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Deposit Insurance and Moral Hazard in Hungary

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Deposit Insurance and Moral Hazard in Hungary

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1 INTRODUCTION

Deposit insurance is the insurance intended to protect depositors and provide for their reimbursement to a certain extent in the event of the dissolution of a financial institution. The explicit form of deposit insurance is created by the legislation determining what kinds of deposits of which institutions should be covered by insurance and up to what amount. The number of countries which have explicit deposit insurance has multiplied in the last four decades: there are more than 100 countries with such institutions today (*IADI*, 2017) in contrast to only 12 countries in 1974. The explicit form of deposit insurance in the 21st century is considered as a determining factor in the safety net of the modern system of finances (*Demirgüç-Kunt* and co-authors, 2008).

The institution of deposit insurance was introduced worldwide in order to improve the trust of depositors in the banking system and thus enhance financial stability. The basic theoretical model of deposit insurance (*Diamond* és *Dybvig*, 1983) also supports this thesis by demonstrating that deposit insurance prevents inefficient bank runs which could give rise to the forced sale of assets committed for a long term. In the event of an inefficient bank run, depositors do not run to the bank because of the inadequacy of the fundaments of banks, but only because other depositors do the same and they don't want to lose their money because of the panic. *Savchenko* and *Kovács* (2017) emphasize with reference to the recent crisis in the Ukraine that the trust in banks is of key importance, in lack of which the banking sector is unable to perform its task, which in turn may set back economic growth. So deposit insurance is advantageous as it prevents inefficient bank runs and reimburses small depositors in the event of the dissolution of a financial institution, some of whom would otherwise face liquidity-related and social difficulties.

However, deposit insurance also has a negative effect: the encouragement of banks and depositors to assume more risks. Deposit insurance encourages depositors to keep their deposit, up to the deposit insurance limit, in the banks promising the highest rate of interest, regardless of how risky the given bank is. Banks offering riskier credits can thus get financing more easily, as they can promise higher interests on the deposits, the

demand for which will be increased by the insurance. These phenomena are called “moral hazard” in deposit insurance, which may mutually give rise to the development of a relatively riskier banking system.

All the authors studying the subject of deposit insurance agree that moral hazard is to be taken into regard when designing and operating the deposit insurance system, however, their positions as to whether or not it is worth assuming the costs of moral hazard in order to prevent bank runs differ. I am looking for a solution in my dissertation which could prevent inefficient bank runs but encourage depositors to be cautious at the same time. The introduction of an own contribution is usually an effective means of maintaining market discipline regarding insurances. In the case of deposit insurance, the portion in excess of the reimbursement limit can be regarded as own contribution, therefore the setting of the deposit insurance limit is a key issue to control moral hazard. There have been few precedents for the introduction of own contributions below the reimbursement limit worldwide as the fear from the loss of the own contribution is generally considered to provide sufficient encouragement for small depositors to run on the bank, which in turn would render deposit insurance to be of no use. My dissertation is also intended to contribute to the dissolution of this controversy by examining moral hazard from a new perspective.

The moral hazard inherent in deposit insurance has been examined in the empirical studies so far only based on the correlations between national deposit insurance regulations and the risk indicators of the banking system. My own empirical study wishes to expend the literature on the matter with a different approach, by comparing the data available on credit institutions liquidated or existing in the same period in Hungary and their depositors.

The purpose of my research is to explore if there are any signs of moral hazard in the case of credit institutions liquidated in Hungary and I will examine the subject from four different perspectives.

I. Comparing interest rates of the liquidated and operating credit institutions

I expect based on the available literature that, on the average, the credit institutions liquidated promised higher interests on the deposits than the credit institutions still

operating, which may have increased the motivation of depositors to deposit their savings with the riskier credit institutions.

II. Comparing liquidated and existing credit institutions from three aspects:

a) The deposit amount

If the distribution of the deposit amounts in the credit institutions liquidated significantly differs from the distribution of the deposit amounts in credit institutions still operating, that would imply that the number of depositors with deposits of a certain size was relatively higher in the credit institutions liquidated than in the existing credit institutions, one of the causes of which may be their tendency to give in to the temptation of the higher interest rates presumed in Section I, which may indicate the existence of moral hazard. I will evaluate the findings with consideration to the fact that large depositors are typically better equipped to monitor the risk of banks compared to small depositors.

b) Age

If we compare the age structure of the depositors of the liquidated credit institutions with that of the Hungarian population as a whole, we may find a customer segment of a certain age which typically had to be reimbursed, which may be explained among others by the readiness of a certain age group to assume higher risks in awareness of the insurance.

c) Settlement type

The differences between the types of settlements where the depositors of the credit institutions liquidated and those still operating came from may reveal if those who had to be reimbursed typically live in smaller or bigger settlements. People living in small settlements could only chose from a few credit institutions within their neighbourhood, therefore they can be “accused” less of taking advantage consciously of the protection offered by deposit insurance.

III. Classification of the credit institutions liquidated and their depositors according to deposit amount, age and settlement type.

a) Classification of depositors

When classifying the depositors reimbursed, I expect to find that the various groups imply different levels of moral hazard (e.g. it may be less characteristic of a group of elderly depositors living in a small village than a group of large depositors in a city).

b) Distinguishing between credit institutions

Distinguishing between the credit institutions liquidated based on their depositors, one may be able to identify a credit institution with a clientele who displayed moral hazard to a higher or lower extent compared to the others.

IV. Comparing the distribution of deposit amounts in the European Union

The deposit insurance limit is unified across the European Union to ensure competitive neutrality on an international scale. If there is a considerable difference between the average size of deposits is the individual member states, that means that the coverage is too high compared to the average deposit size in certain countries, which in turn may entail certain costs related to moral hazard.

The part of my research concerning Hungarian depositors (approaches II and III) is based on the database of the National Deposit Insurance Fund (hereinafter: "NDIF") containing the depositors of the credit institutions liquidated, which is being analysed for the first time for a scientific purpose. The database includes deposit amounts (up to the reimbursement limit), the date of birth of depositors and the post code of their domicile. I will supplement the database with the Regional Statistics of the Hungarian Central Statistical Office (*KSH*, 2014) so that the domicile, which is a significant dimension in terms of the moral hazard, can also be analysed in addition to the distribution of deposit amounts and the age of the depositors.

I will compare the supplemented database of depositors reimbursed by NDIF with the available data of the depositors of existing credit institutions along the three variables examined.

a) in the dimension of the deposit amount, with the cumulated internal database kept by NCIF of existing credit institutions;
b) in the dimension of age, with the demographic statistics of the Hungarian Central Statistical Office (*KSH*, 2015);

c) in the dimension of the settlement type, with the findings of the Household Monitor survey of the savings of Hungarian households by TÁRKI Social Research Institute (*TÁRKI*, 2015).

I will compare the publicly available average deposit interests of existing credit institutions (*MNB*, 2015a) with the database of Magyar Nemzeti Bank (the National Bank of Hungary) containing the average deposit interests of the credit institutions liquidated, the accessibility of which is restricted. The distribution of the deposit amounts was analysed based on the questionnaire survey conducted by the European Central Bank (ECB) in twenty Member States of the EU. The analysis of NDIF, MNB, TÁRKI and ECB databases is subject to individual licence, which I obtained based on my research plan.

The next (second) chapter of my dissertation presents the findings of previous research into the correlations between deposit insurance and moral hazard based on the available literature. In the third chapter, I will present the characteristics, challenges and international environment of the deposit insurance system in Hungary. In the fourth chapter, I will detail the findings of my own empirical research and finally, the fifth chapter presents the conclusions of my research.

I have published my research results in four refereed journal articles and have incorporated them into the dissertation.

2 DEPOSIT INSURANCE AND MORAL HAZARD IN LITERATURE

There seem to be three directions of research in the literature on deposit insurance and moral hazard, so I will process the findings on the topic in three subchapters accordingly. In chapter 2.1, I will present the theoretical mechanism of deposit insurance creating added value for society in that deposit insurance promotes the stability of the financial system by preventing bank runs (*Diamond* and *Dybvig*, 1983). In chapter 2.2, I will present the general model of moral hazard in insurance, which leads me to the conclusion of its presence in deposit insurance. Finally, in chapter 2.3, I will summarize the scientific results available on the empiric research into deposit insurance systems and moral hazard.

I will define deposit insurance and moral hazard in accordance with the definitions approved by the deposit insurance profession and reviewed in the near future. According to the *International Association of Deposit Insurers*, "deposit insurance is a system protecting the insured deposits of depositors upon the occurrence of an event rendering a bank unable to perform its obligations towards its depositors (*IADI*, 2014, p. 8). Practically every country has some kind of a deposit insurance system, as governments are under huge political pressure to reimburse depositors to some extent during bank failure (*Demirgüç-Kunt* and co-authors, 2006). Depositors can be rescued in countries with only a so-called implicit (indirect) instead of an explicit (institutionalised) deposit insurance system as well. The difference between the two models is that whereas the safeguarding of deposits constitutes a statutory obligation in the explicit system, this is not the case in the implicit system. For the purposes of my dissertation, the term "deposit insurance" denotes the explicit form of deposit insurance, unless I make a specific reference to its indirect form.

According to the *International Association of Deposit Insurers*, moral hazard related to deposit insurance "arises when the parties are encouraged to assume higher risk, because the cost of risk assumption is limited, as it is assumed by others, whether in part or as a whole" (*IADI*, 2014, p. 10). This means that depositors are encouraged to deposit their money with the bank promising the highest rate of return as the risk involved is borne by

the deposit insurer instead of the depositors. Depositors are not motivated to monitor the risk of the bank and are ready to deposit their money with a bank where the higher interest on deposit is accompanied by a riskier credit portfolio. Banks offering riskier credits can thus get financing more easily, as they can promise higher interests on the deposits, the demand for which will be relatively higher because of the insurance. This means that the change caused by insurance in depositors' behaviour may give rise to the financing of a relatively riskier banking system.

Deposit insurance also influences the risk appetite of banks through another mechanism. "Deposit insurance is practically a mandatory liability insurance taken out by banks to the benefit of their depositors." (*MNB*, 2002, p. 55) This means that, in the event of the dissolution of the bank, a portion of the depositors' claims are settled by the deposit insurer instead of the bank. In awareness of the insurance, banks are "liable to accept more risk at the expense of the insurance community and, in the end, of the taxpayers" in the course of their operation (*MNB*, 2002, p. 55). According to *Kornai* (2014, p. 873), the insurance encourages the bank "to exercise less caution or even accept a dangerously high amount of risk when making its decisions on the extension of loans". That is, deposit insurance increases the willingness to accept risks on the side of banks and depositors alike, the interaction of which may make the banking system more hazardous. *Banai* and co-authors *(2010, p. 129)* are of the opinion that "the crisis made it obvious that the higher is the level of risks, the higher are the real economy costs required for the banking system to be able to adapt to the shocks." If deposit insurance contributes to the increasing of the risks of the banks, then it is actually counterproductive in terms of financial stability, which may in turn give rise to real economy costs.

It is obvious that a desirable deposit insurance system would keep moral hazard within reasonable limits, while paying regard to the fact that the majority of depositors have a difficulty with evaluating the risks of banks. Before going into details regarding the impact of moral hazard, I will explain why we need the institution of deposit insurance at all.

2.1. The basic theoretical model of deposit insurance

According to the basic theoretical model of deposit insurance, the institution of deposit insurance creates added value for the society by preventing inefficient bank and the forced sale of assets committed for a long term (*Diamond and Dybvig*, 1983). Before the development of the theoretical model referred to above, literature had not verified by the ability of deposit insurance to create value, but used to deal with the issue of the pricing of deposit insurances instead (*Merton*, 1977, 1978; *Kareken* and *Wallace*, 1978; *Dothan* and *Williams*, 1980; *Buser* and co-authors, 1981). Each of the articles listed regarded the probability of bank failures as an external factor. *Diamond* and *Dybvig* (1983) were the first to highlight that deposit insurance goes before inefficient bank runs and thus reduces the probability of bank failures. This is because depositors run on the bank in the event of an inefficient bank run because everyone does the same and they want to get their money back as soon as possible as they expect the bank to fail. However, by doing so, they increase the chance of an actual bank failure, regardless of whether or not it would occur, should depositors not withdraw their deposits en masse. Bank failures can cause a significant amount of loss not only to depositors directly, but indirectly also to other participants of the economy.

The model of *Diamond* and *Dybvig* (1983) highlights a function of banks which there had been little mention of before. Banks satisfy depositors' demand for liquidity by transforming their illiquid assets (loans) to liquid resources (deposits). This service can also be regarded as an insurance enabling depositors to withdraw their money when they need it the most. The problem is caused by the asymmetrical flow of information between the participants. On the one hand, the bank does not know when depositors wish to withdraw their money and, on the other hand, depositors do not know whether or not the bank will fail, therefore they are susceptible to panic and run on the bank. *Diamond* and *Dybvig* (1983) have created the following game theory model based on this line of thought.

There are three periods (T = 0, 1, 2).

- A unit of investment made in period 0 will yield a return of $R > 1$ in period 2 (where R is the result of the production technology).

- However, if production is interrupted in period 1, then the investment will yield no return, i.e. the amount paid to the investor will correspond to the amount of the initial investment.

There are two different types of agents presented in the model.

- Agent 1: prefers consumption in period 1
- Agent 2: prefers consumption in period two to consumption in period one, provided that the bank does not fail.

The type of the agent cannot be determined in period 0, when all agents seem to be identical and not even the agents themselves are aware of their own type. It will become clear to the depositor in period 1 if he is of type one or two. Hereinafter I will call agent 1 and agent 2 the "impatient agent" and the "patient agent", respectively. The impatient agent always withdraws his deposit in period 1. Agents will be paid in the three periods as follows:

$$\begin{array}{ccc} T=0 & T=1 & T=2 \\ -1 & \begin{cases} 0 \\ 1 \end{cases} & \begin{cases} R \\ 0 \end{cases} \end{array}, \qquad \textbf{Equation 1}$$

where agents opt for payment (0, *R*) or (1, 0) in period 1.

Diamond and Dybvig (1983) applies the general game theory model presented above in to the contract between the bank and the depositor specifically. The bank satisfies depositors' claims one after the other, as long as its assets are depleted. The completion of the payment only depends on the serial number of the agent. In the event of a bank run, the bank fails in period two, therefore anyone wishing to withdraw their money in that period only gets back a certain proportion of their investments, from the remaining assets of the bank. Payments will occur like this with regard to the supplementary information mentioned above:

$$V_1(f_j, r_1) = \begin{cases} r_1 & if\ f_j < r_1^{-1} \\ 0 & if\ f_j \geq r_1^{-1} \end{cases}, \qquad \textbf{Equation 2}$$

where r_1 is the payment made in period 1 after each unit invested by depositors in period 0, and where f_j indicates the number of payments (withdrawals of deposits) completed before agent No. *j* in proportion to the total number of payments made.

- Payment in period 2 (V_2), depending on the total payments made inperiod 1:

$$V_2(f, r_1) = max\{R(1 - r_1 f)/(1 - f), 0\}, \quad \textbf{Equation 3}$$

where r_1 is the payment made in period 1 after each unit invested by depositors in period 0, and where *f* indicates the number of all payments.

There are two possible stable states (Nash equilibrium) in the game theory model of *Diamond* and *Dybvig* (1983) depending on the value of r_1. If r_1 is less than or equal to 1, a desirable stable state with an optimum sharing of risks is realized. However, if r_1 is higher than 1, a multiple equilibrium will be present, one of them being the desirable state and the other one being the bank run. Which one of the two occurs will depend on the depositors' supposition, which in turn is influenced by a random factor. If the desirable equilibrium is present, every agent can withdraw their deposits according to their optimum consumption: impatient agents in period 1 and patient agents in period 2, by realizing to return on their investments. However, if the non-desirable equilibrium is present, all the agents want to withdraw their money in period 1, because the patient agent may not get back his money invested, if he waited until period 2. This means that those who cannot withdraw their money in time from the bank in the stable state of a bank run will be worse off than if they had not even deposited it in the first place.

Diamond and *Dybvig* (1983) introduce deposit insurance to the model presented above, which guarantees every agent the possibility of withdrawing the desired amount from the bank. As the repayment of their money is guaranteed for every agent, there is no point for patient agents to withdraw their deposits in period 1. The optimum consumption of the agents after the introduction of deposit insurance looks like this:

$$c_1^1 = 1,\ c_2^1 = c_1^2 = 0, \text{ and } c_2^2 = R, \quad \textbf{Equation 4}$$

where c_k^i is the consumption of agents type *i* at time No. *k*.

To summarize the findings of *Diamond* and *Dybvig* (1983): deposit insurance makes it possible to achieve the desirable Nash equilibrium (provided that there is a tax of an optimum rate levied on the financing of the deposit insurance), and the elimination of the adverse equilibrium, i.e. the prevention of inefficient bank runs, creates added value for society as banks are not compelled to sell their illiquid assets below market price in a short time.

Other research has shown that deposit insurance is not a suitable answer to the lack of liquidity of banks. In the opinion of *Wallace* (1988), depositors withdrawing their money in the model of *Diamond* and *Dybvig* (1983) for liquidity reasons will most probably spend the money withdrawn, therefore it cannot be taxed, which means that taxation cannot be the basis of deposit insurance.

Despite critical comments, the model of *Diamond* and *Dybvig* (1983) has provided a basis for both the simulation of bank runs and the related research into the system risk inherent in the operation of the banking system. *Chari* and *Jagannathan* (1988) modelled in their study the phenomenon of people seeing long queues of people in front of a bank office and running on the bank even if they have no information as to whether or not the bank will go bankrupt. Alternatively, *Kiss* and co-authors (2012) found that the ability of the creditors to observe each other's decisions on withdrawing bank deposits also influences the probability of bank runs. When such decisions cannot be observed, the coverage ratio of deposit insurances must be higher, whereas otherwise a lower coverage ratio is sufficient. This lead the authors to the conclusion that the extent of the observability of the decisions must be taken into regard for the creation of an optimal deposit insurance system. *Freixas* and his co-authors (2000) concluded regarding the correlation between deposit insurance and system risk that deposit insurance facilitates the prevention of bank runs and thus the reduction of the system risk.

Allen and *Gale* (2000), again in reliance on the model of *Diamond* and *Dybvig* (1983), highlighted by simulating system risk that a single liquidity shock (bank run) can spread from one region to the other (infection), if the intertwining of the banks is substantial or there are deficiencies concerning the operation of the interbank market. The Hungarian connotation of the issue was examined by *Lublóy* (2005) on the Hungarian market, where the risk of infection was, however, limited in 2005, given the low interbank exposure and

moderately concentrated structure of the banking market. The Hungarian banking market has become much more concentrated since then: at the end of 2016, only 85 remained from the more than 200 credit institutions existing in 2005 (*Vajai* and *Tóth*, 2017). The background and impacts of consolidation on the Hungarian banking market are presented by *Kovács* (2014b) and *Walter* (2014), whereas the various banking strategies are discussed in detail by *Walter* (2016). Further research should be undertaken to assess the impact of the concentration of the Hungarian banking sector on system risk from the point of view of supervision and deposit insurance alike.

Deposit insurance is not the only field where the capacity of state aid to create added value for the society can be demonstrated. *Berlinger* and co-authors (2015) have demonstrated that where the flow of information between the investor providing financing for a project and the contractor using the financing is asymmetrical, the benefit of state aid exceeds the costs arising due to moral hazard. Moral hazard may cause for example credit crunch in the financing of companies with buyers defaulting on their payment liabilities: this phenomenon observed among Hungarian small and medium enterprises is described by *Szűcs* and co-authors (2010).

It is also worth mentioning the positive effect of deposit insurance attracting cautious clients to the banks who would not decide to keep their money on a bank account in the absence of insurance. Increasing their trust might also increase the volume of deposit portfolios, which in turn may improve the credit/deposit indicator subject to regulatory limitation and certain liquidity indicators, creating an opportunity for lending above the minimum determined by the regulator. The Basel package of legislation regulating the capital requirement of banks includes for example the liquidity indicator NSFR (Net Stable Funding Ratio). The deposits of private persons and micro and small enterprises (Retail deposits) are regarded as stable funds in the calculation of the NSFR, which means that their probability of being withdrawn in the event of a shock is much smaller compared to the deposits of medium or large companies (Wholesale deposits), especially if they are protected by deposit insurance (*King*, 2013). The importance of the stability of small deposits is also substantiated by the lessons drawn from the famous Northern Rock bank run of 2007, the intensity of which was increased by the high ratio of the less stable (Wholesale) deposits of medium and large enterprises (*Goldsmith-Pinkham* and *Yorulmazer*, 2010).

2.2 Moral hazard in deposit insurance

The expression “moral hazard” appeared in the insurance terminology of Europe and the United States at the end of the 19th century, contemporaneously with the introduction of social insurance systems (*Dembe* and *Boden*, 2000). *Haynes* (1895) defined moral risk at the time as an insurance risk arising from the lack of honesty and morale. From the definition used by *McNeill* (1900), on the other hand, we can infer how moral hazard was typically manifested in that era: moral hazard arises in the opinion of the author in connection with people who steal or lie, exaggerate their minor injuries or don't work, despite their being capable of work. The insured with a low morale seem to have abused the advantages offered by insurance, which obviously made insurance more expensive for the insured with a high morale, too. *Pauly* (1968) later revealed that moral hazard does not arise due to low morale, but is brought abouth by the rational behaviour of the insured. *Kornai* (2014, p. 873) says that moral hazard is “the description of a situation in which a participant is liable to accept a risk the cost of which is borne by another participant in his stead”. *Berlinger* and *Walter* (2013, p. 481) put it as follows: “if a portion of the costs or risks arising from the activity of the parties to the contract (author’s note: in this case the depositors) is borne by participants not party to the contract (author: in this case the deposit insurer), then the parties to the contract tend to disregard such negative impacts and make their decisions by concentrating on their own gains, losses and risks, exclusively.”

The foundations for the research into the subject of moral hazard related to insurances were laid by the study published by Nobel prize winning economist Kennett Arrow in 1963. *Arrow* (1963) highlighted that health insurance increases the rate of use of healthcare services both by patients and doctors, which is a manifestation of the moral hazard. Despite this negative side effect, *Arrow* (1963) held that the provision of insurance for any uncertainty created added value for society and was particularly necessary in the areas where the individual cannot really influence the risk. Deposit insurance can be regarded as necessary from this point of view, as the majority of people cannot assess the risk of banks.

Arrow (1963) described the mechanism of insurances improving social welfare. The model presumes that every individual strives at avoiding risks and maximizing the expected utility and, in the case of health insurance, that diseases are random occurrences. According to the theory created by *Bernoulli* (1954[1]) in 1738, a person described above would prefer taking out the insurance in consideration for the payment of a premium amounting to *m* to undertaking the random costs of healthcare without being insured, with an average probability distribution *m*. According to *Arrow* (1963, p. 960), the purchasing of such an insurance generates social benefit, as the centralized management of risks reduces the total volume of risks and, thus also the per-capita risk of the insured, based on the law of large numbers.

Pauly (1968) resolves the idea of the model of *Arrow* (1963) in that the costs of loss events (such as the use of healthcare services) are random variables. It is important to note that *Pauly* (1968) does not change the condition of the probability of becoming sick being a random variable. *Pauly* (1968, p. 532) believes that the healthcare expenditures related to diseases are not necessary random because the expenditures are influenced by the volume of healthcare applied for by the individual. The demand for healthcare services depends, among others, on the income, preferences and type of disease of the individual, as well as the price of the given service. For example, an individual taking out health insurance is entitled to use medical service for no consideration or for a consideration lower than the market price. If the individual's demand is price sensitive, his/her demand for cheaper services will be relatively higher. This means that the costs of using a service will not be random because of the insurance, except for the theoretical, unrealistic case where the demand for the service is not sensitive to the price of the service at all (perfectly inelastic demand).

I am presenting the model of *Pauly* (1968) with the help of figure No. 1. The volume of the product or service subject to the insurance is demonstrated on the horizontal axis and its price is demonstrated on the vertical axis. The implicitly presumed, perfectly inelastic demand is labelled with *D'* in the model of *Arrow* (1963). Where the demand is not sensitive to prices (*D'*), the price of the insurance is *p'*, representing the price at which an individual making rational decisions and striving to avoid risks is willing to take out an

[1] The English translation of the 1738 theory of Bernoulli was published in 1954.

insurance, i.e. rather choose to pay the amount of *p'* to the insurer than to incur healthcare costs according to the expected probability distribution *p'*.

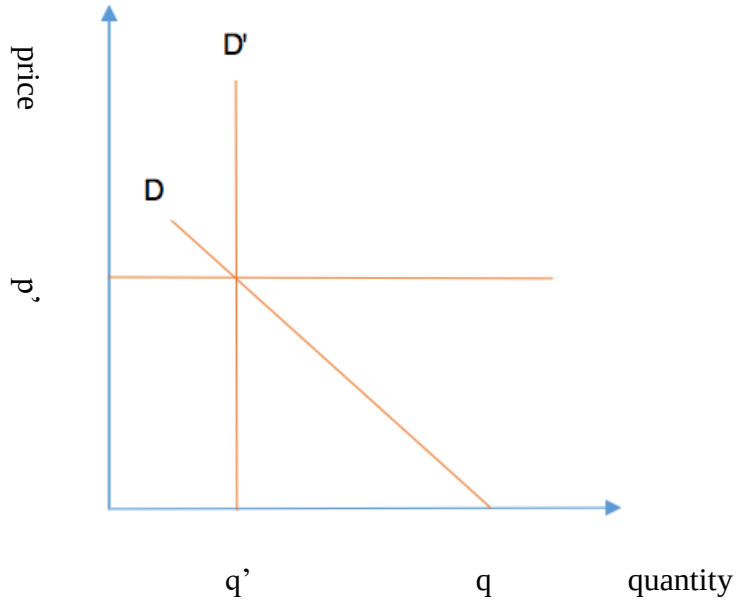


Figure 1: The introduction of price elasticity into the insurance model of *Arrow* (1963). Source: Edited from *Pauly* (1968, p. 533)

Price-dependant demand (*D*) is introduced by *Pauly* (1968) in the insurance model of *Arrow* (1963). The expected amount of expenditure does not change for an individual with a demand function *D* and without insurance: the expected value of the probability distribution will be p'. However, when the individual with a demand function *D* takes out the insurance, he/she can use any service either free of charge or for a consideration which is lower than the market price. And if the service is cheaper, he/she will use services in a volume of $q > q'$, which will make the equilibrium insurance premium more expensive than *p'*. This in turn will mean that paying an amount higher than *p'* will not necessarily be a reasonable decision for the individual, compared to the healthcare expenditures he/she would incur according to the expected probability distribution *p'*.

Pauly (1968, p. 534) believes that his inconsistency, which is a demonstration of moral hazard, is unavoidable due to the "prisoner's dilemma" known in game theory. Every participant to the game admits that the "unnecessary" use of healthcare services raises the insurance premium. However, as long as this cost is distributed among the other insured, the incidental benefit of the extra use of the services will be relatively high, therefore

nobody will be motivated to cut back on their use of the service. The limitation of the use of the service (cooperation) would be more favourable to all the insured, nevertheless, this is not what will happen, because ”excess use” will be the dominant strategy (*Pauly*, 1969, p. 534), which in turn will bring about the Nash equilibrium (Nash, 1951). *Pauly's* (1968) economic model presented above provides an explanation for the phenomenon observed, in that health insurance generates a growth in the use of healthcare services, and thus creates the basic theoretical model of moral hazard in insurance.

