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Debt Service: Evidence Based on Consolidated Statements of Russian Companies

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Abstract

This paper features a modification of the debt service ratio by expanding the debt service concept and breaking down debt service and debt by currency, and using consolidated data. Our debt service analysis also takes into account the company's ability to meet its current liabilities with cash and funds borrowed under credit lines.

Our sectoral analysis of Russian companies highlights sectors of particular concern. The machinery and electronic components sector has a large share of non-profitable companies with a small amount of cash, on the one hand, and profitable companies' DSRs are higher on average than in other sectors, on the other hand. Oil and gas companies and firms in metals, mining and chemicals and agriculture largely have a big difference between the share of rouble debt service and the share of revenue originating from Russia and CIS countries, which indicates exposure to currency risks (although companies hedge their foreign currency risks with cross-currency and interest rate swaps).

Credit lines may be a source of funds to meet current liabilities, but actually, they only allow postponing payments building up debt service for future periods. Using simulation of a 25% revenue shock, we demonstrate a significant increase in the debt service ratio, especially in such sectors as machinery, construction and real estate, and energy. The use of credit lines concurrently with the emergence of this shock brings financial stability risks for the broader economy.

Contents

1.   Introduction

The ability of a company to cover its debt liabilities is a central issue for economic policy, which determines assessments of credit and financial stability risks.

The debt service ratio (DSR) (Drehmann & Juselius, 2012) is used as one of the key indicators here. We propose three modifications of its calculation, seeking to refine analysis based on this ratio. First, we include in the debt service not only loans, but also other corporate liabilities, in particular bonds, capital lease payments, and all other borrowings. This gives us a fuller picture of corporate debt service. Second, we work with consolidated financial statements. Consolidated data make it possible to aggregate information on the whole group, and this is how we can avoid distortions occurring when some companies are included in a group that assumes excessive debt servicing (or, conversely, that sets this indicator too low). Third, we expand our analysis with the foreign currency component. Foreign currency risks may be estimated based on the calculation of rouble and foreign currency DSRs.

To calculate DSRs for 153 Russian companies covering over 25% of bank debt, we refer to the S&P *Capital IQ* database and conduct a multilateral analysis of debt service, economy-wide and on a sectoral basis.

Our debt service analysis goes beyond the DSR. It was found that although the DSR signals that a company's profit is negative, this does not enable an assessment as to how critical the situation is for the company. It is important to understand whether companies can cover their debt service with cash. Furthermore, we are focused on the availability of credit lines. Are the funds of approved credit lines sufficient to cover the debt service? If cash cannot help here, which is normally the case, current liabilities of the company may be covered by credit lines. Yet, we can see several financial stability risks associated with the option of using credit lines – to be demonstrated in estimating the 25% revenue shock scenario.

The practical relevance of this analysis is as follows. First, we explain the need to use consolidated statements. We stress that the use of unconsolidated data may distort an understanding of how heavily indebted one company is compared to another. Specifically, analysis based on unconsolidated data and the borrower-bank relationship may have a certain level of error. This error is overcome by switching to the consolidated level, whereby the structure of the holding company is considered, as is the distribution of profit and debt within the holding company. Second, the results of our scenario analysis of the revenue shock may serve as a starting point for subsequent research. We have obtained an understanding of what effect a 25% revenue shock will make on a company's ability to cover its debt service, on a sectoral basis. This estimate can be used by other researchers as they compare their own findings.

The paper is structured as follows. Section 2 presents a review of literature on the subject, highlighting current approaches to debt service analysis and their limitations. The data and methodology sections follow. The first part of the results exposes debt service as it changes, in various aspects. The second part of the results is sectoral analysis. In what follows, we discuss the role of credit lines in debt service coverage and conduct a scenario analysis of a 25% revenue shock. In conclusion, we present our key findings.

2.   Related literature

In the context of debt service studies, the key indicator is the debt service ratio (DSR), defined as the proportion of interest payments and mandatory repayments of principal to income. Drehmann & Juselius (2012) developed a methodology for calculating the DSR, which takes into account the amount of outstanding debt, its maturity and the interest rate (for details, refer to the Methodology section).

The DSR is viewed as a leading indicator to detect an impending banking crisis (Drehmann & Juselius, 2014; Alessi & Detken, 2018; Donets & Ponomarenko, 2017). The DSR is also used in company bankruptcy models (Donets & Mogilat, 2017). The Russian colleagues in their aforementioned papers relied on aggregate data; therefore, they worked under the assumption that the average maturity of loans was fixed, as was the average level of effective interest rates. DSR estimation for individual bank loans for Russia was made by Burova (2020). DSR estimates turned out to be significantly higher than the results based on aggregate data.

Studies of debt service are rising up the research agenda in response to major negative shocks in the economy, such as the coronavirus pandemic in 2020. Specifically, even at the beginning of the pandemic (Slater, 2020) published estimates showing that the DSRs in France, Canada, the USA and Germany were on course in 2020 to exceed their long-term average levels, and this excess may be a twenty-year high. According to OECD (2021) calculations, debt service in the private non-financial sector was up in 2020 in 12 out of 23 OECD countries.

As a rule, bank loans are recognised as debt in DSR calculations. However, corporate borrowings are not limited to loans: companies issue bonds and enter into lease agreements. Therefore, the calculation of the ratio could be supplemented by the inclusion in the debt concept of bonds, leases and other borrowings.

It is also worth noting that research would benefit from analysis of debt service by currency. A sustainable DSR may allow for foreign currency mismatches between the debt currency and the income currency, which entails foreign currency risks (Burova, et al., 2021). Russian data show that companies whose cash flow in foreign currency is steadier than that in roubles tend to borrow in foreign currency (Burova, et al., 2022). In the context of debt service, it would be useful to relate the foreign currency debt service to the company's income in foreign currency.

The DSR is not the only measure of debt. Researchers also use the interest coverage ratio and the difference between the company's funds and debt service costs. The interest coverage ratio makes it possible to identify so-called zombie companies, i.e. those whose income is insufficient to meet interest payments. The rise in corporate debt increases the risks of the emergence of zombie companies. In the US, the share of firms whose interest coverage ratio was less than one went up from 16% in 2008 to 32% in 2020 (Slater, 2020). In Russia, the share of companies with an interest coverage ratio less than one increased from 2.9% in 2019 to 7.7% in 2020 – in two years, according to National Credit Ratings (Taiketaev, 2022). At the same time, (Bessonova et al., publication pending) concludes that very few zombie companies were able to take advantage of the preferential lending programme in 2020, and participation in it did not work towards better income or growth in headcounts at those companies.

Researchers of debt service and interest coverage ratios point to a key methodological weakness: the unconsolidated nature of available corporate statements. The fact that the interest coverage ratio of a subsidiary is, for example, below one does not necessarily signal that the company is in trouble. This may come as a result of the internal setup and distribution of financial flows within the group (Tkachev et al., 2022). For example, a company may intentionally have accumulated borrowed funds, while the bulk of group profits could have been assigned to other companies within the group. Consequently, the distribution of revenue and debt within a holding company may be uneven. This is why the use of consolidated statements would help avoid distortion of statistics on debt service indicators aggregated for the industry or for the overall country.

Researchers are not only discussing the need to use consolidated data in the context of debt service analysis. Niskanen et al. (1998) showed that consolidated profit is a significant additional explanatory variable for return on equity, unlike the parent company's profit alone. Tissot (2016) showed that analysis of global financial stability risks should involve consolidated statements of multinational companies, rather than focus only on risk assessments for resident companies in a particular country.

In estimating debt service, it is also useful to assess whether a company's funds are sufficient to cover debt service costs.[1] Banerjee et al. (2020) calculated that at the end of 2019, in 26 advanced and emerging economies, 25% of companies did not have the money to meet their liabilities due in the course of 2020. The authors expose heterogeneity by country and by type of activity. In high-inflation countries, where alternative costs of storing funds are high, the indicator under discussion is on average lower than in low-inflation countries. In a sectoral view, the weakest ability to meet loan liabilities was demonstrated by companies in textiles, metals and mining, and oil and gas.

Banerjee et al. (2020) highlights the important role of credit lines in providing additional liquidity to companies. According to the authors, countries with a low cash to short-term debt ratio are marked by higher approved credit lines of companies. A similar result was obtained for various industries. Moreover, Russia has the largest excess of available credit line amounts over debt among all emerging economies. Banerjee et al. (2020) show the uneven distribution of credit lines across companies, the low maturity of loans issued under credit lines (2.6 years vs 4.7 on fixed-term loans) and the option of credit institutions to deny extension. In the event of a negative shock, banks tend to reduce the number of approved credit lines more aggressively than the issue of fixed-term loans, the authors also stress.

This paper uses the DSR, the cash debt service coverage indicator and the indicator of debt service coverage with credit lines.[2] We have eliminated the restrictions of previous studies, i.e. the use of unconsolidated loans-only data. This paper contributes to the literature as the first attempt to estimate the DSR based on consolidated data, with bank loans, bonds and capital lease payments, denominated in various currencies, factored in.

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[1] To do this, one can use an indicator equal to the ratio of the difference between funds and debt servicing expenses maturing within one year to the value of assets (for details, refer to the Methodology section).

[2] Although mentioned in this section, the interest coverage ratio will not be used since it is essentially close to the debt service ratio but narrower in its sense (does not take into account the company's ability to pay principal debt).

3.   Data

In this paper, debt service is understood to be the amount of payments due for the coming year under loans, credit lines, bonds, capital lease and other borrowing (both interest and principal). Data for calculating the debt service (the residual amount of debt, maturity date and the interest rate) are available in the notes on financial statements of companies. We obtained this information from the *Capital Structure Details* section of the *S&P Global Market Intelligence (Capital IQ)* database. Capital IQ has the advantage over its peers in the availability of data from IFRS-compliant consolidated financial statements of groups. We consider companies that have bank debt, and exclude credit institutions and insurance companies; the resulting sample includes 153 Russian companies[3] with 2016–2021 data.

Companies are divided into nine sectors: consumer goods and services, passenger and freight transportation, construction and real estate, commercial services,[4] machinery and electronic components, oil and gas, metals, mining, and chemicals, energy, agriculture and fishery.[5] The number of companies broken down by sector and subsector is presented in Appendix 1.

The *Capital IQ* database also provides other data for our analysis (operating profit, cash and equivalents, and other measures). Separately, the database features the corporate revenue structure by geographical segment, which we also used.

To obtain data on available credit lines, Form 0409303 bank reporting data were used.[6] Form 0409303 data and the *SPARK* information resource were used to calculate the DSR based on unconsolidated statements. In particular, to generate the corporate income indicator, we refer to the *profit before interest and tax* indicator in financial reports available in *SPARK*.

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[3] Most of the sample (105 companies) are holding companies. However, there are also several companies (48) without subsidiaries. The latter were also included in the sample since we sought to create a sample of companies whose debt service is not subject to the specifics of corporate accounting and the distribution of financial flows (that is, to avoid the inclusion of subsidiaries).

[4] Commercial services include financial services, utilities, communication services, information technology and industrial production (woodworking and glass production). Importantly, with credit and insurance institutions out of the sample, three providers of other financial services (a mortgage agent and leasing companies) are nevertheless included.

[5] It should be noted that the companies in our sample cover over 30% of the industry revenue of medium and large companies in energy, passenger and fgeight transportation, metals, mining, and chemicals, agriculture and fishery, oil and gas (close to 100%), 20% - in commercial services, 9% - in consumer goods and services, machinery and electronic components, 2% - in construction and real estate. Industry revenue was calculated according to SPARK data as the total revenue of medium and large companies with the OKVED code related to one or another sector of our analysis.

[6] See Bank of Russia Ordinance No. 4927-U, dated 8 October 2018, 'On the List, Forms and Procedure for Compiling and Submitting Credit Institutions' Reporting Forms to the Central Bank of the Russian Federation'.

4.   Methodology

To calculate the debt service, we need three measures of all types of debt in the company's statements: the principal due amount, the maturity date for this debt, and the interest rate. Some characteristics of the disclosed information necessitate several assumptions for DSR calculations:

1)   The maturity date and/or the interest rate for a certain liability could be denoted by a range of values (i.e. minimum and maximum values are presented). On the one hand, this could be the result of the dependence of the maturity date and/or of the interest rate on future conditions. On the other hand, this may suggest submission of information on an aggregate basis (that is, we can see information on a certain category of liabilities including on several agreements rather than on a particular agreement).

To ensure the unambiguity of calculation, we have assumed that:

1.1. If there is a range of interest rates, we calculate their average.

1.2. If there is a range of maturity dates, we make calculations separately for the left bound of the range (minimum maturity) and separately for the right bound of the range (maximum maturity). We have noted that the results of the research are largely the same regardless of minimum or maximum maturity we operate with (more details will be available in Section 5.2). Therefore, for the sake of brevity most of subsequent information will be provided allowing for maximum maturity, which suggests the most comfortable agreement terms for companies.

2)   The maturity date and/or interest rate may be unavailable.

2.1. If there is no information on the interest rate, the latter is assumed equal to the Bank of Russia key rate plus 2 pp.

2.2. If there is no information on the maturity date, the latter is taken as a reporting date plus five years, which is consistent with the average maturity period where the maturity date was specified. The exception is *lease* liabilities: these liabilities were found to expire at the beginning of 2025 on average regardless of the reporting date; therefore, in the absence of information the maturity date was taken to be 01.01.2025.

3)   As of the time the information was collected, not all companies had submitted their reports for the end of 2021; however, 2021 Q1, Q2 and/or Q3 information was available for most companies, for the end of the quarter or for the last 12 months (as for operating profit). Thus, we used the latest available data from companies for 2021 (if any in 2021).

When a company stated 2022 as its debt repayment date, we specified this to be 01.01.2022. This assumption may be more stringent than reality if, for example, the statements are submitted as of the end of 2021 Q2, whereas the actual maturity date falls in 2022 Q3 or Q4. We believe this inaccuracy may be disregarded since it is impossible to establish the actual repayment date and such observations are scarce.

