IMPACT OF FINANCIAL DERIVATIVES ON SYSTEMIC RISK

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Abstract. Financial derivatives are a fast-growing area of financial instruments. They take a very important place among other financial products, because not just their value depends on underlying assets, but they are also used in many other financial products. Scientists observe, that financial derivatives are beneficial to country's economy but at the same time pose many risks, which increase country's systemic risk. It can be noticed, that financial derivatives were highly criticized after 2008 global financial crises, and it became very important to assess their impact on country's systemic risk. However, no scientific analysis has been performed so far to asses and justify theoretical impact of financial derivatives on the country's systemic risk. This research analyses scientific literature and theoretical insights are provided regarding the impact of financial derivatives on country's systemic risk.

Keywords: Derivatives, Systemic risk, Factors of derivatives impact on systemic risk

JEL classification:

G01 – Financial Crises

G15 – International Financial Markets

G19 – Other

G23 – Non-bank Financial Institutions, Financial Instruments, Institutional Investors

O16 – Financial Markets, Saving and Capital Investment, Corporate Finance and Governance

Introduction

Financial derivatives are a fast-growing area of financial instruments. Their growth over the last few decades has been staggering. However, research by most scientists reveals that financial derivatives are not only beneficial to the economy, but also pose a systemic risk that has been widely discussed among scientists since the 2008 global financial crisis.

The study conducted by Irena Mačerinskienė et al. (2015) identified factors that could be used to assess the impact of financial products on a country's systemic risk. However, it should be noted that despite the identified factors for assessing the impact of financial products on systemic risk, no scientific analysis has been performed so far to asses and justify theoretical impact of financial derivatives on the country's systemic risk.

Thus, the expected problem of the research is: what is the importance of financial derivatives for the country's systemic risk? The object of the research is the impact of financial derivatives on the country's systemic risk. The aim of the research is to analyse the scientific literature and justify the impact of financial derivatives on the country's systemic risk.

Objectives of the research:

1. To analyse scientific literature regarding the factors, which are studied by scientists when assessing country's systemic risk;
2. To justify the impact of financial derivatives on the country's systemic risk via the identified factors, which impact country's systemic risk.

Methodology of the research:

1. Analysis of scientific literature;
2. Theoretical analysis and generalization.

1. Market Size Factor of Financial Derivatives

As revealed in the research of Irena Mačerinskienė et al. (2015), the impact of financial products on the country's systemic risk can be assessed via six identified key factors. This suggests that it is necessary to evaluate the theoretical basis of these factors and the country's systemic risk and to provide theoretical insights regarding the impact of financial derivatives on the country's systemic risk via those six factors.

The market of financial derivatives is one of the largest markets of financial products in the world. Data from the Bank for International Settlements and the World Bank show that the market of financial derivatives is significantly larger than that of debt and equity securities.

According to scientists, the "size" factor is an important systemic risk factor when assessing the country's systemic risk. Luc Laeven et al. (2016) found that systemic risk increases with the

increase of bank size. The study conducted by Olivier De Jonghe et al. (2015) showed that bank size influences the impact of non-interest income on systemic risk: for large banks, non-interest income reduces systemic risk, while for small ones, on the contrary, it increases systemic risk. The results of the study by John Sedunov (2016) show that important factors of systemic risk are size, securitization, and foreign asset trading. Sergio Rubens Stancato de Souza et al. (2016) conclude that in Brazil, medium-sized banks have a greater impact on systemic risk and small and large-sized banks have a correspondingly smaller impact. Benjamin M. Tabak et al. (2013) emphasize that an uneven banking market in terms of bank size is detrimental to the performance of smaller banks and reduces the stability of the entire system.

