CORPORATE LIQUIDITY IN CORONACRISIS: EXPERIENCE OF SERBIAN ECONOMY

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Abstract

The appearance of coronavirus in the spring of 2020 has significantly revalued risk exposures in the business environment, which required new approaches in the measurement of financial risks. This paper defines and explains a new approach to the measurement of liquidity risk in companies in a time of an economic crisis. This approach is more responsive to stressful circumstances in the business environment and measures the time in an economic crisis when a company can still pay maturing liabilities out of its own inventory of liquid assets, where sales of a company on the market are limited or completely prohibited, as this was the case for some industries during the first wave of Covid -19 in spring 2020. The objective of this paper was to define a new metric for the measurement of corporate liquidity, which is sensitive to this environment and shows the propensity of a company to the risk of illiquidity if an economic crisis appears. This paper, in the next step, leverages the newly defined metric of corporate liquidity and calculates the average liquidity of all companies, as well as the average liquidity by business sectors in the Serbian economy, to discuss corporate liquidity in a crisis. The results show that the average liquidity of the Serbian economy in crisis at the end of 3Q 2020 was 78,02 days, i.e., the average company in the Serbian economy was able to survive 78,02 days in stress by the end of 3Q 2020 if its sales on the market were prohibited.

Implications for Central European audience: The model in this paper is in the interest of every company and bank to measure the liquidity risk of business partners in times of an economic crisis and to predict which business partners may have liquidity problems in crisis and may therefore not be able to pay their open liabilities. The contribution of this paper to liquidity risk measurement in companies in times of stress is high as the currently available literature does not offer an alternative approach.

Keywords: corporate liquidity; risk management; stressed liquid assets; stress testing
JEL Classification: G32, C53, D22

Introduction

Donthu and Gustafsson (2020) argue that early in 2020, the appearance of coronavirus changed the business environment overnight. Dramatic changes appeared in how businesses act and consumers behave. As this was a new virus with unknown properties

relating to its spread, impact and consequences on health, severity and other relevant properties, governments in many countries have reacted rapidly and vigorously by limiting public life and hence limiting the economic activity of industry sectors, which interact with crowds of people. These government measures have hit hard especially small businesses, explains Kalogiannidis (2020). He further explains that due to the lockdown, many small businesses were shut down permanently. Haliti Baruti (2021) explains that countries in the western Balkan which implemented immediate lockdowns, such as Greece, Romania, Montenegro, Serbia, and Slovenia, experienced an increase in the unemployment rate, which rose from 4.8% to 46%. This increase illustrates the negative impact of the pandemic towards socioeconomic welfare.

Governmental measures have surprised many businesses, on the one hand, because market participants have not believed that the appearance of a pandemic is possible due to the available knowledge and technology which current society possesses, and on the other hand, because nobody expected that the total prohibition of business operation is a feasible measure. Moreover, due to uncertainty within the market, banks have responded by reducing available loans to companies. As a result, market participants have realised that they need to rely primarily on their own inventory of liquid assets to pay maturing liabilities. Own inventory of cash and cash equivalents has become more important than ever. This conclusion has made market participants aware that they were in a stressful economic situation. Challenges and consequences of entrepreneurship during the times of the COVID-19 pandemic have been studied and also explained by Dvouletý et al. (2021). Their finding is that a pandemic undoubtedly represents a challenge for entrepreneurs and self-employed persons. Hence, the pandemic may motivate researchers to establish new partnerships, especially with policymakers, but also with professional organisations and entrepreneurs, with a mutual objective to cooperate on research activities, providing data platforms to derive actions and policies that are compatible with entrepreneurship. Authors further argue that it is crucial to see the COVID-19 pandemic as another crisis, compare it with prior crises and shocks, revisit the established theories and use them to better understand entrepreneurial behaviour in the post-pandemic period. Stakeholders need to better understand the new business registrations and entrepreneurial intentions if these have grown during the pandemic and exceeded the bankruptcies, and discouraged individuals by adverse times from starting a new venture. With the awareness that the company is under stress, the management of the company has been motivated to think about how the same business environment has hit its business partners. It may have reduced their operating cash flows and, consequently, their ability to pay open claims, which will deteriorate the liquidity position of their suppliers. Research results of Bartik et al. (2020) show that many small businesses were financially fragile at the eruption of the coronacrisis. At that time, half of all businesses with monthly expenses of 10.000 USD had available cash in hand to cover ongoing expenses only for two weeks. Demmou et al. (2021) also explain that without any policy intervention, up to 38% of firms would face liquidity shortfalls after ten months after the implementation of confinement measures.

Therefore, existing risk management practices in companies had to be upgraded with techniques to predict the liquidity position of business partners in stressful conditions.

The purpose of this paper is to critically review metrics for the measurement of corporate liquidity that are currently in practice and to introduce a new robust metric for the

Volume **12** | Issue **1** | 2023
https://doi.org/10.18267/j.cebr.311

measurement of corporate liquidity, which shows the strength of the corporate's balance sheet and, consequently, corporate liquidity in case of an economic crisis. Our hypothesis is that corporate liquidity risk metrics currently in use show static corporate liquidity and not base corporate liquidity, which is corporate liquidity in a worst-case scenario, and this worst-case scenario may appear in times of an economic crisis. Something close to the worst-case scenario we have witnessed for a very short period of time during the eruption of Covid-19 in the spring of 2020.

1 Literature review

Liquidity risk management incorporates has been so far studied by many authors. Azman (2019) explains that corporate liquidity depends on internal and external factors. External factors expose GDP, which is positively correlated with corporate liquidity. The operating margin is the most significant internal factor which drives corporate liquidity. The higher the operating margin, the better the liquidity position of a company. Huang (2018) has studied the importance of corporate liquidity, and which variables measure and reflect corporate liquidity. He shows that excess cash improves trading continuity and reduces both liquidity risk and the cost of equity capital. His research results further show that firms with excess cash attract more traders even when market liquidity dries up. This indicates that investors consider firms with excess cash as firms with a smaller exposure to the risk of illiquidity, which would result in their inability to pay received invoices.