To analyse the ability to cover the debt service with cash and equivalents (and credit lines), we used the following indicators:

$$\frac{Cash\ and\ Equivalents - Debt\ Service}{Assets}$$

$$\frac{Cash\ and\ Equivalents + Approved\ Credit\ Lines\ - Debt\ Service}{Assets}$$

The main focus of the paper is the DSR, calculated by the following formula (Drehmann & Juselius, 2012):

$$\text{DSR}_t = \frac{\text{Debt Service}}{\text{Income}} = \frac{\sum_{n=1}^{N} \frac{i_{n,t} * D_{n,t}}{\left(1 - \left(1 + i_{n,t}\right)^{-s_{n,t}}\right)}}{Y_t},$$

where $D_{j,t}$ is outstanding debt under liability n at the end of the period t, i is the annualised interest rate, s is the maturity, N is the number of all various liabilities, and Y is the amount of income for the last 12 months of period t. When the DSR is calculated on the basis of consolidated statements, the amount of income is determined by the amount of operating profit and amortisation. To build up the ratio based on unconsolidated statements, the *earnings before interest and tax* (EBIT) measure is used.[7]

Moving forward, we will consider the following pairs of terms to be synonyms: *debt service* and *debt burden*, *income* and *operating profit*.[8]

In Appendix 2, we provide technical details of the calculations: the adjustment of the original formula for cases when the interest rate is zero and/or the maturity period is less than one year.

For the sake of clarity, let us show how debt service is related to balance sheet items. In a balance sheet, *the Total Current Liabilities* section is broken into *Short-term Borrowings* and the *Current Portion of Long-Term Debt/Leases.* In the *Total Liabilities* amount, the *Long-term Debt/Leases* item is also differentiated. This means that debt service should be closest to the sum of short-term borrowings, the short-term portion of long-term liabilities and interest payable on all liabilities.

However, there may be significant differences in some cases. We can see the following sources of non-conformities:

• First, the inconsistencies may be associated with shortcomings in the build-up of the *Capital Structure Details* section. The data in this section are the result of *Capital IQ* analysts' efforts to aggregate the maximum available information – in other words, the information in the form we are working with is not audited. Therefore, there may be some discrepancies with balance sheet data caused by both inaccuracy of information obtained from notes on financial statements and possible retrospective revisions of financial statements by companies.

• Second, quarterly financial statements (relevant for 2021 data) are not audited but only reviewed, which assumes that the commentary information will not be fully disclosed. As a result, *Capital IQ* analysts can complete information based on previous audited data, which may also cause distortions.

Having said that, we have not identified any systematic information distortions in need of adjustment and consider that it is acceptable to use data contained in the *Capital Structure Details* section for our assumptions.

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[7] The difference in the definition of income is explained by the specifics of data disclosure in *Capital IQ* and *SPARK*. However, both operating profit and EBIT were considered for the last 12 months.
[8] For the DSRs calculated based on *Capital IQ* data, operating profit means operating profit adjusted for depreciation.

Another focus of this paper is the foreign currency aspect, that is, we seek to identify the DSR accounting for only rouble/foreign currency debt and only rouble/foreign currency income (operating profit).

Companies report the currency of debt, but do not report the currency of operating profit. However, we can see the geographical segment of corporate revenue. We cannot decompose operating profit (the DSR's denominator) by geographical segment; hence we will assume that the structure of revenue on which we have available information is the same as the structure of operating profit (adjusted for amortisation).

This enables a focus on the concept of *rouble* and *foreign currency* DSRs, also referred to hereinafter as currency-weighted DSRs. We have the following breakdown by currency and geo segment:

Table 1. Rouble and foreign currency DSRs

	Rouble DSR	FX (non-rouble) DSR
Debt service structure (DSR numerator)	Currency: rouble, Kazakhstan tenge, Georgian lari	Currency: other currencies (dollar, euro, Swiss franc, Chinese yuan, Japanese yen, pound sterling, Czech koruna)
Revenue structure defining the structure of operating profit adjusted for amortisation (DSR denominator)	Geo segments: Russia, CIS countries, Georgia[9]	Geo segments: other countries

The DSR values will be given by the following formulas:

$$\text{Rouble DSR}_t = \text{DSR} * \frac{\text{Portion of Rouble Debt Service}}{\text{Portion of Revenue from Russia, CIS, and Georgia}}$$

$$\text{FX DSR}_t = \text{DSR} * \frac{\text{Portion of FX Debt Service}}{\text{Portion of Revenue from Countries other than Russia, CIS, and Georgia}}$$

Use of rouble and FX DSRs helps avoid distortions of the actual ability to cover debt service in the presence of risks of appreciation or depreciation of the rouble.

These indicators will enable us to determine whether companies have sufficient rouble/foreign currency income to cover their rouble/foreign currency liabilities.

Disclosure of geographical segment information has a key element. The list of segments may contain an item denoted as *Unallocated*, *Elimination* or *Segment Adjustment*. In the first case, this may mean that the exact source of revenue is unknown. Yet, this may also be the case of this revenue item being a balancing adjustment and taking on a negative value. The need for adjustment arises in sales between group companies in different geographical segments, and the adjustment helps eliminate the intra-group revenue effect. For our research, the source of revenue does not really matter; therefore,

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[9] Here and elsewhere, the wording will be 'Russia and CIS countries' for short, implying that this includes Georgia.

balancing adjustment items[10] will be stripped out as we construct the revenue structure by geo segment.

Finally, when analysing information, we will refer not only to companies as such, but also to observations: one observation covers one company in one of the periods under study.

5. Companies' ability to cover debt service

In this section, we aim to explore key trends in companies' ability to cover their debt service. To this end:

- First, we will estimate overall dynamics of the debt structure.

- Second, we will assess the ability of companies to cover their debt service with cash and income (with the help of the DSR), and discuss the DSR structure by debt type.

- Third, we will demonstrate differences stemming from the use of data based on consolidated and unconsolidated statements.

- Fourth, we will investigate the foreign currency aspect. This will include a study of the debt service structure by currency and of the revenue structure by geo segment; furthermore, we will provide currency-weighted DSR estimates (roubles and non-roubles).

5.1. Long-term debt prevails

Appendix 3 shows descriptive statistics for several key financial indicators of companies: the cash to assets ratio, the logarithm of total assets and the logarithm of debt service. These indicators are stable over time, although they vary widely across companies.

Let us consider debt indicators. Companies in our sample cover in total 28% of all loans of Russian banks. While we cannot make a similar estimate for other debt categories, we can note that the largest part of the debt, in absolute numbers, falls on oil and gas sector companies, commercial service providers, metals and chemical firms, and passenger and freight transportation companies, with a very small share accounted for by the rest of the activity types (those companies are small in size).Figure 1 shows the 2021 debt structure by maturity, broken down by industry. The average share of long-term borrowings is around 80%. The highest share of long-term debt is in construction and real estate, and the lowest, in the energy sector (68%). We find no companies where short-term debt prevails.[11]

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[10] For example, if a company receives 90 units in Russia and 30 units abroad, with -20 being a balancing adjustment, we will assume that 75% of revenue [90/(90+30)] originates from Russia and 25% [30/(90+30)], from overseas.

[11] Importantly, our analysis of maturity rests on adjusted data (a five-year maturity was used where maturity information was unavailable, see the Methodology section).

Figure 1. Debt structure by industry, 2021

■ Over 3 years   ■ From 1 to 3 years   ■ Up to year
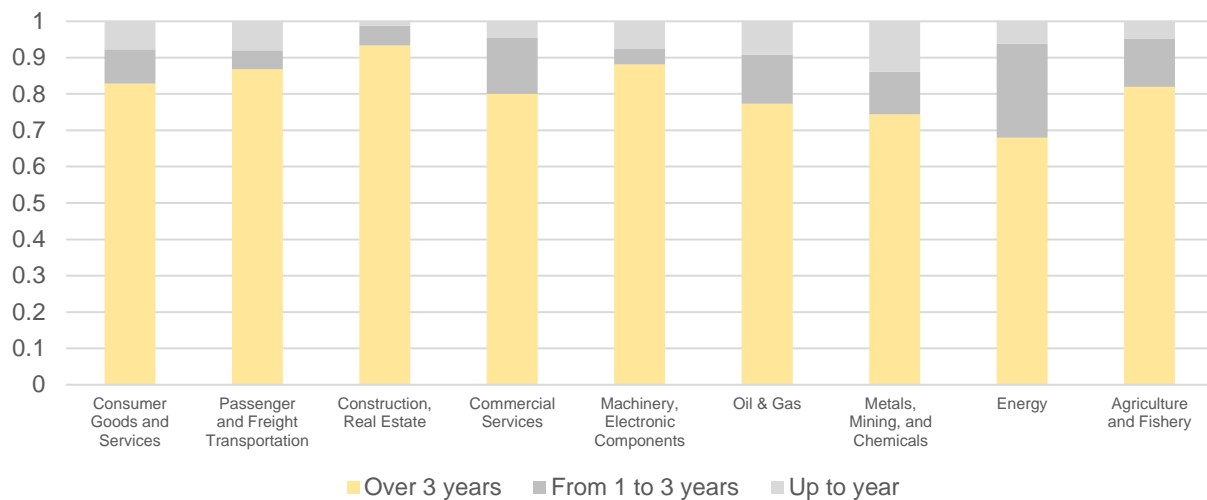
5.2.   Companies are less able to cover their debt with cash than with operating profit

In this section, we discuss two options for a company to cover its debt service: cash and equivalents and income (operating profit adjusted for amortisation).

Figure 2. The DSR and debt service coverage with cash

First, let us turn to the overall picture. Figure 2 divides the sample of companies into those making profit (upper half-plane) and those having sufficient cash (right half-plane). The most alarming situation is in the third quarter, where the companies lack both income and cash to cover the debt service. Most of the observations are presented in the second quarter, that is, companies do not have enough cash but have some profit, but it is hard to say for sure whether their profit covers the debt service. Therefore, we will proceed to
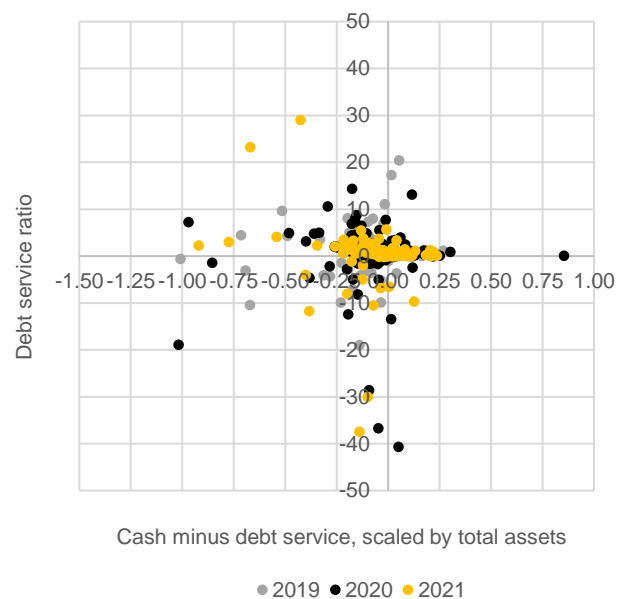

Cash minus debt service, scaled by total assets

● 2019 ● 2020 ● 2021

Figure 3 and Figure 4 for a more detailed analysis.

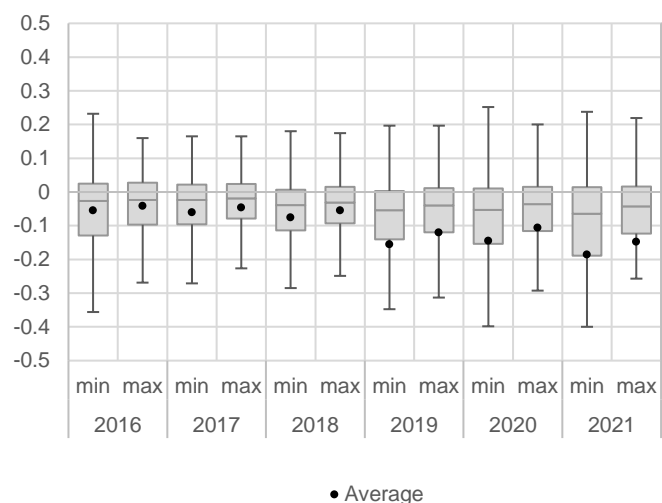Figure 3. Difference between cash and debt service to assets

• Average

Figure 3 shows that the debt service can be covered with cash.[12] One can see that cash is insufficient in more than half of cases. In 2016–2018, the average shortfall to cover debt was under 10% of assets. In 2019–2021, a further 10–20% of assets were needed.

Figure 4. Debt service ratio

Figure 4 shows a box-and-whisker plot of the DSR. It should be noted that such figures were constructed only for observations with positive DSR values, in other words, for observations with positive profit.