The analysis of scientific literature shows that size has various impact on systemic risk. This factor is usually analysed in terms of financial institution size. However, in terms of financial derivatives, the best equivalent of financial institution size would be the market size of financial derivatives. According to the authors of this research, it should be emphasized that financial derivatives are one of the channels through which financial institutions establish interconnections in the financial system: one financial institution buys financial derivative, another sells it. The larger the market of a financial instrument, the more various financial institutions depend on that financial instrument, its price fluctuations, market stability. An assessment of the balance sheet of the financial statements of an individual financial institution may provide information about the extent to which a particular financial institution is dependent on a financial product. However, the overall market size of a financial instrument indicates the extent to which the entire financial system is dependent on the financial product.

Furthermore, closely related to the size factor is diversification, which is widely analysed by many scientists. Diversification, as observed by Paolo Tasca et al. (2014), Louis Raffestin (2014), Hsiu-Chuan Lee et al. (2016) and many other scientists, is often beneficial to the financial system as it helps to reduce risk, increase profits, and control cash flows more successfully. The more financial products that exist in the financial system, the more opportunities for diversification. However, when financial markets are focused on a few financial products, the diversification effect diminishes. Meanwhile, with excessive diversification, most market participants begin to hold similar assets in their portfolios, leading to increased systemic risk.

In summary, if the market of financial instruments is perfect, it would consist of many different financial products. Similarly to perfectly competitive market, such a market of financial products would provide significant benefits of the diversification effect, because market participants would be able to choose from a wide range of financial instruments. However, in a market of financial instruments, it is also important that the correlation between different financial products is different. If there are many financial products in the market and the prices of all move in a similar way

(correlation close to 1), then the diversification effect decreases. A similar thing happened during the financial crisis of 2008, when market participants started selling various financial instruments and their price changes became more similar. According to the authors of this research, the market size of a financial instrument, correlation between different financial instruments and systemic risk can be described as in Figure 1.

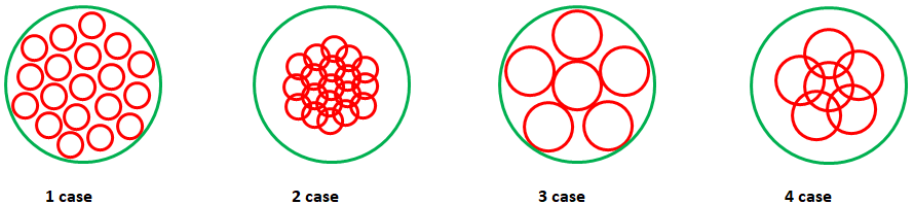


Figure 1. Market size of financial instruments and correlation impact on systemic risk

Each case in Figure 1 can be described as the following:

1. If the market of financial products is perfect, then existing different correlations between products decrease systemic risk;
2. If the market of financial products is perfect, then similarly fluctuating prices of products increase systemic risk;
3. If the market of financial products is concentrated, then existing different correlations between products decrease systemic risk;
4. If the market of financial products is concentrated, then similarly fluctuating prices of products increase systemic risk.

In the first case of market size and correlation impact on systemic risk, there systemic risk should be lower than in the third case, because market participants would be able to choose from a wide range of financial instruments. Thus in a perfect market of financial products, in the event of a financial shock, the impact on the financial system would be small. Meanwhile, in a concentrated market, a large proportion of market participants would have a concentrated financial instrument as an asset, which would transmit a financial shock to a large number of market participants and have a more significant impact on the financial system.

In the second case, there systemic risk should be lower than in the fourth case. Although asset prices would move similarly in both situations, in a perfect market of financial products, market participants would be able to choose from a wide range of financial instruments. Possibly some market participants would not hold all financial instruments, but only a part of all existing products. Scientists note that the financial shock is gradually being absorbed by market participants, in other words, the impact of the spreading shock is gradually diminishing. Accordingly, a shock would spread among many financial instruments and fade faster than in a concentrated market (fourth case). In a

concentrated market, a large proportion of market participants would also have a concentrated financial product as an asset, which would transmit a financial shock to a large number of market participants. Due to the slower absorption of the impact of the financial shock and similar movements in the prices of financial instruments, a financial shock would have a more significant impact on the financial system in a concentrated market.

