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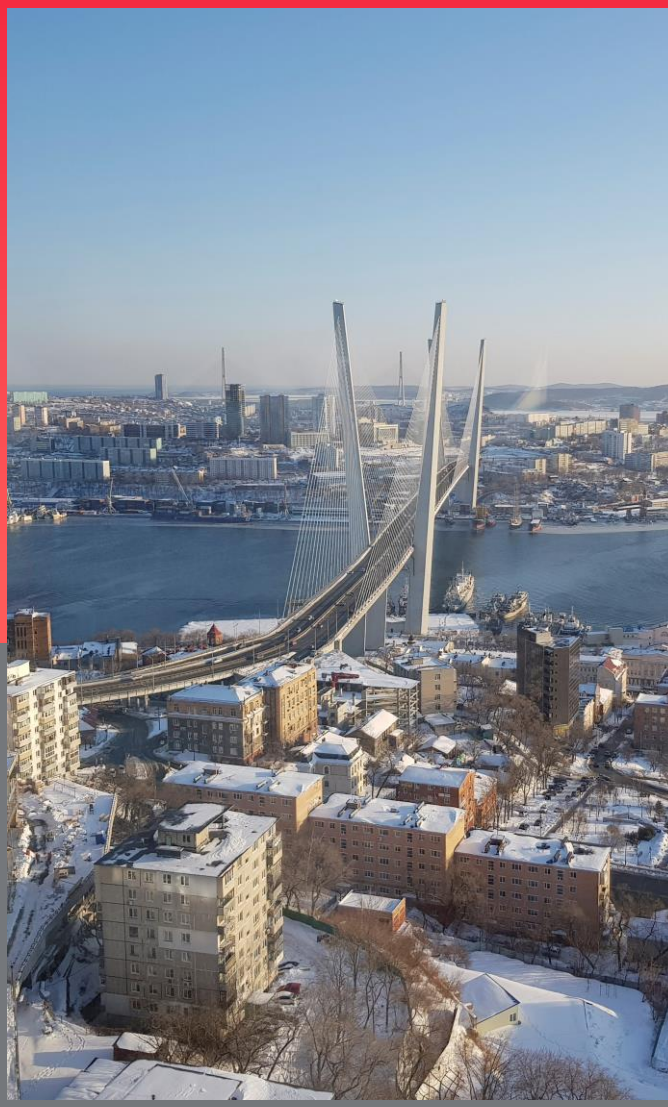

Measuring Market Liquidity and Liquidity Mismatches across Sectors

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Abstract

We offer tools for measuring, monitoring and analysing the liquidity of financial markets in the context of various liquidity aspects. The liquidity mismatch concept makes it possible to assess how liquidity risk acceptance varies across economic sectors. We calculate liquidity indices – that is, liquidity mismatch indicators, and conduct a comparative analysis of the degree of liquidity risk acceptance by various sectors of the Russian economy. The values of liquidity indices in the household sector vary significantly across countries, depending on the degree of population involvement in the stock market.

We use the proposed tools to assess the development of financial market segments in Russia and conduct cross-country comparisons of the degree of liquidity of capital markets. Higher liquidity of financial markets is associated with a higher development of these markets; however, this is fraught with liquidity risks that may lead to financial losses.

Considering the concept of liquidity in various aspects, we expand the discussion of the availability and development of long-term investment financing in Russia.

JEL-classification: G10, G23, O16

Keywords: market liquidity, liquidity mismatch, liquidity risks, bank-based and market-based financing, financial instruments, balances of financial assets and liabilities

Contents

1. Introduction

The development of financial markets is a hot topic in transitional economies since the possibility of fundraising using a variety of financial instruments is viewed as an important factor in ensuring investment growth and the sustainability of economic development.[1]

Our work is aimed at systematising liquidity measurement concepts and the structure of financial markets, which allows us to assess the development level of market segments. The main contribution of this work is the creation of tools that can be used to monitor and analyse liquidity and the structure of financial markets, which makes it possible to expand the discussion on promoting the accessibility of financing in Russia.

Liquidity is determined by a large number of factors, so it is difficult yet always appropriate to give a uniform definition. We consider the concept of liquidity from different perspectives and offer a toolkit for measuring it. On the basis of a cross-country comparison, we analyse the degree of liquidity of the stock and government bond markets.

Higher liquidity of financial markets is associated with a higher development level of these markets; however, this is fraught with liquidity risks where assets and liabilities may not correspond in terms of liquidity, which may lead to financial losses. In our work, we calculate liquidity indices (indicators of liquidity mismatch) that result from the operation of financial markets and assess the extent of risk acceptance by economic sectors. We also perform a cross-country comparison of liquidity indices based on data from financial accounts in the system of national accounts.

This work is structured as follows. In the literature review, we first show that in conditions where household savings are not automatically transformed into investments, it is important to create demand for long-term and risky financial instruments. This leads us to a discussion of the differences between the financial systems of bank-based and market-based financing We also introduce the concept of market liquidity and the concept of a liquidity mismatch. Next, we move on to the practical part where we first present the data used in our work, after which we conduct an empirical analysis that allows us to demonstrate the concept of market liquidity and the concept of liquidity mismatch and to interpret the values of liquidity indices in conjunction with the structure of the financial system. At the end, we draw up conclusions based on the results of our analysis.

2. Literature review

In this section, we first will show that economic development requires the development of various segments of the financial markets. We will determine what type of financial system may be preferable for this. This will allow us to move on to the concept of liquidity as an indicator of the development of financial instruments and financial markets. Finally, we go on to focus on the liquidity mismatch concept as an indicator of the acceptance of liquidity risks by economic agents.

[1] In Russia, when discussing this topic, access to 'long money' is often mentioned. In our opinion, this term does not fully reflect the essence of the problem as the characteristics of financial instruments that determine their liquidity and the level of debt burden they create are not limited to maturity.

2.1 The demand for risky financial assets is a source of investment financing, while savings alone are not

A high level of household savings does not guarantee a high level of investments in the economy. (Borio & Disyatat, 2015) note that the systems of national saving accounts are, by definition, simply unused income, which is not the same as investment financing[2]. (Jakab & Kumhof, 2015) question the intermediary function of banks – that is, the function of banks to convert the savings of some customers into borrowings for others. According to the authors, banks create money themselves by financing customers who are both borrowers and depositors. When issuing a loan to a customer, the bank recognises it on its balance sheet as an asset, simultaneously creating a new liability as the borrowed funds go to the customer's current or settlement account with the same bank (whereby they become deposit holders).[3] The authors claim that to issue loans, the bank does not need household savings, it is enough for it to have current and settlement accounts of customers (in other words, on-demand deposits) and liabilities created after the issuance of loans. Thus, savings in the form of deposits are a consequence of bank financing rather than the cause.

Governor of the Bank of France Villeroy de Galhau, speaking at conferences on savings in 2016, noted that there was a high level of savings in France; however, most of those funds were placed in bank deposits at low interest rates. In such conditions, there is underinvestment in the innovation sector of the economy requiring long-term and riskier investments, which undermines the potential for economic growth (Villeroy de Galhau, 2016a). For the growth in investment, it is necessary to create demand for long-term financial instruments by offering savings products beneficial to households (Villeroy de Galhau, 2016б). The demand for instruments riskier than bank deposits arises when the stock markets function well.

2.2 The dominance of market-based financing may provide more benefits than bank-based financing

The structure of the financial system may be of two types determined by the ratio between bank-based or market-based financing. In a bank-based[4] financial system, financial intermediaries raise savings, issue loans and manage risks. In a market-based financial system, the stock and bond markets are the main source of funding. In this case, we are talking about the financing of the private non-financial sector.

(Al Mamun, et al., 2018) found that the stock market (as compared to the credit market) plays a more significant and positive role in expanding production in industries that require long-term investments with long payback periods, for example, to expand the production of clean energy. (Fink, et al., 2006) also assumed that raising large amounts of financing for long periods would more likely involve using stocks and bonds than bank loans.

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[2] For the authors, this difference becomes fundamental when analysing the current transactions of the balance of payments. In particular, the authors claim that the current account tells us not about the real need for funding or the real willingness to finance the rest of the world but about how many resources are released by the economy to finance the rest of the world or held back to get credit from the rest of the world.

[3] Where a client takes a loan to purchase new goods or services, these funds become assets of other clients, who also keep their funds on current and settlement accounts with the bank – that is, the funds initially issued by the bank remain on the liability side in the form of deposits (if not of the same bank, then of the banking system as a whole).

[4] The terms 'bank-based' or 'market-based' are used as in (Demirgüç-Kunt & Levine, 2001) and (Bats & Houben, 2017), (Gambacorta, et al., 2014).

There has been extensive debate in the academic community about which type of financial system is preferable for the economy. (Demirgüç-Kunt & Levine, 2001) and (Levine, 2002) showed that the structure of the financial system itself does not affect economic growth; the development of the financial system as a whole is much more important. Although this point of view has been criticised by (Luintel, et al., 2008; Luintel, et al., 2016), the subsequent papers addressed narrower issues concerning the influence of the structure of the financial system on economic performance. In particular, it was shown that in bank-based economies the financial crisis had a greater adverse impact on the economy. Thus, (Gambacorta, et al., 2014) revealed that the impact of the financial crisis of 2008–2009 on the GDP of countries with prevailing bank-based financing was three times more serious than in countries using market-based financing. (Langfield & Pagano, 2016) found that during the real estate crisis the European bank-based financial system faced higher increases in systemic risks and lower economic growth than other countries.

Moreover, (Bats & Houben, 2017) showed that the predominance of bank-based financing contributes to the accumulation of systemic risks. Highly leveraged banks may face difficulties in complying with regulatory requirements at a time of severe impairment of financial assets. Given that banks are interconnected through interbank transactions, risks of instability accumulate in the banking system. In market-based financing, risks are shared across multiple investors rather than within the banking system.

Non-bank financial institutions play an important role in the provision of financing. On the one hand, such organisations ensure the functioning of the stock and bond market and are active participants in it. On the other hand, they issue loans to the private non-financial sector and securitise bank loans. Non-bank financial institutions that issue loans but are not subject to banking regulations form a shadow banking system. (Unger, 2016) described several forms of interaction in terms of creating a loan between banks and institutions related to the shadow banking system. First, a non-bank institution may use funds raised from the issue of securities to redeem a mortgage from a bank and thereby receive a loan from this bank as an asset (for example, this is how government-sponsored enterprises operate in the United States). Second, a non-bank institution may for a start open a credit line with a bank to redeem the bank's credit asset and then issue securities backed by that asset. Third, a non-bank institution may raise financing by issuing securities and may issue loans on its own. In this case, the bank does not participate in issuing a loan but only allows the customer to keep free funds on its accounts. Moreover, (Unger, 2016) comes to the conclusion that the functioning of the shadow banking system in the United States in the 2000s, despite increasing the risks to financial stability given the lack of banking regulation there, was not a sufficient condition for a credit boom. (Абрамова & Мамута, 2014) noted that the spread of the shadow banking sector in Russia may pose risks to financial stability due to the emergence of unethical (predatory) consumer lending and the use of money laundering technologies by non-bank financial institutions.

Rojas-Suarez (БМР, 2013) pointed out the complementarity of the capital and credit markets associated with the interaction of banks and non-bank financial institutions. Non-bank financial institutions may fund their inventories (in the form of securities) with bank credit lines, as a result of which financial shocks affecting the banking system will have an effect on the non-bank financial sector. On the other hand, in emerging economies, the credit history of companies may reduce the informational asymmetry for investors planning to purchase securities of a given company.

It is worth noting an alternative view of the relationship between the financial system structure and economic growth. (Unger, 2018) showed that if, in the economic growth

regressions for financing volumes, control is introduced over financing distribution by economy sectors, it will not be so important for the economy in which way financing is provided. (Unger, 2018) attributed the negative relationship between the share of bank financing and economic growth to the fact that part of loans is issued to households, which demonstrates an inverted U-shaped relationship between financing and economic growth. According to (Unger, 2016), in matters regarding the influence of finance on economic growth, the distribution of such finance between non-financial corporations and households is much more important than the financing methods.

Let us also mention the articles by (Kurronen, 2015; Allen, et al., 2018) claiming that the structure of the real sector predetermines the structure of the financial sector. (Allen, et al., 2018) attributed this to the fact that capital-intensive companies tend to use bank lending (the risks of these companies are easier to assess, and it is possible to issue loans secured by property), while high-tech companies and companies with a high proportion of intangible assets tend to resort to the stock and bond market. (Kurronen, 2015) notes that in countries dependent on the export of resources large resource companies prevail, for which, on the one hand, it is easier to raise market capital as investors have larger access to information about the financial condition of companies or their credit history than to information about small companies. On the other hand, it may be more difficult for large companies to obtain financing from one bank as the company's need may exceed the capabilities of a single bank, which, in addition, seeks to diversify its loan portfolio. It turns out that the financial sector meets the real sector's demand for financing; therefore, its structure adjusts to the real sector's requirements.

Thus, the comparison of financial systems based on different types of financing does not allow us to determine precisely which system is better. It should be noted that the transition to a market-based financing system may be preferable if there is demand for long-term financial instruments, on the one hand, and, on the other hand, it can prevent the accumulation of systemic risks through the use of stocks and bonds along with loans.

Speaking about the availability of various kinds of financing for borrowers and taking into account possible maturity and debt burden, it is important to select market development indicators for certain financial instruments. One of the important market development indicators and instruments is their liquidity. On the one hand, liquid financial instruments provide ease of transactions for the holders of these financial instruments, on the other hand, in developed financial markets, less liquid liabilities of companies are transformed into liquid financial instruments traded on the market. Therefore, measuring the liquidity of financial instruments of both issuers and holders makes it possible to judge the development of financial markets. In the next section, we will look in more detail at the meaning of the concept of liquidity.

2.3 Multidimensionality of the concept of liquidity in the context of the development of financial markets

The concept of liquidity is multifaceted; therefore, the same financial instrument may be viewed as both liquid and illiquid, depending on whether the economic agent wants to buy/sell or issue this instrument. There are many approaches to determining liquidity focusing on various aspects of this concept. We systematise the approaches that will be useful for us in comparing the development of financial markets in various countries.

First, it should be noted that the view of liquidity differs across regulators and investors. The first group of users includes international organisations that set banking standards. Within the scope of ensuring financial stability, regulators identify the main

criteria for liquidity as a capability to receive the maximum amount of monetary funds from assets at a given time and the current need to pay the maximum amount of monetary funds on its liabilities (Krishnamurthy, et al., 2016). A group of practitioners, represented by investors, are interested in the liquidity of financial instruments they want to take profit from. Profit may be obtained both in the form of dividends for shares or coupon payments for bonds (if any) and in the form of a change in the price of a financial instrument. The liquidity of an instrument is important if there is a need to buy or sell an instrument at a specific time to benefit from a price change. The possibility or impossibility of the quick sale of a financial instrument may affect its pricing due to the establishment of a liquidity premium.

(Sarr & Lybek, 2002) note that the concept of liquidity may differ depending on the object: an asset, the market for an asset, the financial market for an asset or the financial institutions in this market (in the latter case, we are talking about institutional liquidity). Below we will briefly explain the differences between these concepts of liquidity for each object.

As for the *liquidity of an asset*, one of the first definitions was by (Fisher, 1959), according to whom, liquidity is the ability of an asset to trade quickly and without loss in its value. (Biais, et al., 1997) argued that an asset is liquid if it can be sold quickly with low transaction costs and at a reasonable price. (Sarr & Lybek, 2002) summarised the existing definitions as follows: an asset is liquid if it can be easily converted into legal tender.

Asset market liquidity is a broader concept, it refers to the ease with which a large amount of assets can be placed in a short period of time without changing the asset prices (IMF, 2018). (Demsetz, 1968) wrote that liquidity is determined by the price concession that a market participant agrees to in order to complete a transaction. (Fleming, 2003) defined a liquid market as a market in which a transaction can be completed with minimal transaction costs. In their fundamental research papers, Demsetz and Fleming point out only one aspect of market liquidity – the presence/absence of transaction costs. However, there are many more aspects of market liquidity, which will be discussed in more detail below.

Financial market liquidity, according to (Sarr & Lybek, 2002), depends on how interchangeable financial instruments are for investors. For example, differences in credit risk may impede the interchangeability of instruments and lead to market segmentation. Even if instruments are issued by the same issuer, they may still have different characteristics (for example, special rights on preferred shares), which makes it difficult to assess financial market liquidity.

Institutional liquidity reflects how easily financial institutions can conduct financial transactions to close the liquidity gap between assets and liabilities (Sarr & Lybek, 2002).