• Average

The median DSR was below 1 through 2018, which suggests that half of companies were able to cover their debt service with their operating profit (adjusted for amortisation). The median DSR increased in 2019 and 2020, as did the interquartile range, that is, increasingly fewer companies had enough profit to cover their debt service. The situation improved in 2021 and became similar to 2018.
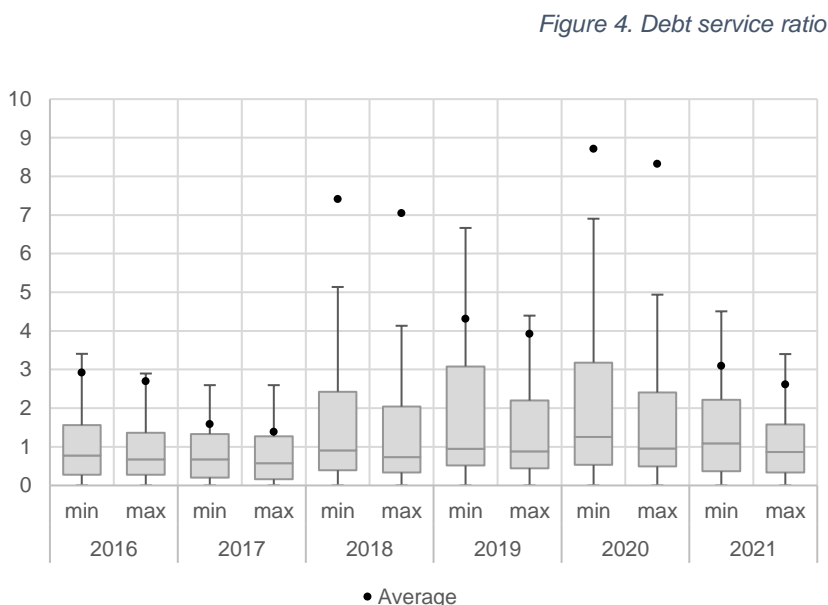
Let us highlight the difference in the results obtained under various assumptions about the maturity date (for what the captions *min* and *max* stand for, see the Methodology section). It follows from Figure 4 that *min* boxes are higher than *max* boxes. This means that the debt service exceeds profit multiple times under the assumption of the minimum possible maturity (*min*) as compared to the maximum possible maturity (*max*). This is true, as they say, 'by construction': in fact, the shorter the maturity period, the greater the debt

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[12] It is worth remembering that in the box-and-whisker plot, the upper and lower sides of the boxes reflect the upper and lower quartile of the sample (25th and 75th percentiles), the horizontal line inside the box reflects the median, the point stands for the sample average, and the whiskers are highs and lows (excluding outliers). Outliers are values beyond the 25th percentile minus 1.5 x IQR and 75 percentiles plus 1.5 x IQR, where the IQR is the interquartile range – the difference between the 75th and 25th quartiles.

service at a certain point in time. Also, it is clear from Figure 4 that the dynamics of *min* boxes are similar to those *max* boxes. The authors of the study also detect this dependence in other graphs; therefore, for brevity, we will operate only indicators calculated at the maximum possible maturity (which was emphasised in the Methodology section).

It can also be seen from Figure 4 that average DSRs are well above median DSRs, which suggests that DSRs of individual companies are too high.

Let us proceed to the analysis of debt service structure by debt type (Figure 5). Loans account for the bulk of it (62% in recent years), followed by bonds, lease, credit lines and other debt.

The dynamics of the DSR structure are marked by an increase in the share of lease liabilities in 2019. The growth came as a result of the introduction in Russia in 2019 of IFRS 16 *Lease* to replace IAS 17 *Lease*. According to the old IAS 17 standard, if a lease is classified as operating (operational leasing), lessees did not record either assets or liabilities on the balance sheet – but only lease payments as a cost item within profit or loss. Under IFRS 16, most lease agreements must be accounted for on the balance sheet. This explains the growth in the DSR numerator.

It should be noted that adjustments in accounting policy have a twofold effect on the DSR: its numerator and denominator both change. A change in the denominator (specifically, in operating profit) is due to the fact that until 2018, operating lease costs were recorded in profit and loss statements as production and operational expenses or general business and administrative expenses. In this case, lease payments reduced the amount of operating profit. Since 2019, lease payments have been recognised as interest expenses in the financial expenses section, in which case there are no implications for operating profit.

Given the changes in accounting policy, it is not entirely correct to compare what was before and after 2019 in analysing how DSRs change over time.[13] Hence, most of the analysis can be simplified, so the work only covers the 2019–2021 period.

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[13] It is also important to understand the impact of changes in accounting policy on DSRs of individual companies (whether there are meaningful or negligible implications). For 98 out of 162 companies, the lease burden accounted for more than 0.5% in at least one of the periods. In 2018–2019, 74 companies registered a significant rise in lease liabilities: before the switch to the new standard, lease accounted for about 1% of the total burden; following the transition to the new standard, this share grew by 5–15pp. At the same time, 20 companies posted growth of more than 20pp (40pp on average, with two companies having shown 100pp growth).

Figure 5. Debt service structure by debt type
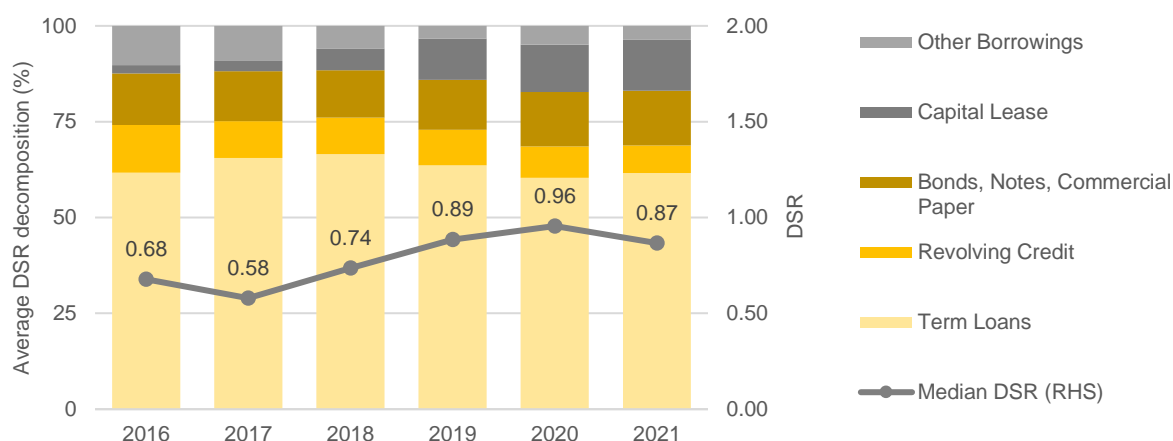
5.3. The advantage of using consolidated statements

In the literature review, we spoke of the need to use data from consolidated statements due to the uneven distribution of income and debt across companies within a group. Let us show what differences arise in the DSR when different data are used.

Figure 6 represents the DSR for 2019 based on three data sets:

1) based on unconsolidated data on parent and subsidiary companies (bank debt in Russia is understood as debt service);

2) based on unconsolidated data on parent companies (bank debt in Russia is understood as debt service);

3) based on consolidated data (debt service includes all types of debt).

It can be seen from Figure 6 that DSR variation for consolidated statements (right-hand column) is lower than for individual statements (left-hand column). We can see the confirmation that a company may have a high DSR, but it is not that high in the group-consolidated view.

We also compared the distribution of DSRs for unconsolidated statements of parent companies (middle column) and consolidated statements of groups (right column) to show the differences for the same sample size. The difference may appear insignificant at first glance. Yet, first of all, for consolidated data, DSRs of 50% of companies are below 1, which is not the case for parent companies with individual statements. Secondly, the middle column takes into account only Russian banks' loans, while the right column takes into account other types of debt. In other words, the middle column (unconsolidated data on parent companies) takes into account less debt service, but has a higher DSR compared to the right column (consolidated data).

Figure 6. Debt service ratio, 2019

Consequently, DSR variance in the case of consolidated data decreases, which is most likely due to the specifics of profit and debt accounting within groups. The use of consolidated data is preferable to the use of unconsolidated data. A comparison of results in dynamics can be seen in Appendix 4.

The use of consolidated accounts may also be useful, beyond debt service analysis, in exploring the efficiency and productivity of Russian companies.

5.4. Debt currency and revenue currency are not always the same, but companies seek to hedge foreign currency risks

Figure 7 captures the structure of debt service by currency. Debt service in roubles (together with the currencies of Kazakhstan and Georgia) accounts for 73–82% of the total debt service. Dollar-denominated debt have accounted for 15%–20% over the last five years. Other currencies make up less than 4% of the total debt service.

Figure 7. Debt service structure by currency
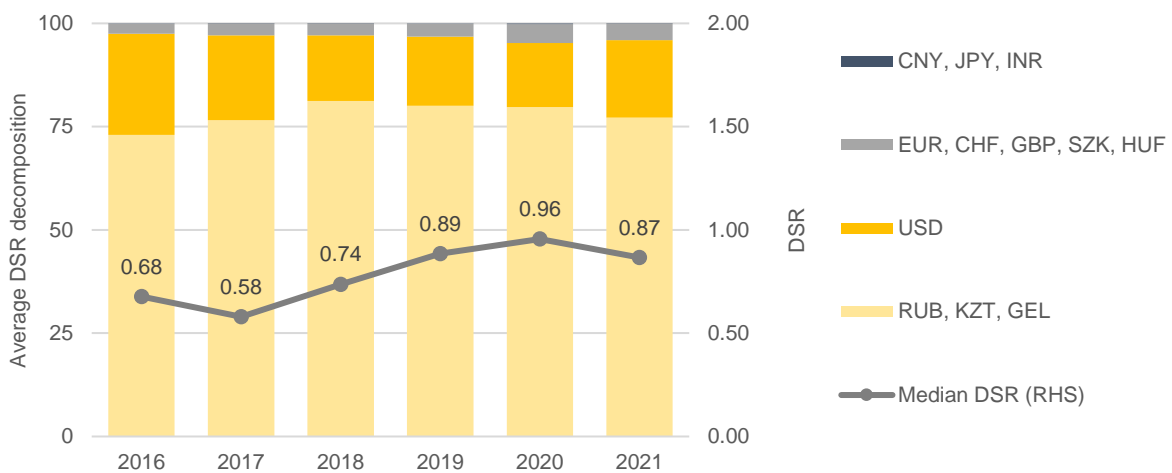
Having discussed the debt currency, let us proceed to what can be said about a company's revenue structure. As mentioned in the Methodology section, we can work only with revenue geography, not with foreign currency. The geo segment-based revenue structure (Figure 8) almost does not change over time: Russia and CIS countries account for 85%, Europe accounts for 5–6%, Asian countries make up 3–4%, and the fraction of 2–3% falls on the Americas, Australia, New Zealand, Africa and the Middle East. The *Other* category includes geographical segments other than Russian territories, but not directly named.

It is clear from a comparison of Figure 7 and Figure 8 that companies do not always pay with the currency of the country where the company receives revenue. This assumption arises, for example, from the fact that the dollar prevails over the euro in terms of debt service, but companies in countries where the dollar is the main currency of settlement receive relatively less revenue than those in Europe or Asia.

Figure 8. Revenue structure by geographical segment
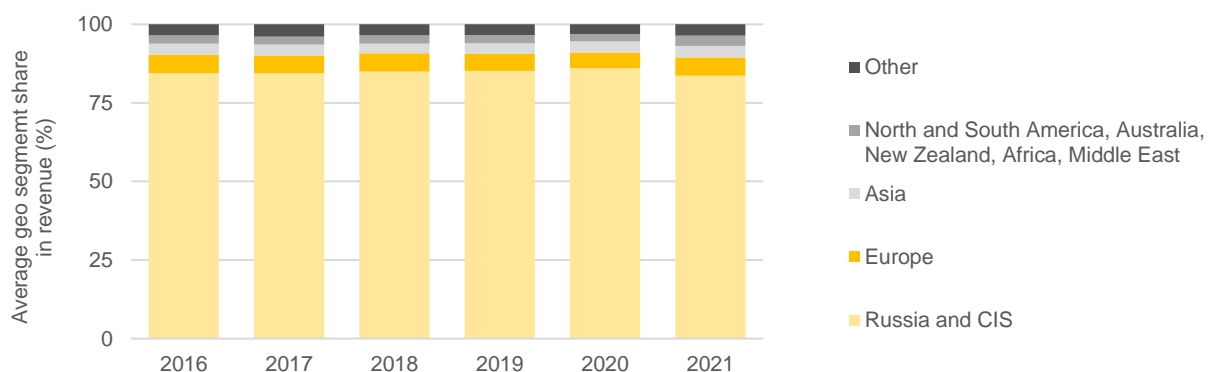
Let us proceed to study the DSR adjusted for foreign currency. Figure 9 captures the number of observations within one of the two DSR ranges: no more than 1, above 1. As a reminder, a DSR at acceptable in this paper is under or equal to 1, that is, the debt service may be covered by income in the respective currency. At the same time, there are rouble and foreign currency (non-rouble) DSRs for 2019, 2020 and 2021. The following technical feature is essential from the interpretation standpoint. This kind of figure cannot capture observations for all the 153 companies in the sample, stripping out companies with negative profit and companies that have not provided up-to-date data. In the case of the foreign currency (FX) DSR, companies having no FX income and no FX debt (about 55) do not enter the sample.

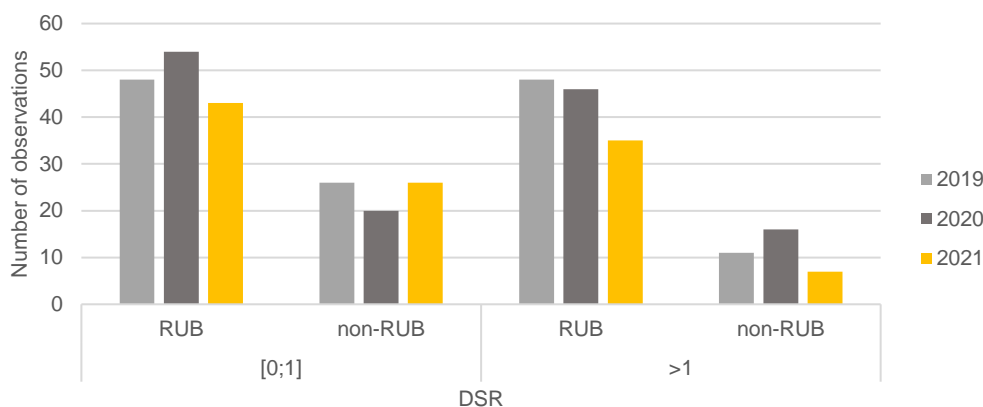*Figure 9. Distribution of rouble (RUB) and FX (non-RUB) DSR frequencies (by number of observations)*

Figure 9 shows that the rouble DSR is above one in approximately 45% of cases, while the FX ratio is above one in approximately 33% of cases. In terms of the financial stability of the sector, a DSR above one is reason for concern, with such cases to be explored in more detail in the Sectoral Analysis section.

To conclude this section, let us identify cases in which the revenue currency and the debt currency may differ, and what companies do in this case.