It should be noted that, according to the authors of this research, the market of financial derivatives is significantly large, so the current market of financial products is not perfect. It is clear that the monitoring of financial derivatives in such a market is important and necessary and that the assessment of systemic risk should consider such market concentration.

2. Interconnections With Other Financial Instruments Factor of Financial Derivatives

The "linkage" or "interconnections" factor is quite often studied by scientists in assessing the country's systemic risk, but there is no clear consensus on the impact of this factor on systemic risk among scientists. Frank Betz et al. (2016) emphasized that the financial crisis of 2008 was influenced by such factors as contractual relations between market participants, counterparty risk, and the consequences of price changes. The study conducted by Ramaprasad Bhar et al. (2013) shows that fluctuating interconnections have been observed between financial sectors of France, Germany, the United Kingdom and the United States in the short term, and there have been constant interconnections between the German and the United States financial sectors in the long term. Georgios Magkonis et al. (2016) conclude that interconnections exist between financial and fiscal sectors and these interconnections have recently increased. Shauhrat S. Chopra et al. (2015) note that individual sectors in the United States, such as energy supply, telecommunications, transportation, are highly interdependent and disruptions in one sector can have serious consequences for the entire economy, affecting sectors that are directly and indirectly related to a sector in difficulty. Aymen Ben Rejeb et al. (2016) found that interconnections strengthen in the presence of bull markets in financial market and weaken in the presence of bear markets.

The analysis of scientific literature shows that majority of scientists emphasize the importance of interconnections factor for systemic risk. Scientists usually analyse this factor in terms of interconnections between different countries, markets, sectors, companies. As mentioned earlier, market of financial derivatives is significantly large. The value of financial derivatives depends on other basic assets, and at the same time financial derivatives are used in various other financial products. This means that financial derivatives are significantly connected to various financial products. So having this in mind, according to the authors of this research, interconnections factor in financial derivatives can be examined by analysing the structure of the market of financial instruments.

Before our era, then currency and coins were created. State-guaranteed paper money was created in China in 1024. The first stock exchange was established in Amsterdam, in which shares were traded, in 1602. An investment fund was established in the Netherlands in 1774. Inflation-linked bonds were created in Massachusetts in 1780. The securitization of the United States real estate loans began in 1970. An exchange traded fund (ETF) was established in Canada in 1989. The origins of financial derivatives are found before our era, but they began to develop most rapidly in the 19th and 20th centuries. Nowadays newer and more sophisticated financial instruments, structured products, etc. are being developed. Noting such development of financial products, the authors of this research would like to draw attention to a fundamental trend in the development of financial instruments – newly created financial instruments are more complex derivatives of existing financial instruments / assets. This trend can be illustrated as in Figure 2.