Of the liquidity objects mentioned above, financial market liquidity is the focus of the highest attention among researchers. In the research literature (Sarr & Lybek, 2002; Diaz & Escribano, 2020), there are five characteristics of a liquid financial market:

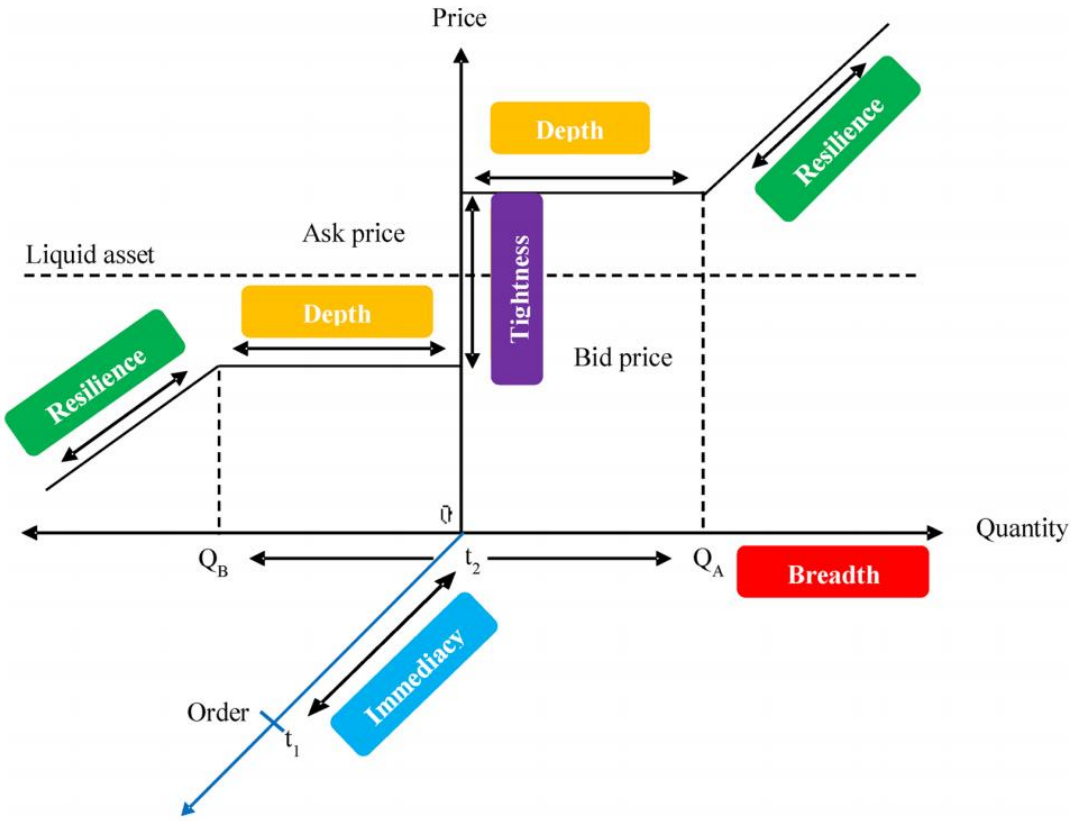
- Tightness is related to the volume of transaction costs. In tighter markets, transaction costs are lower, which is reflected in a smaller difference between the minimum selling price and the maximum purchase price. Tighter markets are more liquid.[5]

[5] However, there is no agreement that a tight market is a more liquid market (as stated in (Kyle, 1985; Sarr & Lybek, 2002), some authors use inverse interpretation: a tight market is a less liquid market (Dick-Nielsen, et al., 2012; Diaz & Escribano, 2020). It is possible as the authors more often use terms transaction costs and spread than tightness.

- Immediacy shows how quickly a financial instrument may be sold or bought, and how quickly a new financial instrument may be placed. Accordingly, the faster a transaction can be made, the higher the market liquidity is. Immediacy is an important aspect of liquidity for monetary authorities regulating banking. Banks' financial assets include not only stocks and bonds, with which market liquidity is associated, but also loans and deposits. To determine the liquidity of bank assets and liabilities, it is crucial to how quickly a financial asset can be cashed out, or, conversely, how long it is possible to postpone repaying liabilities. However, here not only the speed is important but also the price of the transaction, which is more related to such aspects as the market breadth and resilience (below).
- Depth is expressed through the number of buy and sell orders for an asset – that is, it is proposed to estimate how many orders exist at different prices (including at prices lower/higher than the one at which the instrument is actually traded). It is assumed that the financial market in which there is a wide range of prices at a given point of time is deeper (Sarr & Lybek, 2002). Market depth is associated with the risks of changes in inventories and demand pressure. The risks of changes in inventories are associated with an unexpected need to buy or sell a large amount of financial assets; if inventories are replenished or reduced easily, the market is deeper. Under the influence of regulatory measures for banking, after the crisis of 2008–2009, the inventories of banks' financial assets started to decline, which had an effect on the decrease in market depth (IMF, 2015).
- Breadth indicates that, being large in volume and quantity, new orders have a minimal impact on the current price when they are sold – that is, new orders can be satisfied without significant price changes.
- Resilience indicates the market's ability to recover from unexpected events; in other words, resilience indicates how new orders can correct the imbalance of supply and demand without letting the price deviate from a fundamentally reasonable level. An imbalance may be associated with a shock caused by both a major market transaction and new information (for example, about the issuer of a financial asset or about the overall economic situation). This aspect also turns out to be key for monetary authorities as if bank liquidity evaporates in the event of any economic shock, this undermines the financial stability of the entire economy; therefore, it is crucial to include the resilience aspect in the understanding of liquidity.

(Bervas, 2006; Hibbert, et al., 2009; Diaz & Escribano, 2020) presented a graphical visualisation of liquidity aspects. Let us look at Fig. 1 from (Diaz & Escribano, 2020), which is largely consistent with the description of the characteristics above. Q_A and Q_B are the number of seller orders at the asking price and the number of buyer orders at the bid price. As was mentioned above, the number of orders reflects the market depth. The difference between the prices of the nearest orders reflects the tightness of the market; as the difference decreases, the prices of buyers and sellers approach the dotted line, which characterises the absolute liquidity of the asset. The volumes of assets that can be sold/bought at set prices without change determine the market breadth. The market ability to recover from unexpected shocks shows the market resilience. The time marks t_1 and t_2 indicate the time of the placement and execution of the order. Accordingly, the immediacy with which the order can be fulfilled will be equal to the difference $t_2–t_1$.

Fig. 1. Liquidity aspects



Source: (Diaz & Escribano, 2020)

To measure the characteristics of liquidity, 4 groups of indicators are distinguished: transaction cost indicators, volume-based indicators, price-based indicators and market-impact indicators. General information about these indicators is provided in Appendix 1. Below we will consider in more detail four indicators that together cover the above-mentioned aspects of liquidity and will allow further empirical analysis: bid-ask spread, turnover rate, Hui-Heubel Liquidity Ratio and Market-Efficiency Coefficient.

The market tightness indicator is the ***bid-ask spread***:

$$Bid - ask\ spread = \frac{P_A - P_B}{(P_A + P_B)/2}, \quad (1)$$

where P_A is the minimum selling price for the period (ask price), P_B is the maximum purchase price for the period (bid price).

In the absence of high-frequency data, closing ask and bid prices are used (Chung & Zhang, 2014). The bid-ask spread refers to indicators that measure transaction costs. Accordingly, the lower the spread value, the higher the market liquidity.

The market depth indicator is the ***turnover rate*** (Gravelle, 1999):

$$Tn = \frac{V}{S * P} = \frac{\sum P_i * Q_i}{S * P} \quad (2)$$

where Tn is the turnover rate, V is the volume traded, P_i and Q_i are prices and quantities of the i trade during a specifies period, S is the outstanding stock of the asset, P is the average price of i trades.

The higher the turnover, the more liquid the asset market in terms of market depth.

The market breadth indicator is the ***Hui-Heubel Liquidity Ratio*** (Hui & Heubel, 1984), which is the inverse indicator of the asset turnover adjusted for the deviation of the maximum price from the minimum price:

$$L_{hh} = [(P_{max} - P_{min})/P_{min}]/[V/(S * \bar{P})], \quad (3)$$

Where P_{max} is the maximum daily price for the last 5 days,

P_{min} is the lowest daily price for the last 5 days,

V is the traded volume of the asset for the last 5 days,

S is the outstanding stock of the asset,

$\bar{P}$ is the average closing price over the last 5 days.

The lower the value of the indicator, the more liquid the asset. It should be noted that in the literature Hui-Heubel LR refers not only to the market breadth indicators but to the market depth and resilience.

The resilience indicator is the ***Market Efficiency Coefficient*** (MEC):

$$MEC = Var(R_t)/(T * Var(r_t)), \quad (4)$$

Where $Var(R_t)$ is the variance of the long-term return logarithm,

$Var(r_t)$ is the variance of the short-term return logarithm,

T is the number of short-term periods in one long-term period.

In more resilient markets, MEC must be slightly less than 1, which means that prices are able to quickly approach the equilibrium level.

Practical research papers show an average decrease in transaction costs for the period from 1996 through 2014 on major world exchanges (NASDAQ, Bombay, Sao Paulo, Tokyo in paper (Fong, et al., 2017)) despite the strong jump in transaction costs in 2008–2009 (Schestag, et al., 2016). It is noted that after the crisis of 2008–2009 the resilience of the US government bond market was not fully restored, and there were episodes of collapses of the liquidity[6] of this market (Broto & Lamas, 2020). In recent years, there has been little research on measuring market liquidity, but what there is mostly focuses on the market of a single country (Będowska-Sójka & Echaust, 2020; Naik, et al., 2020; Brandao-Marques & Danninger, 2016). We correct this omission and, in the empirical part of our work, review the market liquidity indicators for 2012–2020 for ten countries.

2.4 Trends in the formation of market liquidity

The IMF Global financial stability report (IMF, 2015) notes several trends determining the level of market liquidity after the 2008–2009 crisis.

First, there is the introduction of various regulatory requirements for banks' capital buffers and requirements for trading securities. As a result, banks began reducing their stocks of financial assets, including those acquired to operate as market makers, which made it possible to increase the resilience of systemically important banks. On the other hand, for banks, this led to an increase in the cost of services in the capital market, due to which market maker banks began to focus on a smaller number of customers, which affected the decrease in market liquidity.

[6] For example, the flash crash in October 2014.

Second, the introduction of algorithmic trading (including high-frequency trading) affects the liquidity of financial markets. Algorithmic trading allows computer programs to be used to fulfil large orders by dividing them into several small ones with set price and volume characteristics. This leads to a decrease in the cost of order fulfilment and a reduction in the influence of a large order volume on the asset price (i.e., it contributes to an increase in the breadth of the market). However, during high-frequency trading, a large number of orders of the same type can be generated on various trading platforms (duplicate orders), some orders will be executed, and the other part (duplicates) will be closed after a short period of time. In this respect, ghost liquidity is discussed as in conditions of instant cancellation of orders created by the algorithm liquidity evaporates (Degryse, et al., 2018). Massive cancellations of orders may also be triggered by an unexpected market shock. This makes the level of market liquidity unpredictable. Another consequence of high-frequency trading can be a decrease in market depth when the order volume is distributed across several venues, and the ability of individual venues to absorb a large counter order decreases.

Third, market liquidity is affected by an unconventional monetary policy (purchase of financial assets). On the one hand, the buyout of financial assets by central banks leads to an increase in liquidity since the central bank is perceived as a large buyer capable of supporting demand in the market. On the other hand, the reduction in the supply of highly liquid and low-risk securities purchased by the central bank is pushing investors to invest in other, less liquid financial assets, which affects the decrease in market liquidity.

Also, the IMF financial stability report notes an increase in the number of institutions representing the buy-side in the capital market, in particular, an increase in the number of investment funds; moreover, mutual funds began to play an increasing role in financial intermediation[7]. These two facts lead to an increase in market liquidity.

Thus, the level of market liquidity is formed under the influence of multi-directional trends.

2.5 The liquidity mismatch concept as an indicator of liquidity risk acceptance

It is important to assess the liquidity not only of stock instruments but also of other instruments shown on the balance sheets of economic agents. Amidst financial crises, this seemed to be especially relevant for credit institutions. Inadequate and ineffective liquidity risk management is one of the reasons for undermining financial stability. Several approaches were proposed at once to control the level of banks' liquidity. Approaches were proposed both by regulators, in particular, the liquidity coverage ratio and the net stable funding ratio (BIS, 2014), and by the academic community, such as the liquidity creation measures (Berger & Bouwman, 2009) and the liquidity mismatch index (Brunnermeier, et al., 2013; Krishnamurthy, et al., 2016).

In our work, we propose to compare the liquidity of assets and liabilities for different economic sectors. To that end, we provide a summary of the experience in measuring liquidity in respect of credit institutions.

(Berger & Bouwman, 2009) proposed to divide all financial instruments into three groups: liquid, semi-liquid and illiquid. Loans were classified taking into account their maturity and their borrowers[8]. For deposits, how quickly money can be withdrawn from

[7] In Russia, mutual funds include exchange-traded mutual funds and open-ended mutual funds.
[8] For example, consumer loans were recognised as semi-liquid, and corporate loans were illiquid since the former can easily be securitised, while the latter cannot.

accounts is taken into consideration. Equity capital is recognised as completely illiquid. Also, recommendations are given on other asset and liability items. Based on the ideas of the liquidity creation theory, each financial instrument receives one of three weights (–½, 0 or ½). It is said that the creation of liquidity in the economy occurs where a bank holds illiquid assets and provides liquid liabilities to the economy. Therefore, a positive weight is assigned to illiquid assets and liquid liabilities, and a negative weight is assigned to liquid assets and illiquid liabilities. Liquidity creation measures are a weighted sum of assets and liabilities. For example, when 1 conventional unit of an illiquid asset turns into 1 conventional unit of a liquid liability, 1 conventional unit of liquidity is created (1*0.5 + 1*0.5 = 1).

(Krishnamurthy, et al., 2016) criticised the approach of (Berger & Bouwman, 2009) for the constancy of weights over time as the authors believed that during a crisis the liquidity of a given instrument changes. Based on the approach of (Berger & Bouwman, 2009), a concept of the liquidity mismatch index was proposed (Brunnermeier, et al., 2013; Krishnamurthy, et al., 2016). Like liquidity creation measures, the liquidity gap index shows the difference between liquidity-weighted assets and liquidity-weighted liabilities. The difference between the index and the liquidity creation measure is that the weights change over time due to the dependence of the weight of a financial instrument on the current market liquidity of this instrument. In particular, the authors use repo haircuts as a proxy indicator of the asset liquidity. At the same time, the asset-side liquidity, according to the authors, reflects how easily a bank can get money for a financial asset. The liability-side liquidity is determined by how much counterparties may demand in the short term in accordance with contract terms. The liability-side weights depend on the liability maturity and on the spread between the overnight indexed swap and treasury bill.[9]

The Basel Committee proposed two indicators for measuring liquidity: the liquidity coverage ratio and the net stable funding ratio. The liquidity coverage ratio represents the ratio of the bank's high-quality liquid assets to the amount required to cover the increased outflow of funds from the bank within 30 days (BCBS, 2013).

The Net Stable Funding Ratio (NSFR) makes it possible to determine the relative amount of stable funding during the bank's continuous operation for the year under a specific stress scenario, where the bank is experiencing difficulties[10] that may become known to its customers and investors (БМР, 2009; BIS, 2014). This ratio is the ratio of the share of available stable funding to required stable funding. Available stable funding is determined on the basis of the bank's resource base structure depending on its type and maturity and using the available stable funding factors (analogues of liquidity weights). The required stable funding is determined based on the structure of the bank's assets and off-balance sheet liabilities using the required stable funding factors. Thus, the amount of available and required stable funding depends on the maturity (long-term financial instruments are considered more stable than short-term ones) and the type of counterparty (for example, deposits provided by individuals and small- and medium-sized businesses are more stable than wholesale funding).

[9] The dependence of the liability-side liquidity on the OIS–Treasury Bill spread is associated with the assumption that at each point of time the bank solves an optimisation problem of maximising carry-trade profit, changing its level of liabilities, taking into account the likelihood of a period of low market liquidity.

[10] Namely, a significant drop in profitability or solvency as a result of an increased credit, market, operational risk and/or other risks; a possible downgrade of a debt, credit or deposit rating by an officially recognised rating agency; a serious event that questions the bank's reputation or creditworthiness. (БМР, 2009)

This section presents several concepts for assessing the liquidity of assets and liabilities of credit institutions. These approaches are intended to help assess the liquidity risks of economic agents.

3. Data

Our empirical research focuses on applying the considered concepts of financial market liquidity and the liquidity mismatch to building liquidity indices for economic sectors based on country data.

To study various aspects of market liquidity, we analyse the stock and government bond markets. To that end, we use data from the Bloomberg system for 2012–2020. For financial instruments, we used the following indicators: closing price, bid price, ask price, daily trading volume, market capitalisation (for stock), duration (for bonds) (for more details, see Table 1, Appendix 2). Since the number of listed shares is large, we work with the shares of companies included in the largest country indices at the end of 2020 (Table 2, Appendix 2). At this stage of our research, 10 countries are included in the sample: Bulgaria, Hungary, Germany, Denmark, Ireland, Russia, Slovakia, USA, Finland and Sweden.

To study the liquidity mismatch, we build liquidity indices for economic sectors using the balances of financial assets and liabilities[11] of the system of national accounts (SNA 2008). We make calculations for various economic sectors of a particular country for 2019[12]. As financial instruments, we take:

F1. Monetary gold and special drawing rights (SDR)

F2. Currency and deposits

F3. Debt securities classified into

- F31. Short-term debt securities
- F32. Long-term debt securities

F4. Loans classified into

- F41. Short-term loans
- F42. Long-term loans

F5. Equity and investment fund shares, including

- F511. Listed shares[13]

F6. Insurance, pension and standardised guarantee schemes

F7. Financial derivatives and employee stock options

F8. Other accounts receivable and accounts payable.

At this stage, it is important to emphasise the specifics of the terminology used in the SNA 2008. In accordance with Clause 11.83 of the SNA 2008 (IMF, et al., 2009), 'equity is treated as a liability of the issuing institutional unit' – that is, we do not assume the division

[11] For methodology on compiling the balance sheets of financial assets and liabilities refer to (IMF, et al., 2009; Банк России, 2019).

[12] The most relevant and complete data at the time of the research.

[13] According to the SNA 2008 and the Russian methodology (IMF, et al., 2009; Банк России, 2019), listed shares are valued at market value. In addition, it was verified that, for example, in Russia, the volume of listed shares of non-financial corporations (according to the balance of financial assets and liabilities) is comparable to the value of the market capitalization of non-financial companies traded on the Moscow Exchange.

of liabilities into equity and liabilities, as is the case, for example, in corporate finance. Therefore, when we mention liabilities, we also include equity capital.

Due to the fact that we look at the values of liquidity indices that arise during the operation of the financial markets, we will be interested in instruments F1–F7, and we will not take into account other receivables and payables[14] (F8).

As economic sectors, we take

S11 – Non-financial corporations

S121 + S122 – Monetary financial institutions[15] (Central Bank and deposit-taking corporations)

S124 + S125 – Other financial institutions;[16]

S128 + S129 – Insurance corporations and pension funds (NCPF)

S13 – Government

S14 + S15 – Households and non-profit institutions serving households (NPISHs)

S2 – Rest of the world.

It should be noted that the banking system, other financial institutions, insurance companies and pension funds form a single sector, S12 – Financial corporations.