This dual currency scenario (revenue in one currency, debt in another) is common to exporters whose revenue is denominated in foreign currency and debt in roubles. In another scenario, companies do not receive FX revenues but issue FX liabilities (e.g. Eurobonds). Specifically, some corporates issue panda bonds or dim sum bonds[14] without a presence in the Chinese market. This may be part of a corporate image strategy of a company with strategic plans for operations in a certain region, and so the company seeks to improve its position there by promoting cooperation with Asian partners.

When corporate revenue is in one currency and debt repayments in another, companies tend to manage FX risk through cross-currency and interest rates swaps. A cross-currency and interest rate swap is an agreement under which the parties exchange interest payments in different currencies for the established nominal amounts within the agreed time. More details are given in Box 4 (Page 47) in (Bank of Russia, 2020).

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[14] Panda bonds are issued in the domestic Chinese market; dim sum bonds circulate outside mainland China.

6.   Sectoral analysis

The sample of companies can be divided into nine sectors by industry group. This section presents a sectoral analysis in the following order:

• First, we assess companies' ability to cover their debt service with cash.

• Next, we interpret the box-and-whisker plot of the DSR – for observations with positive profit.

• We also consider the ratio of rouble debt service to Russia and CIS-originated revenue, which helps identify the currency discrepancy between debt and revenue.

• We track rouble and FX DSRs separately.

In conclusion, we formulate conclusions on the specifics of corporate behaviour in each sector.

6.1.   The ability to cover debt service with cash

Figures 10–12 show box-and-whisker plots for the cash debt service coverage indicator (for 2019, 2020, and 2021). More than 50% of companies are unable to fully cover their debt service with money.

The *oil and gas sector* is in the best position, with its lowest gap between the debt service and cash (in Figure 10–12, this is shown by the highest median values and the lowest heights of the boxes). The share of companies with positive debt service coverage ratios is minimal in *consumer goods and services, energy, agriculture and fishery* (the boxes in Figure 10–12 are in the negative half-plane in at least two of the three years).

At the same time, sectors' positions relative to each other remain steady over the years. The noticeable trend is an improvement in *agriculture and fishery sector* companies in 2021 (25% of companies were able to immediately cover their liabilities with cash).

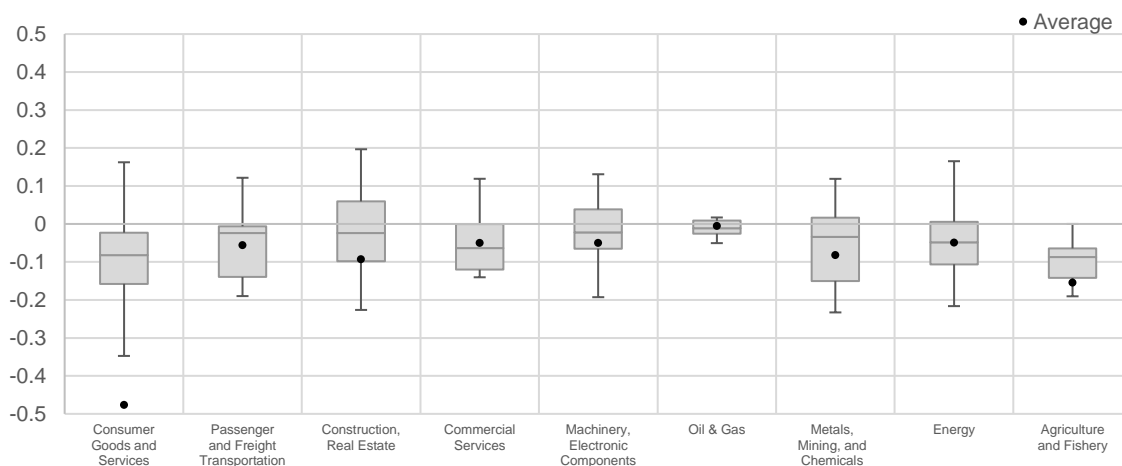*Figure 10. Difference between cash and debt service to assets, 2019*

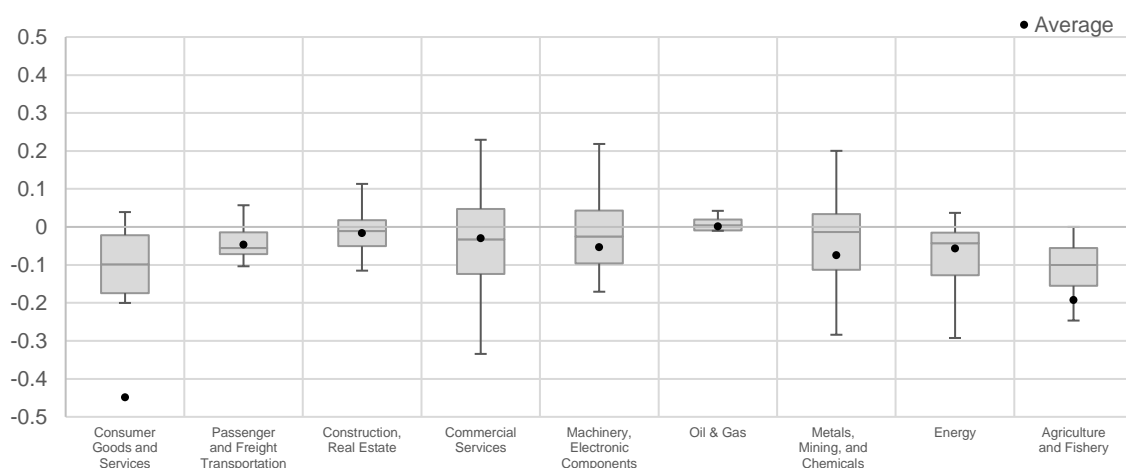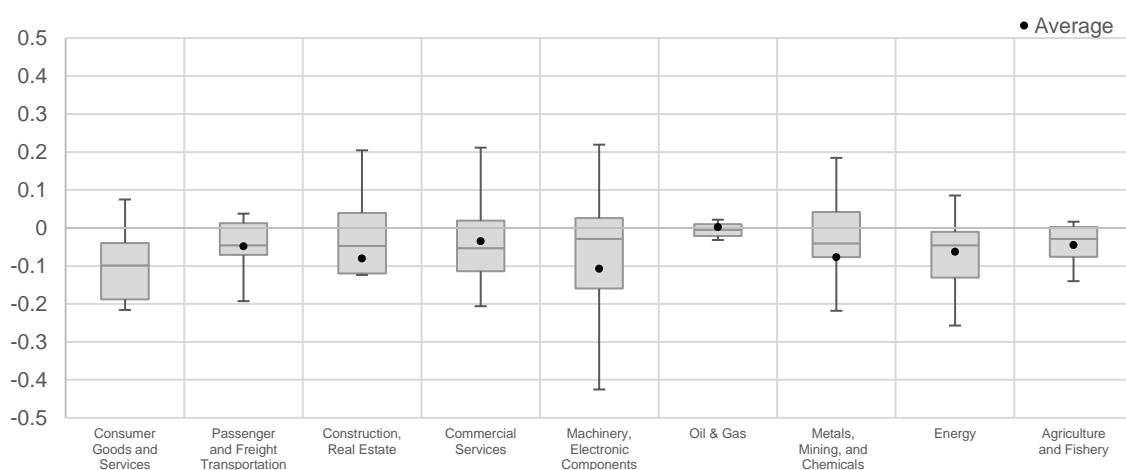*Figure 11. Difference between cash and debt service to assets, 2020*

Figure 12. Difference between cash and debt service to assets, 2021

6.2.   Debt service ratio

In this subsection, we focus on companies that had positive profit at a certain point in time so we can assess their ability to cover their debt service with income (Figures 13–15).

The median DSR in such sectors as *oil and gas, metals and mining, passenger and freight transportation, energy and commercial services* is equal to or below 1, that is, at least 50% of companies have sufficient profit to cover their debt service. There are reasons for concerns in such sectors as machinery *and electronic components,* and *consumer goods and services*, where debt service of over 25% of companies were twice as high as their income.

Importantly, the DSR varies considerably from year to year in a number of sectors (this is manifested in median DSR fluctuations and a narrowing/expansion of the interquartile range).

•   In 2019–2020, the *metals, mining, and chemicals* sector show a wide interquartile interval relative to 2021. The interval expansion by 2019 came together with a 20% decline in operating profit and a 50% increase in the debt burden. Operating profit increased in 2020 by 20% and the debt service was up 40%. The rise in the debt service is explained by the

expansion of loans and the need to redeem face values of bonds. The drop in the interquartile range in 2021 was associated with a 120% rise in operating profit and a relatively low 20% rise in debt service.

• By 2021, the decrease in DSRs in *agricultural and fishery* businesses is explained by a nearly twofold rise in operating profit and a 20% drop on average in debt service.

• Changes in DSRs in *construction and real estate* are explained by fluctuating operating profits. The following trend stands out. Initially, a company makes profit, which drops, but remains above zero, and thereafter the company makes loss. Therefore, a decrease in the interquartile interval in 2020–2021 means that companies with a small but positive profit in 2020 and a negative profit in 2021 exit the sample. Such profit trends are mostly shown by *construction* subsector companies, but it is important to understand that this category includes construction of residential property, highways and other infrastructure facilities.

• In *machinery*, the median DSR drops almost twofold from 2019 to 2020, which is driven by, on the one hand, the average income growth of 60% and, on the other hand, a slower increase or even a decrease in debt (the average growth of 20%). Overall, debt service fluctuations occur in loans or (less frequently) in loans and bonds – simultaneously and codirectionally. The drop in the median DSR is also explained by several companies exiting from the sample due to their negative profit in 2020 and/or 2021.

• In the *commercial services* sector, companies providing financial services or operating in the housing and utility sector (housing and utility services) are marked by the highest DSRs. As a rule, the aforementioned companies have either negative operating profit or very low profit, which pushes the DSR to very high values. The presence of companies with low operating profit accounts for the increase in the interquartile interval in 2020.
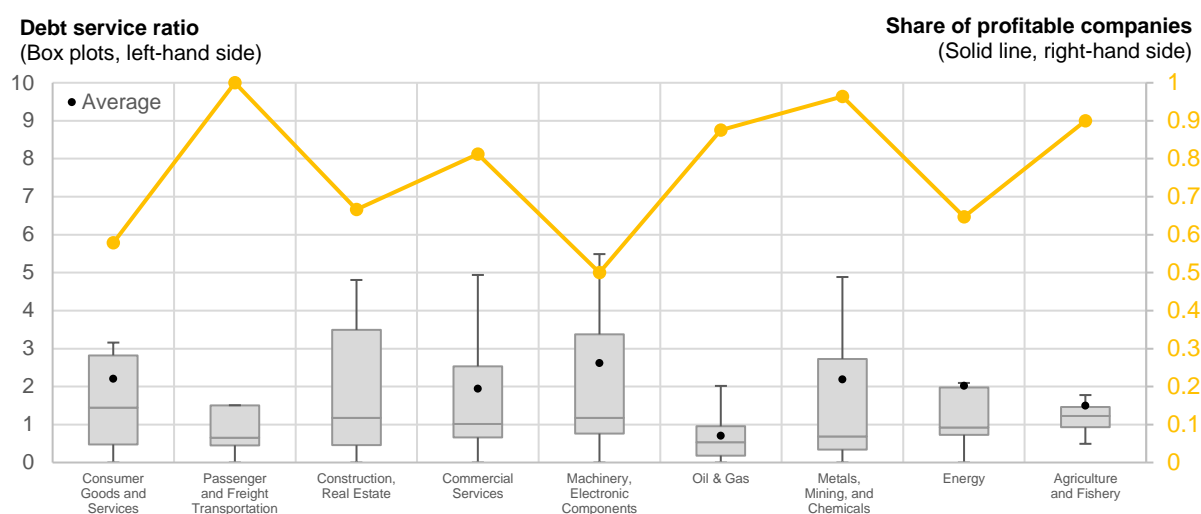
Figure 13. Debt service ratio, 2019
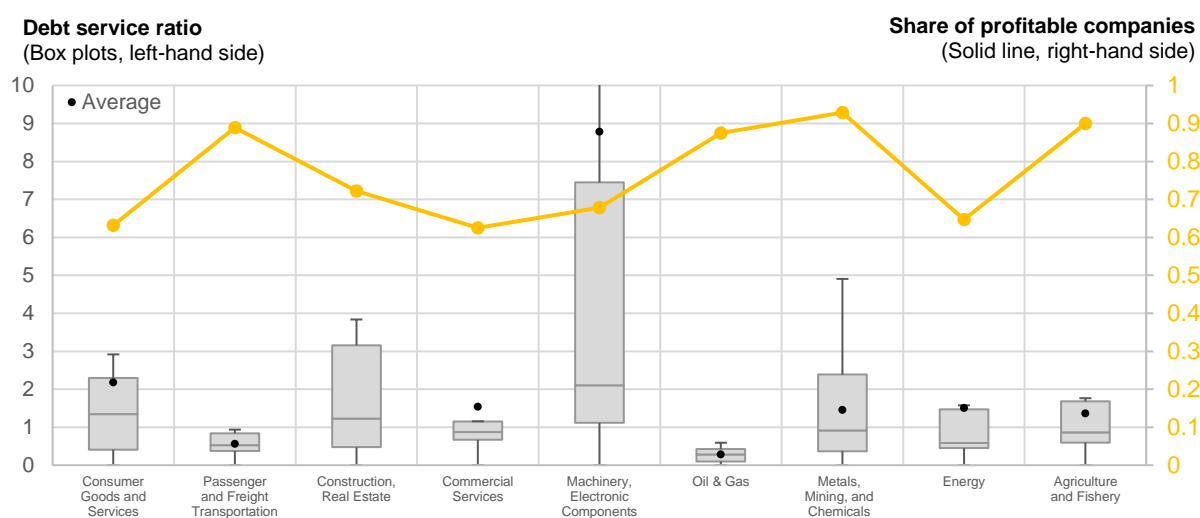
Note: the share of profitable companies is the ratio of the number of companies with positive profits to the total number of companies in this industry.