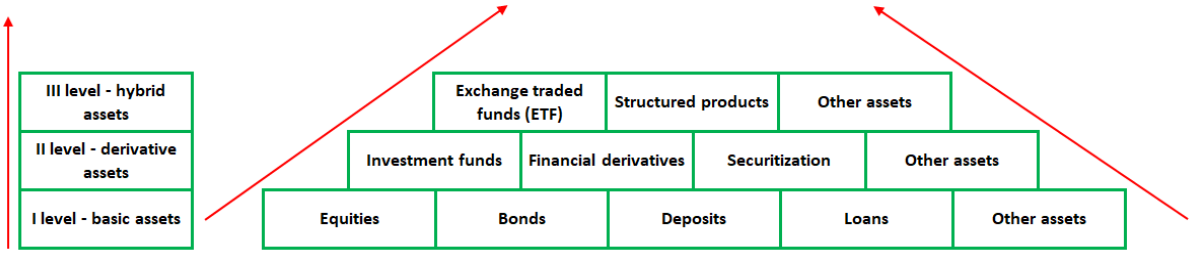


Figure 2. Market structure of financial products

Level 1 in Figure 2 shows the underlying assets, which are assets whose value depends on their own price fluctuations, demand / supply. Level II shows derivative assets, the value of which depends on the price fluctuations of the underlying assets. Level III shows hybrid assets, the value of which may depend not only on fluctuations in the prices of the underlying assets, but also on fluctuations in the prices of derivative assets. There is a clear trend in the development of financial instruments – it's not new basic products that are being developed, but derivatives based on basic products. In this way, a pyramid of financial instruments is created. Intuitively, such a structure of financial instruments is not stable, because when any underlying asset collapses, the whole pyramid of financial instruments collapses. Due to a similar situation, the global financial crisis of 2008 had significant negative consequences for the global financial system. As the real estate prices in the United States began to decline, the value of financial instruments linked to those prices also began to decline. The sale of linked financial instruments was launched and, due to the interrelationships between the financial instruments, such sales also had a negative impact on the prices of other assets. Then prices of many assets began to fall, and the long-standing negative historical correlation between some assets suddenly increased and became a positive correlation.

Obviously, for the market structure of financial products to be stable, new underlying assets

should be created. This in turn would increase the benefits of diversification. Financial derivatives are at level II in Figure 2. Therefore, in terms of interconnections, in order to assess the impact of financial derivatives on systemic risk, it is important to assess the links between financial derivatives and other assets, both underlying and hybrid assets.

3. Leverage Factor of Financial Derivatives

Another important factor, which is often analysed by various scientists, for assessing systemic risk is "leverage". The study conducted by Sanjai Bhagat et al. (2015) showed that financial institutions took on more risk by increasing leverage between 2002 and 2012. Such behaviour by banks contributes to less stability in the financial system, as, according to various scientists, high leverage can significantly worsen the situation of any company in times of economic difficulties. Christopher Bierth (2015) concluded that systemic risk is low in the global insurance sector, and the main systemic risk factor in the insurance sector is leverage of policyholders. Tarik Roukny et al. (2018) found that leverage increases uncertainty in both the interbank market and the external assets market. S. Thurner (2011) demonstrated that higher leverage leads to increased price variability in financial markets, which in turn increases risk. In addition, small random events, that do not normally cause damage at low leverage, can have a strong impact on the entire system at high leverage.

The analysis of scientific literature shows that leverage factor is usually considered as having negative impact on systemic risk and is usually analysed in terms of financial institution leverage, which is called financial leverage in microeconomics. However, leverage is also sometimes analysed in financial markets as a credit to supplement speculative investments. In terms of financial derivatives, the best equivalent of leverage would be the "leverage as a credit to supplement speculative investments". Financial derivatives enable market participants to acquire large amounts of assets for a sum of several or tens of times less than the value of the assets being acquired. Considering observations made by S. Thurner (2011), "leverage" factor of financial derivatives has two features: a) the multiplier and b) the speculative (see Figure 3).

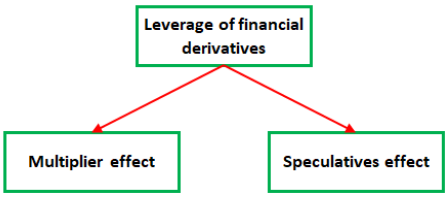


Figure 3. Impact of leverage of financial derivatives on financial system

The first feature of leverage encourages money creation, much like the multiplier effect in the financial system. In this way leverage creates additional demand / supply in assets markets and encourages price variability. For the second feature of leverage the nominal value, for which the

financial derivative allows to execute (buy / sell) the transaction in relation to the underlying asset, of the financial derivative becomes very important. Despite the fact that a large proportion of financial derivatives are settled in cash rather than by delivery of the underlying asset, it is the nominal value that indicates the amount of the underlying asset of the transaction. If financial derivatives were used only for risk management, the nominal value of financial derivatives should not exceed the value of the underlying assets existing in the market. However, according to BIS data, the value of financial derivatives is significantly higher than the value of underlying assets. Such a situation is speculative. According to various scientists, speculation destabilizes the financial system by raising asset prices too much during good times and by dropping prices too much during bad times. Therefore, the leverage of financial derivatives and the ability to settle without delivering the underlying asset creates favourable conditions for market participants to use financial derivatives for speculative purposes, which in turn inflates asset prices and increases their variability, in other words, systemic risk increases.