Ghaly et al. (2015) have studied the relationship between employee welfare practices and corporate cash holdings. Results of the research have shown that companies, which are strongly committed to employee well-being, hold more cash. The effect of employee welfare standards on cash holdings is stronger for firms in human capital-intensive, competitive, and high-labour-mobility industries in which employees are more important to their businesses. These results are consistent with the predictions of the stakeholder theory and provide new evidence about how human capital and employee relations impact cash management policy.

Corporate liquidity in crisis has been researched by many authors. Wang and Simi (2015) studied corporate liquidity during the financial crisis of 2008. Their research shows that corporate liquidity risk played a significant role in impacting stock returns. Drivers of unpredicted rises in corporate liquidity have been explored by Boileau and Moyen (2016). They have found two factors which increase cash holdings in companies and their use of credit lines. These are the reduction of the cost to hold liquidity and an increase in risk. And this research is particularly important when we think about corporate liquidity in times of crisis. Any crisis increases risk in a business environment, and as a response to a crisis in a business environment, we can expect companies to increase their inventories of liquid assets.

Li (2020) has studied the role of accounting quality in accessing credit lines for liquidity purposes. His research shows that some firms meet liquidity needs through cash holdings and not through credit lines, as the literature suggests. The reason for such decisions is limited access to credit markets. And access to credit markets is even more limited in a crisis. As a result, companies hold more cash than credit lines when they are distressed when credit markets are tightening, which was also the case during the financial crisis in 2007-2008. Chang et al. (2017) studied the impact of cash holdings on firm values before and during the 2008 financial crisis. Research has shown that the equity market places a higher value on

corporate cash holdings during a financial crisis. Additionally, research has also shown that cash holdings are more valuable to companies with financial constraints compared to companies without financial constraints.

The impact of a crisis on cash holdings for family firms has been studied by Macciocchi and Tiscini (2016). Specifically, they have studied the behaviour of family firms in financial crises. Within their research, they show that during a financial crisis, family firms report higher performance, experience more financial support from their shareholders, report lower investment cuts, have a greater level of cash and have lower leverage ratios in comparison to non-family firms. As a result, they show that owners of family companies have a greater incentive to preserve the continuity of the firms during a financial crisis in comparison to owners of widely held public corporations.

The correlation between uncertainty and cash holdings has also been studied by many authors. Im et al. (2017) have studied uncertainty in general and cash holdings. Based on their work, they have found that a company facing higher uncertainty has a higher value of cash, which is mainly driven by the increased value of the option to wait and see. The same correlation between uncertainty and cash holdings has been further explored by Miloud (2020). He explored the impact of systematic uncertainty on corporate cash holdings. The empirical results of his research show that macroeconomic uncertainties significantly drive the cash holdings of a company. Companies with a higher level of exposure to macroeconomic uncertainty have a higher level of cash holdings. Duong et al. (2020) have also explored the correlation between economic policy and corporate cash holdings. They have found that U.S. corporations increase their cash holdings in response to higher economic policy uncertainty. Higher cash holdings due to policy uncertainty alleviate the negative impact of policy uncertainty on capital investment and innovation outputs.

Chen et al. (2020) propose CEO overconfidence to be an alternative explanation of corporate cash holdings. They have found positive effects of CEO overconfidence on the level of cash holdings. Some authors have studied the relationship between corporate liquidity and productivity. This relationship has been theoretically and empirically explored also by Feng et al. (2020). With a dynamic investment model, they showed that more productive companies require less capital and hold more liquidity compared to less productive companies when financing costs are sufficiently high. They have empirically proven this hypothesis based on a comprehensive dataset of Chinese manufacturers, but they were unable to prove the same hypothesis for U.S. manufacturers. A similar study was made by Lusida and Suk (2019). They investigated if manufacturing firms in Indonesia, which have high productivity, also have a high level of liquidity. For the research, they used data from manufacturing firms listed on the Indonesia Stock Exchange in the period 2008 to 2017. They measured productivity with the Generalised Method of Moments and the effects of productivity on corporate liquidity with the linear panel model. Research has shown that manufacturing firms in Indonesia with high productivity levels have a higher level of corporate liquidity in comparison with firms which have lower levels of productivity. The same research also shows that other types of financial frictions incentivise firms to allocate more of their resource to liquid assets than to fixed assets.

A lot of research work has also been conducted in the field of liquidity risk measurement in companies. Zakaria (2009) has studied static and dynamic metrics of corporate liquidity. Her study has shown that both earnings and cash flow can provide information about corporate

Volume **12** | Issue **1** | 2023
https://doi.org/10.18267/j.cebr.311

liquidity in small and medium enterprises in Malaysia in line with the dynamic measurement of corporate liquidity, whereas static liquidity risk metrics represented by the current ratio and quick ratio did not show any significant relationship with corporate liquidity. Some authors have studied only dynamic metrics of corporate liquidity. Such an example is Anderson and Carverhill (2004). They have studied a continuous-time model of a levered firm with fixed assets generating a cash flow which fluctuates with business conditions. Their study shows that the cash holdings of a company are a non-monotonic function of business conditions. In good times, the firm does not need a high liquidity reserve, but as conditions deteriorate, it will target a higher reserve. In very poor conditions, the firm will declare bankruptcy, usually after it has depleted its entire liquidity reserve. Jankensgård (2010) introduces a framework for the measurement of liquidity risk in corporates. Defined measures of liquidity risk are designed to avoid financial distress or default and to undertake all strategic investments. All of them have two important features. One is the dependency on the balance sheet as a risk buffer. The second feature of a liquidity risk measure is its ability to estimate the opportunity costs in terms of the value of the investment opportunities that a liquidity shortage could jeopardise. The author illustrates the application of the proposed risk measures with an example of a company evaluating a hedging strategy, where the author shows how to assess the effectiveness of a proposed hedge in terms of its expected ability to reduce costly cash shortfalls in scenarios in which the firm's debt capacity is also expected to be depleted. Tomczak (2014) has analysed five liquidity ratios with predictive characteristics to reflect changes in the financial condition of the manufacturing companies during the year prior to bankruptcy in the period 2007-2012. His research establishes limit values for three analysed indicators, below or above which there is over-liquidity or a lack of liquidity in the manufacturing sector. However, his research does not specifically limit values for two liquidity ratios.