Balances of financial assets and liabilities allow the identification of counterparties – that is, issuers of financial assets and holders of liabilities. This, in turn, will allow us to separate financial instruments traded between sectors from those traded within a sector – that is, to perform a consolidation. We exclude instruments traded within a sector as they are not the result of the operation of the financial market.

The sources of information are the database 'QSA – ESA2010 quarterly financial and non-financial sector accounts'[17] for 26 European countries and statistical sections of the websites of the Central Banks of the USA and Russia[18]. The sample of countries includes Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Germany, Denmark, Estonia, Spain, Finland, France, Greece, Hungary, Ireland, Italy, Lithuania, Latvia, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Sweden, Slovenia, Slovakia, USA and Russia.

Let us note the limitations in our statistics. We faced certain difficulties in consolidating US and Russian data for the following sectors and financial instruments:

- Non-financial corporations: debt securities, loans, equity and investment fund shares (including listed shares) – for Russia and the United States.

[14] Accounts receivable/payable include debt related to the purchase and sale of securities, payment of dividends, rent, salary, taxes and utility bills as well as other debt. Source: https://www.cbr.ru/statistics/macro_itm/households/metod/1.

[15] Hereinafter, for brevity and clarity, 'banking system'.

[16] Other financial institutions include investment funds, brokers, dealers, depositories and other professional securities market participants, microfinance organisations, pawnshops, consumer credit cooperatives, leasing companies etc. (Банк России, 2019).

[17] QSA – ESA2010 quarterly financial and non-financial sector accounts: https://sdw.ecb.europa.eu/browseExplanation.do?node=9689710.

[18] In particular, for Russia, the SNA balance sheets of financial assets and liabilities, the 'From-whom-to-whom' table and the Banking System Survey were used.

- Banking system: debt securities, loans, equity and investment fund shares (including listed shares) – for Russia and the United States.
- Other financial institutions: debt securities, loans, equity and investment fund shares (including listed shares) – for Russia and the United States.
- Government: debt securities, loans – for Russia.

As a result, not all the lines of the US and Russia are cleared of financial assets and liabilities traded within the sector.

Another limitation of our analysis is the difficulty for Russia to divide debt securities and loans into short-term and long-term and to separate Instrument F511 – Listed shares from Instrument F5 – Equity and investment fund shares. We did the following:

- For debt securities on the side of liabilities. From the Russian statistics, it is possible to obtain the volumes of debt securities issued *at par value* with a breakdown by sector and maturity. We assume that the ratio of short-to-long-term securities at par value is the same as their market value.
- In other cases, we assume that in Russia the shares of short- and long-term debt securities (loans) or listed shares in the total amount of debt securities (loans) or equity, respectively, coincide with the median shares in the sample of foreign countries.

We will not take absolute values of financial assets and liabilities, the information will be presented either as a share of GDP or as a share of the total value of sector assets. The line for GDP at current prices is obtained from the OECD database (OECD.Stat).[19]

4. Empirical analysis of the liquidity of financial assets and liabilities for various structures of the financial system

In this section, we illustrate the concepts presented in the literature review.

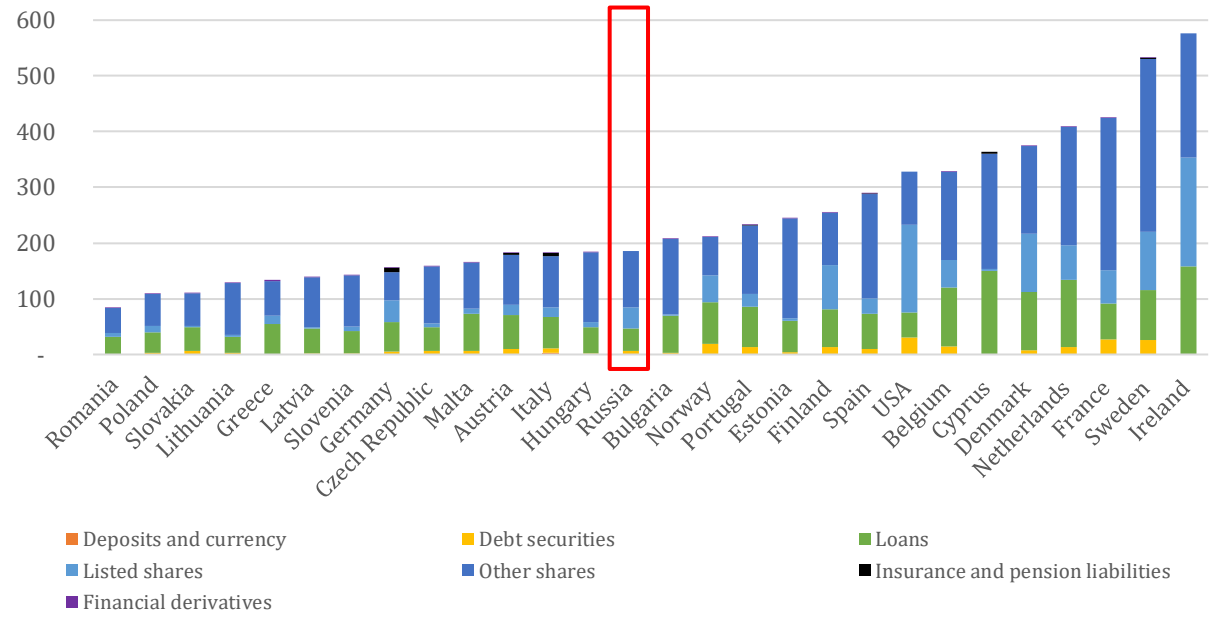
- First, we consider the structure of liabilities of non-financial corporations, which allows us to assess what type of financial system different countries have.
- Second, we demonstrate the concept of market liquidity, taking into account its various aspects, by the example of the stock and government bond markets. We demonstrate that the market for a given instrument in one country may differ from a similar market in another country.
- Third, we show the application of the liquidity mismatch concept. In particular, we compare the values of the liquidity indices of economic sectors across countries with financial systems of different structures. We justify the selection of liquidity weights for calculating the liquidity index and consider how liquidity accounting may affect the liabilities of non-financial corporations. This allows us to move on to analysing the values of the liquidity indices of economic sectors. We consistently analyse the values of liquidity indices for non-financial and financial corporations, households and NPISHs, the government and the rest of the world.

[19] OECD.Stat: https://stats.oecd.org/.

4.1 Structure of liabilities of non-financial corporations

Fig. 2 shows the structure of liabilities of non-financial corporations (% of GDP) for 28 countries. On average, in the countries of Eastern and Southern Europe, the liabilities of non-financial corporations account for a smaller share of GDP than in the countries of Western and Northern Europe. In Russia, the liabilities of non-financial corporations account for 185% of GDP, making Russia the median country in the sample.

*Fig. 2. Liabilities of **non-financial corporations**, 2019 (% of GDP)*



Source: compiled by the authors based on financial accounts.

Generally, liabilities are divided into loans (F4) and equity (F5). Loans account for 14% to 42% of all liabilities of non-financial corporations. Cyprus, Greece and Malta have the highest shares of loans in liabilities (40–41%). The smallest share is observed in the United States (14%), where most of the liabilities are listed shares.

Equity (F5) account for 55 to 77% of liabilities of non-financial corporations. At the same time, shares traded on the stock exchange (F511) make up 1 to 48% of liabilities (Table 1). The minimum percentage of listed shares in liabilities are observed in Bulgaria, Latvia, Cyprus (1% each), Slovakia and Estonia (2% each). The USA has the maximum percentage of listed shares in liabilities (48%) followed by Ireland (34%) and Finland (31%).

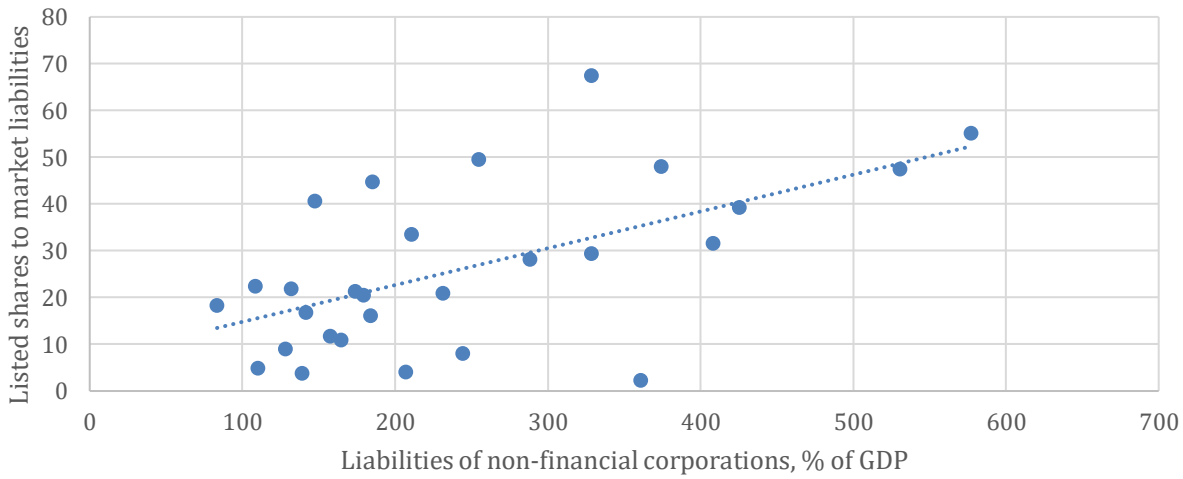
Table 1. Percentage of listed shares in the liabilities of non-financial corporations (%)

Country	Percentage (%)	Part of Europe		Country	Percentage (%)	Part of Europe
USA	48			Spain	10	Southern
Ireland	34	Northern		Portugal	10	Southern
Finland	31	Northern		Italy	10	Southern
Denmark	28	Northern		Romania	8	Eastern
Germany	25	Western		Slovenia	6	Southern
Norway	22	Northern		Malta	5	Southern
Russia	20			Hungary	5	Eastern
Sweden	20	Northern		Czech Republic	4	Eastern
Belgium	15	Western		Lithuania	3	Eastern
Netherlands	15	Western		Slovakia	2	Eastern
France	14	Western		Estonia	2	Eastern
Greece	11	Southern		Bulgaria	1	Eastern
Poland	11	Eastern		Latvia	1	Eastern
Austria	10	Western		Cyprus	1	Southern

Source: compiled by the authors.

In Fig. 2 and Fig. 3, we see that the variation in the component of listed shares is higher than the variation in the component of debt instruments, it is this that provides higher indicators of the size of the balance sheet of non-financial corporations. This may serve as an illustration of the point of view that, if a corporation needs to expand its funding above a certain level, it is more likely to turn to the stock market. However, we cannot assert the existence of a causal relationship and will leave this issue outside the scope of our research.

Fig. 3. Percentage of listed shares and liabilities of non-financial corporations, 2019 (% of GDP)



Source: compiled by the authors.

Note: The percentage of listed shares is considered to be the ratio of the volume of listed shares to the sum of the volumes of listed shares, debt securities and loans.

The percentage of listed shares in the company's liabilities allows us to draw conclusions about the structure of the financial system of each country[20]. According to this indicator, the USA belongs to countries with market-based financing, while among other European countries bank-based financing is more common. At the same time, Ireland, Finland, Denmark, Germany,[21] Norway, Sweden, Belgium, the Netherlands and France, despite the fact that they are countries in which bank-based financing prevails, have a relatively high percentage of listed shares in the liabilities of non-financial corporations (from 14 to 34% of liabilities). Moreover, these countries belong to Northern and Western Europe (according to the classification of the UN Statistics Division[22]). Other countries from our sample have a percentage of listed shares in liabilities ranging from 1 to 11% – that is, these are countries with the least market-based financing. These include the countries of Southern and Eastern Europe, with the exception of Austria, which belongs to Western Europe, and Lithuania, Latvia and Estonia, which may refer to both Eastern and Northern Europe.[23] [24]

Next, we consider the weighing of liquidity liabilities. However, we understand that the markets for the same financial instrument may differ across countries. Therefore, before determining the weights, it was decided to analyse the market liquidity of financial instruments in different countries.

4.2 Market liquidity of financial instruments in different countries

In this section, we examine the liquidity of stocks and government bonds to determine the maturity of these markets in different countries. The choice of financial instruments depends on the availability of data and the promptness of their receipt. Ten countries were selected for the analysis with different structures of the financial system. These are the USA as a country with market-based financing, Germany, Ireland, Finland, Denmark, Sweden as countries in which bank-based financing prevails with a developed capital market, Bulgaria, Slovakia, Hungary as credit-based countries with the least developed capital market. Russia is also included in the sample.

For stocks, 4 indicators were calculated, such as the bid-ask spread, the turnover rate, Hui-Heubel Liquidity Ratio (LR) and market-efficiency coefficient (MEC). For government bonds, the bid-ask spread and MEC were calculated.

[20] In the literature, the ratio of the market capitalisation of companies to GDP (Bats & Houben, 2017) or the ratio of market capitalisation to the volume of bank loans is used as an indicator of the financial system's structure (Levine, 2002; Allen, et al., 2018). (Unger, 2018) uses the ratio of market capitalisation of non-financial corporations to GDP, thereby excluding financial sector indicators. We go further and suggest looking at the ratio of market capitalisation to the liabilities of non-financial corporations to exclude the influence of the size of the non-financial corporate sector on the financial structure indicator.

[21] (Unger, 2018) also noted that although the German financial system is usually perceived as a classic example of a bank-based system other financing sources account for a large share in the liabilities of non-financial corporations.

[22] Standard country or area codes for statistical use (M49), Geographic Regions: https://unstats.un.org/unsd/methodology/m49/.

[23] The UN Statistics Division classifies these countries as Northern Europe, and the CIA's World Factbook classifies them as Eastern Europe (for details, see https://www.cia.gov/the-world-factbook/).

[24] As we can see, sorting countries by share of listed shares and sorting by geography have some similarities, so in the future, we will appeal to geography features to shortly describe a set of countries with similar financial system characteristics.

4.2.1 Stock markets

Appendix 3 provides the indicators of stock market liquidity for 10 countries: Russia, USA, Germany, Bulgaria, Hungary, Denmark, Ireland, Slovakia, Finland and Sweden. The liquidity indicator for a specific year for a certain country is the average daily values of the indicator for the shares of companies included in the country stock exchange index (for example, for Russia, for companies included in the Moscow Exchange index as of the end of 2020). Colour scales make it possible to visually correlate numerical values with each other, and one scale is created for each individual indicator and is common for all countries.

Russia's data show that the *bid-ask spread* has been declining since 2015, although in 2020 it turns out to be slightly higher than in 2019. A decrease in the spread indicates an increase in the liquidity of Russian stocks. At the same time, the spread values turn out to be higher than in the USA, Germany and Sweden but lower than in other countries covered (Bulgaria, Hungary, Denmark, Ireland, Slovakia and Finland).

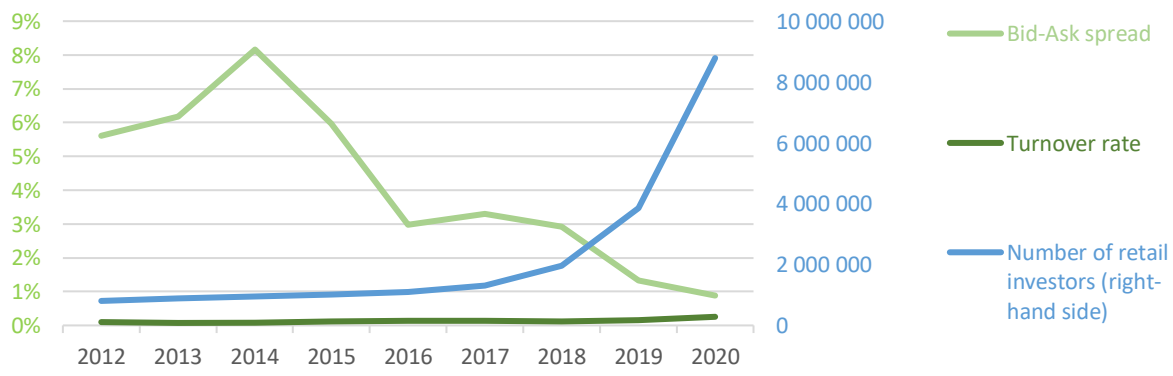
Turnover rate for Russia hovered around 0.0014 in 2016–2019 and increased to 0.0032 in 2020. An increase in the turnover means that ever-higher volumes are traded over a longer period of time. Asset turnover in Russia is lower than in the USA, Germany, Denmark and Sweden (countries with deeper markets) but higher than in Ireland, Finland, Bulgaria and Slovakia.

The *Hui-Huebel LR* in Russia indicates that in the period from 2015 through 2019 the market liquidity (its breadth) was growing (i.e., the influence of trading in large volumes on asset prices decreases). In terms of Hui-Huebel LR, the markets of the USA, Germany, Denmark and Sweden are more liquid than the Russian market.

The Russian *MEC* (resilience indicator) ranged from 70 to 74% in 2012–2018 and reached 76% and 78% in 2019 and 2020, respectively. This suggests that despite a slight increase in transaction costs in 2020 versus 2019 the market is becoming more resilient – that is, the variance of short-term fluctuations is close to the variance of long-term fluctuations. In terms of resilience, our indicators are close to those of the USA, Denmark, Sweden and Germany.

Thus, the Russian stock market turns out to be less liquid than those of the countries of North-Western Europe and the United States but more liquid and resilient than those of the countries of Eastern Europe. For all Russian liquidity indicators in the period from 2012 through 2020, there is an increase in liquidity; however, in recent years, it is largely due to the massive influx of retail investors (Fig. 4).

Fig. 4. Russian stock market liquidity and the number of retail investors



Sources: Moscow Exchange, author calculations.

The comparison of the USA and Germany shows that the lowest transaction costs are observed in the USA (in terms of the bid-ask spread). However, in terms of market breadth and depth (turnover rate and Hui-Huebel LR), the German market turns out to be more liquid than the US market[25]. The resilience of the two markets is at a high level (on average 72% for the USA and 75% for Germany).

The analysis of other countries reveals that Slovakia, as the country with the least market financing, has the least liquid stock market, on the one hand, but, on the other hand, the liquidity indicators are the most volatile.

