle. Our assumption of higher correlations representing higher systematic risk in the period of crisis has been proven correct. Analyzing the dependence of economic cycle and average correlations we can observe that it has taken approximately one year since the information of economic downturn had been translated into the significant increase in asset correlations which could give banks a certain time to prepare its portfolios for systematic risk shock. The highest level of correlations has been observed within US market, while Australian market resulted to be the lowest which supports the fact that Australia economy was performing well during the last global economic crises. The industries with highest level of systematic risk such as Automotive, Construction and Real Estate represent major contributors to Slovak

GDP. This observation is stressing the importance of Slovak economy diversification and systematic risk mitigation and it should be considered by banking institutions in the respect of their portfolio concentrations.

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