Management of corporate liquidity is mandatory at all times to avoid bankruptcy of a company as defined in the bankruptcy legislation. Bankruptcy legislation by countries may be different, but the definition of bankruptcy is similar. Bankruptcy is typically defined as an unfavourable financial position of a company, where the company is unable to pay for its current liabilities on a longer time horizon. Consequently, bankruptcy law does not talk about the instant inability to pay for current liabilities. Instead, it describes the inability to pay for current liabilities over a longer period of time, which demonstrates severe trouble in the balance sheet of a company and hence poor outlook for creditors to expect from the company to pay for maturing liabilities in the near future. Existing literature explains various metrics for measuring corporate liquidity, where all these metrics have one common characteristic. They all measure and show corporate liquidity at one particular moment in time and give no information about expected corporate liquidity in the next moment. Bankruptcy legislation leverages existing metrics for the measurement of corporate liquidity and observes if a company is able to pay for current liabilities now. If a company is unable to pay, the bankruptcy legislation reiterates the same question again every day over the period of time as defined in the bankruptcy legislation. In case of minor difficulties in the balance sheet of a company, the company will be able to pay for maturing liabilities before the long period of time as defined in the bankruptcy legislation expires. But if there are severe difficulties in the balance sheet of a company, the company will not be able to fix existing problems in the balance sheet before the long period of time as defined in the bankruptcy legislation expires and will go bankrupt.

By all means, bankruptcy is an event that each company wants to avoid. So we need a tool which will help each company to avoid entering into a longer period of time as defined in the bankruptcy legislation. Therefore, we need a different metric of corporate liquidity, which eliminates the weaknesses of existing metrics of corporate liquidity. This is an instantaneous reflection of corporate liquidity and provides information about expected corporate liquidity in the next moment.

After a comprehensive literature review, we find that existing literature does not explore how to measure corporate liquidity in times of stress in a business environment and if companies with higher cash holdings are better prepared for disturbances in a business environment. This paper expands the economic literature with the methodology to measure corporate liquidity in times of stress. This contribution is in the interest of every market participant who wants to measure the corporate liquidity of its business partners and who wants to identify business partners with low liquidity on the doorstep of an economic crisis, which may lead to late payments or even defaults later in crisis. This contribution is also in the interest of banks to measure the liquidity capabilities of clients, which will help to identify clients that may become unable to pay periodic instalments for loans in a crisis. Finally, the research results from this paper are in the interest of consultants, who help companies to build or upgrade risk management systems suitable for stressful conditions in a business environment.

2 Methodology

De Vito and Gomez (2020) have defined the cash burn rate as a ratio between cash and cash flow from operations. Cash includes corporate cash holdings and accounts receivables. Based on this definition, the cash burn rate measures how long a company is able to pay for its operating costs without cash contributions from creditors or shareholders. This ratio consequently shows how many days it would take for the company's current cash flow from operations to build up (if positive) or burn through (if negative) its cash holdings.

We will use so defined ratio as a starting point, and we will further develop it to obtain a metric suitable for the measurement of corporate liquidity in a crisis. This new metric will measure the number of days when a company can pay maturing liabilities in crisis out of its own inventory of liquid assets, which are available to the company in stress. We assume that during a pandemic, sales of products and services on the market are limited or completely prohibited, as this was the case for some industries and in some countries during the first wave of Covid-19 in the spring of 2020. We have named this new metric of corporate liquidity as the survival period in crisis, or alternatively, as Time To Wall (TTW). It is defined as a ratio between the stressed liquid assets and the absolute value of the negative cash flow, where the negative cash flow usually appears if sales on the market are limited or prohibited due to government measures or other restrictions on the market. Results tell us how long a company in an economic crisis can survive before it runs out of its own inventory of stressed liquid assets and before it runs into liquidity problems. If reduced sales lead to a non-negative cash flow and the cash flow in spite of sales reduction remains positive, then the mathematical result of TTW is infinite. However, since the TTW metric is a metric of corporate liquidity and since liquidity is a short-term economic category, the TTW result has, in line with economic theory, an upper bound, which is 365 days.

For TTW calculation purposes, we will use an expanded definition of cash flow. Therefore, we will also include in the calculation of the cash flow, besides the net profit, depreciation and

Volume **12** | Issue **1** | 2023
https://doi.org/10.18267/j.cebr.311

write-offs, deferred costs and accrued revenues, accrued costs and deferred revenues and fair value reserves. Within the TTW calculation, we assume that the business model of a company and accounting policies remain unchanged. The only elements which change are the situation in the business environment and its impact on individual items in the profit and loss account.

If net sales on the market during a pandemic are completely prohibited, then net sales of the company are reduced to zero. A reasonable consequence is that the purchase value of input materials reduces to zero as there is no reason to buy input materials if there is zero demand for final products on the market. We apply the same logic to all other relevant items in the profit and loss account. Such an example is the financial income from investment in associated enterprises. If companies assume moderate strategic risk, they invest in associated companies, which are in the same or an adjacent industry sector. In this case, the same trigger of an economic crisis hits companies in the same and adjacent industry sectors in a similar way. Consequently, if a company cannot sell products on the market due to restrictions, which drives net sales of the company to zero, associated companies cannot sell products on the market, which drives their net sales to zero also, in which case the associated companies are not in a position to deliver profit and the mother company has zero financial income from investment in associated enterprises.

Labour costs remain in economic crisis temporarily unchanged due to legislation, which in some countries does not allow a significant reduction of the workforce overnight. It is also not reasonable for a company to instantly reduce their workforce when a crisis appears since it is unknown how long the crisis will last and how severe it will be. If the crisis will be short, which was also the case with Covid-19 in the spring of 2020, then the company will need its workforce back promptly, so it is imprudent and cost-inefficient to reduce a workforce at the inception of the crisis and then after a short time re-hire it. Many industries and many companies faced this problem after Covid-19 in the spring of 2020 because we have seen strong economic growth in the third quarter of 2020, and the best business decisions have been made by those companies that have not reduced their workforce at the inception of the crisis.