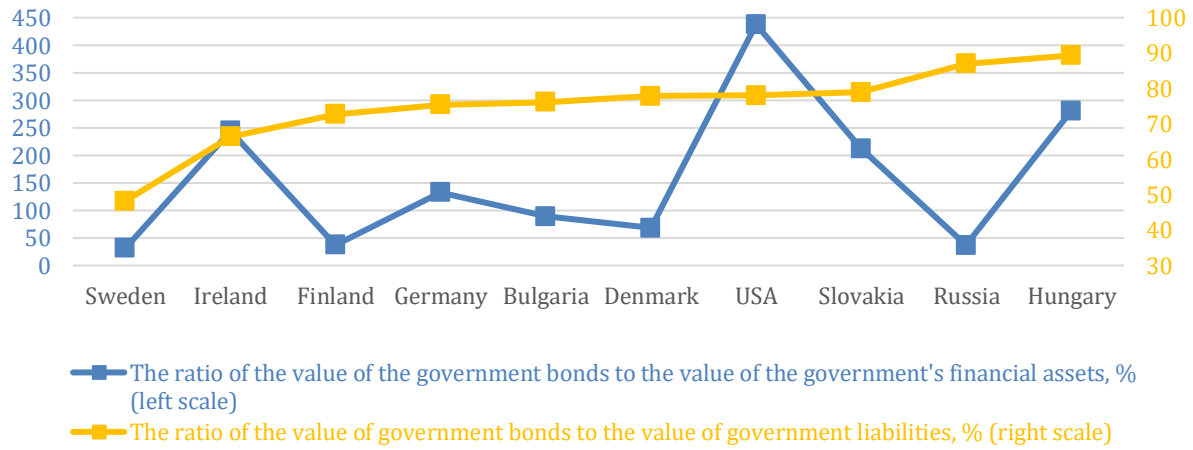
4.2.2 Government bond market

Appendix 4 shows liquidity indicators for government bonds of different countries (these are also daily average values of the indicators). For Russia, in addition to the bid-ask spread and MEC indicators, the turnover rate and Hui-Heubel LR indicators were established.

Government bonds constitute a large part of government liabilities: in Russia and Hungary, the share of bonds in government liabilities reaches 87% and 89%, respectively, and for the ten countries, the number amounts on average to 75%, while the minimum level is observed in Sweden (48%) (Fig. 5).

Countries also differ by the ratio of the size of government bonds to the total financial assets of the government. This ratio makes it possible to assess how large the liabilities are (in the form of government bonds) compared to assets. The lowest indicators are achieved for Sweden (31%), Finland and Russia (37% each), the largest shares of bonds in assets are observed in the USA (438%), Hungary (281%) and Ireland (244%).

Fig. 5. The ratio of government bonds to assets and liabilities, 2019



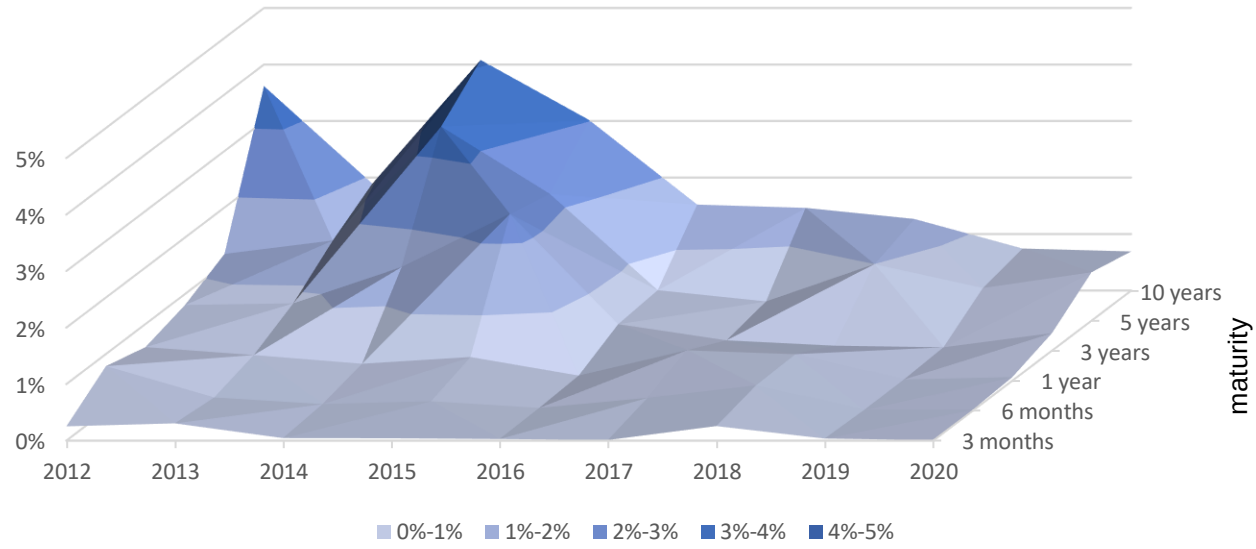
Source: compiled by the authors based on the financial accounts from the government.

The *bid-ask spread* data for Russia are presented graphically in Fig. 6. The lowest values of transaction costs (in terms of the bid-ask spread) were observed in 2013 when access to the Russian government bonds (OFZ) was liberalised for non-residents (due to

[25] When analysing the liquidity indicators, it should be borne in mind that in 2020 the German stock index included 30 companies, and the American S&P500 index comprised 505 companies. Therefore, the conclusions drawn for the companies included in the country stock exchange index must be interpreted with caution regarding the country as a whole.

the opening of nominee accounts (with the central depository) for foreign clearance and settlement) (Mau, et al., 2018). The highest values of the bid-ask spread were observed in 2014, which was the result of increased volatility in the domestic financial market and the introduction of international sanctions. In 2015, the government securities market was becoming more liquid despite the expected downgrade of the Russian sovereign rating aided by a new type of OFZ issue (inflation-indexed OFZ-IN and OFZ-PK (linked to the RUONIA)). There were local highs in bid-ask spreads in 2018, which might be due to fears among non-residents about new sanctions, which never materialised (Mau, et al., 2018). In 2020, despite fears of non-resident withdrawal from OFZ and capital outflows from emerging markets due to the COVID-19 pandemic, liquidity performance across the curve remained better than in 2012–2018. We also see a natural increase in transaction costs with increasing duration – that is, a decrease in liquidity for the 'longer' securities.

Fig. 6. Russia: bid-ask spread on government bonds



Source: Our own calculations based on Moscow Exchange data.

The bid-ask spread in the other countries under consideration (Appendix 4) is on average lower than in Russia (Bulgaria is the country that demonstrates a value for this indicator closest to that of Russia). The lowest bid-ask spreads are in Germany and in the US indicating that these countries' government bonds have the greatest liquidity.

For Russia, we were also able to calculate the turnover rate and Hui-Heubel LR. The turnover rate of government bonds does not change much over time and averages 0.01 with the turnover rate expected to decrease with increasing duration. The highest turnover rate was in 2014 and 2020 for bonds with a duration of up to 3 months (0.07 and 0.05, respectively). In terms of Hui-Heubel LR, Russian government bonds were the least liquid in 2014 (value of 1,794) and the most liquid – in 2017 and 2019 (134 and 57, respectively). As duration increases, there is an increase in the Hui-Heubel LR indicator value.

The Russian market-efficiency coefficient averages 59% for Russian government securities, while the average yearly MEC was 48% in 2012 and 66% in 2020. On average, Russia has one of the lowest MEC values over the period of 2012–2020 (only Bulgaria and Slovakia are lower with 51%); in other countries, it ranges from 66% in Germany and in the USA to 88% in Hungary. As duration increases, the MEC rises, indicating greater integrity of long-term government bonds.

Thus, Russian government bonds prove to be the least liquid among European countries and the US in various respects, but Russian securities have seen an increase in liquidity over the last eight years.

A study of stock and government bond market liquidity has assessed how markets for the same financial instrument differ between countries while demonstrating their varying degrees of development.

The next section of our paper focuses on the creation of economic sector liquidity indices. Although we recognise that markets for instruments differ between countries, we assume that the liquidity ratios of financial instruments will be the same in each country as we will be interested in an international comparison of asset and liability structures.

4.3 Principle of creating the liquidity index

We propose to estimate the amounts of financial assets and liabilities taking into account the liquidity of the financial instruments. The concept of the liquidity mismatch will be useful for this. As was mentioned above, (Berger & Bouwman, 2009), (Brunnermeier, et al., 2013), (Krishnamurthy, et al., 2016), (BIS, 2014) propose that rather than considering the simple sum of financial assets and liabilities, their weighted sum be considered, where the degree of liquidity of the financial instrument is used as the weight:

$$Liquidity\ index = \sum \alpha * financial\ asset_i - \sum \beta * libility_j$$

where α, $\beta > 0$ are weights for financial assets and liabilities, respectively.

In this section, we will discuss the selection of the weights for calculating the weighted indicators. This discussion will be based on the NSFR methodology for calculating net stable funding ratio (BIS, 2014), the liquidity mismatch index (Brunnermeier, et al., 2013; Krishnamurthy, et al., 2016) and the concept of market liquidity aspects. Note the specific feature of our terminology: we can consider both the liquidity of a financial instrument and its stability referring to the NSFR approach. Stability in the understanding of the NSFR is interpreted as the least liquidity and instability – as full liquidity. The net stable funding ratio varies from 0 to 100, where 0 corresponds to the least stable instrument (i.e., the most liquid one) and 100, to the most stable instrument (the least liquid one).

We have created a liquidity scale from 0 to 1, where 0 corresponds to a completely non-liquid instrument, and 1, to a fully liquid instrument (in particular, cash). Tables 2 and 3 show the selection of weights for each financial instrument[26]. The economic interpretation of this weight selection will be described below.

Monetary gold (F11) is an asset for the Central Bank only. According to the NSFR, (BIS, 2014)monetary gold is regarded as one of the most stable financial instruments, so we have assigned a liquidity weight of 0.3 to this instrument.

Special Drawing Rights (SDR, F12) are only used by the Central Bank, which is part of the banking system. SDRs were created as an additional international reserve asset and are intended to provide additional liquidity. SDRs represent a guaranteed and unconditional right of the holder to receive other reserve assets. We, therefore, consider the SDR to be a fully liquid financial instrument (weight 1).

[26] Our empirical research is conducted for 2019, so we select static liquidity weights of financial instruments. Generally speaking, the liquidity of the instrument can change over time, so, at the peak of the crisis of 2007-2008, some instruments lost their liquidity (in particular, subprime mortgages). The change in the liquidity weight over time is implemented in the work (Krishnamurthy, et al., 2016).

Currency (F21) is recognised as the most liquid (weight 1). Note that cash acts as a liability only for the Central Bank.

Weights for the following financial instruments will be considered separately for assets and for liabilities. Let us consider financial instruments on the ***asset*** side, in other words, from the point of view of the financial instrument holders (***investors***).

Deposits (F22–29) are assigned the weight of 0.9. On the one hand, deposits can be withdrawn at any time (indicating a high level of liquidity). On the other hand, withdrawal may involve the risk of losing accumulated interest, and, in addition, in the event of bankruptcy of the bank, the holder may not receive the whole amount, but only the government-insured part of it. As a result, we cannot speak of the absolute liquidity of deposits.

Debt securities (F3) are proposed to be categorised as government securities and other securities. We assume that *government debt securities* are more liquid due to their higher reliability and lower risk, so we assign them the same weight as deposits –that is, 0.9.[27] We assign a lower weight of 0.7 to *non-government debt securities* (other debt securities).[28]

Loans (F4) are proposed to be split into short-term (F41) and long-term (F42), and loans to financial corporations are singled out separately as part of long-term credits. Following the NSFR methodology (BIS, 2014), we assign a weight of 0.5 to all *short-term loans*. We assume that *long-term loans* are a less liquid asset than short-term loans as their repayment schedules differ. So, we assign a lower weight of 0.4 to long-term loans. NSFR defines *loans to financial corporations* as the most stable (least liquid) compared to other loans, so loans to financial corporations receive a minimum weight of 0.2.

Equity and investment fund shares (F5) should be divided into listed shares (F511) and other shares. We assign the weight of 0.6 to *listed shares* as we assume that equities are more liquid than short-term loans because they can be sold on the stock market, but less liquid than debt securities as the average variation in bond price is lower than that of listed shares – that is, we assume that a debt security is more likely to be sold at the expected price.

Unlisted shares are assigned 0 weight, which means that the asset is completely non-liquid. The issuer is not obliged to buy back its own shares, so the cash received from the issue of the share remains with the issuer forever, and the holder of the share is unable to convert it into cash promptly.

Insurance, pension and standardised guarantee schemes (F6) receive the weight of 0, as we assume that the conditions for receiving benefits are so specific that these assets are completely non-liquid.

When estimating weights for ***financial derivatives*** (F7), we refer to the NSFR methodology (BIS, 2014). NSFR proposes to calculate (derivatives receivable) – (derivatives payable). If the amount is positive (receivable is greater than payable), NSFR assign the weight of 100% (i.e., it is a stable asset [non-liquid]), if the amount is negative (receivable is less than payable), NSFR assign the weight of 0% (i.e., it is an unstable

[27] NSFR assigns stability weights of 5 and 15 out of 100 to debt securities according to the Basel II Standardised Approach for credit risk. We have calculated the arithmetic mean of these weights (10) and obtained the weight of interest for us ((100 – 10) / 100 = 0.9).

[28] NSFR assigns debt securities a weight of 15 and 50 depending on their quality (rating). We have rounded the average of these weights to 30 and obtained the liquidity weight of 0.7 (= (100 – 30) / 100).

liability [liquid]). For simplicity, we assign 0 weight to derivatives if they are registered as assets and the weight of 1 if they are registered as liabilities.

Table 2. Weights for calculating the liquidity index: assets

Instrument		Counterparty (issuer)	Weight: 0 – non-liquid, 1 – liquid
F1	F11.Monetary gold		0.3
	F12. SDR		1
F2	F21. Currency		1
	F22–29. Deposits		0.9
F3	F31. Short-term debt securities	Government	0.9
		Other debt securities	0.7
	F32. Long-term debt securities	Government	0.9
		Other debt securities	0.7
F4	F41. Short-term loans		0.5
	F42. Long-term loans	Financial corporations	0.2
		Other	0.4
F5	F511. Listed shares		0.6
	Other		0
F6. Insurance, pension and standardised guarantee schemes			0
F7. Derivatives			0

Source: compiled by the authors.

Let us consider financial instruments on the ***liability*** side, in other words, from the ***issuer*** point of view.

Deposits (F22-29) are liabilities only for the banking system and the government. We assume that deposits are fairly stable liabilities. Meanwhile, household deposits are the least liquid (weight of 0.5), deposits from non-financial companies, the government and the rest of the world have the same weight as short-term loans (0.7), and deposits of financial corporations are the most liquid (0.9).[29]

Debt securities (F3) are proposed to be divided into short-term (F31) and long-term (F32). Short-term securities receive a higher liquidity weight than long-term securities: 0.5 for *short-term* securities and 0.3 for *long-term* securities because the probability that the full value of a short-term security is paid in the short term is higher than that for long-term securities.

Loans (F4) are also proposed to be divided into short-term (F41) and long-term (F42). Let us assume that short-term loans have a higher weight than long-term loans: 0.7 for *short-term* loans and 0.4 for *long-term* loans. The specific weights were chosen on the basis of the following considerations. First, the average weighting should be higher for loans than for debt securities (0.7 > 0.5 and 0.4 > 0.3) because each period interest is paid on the loan, and the principal is repaid, while only coupons are paid for debt securities – that is, all other things being equal, the debt servicing cost is higher for loans; therefore, a loan is more liquid than a debt security. Second, we assume that a long-term loan is less liquid than a short-term bond (0.4 < 0.5) because the short-term bond pays both coupons and the original

[29] The liquidity ratio of deposits was determined in accordance with the methodology for calculating the liquidity coverage ratio (БМР, 2009).

cost of the bond, while the long-term loan only pays interest – that is, the debt servicing cost for the loan is lower.

Equity and investment fund shares (F5) are assigned 0 weight as the shares issued do not impose an obligation on their issuers to repurchase their shares making them a completely non-liquid liability.

Insurance, pension and standardised guarantee schemes (F6) are represented by only one sector – Insurance corporations and pension funds. This type of liability has sale limitations for its holders, so we assign 0 weight to insurance and pension liabilities (as a completely non-liquid financial instrument).

It is important to note that when we consider assets, we assign weights regardless of who holds those assets, in particular, for example, we assume that government bonds are equally liquid for both non-financial institutions and banks. Similarly, when we look at liabilities, it does not matter who the issuer of these liabilities is; for example, the shares issued will be equally non-liquid for both non-financial institutions and banks.