4. Market Liquidity Factor of Financial Derivatives

The analysis of scientific literature shows that "liquidity" factor is usually analysed both from microeconomics and macroeconomics aspects. In the first case liquidity is examined in terms of companies', financial institutions' liquidity. In the second case liquidity is examined in terms of individual financial products or overall market of financial products liquidity. Giovanni Dell'Ariccia et al. (2014) observed that the 2008 crisis may have been triggered by low interest rates and the high level of asset liquidity that existed at the time, prompting financial institutions to take excessive risks, thereby increasing asset prices and leverage in the financial system. Eleonora Iachini et al (2016) also highlighted that the financial crisis of 2008 revealed how market liquidity can suddenly decline. Liquidity changes over time for both individual securities and the overall securities market. Andreas A. Jobst (2014) also noted that funding decisions by individual banks can have a direct impact on the vulnerability of other banks. When a financial institution faces financial difficulties, it has to sell its assets or avoid taking on too much risk. In this case, the prices of the assets may start to fall or their liquidity may decrease, which will also affect other market participants related to the bank in financial difficulties or related to the capital markets in which such a bank is trading.

Viral V. Acharya et al (2016) described the relationship between leverage and liquidity, arguing that leverage helps to increase liquidity, provides an opportunity to choose better assets. But on the other hand, scientists agree that high leverage makes the financial system fragile. At this point, the authors of this research would like to object to Viral V. Acharya et al (2016) opinion on the relation between leverage and liquidity. According to the authors of this research, greater leverage in the financial system creates the impression of a larger amount of money, but the existence of leverage

does not increase the actual amount of money and any other assets. As a result, greater liquidity and leverage would only lead to higher asset prices. It is intuitive that such a situation creates the impression of greater liquidity, but does not increase actual liquidity, so the authors do not agree that it is fair to assume that liquidity driven by leverage benefits the financial system.

Mabrouk Chouchène et al (2017) investigate the spread of liquidity shocks, by focusing their research on interbank lending during the 2008 financial crisis in the French state. The scientists have found that the interbank deposit channel plays an important role in transmitting liquidity shocks in the banking system. Scientists' research shows that the impact of liquidity factor can affect systemic risk via one of the many possible channels – the interbank lending market. Considering analysed scientific literature, in terms of financial derivatives, the best equivalent of liquidity would be overall market of financial derivatives liquidity. Financial derivatives are different market of financial products, and similarly to interbank lending market, liquidity shocks via financial derivatives market should also affect systemic risk.

The market of financial derivatives is large in size, and takes up a large share of financial products markets, so a sharp drop in liquidity could have a significant impact on most global financial institutions or other market participants. And due to the existing leverage feature in financial derivatives, a lack of liquidity can lead to a sharp drop in the prices of various other financial products.

5. Market Volatility Factor of Financial Derivatives

The analysis of scientific literature shows that "volatility" factor is usually analysed from macroeconomics aspect. In their analysis, scientists analyse price volatility of individual financial products. As noted by various scientists, price volatility is higher for those assets that have leverage, longer maturity, or options. Inchang Hwang et al. (2017) examine volatility in relation to hedge fund returns. Their results suggest that hedge funds with higher systemic risk yield higher returns. Elyas Elyasiani et al. (2017) also investigate hedge funds. The scientists observe that hedge fund volatility shocks have side effects on other hedge funds, major banks, and major asset classes. In their study, Massimiliano Caporin et al (2017) propose a three-factor model composed of a constant factor that reflects long-term volatility; a short-term factor that reflects the temporary component of the volatility index; the volatility jump factor that determines the distribution of volatility in the right tail of the frequency distribution graph. Their study shows that the likelihood of volatility jumps increases dramatically during financial crises.

