

CZELLENG ÁDÁM

**THE MACROECONOMIC ROLE OF MARKET LIQUIDITY**  
-  
**MICROSTRUCTURE ANALYSIS FROM A REGULATORY POINT OF  
VIEW**

PHD DISSERTATION

THESES

SZEGED, 2019

University of Szeged  
Faculty of Economics and Business Administration  
Doctoral School in Economics

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## 1. Introduction

Since the beginning of the modern economic system, liquidity of financial market has been playing an important role in the economy.

As Keynes noted (1936, 160 p.), “*For the fact that each individual investor flatters himself that his commitment is “liquid” (though this cannot be true for all investors collectively) calms his nerves and makes him much more willing to run risk*”. After the financial crisis of 2008-2009, liquidity of financial markets has become an issue and become to interest for many research.

In recent decades, financial markets have undergone significant changes. Financialization denotes the rise in prominence of financial activity, financial markets and financial institutions in the economy. The value of global financial assets multiplied as a result of financialization. One of its other equally visible consequences is that the barriers between firms conducting financial activities began to vanish. While previously only financial firms and banks dealt with loans and investment into financial assets, now it has become an ordinary activity regardless of branches. In my opinion, one of the most important consequences of financialization this article discusses, yet one that the international literature rarely explores, is the propagation of a short-term view. Due to the high profitability of the financial sector, the allure of quick returns replaced the long-term investment view, thereby diverting a significant amount of resources from real investment markets. According to Stein (1989), short-term view can be seen as a rational response from managers who have long-term objectives but believe that their activity is valued by the current stock price. In this case, managers need to adopt a short-term view in order to maximize their rewards.

As a result of this, managers chase extra profit by decreasing cost and take more risks. As equity is the most expensive way of financing, managers take on more debt. One source of risk is the increased leverage. The short-term view accompanied by financialization has also enhanced the financial companies to take on excessive risk in their balance sheet, thus it has made the financial system more fragile. There are plenty of empirical evidence-that the business cycles are shorter going forward in time. Seeing the anatomy of a business cycle, we could detect that it is mostly parallel with the financial cycle. Minsky (1992) carefully described his model and defined its stages. The Minsky super cycle illustrates that the system is allowed to take more financial risk. It can be done by increased risk-taking or regulatory relaxation.

The emergence of new monetary policy instruments was necessary not only due to financing constraints and the need for rapid intervention, but also because of the change in monetary

transmission and the emergence of new channels. One of the consequences of financialization presented earlier is that financial markets play an increasing role in fundraising, as well as saving. The line between the behaviour of financial and non-financial businesses is becoming thinner as many non-financial firms offer loans, manage portfolios and finance their activities by issuing bonds instead of bank loans. As a result, the importance of financial market liquidity has become more visible, which caused that central banks moved away from their position as ‘lenders of last resort’ towards a new position of ‘dealers of last resort’ (Mehrling, 2014).

Liquid financial markets are desirable for financial economists for many reasons. Higher liquidity means higher efficiency in source and information allocation. Therefore, central banks can intervene in the market in a more efficient way and central banks can even use indirect monetary policy tools as the transmission channel is stable and the effects of central banks’ operations are predictable. Liquidity has significant role to determine financial institutions’ behaviour as liquid markets allow banks to take larger maturity mismatch and also currency mismatch between assets and liabilities. Liquidity also has an impact on crisis management as financial and non-financial companies can fund their operation more easily, therefore reducing the risk on central banks to act as a lender of last resort during a recession.

Recently, liquidity has been in focus of theory and practice. Although liquidity and liquidity risk have been researched for decades, there are still various misconceptions about liquidity in practice and theory. The different concepts of liquidity are introduced by Váradi (2012a) and described shortly as the followings.

- Liquidity for a company means whether the company is able to meet its financial obligations.
- Liquidity for an asset market means whether the security can be traded quickly in a large volume without impacting the current price on the market.
- We can also use the concept of funding liquidity which means if a company/bank is able to add additional financing to its operation quickly on the current market price. This dimension of liquidity can be impacted by the market but by also a single company.
- Liquidity for the financial system means the excess of available cash in the whole system.