Table 3. Weights for calculating the liquidity index: liabilities

Instrument		Counterparty (holder)	Weight: 0 – non-liquid, 1 – liquid
F1	F12. SDR		1
F2	F21. Currency		1
	F22–29. Deposits	Households	0.5
		Financial corporations	0.9
		Other	0.7
F3	F31. Short-term debt securities		0.5
	F32. Long-term debt securities		0.3
F4	F41. Short-term loans		0.7
	F42. Long-term loans		0.4
F5. Equity and investment fund shares			0
F6. Insurance, pension and standardised guarantee schemes			0
F7. Derivatives			1

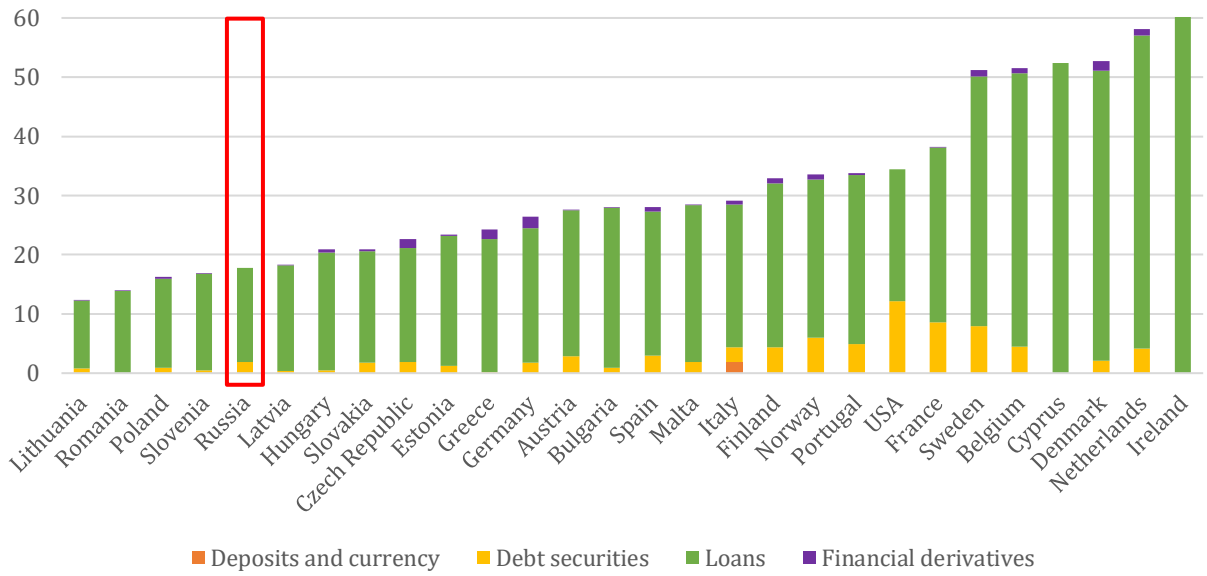
Source: compiled by the authors.

4.3.1 Liquidity index of non-financial corporations

Let us first consider Fig. 7, which shows the weighted liabilities of non-financial corporations. Liquid liabilities – that is, those that can be at least partially claimed by creditors in the short term, are mainly represented by loans.

Russia has relatively less liquid liabilities than other countries as it is the median country for the share of total liabilities in GDP. It is in the first quartile of the sample for the share of weighted liabilities in GDP.

*Fig. 7. Weighted liabilities of **non-financial corporations**, 2019, % of GDP*



Source: compiled by the authors.

Note: For Russia and the US, the 'Debt Securities' and 'Loans' blocks are unconsolidated (include weighted liabilities where non-financial corporations are the issuer and holder).

Let us consider now not only the liabilities of non-financial corporations but also their assets. The analysis of weighted assets and liabilities will make it possible for us to ***assess the liquidity index***. The liquidity index is the difference between the weighted assets and the weighted liabilities. The liquidity index thus provides information on how much liquid financial assets exceed liquid liabilities. The lower the value of the liquidity index, the more risk the sector takes on. By risk, we mean the liquidity mismatch risk – that is, the risk of losses caused by the mismatch between the maturity of assets and liabilities.

Fig. 8 shows the weighted assets and liabilities of non-financial corporations. Assets are shown in the positive area, liabilities are shown in the negative area and the liquidity index is also shown on the chart as a black dot.

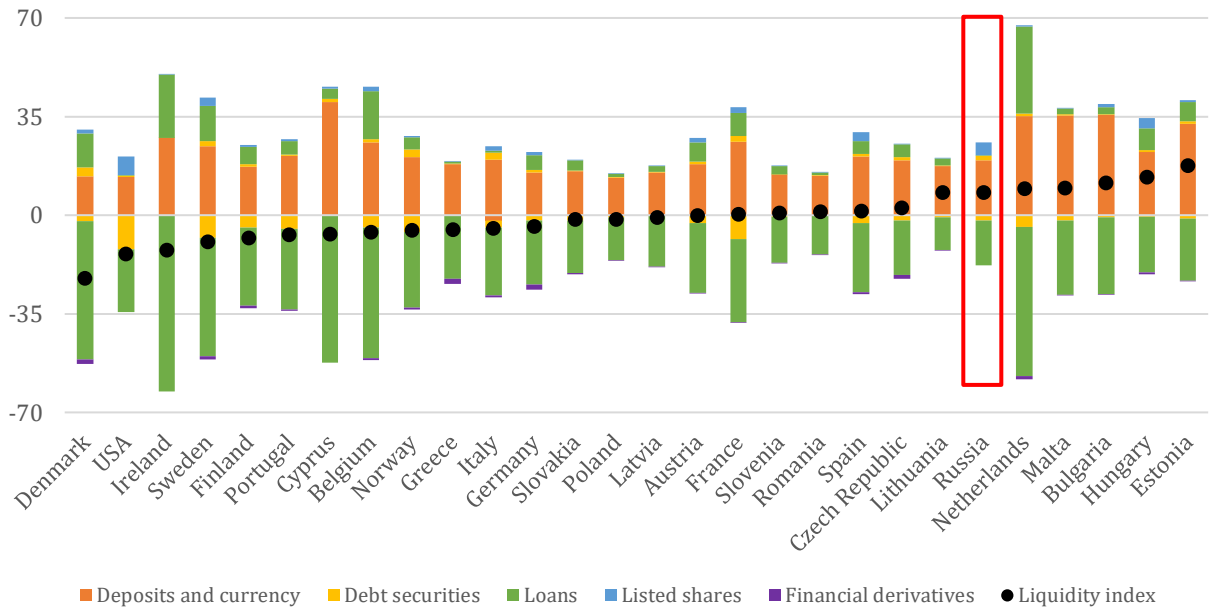
Companies' weighted assets are mainly represented by deposits[30] and loans to other sectors of the economy (usually, loans to non-resident companies[31]).

Liquidity index values range from -22% of GDP in Denmark to 18% of GDP in Estonia. In general, there is little variation in liquidity index values. It is likely that regardless of their financial structure, companies seek to balance the liquidity of their assets and liabilities.

[30] For the sake of brevity, here and below, deposits will refer to deposits and currency, which corresponds to the orange column in the charts of weighted assets and liabilities of the sector.

[31] Loans from non-financial institutions to non-residents probably reflect loans to foreign companies included in the same group of companies. In this case, it would be logical to exclude them from the analysis, just as we do not include all intra-sectoral operations. When we do this, we get lower liquidity index values, although the overall conclusions for non-financial corporations do not change.

Fig. 8. Weighted financial assets (+) and liabilities (-) of ***non-financial corporations****, 2019, % of GDP*

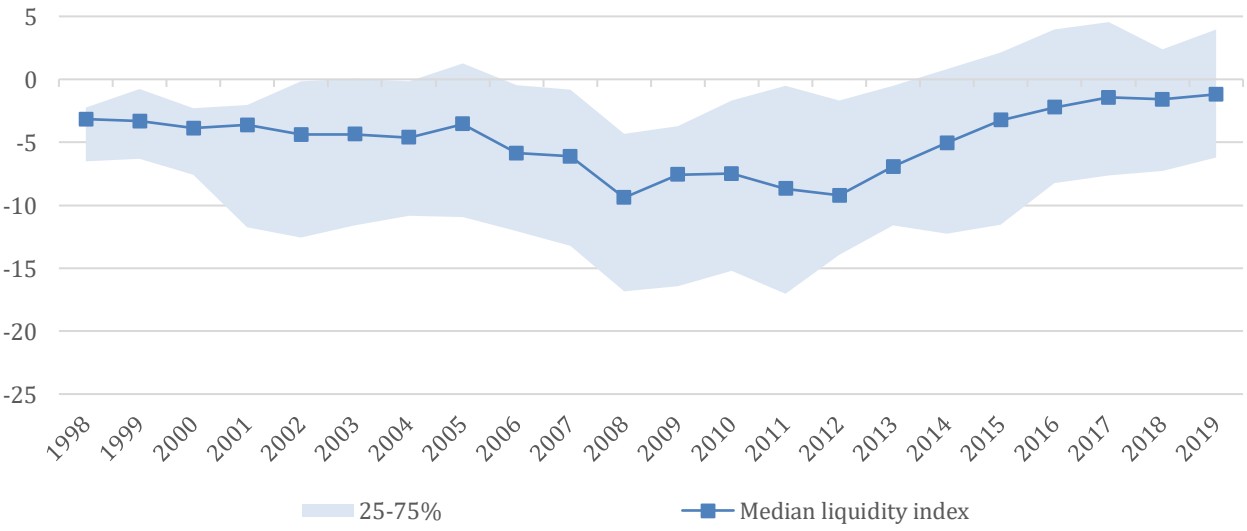


Source: compiled by the authors.

Note: For Russia and the US, the 'Debt Securities' and 'Loans' blocks are unconsolidated (include weighted assets and liabilities where non-financial corporations are the issuer and holder).

Fig. 9 shows the change in the liquidity index over time. Speaking of the level of the liquidity index value as the degree of acceptance of the liquidity risk, the dynamics of the accumulation of financial imbalances can be traced. Before 2008, the liquidity index values were declining. During the financial crisis, they reached a minimum, and since the crisis the liquidity index values have risen to safer levels.

Fig. 9. Change in the liquidity index values of non-financial corporations, % of GDP

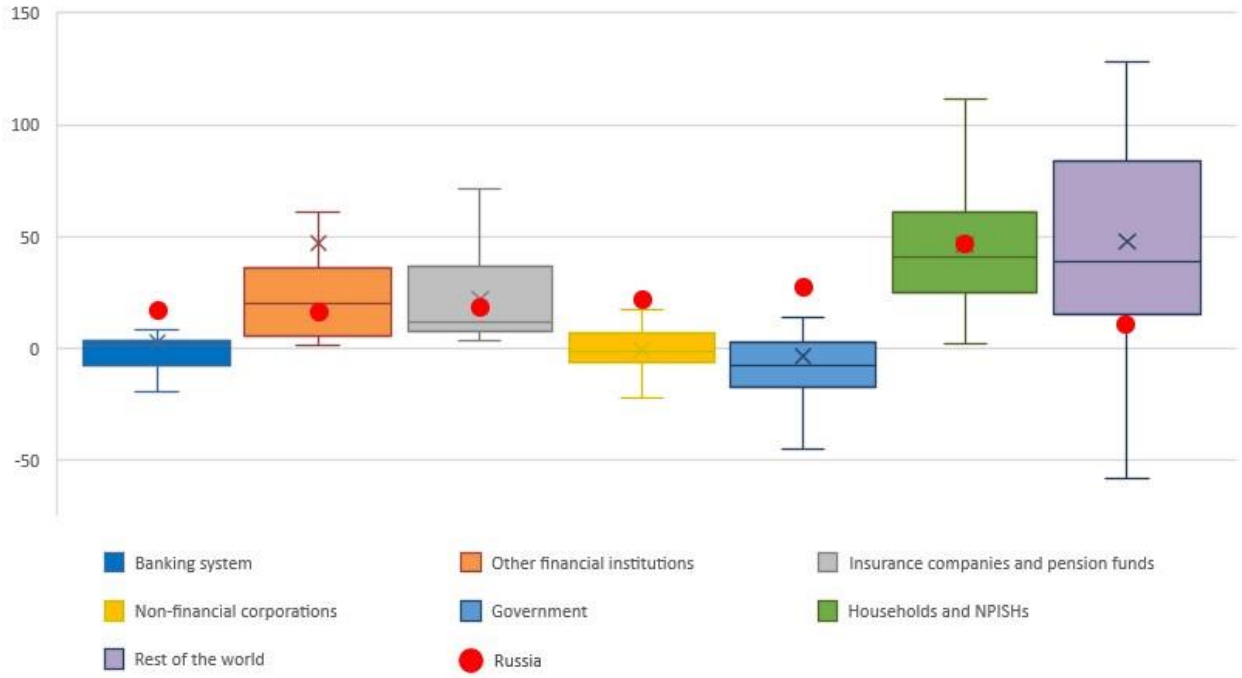


Source: compiled by the authors.

4.3.2 Liquidity indices for other sectors of the economy

We have considered the liquidity index values of non-financial corporations. Let us now look at the values of the liquidity indices for the other sectors of the economy. Fig. 10 shows the box plot[32] for the liquidity indices for the main sectors of the economy.

Fig. 10. Distribution of liquidity indices by sector, 2019, % of GDP



Source: compiled by the authors.

Fig. 10 shows[33] that the median value of the liquidity index of the banking system and non-financial corporations is around 0, and 'boxes' are skewed to the negative area. This suggests that the banking system and non-financial corporations are inclined to take on the liquidity mismatch risk. The government also most often takes on the liquidity mismatch risk – that is, this sector's liabilities are more liquid than its assets (in Fig. 10, the 'box' is almost entirely in the negative area). A high liquidity index value is observed for insurance corporations and pension funds as well as other financial institutions indicating a comparatively lower acceptance of liquidity risk. The greatest values of the liquidity index are recorded for households and the rest of the world sector. However, the rest of the world's liquidity index values vary more between countries than do the index values for any other sector of the economy.

Let us then look in more detail at each of the sectors: first, the financial corporations (banking system, other financial institutions, insurance companies and pension funds), then households and NPISHs, government and, finally, the rest of the world. Let us consider the

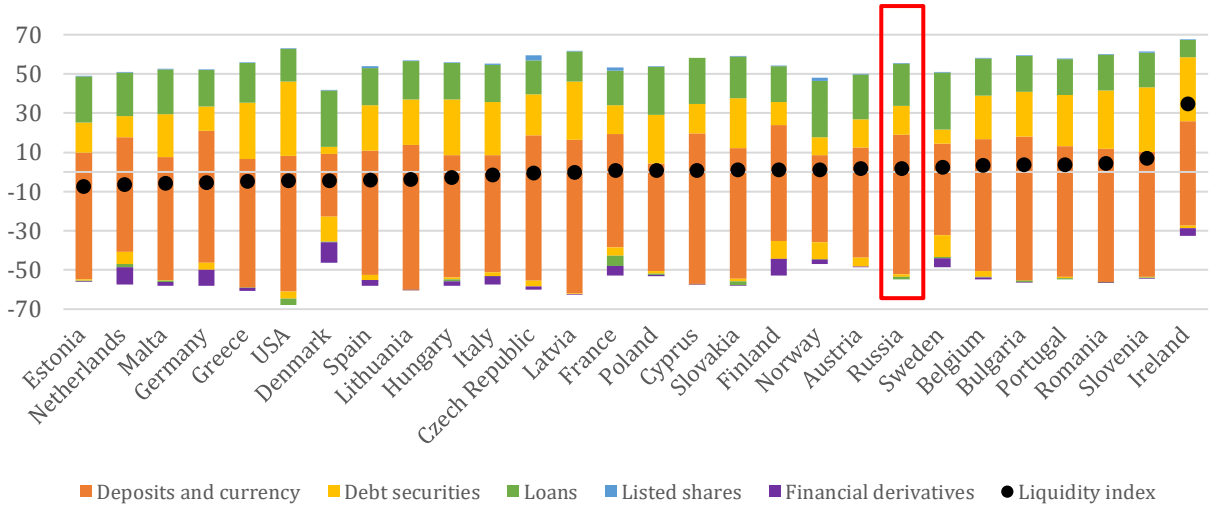
[32] The upper and lower sides of the 'boxes' represent the upper and lower quartiles of the sample; the horizontal line inside the box represents the median; the crosses represent the sample mean, and the 'whiskers' represent the maximums and minimums (not including outliers).

[33] It is important to note that in this case we observe some equilibrium values of liquidity indices. At the same time, we cannot judge the nature of this equilibrium, that is, whether this equilibrium is a solution to the optimisation problem of the sector without restrictions (acceptance by the sector of a certain business model) or a solution to the optimization problem in conditions of imperfect markets. We leave this question outside the scope of our study.

weighted assets and liabilities as a % of total financial assets of the sector. Changing the dimensions will allow us to reflect the differences between countries on the graphs when the assets and liabilities as a % of GDP of one country are several times higher than those of another country[34].

The banking sector liquidity index (Fig. 11) is around 0 in all countries, except Ireland. This is due to the fact that the banking sector is subject to strict regulatory liquidity requirements. Therefore, the extent to which the banking system accepts liquidity risks does not depend on the financial system type in the country.

*Fig. 11. Weighted financial assets (+) and liabilities (-) of the **banking system**, 2019, % of sector assets*



Source: compiled by the authors.

Ireland stands out in terms of its banking system liquidity index. On the one hand, foreign illiquid capital (equities) plays a significant role in the liabilities of Irish banks, whereas more liquid deposits dominate in other countries (see Fig. 1 in Appendix 5)[35]. On the other hand, foreign deposits and debt securities account for a relatively large amount of assets. These two facts result in the high value of the liquidity index in Ireland.

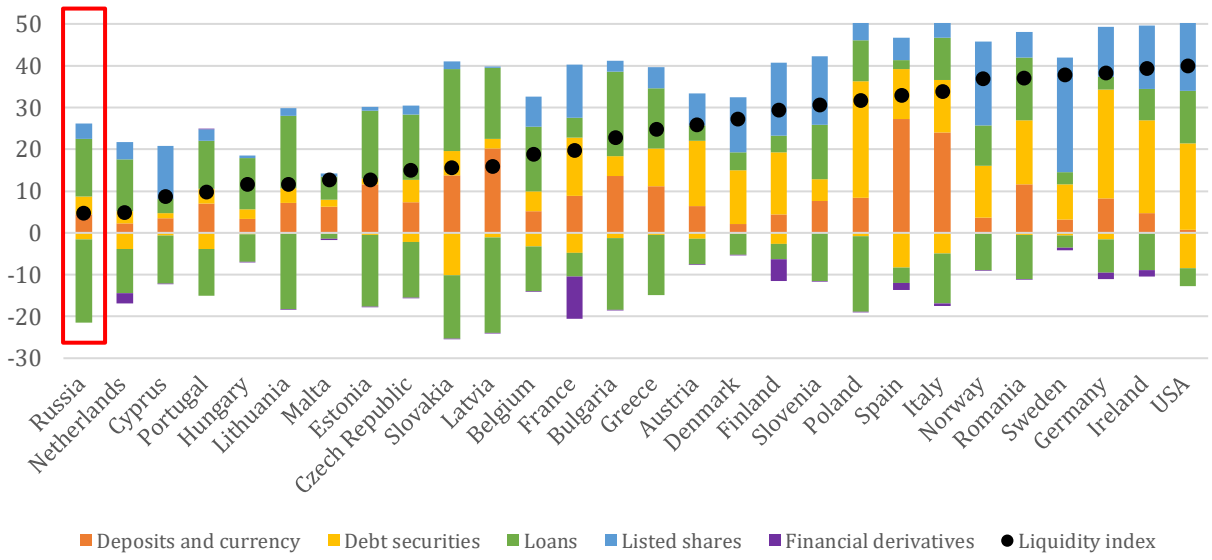
In terms of the liquidity index structure, Denmark stands out with a small share of deposits in the bank's liabilities[36], but given the small amount of bonds in the assets the liquidity index value is around zero. The low level of deposit investments in Denmark is due to the preference of households to invest in pension and insurance reserves.