Figure 14. Debt service ratio, 2020

Note: the share of profitable companies is the ratio of the number of companies with positive profits to the total number of companies in this industry.

Figure 15. Debt service ratio, 2021

Note: The share of profitable companies is the ratio of the number of companies with positive profits to the total number of companies in the industry (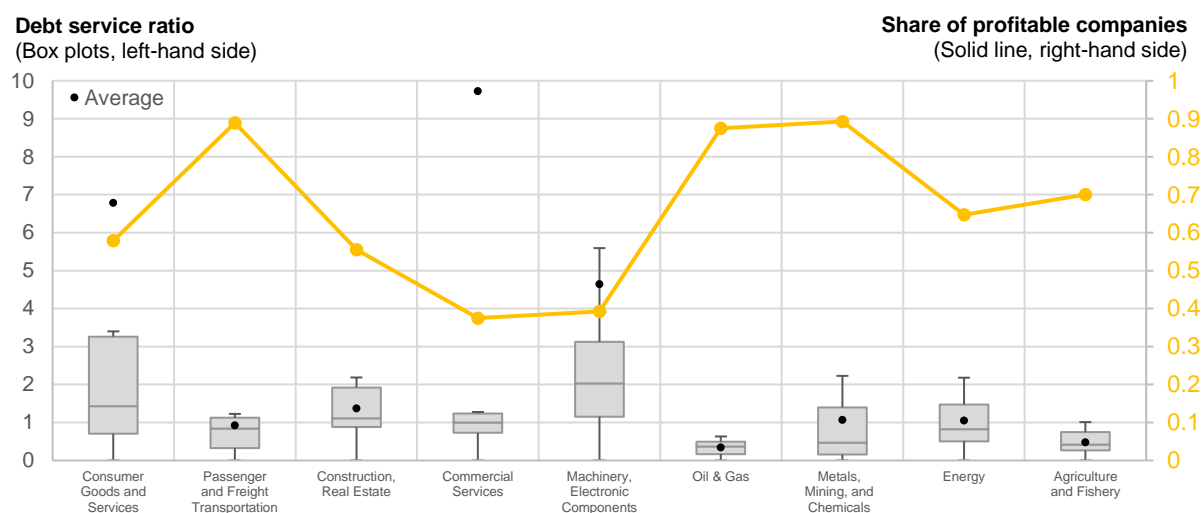which includes companies for which no data was provided for 2021). The decline in the share of profitable companies is due both to an increase in the number of unprofitable companies and to the lack of data for 2021 for several companies.

6.3. Correlation between rouble debt service and Russia and CIS-originated revenues

The comparison of the share of rouble debt service and revenues originated from Russia and CIS countries helps identify the currency mismatch between debt and revenue.

In Figure 16–18, the currency mismatch is illustrated by the position of the companies: they are not on the 45-degree line, that is, the share of rouble debt service does not coincide with the share of revenue originating from Russia and CIS countries. Companies above the 45-degree line are exposed to FX risks if the rouble weakens (FX

debt becomes more expensive as FX revenue is insufficient). Companies below the 45-degree line are exposed to FX risks if the rouble strengthens (rouble debt becomes more expensive as rouble revenue is insufficient).

Figure 16. Correlation between rouble debt service and revenues originating from Russia and the CIS, 2019
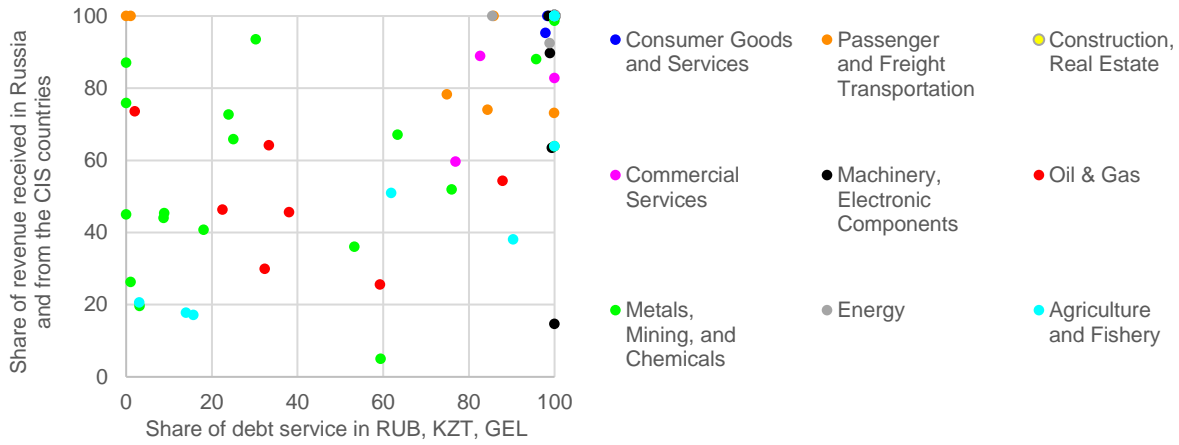

Figure 17. Correlation between rouble debt service and revenues originating from Russia and the CIS, 2020
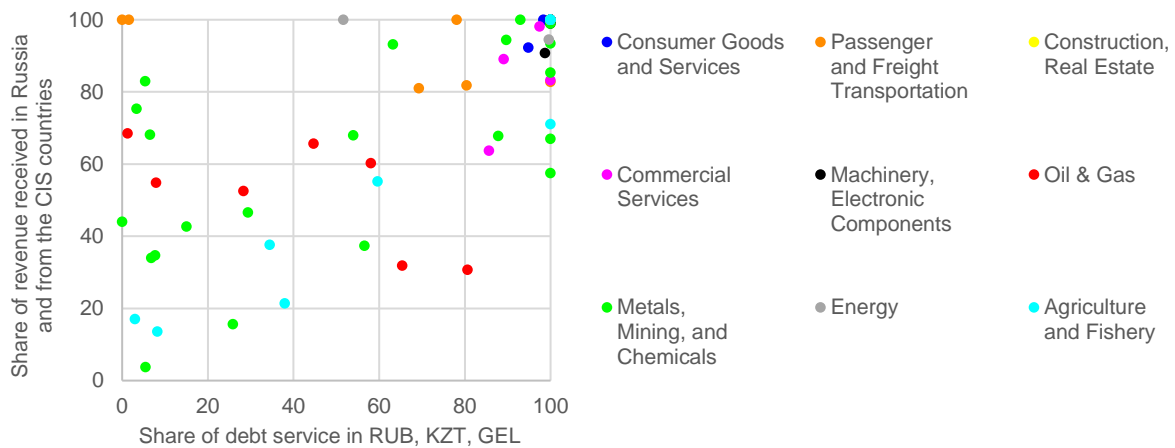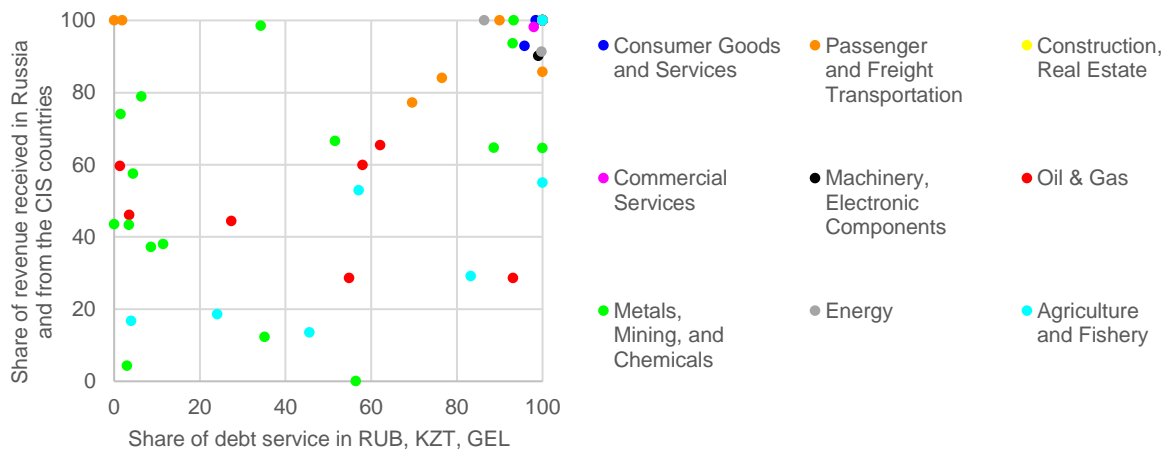

Figure 18. Correlation between rouble debt service and revenues originating from Russia and the CIS, 2021

The three sectors most exposed to foreign currency risks are the *oil and gas sector, metals, mining, and chemicals,* and *agriculture and fishery*. Businesses in these sectors tend to widely use derivatives to manage FX risks (see also (Burova et al., 2021)). To offset the impact of foreign currency risks, companies enter into cross-currency and interest rate swaps with Russian banks. In addition, some companies use foreign currency liabilities to hedge US dollar-denominated revenue.[15]

Companies in the *passenger and freight transportation,* machinery *and electronic components, energy, consumer goods and services,* and *commercial services* sectors mainly have rouble debt service and receive revenue in Russia and the CIS. However, several companies operating in global markets have FX debt and are exposed to FX risks. Importantly, this group includes corporates that have been working for several years to minimise foreign currency risk by aligning their liabilities in foreign currency with net export sales.

Separately, we would like to highlight a company in the *passenger and freight transportation* sector; it is located in the upper left corner of the coordinate plane. According to *Capital IQ*, the company has only FX debt and no FX revenue. The authors of the paper believe that the information about the absence of foreign currency revenues may be incorrect: according to the company's statements, the group has business operations in several jurisdictions and its Russian counterparties account for no more than 55% of its revenue.

In conclusion, let us mention *construction and real estate*. In 2019–2021, all such companies under study had both their debt and revenue denominated only in roubles, which is driven by the specifics of their business operations (construction and real estate management in Russia).

6.4. Rouble and FX DSRs

This subsection is dedicated to currency-weighted DSRs by sector.

First, we will explore the rouble-denominated DSR (yellow columns, Figure 19–21). There is particular concern about the machinery *and electronic components* sector: in 2019 and 2021, the number of companies with a DSR above 1 exceeded the number of companies with a DSR below 1. This trend is less pronounced in *consumer goods and services, agriculture and fishery,* and *construction and real estate*. There is less concern about the *oil and gas* sector.

Let us consider the FX DSR (grey columns, Figure 19–21). *Metals, mining and chemicals, oil and gas, agriculture and fishery, commercial services, passenger and freight transportation* are all sectors wherein at least one of the companies had a FX DSR above one unit in a particular year. This excess is of concern, suggesting that FX funds are insufficient to cover the FX debt service. However, as mentioned in the previous section, companies in these sectors use derivatives to hedge FX risks. Moreover, the FX debt of companies in *commercial services* and *passenger and freight transportation* sectors is relatively small and gradually subsiding over time.

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[15] For example, a metals company issued a bond loan for this purpose. The nominal amounts of FX revenue and hedging instruments are equal. At the same time, the share of ruble debt fluctuates around zero, with revenues received in Russia and the CIS making up 43%.

Although the previous subsection exposed the foreign currency mismatch in machinery, *energy, consumer goods and services* companies, their FX DSR is still less than 1 – an acceptable proportion of FX debt to FX income.

Figure 19. Distribution of rouble (RUB) and FX (non-RUB) DSR frequencies (by number of companies), 2019
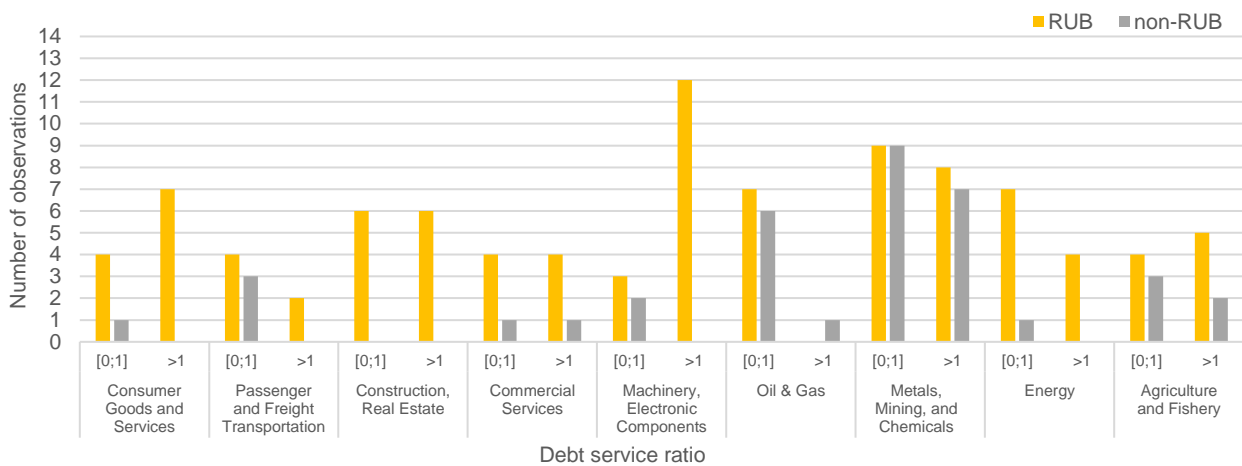