*“These liquidity concepts are related to each other as the liquidity of a company is determined by its assets’ market liquidity which is determined by the liquidity of the financial system” (Váradi, 2012, 3. p).*

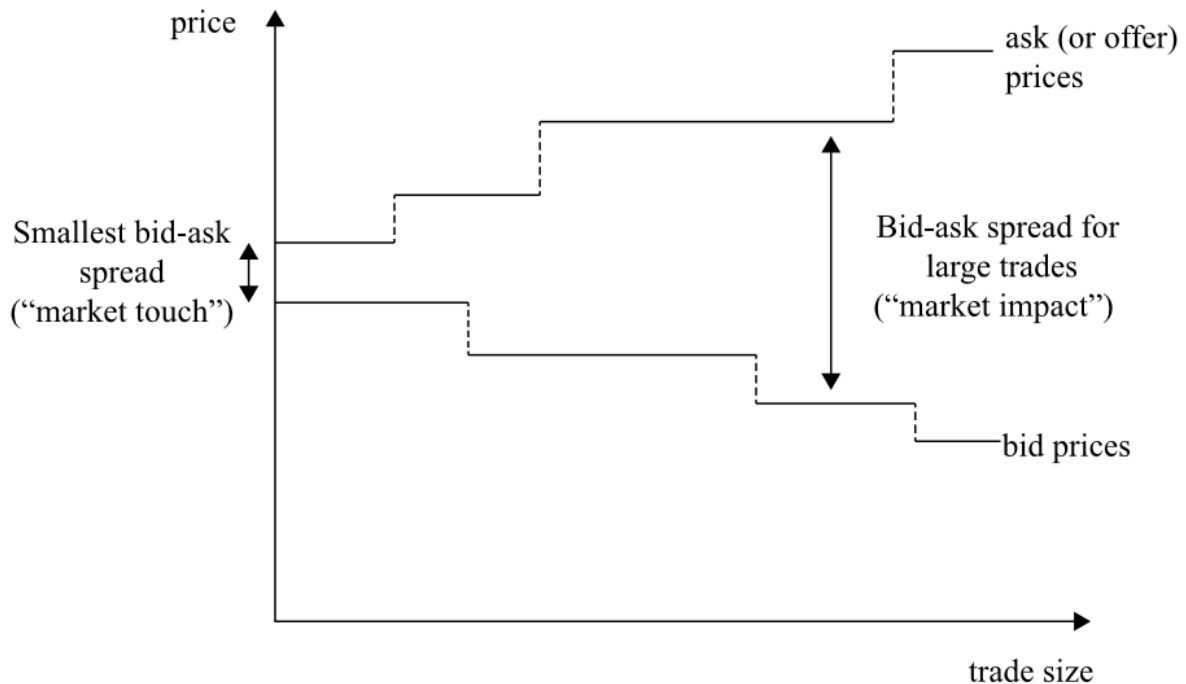
The concept of liquidity is really broad and complex therefore in this paper only on a particular type of liquidity is focused which is market liquidity. Market liquidity may be defined as the easiness with which market participants can buy or sell an asset in a market without affecting its price (Elliot, 2015).

As we focus on only liquidity of government bonds which is typically quote driven or so called dealer driven market. In dealer markets, the investors do not trade directly with each other, instead they trade with the dealer or so called market maker who is a kind of special intermediary. So, in dealer markets the market makers provide liquidity, and final investors are liquidity demanders while in limit order type markets investors can choose whether they would be on the side of liquidity suppliers or liquidity demanders.

*“Dealers’ quotes are typically valid for only a limited volume and short period of time. A large order may be executed by splitting it among several dealers. In that case, effectively, a seller/buyer is walking down/up on the demand/supply curve resulting from the aggregation of dealers’ bid-ask quotes” (Sommer – Pasquali, 2016, 4. p.).*

Figure 1 shows how different liquidity dimension are linked to each others. Bid-ask spread is often referred as market touch by practitioners. This can be measured any time on the market as it is a proxy for market liquidity. The figure illustrates how the transaction costs change and the spread varies when transaction is made in significantly larger amount.