Since the budgeting process is a starting point for the next business year utilising achieved results from the prior year, we assume that the planned profit and loss account for the business year to come remains unchanged in comparison to the actual profit and loss account from the prior business year. Let b_j be the value of an item j in the profit and loss account from the prior business year, where $j \in \{1, 2, \dots, m\}$.

The International Accounting Standards Board (2003) defined the profit or loss of a company π in the International Financial Reporting Standards (IFRS) as:

$$\pi = \sum_{j=1}^{m} b_j \tag{1}$$

If sales of a company on the market are limited due to restrictions, then the reduction of sales will linearly reduce the value of profit and loss account items, which are directly driven by sales. Values of the other profit and loss account items remain temporarily unchanged. Let k_j be a coefficient, which reflects the impact of sales reduction on the item b_j in the profit and loss account, where $j \in \{1, 2, \dots, m\}$, and let x be the per cent of sales reduction, which is in coronacrises defined by government measures.

Then it holds:

$$k_j = \begin{cases} 1 - x; & for\ all\ items\ b_j\ which\ are\ directly\ driven\ by\ sales \\ 1; & else \end{cases} \quad (2)$$

As a result, we can define the stressed profit or loss of a company π_s as

$$\pi_s = \sum_{j=1}^{m} k_j \cdot b_j \quad (3)$$

If we add to the stressed profit or loss depreciation and write-offs, deferred costs and accrued revenues, accrued costs and deferred revenues and fair value reserves, we can define stressed cash flow c as follows

$$c = \sum_{j=1}^{m} k_j \cdot b_j + d - \sum(dc + ar) + \sum(ac + dr) - r \quad (4)$$

Where d are depreciation and write-offs, dc are deferred costs, ar are accrued revenues, ac are accrued costs, dr are deferred revenues and r are fair value reserves.

Consequently, we can define TTW as:

$$TTW = min\left(\frac{\sum_{i=1}^{n} h_i \cdot a_i}{abs(\sum_{j=1}^{m} k_j \cdot b_j + d - \sum(dc+ar) + \sum(ac+dr) - r)}, 365\right) \quad (5)$$

where a_i is an individual short-term asset of a company and h_i is the corresponding haircut for this asset in stress, defined by the risk management function in the company, where $i \in \{1, 2, \dots, n\}$.

The value of TTW is limited to 365 because of a few reasons. The first reason is the threshold between short-term and long-term is one year or 365 days. The second reason is the assumption behind accounting policies, which in the short term remain static but can change in the long term if the situation in the business environment changes significantly. And the third reason is the fact that we are simulating the profit and loss account for one year in the future, and this simulated profit and loss account assumes an unchanged structure of the profit and loss account as well as an unchanged relationship between items in the profit and loss account. The minimum value of TTW is zero and is defined by the value of the expression:

$$\sum_{i=1}^{n} h_i \cdot a_i. \quad (6)$$

In a special example, where stressed cash flow is $c = 0$, then

$$\frac{\sum_{i=1}^{n} h_i \cdot a_i}{abs(\sum_{j=1}^{m} k_j \cdot b_j + d - \sum(dc+ar) + \sum(ac+dr) - r)} = \frac{\sum_{i=1}^{n} h_i \cdot a_i}{0} = \infty \quad (7)$$

This means that a company may generate a cash flow in a stressful business environment, which is equal to zero and hence non-negative. In this situation, the company does not consume its own inventory of stressed liquid assets to keep the business up and running, and it this situation, the company can survive in an economic crisis for an unlimited amount of time, so the TTW metric provides a correct result of:

$$TTW = min\left(\frac{\sum_{i=1}^{n} h_i \cdot a_i}{abs(\sum_{j=1}^{m} k_j \cdot b_j + d - \sum(dc+ar) + \sum(ac+dr) - r)}, 365\right) = min(\infty, 365) = 365 \quad (8)$$

Volume **12** | Issue **1** | 2023
https://doi.org/10.18267/j.cebr.311

3 Data

Core data for the measurement of corporate liquidity in times of stress are accounting statements of a company. The more granular and frequent they are, the better they reflect the impact of a crisis on the company and its liquidity situation. For the purpose of this paper, we will use the annual accounting statements of companies in Serbia for the business year 2019. In 2020, due to the coronacrisis, the local law required each company in Serbia to deliver annual balance sheets and income statements for the business year 2019 to the Serbian Business Registers Agency by the end of June 2020. Delivered accounting statements were tested for logical errors, and all accounting statements with identified logical errors were then replaced by the owner with the correct accounting statements. Each balance sheet item and each income statement item has its own AOP code, which is an alternate name for this item. AOP acronym stands for automatic data processing and enables storage of data in the data warehouse as well as further calculations with financial data. AOP codes are defined by the law and do not change over time. Also, each company is required to report financial data to the Serbian Business Registers Agency by AOP codes. The Serbian Business Registers Agency is the primary and the only source of accounting statements for Serbian companies, which we will use for calculations in this paper.

The primary source of liquidity in a company is short-term assets. However, not all short-term assets are liquid assets and not all liquid assets in a normal business environment are liquid assets in crisis (stress). Liquid assets in stress or stressed liquid assets are short-term assets of a company, which are sellable on the market in the time of an economic crisis for a price which is comparable to the price from a normal business environment with no crisis. Such examples are unpaid claims, which are considered liquid assets in a normal business environment because companies expect payment of unpaid claims on a time horizon below one year, in the majority of all cases, in a few months. In times of stress, this is no longer a rational expectation. In times of stress, market participants start to look after themselves first, and their own liquidity becomes the top priority. As a result, unpaid claims may or may not become cash over the next few months, as this is usual in the normal business environment. Unpaid claims in stress look more like a random variable, and companies should not count on liquidity from unpaid claims in times of stress.

Consequently, the definition of liquid assets becomes narrower in times of stress in comparison with the definition of liquid assets in a normal business environment. In times of stress, liquid assets include only the most liquid forms of assets, which are cash holdings and cash equivalents. Cash equivalents are marketable securities if they exist in the balance sheet of a company. Marketable securities are very unusual and rare asset in the balance sheet of a company. If they exist in the balance sheet of a company, we must count them into the pool of liquid assets and consequently in the pool of corporate liquidity with a haircut because their market value typically reduces in times of stress or at concluding deals on the market in times of stress. The most value resilient securities in times of stress are government securities. All other types of marketable securities usually lose more value during a crisis.