Other financial institutions (excluding insurance companies and pension funds) have positive liquidity index values (Fig. 12). This is generally due to stable liabilities (in the form of equity and loans) and more liquid assets[37] (in the form of deposits, debt securities, listed shares) (Fig. 2 in Appendix 5). A positive liquidity index value indicates that other financial institutions do not take on liquidity risks. Moreover, sectors that make equity investments in other financial institutions, such as the household sector, take on liquidity

[34] We do not present a graph in % of the sector assets for non-financial corporations as the conclusions obtained do not differ in different dimensions.
[35] Deposits account for 39% of Irish banks' liabilities compared with the sample average of 74%.
[36] 30% of liabilities come from deposits, which is lower than in Ireland.
[37] Other financial institutions also have investments in illiquid equity in their assets, but the share of these investments in assets is much lower than the share of equity in the liabilities of other financial institutions.

risks. If we compare other financial institutions and the banking system, we can conclude that the former do not accept the liquidity risks of the financial system.

*Fig. 12. Weighted financial assets (+) and liabilities (-) of **other financial institutions**, 2019, % of sector assets*



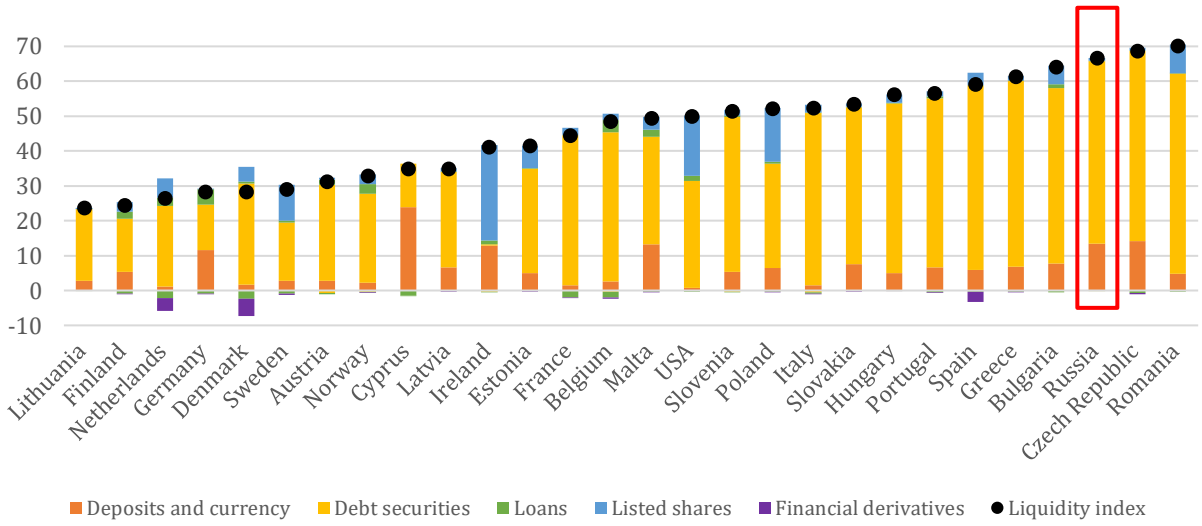
Source: compiled by the authors.

Note: For Russia and the US, the 'Debt Securities' and 'Loans' blocks are unconsolidated (include weighted assets and liabilities where other financial institutions are the issuer and holder).

Fig. 12 also shows that the structure of weighted assets and liabilities varies greatly between countries. The differences in asset and liability structures are due to the fact that other financial institutions include a broad list of companies: professional securities market participants (brokers, dealers, depositories and other participants), stock exchanges, microfinance organisations, pawnshops, credit consumer co-operatives, leasing and factoring companies and public financial corporations. The structure of financial instruments depends on which type of financial institution dominates the sector. It is beyond the scope of our study to assess the structure of the sector by country; however, at the end of 2020, liabilities of state financial corporations in Russia (VEB.RF, Deposit Insurance Agency, DOM.RF) totalled ₽7 trillion; investment funds, ₽5.2 trillion; leasing companies, ₽5 trillion; stock exchanges, ₽4 trillion; professional securities market participants, ₽1.5 trillion; microfinance organisations, ₽0.25 trillion. The total liabilities of other financial institutions amounted to ₽54.4 trillion at the end of 2020. Russian financial institutions have the lowest liquidity index due to the high share of loans in both assets and liabilities.

Insurance corporations and pension funds (Fig. 13) have the highest liquidity index values as a % of total sector assets. These companies have low-liquid liabilities and more liquid assets, which is why insurance corporations and pension funds have the potential to make long-term investments.

*Fig. 13. Weighted financial assets (+) and liabilities (-) of **insurance corporations and pension funds**, 2019, % of sector assets*

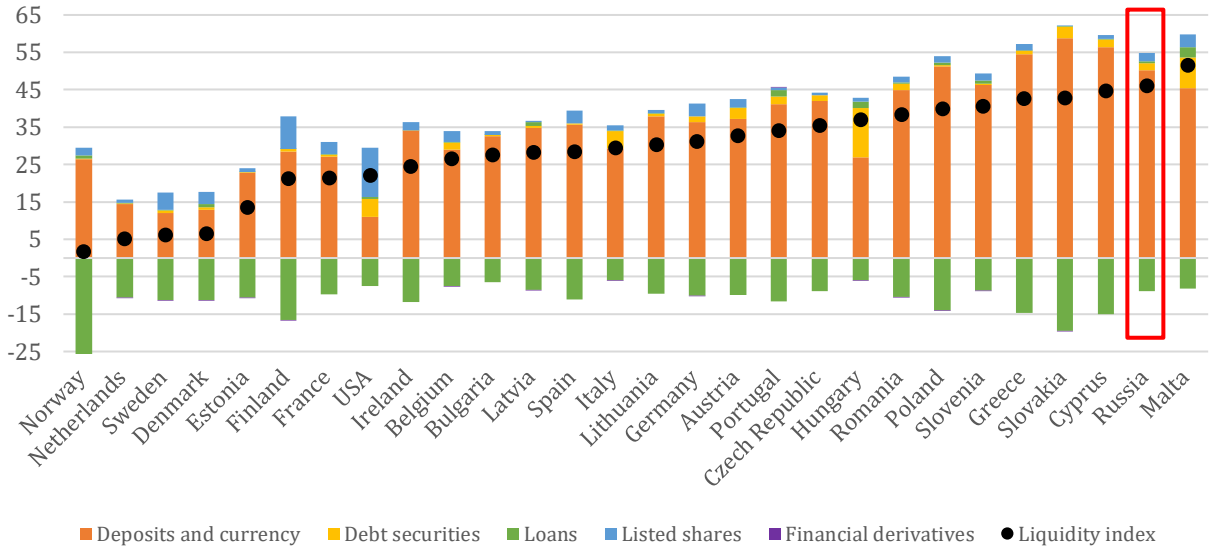


Source: compiled by the authors.

Most insurance corporations and pension funds invest in debt securities and, to a lesser extent, in deposits and equity. Cyprus, Ireland, the US and Poland stand out in terms of the structure of the liquidity index. In Cyprus, insurance corporations and pension funds prefer to invest in deposits; less, in debt securities. There are virtually no investments in debt securities in Ireland, but there are investments in foreign deposits and equities. The US and Poland stand out in terms of the share of investments in listed shares; their investment structure indicates that insurance and pension funds cover some of the liquidity risks of companies as companies have more opportunities to finance themselves with stocks rather than less stable sources of funding, such as loans and debt securities.

Households and NPISHs (Fig. 14) have positive liquidity indices, which is explained by liquid deposits in assets on the one hand and less liquid loans in liabilities on the other. Russia has one of the highest liquidity indices, which can be explained by the low indebtedness of the population compared to other countries and the high level of investment in deposits.

Fig. 14. Weighted financial assets (+) and liabilities (-) of ***households and NPISHs****, 2019, % of sector assets*



Source: compiled by the authors.

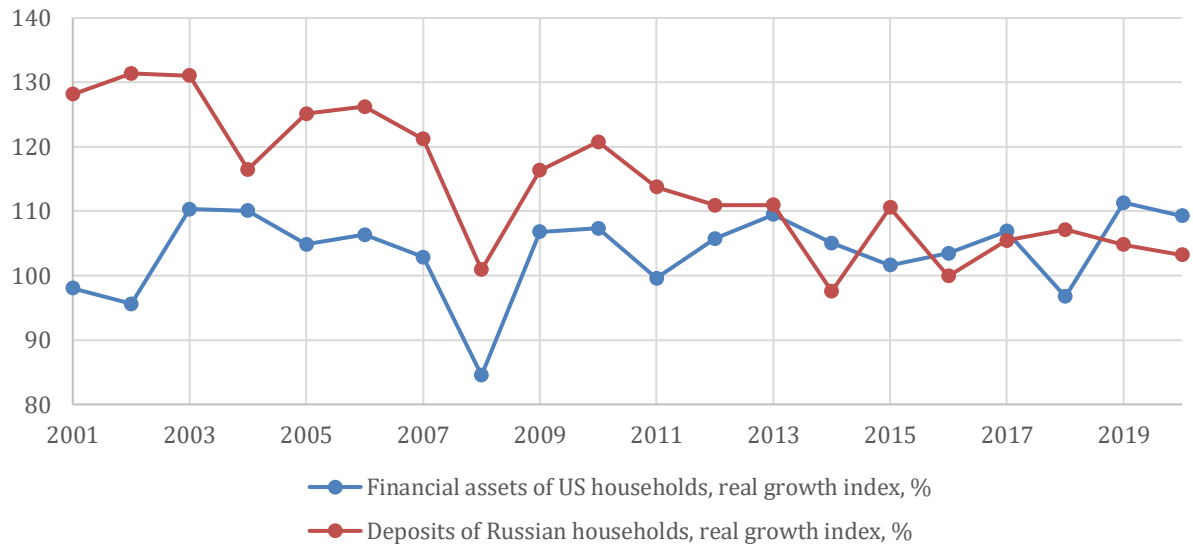
The lowest liquidity index values are recorded in Norway, the Netherlands, Sweden and Denmark. This is due to the fact that people in these countries prefer to invest in pension and insurance reserves, which are less liquid than deposits, debt securities and equities.

Speaking of different financial systems, we note the dilemma that the economy may face. On the one hand, the development of stock markets helps reduce liquidity risks for non-financial corporations as companies are able to finance themselves not only using less stable funding sources such as loans but also using more stable sources, such as listed shares and bonds. The transition to a capital market-oriented financial system is favourable for non-financial corporations. On the other hand, this transition may be less favourable for households. It is worth keeping an eye on who is taking on liquidity risks as financial markets develop. Other financial institutions (including insurance companies and pension funds) are expected to cover the risks. However, the liabilities of other financial institutions, consisting mainly of equity, pension and insurance contributions, are sufficiently stable not to expose other financial institutions to the liquidity risk. Liquidity risks are therefore passed on to the owners of the liabilities of the financial institutions – households. Although the liquidity index of the households is always positive with a high proportion of investments in equity, pension and insurance reserves, the index value is lower than in other cases – that is, liquidity risks begin to emerge.[38]

Let us illustrate the negative consequences of households' excessive acceptance of liquidity risks in Fig. 15. The figure shows the real growth index of the US household financial assets. For Russia, the ranks of the population's financial asset are not that long, so we are showing real growth index in household deposits (implying that deposits set the main momentum for financial assets).

[38] However, it should be understood that the greater risk of the instrument is reflected in its higher profitability. In this case, the development of the stock market allows market participants with long-term goals to invest in more highly profitable instruments, albeit taking on more liquidity risks. In this case, we are not trying to find out which financial structure is the best for the economy. For more information on the types of structure of the financial system and the role in the development of the economy, see the literature review (section 2.2).

Fig. 15. The real growth index of financial assets of the US and Russian households

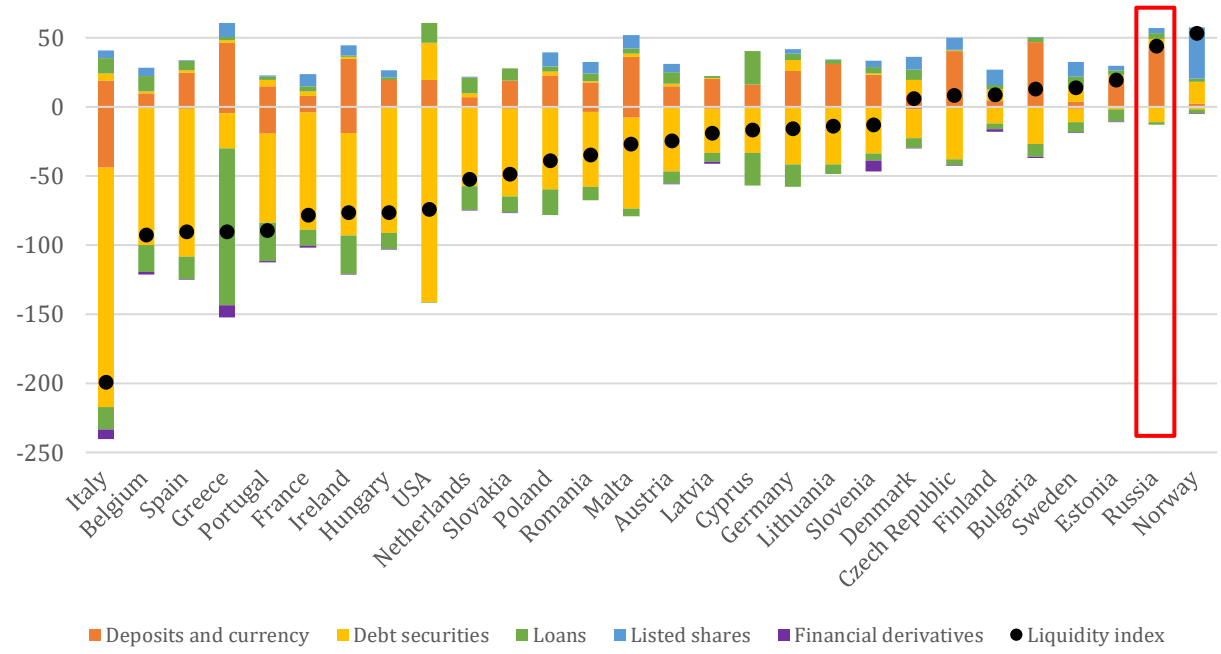


Sources: US Financial Accounts (Fed), Banking sector survey (Bank of Russia).

Fig. 15 shows that the US household financial assets fell by 15% in real terms in the crisis year of 2008, while the real level of deposits remained unchanged in Russia. This demonstrates the fact that as stock markets develop, the risks of liquidity mismatch for certain sectors of the economy, particularly households, increase. Monetary authorities should take this into account when developing stock markets.

The values for the ***government*** liquidity index are shown in Fig. 16 – most countries have a negative index value. On average, the government takes the risks of a liquidity mismatch between financial assets and liabilities. Acceptance of the risk may have a negative impact on the integrity of public finances. In the context of high volatility in government revenue flows, a small negative value in the liquidity index could add more risks for the public sector and the economy as a whole. Therefore, for countries whose public revenues depend on the export revenues of one or more important commodity (as do Russia and Norway), it is important to maintain a positive liquidity index.

*Fig. 16. Weighted financial assets (+) and liabilities (-) of the **government**, 2019, % of sector assets*

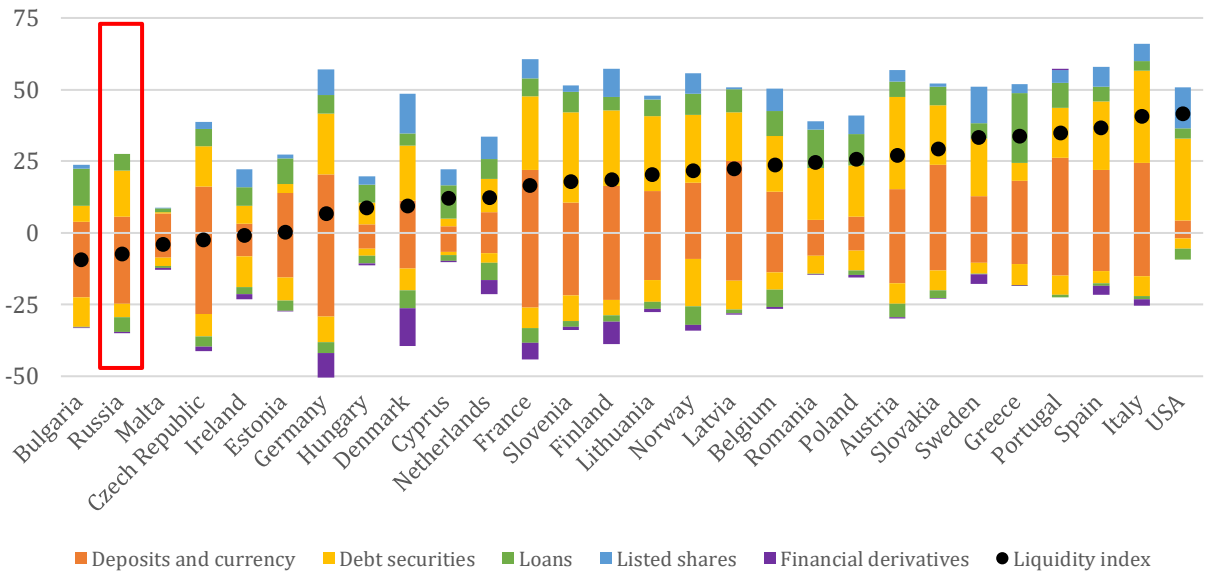


Source: compiled by the authors.