1. Figure: The bid-ask spread and its change over the size of trade



Source: Foucault et al. (2013)

In practice, the quantitative modelers use market touch (the initial bid-ask quotes) until the point from the modelers assume the trading size impact the quoted prices. The turning point is called the point of endogenous illiquidity which reflects the depth of the market. After the point of endogenous illiquidity simple convex/concave functions or liquidity cliff (concave/convex until a point then convex/concave) can be assumed. These stochastic models usually include central bank floors as the new role of central banks is called as dealer of last resort instead of lender of last resort.

The liquidity of OTC markets is difficult to measure as the amount of available information is limited. As Sommer – Pasquali (2016, 6.p.) described “*the different levels of transparency in equity and bond market impact models are not as easily formulated for the latter as they are for the former. While transaction prices and volumes are made available by exchanges, fixed income markets are significantly less transparent and moreover, bonds are generally traded with slower turnover*”.

The aim of the dissertation is to contribute to the understanding of market liquidity and thus provide recommendations for a more effective regulation.

## 2. Objectives of the research

Not many theoretical and empirical studies examine the causality relationship between market liquidity and funding liquidity. Both theory and empirical works have been divided by the liquidity direction between the two. Mehrling (2014), Gromb and Vayanos (2002), Brunnermeier and Pedersen (2009) argue that increasing funding liquidity will result in elevated market liquidity because financial institutions provide liquidity of financial assets therefore their liquidity will impact the markets of financial assets. On the other hand, the broad literature of financial flexibility (a concept that emerged recently) consider financial markets' liquidity to determine the liquidity of the banking system and other companies. According to financial flexibility, a liquid financial market (i.e. a liquid financial asset) would provide liquidity to the banks as they would be able to easily raise funds by selling their assets, therefore they do not need to worry about the liability side of their balance sheets. Recently, the statement about funding liquidity determines market liquidity dominates the empirical works. Nevertheless, these papers are based on the data of the US financial markets. Based on the above, the research question is that: what is the source of liquidity in the CEE region? Transforming the research question into a hypothesis is considered as the hypothesis 1.

**Hypothesis 1: Funding liquidity of market makers determines the market liquidity in the CEE region.**

An empirical analysis is considered to test the hypothesis. For this empirical work, bid-ask spread and funding liquidity proxy are supposed to be collected for a group of CEE countries. Since Sims (1980), unrestricted estimation in system of equations of vector autoregression has become common in the economic literature. Therefore, analysing the effects and their significance can support or reject the hypothesis.

The most popular - Amihud and Mendelson (1980); Kyle (1985); Glosten and Milgrom (1985); O'Hara and Oldfield (1986) and Wang (2014) - microstructure models played an essential role to help us understanding the price and spread setting mechanisms. The majority of the literature assume a risk neutral, uninformed market maker which is a kind of exogenous, fixed point of the system. Therefore, bid-ask spread is usually described and considered as a market feature affected only by exogenous factors like the proportion of informed traders, transaction costs and selling/buying probabilities by liquidity traders. However, in the real world, market makers are profit oriented vehicles who face with risks and uncertainty thus their decisions and continuously changing behavior matters for market liquidity point of view.



**Hypothesis 2: Bid-ask spread is not just determined by exogenous factors as the behaviour of market maker also have impact on the bid-ask spread.**

None of the above mentioned leading studies examine the role of monetary policy in market liquidity. Neither direct nor indirect effect have been studied. The value of the financial asset may be affected or the probability of trade but it is not obvious impact. That is why one of the research questions of the dissertation is how market liquidity is affected by monetary policy as the current microstructure models do not cope with monetary conditions at all?

**Hypothesis 3: Monetary policy plays a more significant role from market liquidity point of view than it is considered by the literature as monetary conditions have direct and indirect effects on market liquidity.**

The majority of microstructure literature with information asymmetry concludes that increasing information asymmetry results in wider bid-ask spreads. Contrary to the literature, the existing empirical literature finds that bid-ask spread may be reduced when information asymmetry is greater. For details see Cornell – Sirri (1992), Shacher (2012) and Collin-Dufresne – Fos (2015) who empirically analysed the relationship of adverse selection and liquidity. The papers surprisingly find that liquidity increases when there is more active informed trading.