European Central Bank (ECB) publishes a list of securities daily, which they are willing to buy from banks if they need liquidity. These are better securities with a lower issuer default risk. In spite of better credit quality, ECB will buy them from banks with a discount, which is expressed with a haircut to the market price. As a result, companies with marketable

securities should first classify securities as those that are on the ECB list of securities and those that are not. And for the ones which are on the ECB list, each company should apply haircuts from the ECB to get an approximate estimation of their market value in stress.

Short-term loans or deposits are not liquid assets in stress because cash has not yet been returned back to the company. Even deposits to banks cannot be considered liquid assets in stress because banks may not be willing to release deposits before the due date, or in a worst-case scenario, the bank may go bankrupt, and the deposit owner will not win his cash back. If we speak of loans to other market participants, then a company as a creditor confronts itself with even higher default risk, as in the case of a bank. The expected loss at maturity of the loan is, in this case, even higher and further reduces the expected cash payment at maturity of the loan.

Furthermore, inventories in a crisis also lose market value and cannot be considered liquid assets. These are inventories of finished products, which cannot be sold on the market with the usual dynamic and price. Companies may also have inventories of semi-products, which share the same faith and cannot be sold on the market as in a normal business environment. Inventories of materials cannot enter the production process if the market does not pay for the final products. On the other hand, companies cannot sell inventories of materials because the market of materials stands still due to the static market of final products. As a result, inventories cannot be considered liquid assets under stress.

Let *w* be the value of liquid assets in stress (hereafter also stressed liquid assets), on a specific day, let a_i be an individual short-term asset of a company and let h_i be the corresponding haircut for this asset in stress, defined by the risk management function in the company, where $i \in \{1, 2, \dots, n\}$. In line with the ECB (2016) then holds:

$$w = \sum_{i=1}^{n} h_i \cdot a_i \tag{9}$$

We know that the value of liquid assets is a function of the sales cycle within the calendar year. At the beginning of a sales season, the value of liquid assets stands at a minimum, and at the end of the sales season, the value of liquid assets stands at its maximum. If we compute growth rates for net sales by quarters during a calendar year and if we compare results for the same quarter among different years, we can observe similar results, which is a reflection of sales seasonality in the industry sector. Since intra-year data about total sales by companies are usually unavailable and since these data are input data in the calculation of the nominal GDP by industry sectors, we can leverage intra-year nominal GDP data by industry sectors to calculate nominal GDP growth rates by quarters. If we deflate nominal GDP data, and so remove the impact of inflation from nominal GDP data, we can compute real GDP growth rates by quarters, and we can build a model to estimate real GDP growth rates by quarters within a calendar year. If we assume a linear relationship between real GDP growth rates and the volume of liquid assets, then we can model liquid assets and consequently stressed liquid assets based on real GDP growth rates for any quarter within a year.

The Statistical Office of the Republic of Serbia provides quarterly data on the nominal GDP in Serbia. Usually, nominal GDP data for a quarter become available about two months after the end of the quarter. Nominal GDP data are available for pre-defined groups of industry sectors and at the level of the entire Serbian economy. Groups of industry sectors are, according to the Statistical Office of the Republic of Serbia, defined as follows (Statistical

Office of the Republic of Serbia, 2022). The first group includes only industry sector A (agriculture, forestry and fishing). The second group includes industry sectors B (mining and quarrying), C (manufacturing), D (electricity, gas and steam, supply) and E (water supply, sewerage, waste management and remediation activities). The third group includes only industry sector F (construction). The fourth group includes industry sectors G (wholesale and retail trade, repair of motor vehicles and motorcycles), H (transportation and storage) and I (accommodation and food service activities). The fifth group includes industry sector J (information and communication). The sixth group includes industry sector K (financial and insurance activities), and the seventh group includes industry sector L (real estate activities). The eighth group contains industry sectors M (professional, scientific, and technical activities) and N (administrative and support service activities). Industries O (public administration and defence, compulsory social security), P (education) and Q (human health and social-work activities) constitute the ninth group of industries for GDP data. And industries R (arts, entertainment and recreation), S (other service activities) and T (activities as households as employers), constitute the tenth group.

4 Results and discussion

Based on this definition of TTW, we will now calculate and analyse TTW results for all companies in the Republic of Serbia as of 30 September 2020. For this research, we will use accounting statements of Serbian companies in the data warehouse of Dun & Bradstreet. We will use accounting statements at the same cut-off time for all Serbian companies. Since not all companies produce quarterly accounting statements, we will use the last available annual accounting statements. These are accounting statements as of 31 December 2019.

If we want to calculate TTW results for all companies in the Republic of Serbia as of 30 September 2020, we need accounting statements for the same cut-off time, this is for 30 September 2020. In order to achieve this, we will use additional quarterly GDP data by industries in the Serbian economy in 2020. This data is collected and provided by the Statistical Office of the Republic of Serbia.

For some industries, GDP data is not available on a standalone basis but is combined with GDP data for other industries. Such cases are industries B (mining) and C (manufacturing), which constitute the first group of industries for GDP data. Industries D (electricity, gas, steam, and air conditioning supply) and E (water supply, sewerage, waste management and remediation activities) constitute the second group of industries for GDP data. Industries G (wholesale and retail trade, repair of motor vehicles and motorcycles), H (transport and storage) and I (providing accommodation and meals) constitute the third group of industries for GDP data. Industries M (professional, scientific, and technical innovative activity) and N (administrative and support service activities) constitute the fourth group of industries for GDP data. Industries O (public administration and defence, compulsory social security), P (education) and Q (health and social care) constitute the fifth group of industries for GDP data. And industries R (arts, entertainment, and recreation), S (other service activities) and T (activities as households as employers) constitute the sixth group of industries for GDP data. GDP data for all other industries exist on a standalone basis.