In the context of deposit insurances, the “excess use” of the banking service in itself will not cause any problem. Actually, if the number of people depositing their cash with banks grows, that will provide stable financing to the banks, which may even affect economic growth positively. “Excess use” will only cause a problem, if it is concentrated on risky banks. But, for depositors striving at profit maximization, it is worth depositing their money, up to the deposit insurance limit, with banks promising the highest rates of interest, many of which have a risky credit portfolio. And the cost of rescuing the banks failing due to too high risks will be as much higher as the amount of the deposits of risk sensitive investors who would not have deposited their money with these banks, had it not been for the insurance. Although these additional losses are also paid by the credit insurer, the banks filling the fund of the credit insurer will finally shift the deposit insurance premium to depositors, who will therefore have to pay a higher premium. This means that all depositors would be interested in monitoring the banks and depositing their money with insurance, according to their individual risk preference, with the bank which they would choose for investment purposes in lack of a deposit insurance. However, this is not what happens, as the individual dominant strategy is to accept the highest rate of interest by shifting the cost to external parties.

The literature on insurances uses the term “moral hazard” in the context of contract theory as well. Because of the asymmetric flow of information between the parties to the contract, the principal can only assume that the agent appointed will comply with the contract, however, it is unable to prevent any abuse by the agent. *Hölmstrom* (1979) suggests spending on monitoring the insured and amending the contracts based on the behaviour of the insured in order to mitigate the moral hazard which may arise in the relationship of the principal and agent. The best solution in the opinion of the author would be, if insurance companies sanctioned the unlawful conduct of the insured in the

contracts. *Hölmstrom* (1979) is, however, aware of the fact that such monitoring would be very expensive or not even possible to realize.

I have already presented the definition, mechanism and interactions of moral hazard arising on the part of depositors and banks at the beginning of chapter 2. Now I will outline the possible ways of mitigating moral hazard. According to *Pauly* (1968), moral hazard can be reduced if there is an amount which is to paid by the damaged party in the event of damage. This contribution may be determined as an absolute value (deductible) or as a proportion of the damage (coinsurance). The point is that it is not recommended for the insurer to assume the total amount of risk of the insured, because that would make the insured lose their motivation to avoid risks.

The findings of empirical research into deposit insurances display certain correlations with the theoretical reasoning of *Pauly* (1968). Many researchers arrived at the same conclusion, in that higher coverage makes the negative impact of deposit insurance, i.e. moral hazard, more probable to arise (for the detailed presentation of the studies please refer to chapter 2.3). In explicit deposit insurance systems, the higher is the reimbursement limit, the higher is the coverage (presuming that the average deposit amounts and the distribution of the deposit amounts are equal). In my view, the amount in excess of the reimbursement limit can be regarded as own contribution to be borne by depositors in the event of the dissolution of a credit institution. I want to note at this point that depositors may keep their deposits in several credit institutions up to the deposit insurance limit, as depositors are entitled to reimbursement in each credit institution separately in most of the countries. However, transaction and banking costs limit such behaviour in the case of large deposits and it is not efficient to keep an account with yet another institution beyond a certain asset volume. This means that large depositors will be affected by the own contribution anyway, which will be the smaller, in addition to transaction and banking costs, the higher is the reimbursement limit. I think therefore that the findings of the empiric researchers of deposit insurance may also be interpreted as follows: where coverage is higher, i.e. the own contribution to be borne by large depositors is smaller, the probability for moral hazard to arise will be higher, one of the explanations for which might be that large depositors are less motivated to monitor the banks. We can find only few examples for the introduction of own contributions in the field of deposit insurance for small depositors. For example in Hungary, the minimum

deposit insurance limit was EUR 20,000 between 2004 and 2009, with a coinsurance ratio of 10% above HUF 1,000,000. The data collected in the study of *Demirgüç-Kunt* and *Detragiache* (2002), a similar kind of coinsurance ratio was also applied in the deposit insurance systems of the United Kingdom, Italy, Ireland, Germany, Columbia and Chile in the period between 1980 and 1997. Nowadays, the introduction of coinsurance for small depositors is exceptional rather than a general practice, which can be probably explained by the fact that the majority of the regulators are concerned that coinsurance would make small depositors run on the bank in an attempt to prevent the loss they would suffer if their turn did not come on time because of waiting too long. There is obviously trade-off between the social benefit of deposit insurance and the costs caused by moral hazard, which manifests itself in connection with own contribution, too. The majority of regulators decide considering this trade-off not to risk the major advantage of deposit insurance, i.e. the prevention of inefficient bank runs, in favour of mitigating the moral hazard.

We need to find a solution for applying own contributions which would promote market discipline, while being suitable for preventing inefficient bank runs. Therefore, an idea may arise namely that the deposit insurance should be applied solely on the invested capital or additionally on the risk-free interest rate instead of the invested capital and high rate of return announced. It could be a deterrent for risky banks promising higher rate of interest against possessing excessive number of deposit portfolios. In other words, it may reduce the moral hazard. However, the uncomprehensive compensation increases the risk of banks runs. If the depositors may face the possibility of bearing losses caused by bank failures, they are trying to avoid it through e.g. deposit withdrawal. The question is how the depositors experience the risk of getting less compared to the announced amount during the compensation process.

According to the researches in behavioural economics (*Tversky* (1977), *Fishburn* and *Kochenberger* (1979), *Hershey* and *Schoemaker* (1980), *Payne* and co-authors (1980), and *Fischhoff* (1983), *Tversky* and *Kahneman* (1986)) the sensing of risk depends largely on the investor's reference point. The investors are generally less sensitive to the changes beyond the reference point (gains) than to the changes below the reference point (losses). This phenomenon can be seen in Figure 2 demonstrating that "the value function is usually concave if there is a gain and convex if

there is a loss and tends to be steeper for losses than for gains" (*Kahneman* and *Tversky*, 2013, p. 99).

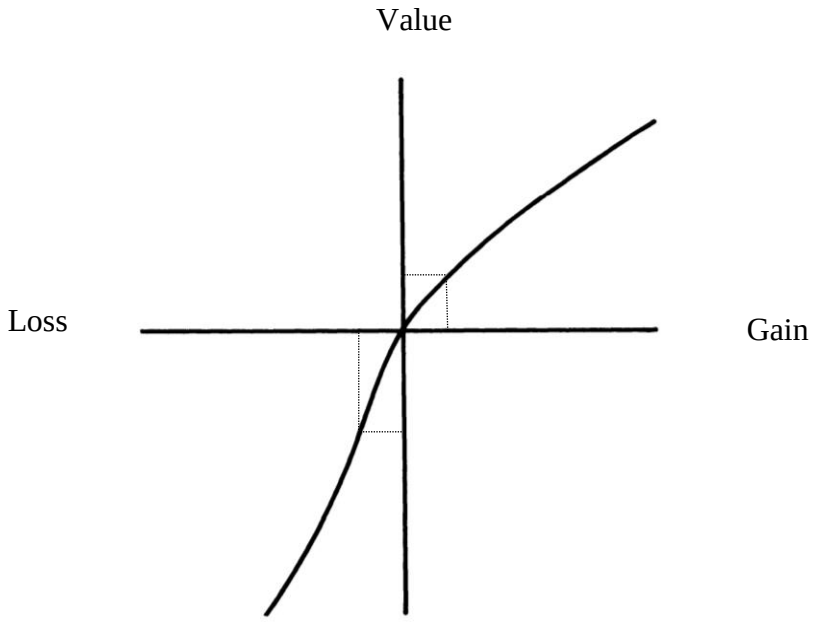


Figure 2: A typical value function. Source: *Tversky* and *Kahneman* (1986, p. 259).

Several researches confirm that the investors' reference point is the existing asset (status quo), in other words the zero-percentage rate of return (*Kahneman* and *Tversky*, 1984, *Grinblatt* and *Han* (2005)), or the risk-free interest rate (*Barberis* and co-authors, 2001)). In these cases, the depositors would not consider the lower level of insurance as a significant jeopardy, accordingly the probability of bank runs would be lower. However, if we consider reference rate as the invested capital incremented with interest rate announced, it may imply a bank run, even if there is a deposit insurance though an uncomprehensive one. The effect of lower level of insurance on moral hazard and on risk of bank runs could be the subject to a further research.

I suggest for consideration - in light of the current findings of the behavioural theory and dependent on the result of further research- that deposit insurance should apply only to the capital invested or maybe also the risk-free return (e.g. the base rate of the central bank) and that depositors should not be reimbursed at the high rate of return including the originally offered risk premium.

I would like to note at this point that regulators may decide to extend the deposit insurance limit in times of crisis. I my opinion, another possible way of reducing moral hazard might be the introduction the countercyclical strategy in credit insurance. The idea of differentiating the regulation according to crisis and non-crisis periods is based on the finding of *Anginer* and co-authors (2014) that whereas the negative effect of moral hazard inherent in deposit insurance tended to be dominant during balance periods, the stabilizing effect of credit insurance prevailed in times of turbulence. I think that while the amount of moral hazard may be reduced by means of stricter regulation without increasing the risk of a bank run if the economic conditions are balanced, insurance coverage could be extended in critical times. I will present international examples for the extension of the regulation in chapter 3.3.

In the next chapter I wish to present the findings of authors who conducted empirical research into the impact of deposit insurance on the banking system as a whole.

2.3 Empirical studies on deposit insurance and moral hazard

Before presenting the findings of practical research on the subject of deposit insurances, I would like to highlight the differences between the two basic types of deposit insurance systems. As it has already been reflected on, the key difference between implicit (indirect) and explicit (institutionalised) deposit insurance systems is that whereas the safeguarding of deposits constitutes a contractual obligation in the explicit system, this is not the case in the implicit system. In implicit deposit insurance systems, the government decides how to protect depositors in light of the circumstances at hand, i.e. neither the method nor the amount of reimbursement is determined in advance. The government may intervene by sanctioning, or prevent the dissolution of the bank by means of capital increase, merging the bank into another bank or by purchasing the bad portfolio. However, the government may also decide to liquidate the bank following its failure and reimburse depositors directly from the central budget or through the central bank (*Cstai*, 2012). In explicit deposit insurance systems, the deposit insurance mechanism, including but not limited to the institutions and their types of deposits subject to insurance or the insurance limit, is

regulated by the law. The way of financing of the deposit insurance system and the means available to the deposit insurer in case of bank failures are also determined in the relevant Act (*Csatai*, 2012). The advantage of explicit deposit insurance systems is that one knows exactly what happens in the event of the dissolution of a bank. Accordingly, depositors can also know for sure what will *not* happen, namely that the deposit insurer will not refund them in excess of the reimbursement limit. Therefore they have to choose the bank they want to deposit this amount with by calculating with the credit risk. Of course the explicit system may also be set up in a way so as to provide coverage for the total deposit amount. The insurance system providing complete guarantee is a good example for the syndrome of the soft budget constraint, first formulated by *Kornai* (1978, 1980) and expanded on by *Kornai* and his co-authors (2004). According to *Kornai* (2014), the soft budget constraint makes one susceptible to irresponsible spending, as the state in the role of the insurer assumes all moral hazard, as a result of which the insured will exercise less care in safeguarding their assets. With regard to the total lack of motivation of depositors to assess risks in a conscious manner in this case, countries with such an operating model constitute a separate class in empirical studies.

The first explicit deposit insurance system was established in 1935 in the United States in response to the bank failures brought about by the Great Depression (1929-1933). Explicit deposit insurance system had not become widespread until the last quarter of the 20th century: in 1974 no more than 12 countries had an explicit deposit insurance system (*Cecchetti*, 2008). According to the database of the International Association of Deposit Insurers, on January 31, 2014, explicit deposit insurance system was included in the legislation of 113 countries and 40 additional jurisdictions were considering the possibility of its introduction (*IADI*, 2017).

White (1995) was the first one to provide an overview of the evolution of deposit insurance in the 20th century based on the experience of almost a whole century in the USA. *White* (1995) did not recommend the introduction of deposit insurance in developing and emerging countries and found it viable only in the short term in developed countries, subject to strict bank and market surveillance. His position was based on the fact that there had been bank failures occurring in the US despite the deposit insurance system, too, and regards bank failures to be the consequences of moral hazard inherent in deposit insurance. I think, however, that the relationship between the two is not obvious,

with special regard to the fact that the number of US bank failures fell drastically in the forty years after the federal introduction of deposit insurance and started to increase again after the oil crisis only. *White* (1995) believes that this panic-free period was only transitional and explains that the banks wrote off their losses and continued their operation with a clear portfolio of the Great Depression (1933), whereas devastating impact of moral hazard generated by deposit insurance manifested only later, in the long term.

Although the authors who have studied the subject of deposit insurance acknowledge the positive role of deposit insurance in the prevention of bank runs, they have arrived at diverse conclusions, by examining various countries and periods, as to whether deposit insurance increased or decreased the risk of the bank system on the whole. For example, *Wheelock* and *Wilson* (1994) or *Alston* and co-authors (1994) cannot see any correlation between the introduction of deposit insurance and the bank failures in the US. Neither do *Karels* an *McClatchey* (1999) find such a correlation, nevertheless, they emphasize the stabilizing impact of the introduction of deposit insurance on American credit associations. *Grossman* (1992), *Wheelok* (1992) and *Thies* and *Gerlowski* (1989) on the other hand do see a significant relationship between deposit insurance and the number of bank failures, namely of a positive direction. *Gropp* and *Vesala* (2004) highlighted based on a study conducted in the Member States of the European Union that the introduction of the explicit credit insurance systems reduced the amount of risk assumed by banks significantly. According to *Chernykh* and *Cole* (2011), the introduction of the deposit insurance resulted in the improvement of the financial intermediary system in Russia. *Garcia* (2000) arrived at a mixed result after the examination of the relations between deposit insurance and the amount of risk present in the banking system: he argued for the explicit system under normal economic conditions, however, found the temporary introduction of insurance providing coverage for the total amount of deposits in periods of crisis.

Laeven and his co-authors (2008, p. 14) stated in their book summarizing the findings of the empirical research into deposit insurance that "*Demirgüç-Kunt* and *Detragiache* (2002) were the first ones to examine the relationship between the deposit insurance system and the development of a crisis based on a substantial amount of international, cross-sectional data". *Demirgüç-Kunt* and *Detragiache* (2001) arrived at the definite

conclusion that explicit deposit insurance increases the chances of a bank crisis and found the adverse effects of deposit insurance to be stronger where the scope of the insured is wider, the coverage ratio is higher and the deposit insurance system is operated by the state. The study prepared by this pair of authors is the work most often referred to among empirical studies related to deposit insurance, therefore I will present the methodology they apply in more detail.

Demirgüç-Kunt and *Detragiache* (2002) examine based on samples gathered from 61 countries, with regard to the period between 1980 and 1997, whether the presence of the explicit deposit insurance system affects the probability of the development of a bank crisis significantly. They test correlations with a logit model of multiple variables, in which the dependant variable demonstrates the development of a bank crisis, one of the explanatory variable demonstrates the presence of the explicit deposit insurance and the remaining explanatory variables are the so-called control variables. Let me start the presentation of the parameters of the model with the introduction of the dependant variable.

The dependant variable within the econometric model of *Demirgüç-Kunt* and *Detragiache* (2002, p. 1381) is a dummy variable demonstrating bank failure, the value of which is 1 if there was a crisis in the given country in the given year and 0 if there wasn't. System level crisis can be defined as follows: "the case when the significant segments of the bank sector become insolvent or illiquid and are unable to continue their activity without the extraordinary assistance extended by the monetary or supervisory authorities" (*Demirgüç-Kunt* and *Detragiache*, 2002, p. 1381). The authors create the dependant variable demonstrating the crisis of the banking system from several indicators characteristic for the bank sector based on the works of *Caprio* and *Klingebiel* (1996) and *Lindgren* and co-authors (1996). Determining the presence of a bank crisis is subject to the fulfilment of one or more of the four conditions specified below:

- no less than 10% of the total assets of the bank system as a whole are non-performing assets;
- no less than 2% of the GDP is spent on bank rescue;
- the state acquires banks on a large scale;

- there are emergency measures taken within the bank system (e.g. forced bank holidays, the freezing of deposits, the introduction of guarantees for depositors or other creditors of the bank).

Demirgüç-Kunt and *Detragiache* (2002, p. 1381) established the occurrence of a bank crisis sometime during the interval subject to their examination in 40 of the 61 countries in view of these four conditions listed above.

The most important explanatory variable in the model of *Demirgüç-Kunt* and *Detragiache* (2002, p. 1381) is a dummy variable indicating the presence or lack of deposit insurance with 1 or 0, respectively. Compared to only 12 countries at the beginning, deposit insurance system was institutionalized in 33 countries (i.e. more than 50% of the countries within the sample) at the end of the period examined. The other explanatory variables are so-called control variables, which were included in the model because they are likely to influence the quality of the banks' assets and thus the probability of the development of a bank crisis. The control variables of the model include macroeconomic indicators such as the GDB growth rate, the change to the external conditions of commerce or inflation, each of which are very likely to influence the quality of assets of the banks according to economic theories. The short-term real interest rate is another control variable in the model, because if it increases that may adversely affect the profitability of the banks through the interest loss suffered on loans extended at a lower interest rate for a long term. Another explanatory variable is the growth of the volume of credit, which can drive the overvaluation of asset prices and the development of a crisis when the bubbles burst.

Demirgüç-Kunt and *Detragiache* (2002) were examining if the dummy variable relevant to the presence of the explicit deposit insurance system has a significant co-efficient, by also incorporating the control variables typically giving rise to bank crises into their model. They had presented the regression equation formula in an earlier study published in 1998. The log-likelihood function of *Demirgüç-Kunt* and *Detragiache* (1998, p. 89) is shown in equation 5.

$$ln\ L = \sum_{t=1\ldots T} \sum_{i=1\ldots n} P(i,t)\ \ln\{F[\beta' X(i,t)]\} + [1 - P(i,t)] ln\{1 - F[\beta' X(i,t)]\},$$ **Equation 5**

where the likelihood for crisis occurring in a given country at a given time is dependent on vector *X(i, t)* of explanatory variable *n*;
and where *P(i, t)* is a dummy variable the value of which is 1 if a crisis breaks out in country No. *i* at time No. *t*, otherwise it is 0;
and where *β* is the vector of the unknown coefficient *n*;
and where *F(β'X(i, t))* is the cumulative distribution function.

Demirgüç-Kunt and *Detragiache* (2002, p. 1382) found that the dummy explanatory variable demonstrating the explicit and the implicit form of deposit insurance with 1 and 0, respectively has a significant positive coefficient at a rate of reliability of 8%, implying that the institutionalisation of the deposit insurance enhances the vulnerability of the banking system. *Demirgüç-Kunt* and *Detragiache* (2002) explained their finding with people's tendency to assume excess risk in awareness of the presence of an insurance.

There is information available regarding the deposit insurance systems in each of the countries included the sample analysed by *Demirgüç-Kunt* and *Detragiache* (2002) as to what types of deposits are subject to deposit protection and up to what amount, are depositors required to contribute in the form of own contribution or the parties financing the system (the banks, the state or jointly). It is also known whether the joining of the deposit insurance system is obligatory for the banks in the given country. *Demirgüç-Kunt* and *Detragiache* (2002) added these characteristics to the basic empirical model presented, by modifying the explanatory variable parameters of deposit insurance. For example, they created a dummy explanatory variable from the information relevant to the type of the deposit insurance system and the reimbursement limit which takes the value 0 for an implicit deposit insurance system, 1 for an explicit deposit insurance system with limited reimbursement and 2 for an explicit system providing full guarantee. The coefficient of the explanatory variable thus created is also positive, what more, it is significant at a reliability level of no more than 1% as well, which means that the better the protection provided by deposit insurance, the greater the likelihood of bank crises.

This finding is in accordance with the suggestion of *Garcia* (1999) in that moral hazard can be reduced by limiting the deposit insurance coverage.

The topic of the deposit insurance coverage is closely related to the own contribution: the higher the coverage, the smaller the portion of the deposit in excess of the reimbursement limit. *Demirgüç-Kunt* and *Detragiache* (2002) did not take this correlation into consideration when they included in their model a separate variable for the own contribution taking the value of 0 for implicit deposit insurance systems, 1 for explicit systems with a single deposit insurance limit an 2 for systems offering reimbursement in proportion to the damage (e.g. with a co-insurance rate of 10%). A variable thus defined has no significant explanatory power within the model. I believe, however, that *Demirgüç-Kunt* and *Detragiache* (2002) oversimplified the issue by listing the contribution variable to three categories (0, 1, 2). On the one hand, they presumed the own contribution to be relatively less in implicit systems. In my opinion, although governments often decide to rescue banks within implicit deposit insurance systems, depositors cannot take this for granted, as the government is not bound by a legal obligation to rescue the banks or reimburse depositors. Accordingly, there is some deterrent effect encouraging market discipline among depositors, which is the possibility of an own contribution of an unknown extent. The classification may also be labelled simplistic because of listing countries with a reimbursement limit of EUR 10,000 or EUR 100,000 in the same category, although there is a huge difference between the amounts of the own contribution, i.e. the portion in excess of the reimbursement limit. With regard to my critic expressed regarding the definition of the variable of the own contribution, the value of the related coefficient, based on which it has no significant impact on the likelihood of bank crises, is not convincing, either in my opinion (even *Demirgüç-Kunt* and *Detragiache* (2002) themselves may have found this result significant as they make no mention of it in their study.) I think that *Demirgüç-Kunt* and *Detragiache* (2002) should either have defined the own contribution variable more accurately in their model or they should not have examined it as a separate variable and associated it with the significant variable of the coverage at all. The result of the model, according to which „the undesirable effects of deposit insurance on the stability of banks are stronger where the coverage of the deposit insurance is larger" (*Demirgüç-Kunt* and *Detragiache*, 2002, p. 1371) could be generalized, in my opinion, in a way that the undesirable effects of

deposit insurance are stronger where coverage is larger, i.e. the own contribution is smaller.

Anginer and co-authors (2014) have examined the impact of deposit insurance on the bank system in respect of both the period of the recent economic crisis and the preceding period of balance. The authors developed a regression model based on the estimated correlation, similarly to the methodology of *Demirgüç-Kunt* and *Detragiache* (2002) presented above. The major difference between the two models is that the dependant variable in the model of *Anginer* and co-authors (2014) is the risk of the banks rather than the likelihood of a bank crisis. The banks surveyed in all of the countries within the sample cover no less than 90% of the total assets within the banking system, therefore they provide information about the risk of almost the entire banking system. The authors determined the dependant variable measuring the risk of the banks based on the so-called *"z value"* calculated by *Laeven* and *Levine* (2009). The *z value* measuring the risk of the banks based on the data in financial reports is equal to the sum of the average return on assets (the ratio of the net income and the total assets) and the ratio of the equity and the assets[2]. The higher the *z value*, the lower the risk of a given bank. Because of the strongly inclined empirical distribution of the variable thus calculated the logarithm of the variable is used to estimate regression.

The explanatory variables in the model are the presence of an explicit deposit insurance and the control variables, similarly to the model of *Demirgüç-Kunt* and *Detragiache* (2002). The difference is that *Anginer* and co-authors (2014) fix the variable value indicating the presence of an explicit deposit insurance to a date before the crisis (2003) and divide their observations into two samples: one of the period preceding the crisis (between 2004 and 2006) and the period of the crisis (years 2007-2009). By applying this methodology, *Anginer* and co-authors (2014) eliminate the problem of reverse causality which would arise from the introduction of deposit insurance in any of the countries right in response to the crisis.

That is, *Anginer* and co-authors (2014, p. 10) also tested if deposit insurance had a diverse impact on bank risk in times before and during the crisis. The correlation is tested

[2] The equity-assets ratio is scaled with a 5-year rolling dispersion of the return on the assets.

according to the regression specification presented in equation 6, with the ordinary least squares (OLS) method

$$\begin{aligned} \text{logzscore}_{ijt} = {} & \beta_0 + \Omega \times \text{bank and country controls}_{ijt-1} \\ & + \beta_1 \times \text{deposit insurance}_{ij2003} \times \text{crisis}_{ijt} \\ & + \beta_2 \times \text{deposit insurance}_{ij2003} \times \text{no\_crisis}_{ijt} \\ & + \beta_3 \times \text{crisis}_{ijt} + \varepsilon_{ijt}\,, \end{aligned} \qquad \textbf{Equation 6}$$

where the $logzscore_{ijt}$ dependant variable is the risk incurred by bank *i* in country *j* and year *t*;

and where $depositinsurance_{ij2003} * crisis_{ijt}$ is the interaction of the dummy variable indicating the presence or absence of an explicit deposit insurance (0 – absent, 1 – present in country *j* of bank *i* in 2003) and the dummy variable indicating that there is a crisis;

and where $depositinsurance_{ij2003} * no\_crisis_{ijt}$ is the interaction of the dummy variable indicating the presence or absence of an explicit deposit insurance (0 – absent, 1 – present in country *j* of bank *i* in 2003) and the dummy variable indicating that there is no crisis;

and where $crisis_{ijt}$ is the dummy variable indicating the presence of crisis (taking the value 0 between 2004 and 2006 and the value 1 between 2007 and 2009);

and where $bank\ and\ country\ controls_{ijt-1}$ are control variables displaying the characteristics of the countries and banks which may affect the risk of the banks.

Anginer and co-authors (2014) found that whereas the negative impact of moral hazard involved in deposit insurance tended to be dominant during the period of balance, the stabilizing impact of deposit insurance prevailed in the turbulent period. Giving more consideration to this finding: if the risk of the banks increases in pre-crisis times due to moral hazard, the economic shock hits a less stable banking system when the crisis occurs, i.e. the likelihood of bank failure is higher than it was in the absence of the deposit insurance. Because of moral hazard, depositors tend to opt for this riskier banks in view of the promises of higher interest rates, therefore it will costs relatively more money to rescue the depositors of banks liquidated as a result of the crisis. In addition, governments tend to raise deposit insurance limits in times of crisis in order to prevent bank runs (see chapter 3.3), which makes reimbursement even more expensive. In light of this, mitigating the moral hazard is a key issue in terms of the maintenance of financial

stability, which could be facilitated by the introduction of a countercyclical strategy in deposit insurance.

The impact of the level of development of the financial and economic environment of deposit insurance systems on the vulnerability of the banking system has also been the subject of numerous empirical studies. The development of the system of financial institutions is determined by the extent of market discipline, which may be improved for example by strict financial and market surveillance. *Demirgüç-Kunt* and *Kane* (2002) believe that it is difficult to set up a well-functioning institutional system of deposit insurance in countries where the system of financial institutions is weak. In countries like this, the „side effect" of deposit insurance, i.e. moral hazard will prevail over the advantages, i.e. it may be introduced with success only in the short term at best. *Hovakimian* and co-authors (2003) and *Laeven* (2002) also concluded that deposit insurance system are destined to fail in countries with a weak environment of financial institutions, regardless of the operational model. *Cull* and co-authors (2004) again believe that deposit insurance is definitely a set-back to the development of the financial system in such an environment. According to *Anginer* and co-authors (2014), moral hazard can be mitigated by a proper mechanism for the surveillance of the banks and the introduction of various incentive schemes.

Summarizing the findings of international empiric studies: deposit insurance involves some moral hazard, the amount of which depends on the level of development of the financial and economic system, the type and expansion of the deposit insurance system and the prevailing economic cycle. Some of the authors argue for explicit deposit insurance systems, where the boundaries of government assistance are clearly defined. However, other studies have revealed that the presence of institutionalized deposit insurance enhances the moral hazard. International recommendations propose at the same time to establish an explicit deposit insurance system when designing a modern financial system, by setting a deposit insurance limit relevant to a limited amount of reimbursement. I share the opinion of *Anginer* and co-authors (2014, p. 313) that in the end it depends on the extent of moral hazard whether deposit insurance increases or decreases the stability of the financial system on the whole. An effective way of mitigating moral hazard is the strengthening of market discipline, e.g. by means of the

strict monitoring of banks or the introduction of the risk-proportionate calculation of deposit insurance premiums.