Figure 20. Distribution of rouble (RUB) and FX (non-RUB) DSR frequencies (by number of companies), 2020
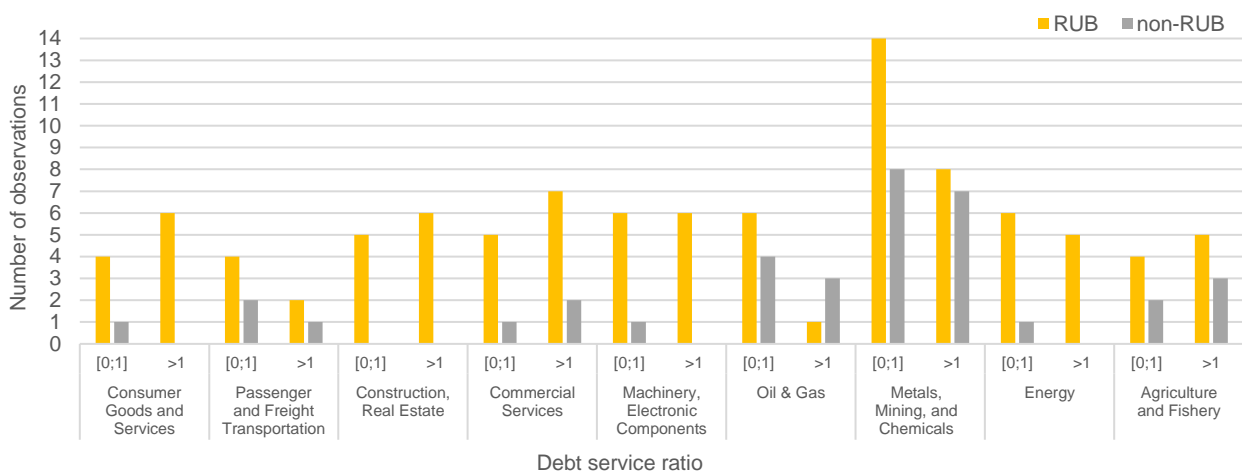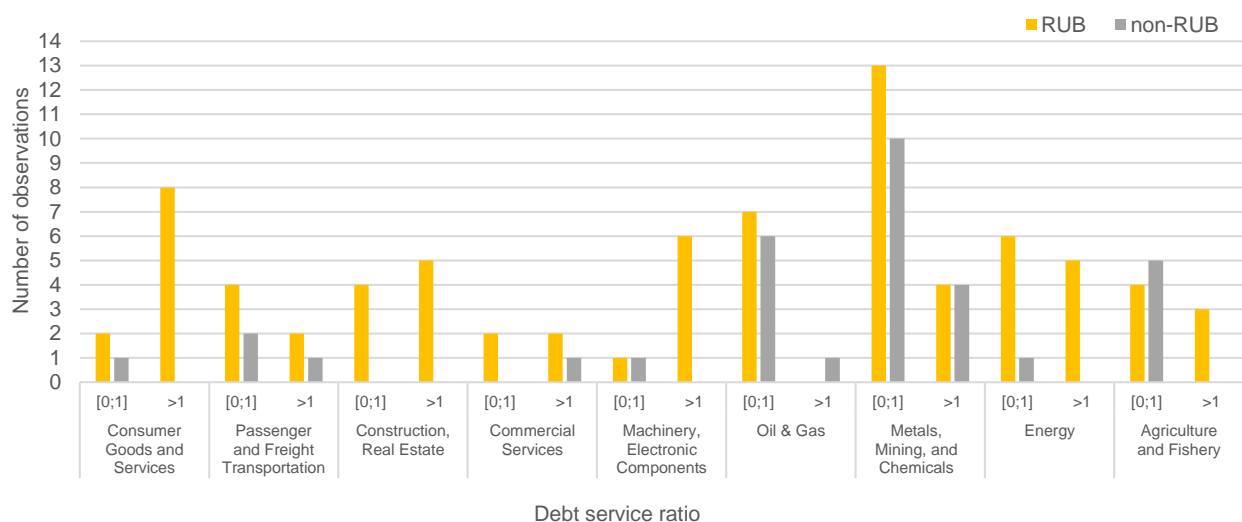

Figure 21. Distribution of rouble (RUB) and FX (non-RUB) DSR frequencies (by number of companies), 2021

6.5.   Findings of sectoral analysis

Based on the sectoral analysis, we highlight the following characteristics of sectors:

- The *machinery and electronic components* sector is the most alarming in terms of companies' ability to pay their debts. Companies in the sector include a large share of those unable to cover their debt with money. For those reporting positive profit, the DSR is higher on average than in other sectors.

- The *construction and real estate* sector is also of concern since it includes a high number of companies with very volatile profits, for which reason the companies are either unable to cover their debt service at all or able to cover its minor portion. Companies in the *consumer goods and services* sector also have low profit to cover their debt service, although it is less volatile than that in construction. An important feature of these two sectors is that business operations are mostly concentrated in Russia, so their exposure to FX risks is minimal.

- Not all companies in the *energy* sector have enough profit to cover their debt service. At the same time, most companies are not exposed to foreign currency risks thanks to the focus of their operations on Russia.

- Companies in the *passenger and freight transportation* sectors and *commercial services* are most diverse. On the one hand, some companies are of concern due to their high profit volatility; on the other hand, some sustain an acceptable level of debt service but are exposed to foreign currency risks.

- The clearest discrepancy between the share of rouble debt service and the share of revenue originating from Russia and CIS countries is found in *oil and gas*, *metals, mining and chemicals*, *agriculture and fishery* sector companies. They are exposed to FX risks when the rouble either weakens or strengthens. The FX mismatch is hedged by derivatives. Additionally, companies may issue FX debt to hedge future cash flows of foreign currency-denominated revenue.

7.   Role of credit lines in debt service coverage

In this section, we analyse whether credit lines can help pay off current liabilities. We discuss approved credit lines – contingent liabilities to credit institutions.

Companies consider credit line funds as a source of financial resources to cover current liabilities. Figure 22 shows how companies' positions change when credit lines from resident[16] banks are included in the cash debt service coverage ratio (horizontal axis). On average, additional debt service worth of 0.07 of assets can be covered.

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[16] Credit lines from non-resident banks are omitted, as our source of information (form 0409303) is drawn up only by resident banks.

Figure 22. The DSR, debt service coverage with cash and credit lines

Debt service coverage with cash and
(optionally) credit lines, scaled by total assets
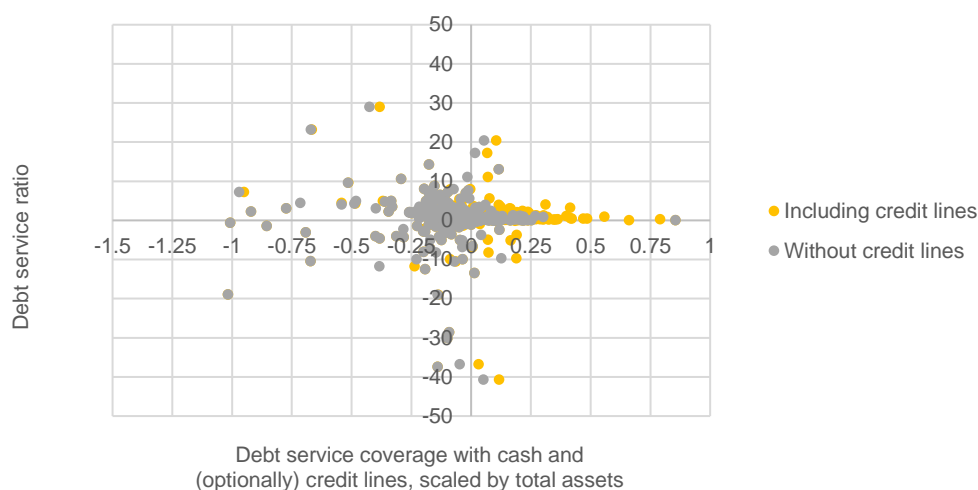
Let us examine the role of credit lines in the sectoral aspect. Figure 23–25 capture both the adequacy of cash (grey fill) and the adequacy of funds together with credit lines (yellow fill) to cover the debt service.

- Based on a comparison of median values (in 2019, Figure 23), companies with an adequate stock of approved credit lines before the pandemic include *energy* companies. Moreover, whereas the median value of the ratio decreased in 2020, the upper quartile fluctuated in 2019–2021 invariably around one level. This is a sign that energy companies enjoy 'support' in the form of approved credit lines, but view this opportunity as an option for the future rather than use it in full.

- Figure 24 it shows that in 2020 support through credit lines was more often used by companies in *construction and real estate* (based on the top quartile), machinery *and electronic components, metals, mining and chemicals,* and *commercial services* (judging by the median). However, we cannot say in this case that there were no changes in other industries. Since we are dealing with period-end values, we do not monitor intra-year changes in debt and approved limits and the reasons behind them. Accordingly, we do not distinguish the cases when corporate credit lines are increased and the company takes advantage of this within the same reporting year. For this reason, the increase in support through credit lines can suggest that companies in these sectors had credit lines approved, but did not use them to the full extent.

- Based on 2021 results (Figure 25), support through credit lines increased for companies in the *agriculture and fishery* (judging by the median) and *oil and gas* sectors (judging by the upper quartile).

Figure 23. Debt service coverage with cash and credit lines (to assets), 2019
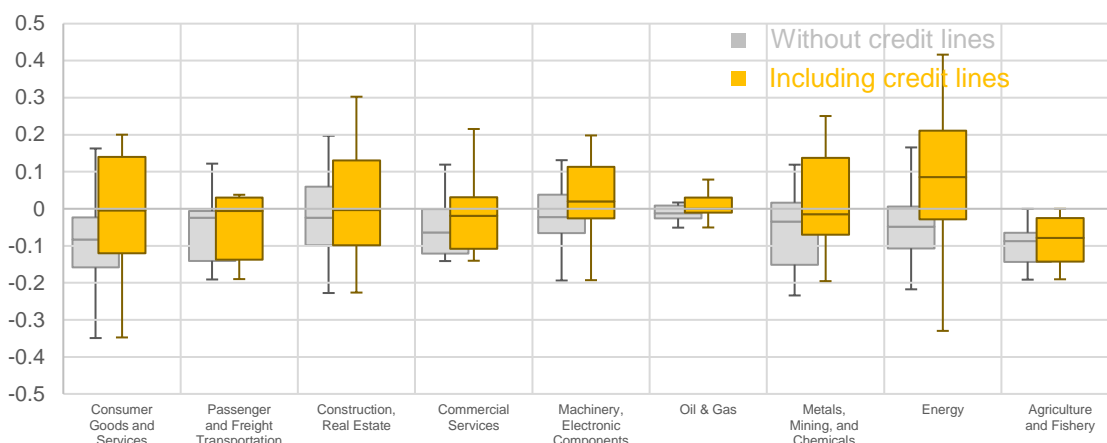
Figure 24. Debt service coverage with cash and credit lines (to assets), 2020
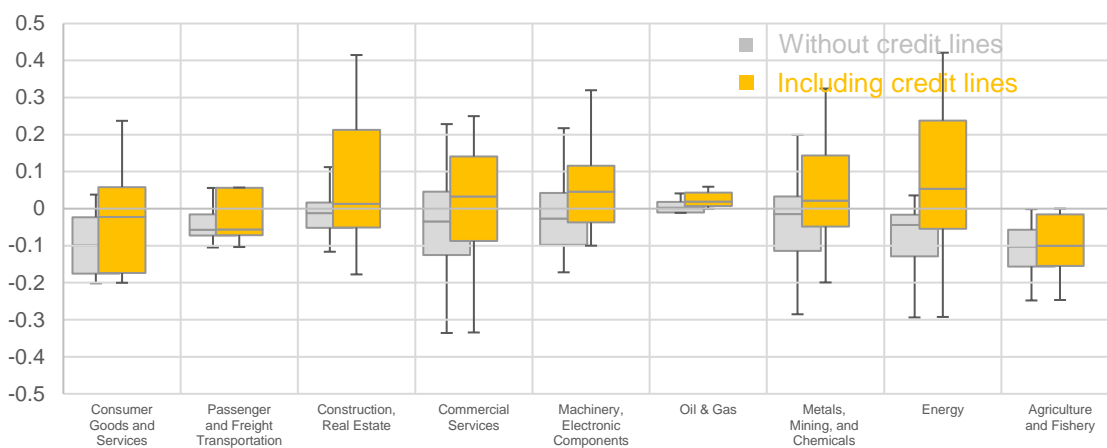
Figure 25. Debt service coverage with cash and credit lines (to assets), 2021
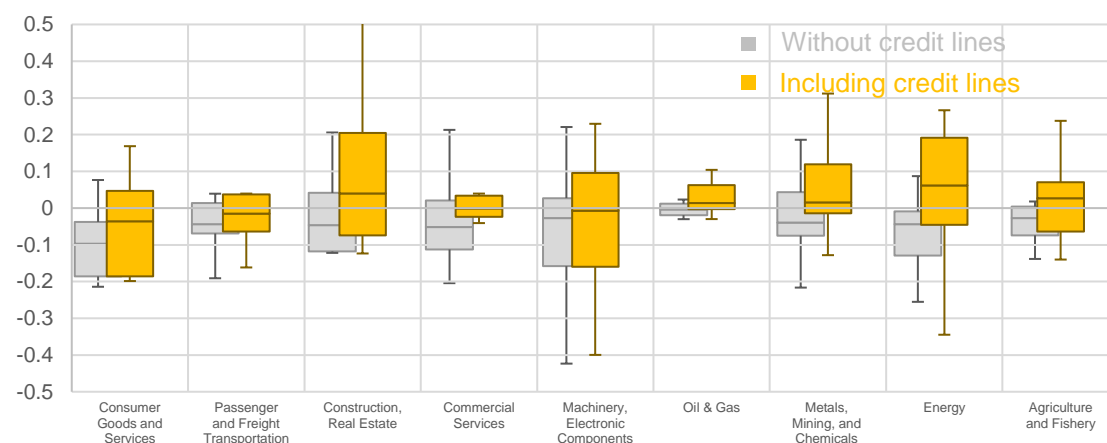
Appendix 5 additionally provides a breakdown of the proportion of credit limits to debt service. The analysis brings similar findings: throughout 2019–2021, credit lines lend strong support to the *energy* sector; growth in this support is most noticeable in *agriculture and fishery* companies in 2020–2021, and *construction and real estate* companies in 2021.

The optional use of funds of approved credit lines is an advantage for companies. However, this involves hidden risks to financial stability for the overall economy. Were companies to decide simultaneously to draw on credit lines, the banking system would have to ramp up the share of assets to cover existing debt, with more borrowers having insufficient funds (profit) to pay future debts. Credit institutions would then be confronted with stronger default risks. For this reason, the existing risks for the banking system should be stressed. The section that follows discusses a scenario when such risks realise.