Collin-Dufresne – Fos (2012) extended Kyle (1985) model where noise trader volatility can change stochastically over time. However, the volatility of uninformed trading is measurable, price impact is following a stochastic process. According to their findings, the informed traders adjust their strategy and trade less when uninformed trading is less and they trade aggressively when the quantity of noise trades are higher. However, in this paper the increased information asymmetry is the consequence of the bid-ask spread and not vice versa.

**Hypothesis 4: Information asymmetry is directly affecting the spread however an increase in the information asymmetry between traders may decrease the spread.**

For analysing Hypothesis 2-4, a new microeconomic model is set and based on this microeconomic model of market makers an agent-based model was applied to identify the determinants of bid-ask spread. For studying the determinants of the bid-ask spread and the positioning of prices, a three-agents model with Monte Carlo simulation was considered as the most appropriate method to investigate. This is because it allows us to analyse a wider variety of scenarios and also let us analyse the impact of different factors. The conducted model captures the complexity of the market so parameters which was previously ignored by the literature and their impact on the bid – ask spread i.e. risk sensitivity, risk taking willingness and so on.

The most popular models - Amihud and Mendelson (1980); Kyle (1985); Glosten and Milgrom (1985); O'Hara and Oldfield (1986) and Wang (2014) – do not explain the effects of regulation. However, in counter to monetary policy, we are able to infer the impact of regulation on market liquidity from those models. Regulation can have impact on trading probability, the proportion of liquidity traders and so on. Due to these models assume a passive market maker, we are not able to analyse the direct effects of regulation. In real world, market makers face with risks and uncertainty thus their decisions and continuously changing behavior matters for market liquidity point of view and regulation can have impact their behavior (and thus on their decisions). That is why one of the key research questions is the following. How can we apply our understanding of market liquidity to compose a more efficient regulation? This leads us to the fifth hypothesis of the dissertation.

**Hypothesis 5: The purpose of regulation is to prevent financial institutions from causing extreme fluctuations within the markets, however due to direct and indirect effects on market makers' behaviour it influences the spread as well.**

For analysing Hypothesis 5, a new microeconomic model is set and based on this microeconomic model of market makers an agent-based model was applied to identify the determinants of bid-ask spread. For studying the determinants of the bid-ask spread and the positioning of prices, a three-agents model with Monte Carlo simulation was considered as the most appropriate method to investigate. This is because it allows us to analyse a wider variety of scenarios and also let us analyse the impact of different factors. The conducted model captures the complexity of the market so parameters which was previously ignored by the literature and their impact on the bid – ask spread thus regulation can be considered as a feature with direct impact on market liquidity.

### **3. Structure of the dissertation**

The dissertation includes 7 chapters but it can be divided into two major parts. The first larger part (chapter 1 - chapter 3) gives theoretical framework for the research, including definitions, detailed discussion of liquidity, its dimensions and how liquidity emerged as an important feature of financial markets. The second part (chapter 4-7) presents my own empirical analysis.

The first major part introduces financialization and give detailed introduction of definitions, trends and summarizes the literature. Based on this literature review, research questions are formed which are turned into five hypothesis.

The second major part introduces and describes the models and methods applied or created to empirically analyzing the above mentioned and later discussed hypothesis. The chapters include the detailed description of econometric analysis (vector autoregression on detrended data by HP filter), a new microeconomic model for explaining the behavior of market makers and also a Monte-Carlo analysis on an agent-based model supported by the new microeconomic theory of market making. This part includes the results which give us a better understanding of market liquidity. Consequences and recommendations are included in those chapters.

#### **4. Methodology**

For analysing Hypothesis 1, Vector Autoregressive models are applied in order to capture the determinants and direction of liquidity in emerging markets. In the interest of structural impacts and changes, it is more convenient to detrend the data before fitting such models. Perhaps the most popular trend filter is Hodrick – Prescott filter or shortly HP filter based on Hodrick-Prescott (1997). The famous methodology was originally developed to capture the cyclical and fluctuations of US' real GDP and therefore assume the output gap. Vector Autoregressive (VAR) models were designed to provide an alternative to the large macroeconomic models. In spite of the fact that VAR models do not necessarily satisfy the Lucas' criteria for policy interventions, the methodology has become a widely used and popular technique in applied macroeconomic research.