2.4 Contribution

Having reviewed the literature available on the subject, it is obvious that the existence of moral hazard related to deposit insurance is a well-established fact. Empirical researchers tried to detect it by testing the correlation between the introduction of the deposit insurance and the risk of the bank system with regression models in the various countries and periods, by incorporating control variables in the models, which allowed them to filter out every factor other than moral hazard which could affect the risk of the banks. Until know, this indirect deduction has been the only one available for testing the manifestation of moral hazard.

My own empirical research contributes to the expansion of the literature on the subject by taking a new approach, by the comparison of the Hungarian data on the deposits and depositors of credit institutions liquidated in the same period and those still existing and the classification of the depositors. The novelty of the dissertation is that it is the first to examine the distribution of deposit amounts on an international scale, which may be used as input for the simulation of bank runs, whereas the classification of the depositors reimbursed may facilitate the identification of certain group features and behaviours, which in turn may help regulators in the prevention of bank runs or other unfavourable outcomes.

The analysis of the manifestation of moral hazard from a new perspective was made possible by the concentration in time (2014-2015) of a considerable number of bank failure in Hungary, which provided a sufficient number of cases and data volume for theoretical examinations. This is the first time that the database of the reimbursed depositors of credit institutions liquidated in the period of 2014-2015 in Hungary has been analysed for a scientific purpose. Until now, the reimbursement-related experience of the National Deposit Insurance Fund has only been analysed in respect of depositors' reactions based on the calls addressed at NDIF (*Kiss*, 2015). I trust that this research taking a new approach will be repeated on the data stored by the deposit insurers of other countries as well, which would further expand our knowledge of moral hazard.

3 THE HUNGARIAN DEPOSIT INSURANCE SYSTEM AND ITS INTERNATIONAL ENVIRONMENT

Because of the substantial amount spent on the financing of banks, deposit insurance has gained key importance. In 2015, the Hungarian retail sector kept approximately 20% of its assets (9 thousand billion HUF) in bank deposits and bonds issued by banks (*Boldizsár* and *Koroknai*, 2016). The insuring of bank deposits may strengthen the trust of depositors in the bank, which may make overcautious customers, who would choose to keep their money at home in lack of an insurance, appear in the banks with scriptural money, thus increasing the volume of deposits. The growth of deposit volumes may in turn increase the loan-to-deposit ratio and in this way the possibility of lending above the regulatory minimum. *Banai* (2016, pp. 137, 142) pointed out based on the analysis of the Hungarian banking sector that "a good financing position (loan-to-value ratio) supports lending activity" and that "deposits provide the most stable financing to banks, therefore they are essential for the safe operation of banks".

3.1 The history and operation of deposit insurance in Hungary

The history of deposit insurance goes back to 1952 in Hungary when *Law Decree 9 of 1952 on savings deposits and depositor rights* took effect. Pursuant to *Article 2* of the Decree, „the repayment of savings deposits is guaranteed by the government". The purpose of the Decree was formulated as „promoting the creation of savings deposits and warranting the enhanced access of depositors to their rights and benefits". The governmental commitment extended to both the amount deposited and interest on it. Later, following the establishing of the two-level banking system, the Hungarian state undertook to become a controlling shareholder in any credit institution where a problem arises (*Csatai*, 2012). So, there has been some kind of an explicit deposit insurance system present in Hungary since 1952 in the sense that the state has had a statutory obligation to reimburse depositors or prevent the dissolution of the bank in the event of its failure.

However, the classic explicit deposit insurance system under the control of a single, specific institution and functioning in the framework and according to the conditions laid down specifically in a legal rule was only established in 1993 in the country. For the period of 25 years since then, the Hungarian deposit insurance system has been managed by the National Deposit Insurance Fund, which was established based on the authority granted in *Act XXIV of 1993 (on the Foundation and the Detailed Rules of Operation of the National Deposit Insurance Fund).* According to the reasoning included in the *Act*, the Parliament adopted the Act in view of „enhancing the volume of savings, promoting the widespread use of cashless payment methods, improving depositors' trust in financial institutions, safeguarding the deposits kept by insured depositors with financial institutions, reducing any unfavourable impacts of the eventual insolvency of financial institutions, promoting the smoothness of cash-flow through safeguarding the funds kept on current accounts and balancing the inequality of competition arising from a dominant position within the financial institution system". Another Act regulating the operation of the Hungarian deposit insurance system is *Act CCXXXVII of 2013 on Credit Institutions and Financial Enterprises („Hpt").* Pursuant to *Article 209 of the Act*, credit institutions pursuing their activities in Hungary are obliged to joint the National Credit Insurance Fund, except for the „branches of third-country institutions […] if the Authority considers that they have deposit insurance that is the equivalent of the deposit guarantee scheme prescribed under Directive 2014/49/EU of the European Parliament and the Council." NDIF member credit institutions shall pay regular membership fees. In addition, NDIF may also require its members to make extraordinary payments for the purpose of the reimbursement of the depositors.

In the event a deposit cannot be withdrawn due to the insolvency of the given bank, NDIF shall pay reimbursement to both private persons and legal entities eligible for reimbursement in twenty working days at the moment. The amount of the reimbursement per depositor and credit institution may not exceed the HUF amount equivalent with EUR 100,000 cumulatively[3] (*OBA*, 2017a). The NDIF guarantee applies to the capital and the interests alike. In addition to the implementation of reimbursement payments and the monitoring of banks, the responsibilities of NDIF include the information of depositors

[3] At the moment, an additional increase of the upper limit of payment by no more than EUR 50,000 is allowed in extraordinary cases. To deposits created before 1993 (until withdrawn) continue being subject to full governmental guarantee.

on the existence and conditions of the deposit insurance. In the event of any change to conditions of the deposit insurance, NDIF compiles an online distance learning material for the administrators of the branch offices and send out an informational letter to bank account holders, again in cooperation with the member institutions (*OBA*, 2015).

NDIF is managed by an independent board of directors seating, besides the managing director of NDIF, the representatives of all participants of the Hungarian financial community (Magyar Nemzeti Bank, the Hungarian Banking Association, the Ministry of National Economy or the Integration Organisation of Co-operative Credit Institutions). Both MNB and the interest organisations (i.e. the Banking Association) delegate two members to the board of directors. NDIF is not an authority but has the powers necessary to perform its duties and closely cooperates with financial regulatory bodies (*OBA*, 2017a).

NDIF finances its activities from the contributions of member institutions and the return on the investment of such funds. NDIF may invest its funds into government security or deposit them with MNB, and may spend the profit generated, if any, to increase its equity, exclusively. The financial management of NDIF is supervised by the Hungarian Court of Auditors, which reports to the Parliament.

The annual membership fee is comprised of a basic fee and a risk-dependant fee. NDIF uses variables reflecting the risk of the individual credit institutions to calculate the latter. The calculation includes, in addition to liquidity (LCR – liquidity coverage ratio, NSFR - net stable funding ratio), leverage and capital adequacy ratios, the ratio of risk-weighted assets (RWA) and non-performing loans (NPL). Besides the risk indicators applied, the calculation of the fee is also influenced by the return on assets (ROA) (*OBA*, 2017b). This means that credit institutions with an operating model or portfolio involving more risk are required to pay a relatively higher fee to NDIF. According to the position of the International Association of Deposit Insurers (*IADI*, 2017), the tariff differentiation applied by NDIF is a suitable means to reduce the excessive risk assumption of banks.

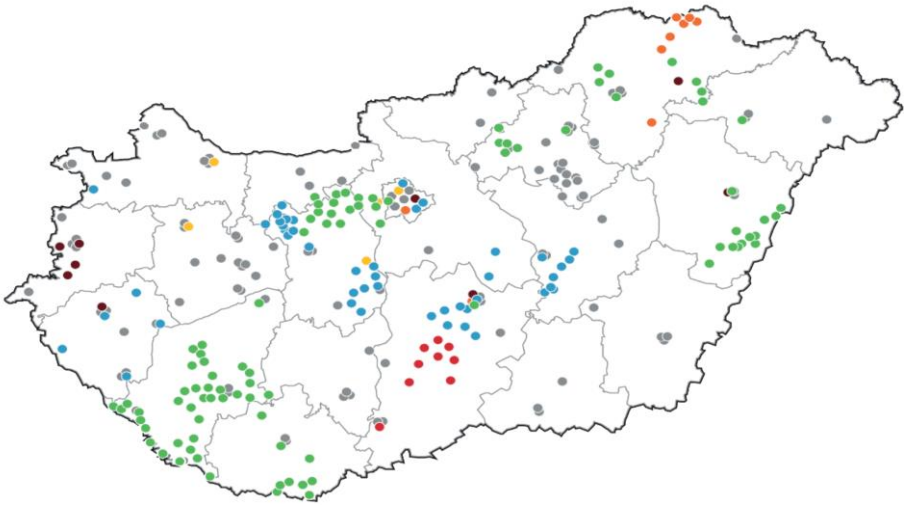
Whereas registered deposits are insured by NDIF (*Article 212 of Act CCXXXVII of 2013*), investments are protected by the Investor Protection Fund (IPF). IPF was established I 1997, four years after the foundation of NDIF, based on the authority granted in *Act CXI of 1996 (Épt)* regulating the securities market and its institutions in a comprehensive

manner. The insurance provided by IPF is related to investment services, therefore the members of the fund include investment companies, credit institutions providing investment services, broker companies and investment fund management companies involved in portfolio management (*BEVA*, 2017). Just like NDIF, IPF provides reimbursement up to an amount equivalent to EUR 100,000 in the event of the insolvency of its members, with the difference that IPF requires 10% own contribution for the amount over HUF 1,000,000. According to *Article 217, Section (2) of Act CXX of 2001* regulating the operation of IPF: "The Fund shall reimburse investors entitled to reimbursement for claims up to a maximum amount of six million forints per person and per Fund member. The amount of reimbursement paid by the Fund is 100 per cent up to one million forints, and for amounts over the one-million forint limit, one million forints and ninety per cent of the amount over one million forints."

NDIF and IPF are similar in terms of their organisational structure, functioning and financing alike and they need the same resources to be able to monitor their member institutions in terms of risks. The two institutions also display considerable overlaps in respect of the participants involved in the processes, the member institutions and the scope of the insured. A significant portion of NDIF member credit institutions provide investment services either in their own right or through a subsidiary functioning as an investment company, so they are members of IPF as well. The reimbursements subject to my research also reveal a possible overlap between the scope of the insured. For example, Buda-Cash Brókerház Zrt was closely related, through its owners, to DRB Bank Group, both of which filed for bankruptcy almost contemporaneously, and the members of DRB Bank Group regularly realized securities transactions of large amounts with Buda-Cash Brókerház Zrt (*MNB*, 2015b). The reimbursement process at IPF is, however, more complex and takes longer than in the case of deposit insurance (*Walter*, 2016). On the whole I think that the synchronisation of the operations of NDIF and IPF may result in synergies because of the numerous similarities between them.

3.2 The reimbursement history of NDIF

Since the establishing of NDIF, nearly 177 thousand clients have received reimbursement in a total amount of more than 275 billion HUF (cumulated at nominal value)[4]. Investors were affected by the liquidations all over the country, as revealed by the locations of the branch offices of the credit institutions closed in Figure 3. A total of 18 credit institutions have been liquidated since the establishing of NDIF, the liquidation of 10 of which concentrated to the period of the last two years, including those two institutions which generated reimbursement obligations of the largest volumes (Orgovány és Vidéke Takarékszövetkezet és a négy bankból álló DRB Bankcsoport).



DRB Bankcsoport (DRB, ÉRB, BRB, DDB) (2015)*
73 000
103 (345)

Tisza Takarékszövetkezet (2014)*
7 100
8,6 (28,6)

Széchenyi Kereskedelmi Bank (2014)*
1 400
14,5 (48,3)

Széchenyi István Hitelszövetkezet (2014)*
2 700
8,8 (29,3)

ALBA Takarékszövetkezet (2014)*
12 000
8 (29)

Orgovány és Vidéke Takarékszövetkezet (2014)*
30 000
54 (196)

Körmend és Vidéke Takarékszövetkezet (2014)*
10 000
22 (80)

Soltvadkert és Vidéke Takarékszövetkezet (2012)*
17 000
33,1 (120)

„Jógazda" Takarékpénztár (2011)*
5 500
9,1 (35)

Általános Közlekedési Hitelszövetkezet (2010)*
1 190
3,1 (10,5)

Rákóczi Hitelszövetkezet (2000)
1 400
0,305 (1)

Realbank (1999)
14 000
8 (27,5)

Iparbankház (1995)
9
2 (6,8)

Agrobank (1995)
0
0,5 (17,2)

Heves és Vidéke Takarékszövetkezet (1993)
1 300
0,262 (0,9)

[4] Own calculation based on the NDIF database (amounts taken at nominal value).

The number of those reimbursed

The amount of reimbursement in billion HUF (million EUR).

* In 20 working days.

Figure 3: The amount and geographical distribution of deposit insurance reimbursements since 1993. Source: Edited from the NDIF database.

The reimbursements made in large volumes in 2014 depleted NDIF reserves almost completely, and the DRB Bank Group was liquidated in this financial situation in 2015, which was refinanced by NDIF by the issuing of bonds in three months after taking out a rapid bridging loan from MNB. The impact of the reimbursement obligations on the liquidity coverage ratio of NDIF is shown in Figure 4. The liquidity coverage ratio measures the financial standing and "top-up" rate of deposit insurance institutions by comparing the liquid assets of deposit insurance funds with their theoretical reimbursement obligation at the same time (*OBA*, 2016, p. 19).

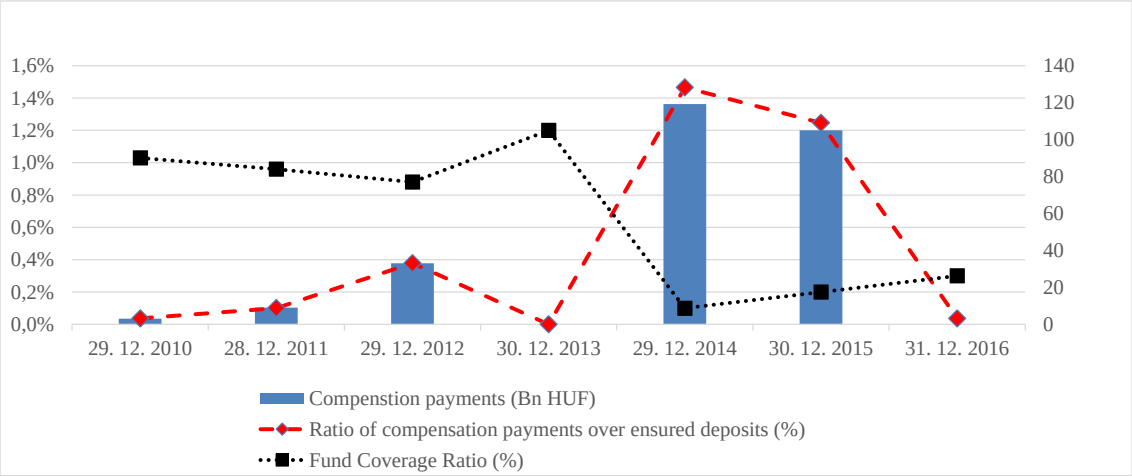


Figure 4: The change to the coverage level of NDIF as a result of reimbursement events. Source: Edited from the NDIF database.

The liquidity coverage ratio of NDIF had been standing stable at around 1% until 2013, but fell back to 0.1% in 2014 and has been standing at this level since then. As of December 31, 2015, NDIF was one of the deposit insurance funds with the lowest liquidity coverage ratios in Europe. On December 31, 2016, the liquidity coverage ratio of NDIF was 0.3%, which is to be increased by NDIF to the level of 0.8% by July 3, 2024 according to *Article 10, Section (2) of Directive 2014/49/EU of the European Parliament and of the Council.* Member institutions have to provide substantial contribution compared to the current top-up of the fund in order for it to be able the reach the target value and discharge its obligations assumed with the bonds issued. The reason for this is

that 1.47% and 1.25% of the reimbursement obligation relevant to the total of the deposits had to be spent on reimbursement in the last two years, respectively. It is important to note at this point that the minimum target level of 0.8% required by the European Union in the future would not have been sufficient to meet the compensation demand in either year. It would be advisable therefore to determine the liquidity coverage ratio targeted with regard to the existing reimbursement experience in addition to the minimum regulatory requirements.

3.3 International outlook

NDIF is involved in ongoing cooperation with the international representatives of the deposit insurance profession. It is a founding member and active participant of both international deposit insurance organisations: the International Association of Deposit Insurers (IADI) and the European Forum of Deposit Insurers (EFDI). This close cooperation is also reflected in the fact that the former managing director of NDIF serves now as the secretary general of the European Forum of Deposit Insurers. The European Forum of Deposit Insurers was founded in 2002 with the support of the European Commission and the objective to provide a common platform for its members (66 institutions at the moment) to exchange their experience (*EFDI*, 2017). The International Association of Deposit Insurers was also established in 2002 in order to improve the effectiveness of deposit insurance by promoting cooperation on an international scale and providing guidance based on research. The Association is a non-profit organisation which 84 deposit insurers have joined up to this date (*IADI*, 2016).

Since the financial crisis of 2008, the importance of an international cooperation has gained even more attention. The crisis revealed how important it is for the countries of the world to apply effective deposit insurance models (*FSF*, 2008), which led the Basel Committee on Banking Supervision (BCBS) and the International Association of Deposit Insurers to formulate the Core Principles for Effective Deposit Insurance Systems. One of them is the minimising of moral hazard, which necessitates an effective deposit insurance system with an appropriate operating model and a strong financial safety net.

The Financial Stability Board (FSB) compared the deposit insurance systems of its member countries as of 2011 in light of the core principles of deposit insurance. The comparison also extended to the reaction of the deposit insurance systems encompassed in the survey to the financial crisis of 2008. Ten of the twenty-one member countries of the Financial Stability Board raised the deposit insurance limit during the years of the crisis and four of them (France, Germany, Hongkong and Singapur) introduced a full deposit guarantee on a temporary basis. Although four countries (Japan, Korea, Mexico and Turkey) did not take any extraordinary measures in response to the crisis of 2008, this may probably be explained by the fact that they had already taken the necessary steps after the crises of the early 90s and the early 2000s. Australia introduced an explicit deposit insurance system in October 2008, right in response to the crisis, with a temporary deposit insurance limit of 1 million AUD and also created a separate guarantee fund to insure deposits of an amount in excess of 1 million AUD, which could be joined on a voluntary basis, in consideration for the payment of a fee. From the outbreak of the crisis until 2012, the United States of America used to provide guarantee for the full amount of non-interest bearing transaction accounts. Three FSB members (Brazil, Korea and the Switzerland) also extended deposit insurance to products which had not been subject to insurance (e.g. foreign exchange deposits, pension fund deposits) (*FSB*, 2012). The Financial Stability Board also established that the deposit insurance coverage is high in some of the countries in terms of both the number and the amount of the deposits insured (e.g. Germany, Japan or the USA).

This means that the majority of FSB member countries extended depositor protection significantly, which may have a negative effect on maintaining market discipline. The Financial Stability Board suggests therefore that IADI and other organisations affected should provide more guidance as to the well-established methods and best practices which may help with minimising moral hazard (*FSB*, 2012). This study is actually also intended to promote the achievement of this goal. The deposit insurance profession is suggesting the monitoring of market players (*FSB*, 2012) and the selection of deposit insurance models providing limited guarantee (*EC*, 2017) as possible means of ensuring a proper balance between financial stability and market discipline. I think that the countercyclical strategy of the USA, which is famous for its effective money and capital market, may also be regarded as good practice, which meant that following an extension of the

insurance to the full amount of transaction accounts for the period of crisis, the guarantee was limited again after the end of the crisis.

The European Union responded to the crisis by the standardization of the deposit insurance level across its Member States so that diverse reimbursement limits should not cause any distortion of the competition within the internal market. According to the reasoning in *Article 19 of Directive 2014/39/EU of the European Parliament and of the Council of 16 April 2014 on deposit guarantee schemes*, in the financial crisis of 2008, "uncoordinated increases in coverage across the Union have in some cases led to depositors transferring money to credit institutions in countries where deposit guarantees were higher. Such uncoordinated increases have drained liquidity from credit institutions in times of stress."

The first step in the process of harmonisation of deposit insurance systems across the EU was realized by the standardization of the coverage and the requirements relevant to deposit insurance systems in 2014, when *Directive 2014/49/EU of the European Parliament and of the Council* took effect. The establishing of a so-called "European Deposit Insurance System" (EDIS) is, however, being debated. It would mean that the funds accumulated by the deposit insurers in the Member States would be transferred to a common fund, which the reimbursement of the depositors in the EU could be financed from, regardless of the Member State of the member credit institution liquidated. The European Deposit Insurance System would constitute the third pillar to bank union, complementing the already existing Single Supervisory Mechanism (SSM) and the Single Resolution Mechanism (SRM). The Single Supervisory Mechanism is supervising the most significant banks of the euro area directly. The Single Resolution Mechanism is intended to ensure the organized resolution of banks filing for bankruptcy by minimising the costs to be borne by taxpayers and the real economy (*EP*, 2017).

The deposit insurance systems in the European Union will thus continue functioning on a national level for the time being and not even the euro area has a single deposit insurance fund. (*Tóth,* 2015). The duality formulated by *Bod* (2015) generally regarding the typical tendencies in the EU can be observed in respect of the deposit insurance regulation, too: the striving at harmonisation and the growing number of economic protectionism cases are present simultaneously. The occurrence of such contradictory phenomena is well

demonstrated by the fact that "the issue of joining the bank union of EU Member States and that of the secession of a Member State from the European Union appeared in the same moment on the political agenda..." (*Bod*, 2015, p. 79). Mérő and Piroska (2017) also explain why the idea of a bank union is not regarded as attractive by countries of East-Central Europe.

Although the European Commission is not recommending a further harmonisation of the deposit insurance funds, it is supporting the idea that the single resolution fund should extend credits to the deposit insurance funds of the Member States on a voluntary basis, if necessary (*Móra,* 2013). A European level deposit insurance model could also work well instead of the European Deposit Insurance System. *Gros* and *Schoenmaker* (2014) suggest for example that a given institution could fulfil the functions of resolution and deposit insurance at the same time. This would mean in practice the adding of deposit insurance to the powers of the existing Single Resolution Mechanism. I think it is worth considering the model of *Pisani-Ferry* and co-authors (2012), where the deposit insurance systems of the Member States would be refinanced centrally. *Pisani-Ferry* and co-authors (2012) also suggest that national and European level deposit insurance authorities could provide financing jointly. One can already see the signs of certain changes taking place in the direct international environment of the Hungarian deposit insurance system which may affect the current way of thinking about reserves or the contribution of member institutions.

In line with the harmonisation processes within the EU, NDIF increased the deposit insurance limit from EUR 50,000 to EUR 100,000 following the crisis (in 2011). An obvious advantage of this measure is that Hungarian banks are not placed at a competitive disadvantage compared to their European competitors offering higher coverage. At the same time, as MNB warned in 2002, "with consideration to the low average size of deposits and the worse income position of the Hungarian population, high coverage may present significant moral hazard as depositors will be less motivated to behave in a cautious manner" (*MNB*, 2002, p. 54). I agree with the suggestion of MNB that the Hungarian deposit insurance system needs a regulation meeting two controversial interests contemporaneously: on the one hand, it has to create neutral conditions of competition for the banks registered in Hungary within the internal market of the EU and, on the other hand, it has to manage the problems arising from moral hazard effectively.

Being familiar with the operation and the international environment of NDIF and the current recommendations of the deposit insurance profession is indispensable for anyone to be able to conduct their own, well-founded empirical research into the subject. To sum it up, Hungary has an explicit deposit insurance system with risk-proportionate premiums and limited coverage. According to the unanimous opinion of the profession, a deposit insurance structure with such characteristics can be regarded as desirable in view of the minimising of moral hazard. It seems, however, that the deposit protection level harmonized across the EU was not adjusted to the income conditions of the Hungarian population, as a result of which depositors might be less motivated to display a cautious behaviour. As I expect on the whole that there will be indications of moral hazard among depositors, this is what I formulated in the hypotheses, too.

4 MY OWN EMPIRICAL FINDINGS

The high number of bank failures in Hungary enables an empiric research of the theoretical correlations between deposit insurance and moral hazard based on the available data of Hungarian banks and depositors. I am investigating the question as to whether or not it is possible to deduce the presence of moral hazard from four different perspectives. In chapter 4.1, I compare the interests offered by liquidated credit institutions with the interests offered by existing credit institutions and, I light of the correlations known from literature, I expect average deposit interests at the failed institutions to be higher (H1). In chapter 4.2, I compare the depositors of the liquidated and the existing credit institutions in terms of the amounts of their deposits[5], their age and the settlement types they come from. One of the reasons for a difference in the marginal distribution of the three variables, if any, might be that the depositors of a certain financial standing (H2, H3 and H4), age (H5) or place of residence (H6) may have been effected by moral hazard to a smaller extent. I list the depositors reimbursed to homogeneous groups along these three variables in chapter 4.3 and expect to be able to identify certain groups of a specific financial standing and place of residence (H7) demonstrating a level of moral hazard which is different from that faced by other groups. For example, it may imply moral hazard if young people living in towns or cities deposit their money in one of the banks liquidated, despite their relative mobility and the wide choice of banks near their home. In chapter4.3, I also list the credit institutions liquidated into homogeneous groups based on such characteristics of their depositors and expect to find easy-to-distinguish groups (H8) in some of which there might be a higher level of moral hazard compared to the others.

The empirical research conducted up to this date have made it clear that own contribution is a determining factor of moral hazard, which is universally the portion above the deposit insurance level EUR 100,000 across the EU. In chapter 4.4, I compare the distribution of the typical deposit amounts of twenty Member States of the European Union and presume

[5] In the case of liquidated credit institutions, the deposit amounts under the reimbursement limit are available.

significant differences between the average deposits (H9). The universal deposit insurance limit may mean higher coverage in countries with a lower average deposit amount, and, accordingly, smaller own contributions to encourage depositors to behave more carefully.

As indicated in Figure5, I will rely on the findings of all of the four directions of research in the identification of the signs of moral hazard.