The largest negative value in the liquidity index is that of Italy. This is due to a significant surplus of liabilities over assets, the weighting of liabilities and assets has smoothed this surplus, but the absolute value of the index is still high compared to other countries.

Fig. 17 shows the liquidity-weighted assets and liabilities of the ***rest of the world***. For each individual country, the rest of the world represents a different set of countries with which the selected country interacts. A positive value of the rest of the world's liquidity index can be interpreted as the presence of liquid external debt of a country that is not covered by the liquid external assets of that country. The liquidity index is positive in most countries. In Russia, the liquidity index is slightly negative. To a certain degree, this suggests that the rest of the world is taking over some of the liquidity mismatch risks. It should be taken into account, however, that when financial assets and liabilities are denominated in foreign currencies, transactions with the external sector involve not only the liquidity risk but also the exchange rate risk. In this context, it may not be entirely correct to talk about the role of the external sector in the functioning of the domestic financial market on the basis of the liquidity index alone.

*Fig. 17. Weighted financial assets (+) and liabilities (-) of the **rest of the world**, 2019, % of sector assets*



Source: compiled by the authors.

5. Conclusion

We have reviewed and made cross-country comparisons of financial market liquidity indicators and the structure of financial assets and the liabilities of economic sectors in terms of their liquidity.

The liquidity of financial markets is presented in five dimensions: tightness, immediacy, depth, breadth and resilience. There is a set of indicators to measure each of these aspects. Financial instruments vary in their liquidity across countries. In terms of tightness, depth and breadth, the Russian equity market proved more liquid than Eastern European equity markets but less liquid than Northern and Western European markets and that of the US, while the Russian market is comparable to the US and North-West European markets in terms of resilience. At the same time, the liquidity of Russian government bonds is low relative to most European and US securities.

The liquidity mismatch concept and the liquidity index values make it possible to assess how the acceptance of liquidity risk varies across economic sectors. A negative liquidity index value is characteristic of the non-financial institution sector and, to a lesser extent, of the banking system. However, in countries where banks dominate financing, non-financial corporations nevertheless maintain the index at a high level by accumulating liquid assets.

The value of the liquidity index for the household sector varies considerably, depending on household participation in the stock market (including investments in pension funds and insurance corporations). If a country has a capital market-oriented financial system, the population of that country accepts more liquidity risk as the strong decline in real financial asset levels in the US compared to the unchanged level of household deposits in Russia demonstrated in 2008.

The move to a capital-market-oriented financial structure reduces the liquidity risks of non-financial corporations in terms of issuing liabilities, but it has implications for greater risk-taking by other economic sectors, in particular, households.

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Appendix

Appendix 1. Market liquidity measurement

This section is an overview of market liquidity indicators. In practice, the choice of which indicator to measure depends on the availability of data of the required frequency. It is often said that liquidity *indicators* are used when using intraday data, and liquidity *proxies* are used when using less frequent data.

There are 4 groups of indicators to measure liquidity characteristics:

- ***Indicators that measure transaction costs*** make it possible to assess market tightness. These indicators include price spreads. The most common is the bid-ask spread, which is mentioned in the main body of the paper. (Diaz & Escribano, 2020) also mention such transaction cost indicators as the effective spread (Lee, 1993), the realised spread (Hong & Warga, 2000), the value of the deviation of the maximum price from the minimum price (Imputed Roundtrip Cost (Dick-Nielsen, et al., 2012)) and the (Huang & Stoll, 1996) ratio. In addition, a number of papers present proxies[39] for measuring transaction costs: the Roll indicator[40] in (Roll, 1984), the LOT, Zero, Zero2 indicators[41] in (Lesmond, et al., 1999), Holden and Effective tick in (Goyenko, et al., 2009), Gibbs, High-Low ratio, FHT in (Schestag, et al., 2016).
- ***Volume-based indicators*** measure the breadth and depth of the market. (Sarr & Lybek, 2002) examine the relation of the price growth rate (|%ΔP|) to the number of assets traded (N) or the volume of transactions (V), the turnover rate and the Hui-Heubel Liquidity Ratio[42].

  Volume-based indicators can also include Range measure (Downing, et al., 2005), Martin index (Martin, 1975), Kyle's lambda (Kyle, 1985), traded volume of the asset (Kamara, 1994), market share of the asset (Diaz & Escribano, 2020), Amihud (Amihud, 2002) and Amivest (Cooper, et al., 1985) indicators and other turnover indicators (Florackis, et al., 2011).

- ***Price-based indicators*** make it possible to assess market resilience. These include the market-efficiency coefficient, which takes into account the ratio of the variance of long-term returns to the variance of short-term returns (Hasbrouck & Schwartz, 1988).

  Price-based indicators can also include the variance of returns (Houweling, et al., 2005), price variance (Jankowitsch, et al., 2011), inter-quartile price range indicator (Han & Zhou, 2008), Gamma indicator, which measures the covariance of price

[39] The abundance of different indicators is related to the specifics of the data we use, as was noted above. The emergence of new indicators, especially proxy indicators, is accompanied by a correlation analysis, where the correlation of the indicator with a more fundamental indicator, for which data are not always available, is examined.

[40] $Roll_i = 2\sqrt{-cov(\Delta p_t, \Delta p_{t-1})}$, where$\Delta p_t$ is the price change in day t.

[41] The idea behind the LOT, Zero, Zero2 indicators is based on the fact that if transaction costs are high, investors will tend not to trade the asset, which increases the probability of zero return on the asset per day. So, the indicators take into account the number of days with zero return.

[42] In particular, (Sarr & Lybek, 2002) analyse the price and volume performance of Nasdaq-listed stocks over the period 1996–2000. They note an increase in the absolute rate of price change (|%ΔP|) with a constant ratio of the growth rate to the number of shares traded (|%ΔP|/N) or the volume of transactions (|%ΔP|/V). The authors conclude that there is more market depth – that is, more transactions can be made with minimal effect on average prices. At the same time, there is an increase in the ratio of the growth rate to turnover rate (|%ΔP|/(V/K)). In the context of rising turnover rate (V/K), this signals a shrinking market breadth.

changes between transactions (Bao, et al., 2011), Lambda[43] (Hasbrouck, 2009) and the following proxies: dispersion of quotes (Garbade & Silber, 1976), latent liquidity ratio (Mahanti, et al., 2008), the indicators presented in (Marsh & Rock, 1986), (Pastor & Stambaugh, 2003), (Abdi & Ranaldo, 2017), (Broto & Lamas, 2020).

- Indicators that measure ***exposure to price changes*** related to changes in ***market liquidity***, excluding other effects (e.g., excluding information on the onset of a crisis that affects all assets at once). (Sarr & Lybek, 2002) include market-adjusted liquidity[44] in them.

(Diaz & Escribano, 2020) also distinguish a category of trade frequency indicators. These include the trading volume for a certain period, including per day (Fleming, 2003), the number of trades per day (Chordia, et al., 2001), the proportion of days when the instrument was not traded (relevant, for example, for bonds) (Dick-Nielsen, et al., 2012).

[43] The index is estimated by regressing the return on the asset by the square root of the volume of the asset taking into account the sign of the transaction: $r_t = \lambda * \sum_k sign(V_{t,k}) * \sqrt{V_{t,k}} + \varepsilon_t$, where $V_{t,k}$is the volume of the transaction k in period t.

[44] To calculate this indicator, it is first necessary to estimate the CAPM model and then regress the squares of the CAPM model residuals on the change in traded asset volumes. The lower the coefficient of the volume change indicator, the lower the impact of trading volumes on price dispersion, and the higher the liquidity of the asset.

Appendix 2. Bloomberg data

Table 1. Indicators for measuring the liquidity aspects of securities

Indicator	Variable name in the Bloomberg system
Closing price	PX_LAST
Bid price	PX_BID
Ask price	PX_ASK
Trading volume for the day	PX_VOLUME
Market capitalisation (for shares)	CUR_MKT_CAP
Duration (for bonds)	DUR_ADJ_OAS_BID

Source: Bloomberg.

Table 2. Market indices

Country	Market index
Russia	MOEX Russia Index
USA	S&P 500 (SPX)
Germany	DAX
Finland	HEX
Ireland	ISEQ
Hungary	BUX
Slovakia	SKSM
Bulgaria	SOFIX
Denmark	KFX
Sweden	OMX

Source: Bloomberg.

Appendix 3. Liquidity aspects of the stock market

Year	Number of fin. instruments	Number of observations	Bid-Ask spread	Turnover rate	Hui-Heubel	MEC
Russia						
2012	29	7373	0.00185	0.00222	30.2	72%
2013	31	7480	0.00169	0.00172	22.0	72%
2014	31	7740	0.00180	0.00247	18.8	74%
2015	33	8063	0.00200	0.00182	34.9	73%
2016	34	8447	0.00158	0.00142	29.8	72%
2017	35	8792	0.00126	0.00130	17.1	72%
2018	35	8890	0.00103	0.00134	12.4	70%
2019	35	8820	0.00071	0.00141	7.5	76%
2020	35	8750	0.00084	0.00323	5.5	78%
Total		**74355**	**0.00139**	**0.00187**	**19.4**	**73%**
USA						
2012	505	114196	0.00043	0.00227	3.5	75%
2013	461	117006	0.00034	0.00196	3.7	72%
2014	469	119745	0.00030	0.00196	3.6	73%
2015	477	122341	0.00032	0.00215	3.8	71%
2016	481	123705	0.00031	0.00239	4.0	71%
2017	486	124129	0.00025	0.00213	2.9	71%
2018	492	125539	0.00023	0.00240	3.7	73%
2019	498	127978	0.00028	0.00225	3.5	73%
2020	503	129680	0.00046	0.00294	5.1	69%
Total		**1104319**	**0.00032**	**0.00228**	**3.8**	**72%**
Germany						
2012	25	6350	0.00069	0.00391	2.2	72%
2013	26	6445	0.00073	0.00330	2.7	70%
2014	26	6552	0.00075	0.00323	2.3	78%
2015	27	6638	0.00082	0.00366	2.6	72%
2016	27	6885	0.00075	0.00329	2.8	79%
2017	28	6931	0.00073	0.00288	2.5	76%
2018	29	7070	0.00063	0.00355	2.1	76%
2019	29	7279	0.00055	0.00322	2.2	78%
2020	30	7432	0.00074	0.00395	3.0	72%
Total		**61582**	**0.00071**	**0.00344**	**2.5**	**75%**
Ireland						
2012	33	5621	0.05315	0.00113	963.7	58%
2013	25	5778	0.05468	0.00117	580.5	61%
2014	27	6732	0.05900	0.00125	470.9	61%
2015	28	7055	0.06979	0.00147	581.4	61%
2016	29	7116	0.09050	0.00126	1986.9	67%
2017	31	7366	0.05756	0.00116	7116.2	62%
2018	33	8194	0.05282	0.00123	1004.3	60%
2019	34	8533	0.08219	0.00129	2799.2	66%
2020	34	8725	0.06723	0.00165	929.4	71%
Total		**65120**	**0.06591**	**0.00130**	**1890.0**	**63%**
Finland						
2012	138	26104	0.02102	0.00120	127.6	59%
2013	109	26769	0.01815	0.00110	76.1	63%
2014	113	28047	0.01720	0.00128	55.5	63%
2015	120	29287	0.01382	0.00144	59.3	66%
2016	123	30880	0.01220	0.00124	61.4	62%
2017	127	31187	0.00848	0.00134	44.2	65%
2018	133	32445	0.01142	0.00116	63.5	66%
2019	134	33266	0.01130	0.00113	65.4	68%
2020	135	33992	0.00806	0.00165	41.0	70%
Total		**271977**	**0.01315**	**0.00129**	**64.2**	**65%**

Year	Number of fin. instruments	Number of observations	Bid-Ask spread	Turnover rate	Hui-Heubel	MEC
Denmark						
2012	20	4569	0.00359	0.00264	5.6	69%
2013	18	4554	0.00267	0.00264	4.0	69%
2014	19	4758	0.00211	0.00284	3.7	78%
2015	19	4807	0.00185	0.00276	3.9	70%
2016	20	4935	0.00120	0.00231	4.3	78%
2017	20	5020	0.00106	0.00236	3.1	69%
2018	20	4960	0.00096	0.00269	3.4	75%
2019	20	4960	0.00088	0.00253	3.4	67%
2020	20	5000	0.00100	0.00303	4.1	71%
Total		**43563**	**0.00166**	**0.00264**	**3.9**	**72%**
Sweden						
2012	28	7112	0.00137	0.00295	3.4	70%
2013	28	7084	0.00108	0.00267	3.2	74%
2014	28	7084	0.00094	0.00272	3.4	75%
2015	29	7283	0.00112	0.00289	4.6	72%
2016	29	7337	0.00092	0.00268	4.5	71%
2017	30	7418	0.00086	0.00263	3.0	69%
2018	30	7500	0.00060	0.00290	3.6	75%
2019	30	7500	0.00069	0.00247	3.9	81%
2020	30	7560	0.00075	0.00299	4.5	71%
Total		**65878**	**0.00092**	**0.00277**	**3.8**	**73%**
Bulgaria						
2012	15	2474	0.03124	0.00030	447.9	51%
2013	11	2493	0.03349	0.00047	385.4	58%
2014	11	2728	0.02726	0.00039	224.9	59%
2015	12	2733	0.03014	0.00028	324.1	50%
2016	13	2974	0.03238	0.00028	265.9	54%
2017	13	3224	0.02161	0.00042	139.7	59%
2018	14	3298	0.02098	0.00024	244.6	44%
2019	14	3444	0.02246	0.00018	344.0	46%
2020	15	3601		0.00027	224.8	54%
Total		**26969**	**0.02735**	**0.00031**	**281.9**	**53%**
Slovakia						
2012	8	1972	0.09903	0.00009	515.2	81%
2013	8	1992	0.06556	0.00005	1459.0	8839%
2014	8	2061	0.34476	0.00002	1302.8	530%
2015	8	2045	0.20328	0.00001	1663.7	163605%
2016	8	2013	0.13771	0.00001	3302.8	115%
2017	8	1972	0.09616	0.00002	68679.0	72%
2018	8	2055	0.14048	0.00002	150003.8	109%
2019	8	2068	0.21858	0.00002	52672.7	72%
2020	8	1992	0.11705	0.00002	79039.9	311%
Total		**18170**	**0.17129**	**0.00003**	**36503.8**	**22237%**
Hungary						
2012	14	3130		0.00188	88.3	57%
2013	15	3571	0.03623	0.00174	129.9	59%
2014	15	3720	0.01565	0.00118	3395.1	62%
2015	15	3735	0.01702	0.00116	492.5	84%
2016	15	3780	0.01547	0.00097	91.3	72%
2017	16	3889	0.01454	0.00301	52.9	63%
2018	16	3904	0.00983	0.00247	28.2	61%
2019	16	3936	0.00726	0.00147	12.7	63%
2020	16	4032	0.00909	0.00141	17.3	68%
Total		**33697**	**0.01417**	**0.00170**	**450.9**	**66%**

Appendix 4. Liquidity aspects of government bonds

Table 1. Government bonds: bid-ask spread (by year)

	Russia	USA	Germany	Bulgaria	Hungary	Denmark	Ireland	Slovakia	Finland	Sweden
Average annual number of issues traded	43	347	15	23	21	10	26	19	18	11
2012	0.0153	0.0002	0.0001	0.0096	0.0063	0.0034	0.0147	0.0098	0.0014	0.0028
2013	0.0132	0.0002	0.0001	0.0107	0.0055	0.0024	0.0050	0.0084	0.0007	0.0021
2014	0.0275	0.0002	0.0002	0.0115	0.0050	0.0014	0.0014	0.0074	0.0004	0.0015
2015	0.0229	0.0003	0.0002	0.0146	0.0060	0.0047	0.0028	0.0072	0.0005	0.0026
2016	0.0083	0.0003	0.0003	0.0110	0.0033	0.0035	0.0040	0.0067	0.0008	0.0024
2017	0.0074	0.0003	0.0005	0.0104	0.0026	0.0017	0.0043	0.0066	0.0014	0.0024
2018	0.0084	0.0004	0.0006	0.0102	0.0031	0.0013	0.0030	0.0067	0.0015	0.0023
2019	0.0049	0.0005	0.0003	0.0110	0.0036	0.0013	0.0015	0.0069	0.0015	0.0023
2020	0.0059	0.0011	0.0005	0.0081	0.0046	0.0032	0.0012	0.0087	0.0018	0.0053
Total	**0.0118**	**0.0004**	**0.0003**	**0.0110**	**0.0043**	**0.0025**	**0.0035**	**0.0076**	**0.0012**	**0.0026**

Table 2. Government bonds: bid-ask spread (by duration)

Duration	Russia	USA	Germany	Bulgaria	Hungary	Denmark	Ireland	Slovakia	Finland	Sweden
Up to 3 m.	0.0013	0.0003	0.0005	0.0007	0.0014	0.0002	0.0014	0.0037	0.0008	0.0001
3-6 m.	0.0030	0.0003	0.0004	0.0016	0.0017	0.0005	0.0017	0.0038	0.0008	0.0003
0.5-1 y.	0.0037	0.0003	0.0004	0.0029	0.0009	0.0010	0.0019	0.0048	0.0008	0.0004
1-3 y.	0.0074	0.0003	0.0002	0.0066	0.0020	0.0023	0.0023	0.0053	0.0008	0.0006
3-5 y.	0.0125	0.0003	0.0002	0.0120	0.0037	0.0045	0.0026	0.0070	0.0009	0.0011
Over 5 y.	0.0172	0.0006	0.0003	0.0188	0.0079	0.0086	0.0041	0.0085	0.0014	0.0039
Total	**0.0118**	**0.0004**	**0.0003**	**0.0110**	**0.0043**	**0.0043**	**0.0035**	**0.0076**	**0.0012**	**0.0026**

Table 3. Government bonds: market-efficiency coefficient (by year)