For analysing Hypothesis 2-5, a new microeconomic model is set and based on this microeconomic model of market makers an agent-based model was applied to identify the determinants of bid-ask spread.

In the new concept of market maker's behaviour, the market maker or so called dealer aims to maximize its profit throughout buying and selling an interest paying security and holding or shorting it with the revenue or the cost of interest payment. The market maker is able to adjust the market price around the economic value of the security within a range called outside spread. The dealer accepts every trade claim from the market but throughout the price adjustments it can affect the quantity of demand and supply. After the trades the net short or long market risk of the dealer determines the price of the security. This is a continuous cyclical adjustment process which starts over every time the dealer's exposure changes.

For analysing the determinants of the bid-ask spread and the positioning of prices, a three-agents model with Monte Carlo simulation was considered as the most appropriate method to investigate. This is because it allows us to analyse a wider variety of scenarios and also let us

analyse the impact of different factors. In the model, we can distinguish market makers or so called dealers, uninformed traders and informed traders who are traders with fundamental information about the true value of the security.

The conducted model captures the complexity of the market so parameters which was previously ignored by the literature and their impact on the bid – ask spread is also analysed i.e. risk sensitivity, risk taking willingness and so on.

## **5. Summary of the results**

The theoretical and empirical models utilized in this paper provides special insights to the market liquidity determinants and methods. Therefore, we can take important economic implications. These are related to the efficiency of the regulation, the limitations of microprudential and macroprudential regulation, central bank policy and the commonality in liquidity.

**Hypothesis 1: Funding liquidity of market makers determines the market liquidity in the CEE region.**

Just a few theoretical and empirical work examine the causality relationship between market liquidity and funding liquidity. These papers are based on the data of the US financial markets so a more general comprehensive empirical analysis was constructed to find out the causal relationship between market liquidity and funding liquidity. The flow of liquidity between the two different liquidity dimensions is necessary to be explored for the dissertation as it makes inventory-based behaviour relevant.

Recursive VAR model methodology was applied for analyzing four countries empirically. The models include four variables and a constant component were used for each country and impulse responses were analysed to various shocks depend on the Cholesky ordering. The model variables are freely available GDP, inflation, banking sector balance sheet data and daily bid-ask spreads of government securities as a good proxy variable for transaction cost based market liquidity measures. The model provides empirical evidence that funding liquidity drives market liquidity. The results are clear, significant and robust and supported by the theoretical models of Gromb and Vayanos (2002) and Brunnermeier and Pedersen (2009). Similar evidence was found by Jylha (2016). The results can be seen as evidence for the important role of trader's funding liquidity for the liquidity of financial assets' markets. As a consequence of this hypothesis we can conclude that central banks can indirectly increase the asset's liquidity by boosting the funding of dealers.

**As a result of the analysis, significant evidences were found to accept Hypothesis 1.**

**Hypothesis 2: Bid-ask spread is not just determined by exogenous factors as the behaviour of market maker also have impact on the bid-ask spread.**

A new microstructure model was constructed with asymmetric information, inventory risk and monetary policy for analysing the determinants of the bid-ask spread and the price setting methodology in financial markets. The earlier microstructure models in the literature examine either the inventory risks' role in price setting or information asymmetry's impact on the market. In order to examine the price setting and liquidity in a more reliable and veritable way, the microstructure model introduced in this dissertation tried to capture various effects in the same time. Due to this, interactions between actors are not able to be solved by analytical methods therefore a three-agent model with Monte Carlo simulation was considered as best method to investigate. Contrary to the earlier models in the literature a microstructure model with inventory risk, information asymmetry and monetary policy is introduced to get better understanding about price and spread setting mechanisms of financial markets.

As the output of the three-agent Monte Carlo simulation showed, the liquidity of financial markets can be considered as a rather complex phenomenon. The liquidity impact of the factors may differ from the initial positions and the applied assumptions (like regulation). Generally, increase in risk taking willingness, risk sensitivity and market size (quantity of issued securities) would make the spread wider but these impact on liquidity are not joint and numerous for every scenario. Initial position, trading activity, trading volume and path of fundamental value do not have such a clear way to affect. The impact can be smaller, larger, convex or concave depending on the underlying initial assumptions.