In each group of industries for GDP data, we will assume that each industry contributes an equal value of GDP to the group and hence that GDP contribution is evenly distributed across industries in the group. Based on the quarterly GDP data, we will calculate quarterly GDP

growth rates, which will serve as proxy variables to calculate quarterly revenue growth rates by industries.

For the TTW calculation, as we need estimated accounting statements as of 30 September 2020 for all companies in the Serbian economy, we need quarterly revenue growth rates at a company level. Therefore, we will assume that quarterly revenue growth rates at a company level are equal to quarterly revenue growth rates at the industry level where this company resides. If we use total revenue from the income statement of an individual company in 2019 and if we apply quarterly revenue growth rates from the first three quarters in 2020, then we can calculate total revenue as of 30 September 2020. Consequently, the application of techniques for planning in accounting enables us to estimate accounting statements at a company level as of 30 September 2020.

Analysis of the Serbian economy as of 30 September 2020 shows that there were 210681 companies in the population and that the average TTW if sales on the market are prohibited, was 78,02 days. The average TTW by industries in the Serbian economy is shown in the table below.

Table 1 | Average TTW as of 3Q 2020 by industries in the Serbian economy if sales on the market are prohibited for all industries

Industry	Mean	N	Standard Deviation
A (agriculture, forestry and fishing)	108.18	4661	147.692
B (mining and quarrying)	78.58	427	123.194
C (manufacturing)	82.18	33257	121.908
D (electricity, gas and steam supply)	114.28	881	153.019
E (water supply, sewerage, waste management and remediation activities)	92.05	1036	134.458
F (construction)	85.70	14208	127.293
G (wholesale and retail trade, repair of motor vehicles and motorcycles)	80.31	70878	117.687
H (transportation and storage)	61.83	13358	107.186
I (accommodation and food service activities)	59.73	18274	103.334
J (information and communication)	83.59	6621	122.251
K (financial and insurance activities)	263.58	2185	150.463
L (real estate activities)	131.30	2502	157.796
M (professional, scientific, and technical activities)	66.11	22826	107.936
N (administrative and support service activities)	64.51	6589	111.973
O (public administration and defence, compulsory social security)	66.90	2251	109.431
P (education)	54.24	2490	90.367
Q (human health and social work activities)	67.48	1509	117.793

Volume **12** | Issue **1** | 2023
https://doi.org/10.18267/j.cebr.311

R (arts, entertainment and recreation)	54.19	6727	98.201
S (other service activities)	0	1	n.a.
Total	78.02	210681	119.409

Source: authors

The last row in the table above shows the average TTW in the economy. This was 78,02 days at the end of 3Q 2020 which means that an average company in the Serbian economy was, at the end of 3Q 2020, able to survive 78,02 days if its sales on the market were prohibited for whatever reason. This reason may be government measures to reduce infections with coronavirus. Consequently, we can expect that after 78,02 days in stress, an average company will deplete its own inventories of stressed liquid assets and will run into liquidity problems, which may appear as delays in the payment of liabilities.

In comparison with other data in the table, we can identify under average industries in the economy, which are H (transportation and storage), I (accommodation and food service activities), M (professional, scientific, and technical activities), N (administrative and support service activities), O (public administration and defence, compulsory social security), P (education), Q (human health and social work activities), R (arts, entertainment and recreation) and S (other service activities). Industry S (other service activities) is a specific industry because it contains only one company. Therefore, we cannot compare this industry to other industries with more companies, and we will hence exclude this industry sector from our comparisons and explanations. Consequently, an industry with the smallest average TTW is industry R (arts, entertainment and recreation). Industry H suffered due to low production, which generated lower demand for transportation. But not all sub-industries within industry H suffered in the same way. The most affected sub-industry was road transportation, whereas air transportation of goods enjoyed prosperity, mainly because prices for air transportation increased steeply. Industries I, N, P and R suffered for the same reason. All of them run businesses in a similar way. They collect people in the same place and provide services to them simultaneously, which was in contradiction with the government measures to decrease infections with coronavirus. The same applies to industry N, which also includes travel agencies which were severely impacted in spring because people were not allowed to travel for tourism. The majority of all companies in industry Q are medical and dental practices, and they were hit due to the nature of their business, which enables a very easy transfer of infection from a patient to the dentist.

A study conducted by Cowling et al. (2020) shows that only 39% of firms were accumulating their cash balances before the appearance of the COVID-19 pandemic, which suggests that 61% of firms were short on cash holdings and were at risk of running out of cash, including 8.6% that had no retained earnings whatsoever with micro firms at particular risk. The same study also explains how firms should manage their cash balances and how they should maintain a conservative view on holding cash reserves in order to hedge a potential risk of illiquidity in the future if future revenues and consequently operating cash flow are lower than expected for an unforeseen situation. The study supports this statement by providing practical evidence. One of every 12 SME firms is at high risk of illiquidity because they hold insufficient cash holdings and cover liquidity needs out of surplus cash obtained from revenue. In a similar way, Juergensen et al. (2020) have studied the impact of COVID-19 on manufacturing

SMEs. Their study explains that after the eruption of the coronacrisis, many SMEs were facing liquidity issues as a result of lockdowns. The same study further explains that many European countries put in place measures that enabled SMEs to postpone payments and new lines of finance to protect liquidity of SMEs. Dörr et al. (2022) explain that the ongoing COVID-19 crisis has put government policy in a special role in releasing economic pressure from many firms. The authors also explain that there is little doubt. In the short term, liquidity subsidies and loan guarantees have been necessary to save companies under severe liquidity pressure from insolvency.