Hayette Gatfaoui (2013) found that during the crisis in the United States real estate market, the overall level of volatility increased, as did the likelihood that volatility would be passed on to other regions. According to the scientist, the process of transmitting volatility shocks takes place simultaneously in all financial markets. Lucia Baldi et al. (2016) analysed the spread of volatility

between agricultural commodity and stock markets and concluded that the spread of volatility increased sharply after the 2008 global financial crisis. According to scientists, this demonstrates the growing interdependence between financial and agricultural commodity markets. Scientists often agree that volatility has a significant impact on systemic risk, especially in cases where leverage is high, because even small fluctuations in such an environment could cause significant damage.

According to the authors of this research, the impact of volatility on systemic risk is quite evident – larger fluctuations increase risk and uncertainty in the financial system, which in turn increases systemic risk. In terms of financial derivatives, as already mentioned, the market is significantly large. Price fluctuations in such large market can affect a large number of market participants. If losses were to be incurred in such a market, many market participants would suffer. In conclusion, it is important to emphasize once again that the volatility of financial derivatives is an important factor in the context of other factors, and that high volatility can have a significant impact on most global financial institutions or other market participants.

6. Complexity Factor of Financial Derivatives

The analysis of scientific literature shows, that scientists often find that the financial system can be seen as a complex system and financial products as increasingly complex and difficult for other market participants to understand. As Mariolia Kozubovska (2017) observes, financial products have become so complex that an investor would have to read about 200 pages to understand the characteristics of real estate bond securities and understand how they work. An investor, who wants to understand components of asset backed securities, would need to read over one million pages. This, according to the scientist, automatically explains the challenges required to fully understand the complexity of structured products.

Jing Ma et al. (2019) found that the financial system is so complex that the model of heterogeneous interbank network and overlapping portfolios developed by the scientists cannot fully reflect the complexity of the system. Prasanna Gai et al. (2011) in their study demonstrate how greater complexity in the financial system can increase the vulnerability of the financial system. Akhigbe et al. (2018) conclude that it is difficult for investors to understand the impact of the use of bank interest rates on financial derivatives on future cash flows. Kaeck et al. (2020) note that the most successful pricing models for VIX financial derivatives are highly complex.

In terms of financial derivatives, these financial products are considered as highly complex. It is difficult to understand how they work, difficult to calculate their value (many financial derivatives require highly complex calculations to find their price) and to read their legal material, which consists of many pages. In conclusion, it is important to emphasize that the analysis of complexity in research is still not very advanced, as it is quite complex to assess “complexity” and

its impact on systemic risk. There is no consensus among scientists as to whether higher complexity really increases systemic risk, but many scientists usually follow such point of view. Nevertheless, all scientists agree that complexity has a significant impact on systemic risk.

Conclusions

Analysis of the scientific literature and provided theoretical insights regarding impact of financial derivatives on the country's systemic risk have shown that financial derivatives are highly interconnected to other financial products. The value of financial instruments is calculated on the basis of the underlying assets. In addition, financial derivatives are used in other financial products, which creates the pyramid of financial products. Such market structure of financial products should be vulnerable and pose high systemic risk. The impact of the size factor of financial derivatives on the country's systemic risk could be best described via the concentration of financial products. The leverage impact of financial derivatives affects systemic risk via multiplier and a speculative features. The liquidity and volatility impact of financial derivatives affects systemic risk via the change in liquidity of financial derivatives market and the change in financial derivatives values. The impact of the complexity factor of financial derivatives on the country's systemic risk could be best described via the limited ability of market participants to properly understand and evaluate these financial instruments.

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