**As a result of the analysis, significant evidences were found to accept Hypothesis 2.**

**Hypothesis 3: Monetary policy plays a more significant role from market liquidity point of view than it is considered by the literature as monetary conditions have direct and indirect effects on market liquidity.**

As a result of financialization financial markets play an increasingly important function within the economic stability. Nowadays not just financial institutions but any other actors within the economy use financial markets to get funded, allocate savings, mitigate risks and so on. Due to this increasing role, central banks have to put more emphasis on financial markets' liquidity. As a result of this phenomenon, many central banks swifed the way they operate. Central banks directly affect financial markets and changed one of their most important

functions for being the lender of last resort to being the dealer of last resort. This slight change for the first sight means a significant way in central banks' communication and even in operation as we could see it during the quantitative easing periods in Japan, US and Europe. Due to these reasons, a microstructure model was constructed with monetary policy tools included in the model. The risk-free interest rate's impact was quantified as an exogenous effect on financial markets' liquidity.

The risk-free interest rate affects the expected rate of return for the market maker. As the model confirms our expectations higher risk-free interest rate results wider spread in the market. Therefore we can conclude that the market liquidity is lower. An increase in the risk-free interest rate increases the financing cost of the market maker and throughout the yield searching the market maker would look for other investment opportunities without increasing. This is why we can say one of the most important roles of the risk-free interest rate is the benchmark role which is getting more emphasized in contemporary times for monetary transmission mechanism. Monetary policy can influence the risk-free interest rate which can determine the liquidity of the markets therefore maintain stability for interbank collateral securities markets. The model results provide essential take aways regarding central bank policy as well. Risk-free interest rate has direct effect on market liquidity because of the profitability of the market makers (this is because yield searching market makers can turn their attention to risk-free assets instead of providing liquidity). However, monetary policy can also affect the risk sensitivity of the market makers if the central bank communicates that it is ready to step in as a dealer of last resort whenever the market needs it. In this case, dealers become less risk sensitive, so it results in tighter spreads. If the market knows that the central bank is ready to act as a dealer of last resort, the market makers would also increase the maximum risk they are willing to take because they are aware of the further possibilities to adjust their risk position via the central bank's asset purchasing program.

As a consequence of hypothesis 1 we already inferred that central banks can indirectly increase the asset's liquidity by boosting the funding of dealers.

**As a result of the analysis, significant evidences were found to accept Hypothesis 3.**

**H4: Information asymmetry is directly affecting the spread however an increase in the information asymmetry between traders may decrease the spread.**

The current knowledge about information asymmetry's effect on market liquidity is still incomplex. The paper also distinguishes low, medium and high level of information asymmetry. The simulation results confirm that the larger proportion of informed traders' results in wider

spreads at high level of information asymmetry while at medium and low degree of information asymmetry the proportion of informed traders increases the liquidity until a point then it decreases. This result can describe the theoretical background of some empirical works which surprisingly find that liquidity increases when there is more active informed trading.

Informed traders can cause information asymmetry induces adverse selection costs that make the dealer to set wider bid and ask prices. The simulation results confirm that the larger proportion of informed traders' results in wider spreads when the market maker has no information at all about the proper value of the underlying security. At medium and low degree of information asymmetry, the proportion of informed traders decreases the spread until a point, then it increases. It is due to the fact that informed traders help the market maker to adjust its balance sheet whenever it is needed therefore they help to maintain the fair price of the market. As a result of the microstructure model simulation, the results are consistent with the empirical literature, bid-ask spread may decrease when information asymmetry is higher. In the medium and low information asymmetry case, we can infer market maker with higher market power and thus more information which is significant qualitative difference from those assume in the existing theoretical literature. However, it is important to note that information asymmetry may have impact on the spread and on the depth as well. The relationship between market depth and information asymmetry is not well documented in the literature neither in theory nor in empirical literature.