8.   What if: a 25% revenue shock

This section examines the case of a 25% decline in revenues – a scenario where we explore changes in a company's ability to cover its debt.

The scenario analysis follows the approach of the Bank of International Settlements presented in the paper (Banerjee et al., 2020). Following the authors, we consider 25% revenue shock. To study companies' liquidity problems, the authors first calculate the revenue elasticity of operating costs. This elasticity can be estimated by a regression of operational cost growth (changes in the logarithm of operating costs) by the growth rate of revenue (change in the logarithm of revenue). A graphic illustration of the regression estimates across various industries is presented in Figure 26. It can be seen that in the third quarter all lines are above the dotted area, that is, operating costs decline at a slower rate than revenues are. In other words, in the event of the revenue shock, costs fail to adjust to the revenue level.

Figure 26. Response of operating costs to changes in revenues
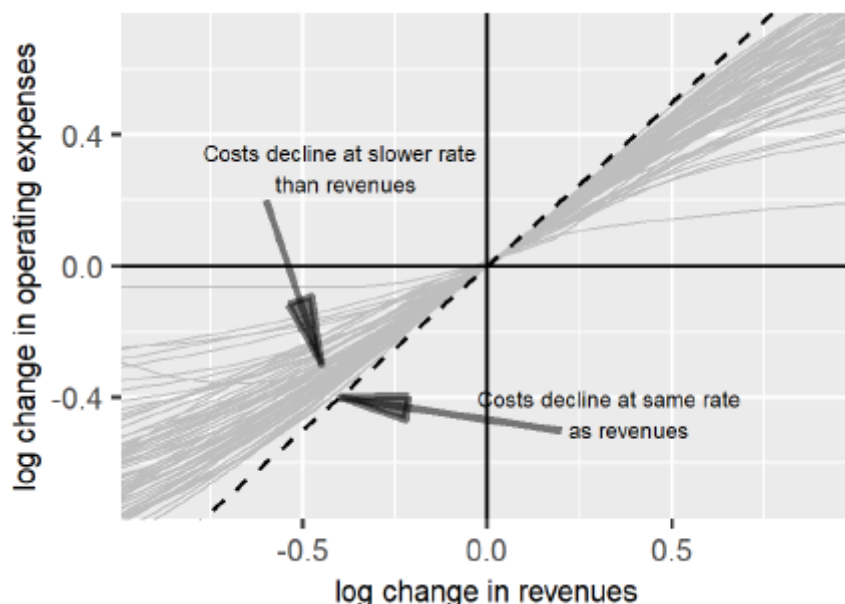
Source:[17] Banerjee et al. (2020)

Note: in their graph, the authors (Banerjee et al., 2020) use quarterly changes in the revenue logarithm and the logarithm of operating costs of 40,000 companies in 26 advanced

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[17] In other figures, unless indicated otherwise, the source is the authors' own calculations.

and emerging economies. The fitted grey curves are constructed using a generalised additive model (GAM) for 62 industries. The dotted line is 45 degrees.

(Banerjee et al., 2020) establish that the revenue elasticity of revenue is 0.6, that is, a 25% shrinkage in operating costs leads to a 15% drop in operating costs (0.6*100*25%).

(Banerjee et al., 2020) use the resulting elasticity to estimate the distribution of profitable and loss-making companies. We applied this approach[18] to the 2021 Russian data (Figure 27). The chart shows that the revenue shock triggers growth in the share of loss-making companies. We have the same results as (Banerjee, et al., 2020).

Figure 27. Proportion of revenue to operating costs
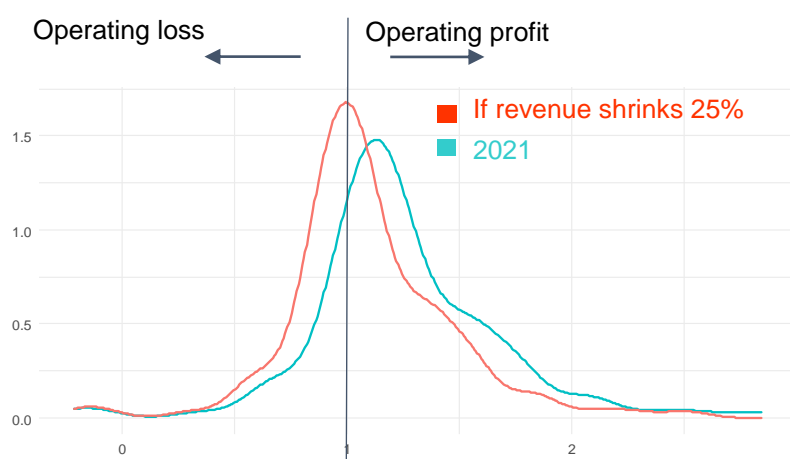
Source: Authors' calculations accounting for revenue elasticity of costs – Banerjee et al. (2020).

The obtained results were applied to calculate the DSR in the event of the revenue shock. We made the assumption that in the event of the shock, interest and principal would have to be paid, so the debt service remained unchanged in the scenario for the DSR (relative to 2021).

Figure 28 demonstrates the changes the sectors would face. The 25% revenue shock would cause a manifold increase in the DSR. Less than 25% of companies would be able to cover their debt service with their profits – in such sectors as construction and real estate, commercial services, machinery and electronic components, and energy.

If such a scenario materialises, companies will be forced to either restructure their debts or seek other sources to cover current liabilities in order to avoid bankruptcy. As mentioned in the previous section, approved credit lines may well be such sources. Credit line funds would just allow companies to postpone debt payments: debt service would be

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[18] In particular,

$$Oper.Profit^{shock} = Earnings^{Shock} - Oper.Costs^{Shock}$$
$$Earnings^{Shock} = (1 - 0.25) * Earnings^{2021}$$
$$Oper.Costs^{Shock} = (1 - 0.15) * Oper.Costs^{2021}$$

up in future periods. The use of credit lines may increase credit risks of individual banks
and financial stability risks of the overall economy.

Figure 28. DSRs under the revenue shock
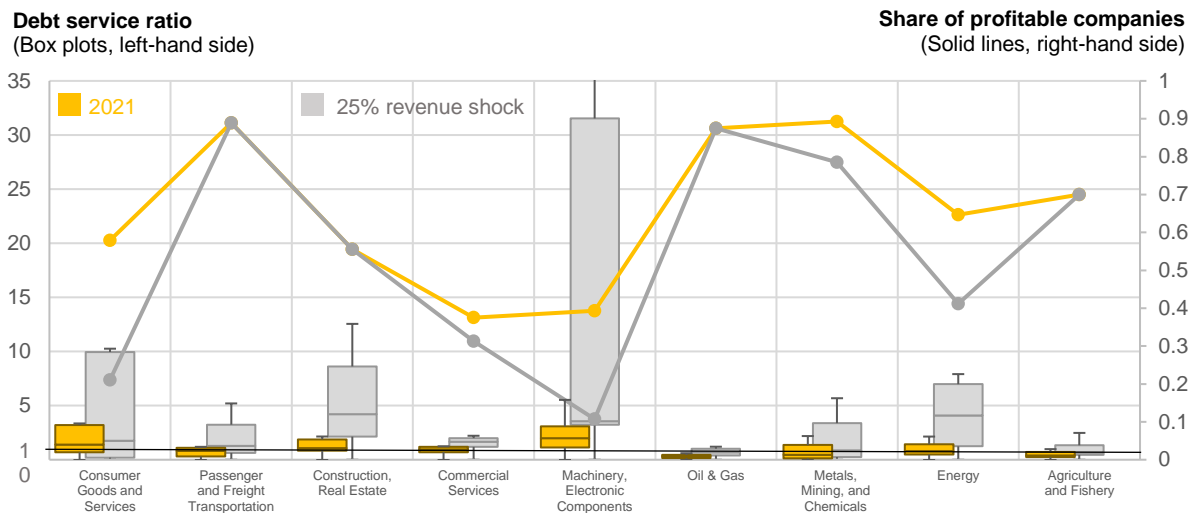
Note: The share of profitable companies is the ratio of the number of companies with positive
earnings to the total number of companies in the industry, which includes companies for which data
was not provided for 2021. The decline in the share of profitable companies in fig. 28 is associated
only with an increase in the number of unprofitable companies.

9.   Conclusions

The use of consolidated data on loans, bonds, lease and other debt from a currency
perspective makes it possible to refine the analysis of corporate debt service. The analysis
in this paper exposes weak points of sectors in a number of aspects (debt service coverage
overall and coverage by domestic and foreign currency).

The ability of machinery *and electronic components* companies to meet their current
liabilities is of the strongest concern. A relatively small portion of their debt is covered by
cash and profits. Companies in the *oil and gas* sector*, metals, mining and chemicals,* and
agriculture are highly exposed to FX risks. Foreign currency mismatch risks are hedged by
derivatives.

Beyond the DSR, it is worth taking into account available credit limits. On the one
hand, credit lines are intended to support companies in challenging times. In 2020, for
example, income of *construction and real estate* companies grew volatile compared to
2019, but the companies had the advantage of approved credit lines. On the other hand,
the simultaneous use of credit lines to cover debt carries financial stability risks. The
realisation of such risks in the event of the revenue shock may aggravate the situation in
the broader economy. The banking system is partially protected against such risks thanks
to the finalised approach to capital adequacy ratio calculation. Under this approach, credit
exposure to contingent liabilities with insignificant risk[19] is calculated with the ratio 0.1
instead of 0.

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[19] Contingent liabilities with insignificant risk include unused credit lines providing for the creditor bank's right
to close them if there are signs that the borrower may fail to repay the loan at maturity (Bank of Russia

This paper is not the last word in debt service analysis; a follow-up study could focus on the specifics of the market response to changes in corporate debt service and the importance of the DSR to investors.

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11. Appendices

Appendix 1. Company sample

Sector	Number of companies	Split	Number of companies
Oil and gas	9	Oil and gas	9
Metals, mining, and chemicals	28	Aluminium	1
		Steel	7
		Hardware	2
		Coal	3
		Gold	4
		Copper	1
		Cement	1
		Diamonds	1
		Diversified metals and mining	6
		Chemicals	1
		Production of pipes	1
Energy	17	Power generation	3
		Power distribution	13
		Alternative energy sources	1
Machinery and electronic components	27	Construction of equipment and heavy trucks	8
		Equipment	4
		Cars and components	3
		Electronic components	3
		R&D	9
Passenger and freight transportation	9	Air flights	2
		River and sea navigation	4
		Railroads	2
		Pipelines	1
Consumer goods and services	19	Core consumer goods	9
		Other consumer goods	6
		Pharmaceutics	3
		Telecasting	1
Agriculture and fishery	10	Agriculture	2
		Fishery	1
		Animal food	1
		Chemicals and fertilisers	6
Construction and real estate	18	Construction	11
		Real estate	7
Commercial services	16	Information technologies	3
		Communication services	4
		Utilities	3
		Industrial production	2
		Financial services	4
TOTAL	153	TOTAL	153

Appendix 2. Details of DSR calculation

We use the DSR formula presented in (Drehmann & Juselius, 2012):

$$\text{DSR}_t = \frac{\sum_{n=1}^{N} \dfrac{i_{n,t} * D_{n,t}}{\left(1 - \left(1 + i_{n,t}\right)^{-s_{n,t}}\right)}}{Y_t},$$

where $D_{n,t}$ is the balance of debt under liability *n* at the end of period *t*, *i* is the annualised interest rate, *s* is the remaining maturity, and *N* is the number of all various liabilities, *Y* is an income for the last 12 months of period *t*.

It is worth noting that for a zero-interest rate on a liability and/or maturity of less than one year, the calculation formula needs to be adjusted. Therefore, below is a more detailed calculation algorithm.

To calculate the DSR at time *t*, we need three indicators from corporate statements: the balance of debt under the liability *n* ($D_{n,t}$), the maturity date for this debt and its interest rate. Let us calculate the indicators $s_{n,t}$ and $i_{n,t}$ as follows:

$$s_{n,t} = \frac{1}{365} * [\text{If (Maturity Date } (n) - t) \geq 0, \quad \text{then (Maturity Date } (n) - t), \quad else\ 0]$$

$$i_{n,t} = \text{If}\left(s_{n,t} = 0\right), \text{then } 0, \text{else} \left[\text{If}\left(s_{n,t} < 1\right), \text{then } \left(1 + \frac{\text{Interest Rate}}{100 * 12}\right)^{12 * s_{n,t}} - 1, \text{else } \left(1 + \frac{\text{Interest Rate}}{100 * 12}\right)^{12} - 1\right]$$

We assume that the principal debt under loans, credit lines and leases is repaid throughout the maturity period (by annuity payments), and the principal debt on bonds and other debt is repaid at the end of the maturity period.