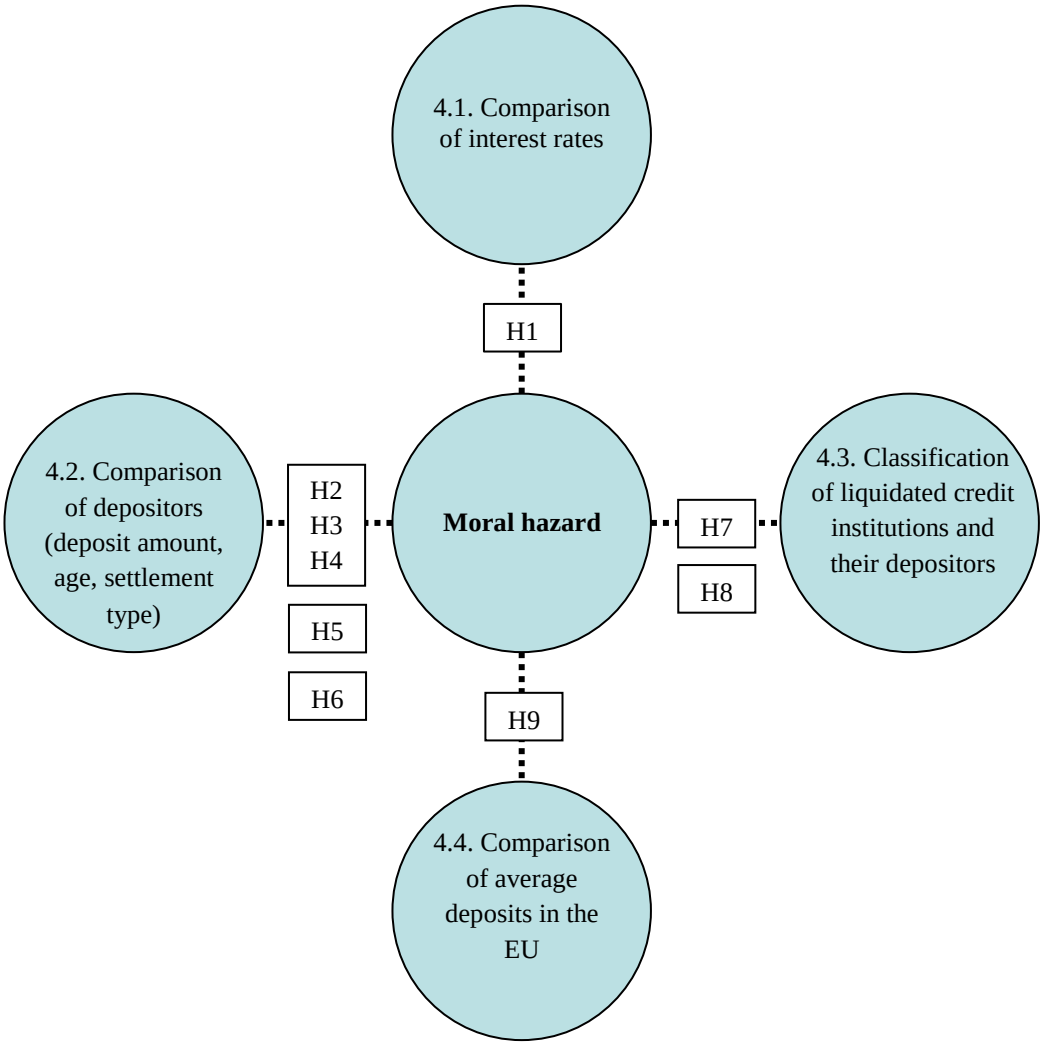


Figure 5: **An empiric research of the signs of moral hazard from four perspectives. Source: Prepared by myself.**

Similarly to other empirical models in the relevant literature, my individual approaches of research only allowed me to draw indirect conclusions regarding the presence of moral hazard as the phenomenon cannot be observed directly. I expect from the combination of the findings of my analyses taking a new approach that we can learn more about the

typical behaviour of depositors and banks in awareness of the deposit insurance based on the Hungarian example.

4.1 Comparing interest rates of the liquidated and operating credit institutions

According to the majority of empirical researches, moral hazard inherent in deposit insurance increases the risk in the banking system, which in turn generates in increase of interest rates. On the one hand, this is because banks with a riskier portfolio get financing more easily, because up to the deposit insurance limit, the demand for higher interest rates is not moderated by the possibility of losing the deposit. And, on the other hand, banks can assume a relatively higher level of risk when extending loans, because the depositor's claims are to be satisfied by the deposit insurer rather than the banks themselves in the event of the dissolution of the banks and they typically charge higher interest rates on credits of a higher rate of risk.

Hypothesis

I suppose therefore based on the available literature and the Hungarian data available that

H1: the liquidated credit institutions offered their depositors higher average interests on their deposits compared to existing credit institutions.

Accepting this hypothesis would be a verification of the above-mentioned correlations in light of the Hungarian data and that Hungarian depositors could be motivated by higher interest rates to deposit some of their savings in institutions which failed subsequently.

Methodology

I will apply descriptive statistics for the purpose of the simple comparison of the average deposit and credit interest rates of liquidated and existing credit institutions. I will determine the significance of the difference between deposit interests based on a two-sample single sided t-test where the distribution of the interest rates is normal, and the Welch's t-test otherwise. I will evaluate the hypothesis regarding normality based on the Kolmogorov-Smirnov statistics.

Data

I derive input data for the comparative analysis of the average annual interest rate agreed upon in the contracts on HUF deposits placed with existing credit institutions from the statistics published by MNB (*MNB,* 2015a). Average deposit interests were weighted with the deposit amount and organised according to maturity (demand deposit, overdraft deposit, short term/long term deposit). I will analyse the average of the deposit interest rates of liquidated credit institutions based on an individual data request field with MNB, by using the same weighting methodology and maturity structure. Deposit interests are average annual interest rates weighted with the contract sum.

In order to be able to include all of the liquidated credit institutions in the comparison, the date of the data request is 31. 01. 2014, as ÉRB Észak-magyarországi Regionális Bank was established on 31. 01. 2014 and the liquidations examined commenced in 2014. However, ÉRB Észak-magyarországi Regionális Bank did not submit any statistical data on interests in January, 2014 and Körmend és Vidéke Takarékszövetkezet was liquidated on 22. 01. 2014, therefore these two institutions were left out of the comparison in the end, just as ALBA Takarékszövetkezet, which was not called upon to submit statistical data on interests, as a result of which there are no data available to MNB regarding this institution. Finally I could compare the average deposit rates of a total of seven liquidated institutions with the conditions provided by existing banks. The total amount of the deposits placed with the seven institutions account for 66% of all reimbursements.

Comparing average deposit interest rates of the liquidated and existing credit institutions

The average interest rates on deposits kept by households in existing and liquidated credit institutions as of 31. 01. 2014 are compared in Table 1.

Average interest rates on deposits	Demand deposits and overdraft deposits	Term deposits		
		Maturity less than 1 year	Maturity more than 2 years	
			Maturity max 2 years	Maturity min 2 years
Existing credit institutions	0,74	2,24	2,91	2,24
Liquidated credit institutions	1,44	3,06	4,35	3,89
Difference (absolute)	***0,69***	***0,83***	***1,45***	***1,65***
Difference (relative)	**93%**	**37%**	**50%**	**74%**

Table 1: The average interest rates on deposits kept by households in existing and liquidated credit institutions (31. 01. 2014) Source: Edited from MNB database

Interest rates are higher in liquidated credit institutions than in existing credit institutions in the case of deposits of any maturity. The difference between deposit interest rates in absolute terms grows in parallel with the length of term of the deposit. In relative terms, the interest rates offered by liquidated credit institutions for demand deposits and overdraft deposits were almost two times the rates offered by existing credit institutions. Higher interest rates regardless of maturity could enhance depositors' motivation to deposit their savings in credit institutions which failed in the end.

Testing hypothesis one (H1)

Deposit interest rates were higher in the liquidated institutions in the case of every maturity, but I would like to determine the statistical significance of the difference. I will examine in respect of each maturity if average deposit interest rates were significantly higher in the liquidated credit institutions than in the existing ones.

I will test hypothesis H1 with paired one-tailed t-test if the distribution of the interests is normal. I dismiss the presumption of normality based on the Kolmogorov-Smirnov statistics in respect of the interest rates of demand deposits and overdraft deposits, but I cannot dismiss it for term deposits regardless of maturity. The result of the normality test is shown in Table 2.

Presumption of normality on average interest rates on deposits	Demand deposits and overdraft deposits	Term deposits		
		Maturity less than 1 year	Maturity more than 2 years	
			Maturity max 2 years	Maturity min 2 years
Kolmogorov-Smirnov statistics based on *p* value	dismiss	cannot dismiss	cannot dismiss	cannot dismiss
95 percent confidence level	0,00	0,07	0,06	0,20

Table 2: Testing of the normal distribution of the interest rates of retail HUF deposits (31. 01. 2014) Source: Edited from MNB database

Since the interest rates of term deposits follow normal distribution, I have applied the paired single-sided t-test to the comparison and the results are displayed in Table 3.

Average interest rates on deposits significantly not higher in liquidated credit institutions	Demand deposits and overdraft deposits	Term deposits		
		Maturity less than 1 year	Maturity more than 2 years	
			Maturity max 2 years	Maturity min 2 years
Paired one-tailed t-test based on *p* value	n.a.	dismiss	cannot dismiss	cannot dismiss
95 percent confidence level	0,10	0,03	0,16	0,20

Table 3: Is the average of the interest rate of retail HUF deposits significantly higher in one population than in the other (31.01.2014)? Source: Edited from MNB database

According to the initial hypothesis of the paired single-sided t-test, there is no significant difference between the averages of the two compared populations. The examination of the significance of the difference between the average interest rates within the various maturity categories of term deposits leads me to mixed conclusions. Whereas in the case of term deposits with maximum one year maturity, I dismiss the initial hypothesis of t-test implying significantly higher average interest rates, this is not the case with term deposits with longer maturity. In the case of term deposits with longer maturity, I cannot dismiss the initial hypothesis of t-test since the average interest rates are not significantly higher in one of the compared populations.

Having dismissed the presumption of normality, I can apply Welch's t-test in the case of demand and overdraft deposits, which tests the significance of the difference between averages. This test yielded the result that at 95% confidence level there was no significant difference between the interest rates of demand and overdraft deposits at the liquidated and existing credit institutions (p=0.27).

So, we can establish based on the testing of hypothesis 1 that liquidated credit institutions offered higher interests on the average than existing institutions for deposits of any maturity, but this difference was significant only in the case of short-term deposits.

Comparing average credit interest rates of the dissolved and existing credit institutions

Various authors who substantiated the adverse effect of moral hazard inherent in deposit insurance with empirical research claim that banks offering higher interest rates tend to extend riskier credits and thus increase the vulnerability of the financial system. In order to analyse the data of credit institutions liquidated in Hungary, I compare the average

interest rates of retail credits extended by such institutions with those of the existing credit institutions (Table 4).

Average interest rates on credits	Overdrafts	Consumer credits	Mortgage loans	Other credits
Existing credit institutions	28,11	18,19	7,30	6,76
Liquidated credit institutions	10,33	9,84	8,47	7,22
Difference (absolute)	***-17,78***	***-8,35***	***1,16***	***0,46***
Difference (relative)	**-63%**	**-46%**	**16%**	**7%**
* variable interest rate or up to one year fixation				

Table 4: The average annual interest rate on HUF retail credits extended by liquidated and existing credit institutions, weighted with the contract sum (31. 01. 2014). Source: Edited from MNB database

The comparison reveals that the credit institutions went bankrupt in Hungary also extended mortgage loans and other credits at a price above the average of the banking market, but they offered overdraft facilities and consumer credits significantly cheaper than the existing credit institutions. One of the reasons for this could be in the case of overdraft facilities that none of the liquidated credit institutions had any outstanding interest-bearing receivables from credit cards in January 2014, which is a type of credit with a significantly higher interest rate compared to other overdraft facilities. As for consumer loans, I compare loans with variable interest rates or interest rates fixed for no more than one year in the case of both populations. The difference might be explained in part by the composition effect, but such a conclusion cannot be drawn from the data available. The credit institutions subsequently liquidated apparently extended riskier consumer loans at half the market price on the average, while they could compensate for their higher cost of financing with the less risky housing loans, typically secured by real estate collateral.

In light of the results of the comparative analysis of interest rates, it seems to be worth checking, from the point of view of supervision, the pricing of the individual deposit and loan facilities of the different institutions as outstanding values may imply the presence of moral hazard. Such analysis could be made based on the interest statistics of MNB for example.

4.2 Comparing the depositors of the dissolved and operating credit institutions

We can find no literature on any research comparing the depositors of liquidated and existing credit institutions. The only think we can know as depositor behaviour may be influenced by deposit insurance in that depositors are liable to accept more risk in the hope of higher interests at the expense of the insurance community. By comparing the Hungarian data, I try to find an answer to the question as to whether or not there ware any depositors of a certain financial standing, age or place of residence who were affected in the liquidations to a higher extent than others, which could imply the arising of moral hazard for many of them. As I did not find any literature on the differentiation of depositors from this point of view, my initial hypothesis according to each of the three dimensions (deposit amount, age, settlement type) is that there is no difference between the populations of liquidated and existing credit institutions.

Data

I attempted to compare the depositors of the liquidated and existing credit institutions in terms of deposit amount, age and settlement type by combining various data bases, as shown in figure 6. However, there are no data available at the level of the banking system on the age structure or settlement type of the depositors of existing banks and I was not given access to bank-level statistics. Therefore I could only make the comparison only indirectly according to the dimensions of age and settlement type, based on the Hungarian population as a whole in the case of the dimension of the age (*KSH*, 2015) and, as for the settlement type, based on the database of a questionnaire survey which assessed among others the depositing customs of Hungarian households (*TÁRKI*, 2015).

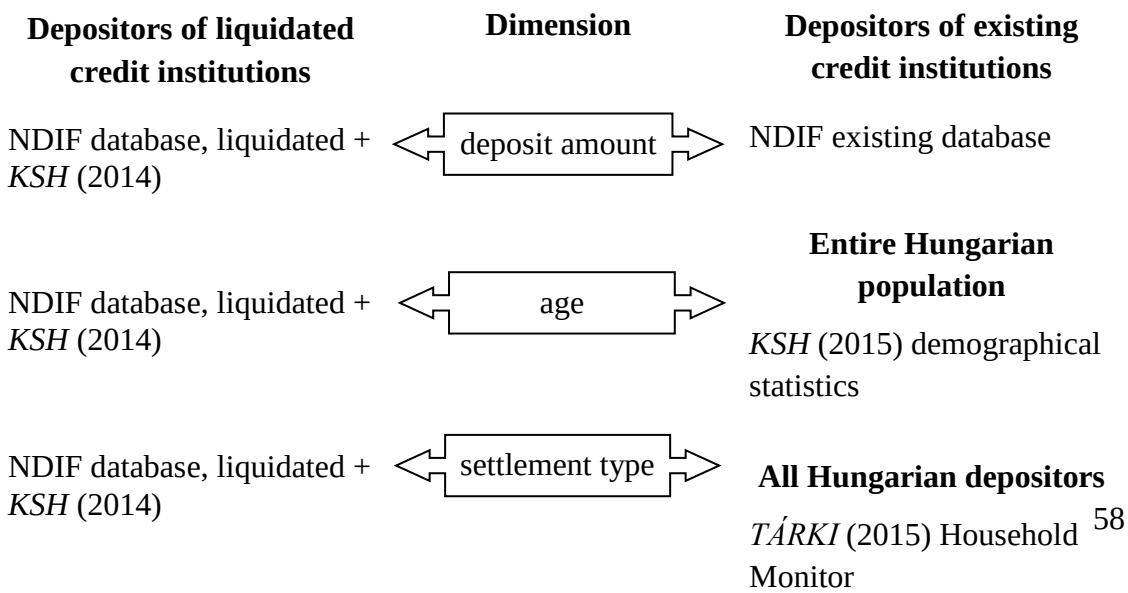


Figure 6: **Databases used and combined to compare the depositors of existing and liquidated credit institutions Source: Prepared by myself.**

The initial database of the analysis is the internal NDIF database of the depositors of liquidated credit institutions, which is analysed for the first time for a scientific purpose. From the credit institutions liquidated in Hungary, the NDIF database contains the data of the depositors of institutions liquidated in 2014 and 2015. My analysis covers 77.1% of all depositors reimbursed and 79.5% of the reimbursements (since 1993). I make the comparison regarding private persons (in a reimbursement value of HUF 188.9 billion) [6] as they decide on the amount deposited with banks individually. I analysed 113.345 observations (the deposit accounts of rescued private persons) in total. The database also contains data of legal entities and ownership communities (typically condominiums), the analysis of which could be subject to further research.

The NDIF database of liquidated credit institutions includes the reimbursement amounts paid, the dates and places of birth of depositors and the post codes of their permanent addresses. So we can compare deposit amounts (up to the reimbursement limit) and the ages and places of residence of depositors based on the database. I supplement the database of the depositors of liquidated credit institutions with the Regional Statistics of the Hungarian Central Statistical Office (*KSH*, 2014), using the post codes of the permanent addresses of the depositors. The HCSO Regional Statistics makes it possible to identify the name, county, region, legal status and the number of inhabitants of the settlement, as well as whether there is a bank branch in the given settlement[7]. I needed to correct several data quality defects when I was combining the two databases, the majority of which were linking errors caused by foreign addresses, missing data or accents and mistyping. The supplementing generated a new, unique database which enables the analysis of the types of the places of residence of depositors as well. The supplementing of the NDIF database was important for the research because the depositors living in larger settlements could choose from several credit institutions, nevertheless, some of them decided to place their deposits with credit institutions that were liquidated subsequently, which implies a higher probability of the presence of moral hazard as in the case of those living in smaller settlements.

[6] Own calculation based on NDIF database.
[7] The list of variables is not complete, it only contains the variables relevant to the subject.

Having supplemented the NDIF database of the depositors of liquidated credit institutions, I compared it with the databases indicated in Figure 6, namely with the internal, consolidated NDIF database of existing credit institutions, the demographical statistics of the Hungarian Central Statistical Office (*KSH*, 2015) and the findings of the Household Monitor questionnaire-based survey of the savings of Hungarian households by the Social Research Institute (*TÁRKI*, 2015) in the dimensions of the deposit amount, the age and the settlement type, respectively. The NDIF and *TÁRKI* (2015) databases are subject to limited access, therefore they can be analysed with individual permit only. I was granted access to the databases based on my research proposal. I will present the content of the databases in detail when comparing the same according to the given dimension.

4.2.1 According to the deposit amount

Hypotheses and methodology

I will describe the distribution of the amounts of deposits deposited with the liquidated credit institutions and compare the same with the amounts deposited with existing credit institutions by applying various methodologies based on three hypotheses (H2, H3, H4).

The second hypothesis of the dissertation deals with the distribution of the reimbursement amounts expressly. It used to be a general practice to assume the normality of the distributions of returns on assets in empirical financial studies in the past, mainly because they made it easy to use several models. However, the extremely large losses seen during financial crises revealed that distributions based on the extreme value theory (Pickands, 1975) describe the behaviour of financial instruments much better in many cases. In awareness of the typical distributions of financial data and taking into regard that the amounts deposited with banks constitute part of the unevenly distributed assets (*Piketty*, 2014), I presume an abnormal distribution. I use the data in the article of *Starr* and *Yilmaz* (2007, p. 1121) on the distribution of frequency of amounts deposited in a Turkish financial institution to make my hypothesis more specific. The distribution is strongly skewed to the left: deposits below USD 1,000 account for 90.7% of all deposits. I formulate the following hypothesis based on these data:

H2: The reimbursement amounts display an extreme value distribution.

I will test the empirical distribution of the reimbursement amounts paid by the matching of various theoretical distributions. Distribution is important information for the deposit insurer to develop an appropriate risk strategy, which in turn may contribute to the reduction of the moral hazard. One of the reasons why the difference in the distribution of the deposit amounts is important is that depositors can behave in different manners depending on the amount of their deposits, as revealed by empirical studies of bank runs (*Schumacher,* 2000; *Starr* and *Yilmaz,* 2007). *Starr* and *Yilmaz* (2007) observed in Turkey that whereas large depositors tended to withdraw their deposits only in response of the run of other large depositors on the bank, small and medium depositors ran on the bank as soon as they saw any other depositor do the same. Despite the significance of the issue, there have been little information on the distribution of deposit amounts in the studies prepared up to this date.

The third hypothesis is related to the difference in the distribution of deposit amounts deposited with liquidated and existing credit institutions. There is no information in the relevant literature as to the higher inclination of small, medium or large depositors to deposit their savings with credit institutions offering higher interest in awareness of deposit insurance, therefore my initial hypothesis is as follows:

H3: There is no significant difference in the distribution of the amounts of deposits deposited in liquidated and existing credit institutions.

This third hypothesis formulates the presupposition that the reason for no significant difference in the deposit amounts is that all depositors were attracted by the higher interest rates to the liquidated institutions to the same extent, i.e. all of them could be equally affected by moral hazard.

I will test this third hypothesis by comparing the relative frequency of the number of deposits placed with liquidated and existing credit institutions by the available classes. I will examine the significance of the difference with the "paired sample t-statistics" or a non-parametric test, depending on the outcome of the first hypothesis. In the event of the adoption of the first hypothesis, the paired sample t-statistics would not generate a reliable result, because it would require a normal distribution of the probability variable, therefore I will rely on the result of the non-parametric test primarily. The Wilcoxon rank sum test

is not dependant on distribution and provides a more robust result in many cases where the distribution of the variable examined is not normal (*Sawilowsky*, 2002).

In addition to the testing of the statistical significance, I will also examine the direction of the difference, i.e. the amount(s) of the deposits over- or underrepresent4ed in the liquidated credit institutions compared to the deposits placed with existing banks.

Starting from the fact that the liquidated credit institutions cannot properly represent existing credit institutions in terms of their size (there is no large or medium credit institution among them), I will also make the comparison in respect of a group of existing banks which only includes small and medium credit institutions. Because of the absence of any previous literature on the subject, I expect no significant difference in this case, either.

H4: There is no significant difference in the distribution of the amounts of deposits deposited in liquidated credit institutions and the existing smaller credit institutions.
By means of differentiation based on size, the liquidated credit institutions can be compared with the population of existing credit institutions of a similar size and organisational form, including only small banks and savings cooperatives. I will examine the significance of the difference with the "paired sample t-statistics" or a non-parametric test, depending on the outcome of the second hypothesis. If the test reveals a significant difference in the deposit amounts, the size of the credit institutions can be filtered from the reasons providing an explanation for the difference.

Data

I will compare the amounts deposited with existing and liquidated credit institutions based on the two databases available at NDIF.

The units of the database of the depositors of liquidated credit institutions are the reimbursement amounts, subdivided by depositors and credit institutions. "Depositors" mean in the databases all depositor accounts subject to deposit insurance (deposit instruments, deposit account, current account, bank account, payment account), subdivided by depositors and credit institutions. This means that depositors who opened an account with more than one credit institution will appear in the database as many times as the number of their insured accounts. Accordingly, I will display the number of the

deposit accounts opened rather than the number of depositors. One depositor may appear in more than one line if he/she was reimbursed several times in various credit institutions. However, the number of such depositors is negligible from the point of view of the statistics.

NHIF paid the reimbursement amounts after all depositor accounts subject to deposit insurance and deposits under the reimbursement limit. The value set of the reimbursement amounts paid in respect of the deposit may be a HUF amount equivalent with EUR 0 – 100,000.[8] I will make the statistics by filtering out reimbursement amounts of EUR 0. These clients not in need of reimbursement either owed some debt or their cumulated account balance was 0. These items need to be filtered out so that they cannot distort the average reimbursement amount or its dispersion. The database does not contain the original deposit amount, therefore there is no information available as to the amount of damage not reimbursed. We will see it, however, later that only a very small portion of the deposits were reimbursed to a maximum extent.

The NDIF database of existing credit institutions contains the deposits of the entire Hungarian banking market as credit institutions in Hungary are required by the law to be members of the NDIF and submit regular reports to NDIF on their current deposits.

In order to be able to make the comparison, I have to take into regard the difference in the structure and data content of the two databases. The value set in the database of liquidated credit institutions ranges from the minimum reimbursement amount (HUF 500) to the reimbursement limit (the HUF amount equivalent with EUR 100,000), therefore the comparison can be interpreted in this range. The owners of deposits of less than HUF 500 were not reimbursed for reasons of cost efficiency and in the case of depositors who deposited an amount in excess of the reimbursement limit with a liquidated institution, the amount in excess of the limit are not included in the database.

I will compare the number and amounts of the disbursements to private persons in the period of 2014-2015 with the amount of the deposits placed with credit institutions existing at the end of 2015. I will examine the disbursement amounts paid in 2014 in nominal value, without adjusting with the time value of money, because the impact of

[8] Converted at the EUR/HUF exchange rate as of the date of the reimbursement.

discounting is negligible from the point of view of the result: the annual base rate used as the proxy of risk-free return was no more than 3% in 2014 (*Magyar Nemzeti Bank*, 2017). Both databases contain the funds deposited by legal entities as well, whose data could be compared as part of further research.

Testing hypothesis 2 (H2), which says that the reimbursement amounts paid display an extreme value distribution

The distribution of the disbursement amounts reveal how many people placed deposits with the institutions reimbursed and the typical amount of their deposits. The distribution function of the total reimbursed mass is strongly skewed to the left (modus < median < average), and extended long to the right. We can see no peak on the right edge, therefore I present only the left edge of the distribution function graphically on Figure 7, indicating the decile values describing the total distribution. The most common, typical reimbursement value (modus, the maximum point of the function) is about no more than HUF 100,000. The median is also low: HUF 368,000, which means that the reimbursement paid was smaller than this amount in 50% and higher in the other 50% of the cases. The average reimbursement amount per deposit was HUF 1.7 million, i.e. even higher than the seventh decile. As demonstrated by the shape of the distribution function, it was rather typical to make several reimbursements in smaller amounts. This may be explained with the fact that deposit insurance does not only apply to term deposits but current accounts as well, where people tend to keep smaller amounts.

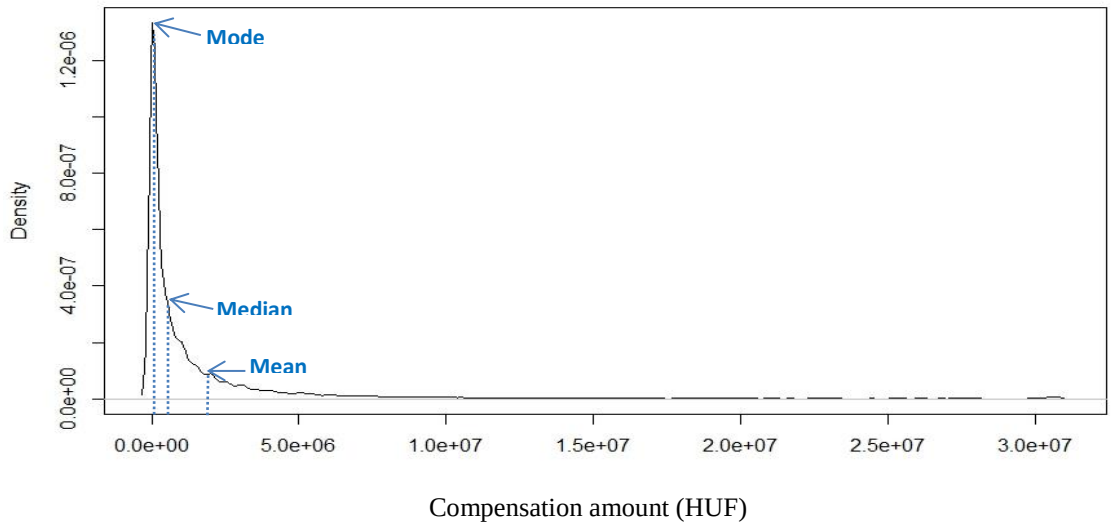


Figure 7: **A section and the decile values of the distribution function of compensation amounts. Source: Edited from the NDIF database.**

We can also read from the decile values of distribution that even if the reimbursement maximum has been no more than HUF 4.2 million (9th decile), 90% of the deposits could have been reimbursed. The distribution is strongly skewed to the left and pointed[9], therefore the presumption of normality can be dismissed, and this conclusion is supported by the Q-Q plot analysis as well. The testing of the normality of deposit amount distributions by credit institutions is attached in the Appendix (Figure F.1). The distribution of reimbursement amounts was tested and matched with the program package R.

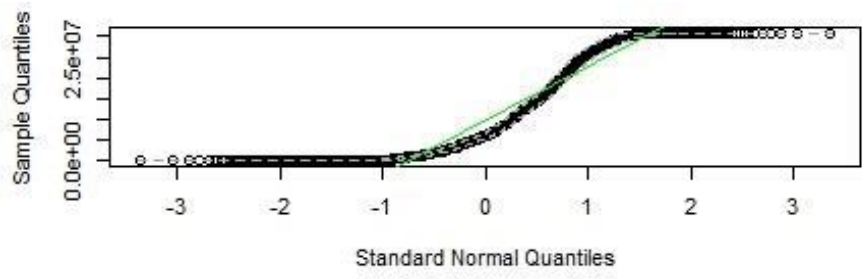


Figure 8: Testing normality with Q-Q plot analysis. Source: Edited from the NDIF database.

I will check after the graphic representation of the distribution function, if the reimbursement amounts display an extreme value distribution (H2).

$$F(x;k,\lambda) = 1 - e^{-(x/\lambda)^k}, \qquad \textbf{Equation 7}$$

where *k* is the shape parameter of distribution and its estimated value in this case is: *k* =0.44

and where λ is the scale parameter of distribution and its estimated value in this case is: λ=696 305.