**As a result of the analysis, significant evidences were found to accept Hypothesis 4.**

**Hypothesis 5: The purpose of regulation is to prevent financial institutions from causing extreme fluctuations within the markets, however due to direct and indirect effects on market makers' behaviour it influences the spread as well.**

Regulation of financial institutions aims to maintain financial stability and therefore economic stability. The regulatory authorities apply different rules to make a substantial contribution towards achieving their target. These rules are mainly about the maximum risk financial institutions can take but these rules are not just limiting their operations but also changing the banks' behaviour.

Regulation directly affects the taken risk by financial institutions which has significant and direct impact on the price and even on the spread. Regulation also have indirect impact risk taking willingness which have important role in price and spread setting method. Even consumer protection has various effects on the market liquidity. There is one clear effect is throughout the stability of dealers' funding liquidity but preventing market abuse and ensuring

that consumers are in safe and get fairly prices services from financial institutions. Consumer protection has a clear effect on promoting effective competition for services provided by financial firms which clearly have impact on risk sensitivity of market makers therefore on the market liquidity.

The term ‘macroprudential’ was coined in the 1970s, when it denoted the systematic supervision of the macroeconomy. However macroprudential regulation only came to receive a substantial amount of academic attention in the past decade. It was, however, the 2008 financial crisis that highlighted the necessity of macroprudential regulation for all countries. Microprudential policies had helped safeguard the interests of individual economic actors, but that was not enough; regulation needed to be implemented to safeguard the financial system as a whole. The model described in this paper provides evidence that microprudential regulation can help us maintain the stability on the level of institutions and the market. However, intensifying regulation would result in more stable financial institutions but (due to the institutions’ declining risk-taking willingness and increasing risk sensitivity) the regulation might have a negative influence on market liquidity.

The results regarding the degree of information asymmetry can help us to understand one of the reasons why the regulations have different impact on different assets’ markets.

As per the above-mentioned factors, we can conclude that there is an optimum level of regulation because too liberal rules would lead instability on both institutional and market level, while too rigorous regulation would no doubt be beneficial for continued institutional stability, yet, on the other hand, it would have a negative impact on the level of the market. The goal of macroprudential regulation is to find the optimum for the application of microprudential rules on the right institutions and right timing. It is also important to emphasize that macroprudential policy has to eliminate the so called regulatory relaxation from Minsky super-cycle which is about not to closely follow the systemic practice on risk taking however the financial institutions’ operation change quickly and willing to take on more risk due to financialization and short termism.

**As a result of the analysis, significant evidences were found to accept Hypothesis 5.**

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## **7. Publications related to the dissertation**

### **Published scientific publications**

*Czelleng Ádám (2019): A visegrádi országok pénzügyi integrációja: a részvény- és kötvénypiaci hozamok, valamint a volatilitás együttmozgásának vizsgálata wavelet és kopula tesztekkel, Statisztikai Szemle, 2019. April*

*Czelleng Ádám (2018): Financializáció a globális gazdaságban: okok és következmények, Külgazdaság 2018/8-9*

*Czelleng (2013): Flexibilitás hatása a tőkeszerkezetre, E-Conom 2:2.*

### **Accepted, but not published yet**

*Czelleng Ádám: Market Liquidity and Funding Liquidity: Empirical Analysis of Liquidity Flow Using VAR Framework, Acta Oeconomica*

### **Conference speeches**

*Czelleng Ádám (2018): The risk and uncertainty on market maker's price decision; XVII. PEME PHD konferencia, Budapest*

*Czelleng Ádám – Veres Máté (2018): Economic Sentiment, Safe Assets and the Visegrad Countries: a Post-Crisis Analysis, Cirt Conference, Rio de Janeiro; Konferencia előadó: Czelleng Ádám*

*Czelleng Ádám (2018): The financial integration of the Visegrad countries: examining the co-movement of stock and bond market return, liquidity and volatility by wavelet and copula tests, 3rd Central European PhD Workshop: Challenges in national and international economic policies, Szeged*

*Czelleng Ádám – Veres Máté (2018): Economic Sentiment, Safe Assets and the Visegrad Countries: a Post-Crisis Analysis, Cirt Workshop, Bécs, Konferencia előadó: Czelleng Ádám*

*Czelleng Ádám (2013): Adaptív pénzügyi piacok és reálgazdasági teljesítmény – magyar példa; 2. Interdiszciplináris Doktori konferencia, Pécs*