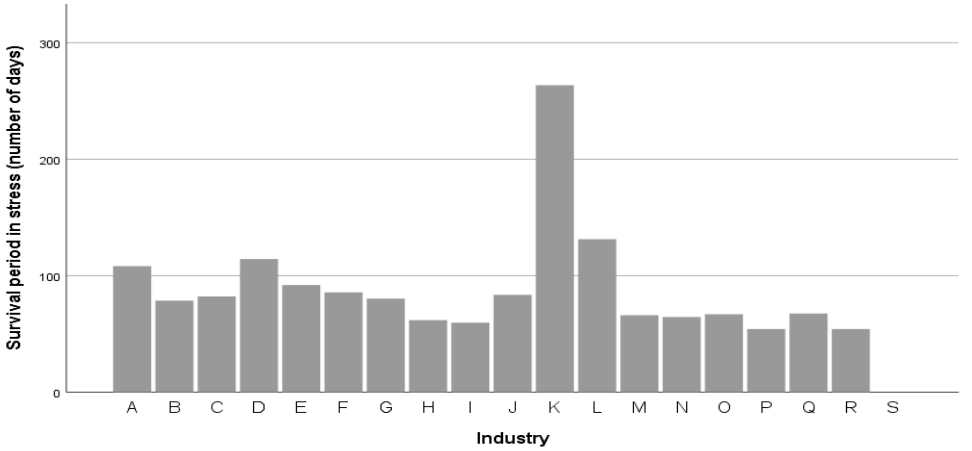
Didier et al. (2021) studied the financing of companies during the COVID-19 pandemic. Their research explains that the COVID-19 pandemic with lockdowns has reduced economic activity worldwide, consequently reducing operating cash flow in many firms and pushing them toward bankruptcy. As a response to stress in the business environment due to the COVID-19 pandemic, they suggest hibernation of a company, which delivers to the company only the minimum expenses necessary to withstand the pandemic until the crisis subdues. Their research also explains that the existing regulation in the banking industry was deficient to deal with stress like a pandemic. As a result, regulation in such a shape could only amplify the problem because it penalises firms with difficulties. Therefore, policymakers had to further develop existing regulations that would otherwise lead to inefficient bankruptcies and excessive destruction of relationships. In the same way, we can identify industries with above-average TTW in the economy. These are A (agriculture, forestry and fishing), B (mining and quarrying), C (manufacturing), D (electricity, gas and steam supply), E (water supply, sewerage, waste management and remediation activities), F (construction), G (wholesale and retail trade, repair of motor vehicles and motorcycles), J (information and communication), K (financial and insurance activities) and L (real estate activities). Out of them, industry K (financial and insurance activities) had the highest liquidity, which is, in comparison with other industries, a disadvantage for this industry. Higher liquidity for financial services means fewer investments, which is less business for this industry. If we look at banks, they were granting fewer loans because they were unsure how coronacrisis will hit individual industries and individual companies. This is a typical reaction of banks when any crisis appears. Companies and entrepreneurs, which are more dependent on banking loans to finance the production process, may be exposed to a higher risk of reduced production because lower banking loans will not allow production at the same level as before the pandemic. The pandemic has delivered an immediate and significant reduction of market demand since governments have relatively quickly stopped public life in countries. The eruption of the coronacrisis raised uncertainty about market demand in the future. Because banks started to grant fewer loans, maturing loans were not rolled over, and a gap in financing appeared, which delivered a lower production quantity in comparison to the time before the pandemic. This type of risk was higher at companies and entrepreneurs, which held less stressed liquid assets to cover liquidity gaps as a result of market disruption.

Similarly, investment funds also hold their liquidity because they have to invest liquidity in securities of individual companies, and they don't know, like banks, how these companies will be hit by the crisis. We also see significantly above-average TTW in industries A, D and L. We see a high average TTW in industry A because this industry produces food, which is the basic good in times of pandemic. Industry D has a high average TTW because people were at home in spring, so at a country level, there were more buildings that required electricity, gas, steam and air conditioning, as this is the case when people go to work.

Volume **12** | Issue **1** | 2023
https://doi.org/10.18267/j.cebr.311

Companies in industry L typically deal with individual clients, therefore, they did not suffer a loss of business.

Graph 1 | Histogram with survival period in stress as of 3Q 2020 by industries in Serbian economy if sales on the market are prohibited for all industries



Source: authors

Due to the pandemic, financial transactions have followed the business on its way online. Financial transactions linked to corporate liquidity in stress are payment transactions and electronic transfer of granted banking products for business financing. Successfully executed payment transactions increase the cash holdings of companies and entrepreneurs in crisis. In order to accelerate online business, successfully executed payment transactions are necessary for deal confirmations. Online payment transactions also enable companies and entrepreneurs to get already granted banking loans and other products for business financing on their bank accounts. The online environment also provides companies and entrepreneurs with the possibility to apply for various banking products for business financing. The online system must also work impeccably in order to transfer business documents from companies and entrepreneurs to banks, which is necessary for banks to initiate a credit process internally. I.T. reliability in times of the COVID-19 pandemic has also been studied by Tworek (2021). This paper analyses elements, which are building the reliability of I.T. solutions used in organisations (system reliability, usage reliability, information reliability and support service reliability), and their influence on I.T. performance in stressful conditions by putting I.T. performance at the centre of attention for organisations seeking ways to survive the crisis. The usage reliability and support service reliability were proven to become key factors influencing I.T. performance under such critical conditions, which makes perfect sense because we have, beforehand, established that successfully executed payment is necessary for a deal confirmation and for economic growth within the online business. If payment has not been executed successfully due to an I.T. issue, support service is necessary to eliminate an existing issue and to process the payment as initially intended.

Since stressed liquid assets are a narrower and hence smaller economic category than liquid assets, corporate liquidity in an economic crisis (stress) is smaller than corporate liquidity in

a normal business environment, regardless of the metric engaged in measuring corporate liquidity. Tomczak (2014) has shown a few such metrics. Consequently, unstressed corporate liquidity or corporate liquidity in a normal business environment puts companies in a liquidity illusion where they think they have more corporate liquidity available than actually available to them if an economic crisis appears. This liquidity illusion is even more problematic for entrepreneurs because their business is usually smaller than the business of small and medium enterprises, and it is typically also younger and hence more volatile. Bigger volatility in times of crisis (stress) results in a position of illiquidity more quickly, especially in the situation where entrepreneurs are aware of their actual corporate liquidity in stress but drives even more often in the position of illiquidity if entrepreneurs are unaware of their actual corporate liquidity in stress due to the liquidity illusion problem. The liquidity illusion may drive the business of an entrepreneur to a premature end if the entrepreneur is not aware of it and, moreover, if he does not consider his actual corporate liquidity in stress instead of unstressed corporate liquidity at business decision making. Premature closure of business operations of an entrepreneur is a pity, especially if an innovative business idea has to be shut down due to the problem of illiquidity illusion.