If the shape parameter is below 1, it means that the distribution is extended long to the right, i.e. the frequency of reimbursements heavily decreases as the reimbursement amount grows. We can establish based on the characteristics of the distribution that if the reimbursement limit was increased, the number of reimbursed depositors would grow almost not at all, but the reimbursement amount would rise significantly.

[9] The value of K-indicator measuring pointedness is 0.175, which indicates a distribution more pointed than 0.263 typical of normal distribution.

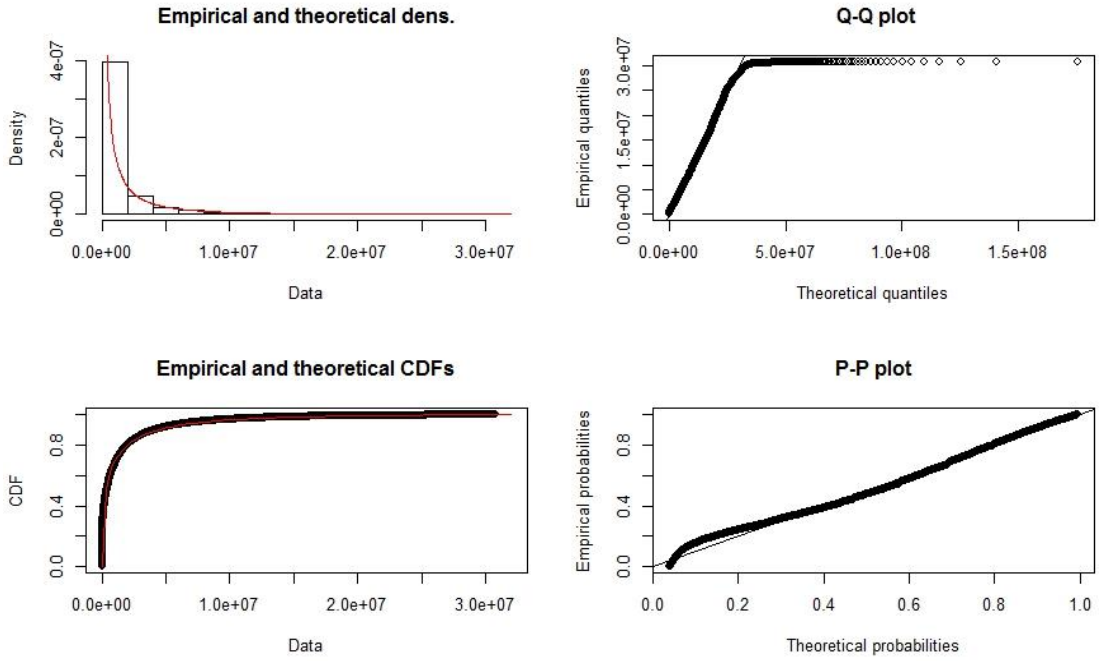


Figure 9: **Testing the Weilbull distribution. Source: Edited from the NDIF database.**

In order to test the hypothesis, I will compare the empirical and theoretical distributions and present my findings in Figure 9. The matching test reveals that the reimbursement amounts display an extreme value distribution.

Besides the Weibull distribution, I also tested the lognormal, gamma and Poission distributions starting from the shape of the empirical distribution and found that the matching of the Weillbull distribution was the best.

Accumulating more information regarding the distribution of reimbursement amounts provides input data for selecting the methodology of the further analysis of my research on the one hand and may be useful for other studies based on the simulation of bank runs.

Comparing the distribution of deposit amounts in dissolved and existing credit institutions

I will compare the number of deposit accounts kept and the amount of deposits placed by private persons in liquidated and existing credit institutions on cumulative data first, based on Table 5. I cumulated the insured deposit amounts deposited with existing credit

institutions and the reimbursement amounts paid in liquidated credit institutions up to the disbursement limit.

	Existing credit institutions (31.12.2015.)		**Liquidated credit institutions** (2014 and 2015)	
Insured deposits (number)	7 575 528	*98,5%*	113 338	***1,5%***
Amount (HUF billion)	5 807	*96,9%*	189	***3,1%***

Table 5: **Deposits of private persons in existing and liquidated credit institutions. Source: Edited from the NDIF database.**

The cumulated data reveal that whereas the number of reimbursed deposits is only 1.5% of the number of all deposits within the banking system, the deposit amount reimbursed is more than two times higher: 3.1% compared to the total amount of the deposits placed with credit institutions. This means that depositors typically deposited larger sums of money with failed credit institutions, one of the reasons for which might be the moral hazard. If the distribution of the amounts deposited with failed institutions had corresponded to the distribution of the entire population, the reimbursement of private persons would have cost half the amount it actually did in the period examined: in numerical terms, reimbursement would have cost HUF 94.5 billion less to the banking system (with regard to private persons only).

We can learn more about the source of moral hazard by analysing the differences between deposits placed with existing and liquidated credit institutions. Differences may only be analysed by classes, because the information in the database of the depositors of existing credit institutions is aggregated for certain classes, so I will compare the frequency of the number of deposits.

Testing hypothesis three (H3), according to which there is no significant difference in the distribution of the amounts of deposits deposited in liquidated and existing credit institutions.

I will examine the difference in the distribution of deposit amounts in existing and liquidated credit institutions with a non-parametric test. The Wilcoxon rank sum test reveals a significant difference at 95% confidence level ($p = 0.028$). It is in line with the result of the paired sample t-test ($p = 0.023$) at the same confidence level.

I have demonstrated the significant differences between deposits placed with existing and liquidated credit institutions in Figure10. The difference expressed as a percentage rate

for the given class shows how much higher or lower the frequency of the number of deposits placed with liquidated credit institutions is compared to the frequency of the number of deposits placed with existing credit institutions. I have connected the marked frequencies in the individual classes with dotted line only for the sake of better visualisation, but the values between the frequencies indicated cannot be interpreted.

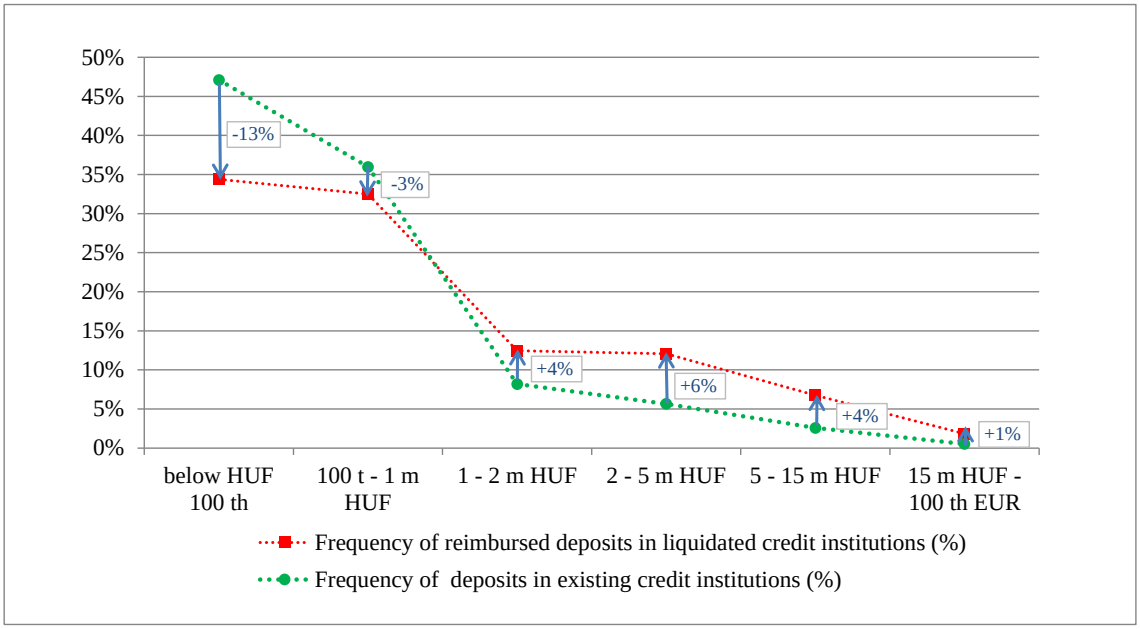


Figure 10: Differences between the frequencies of the numbers of deposits placed with existing and liquidated credit institutions. Source: Edited from the NDIF database.

Figure shows that that the proportion of deposits placed with liquidated credit institutions was less in the range below 1 million HUF and more in the range above 1 million HUF than in the existing credit institutions. That is, deposits of an amount in excess of 1 million HUF are overrepresented in liquidated credit institutions compared to existing credit institutions. One of the possible explanations for this might be that depositors with deposits larger than 1 million HUF were more inclined to deposit their savings with institutions offering higher interests and subsequently liquidated than small depositors, which may imply that they were more affected by moral hazard.

According to the current recommendation of the International Association of Deposit Insurers, setting the deposit insurance limit properly is a key element in reducing moral hazard (*IADI*, 2014, p. 11), so I will continue to examine the correlations between the deposit insurance limit and the insured deposit volume. Deposit insurance limit used to be much lower in Hungary: it was the HUF equivalent of EUR 50,000 before 2011 and

of EUR 20,000 from 2004 to 2009[10], HUF 3 million directly before Hungary's accession to the EU (2004) and HUF 1 million from the establishing of NDIF until 2003 (*Pataki* and *Kenesey*, 2015). I demonstrate in Figure 11 the frequency of the number and amount of the insured deposits placed with existing credit institutions by classes, as of 31. 12. 2015.

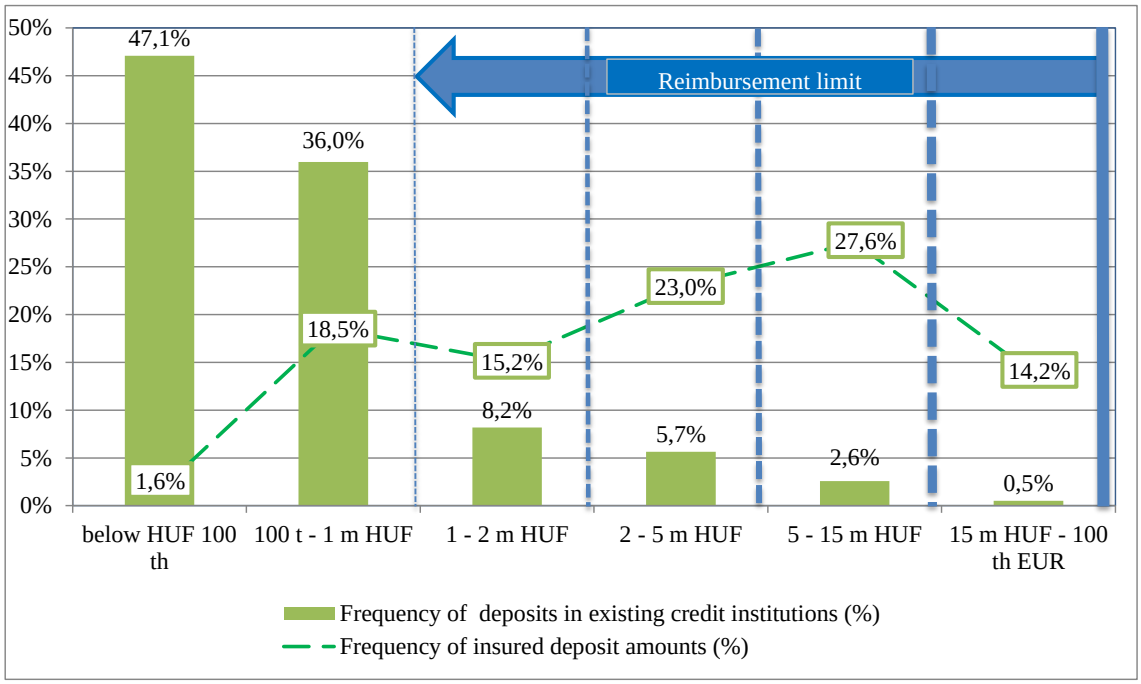


Figure 11: The frequency of the number and amount of insured deposits (31. 12. 2015) Source: Edited from the NDIF database.

Figure 11 demonstrates that the reimbursement of deposits above HUF 5 million would cost nearly as much (41.8%) as the reimbursement of all other deposits (58.2%), although they account for no more than 3.1% of all insured deposits (2.6% + 0.5%). For example, if the insurance limit was HUF 5 million, approximately[11] 3% of the depositors currently insured would no longer be insured, but the total amount of deposits insured would decrease by 42%. Having examined the distribution of the reimbursement amounts paid to the depositors of liquidated credit institutions, *Kallóné Csaba* and *Vajai* (2017) established in this connection that the number of reimbursed deposits grows only to a very slight extent, however, the reimbursement amount increases significantly above HUF 5 million. It seems therefore that the majority (96.9%) of the deposits currently insured would continue being insured if moral hazard was reduced. As recommended by

[10] With 10% own contribution above HUF 1 million.
[11] One depositor has one deposit in the great majority of the cases, but not necessarily, therefore the frequency of the number of deposits and of the number of depositors are only approximately equal.

the International Association of Deposit Insurers, in order for the deposit insurance limit to be set properly, “the insurance should provide coverage for the majority of the depositors, while leaving a substantial amount to compliance with market discipline (*IADI*, 2014, p. 27). It seems therefore probably that the moral hazard inherent in the Hungarian deposit insurance system could be reduced by setting the deposit insurance limit relevant to private persons below the EUR 100,000 limit currently required by the European Union. The reduction of the insured deposit volume would make the deposit insurance system cheaper at first sight, as the reserve to be set up in respect of the insured deposit volume would be much less, which in turn would decrease the premium payable to the deposit insurer. However, it would be necessary at the same time to model the behaviour of the owners of deposit amounts no longer subject to the insurance system. This is because the reduction of the deposit insurance limit may give rise to the loss of trust, which may lead to a mass withdrawal of deposits, thus jeopardizing the stability of the financial system.

One can suspect in light of the analysis that moral hazard is more characteristic for depositors with deposits in excess of HUF 1 million, because they are overrepresented in the liquidated credit institutions.

Testing hypothesis four (H4), according to which there is no significant difference in the amounts of deposits deposited in liquidated and existing credit institutions.
In order to create a population of existing credit institutions of a size and organisational form similar to that of the liquidated credit institutions, existing banks with a balance sheet total in excess of HUF 140 billion (as of 31. 12. 2015) were filtered out. The 140 billion limit was determined with regard to the balance sheet totals of reimbursed credit institutions and the breakdown of the distribution of existing credit institutions according to their balance sheet totals based on the Pareto principle. Because of the confidential nature of the data, existing credit institutions were broken down based on their size by the chief risk management officer of NDIF, who had previously consulted me on the methodology of the classification.

According to the result of the Wilcoxon rank sum test, at 95% confidence level there is a significant difference between the amounts deposited with the two populations ($p = 0.028$, H4), i.e. the behaviour of the depositors of existing and liquidated credit institutions of a

similar size was also significantly different in terms of the amounts deposited. This result implies that we cannot attribute any significant difference to the difference in the size of the credit institutions, e.g. that credit institutions would target different clienteles or offer different forms of saving because of their size. That is, moral hazard remains the possible cause of difference.

If we examine the direction of the difference, we can find that deposits in excess of HUF 1 million are again overrepresented in liquidated credit institutions, which implies that larger depositors preferred institutions which failed subsequently to the still existing institutions of a similar size.

To sum up the results so far, deposit insurance encourage large depositors in Hungary to deposit their money with institutions that offered relatively higher rates of interest but failed subsequently, and such expression of the moral hazard lead to a significant difference in the distribution of deposit amounts in these institutions compared to the existing banks.

4.2.2 According to depositor age

The investigation of the difference between liquidated and existing credit institutions according to depositor age is intended to reveal if there is a stratum of clients which typically needed to be reimbursed so that we can identify the age of the depositors who may have been affected by moral hazard to a larger extent.

Hypothesis and methodology

As there is no reference in literature to age influencing the affectedness by moral hazard, my initial hypothesis is as follows:

H5: the distribution of depositors according to age is the same in liquidated and existing credit institutions.

I would have like to compare the distribution of the depositors reimbursed according to their age expressed in years to that of the depositors of existing credit institutions. However, there is no banking system level data available on the age distribution of depositors in Hungary. The Hungarian banks I interviewed do draw up bank level statistics, but as did not grant me access to their analysis due to confidentiality reasons, I

can only make the comparison indirectly. I will analyse the distribution of the liquidated credit institutions according to their age compared to the age composition of the Hungarian population as a whole in the first step, based on the relevant demographic data collected from the Hungarian Central Statistical Office (*KSH*, 2015). In the second step, I will try to draw conclusions from the findings of the questionnaire survey representing the depositors of existing Hungarian banks (*TÁRKI*, 2015) as to the tendency of Hungarian people of various ages to have bank deposits.

Data

I will calculate the age distribution of reimbursed depositors based on the dates of birth indicated in the NDIF database of the deposits of liquidated credit institutions.

I will generate the age distribution of the entire Hungarian population from the age distribution published by the Hungarian Central Statistical Office (*KSH*, 2015).

Testing hypothesis five (H5), according to which the distribution of depositors according to age is the same in liquidated and existing credit institutions.

The age distribution of reimbursed depositors expressed in years of age compared to the age distribution of the entire Hungarian population is presented in Figure 12. The proportions of the depositors reimbursed according to their ages compared to all reimbursed depositors and the proportions of various age groups within the Hungarian population as a whole are presented in the same chart.

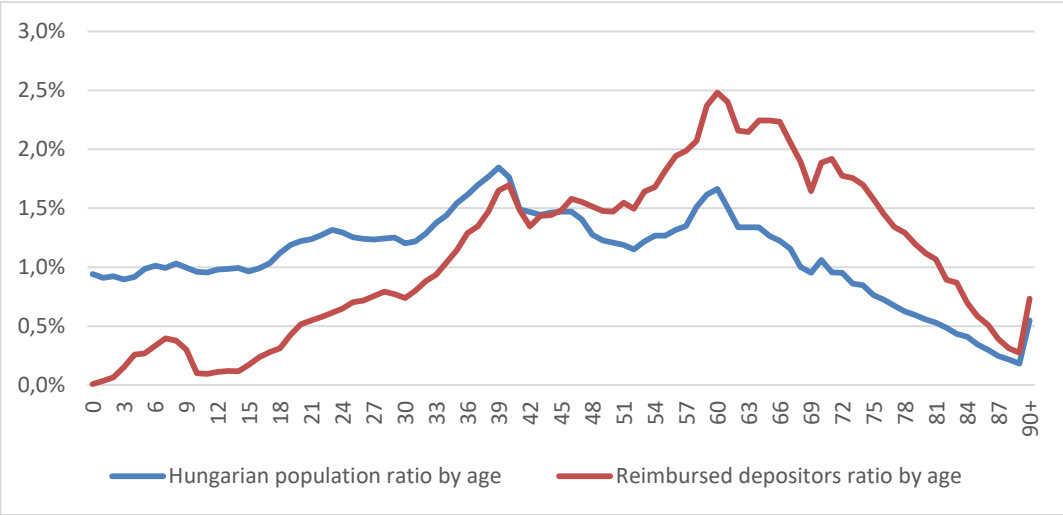


Figure 12: **Comparison of the distribution of reimbursed depositors and the Hungarian population by age. Source: Edited from the databases of NHIF and *KSH* (2015).**

As shown in Figure 12, the two curves are matching only for the age groups of 40-45 and 88+. In light of Figure12, the depositors of the credit institutions liquidated do not represent the demographic distribution of the population in Hungary. The proportion of young people keeping any deposit or account with the liquidated credit institutions was much smaller than the proportion of their age group within the population. Whereas the two ratios were the same for the age group between 40 and 45 years, people above 45 years of age had more deposits than justified by their proportion within the population as a whole. The proportion of deposits within the individual age groups reaches its peak (2.5%) in the group of those of the age of 60, which is 1% higher than their proportion in the population. With the growing of the age, the curve of the reimbursed depositors approaches that of the population from above and they meet in the 88+ age group. We can also find when comparing the proportions of reimbursed depositors and the Hungarian population in terms of their age that the curve of the reimbursed depositors follows closely the demographic leaps of the Hungarian population ("Ratkó children" and "Ratkó grandchildren").

The difference between the two curves may be explained with various factors. The most important factor is that the various age groups within the population in Hungary probably have different customs regarding deposits. This idea stems in the lifecycle theory of Modigliani (*Modigliani*, 1986). Modiglini's life cycle hypothesis is one of the basic models of the studies of the willingness of households to save money. It says that households make rational decisions on how much they want to consume in the various phases of their lives and adjust their saving behaviour to such decision. The savings rate of young households is low or negative (they take out loans), because they incur high expenses (purchasing a home, raising children) compared to a relatively low income. In the intermediate phase of their lives, households with a relatively high income save a larger portion of their income in order to prepare for the ages of retirement when they will no longer have an income according to the initial supposition of the model (*Modigliani*, 1988). Modigliani's life cycle theory (*Modigliani*, 1986) may thus be one of the possible explanations for the underrepresentation of young people and the overrepresentation of the elderly in the liquidated institutions compared to their respective proportions within the population.

Specific information on the deposit customs of the Hungarian population according to age groups can be derived from the analyses prepared based on the "Household Monitor" representative questionnaire survey conducted by TÁRKI (*TÁRKI*, 2015). *Szivós* and *Tóth* (2015) found bank deposit to be the most important form of saving of the elderly. *Tóth* (2016) established based on the examination of people holding bank deposits with a regression model that the eldest age group (70+) were more likely to have this form of saving than people younger than 30. One of the explanations for the difference between the two curves may be therefore that, within the volume of savings growing with years of age (life cycle theory), bank deposit as a form of saving is more characteristic of the elderly than younger people.

We could only draw reliable conclusions regarding the age distribution of the depositors of existing credit institutions if we knew or could reliably estimate the correlations between the age and the deposit creation habits of the Hungarian population. However, I did not find any research on the topic in the literature, and the database of the Household Monitor survey (*TÁRKI*, 2015) does not examine deposit holding on the level of individuals but of households, which does not make it possible to estimate the distribution according to age in a reliable manner.

Hypothesis five can therefore not be tested for lack of data, I just presented my efforts aimed at testing it to keep to logical unity of my dissertation. The preparation of a questionnaire survey which may provide a reliable basis for estimating the age distribution of the depositors of existing credit institutions may be subject to additional research.

To sum it up: we cannot of if any age group of the depositors of liquidated institutions were affected by moral hazard more heavily than others, nevertheless, it is important to keep the age variable for the analysis as a whole, because I classify the reimbursed depositors presuming that elder people tend to choose banks in their neighbourhood as they are less flexible in respect of travelling. Accordingly, the age factor has a strong influence on the conclusions of my research in chapter 4.3.

4.2.3 According to settlement type

The difference between the settlement types of the depositors of liquidated and existing credit institutions may reveal whether the majority of the people reimbursed lived in smaller or larger settlements, which in turn may imply whether moral hazard was typically present among those living in Budapest, cities, towns or villages.

Hypothesis and methodology

As there is no reference in literature to the settlement influencing the affectedness by moral hazard, my initial hypothesis is as follows:

H6: there is no significant difference in the distribution of the number of depositors in liquidated and existing credit institutions according to settlement types.

I will use the paired sample t-test and the Wilcoxon rank sum test to measure the difference between the distributions according to settlement type and I will also examine the direction of the difference. I will use the result of such comparison for the classification of the liquidated credit institutions and their depositors.

Data

I can examine the settlement type of the reimbursed depositors based on a unique database created by the combination of the NDIF database of the depositors of liquidated credit institutions and the Regional Statistics of the Hungarian Central Statistical Office (*KSH*, 2014).

The information on the settlement type of the depositors of existing credit institutions from the questionnaire survey of the saving customs of Hungarian households. The database of the Household Monitor survey, which was conducted by TÁRKI in 2015 (*TÁRKI*, 2015), is a probability sample representing Hungarian households on a regional level, too. The answers given to the questions in the survey reveal if the given household has any bank deposit. If the answer to any of the questions pertaining to retail current account (hgautal), foreign exchange account (hgdeviz), savings deposit or savings book (hgtakszl) or any other deposit (hgtakegy) was positive, then the household in question does have a bank deposit. All households possessing any of the foregoing types of deposit are subject to my analysis, as the database of liquidated credit institutions contains all

kinds of deposits. It is not possible, however, to make a comparison by deposit type, because it is not indicated in the database of the depositors of liquidated credit institutions. After the filtering of the data, I could analyse 3522 observations in total.

The questionnaire survey was conducted by multi-stage, proportionally layered probability sampling. There was a base weight (htesuly) prepared to eliminate the distorting effect caused by households and individuals who failed to respond, which is a suitable means for weighting the distributions of responding households to the distribution typical of Hungarian households and the distributions of the individual sample comprising all members of the households to the relevant distributions of the population living in Hungarian households at the same time. The representative nature of the sample is thus ensured by the application of the base weight.

The value set (Budapest, chief town of the county, town, village) of the settlement type variable (teltip) in the database of Household Monitor study by TÁRKI (*TÁRKI*, 2015) can be matched, following the improvement of data quality, with the value set of the settlement type variable in the Regional Statistics of the Hungarian Central Statistical Office (*KSH*, 2014).

Testing hypothesis six (H6), according to which there is no significant difference in the distribution of depositors in liquidated and existing credit institutions according to settlement types.

The comparison of the relative frequency of the depositors in liquidated and existing credit institutions according to settlement type is demonstrated in Figure 13.

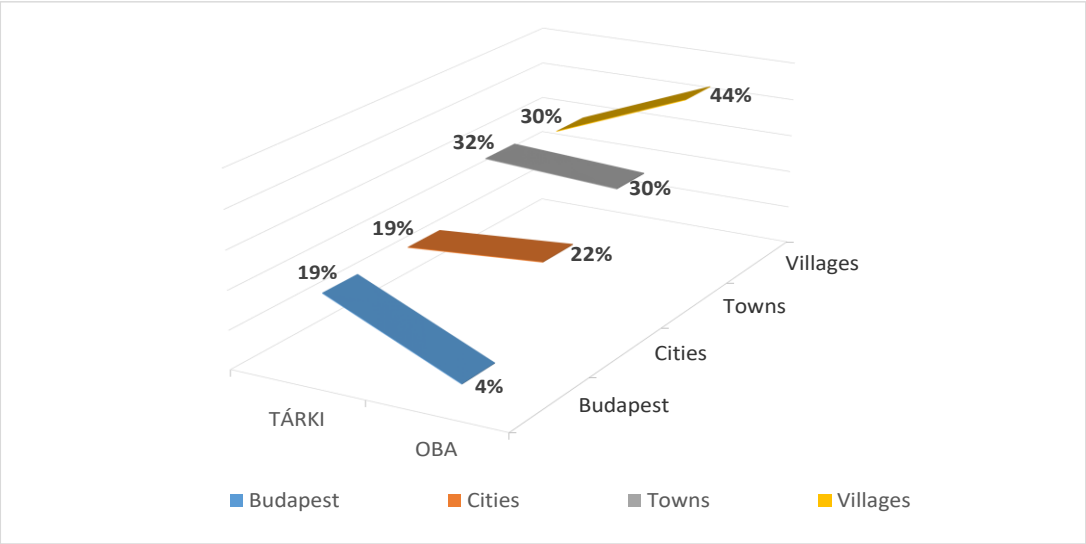


Figure 13: **Comparison of the distributions of reimbursed depositors and the population of Hungary according to settlement type the direction of the difference. Source: Edited from the databases of NDIF, *KSH* (2014) and *TÁRKI* (2015).**

As shown in the Figure, the proportion of people from Budapest keeping any deposit or account with the liquidated credit institutions was much smaller than their proportion within the population. At the same time, people living in villages were overrepresented in the institutions liquidated. This difference may be explained in part by the fact that a significant portion of the credit institutions liquidated used to operate in small settlements in the country and served a local clientele. Another possible cause of the difference is that there may have been more people living in villages who made use of the advantage of deposit insurance and deposited their money with riskier institutions in the hope of higher interest rates.