	Russia	USA	Germany	Bulgaria	Hungary	Denmark	Ireland	Slovakia	Finland	Sweden
Average annual number of issues traded	43	347	15	23	21	10	26	19	18	11
2012	48%	72%	66%	57%	74%	75%	88%	61%	75%	80%
2013	55%	67%	68%	52%	77%	70%	91%	65%	75%	79%
2014	47%	62%	46%	57%	75%	53%	89%	49%	54%	69%
2015	57%	60%	61%	56%	85%	67%	129%	64%	69%	83%
2016	62%	72%	69%	47%	100%	61%	75%	62%	68%	84%
2017	56%	62%	83%	49%	104%	70%	84%	116%	80%	87%
2018	64%	67%	70%	42%	92%	62%	81%	67%	65%	82%
2019	61%	73%	68%	41%	83%	68%	67%	68%	66%	89%
2020	66%	64%	72%	58%	93%	78%	75%	60%	70%	87%
Total	**59%**	**66%**	**66%**	**51%**	**88%**	**67%**	**85%**	**69%**	**69%**	**82%**

Table 4. Government bonds: market-efficiency coefficient (by duration)

Duration	Россия	США	Германия	Болгария	Венгрия	Дания	Ирландия	Словакия	Финляндия	Швеция
Up to 3 m.	46%	41%	42%	35%	80%	40%	29%	292%	30%	32%
3-6 m.	44%	59%	45%	44%	64%	52%	43%	38%	43%	44%
0.5-1 y.	49%	72%	60%	45%	65%	62%	54%	43%	51%	43%
1-3 y.	53%	66%	70%	46%	92%	82%	71%	45%	68%	80%
3-5 y.	60%	67%	70%	56%	92%	90%	113%	59%	69%	88%
Over 5 y.	66%	68%	75%	55%	92%	90%	84%	70%	73%	87%
Total	**59%**	**66%**	**66%**	**51%**	**88%**	**81%**	**85%**	**69%**	**69%**	**82%**

Table 5. Russian government bonds: liquidity aspects by year

Russia	Number of instruments	Number of observations	Bid-ask spread	Turnover rate	Hui-Heubel LR	MEC
2012	40	8 135	0.0153	0.0128	1	48%
2013	41	8 671	0.0132	0.0114	493	55%
2014	36	8 667	0.0275	0.0119	1794	47%
2015	40	9 428	0.0229	0.0089	1003	57%
2016	42	9 324	0.0083	0.0118	576	62%
2017	42	9 908	0.0074	0.0128	134	56%
2018	43	10 066	0.0084	0.0132	730	64%
2019	46	9 781	0.0049	0.0114	57	61%
2020	55	11 138	0.0059	0.0089	337	66%
Total			**0.0118**	**0.0114**	**571**	**59%**

Table 6. Russian government bonds: liquidity aspects by duration

Russia	Number of instruments	Number of observations	Bid-ask spread	Turnover rate	Hui-Heubel LR	MEC
3m	40	2 335	0.0013	0.0284	12	46%
6m	40	2 633	0.0030	0.0200	100	44%
1y	38	5 312	0.0037	0.0141	76	49%
3y	45	19 449	0.0074	0.0102	418	53%
5y	43	20 158	0.0125	0.0098	788	60%
10y	57	35 231	0.0172	0.0105	700	66%
Total			**0.0118**	**0.0114**	**571**	**59%**

Appendix 5. Financial assets and liabilities of economic sectors

Fig. 1. Financial assets (+) and liabilities (-) of the banking system, % of sector assets

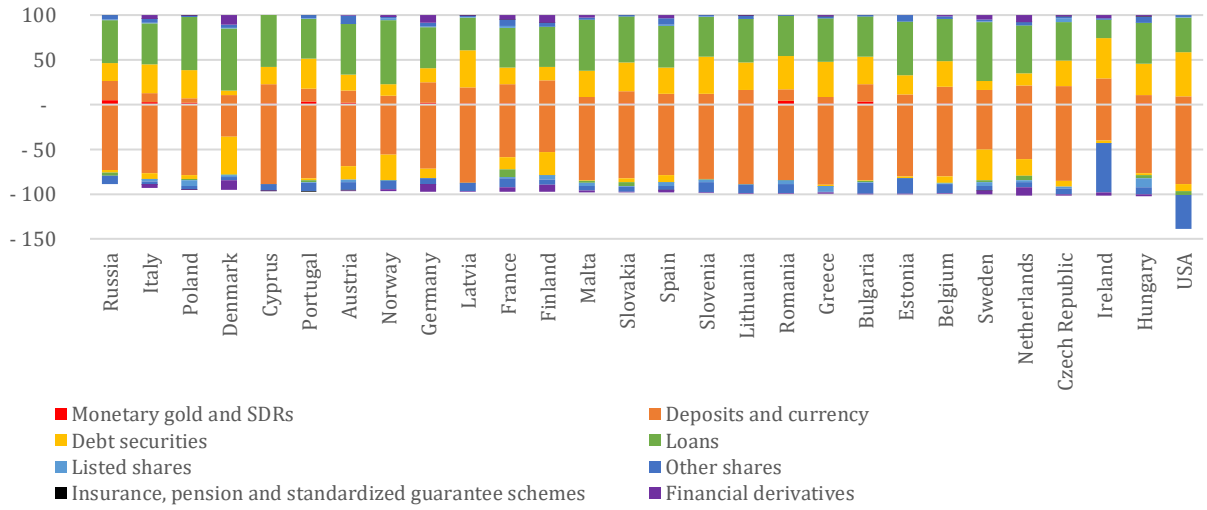

Fig. 2. Financial assets (+) and liabilities (-) of other financial institutions, % of sector assets

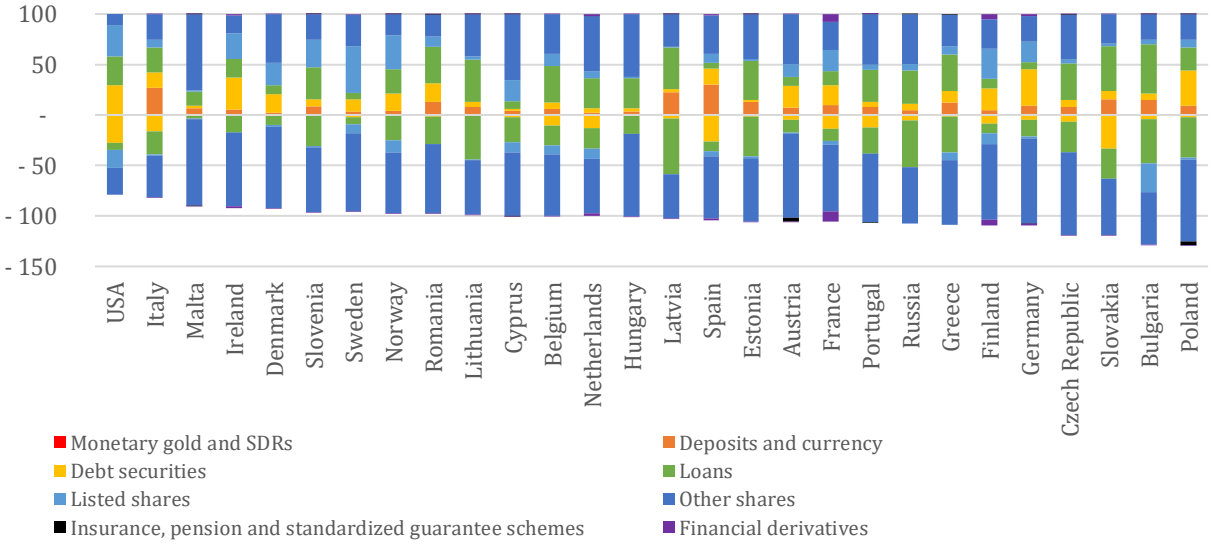

Fig. 3. Financial assets (+) and liabilities (-) of insurance corporations and pension funds, % of sector assets

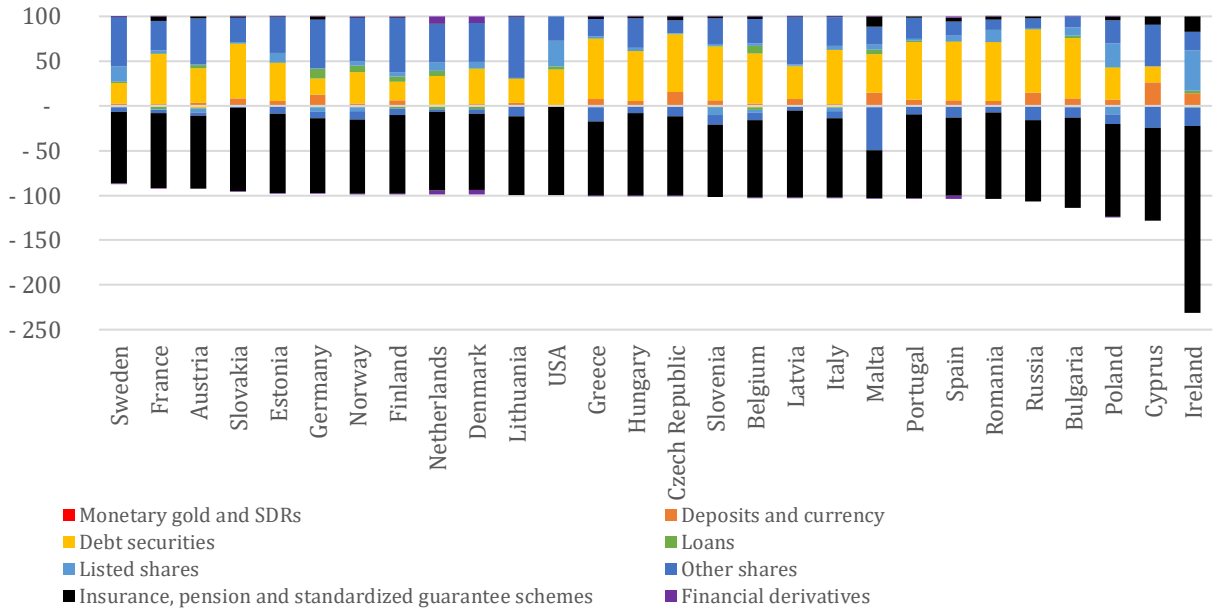

Fig. 4. Financial assets (+) and liabilities (-) of non-financial corporations, % of sector assets

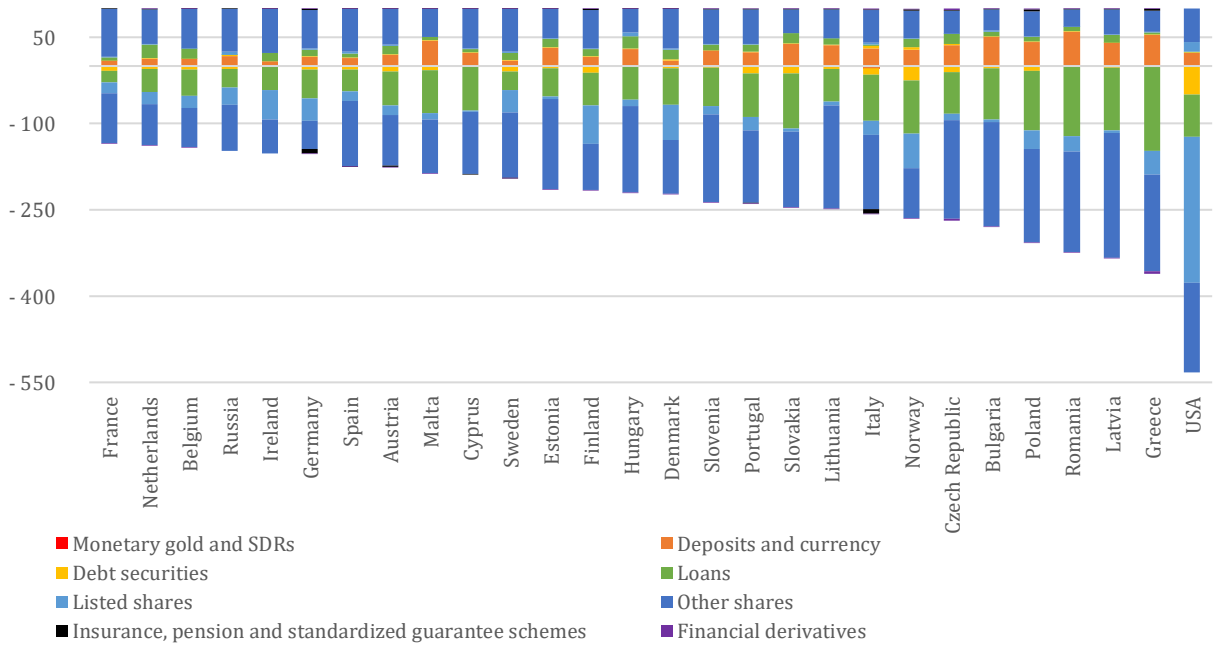

Fig. 5. Financial assets (+) and liabilities (-) of the government, % of sector assets

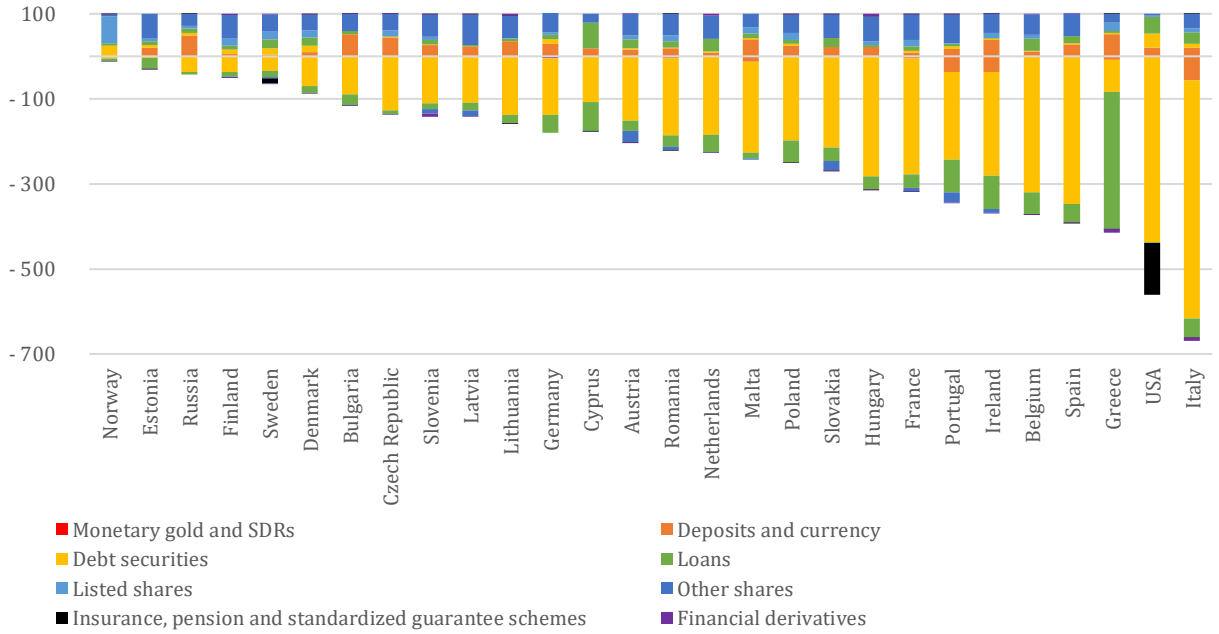

Fig. 6. Financial assets (+) and liabilities (-) of households and NPISHs, % of sector assets

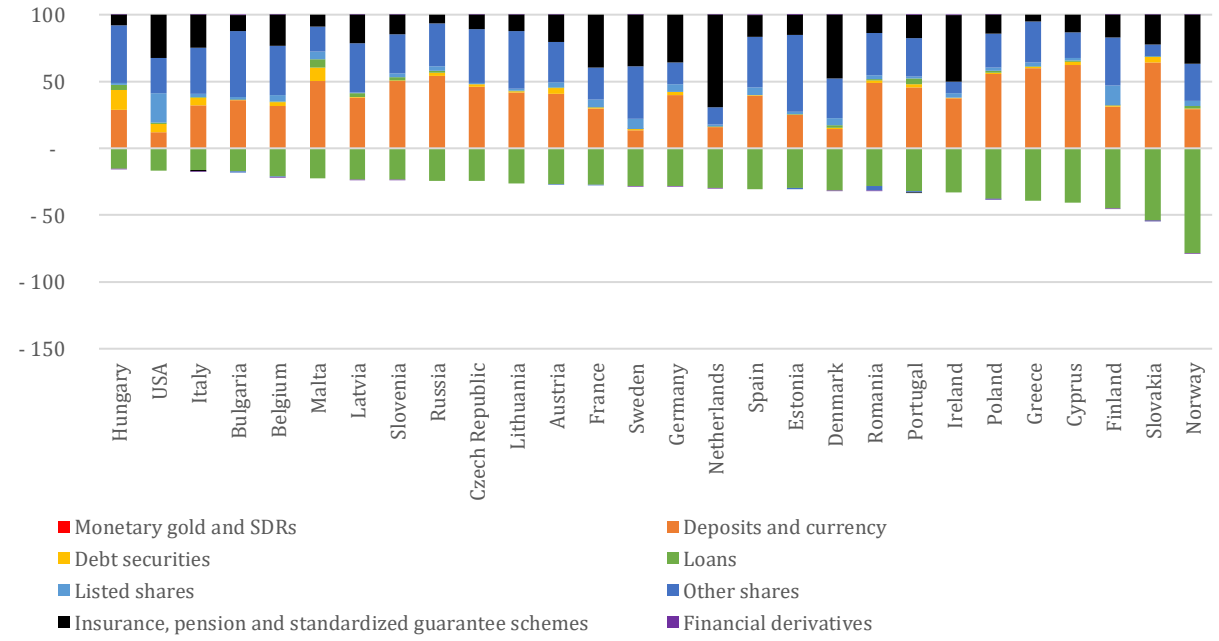

Fig. 7. Financial assets (+) and liabilities (-) of the rest of the world, % of sector assets