Then, the DSR numerator is adjusted as follows:

$$DSR\ Numerator\ (\text{debt service}) = \text{If}\left(\text{payment of principal debt at maturity and } s_{n,t} > 1\right),$$
$$\text{then } D_{n,t} * i_{n,t},$$
$$\text{else}\left[\text{If}\left(i_{n,t} = 0\right), \quad \text{then}\left[If\left(s_{n,t} \leq 1\right), \text{then } D_{n,t}, \quad else\ \frac{D_{n,t}}{s_{n,t}}\right],\right.$$
$$\left.\text{else}\left[\text{If}\left(s_{n,t} \leq 1\right), \text{then } D_{n,t} * \left(1 + i_{n,t}\right), \text{else } \frac{i_{n,t} * D_{n,t}}{(1 - \left(1 + i_{n,t}\right)^{-s_{n,t}}}\right]\right]$$

Appendix 3. Descriptive statistics
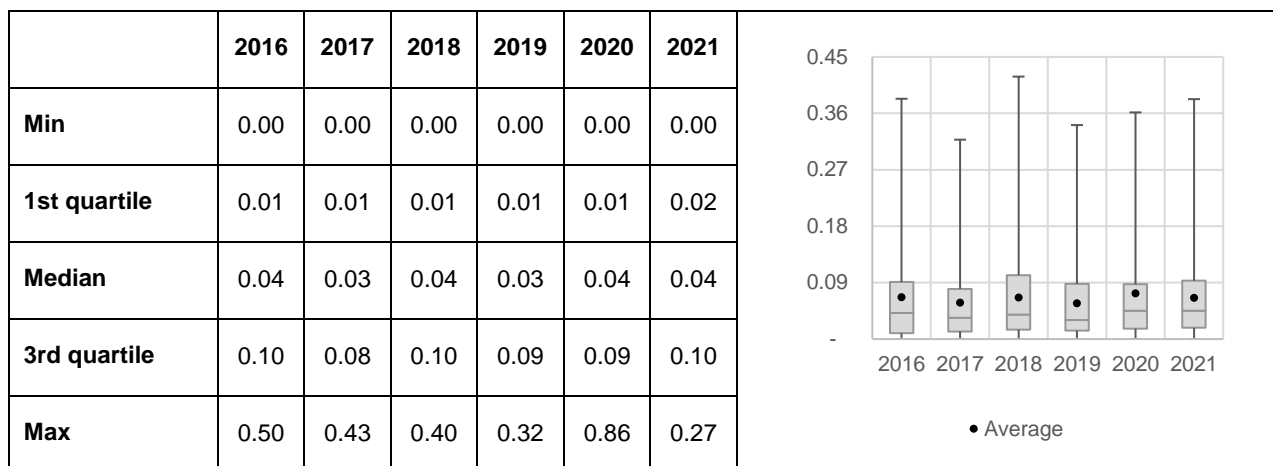
Table 2. Cash to assets ratio

	2016	2017	2018	2019	2020	2021
Min	0.00	0.00	0.00	0.00	0.00	0.00
1st quartile	0.01	0.01	0.01	0.01	0.01	0.02
Median	0.04	0.03	0.04	0.03	0.04	0.04
3rd quartile	0.10	0.08	0.10	0.09	0.09	0.10
Max	0.50	0.43	0.40	0.32	0.86	0.27

Table 3. Assets (logarithm)

	2016	2017	2018	2019	2020	2021
Min	18	18	19	17	17	16
1st quartile	22	22	22	22	22	23
Median	24	24	24	24	24	25
3rd quartile	26	26	26	26	26	27
Max	30	31	31	31	31	31

Table 4. Debt service (logarithm)

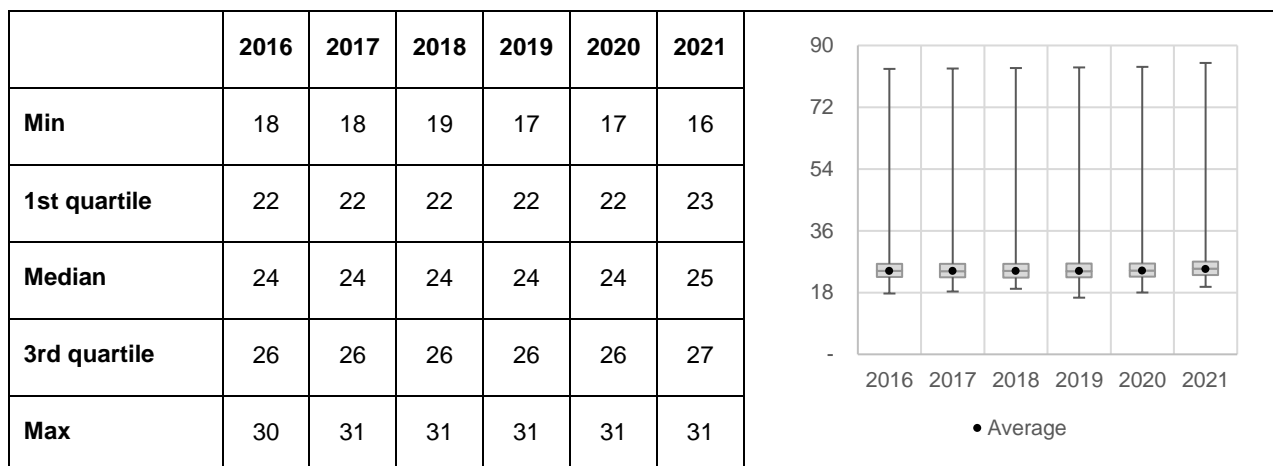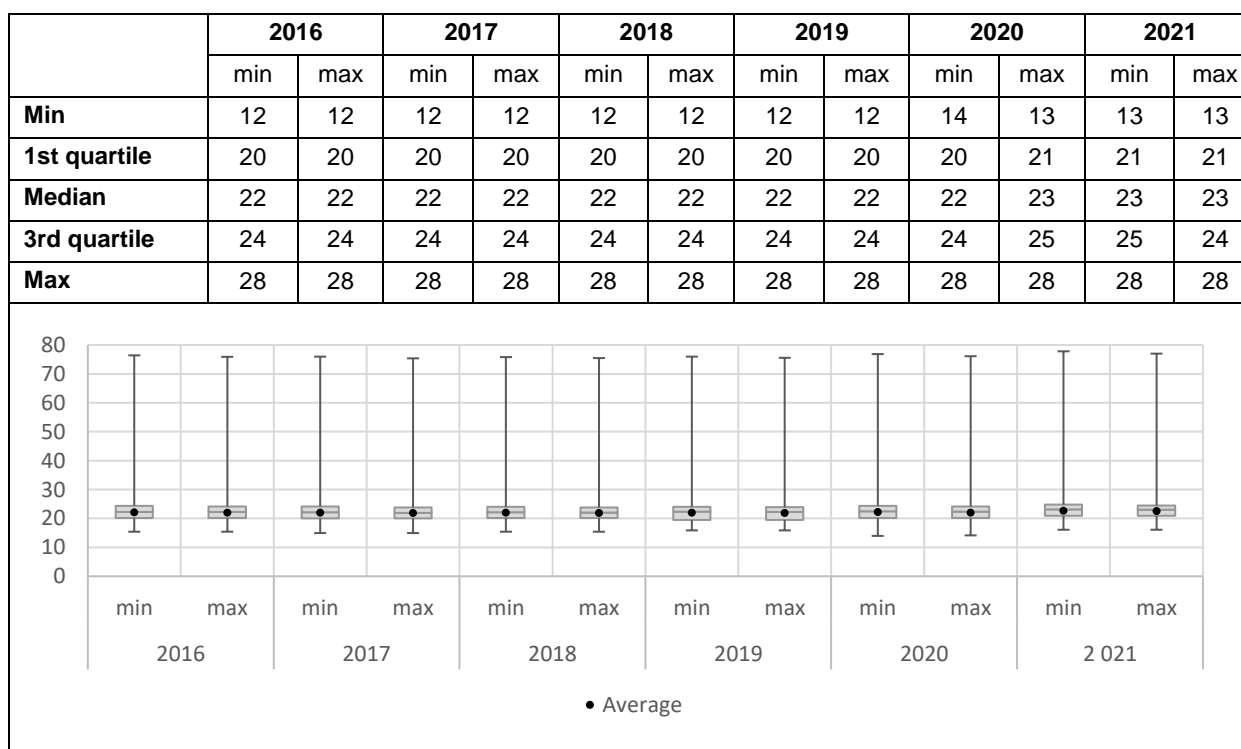|	2016		2017		2018		2019		2020		2021	
	min	max	min	max	min	max	min	max	min	max	min	max
Min	12	12	12	12	12	12	12	12	14	13	13	13
1st quartile	20	20	20	20	20	20	20	20	20	21	21	21
Median	22	22	22	22	22	22	22	22	22	23	23	23
3rd quartile	24	24	24	24	24	24	24	24	24	25	25	24
Max	28	28	28	28	28	28	28	28	28	28	28	28

Appendix 4. Comparison of the DSR based on consolidated and unconsolidated statements (by year)

The results for 2019 presented in the principal text of this paper reoccur in 2020 and 2021. Also, regardless of the data source, the dynamics of median and quartile values remain unchanged.

Figure 29. DSR, consolidated and unconsolidated data, 2019–2021
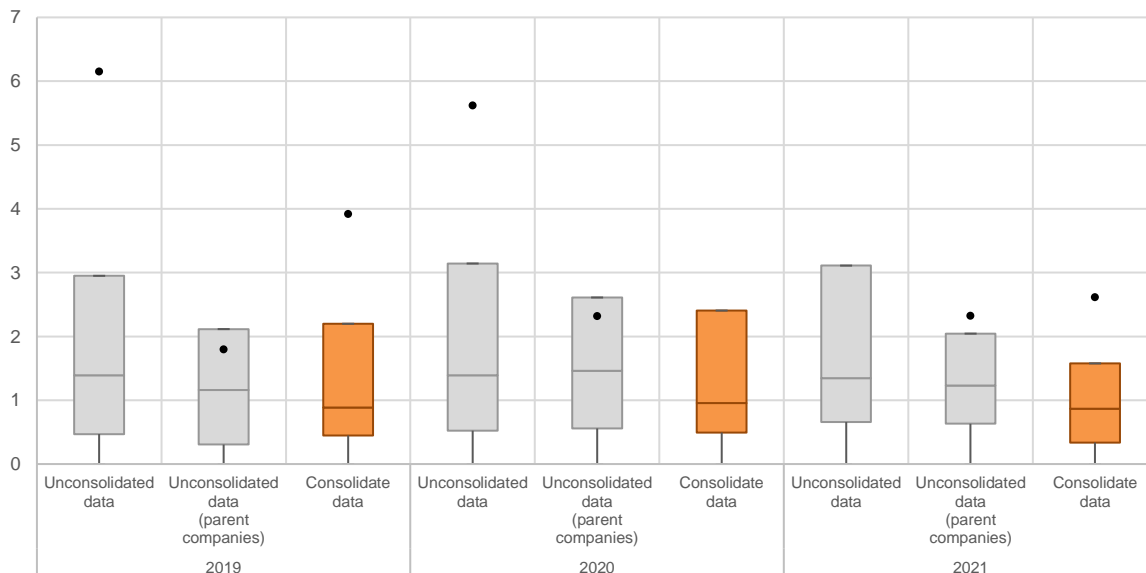
Note. The revenue level (unconsolidated data) in 2021 was obtained by multiplying the level of revenue in 2020 by the GDP growth rate at current prices (1.2) following the absence of up-to-date data in *SPARK*.

Appendix 5. Proportion of credit limits to debt service

Figure 30. Ratio of available credit limits to debt service, 2019

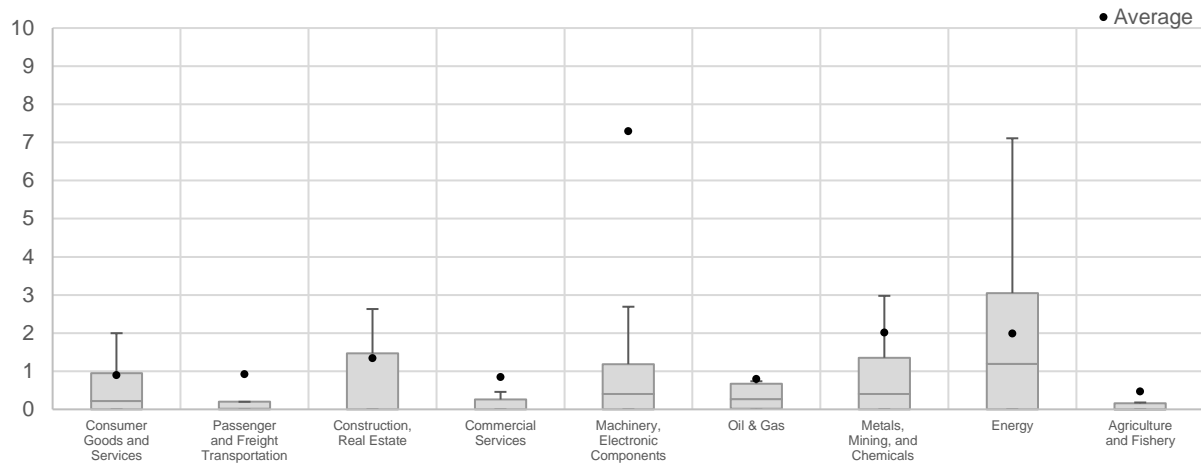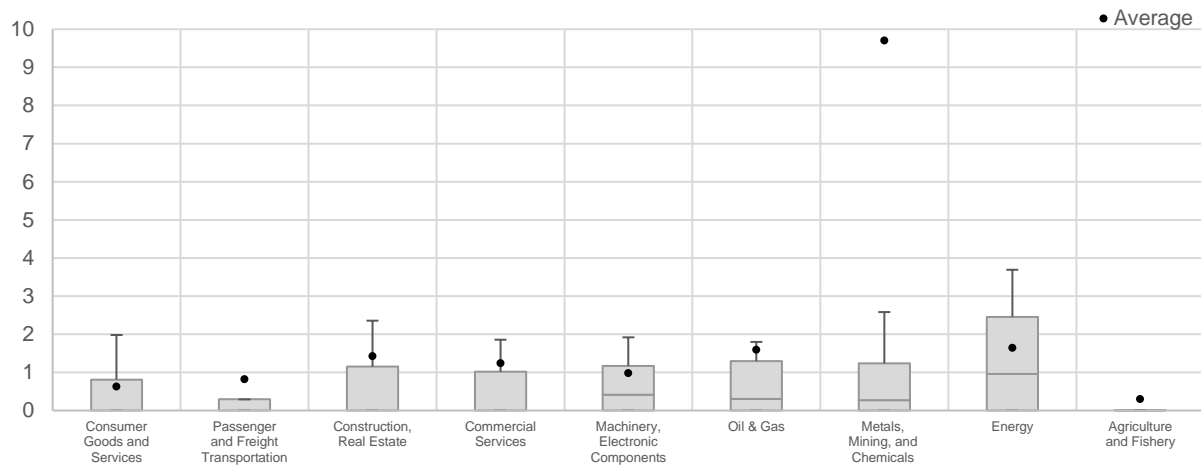*Figure 31. Ratio of available credit limits to debt service, 2020*

Figure 32. Ratio of available credit limits to debt service, 2021