I applied both parametrical and non-parametrical tests to assess the significance of the difference, both of which established that the difference between the two populations in respect of the settlement type was not significant. The *p* value was 0.061 and 0.11 in the paired sample t-test and the Wilcoxon rank sum test, respectively, in light of which we can adopt hypothesis six, in that there is no significant difference between the two populations in respect of the settlement type variable.

4.3 Classification of the credit institutions dissolved and their depositors according to deposit amount, age and settlement type

I expect the classification of the liquidated credit institutions and their depositors to indicate moral hazard was present within the various groups to different extents.

Data

I will use the NDIF database of the depositors of liquidated credit institutions, supplemented with the Regional Statistics of the Hungarian Central Statistical Office, to classify reimbursed depositors and liquidated credit institutions (*KSH*, 2015).

4.3.1 Classification of the reimbursed depositors

Hypothesis and methodology

H7: The depositors of liquidated credit institutions can be listed to distinct groups based on the reimbursement amount, age and settlement size.

I will test the hypothesis by separating the groups created based on the variables of the disbursement amount, age and place of residence by the application of cluster analysis. I will calculate depositor age from the dates of birth accessible in the NDIF database, which allows me to analyse a variable which is measurable on a proportion scale. The variable of the legal standing of the settlement is derived from the settlement statistical data of the Hungarian Central Statistical Office (*KSH*, 2014) and generate from it a variable measured on an ordinal scale as follows: 1 – village, 2 – town, 3 – chief town of the county, 4 – capital city. The reimbursement amounts paid to depositors are also available in the NDIF database.

I will start my analysis by preparing descriptive statistics in order to gain a broad picture of the characteristics of reimbursed depositors regarding the three variables selected and to filter out any extreme values. The filtering of extreme values is of special importance from the point of view of the methodology selected for analysis, as the technique of cluster analysis is sensitive to extreme values. An extreme value may be listed to a separate cluster or distort the groups of observations evolving without the extreme value, which means that the requirement concerning the stability of the model may be impaired if it is not filtered out. Therefore, filtering of extreme values makes the model more robust.

The variables do not follow a normal distribution despite the filtering out of extreme values. *Kallóné Csaba* and *Vajai* (2017) established that the reimbursement amounts paid follow an extreme distribution and, more specifically, the Weibull distribution the most (the distribution is strongly skewed to the left). Nevertheless, I will standardize each of the three variables with a view to enabling the comparison of the distance between the observations in respect of each variable. Standardization can be realized with variables measured on ordinal and proportional scales.

I have chosen the technique of cluster analysis from the classification procedures to explore the relationship between and the groups of the objects. I will use the SPSS programme package for the analysis. The method of hierarchical cluster analysis cannot be applied because of the large number of the observations (more than a hundred thousand), therefore the analysis can be implemented with this method. As for the non-hierarchical methods, I take the processes generating disjunct groups into consideration (optimizing, partitioning and density detection methods), because I would like a given deposit to appear only in one cluster. I choose the McQueen method from the non-hierarchical methods and, more specifically, the centroid methods most similar to hierarchical clustering and most often applied. I will present McQueen's k-means method according to the description f the methodology by *Füstös* (2010, p. 200). In order to create the initial clusters, the procedure selects the first *k* unit to be the core point and lists the individuals to the cluster the core point of which they are the closest to. The procedure recalculates cluster centroids after the classification of each individual. Having classified all individuals, it matches the new centroids with the core points and compares the data again with the core points. The McQueen method uses this algorithm to make the division independent from arbitrary core point selection (*Füstös*, 2010, p. 199), which is important to note because it is desirable for the result of clustering to be independent from the order of the observations. Therefore selecting the technique of non-hierarchical cluster analysis, the McQueen method (and within that, *k*-means clustering) makes classification possible, but the number of the clusters to be created must be determined before starting the running.

Determining the optimal number of the clusters is the most important task from a methodological point of view, because the analysis may produce a false cluster structure if the number of the clusters is not properly defined. In theory, the method of hierarchical

cluster analysis could provide indication as to the optimal number of clusters (*Kovács*, 2014a), but it cannot be applied in this case because of the high number of the observations. In order to be able to determine the optimal number of clusters, I will specify an initial cluster number which is relatively high compared to the number of the variables examined (3), but still interpretable (let it be 10), so that I can map the groups of observations which have developed. The 10-cluster result is significant for each of the three variables, i.e. the clusters are easy to distinguish. I would like to study the geographical location of the 10 clusters, which is made visible by the method of multi-dimensional scaling the most, and then I would like to draw conclusions regarding the number of the clusters. To this end, I will demonstrate the distance between the cluster centroids by means of multi-dimensional scaling in the latent two-dimensional space. My initial idea was to aggregate (take the average of) the close cluster centroids from the matrix of the distances between cluster centroids, then to run the analysis, after the entering of the new cluster centroids generated by averaging, with cluster numbers getting smaller and smaller, as long as I arrive at the optimal cluster number. However, the two-dimensional demonstration of the 10-cluster solution (Figure 14) provides a strong hint as to the optimal cluster number, so I rather decided to dismiss the original idea. Figure 14 shows the result of the MDS ALSCAL process (Multi-Dimensional Scaling / Alternating Least-squares SCALing) (*Takane* and co-authors, 1977).

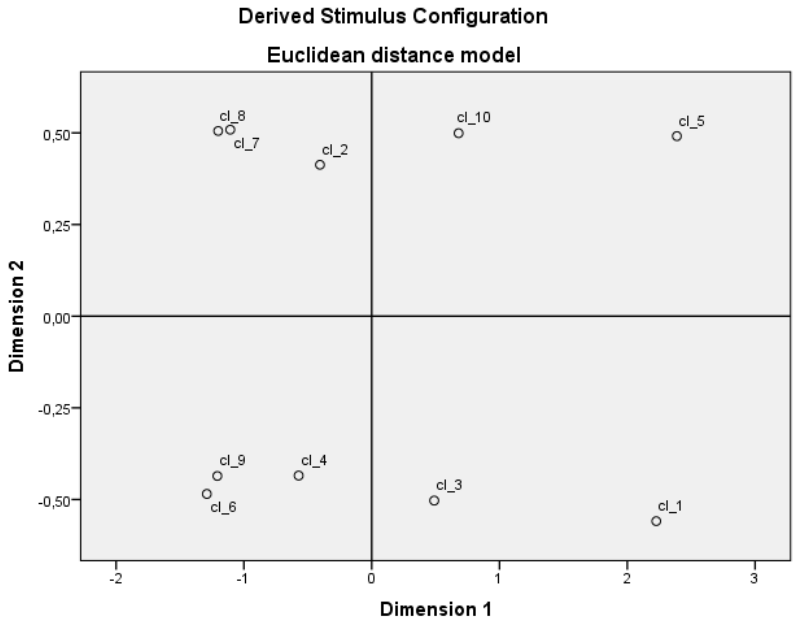


Figure 14: The location of the ten clusters in the latent two-dimensional space - Euclidean distance model. Source: Edited from the databases of NHIF and *KSH* (2014).

As seen in Figure 14, the reimbursed depositors tend to be concentrate4d in four major clusters in the four quarters along the three variables examined. It is also possible that the four clusters may be contracted by two, therefore I will examine both the four-cluster and the two-cluster solutions, but in the case of the latter, 4% of the observations will be listed to one of the clusters and 96% to the other one. I dismiss the two-cluster solution because of this major disproportionality and continue with the presentation of the results of the four-cluster solution.

The "correctness" of the classification cannot be measured clearly, because there is no objective function existing either for the hierarchical or the non-hierarchical clustering and there are no strict mathematical conditions the fulfilment of which could be checked (*Füstös*, 2010, p. 199), nevertheless, we can check by means of discriminant analysis whether the grouping was correct. The classification probability chart summarizing the testing of the four-cluster solution with discriminant analysis (see Table F1 in the Appendix) reveals that the probability of correct classification in 97% with four groups distinguished in the discriminant space. Accordingly, the four-cluster solution can be regarded as excellent in respect of the correctness of the classification based on the high posterior probability.

Testing hypothesis seven (H7), according to which the depositors of liquidated credit institutions can be listed to distinct groups based on the reimbursement amount, age and settlement size.

The four-cluster solution of McQueen's k-means hierarchical cluster analysis shows significant differentiation (see the result of the ANOVA F test in Table F2 in the Appendix). Figure 13representing the deviations of the cluster centroids from the average of the total population helps with the interpretation of the differences between the clusters. I have connected the marked values with a line to make demonstration easier, but the values between the marked values cannot be interpreted. As the variables have been standardized, the average of the total population is 0 for each of the three variables.

Figure 15: The deviation of the four clusters from the total average (MCA). Source: Edited from the databases of NHIF and *KSH* (2014). Note: The values presented in the figure have been standardized.

I have organized the four clusters in descending order (from the left to the right) based on the difference in terms of the reimbursement on the horizontal axis in Figure 15. Depositors in the first cluster were paid reimbursement in an amount well above the average in relative terms. Whereas those in the fourth cluster were also holding deposits of an amount above the average, the amounts of the deposits of depositors listed to the third and the second cluster were below the average.

I have summarized the characteristics of the depositors listed to the four clusters in Table 6 based on the three dimensions selected. The methodology of clustering and the description of the clusters constitute an objective analysis, but the names and the interpretations of the individual clusters reflect my own professional opinion.

Variables	**Millionaires (Cluster 1)**	**Savers (Cluster 4)**	**Stayers (Cluster 3)**	**Poor (Cluster 2)**
Reimbursement amount	high deposit	medium deposit	small deposit	smallest deposit
Age	older	older	old	young/middle-aged
Settlement type	larger city	capital	small towns	smallest settlements
Number of observations	1 787	8 676	60 123	42 652
Frequency of observations	1,6%	7,7%	53,1%	37,7%

Table 6: Interpretation of the four clusters. Source: Edited from the databases of NHIF and *KSH* (2014).

The cluster of "Millionaires" includes depositors who were paid reimbursement well above the average amount. They account for only 1.6% of all deposits, which is obvious with regard to the fact that the distribution of reimbursement amounts is strongly skewed

to the left. This means that the analysis can be evaluated regardless of the disproportionate distribution of the clusters. Depositors listed to the cluster of “Savers” are better-off than the average, but not the richest (with deposit amounts higher than 1.7 million HUF). There is almost no difference between “Millionaires” and “Savers” in terms of age, i.e. all of them represent the age group of the elderly (54.5+ years). “Millionaires” and “Savers” tend to live in larger towns and the capital city, respectively. Despite the fact that the depositors of both groups could choose from numerous credit institutions in large towns, they decided to deposit their money with credit institutions which were subsequently liquidated. Although one usually tries to exercise special care when choosing a credit institution for depositing a larger amount and the better-off usually have access to more information, credit insurance makes it unnecessary to contemplate the risk up to the deposit insurance limit. We can presume therefore that the proportion of those depositors who deposited their money in financial institutions which failed subsequently in awareness of the reimbursement promises of the deposit insurer, without contemplating the risk, was higher in these two clusters than in the others. This does not mean, however, that none of these depositors would have kept their deposits with the failed institutions in the absence of a deposit insurance, too, because of trusting the given institution for some reason.

The cluster of “Stayers” includes the elderly depositors from small towns, with deposits of an amount below the average (1.7 million HUF). I call them “Stayers” because of suspecting that they necessarily chose a credit institution with a customer service office located close to their home in the small town because of their advanced age. That is, “Stayers” can be “accused” less of making a conscious use of the protection provided by deposit insurance. The cluster of the “Poor” contains those with the smallest deposit amounts; they are the youngest and live in the smallest settlements compared to the total reimbursed population. We know from the life cycle theory of Modigliani (*Modigliani*, 1986) that the savings rate of young people is low or negative (they take out loans), because they incur high expenses (purchasing a home, raising children) compared to a relatively low income. People living in the smallest settlements are listed to the group of the “Poor”, which means that they had the smallest chance to choose from several credit institutions near their place of residence. In my opinion, the majority of these depositors would have opted for the same credit institution (subsequently liquidated) in the absence

of a deposit insurance, too, because they needed daily contact with the bank in order to access their savings of small amounts, and the number of bank branches where this is available is very limited in the neighbourhood of small settlements. Deposit insurance and quick reimbursement are of key importance for these more than 42 thousand depositors. If a deposit placed with a credit institution cannot be withdrawn due to the insolvency of the institutions, NDIF reimburses eligible depositors in twenty working days (*OBA*, 2017), in order to prevent the most needy from facing any liquidity or livelihood problems.

Combining the results of the clustering of reimbursed depositors with the observation that depositors with deposits in excess of 1 million HUF chose credit institutions which failed subsequently (Chapter 4.2) in higher proportions, we can say that it is worth paying increased attention to depositors with above-the-average deposit amounts from the point of view of the regulator as deposit insurance seems to change their behaviour to a higher extent than that of depositors with below-the-average savings. The finding that the number of those more inclined to accept increased risk in awareness of the deposit insurance could be higher among large depositors in light of the Hungarian data may be valuable information for the simulation of bank runs.

4.3.2. Distinguishing of liquidated credit institutions based on their depositors

Hypothesis and methodology

H8: Liquidated credit institutions can be clearly distinguished in space based on their depositors.

I described the liquidated credit institutions with statistical means based on the characteristics of their depositors, then checked it with multi-dimensional scaling if they can be clearly distinguished in space based on their depositors. I expect based on the statistics to be able to identify one or more credit institution(s) the depositors of which may have experienced moral hazard to a higher extent than others.

I drew up the statistics based on the database of the depositors of liquidated credit institutions extended with settlement type, so I could include three variables in the

analysis: the amount of reimbursement paid, the age of the reimbursed depositors and the type of settlement where they live. I used the absolute values of the three variables for the descriptive statistical examinations, but standardized the variables for multi-dimensional scaling in order to derive scale-independent variables. I examine if the ten liquidated credit institutions as nominal variable are distinguished in the latent space. I apply the MDS ALSCAL process (Multi-Dimensional Scaling / Alternating Least-squares SCALing) (Takane and co-authors, 1977).

Description of liquidated credit institutions based on their depositors

I will start the description of liquidated credit institutions with the examination of the average and dispersion of reimbursement amounts paid to private persons per institution. The grand average of the reimbursement amounts paid to private persons is HUF 1.7 million, which is indicated with a horizontal, broken line in Figure 16. I interpreted the statistics of the individual institutions compared to the grand average.

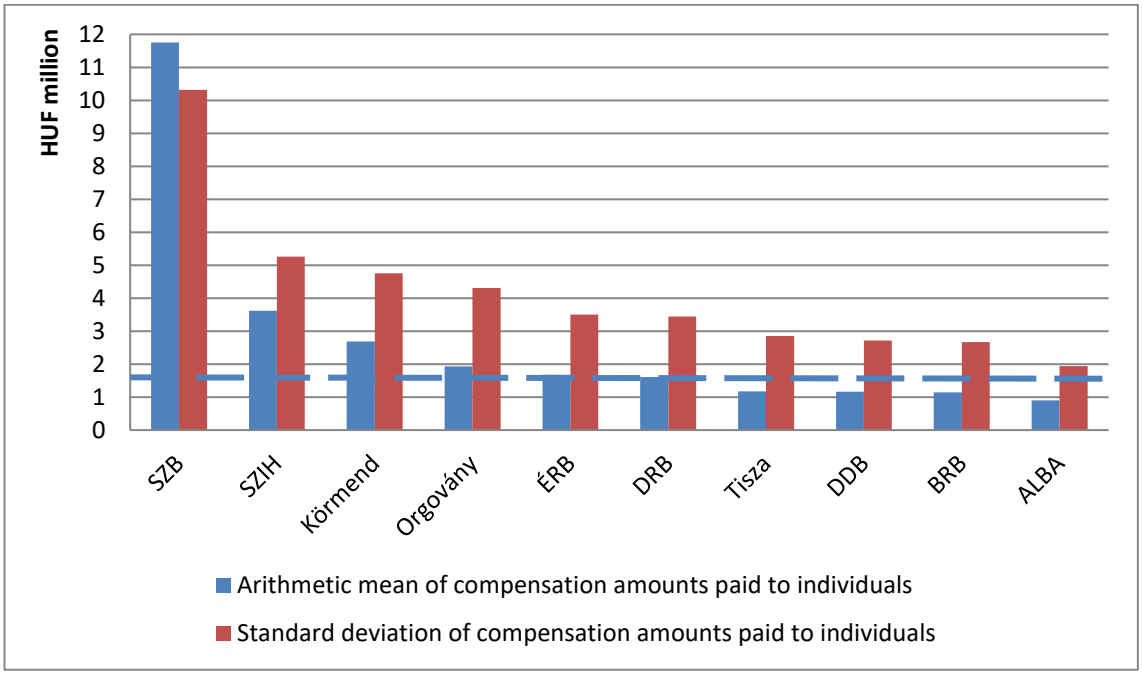


Figure 16: **The average and dispersion of reimbursements paid to private persons by institutions. Source: Edited from the NDIF database.**

The averages of Széchenyi Kereskedelmi Bank (SZB), Széchenyi István Hitelszövetkezet (SZIH) and Körmend és Vidéke Takarékszövetkezet (Körmend) are much higher than the

grand average. These three credit institutions were under the control of the same owners, their fund raising business policy was therefore probably synchronized, which may be one of the explanation for their attracting deposits of amounts well above the average. The four institutions of DRB Bank Group (BRB, DDB, DRB, ÉRB) also have similar averages (presumably for the same reason), which are dispersed around the grand total. The average disbursement amount paid by ALBA Takarékszövetkezet (ALBA) and Tisza Takarékszövetkezet (Tisza) are below the grand average and Orgovány és Vidéke Takarékszövetkezet (Orgovány) is somewhat above the average. My dissertation is not meant to explore the causes of failure of the credit institutions, however, I would like to highlight that there is a possibility of cross financing in the case of seven from the ten liquidated institutions. This leads me to the conclusion that the ownership and interest relations of the individual institutions should be explored and monitored from the point of view of supervision in the interest of the stability of the bank system.

The average reimbursement per deposit paid at Széchenyi Kereskedelmi Bank to private persons was more than seven times higher than the grand average (HUF 11.8 million) and the relative dispersion of the disbursement amounts was 90% in contrast to a high rate about 200% at all other institutions. If we analyse the distribution of reimbursement amounts by institutions, we can see that the average was significantly higher than the median in nine cases, what more, in eight cases it was even higher than the third quartile. This means that the distribution was skewed to the left from normal in all of the nine institutions. Whereas the presumption of the normal distribution of the reimbursement amounts can be clearly dismissed in each of the nine cases based on the Kolmogorov-Smirnov test (see Table F5), the distribution of the disbursement amounts converges to normal at Széchenyi Kereskedelmi Bank. I use Figure 17 (Q-Q plot) to demonstrate this.

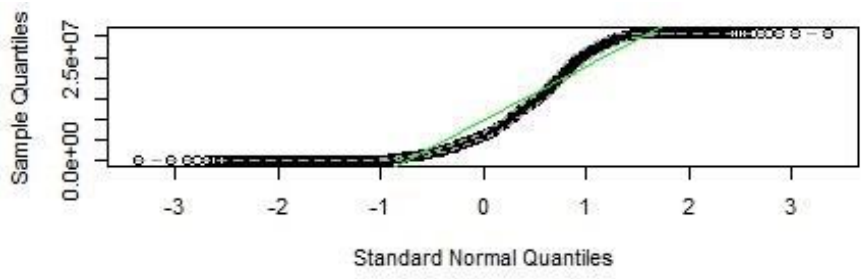


Figure 17: **The Q-Q plot analysis of the distribution of reimbursements paid by Széchenyi Kereskedelmi Bank. Source: Edited from the NDIF database.**

That is, the descriptive statistics of Széchenyi Kereskedelmi Bank differs significantly from those of the other credit institutions in respect of the distribution of the amounts of reimbursement. There were several depositors within the bank's clientele who deposited larger amounts, i.e. they came from the private banking sector.

I continued the description of liquidated credit institutions by comparing their depositors based on their ages. The comparison is illustrated by Figure 18, where the institutions follow each other according to the descending order of the average reimbursement amounts (in accordance with Figure 16).

As seen in Figure 18, the age composition of depositors is similar in the individual institutions. The average age of reimbursed depositors is within the interval of 52-58 years and dispersion within 16-20 years[12]. The high rate of dispersion can be explained in part by the fact that current account products and other related products (overdraft loan, debit card, credit card, etc.) are used by all age groups.

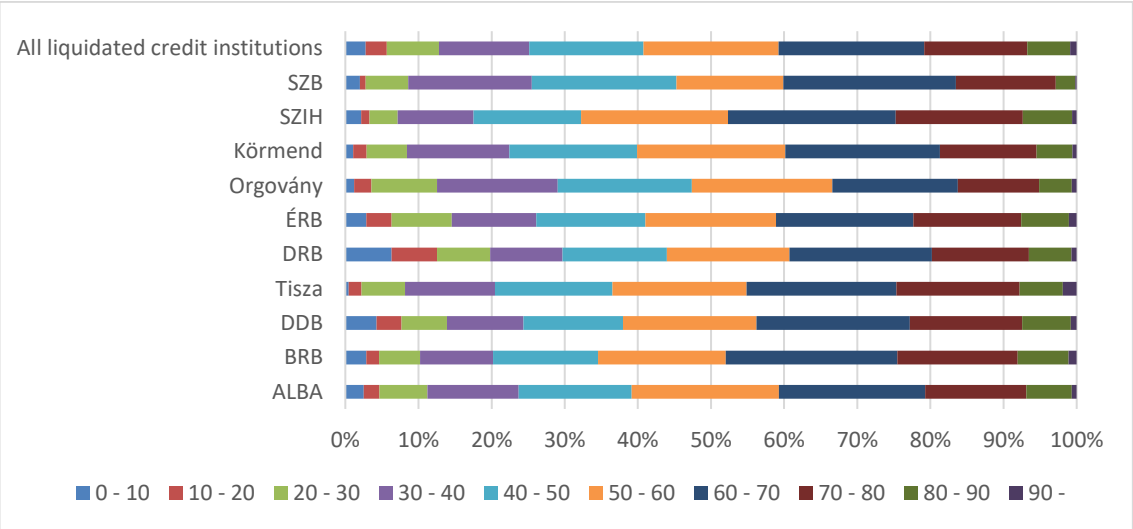


Figure 18: Comparison of the age distribution of depositors in liquidated credit institutions by classes. Source: Edited from the NDIF database.

The ordinal variable of settlement type generated from the legal standing of the settlement can take the following values: 1 – village, 2 – town, 3 – chief town of the county, 4 – capital city. The average and dispersion of the settlement type by institutions are demonstrated by Figure 19.

[12] Calculated from the NDIF database

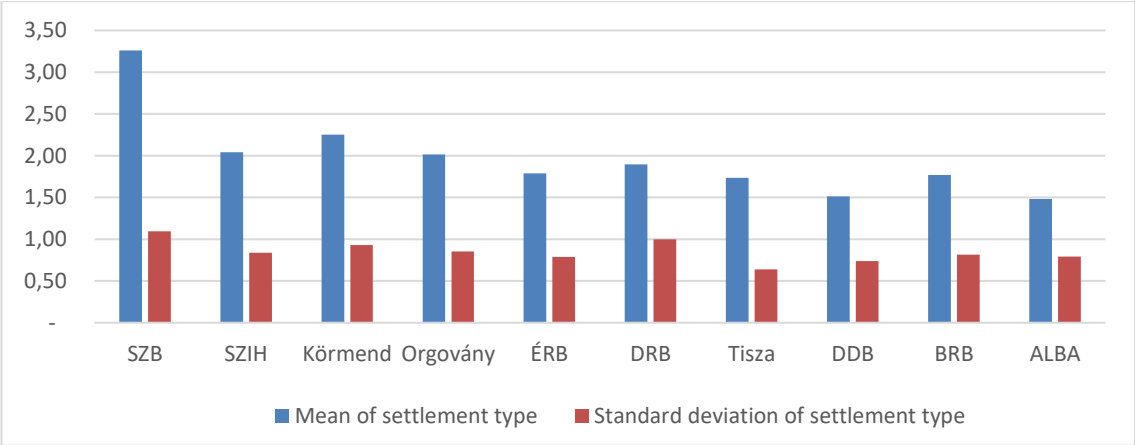


Figure 19: **The average and dispersion of the places of residence of the depositors of liquidated credit institutions according to settlement type, by institutions. Source: Edited from the databases of NHIF and *KSH* (2014).**

The institutions in Figure 16follow each other according to the descending order of the average reimbursement amounts (in accordance with Figures 17 and 18). Figure 19 reveals that the depositors of institutions with a higher average reimbursement amount typically live in settlements which are bigger than the average of liquidated institutions. One of the reasons for this may be the correlation that there are more and better jobs available in larger settlements, as a result of which the disposable income of the population is also higher, which in turn leads to higher savings, including the amounts of deposits. The research into the savings of the population of Hungary also supports this reasoning. According to the study of *Szivós* and *Tóth* (2015), the settlement slope can be observed in the field of savings as well. Compared to 61% in Budapest, no more than one third of the households have any kind of savings in villages and smaller towns. Whereas 19% of the households in the capital city have a savings book, this ratio is only 4% in villages (*Szivós* and *Tóth*, 2015).

Up to this point, I have examined liquidated credit institutions with descriptive statistical methods separately in respect of the three variables. Now I will look at the possible distinguishing of the institutions examined with consideration to all of the three variables.

Testing hypothesis eight (H8), according to which liquidated credit institutions can be clearly distinguished in space based on their depositors.

According to the result of multi-dimensional scaling, liquidated credit institutions can be distinguished in space significantly based on their depositors. The averages within the

individual banks are significant compared to the grand average, mainly due to the extreme values of Széchenyi Kereskedelmi Bank (SZB) and Széchenyi István Hitelszövetkezet (SZIH). The significance of the separation can be seen in Table 7 (the ANOVA chart).

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
Kifizetettbruttóösszeg Kifizetett bruttó összeg * Bankod Bankok kódolása	Between Groups	(Combined)	1,364E+17	9	1,515E+16	1176,094	,000
		Linearity	2,338E+16	1	2,338E+16	1814,457	,000
		Deviation from Linearity	1,130E+17	8	1,412E+16	1096,298	,000
	Within Groups		1,460E+18	113335	1,288E+13		
	Total		1,597E+18	113344			
eletkor_egesz * Bankod Bankok kódolása	Between Groups	(Combined)	258219,841	9	28691,093	82,228	,000
		Linearity	10101,583	1	10101,583	28,951	,000
		Deviation from Linearity	248118,259	8	31014,782	88,887	,000
	Within Groups		39545135,25	113335	348,923		
	Total		39803355,09	113344			
Teltip Település típusa * Bankod Bankok kódolása	Between Groups	(Combined)	7646,219	9	849,580	1234,652	,000
		Linearity	2785,554	1	2785,554	4048,107	,000
		Deviation from Linearity	4860,665	8	607,583	882,970	,000
	Within Groups		77914,309	113229	,688		
	Total		85560,528	113238			

Table 7: Liquidated credit institutions are significantly distinct in respect of their depositors. Source: Edited from the databases of NHIF and *KSH* (2014) (SPSS).

Credit institutions are distinguished in the two-dimensional space and classify their clients as shown in Figure 20. Matching is excellent in two dimensions, the value of S is much smaller than 0.05, i.e. the error of projection into two dimensions is only 5%. The RSQ (stress and squared correlation) measuring the matching of data and distances is very high, the rate of determination of the distances is 99.9%.

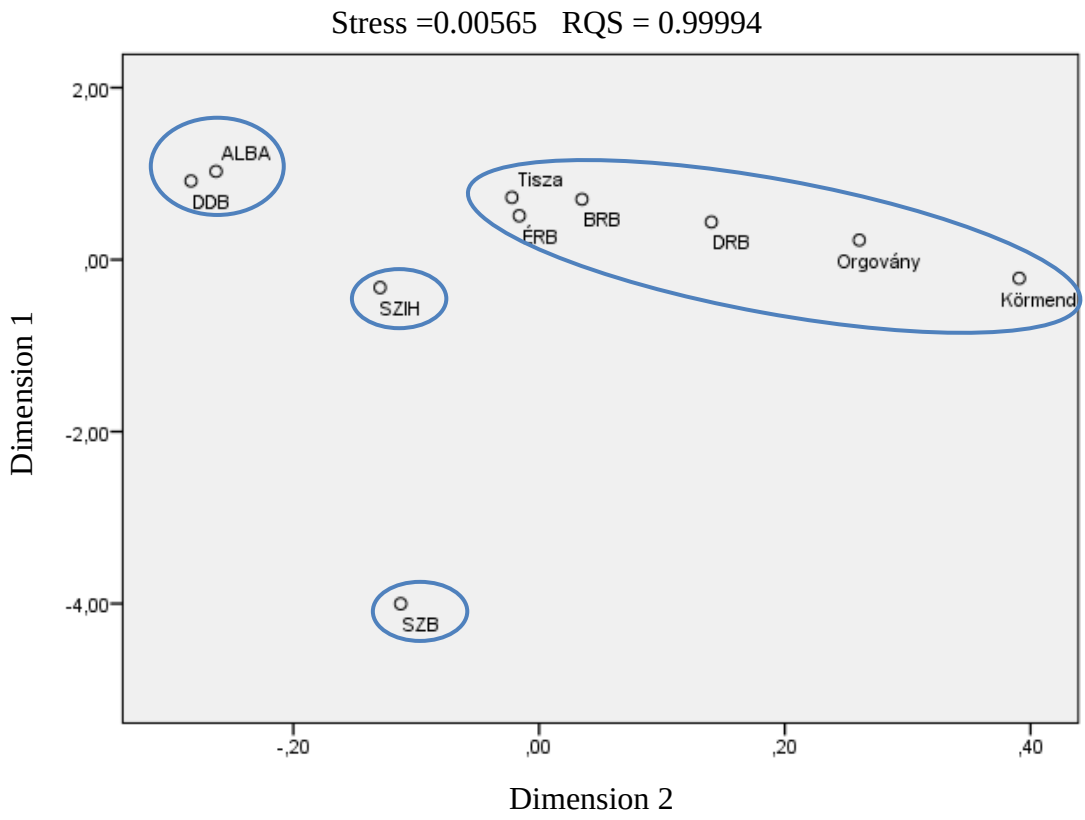


Figure 20: **The separation of credit institutions in the two-dimensional space of the clients. Source: Edited from the databases of NHIF and *KSH* (2014).**

Based on the results of the descriptive statistics it is not surprising that Széchenyi Kereskedelmi Bank (SZB) and Széchenyi István Hitelszövetkezet (SZIH) are distinguished among the ten liquidated credit institutions. ALBA Takarékszövetkezet (ALBA) and Dél-Dunántúli Takarék Bank (DDB) are close to each other in the two-dimensional space and distinct form the other six credit institutions. I will check based on the next three figures how the two-dimensional space is "pulled away" by the liquidated credit institutions based on the individual variables.

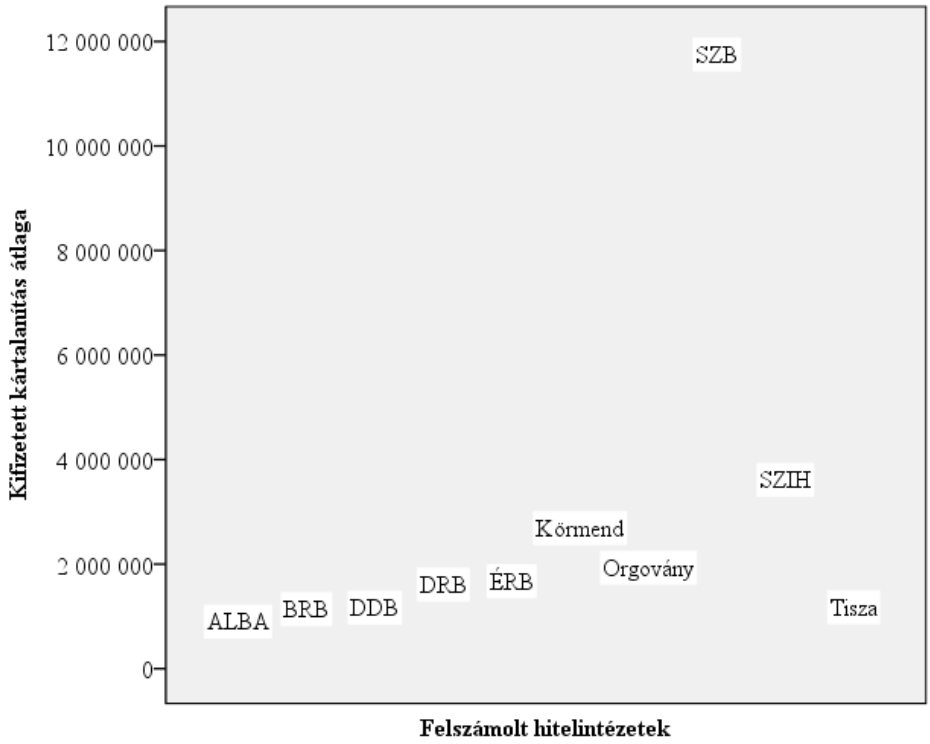


Figure 21: The separation of the banks according to the average disbursement amount. Source: Edited from the databases of NHIF and *KSH* (2014).

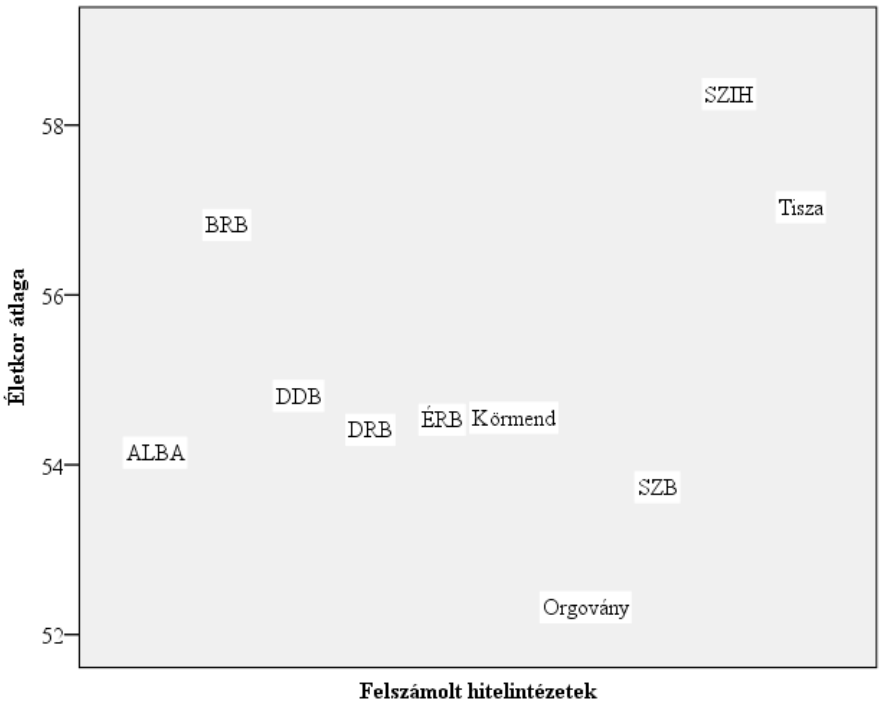


Figure 22: Distinguishing of the banks according to the average age of the depositors. Source: Edited from the databases of NHIF and *KSH* (2014).

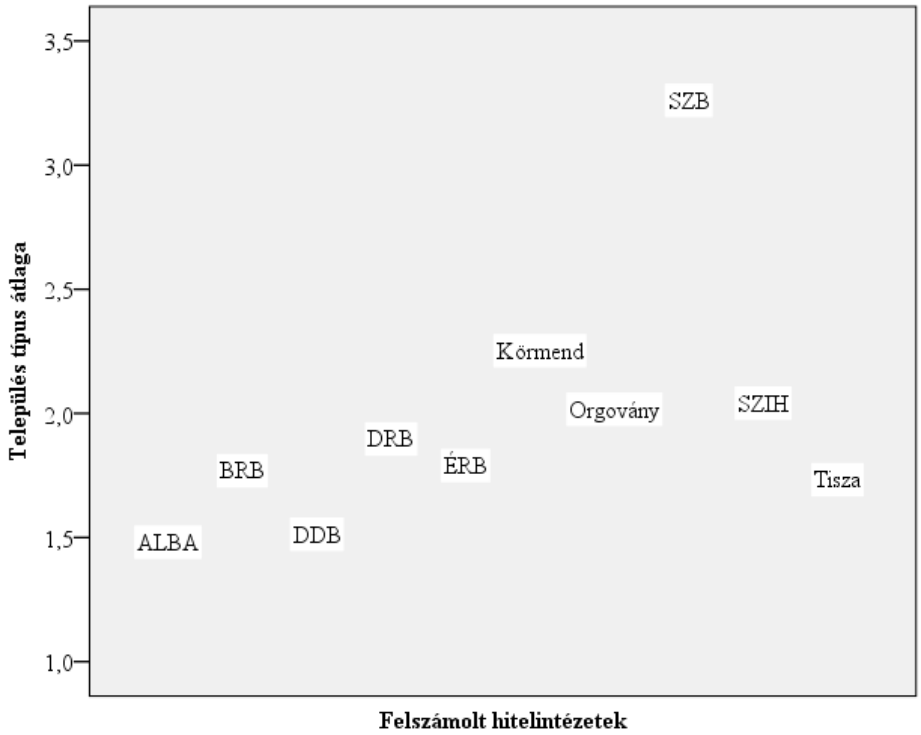


Figure 23: **Distinguishing of the banks according to the average settlement type of the depositors. Source: Edited from the databases of NHIF and *KSH* (2014).**

In accordance with the descriptive statistical analysis, Széchenyi Kereskedelmi Bank (SZB) is distinguished markedly from the other credit institutions by its clients with deposit amounts well above the average, most of whom live in the capital city. Széchenyi István Hitelszövetkezet (SZIH) is distinguished from the other credit institutions by its elderly clients with above-the-average deposit amounts. ALBA Takarékszövetkezet (ALBA) and Dél-Dunántúli Takarék Bank (DDB) are distinguished from the other credit institutions by its poorer clients living in settlements smaller than the average. The depositors of the remaining six credit institutions (Körmend, Orgovány, DRB, BRB, ÉRB, Tisza) were typically paid reimbursements of a similar amount and the types of their settlements were also similar; they rather tend to be distinguished in the two-dimensional space in terms of their age.

As depositors living in small settlements could choose only from a limited number of credit institutions in the neighbourhood of their place of residence in contrast to depositors living in larger settlements, who could choose from several credit institutions, the customers of Széchenyi Bank were more likely to be affected by moral hazard than the poorer customers of ALBA Takarékszövetkezet and Dél-Dunántúli Takarék Bank (DDB), who were living in settlements smaller than the average.

4.4 Comparing the distribution of deposit amounts in the European Union

The European Union requires each Member State to apply the same deposit insurance limit. I will compare the distribution of the deposit amounts in order to see if there are any significant differences between the Member States of the European Union in spite of their being subject to the same universal deposit insurance limit. It is beyond dispute in a global banking market that a uniform insurance limit is necessary on a global level in order to maintain competitive neutrality. Nevertheless, we do need to compare deposit amounts to see if there are countries with a smaller average deposit amount where the uniform reimbursement limit means a relatively higher coverage ratio, which increases the probability of moral hazard on the side of the depositors and the bank alike. According to the current recommendation of the International Association of Deposit Insurers, "setting the deposit insurance limit properly is a key element in reducing moral hazard" (*IADI*, 2014, p. 11), and *Kiss* and co-authors (2012) even confirm with a theoretical experiment that the setting of the deposit insurance limit has a considerable impact on bank runs.

Hypothesis

By comparing the net assets of households on an international scale, *Boldizsár* and co-authors (2016) reveal that there are differences in the net assets of the households in the 20 European Member States subject to their examination. The amount of bank deposits typically changes in parallel with the net assets, therefore my initial hypothesis is that

H9: there are significant differences between the deposit amounts in the EU Member States subject to the examination.

As far as I know, there has been no scientific research conducted up to this date to study, compare and analyse deposit amounts across the European Union. Actually, I have not found any research on such comparative analysis regarding any other part of the world, either. The most probably cause of the lack of such analysis is that there have been no data available for researchers until now. This analysis is based on the first international statistics made by the European Central Bank in a uniform manner to assess the

consumption, income, real and financial assets and loans of the households as part of a standard analysis. The study hereinafter referred to as *HFCS* (*Household Finance and Consumption Survey*, 2014) is a questionnaire survey which was conducted in twenty Member States of the European Union.

Data

I will use the data from the second wave of the questionnaire survey assessing the financial and consumption habits of European households (*HFCS*, 2014), recorded from 2013 to the first semester of 2015, but mainly in 2014 in the various countries, for my comparative analysis. The data recorded in the second wave may be analysed since December 2016, based on the permit of the European Central Bank. I was granted access to the database based on my research proposal. The survey contains the anonymized data of 84 thousand households in 18 countries within the euro area (all countries except for Lithuania) and Hungary and Poland. In Hungary, the data were recorded by the Hungarian Central Statistical Office. Due to its complexity and size, the database is only available in several portions, therefore the combination of the data, the labelling of the variables and data cleansing take a long time.

As a result of the data cleansing, 15 of the 20 Member States were finally included in the analysis, because the number of households observed was below 500 in 5 countries (Hungary, Poland, Slovenia, Malta, Portugal), which is too little compared to their population, therefore I decided not to include these countries in the analysis. So there were 61 thousand household level observations available in the end for the deposit amount variable (*DA2102*) from 15 countries (*SA0100* variable).

2. 3 Methodology

Analysing the HFCS database is difficult because the deposit amount variable (*DA2102*) of the European questionnaire survey was only recorded on the level of households, i.e. the value of the variable demonstrates the amount of the demand and term deposits of the households interviewed. As I wish to draw conclusions regarding the size and distribution of the deposit amounts from the perspective of the deposit insurance, I need to create a new variable. To this end, I will examine the frequency of the sizes of households in the sample in order to learn the typical number of members within a household (Figure 24).

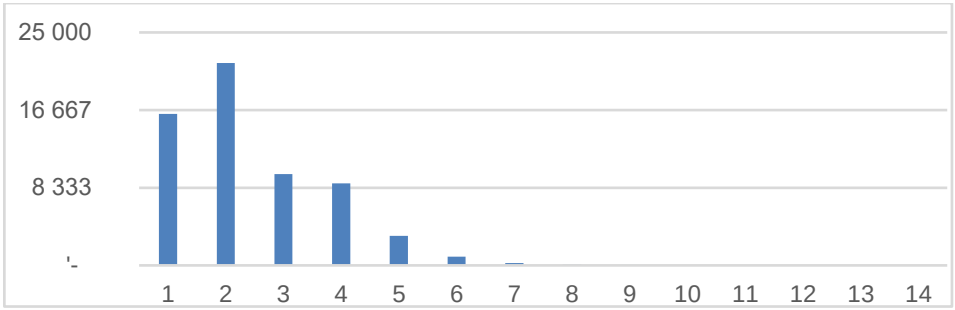


Figure 24: **The frequency (y axis) of the number of members (x axis) of the households in the sample. Source: Edited from *HFCS* (2014) data.**

According to Figure24, the majority of the households included in the survey have two members. I suppose that there are two deposit accounts in these households as they tend to have two adult members. I also presume two accounts in households with more than two members, as they are comprised of 2 adults and children in the majority of the cases. I presume by simplification that minors have no bank account because there are very few persons holding a bank account from the age group below 18 compared to the population as a whole according to the statistics of Hungarian reimbursed depositors. I presume that there is one deposit account in single-person households. My presumptions are based on the available statistics of Hungarian depositors. According to the NDIF database, at the end of 2015, 8,724,024 deposits were insured compared to the adult population of more than 8 million (exactly 8.114.580 persons on January 1, 2016), i.e. the Hungarian data support that one adult inhabitant had one bank account on the average at the end of 2015. As for the actual distribution of deposit holding despite this average one bank account per person, some of the inhabitants probably do not have any bank account, whereas others have two or more. As I presume in my analysis every adult individual to have one deposit, the bank deposits may be more fragmented in reality than presumed in the analysis, but this does not limit the comparison in any manner, because the same presumption is applied to every observation. In the case of households comprised of two or more members, I divided the deposit amounts into two equal portions for each observation.

After data cleansing and the filtering of deposits of HUF 0, I take into consideration 77,110 observations made in 15 Member States examined. I will analyse the distribution of the deposit amounts with descriptive statistics and test the significance of the deviations of the averages with variance analysis according to the methodological guide of *Füstös* (2010).

Testing hypothesis nine, according to which there are significant differences between the deposit amounts in the EU Member States subject to the examination.

I will analyse the distribution of the deposit amounts with descriptive statistics in the first step. The cumulated frequency of the deposit amounts within the sample regarding the 15 Member States is presented in Figure 25. This Figure represents only deposit amounts up to EUR 100 thousand, because deposits with a higher value would not appear in the figure due to their low number.

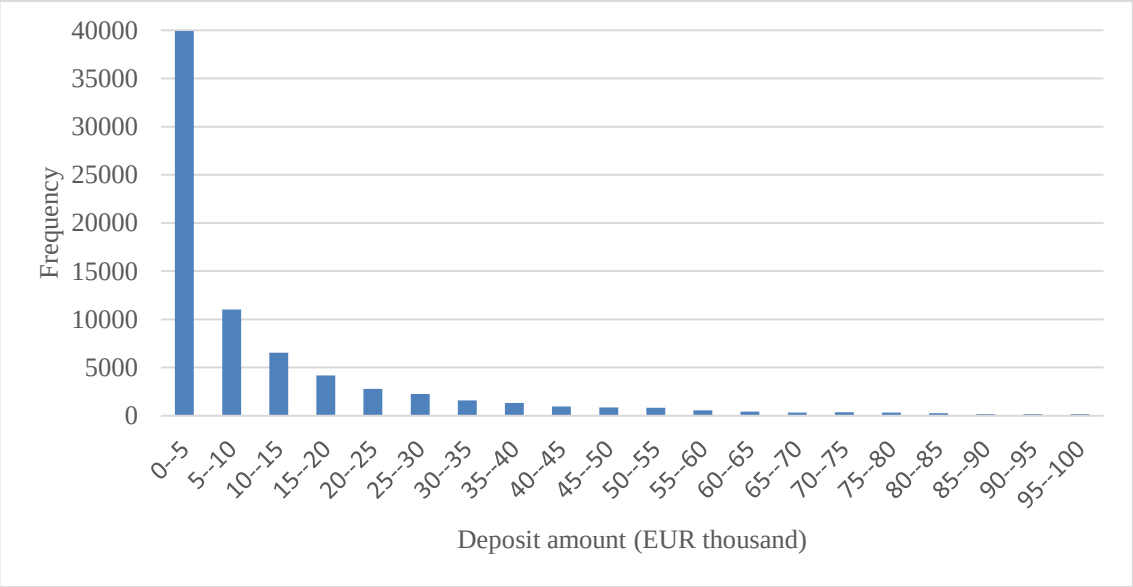


Figure 25: **The frequency of deposit amounts in each of the Member States included in the sample up to EUR 100 th. Source: Edited from *HFCS* (2014) data.**

As seen in Figure 25, the distribution of the deposit amounts in all Member States is strongly skewed to the left (Modus < Median < Average), extended long to the right, sticking to the horizontal axis, and the inclination rate is 115.

With the current deposit insurance limit of EUR 100,000, 97.3% of the depositors in the sample are insured as a minimum. It must be noted that the database has not been adjusted by the impact of the placing of deposits in excess of the deposit insurance limit of EUR 100,000 currently in effect in the European Union with various credit institutions and in various accounts by depositors who made rational decisions. This means in respect of the sample that in reality, the number of deposits below the limit of EUR 100,000 would probably be higher than I suspect, which means that the coverage in the sample is 97.3% as a minimum.

The decile value describing the distribution is illustrated in Table 8 for all Member States included in the sample. As the distribution is skewed, we find the largest difference between the 9th and the 10th deciles, therefore I also provide the percentile values between them.

Percentile	Deposit amount (EUR)	Differences between percentiles (EUR)
10	250	
20	772	522
30	1 590	818
40	2 950	1 360
50	5 000	2 050
60	7 653	2 653
70	12 490	4 837
80	20 000	7 510
90	39 999	19 999
91	42 784	2 785
92	47 500	4 716
93	51 652	4 152
94	57 000	5 348
95	65 000	8 000
96	76 250	11 250
97	92 899	16 649
98	120 000	27 102
99	184 443	64 443
100	20 003 413	19 818 970

Table 8: The decile and certain percentile values (above 90) describing distribution in each Member State included in the sample. Source: Edited from *HFCS* (2014) data.

It can be read from Table that the absolute differences between the decile values of the distribution are monotonously increasing and far the largest between deciles 9 and 10. The value of the 9th decile is only EUR 40,000, which means that 90% of the deposits in the sample could be insured with a EUR 40,000 limit, too. And if we examine the

percentile values of the distribution, we can conclude that either the decreasing or the increasing of the current limit of EUR 100,000 would affect the coverage of no more than 1% of all deposits in the Member States subject to the examination.

Now I will examine the frequency of the various deposit amounts in each of the Member States in the sample separately. For the sake of easier comparability, I will present the frequencies up to a universal amount of EUR 500,000 instead of the maximum deposit amount. The frequency above EUR 500,000 could not be well illustrated by a graph in any of the Member States due to the small number of the elements. The histograms of the 15 Member States can be found in the Appendix (Figure F.2). Figure 26 only presents an example for illustration, namely the frequency found in the sample of the depositors interviewed in Austria.

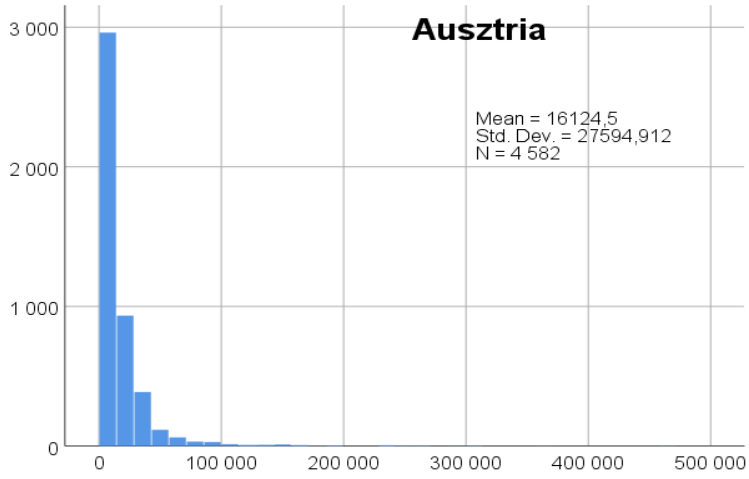


Figure 26: **The frequency of deposit amounts up to EUR 500,000 on the sample taken in Austria. Source: Edited from *HFCS* (2014) data.**

The distributions of the deposit amounts in the individual Member States are also characterised by being strongly skewed to the left and extended long to the right, which means that a minor change to the insurance limit would modify the number of the insured only to a small extent, but the insurance obligation would change considerably. The distribution of the deposit amounts could not be deduced from any previous studies except for the study I prepared with my co-author, in which we analysed the distribution of the reimbursement amounts paid by the National Deposit Insurance Fund to depositors reimbursed in 2014 and 2015 and published that they demonstrate an extreme value distribution and, more specifically, a Weibull distribution (*Kallóné Csaba* and *Vajai*,

2017). I believe that we can state it with ever greater certainty based on the Member State level data in the international *HFCS database* (2014) that the distribution of the deposit amounts is strongly skewed to the left and extended long to the right.

Although the shape of the distributions is similar based on the Member State level statistics, there are considerable differences in respect of the average deposit amounts, so I have tested the significance of the deviations.

ANOVA			Sum of squares	df	Root mean square	F	Sign.
Deposit amount * Country	Between clusters	(Combined)	1.02542E+13	14	7.32441E+11	43,886	0,000
		Linearity	8.48379E+11	1	8.48379E+11	50,833	0,000
		Deviation from linearity	9.4058E+12	13	7.23523E+11	43,352	0,000
	Within clusters		1.28652E+15	77 085	16689591390		
	In total		1.29677E+15	77 099			

Figure 9: ANOVA table of the significant differences between the average deposit amounts of the Member States. Source: Edited from *HFCS* (2014) data.

According to the lessons which may be drawn from the variance analysis, there are significant differences between the averages of the deposit amounts. The results of the test are confirmed by the robustness tests of Welch and Brown-Frosythe, too. According to the Eta indicator, 0.7% of the variance to the deposit amount can be explained by belonging to a given Member State.

I have demonstrated the result of the unidirectional ANOVA analysis on Figure 27. I have connected the marked mid values with a broken line only for the sake of better visualisation, but the values between the averages indicated cannot be interpreted.

Figure 5: Illustration of the differences between the averages of the deposit amounts

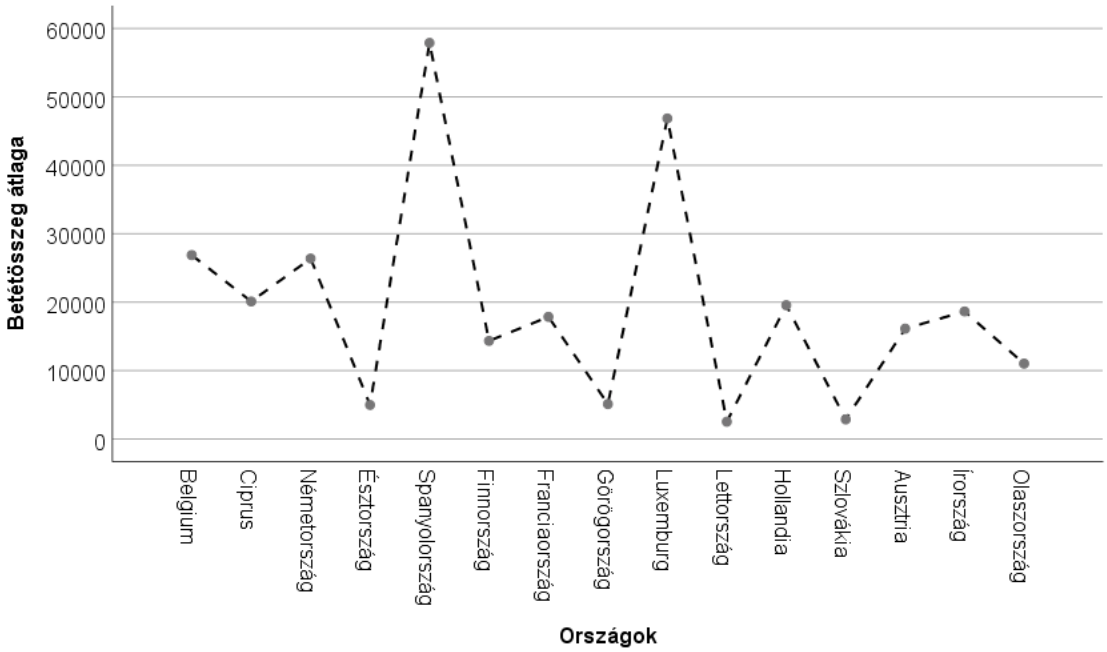


Figure 27: **Illustration of the differences between the averages of the deposit amounts Source: Edited from *HFCS* (2014) data.**

In order to demonstrate the consequence of a major difference, I will show in Figure 28 the deposit insurance levels by which the individual Member States could attain the average coverage level of the European Union (97.3%).

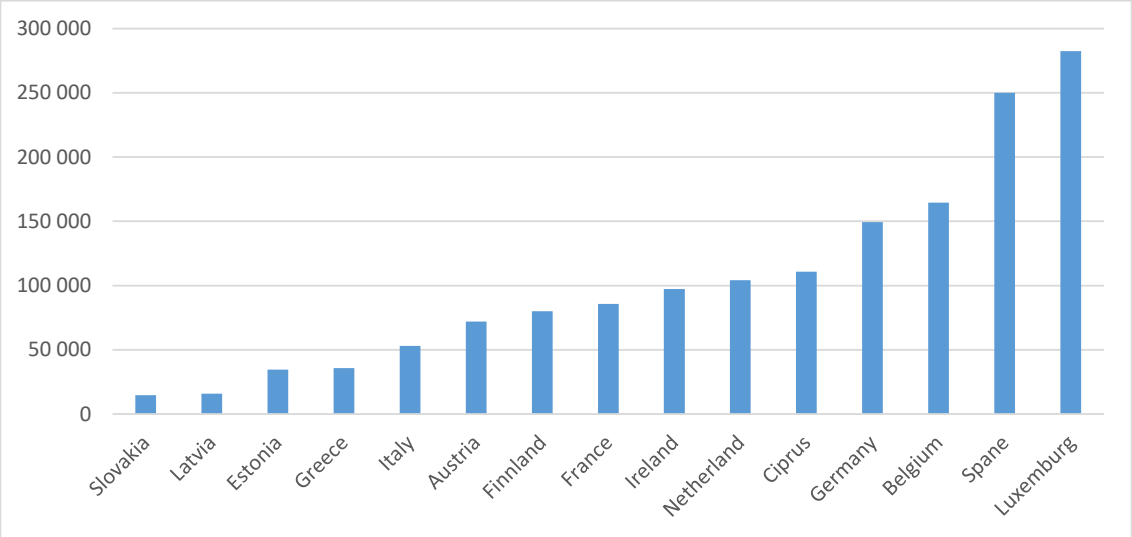


Figure 28: **Deposit insurance limits necessary to attain the average coverage in the individual Member States in the sample. Source: Edited from *HFCS* (2014) data.**

The average coverage can be attained with a much smaller amount in the case of Slovakia, Latvia, Estonia and Greece (Figures 27 and 28), implying the presence of the risk of over-insurance is present, which in turn entails moral hazard according to the literature.

I can establish therefore for the 15 Member States of the European Union that their average deposit amounts display significant differences despite being subject to the same, universal deposit insurance limit. This may result in a relatively higher coverage ratio in countries with a smaller average deposit amount (e.g. Slovakia, Latvia, Estonia or Greece), which increases moral hazard on the side of the depositors and the banks alike. At the same time, maintaining competitive neutrality is a strong argument for upholding the universal deposit insurance limit, which is brought even more to the forefront because of the technological innovations appearing on the banking market and promoting its globalisation as the so-called "fintech" providers offering digital financial solutions gain ground. Therefore, in spite of the considerable differences between the average deposit amounts in the Member States, I suggest that the unity of the deposit insurance limit should not be broken. However, it is worth considering how the Member States with a smaller average deposit amount could be compensated for the potential loss which may be caused by the moral hazard brought about by the relatively higher coverage ratio. For example, in case of setting up a joint deposit insurance fund in the future, the differentiation between the deposit insurance contributions of the individual Member States might be one of the possible ways of compensation.

The examination of the distribution of the deposit amounts also reveals that the distribution is strongly skewed to the left and extended long to the right in each Member State, just as in the analysis independent from survey, based on the Hungarian data (Chapter 4.2), which can lead us to the conclusion, on the one hand, that the distribution of the deposit amounts is typically of such nature. This conclusion may be of significance in the simulation of bank runs. On the other hand, it also means that a minor change to the current deposit insurance limit would change the number of the deposits insured only to a slight extent, while the insurance obligation would change considerably.

5 CONCLUSIONS

Researchers examining deposit insurance systems agree that the main advantage of deposit insurance - the prevention of inefficient bank runs - comes at the expense of costs related to moral hazard. However, the majority of the empirical studies arrive at the conclusion that in deposit insurance systems of a high coverage ratio the negative effect related to moral hazard offsets the beneficial effects of deposit insurance and increases the risk of the banking system on the whole (Table 10).

The hazard decreases	**The hazard increases**	**Mixed finding**
Gropp and Vesala (2004)	*White (1995)*	*Garcia (2000)*
Chernykh and Cole (2011)	*Grossman (1992)*	*Laeven (2002)*
	Wheelok (1992)	*Cull and co-authors (2004)*
	Thies and Gerlowski (1989)	*Anginer and co-authors (2014)*
	Demirgüç-Kunt and Detragiache (1998)	
	Demirgüç-Kunt and Detragiache (2002)	**No correlation**
	Hovakimian and co-authors (2003)	*Wheelock and Wilson (1994)*
		Alston and co-authors (1994)
		Karels and McClatchey (1999)

Table 10: **The direction of the correlation between deposit insurance and the risk in the banking system according to empirical studies. Source: Prepared by myself.**

The understanding and examination of the phenomenon of moral hazard are therefore of prime importance. In this dissertation I have studied the signs of moral hazard by taking a new approach, i.e. by comparing the credit institutions existing or liquidated in Hungary and their depositors and by analysing the composition of Hungarian depositors.

Liquidated credit institutions used to offer in Hungary higher interest rates on the average than existing credit institutions for any maturity, although the difference was statistically significant only in the case of short-term deposits (H1), as I have established with a paired

one-tailed t-test in case of a normal distribution of the interest rates and with Welch's t-test for all other cases. Depositors with deposits larger than 1 million HUF were more inclined to deposit their savings with institutions offering higher interests and subsequently liquidated than small depositors, which may imply that they were more affected by moral hazard. Based on the Wilcoxon rank sum test, this difference in behaviour gave rise to a significant difference in the distribution of the deposit amounts in existing and liquidated credit institutions (H3). The difference is also significant in the case of comparison with institutions of a size similar to the liquidated institutions (H4), i.e. it cannot be explained by difference in the size of the institutions. Financing the reimbursement of deposits of higher amounts cost a lot to the Hungarian banking system: if the proportion of the amounts deposited with failed credit institutions had corresponded to the distribution of the total population, reimbursing the depositors of institutions liquidated in 2014 and 2015 would have cost HUF 94.5 billion less.

Based on the information available regarding reimbursed depositors (deposit amount, age, place of residence), I examined their typical groups: four clusters could be distinguished significantly and objectively (H7) by means of McQueen's k-means clustering. I used the multi-dimensional scaling/alternating least-squares scaling (MDS ALSCAL) to determine the optimum number of clusters. In my opinion, moral hazard could arise with a higher probability within two clusters, i.e. among the elderly depositors in the clusters "Millionaires" and "Savers", living in large cities and more well-off than the average, than in the other two clusters. This is because these depositors decided to deposit their savings in institutions which failed subsequently, although they could have chosen from the offers of many institutions in their neighbourhood. It seems probable at the same time that some of the depositors in both groups would have kept their money in the credit institutions that failed subsequently without a deposit insurance, too, because they trusted the given institution for some reason. The majority (91%) of the depositors fall in the cluster of "Stayers" or "Poor", who hold much smaller amounts in deposit than the reimbursed total population on the average. "Stayers" probably chose a credit institution close to their place of residence necessarily, with regard to their advanced age, i.e. they may be "accused" less of having taken a conscious advantage of the protection provided by deposit insurance The group of the "Poor" includes the youngest depositors living in the smallest settlements, who probably had to select a credit institution from the

narrower choice available in their neighbourhood in order to be able to access their savings of small amounts on a daily basis. The more than 42 thousand, most needy depositors in the cluster of the "Poor" could thus evade serious liquidity or livelihood problems thanks to the reimbursement by the NDIF.

The classification of the liquidated credit institutions based on the characteristics of their depositors reveals that Széchenyi Kereskedelmi Bank is clearly distinguished from other institutions by its customers with deposit amounts high above the average, most of whom live in the capital city. We can establish based on the principles applied to cluster depositors that the customers of Széchenyi Bank were more likely to face moral hazard compared to the poorer customers of ALBA Takarékszövetkezet and Dél-Dunántúli Takarék Bank (DDB), living in settlements smaller than the average.

In summary, my findings corroborate international empirical research by establishing that the signs of moral hazard can be identified with some of the Hungarian depositors, too. The positive impact made by deposit insurance on society through both the prevention of inefficient bank runs and the reimbursement of the group of depositors in need is beyond dispute. In light of the foregoing facts, I believe that credit insurance is a desirable institution in Hungary from both a social and economic perspective alike, nevertheless, the possible ways of mitigating moral hazard are worth considering.

I will make suggestions as to the mitigation of the moral hazard based on and in connection with the recommendations found in literature concerning own contribution and the monitoring of the market players.

Deposit insurance limit, own contribution

According to *Pauly* (1968), moral hazard usually inherent in insurances can be reduced if there is an amount which is to be paid by the damaged party in the event of damage. In the case of explicit deposit insurance systems, this own contribution usually means the amount above the reimbursement limit, which is to be borne only by large depositors. *Demirgüç-Kunt* and *Detragiache* (2002, p. 1371) highlight that "the undesirable effects of deposit insurance on the stability of banks are stronger where the coverage of the deposit insurance is larger", i.e. in general, where the own contribution is smaller. *Garcia*

(1999) then proves in connection with the foregoing that moral hazard may be reduced by the limitation of the coverage ratio of deposit insurance.

I have established in my dissertation by means of variance analysis (ANOVA) for 15 Member States of the European Union that their average deposit amounts display significant differences (H9) despite being subject to the same, universal deposit insurance limit. This may result in a relatively higher coverage ratio in countries with a smaller average deposit amount (e.g. Slovakia, Latvia, Estonia or Greece), which increases moral hazard on the side of the depositors and the banks alike. Nevertheless, I suggest that the unity of the deposit insurance limit should not be broken, because varied reimbursement limits may distort competition within the internal market of Europe. I would rather suggest that the Member States with a smaller average deposit amount could be compensated for the potential loss which may be caused by the moral hazard brought about by the relatively higher coverage ratio. For example, in case of setting up a joint deposit insurance fund in the future, the differentiation between the deposit insurance contributions of the individual Member States might be one of the possible ways of compensation.

The idea of introducing own contribution for deposits in excess of HUF 1 million may arise in Hungary as a possible means to mitigate moral hazard (e.g. 10% as in the case of BEVA) as the probability of a conscious use of the advantages of insurance is higher above this limit. However, with this solution applied, depositors might have still sufficient motivation to run on the bank in the event of a bank panic on the one hand and the principle of competitive neutrality within the European Union would violated. Nevertheless, it would be necessary to introduce own contribution to mitigate moral hazard, but in a form which would not cause a bank run and could be applied universally. I recommend for consideration in reliance on the behavioural economy theory of loss aversion that depositors should be paid as reimbursement the amount of the invested capital or maybe the risk-free return on it (e.g. the base rate of the central bank), rather than the high rate of return originally announced and containing a risk premium, too. I propose to evaluate the effects of this solution and to introduce it uniformly within the European Union, depending on the results of further research.

Monitoring the market players

The empirical researchers of deposit insurance unanimously believe that deposit insurance systems have a better chance of being successful in countries with a better developed financial and economic environment and stronger market surveillance. Now I will try to formulate suggestions as to the improvement of the institutional system and market surveillance.

a) The monitoring of banks: I have concluded based on the comparison of liquidated and existing credit institutions according to various aspects that it is worth continuously monitoring pricing deviating from the bank market average significantly (on the debit and credit side) and the distribution of the deposit amounts from a supervisory point of view.

b) The monitoring of depositors: The number of persons who chose credit institutions which offered higher interest rates but failed subsequently may have been higher among the Hungarian depositors with deposit amounts above the average, because they relied on the protection provided by deposit insurance, even though they most probably had financial literacy and could have chosen from more banks in their densely populated neighbourhood. In light of the Hungarian example, it may be worth paying more attention to, and maybe also analyse by questionnaires, the deposit creation behaviour of persons with deposit amounts above the average.

c) Countercyclical strategy: *Anginer* and co-authors (2014) found the negative impact of moral hazard related to deposit insurance to dominate in balanced periods and the stabilizing effect of deposit insurance to prevail in the crisis. I think when the economic conditions are balanced, stricter regulation can reduce moral hazard without increasing the risk of a bank run if, while in critical times insurance coverage could be extended (just as we saw it during the financial crisis of 2008). I propose therefore the introduction of a countercyclical strategy in deposit insurance.

d) Bank run simulations: My research is the first to examine the distribution of deposit amounts on an international scale. This information may be used as input data for the simulation of bank runs. The observation of the total Hungarian population of depositors supplemented by the analysis of the distribution of deposit amounts in 15 Member States included in the *HFCS* database *(2014)* both confirm that the distribution of deposit

amounts is strongly skewed to the left. This also means in respect of the European Union that a minor change to the current deposit insurance limit of EUR 100,000 would change the number of the deposits insured only to a slight extent, while the insurance obligation would change considerably.

6 APPENDIX

Classification results [a]							
4-cluster solution			Presumed number of the members of the cluster				Total
			1	2	3	4	
Original	Number	1	1786	0	0	1	1787
		2	0	41410	852	390	42652
		3	0	363	58945	815	60123
		4	40	201	717	7718	8676
	%	1	99.9	.0	.0	.1	100.0
		2	.0	97.1	2.0	.9	100.0
		3	.0	.6	98.0	1.4	100.0
		4	.5	2.3	8.3	89.0	100.0
a. 97% of the cases originally classified were listed to the correct cluster.							

Table F1: Discriminant analysis. Source: Edited from the databases of NHIF and KSH.

ANOVA						
	Cluster		Error		F	**Sign.**
	Sum of squares	df	Sum of squares	df		
Zscore (Reimbursement paid)	31437.127	3	.164	113234	191422.154	**.000**
Zscore (Age)	24551.455	3	.350	113234	70169.013	**.000**
Zscore (Settlement type)	1877.753	3	.901	113234	2085.148	**.000**

Table F2: Source: ANOVA table. Edited from the databases of NHIF and KSH.

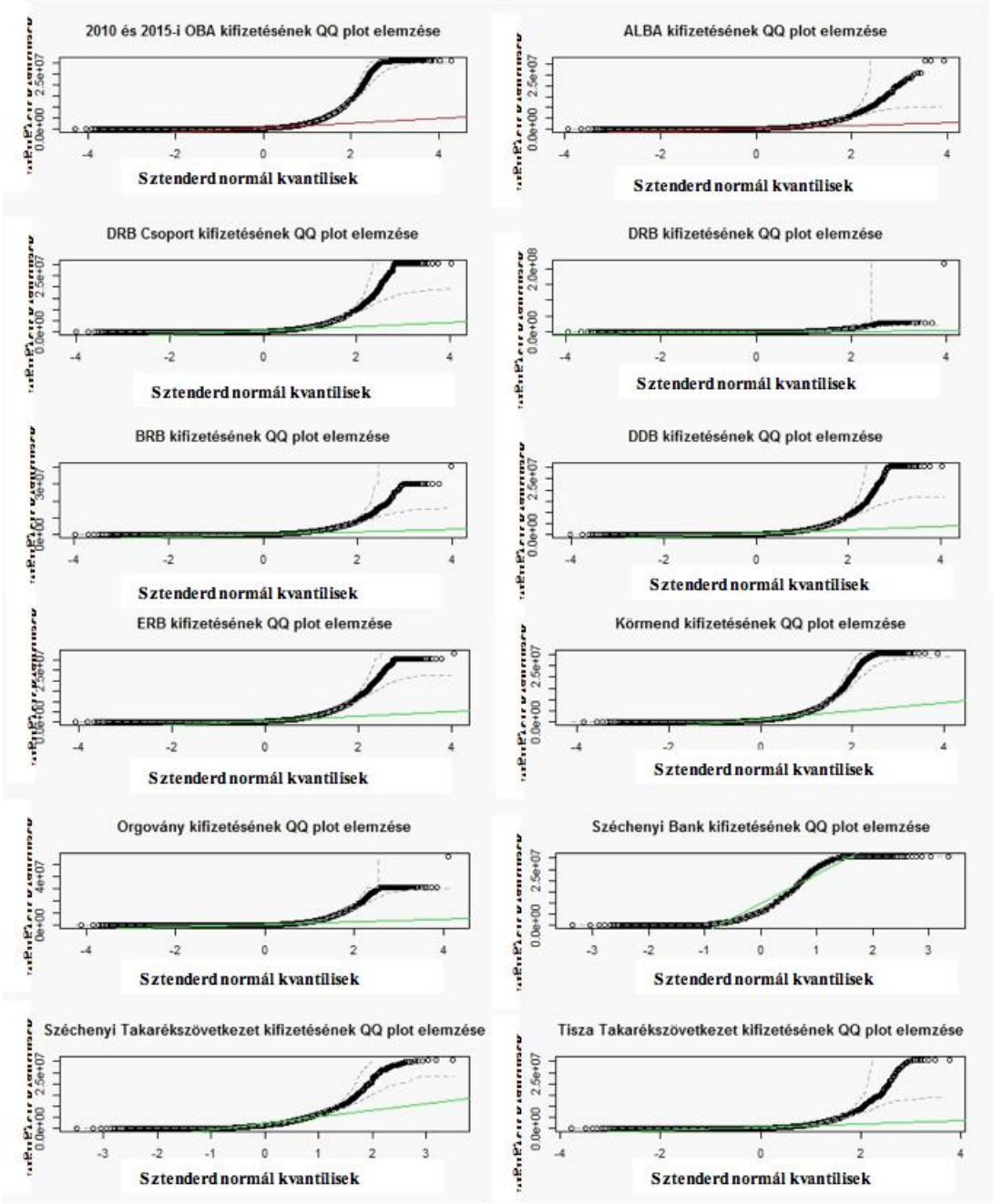
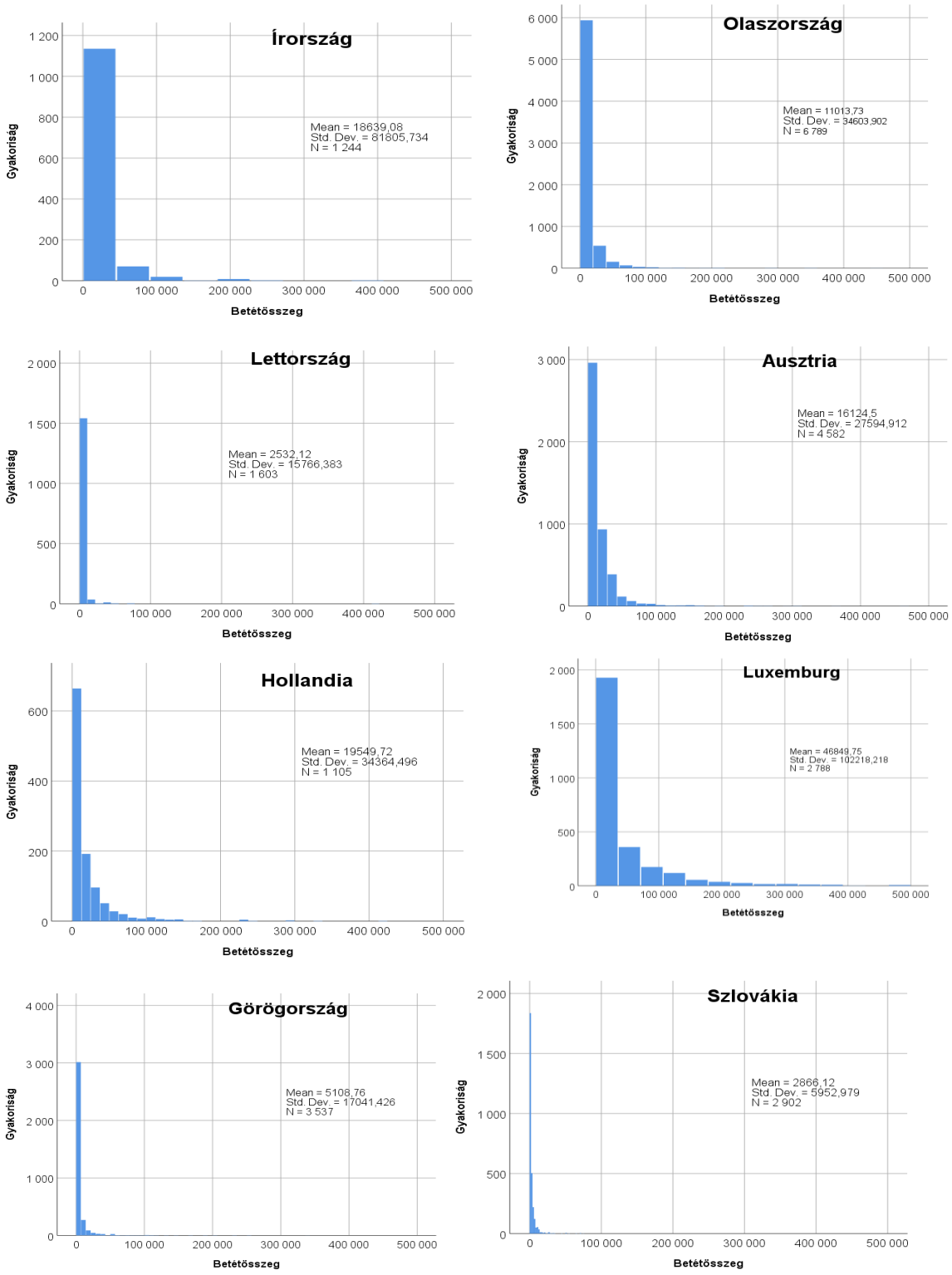

2010 és 2015-i OBA kifizetésének QQ plot elemzése
Sztenderd normál kvantilisek
ALBA kifizetésének QQ plot elemzése
Sztenderd normál kvantilisek
DRB Csoport kifizetésének QQ plot elemzése
Sztenderd normál kvantilisek
DRB kifizetésének QQ plot elemzése
Sztenderd normál kvantilisek
BRB kifizetésének QQ plot elemzése
Sztenderd normál kvantilisek
DDB kifizetésének QQ plot elemzése
Sztenderd normál kvantilisek
ERB kifizetésének QQ plot elemzése
Sztenderd normál kvantilisek
Körmend kifizetésének QQ plot elemzése
Sztenderd normál kvantilisek
Orgovány kifizetésének QQ plot elemzése
Sztenderd normál kvantilisek
Széchenyi Bank kifizetésének QQ plot elemzése
Sztenderd normál kvantilisek
Széchenyi Takarékszövetkezet kifizetésének QQ plot elemzése
Sztenderd normál kvantilisek
Tisza Takarékszövetkezet kifizetésének QQ plot elemzése
Sztenderd normál kvantilisek

Figure F1: Q-Q plot analysis of the reimbursement paid by institutions. Source: Edited from the NDIF database.



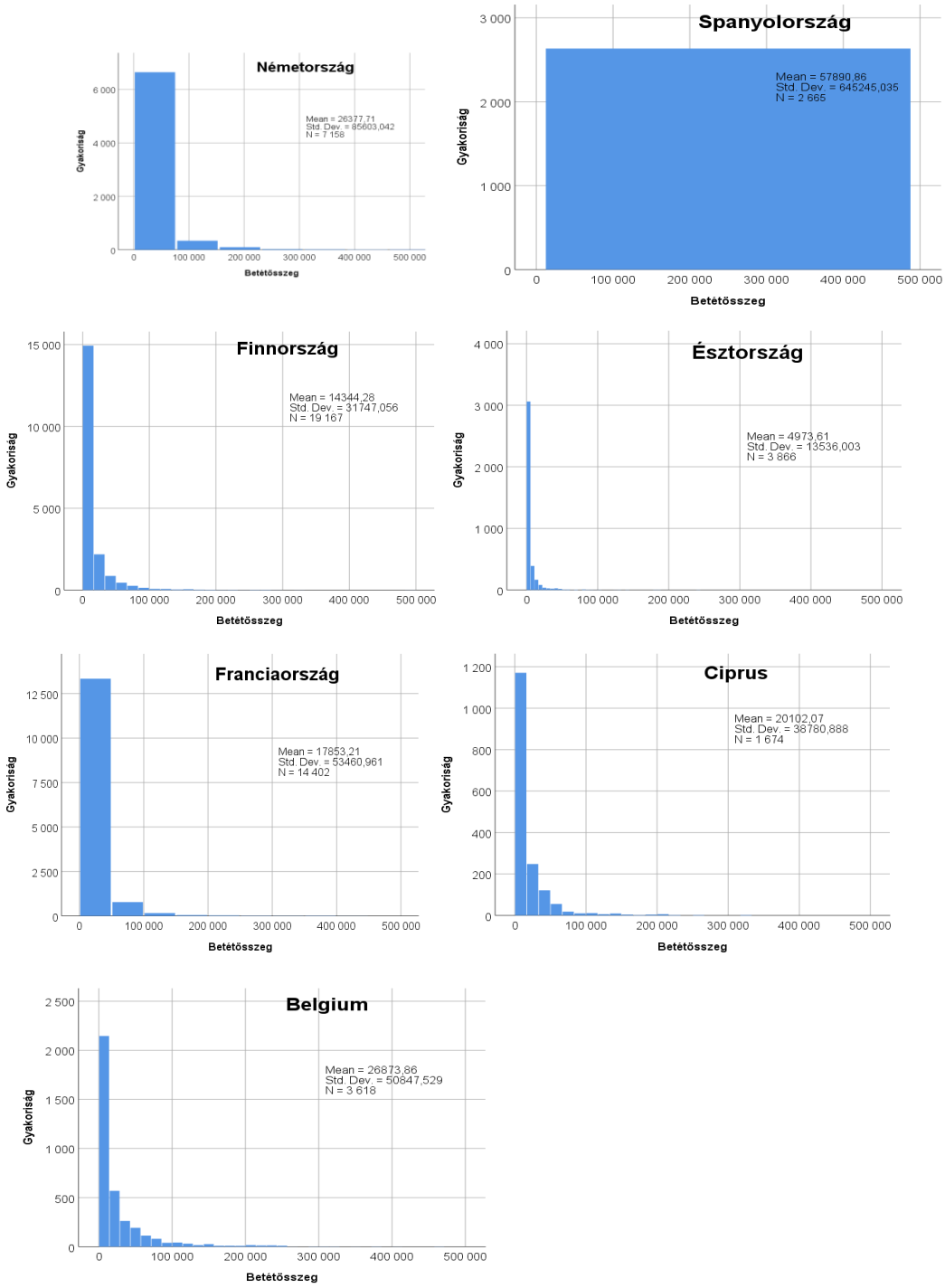


Figure F: The frequency of deposit amounts up to EUR 500,000 based on the sample by Member States (histogram) Source: Edited from HFCS (2014) data.

Definitions

Deposit	Liability based on a deposit agreement defined in the Civil Code or a savings deposit contract defined in the relevant legal rule, including a positive payment account balance.
Depositor	The person to the name of whom the deposit is created or, exclusively in the case of non-registered deposits, the person who bears and produces the deposit document.
Deposit insurance	"A system protecting the insured deposits of depositors upon the occurrence of an event rendering a bank unable to perform its obligations towards its depositors" (*IADI*, 2014, page 8).
Moral hazard	"Moral hazard arises when the parties are encouraged to assume higher risk, because the cost of risk assumption is limited, as it is assumed by others, whether in part or as a whole" (*IADI*, 2014, p. 10).

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