Results of this research also supplement understanding of the bankruptcy legislation in the following way. Bankruptcy legislation does not distinguish between good times and bad times in the business environment and does not give any credit to companies and their ability to pay for current liabilities in bad times in the business environment. The bankruptcy of a company is defined in one way regardless if there is prosperity or recession in the business environment. Consequently, companies must ensure sufficient corporate liquidity and hence their ability to meet current liabilities in all times if they are unwilling to go bankrupt. And this is where our newly defined liquidity metric steps in. Existing liquidity metrics, presented in the existing literature, measure instant corporate liquidity, whereas our newly defined liquidity metric estimates corporate liquidity in times of crisis in the business environment and hence helps companies to avoid longer payment inability and hence bankruptcy in times of a crisis in a business environment.

Conclusion

In this paper, we have discussed corporate liquidity in an economic crisis. Because liquid assets in a normal business environment are not necessarily liquid in times of stress, we have defined a new metric, which measures the number of days in an economic crisis when a company can still pay maturing liabilities out of its own inventory of stressed liquid assets and when sales of a company on the market are limited or completely prohibited, as this was the case for some industries in some countries during the coronacrisis. As a result, we have defined this metric as a ratio between the stressed liquid assets and the absolute value of the negative cash flow, where the negative cash flow usually appears if sales on the market are limited or prohibited due to government measures or other restrictions on the market, and we have named the metric as survival period in crisis or alternatively, as Time To Wall (TTW). The defined TTW metric shows base corporate liquidity, which is corporate liquidity in unfavourable economic conditions on the market, and such conditions appear in times of an economic crisis. This characteristic of the TTW metric helps us to confirm our hypothesis from the introduction section of this paper.

Volume **12** | Issue **1** | 2023
https://doi.org/10.18267/j.cebr.311

De Vito and Gomez (2020) have investigated how the COVID-19 crisis affected the corporate liquidity of listed firms across 26 countries. For this purpose, they stress-tested three liquidity ratios for each firm with full and partial operating flexibility in two simulated distress scenarios corresponding to drops in sales of 50% and 75%, respectively. These three liquidity ratios were the cash burn rate and the cash flow from operations to current liabilities, which measure the short-term liquidity risk, whereas the cash flow from operations to total debt measures the long-term liquidity risk. Authors have defined the cash burn rate as a metric which measures how long a firm is able to finance its operating costs without further cash contributions from creditors or shareholders.

Ratios cash flow from operations to current liabilities and cash flow from operations to total debt both have a denominator, which remains unchanged if a crisis appears. In a crisis, cash flow is likely to reduce, which will reduce the ability of a company to pay current liabilities and its ability to repay total debt. The cash burn rate, on the other hand, measures how long a firm is able to finance its operating costs, where the interests paid are not part of the operating costs. In addition, the cash burn rate ratio also includes accounts receivables in the calculation even though the collection of accounts receivables is less probable compared to times when there is no crisis in the business environment. Consequently, all three liquidity ratios in this research measure the operating corporate liquidity of a company. TTW, on the other hand, does not consider only operating costs but also other contractual revenues and expenses of a company, such as interest. Therefore, TTW is a similar metric to measure corporate liquidity in an economic crisis, only a more holistic metric because it includes not only operating costs but also other contractual revenues and expenses, which at the end of the day shape and define corporate liquidity in the normal business environment, but also in stressful conditions in the market. We see TTW as a new contribution to economic science and to corporate liquidity risk management because it helps companies to identify business partners with low liquidity in stress, which may lead to their inability to pay liabilities in times of stress. As a result, the TTW metric helps companies to build a balance sheet, which will be more resistant to an economic crisis. Based on TTW, a company will enter into a new deal if it can leave with the deal not only in a normal business environment but also if tomorrow an economic crisis appears. This means that a company should not use TTW only when there is an economic crisis in the business environment but also in times when there is no crisis in the business environment, to be prepared for a crisis appearing tomorrow. Such an approach will help companies to build balance sheets, which will contain some profitable and risky deals but also other deals which are less risky and hence more risk resistant if stress appears in the business environment. All deals together will construct a balance sheet, which will ensure higher self-sufficiency and a longer survival period for a company in a stressful environment. Furthermore, TTW brings another contribution to economic science and to corporate risk management. It helps companies to measure the appropriateness of their policy to manage working capital under stress. Accounting statements also reflect what kind of policy to manage working capital a company uses. TTW helps companies to understand how appropriate their selected policy manages working capital in times of stress. A more restrictive policy delivers smaller TTW, which provides less comfort to the company in stress and is hence less appropriate when a crisis appears. TTW also supplements an understanding of bankruptcy legislation. Each company must ensure sufficient corporate liquidity and hence the ability to meet current liabilities at all times if it is unwilling to go bankrupt. TTW calculates corporate liquidity in times of crisis in the business environment already today and

consequently helps companies to manage corporate liquidity in case of a crisis and to avoid longer payment inability in times of a crisis. When the next crisis appears and what kind of crisis this will be, of course, is anyone‘s guess. We calculated the average TTW for the Serbian economy at the end of 3Q 2020 if sales on the market are prohibited. Results have shown that the average TTW was 78,02 days, which means that an average company in the Serbian economy was, at the end of 3Q 2020, able to survive 78,02 days in stress if its sales on the market were prohibited. This reason may be government measures to reduce infections with coronavirus. Consequently, we can expect that after 78,02 days, an average company will deplete its own inventories of liquid assets and will run into liquidity problems, which may appear as delays in the payment of liabilities. On the same cut of time, industry K (financial services and insurance activities) had the highest average TTW, which was 263,58 days and industry R (arts, entertainment, and recreation) had the lowest average TTW, which was 54,19 days.

The TTW model explained in this paper has a few model limitations. The first limitation is the available granularity of accounting statements. The more synthetic accounting statements are the less insight we have into the financial position of the counterparty and the less accurate the TTW result is. For example, financial income from dividends is a sub-category of the total financial income, just like financial income from loans. In times of stress, however, we can still expect financial income from given loans because interests are contractually agreed upon and non-deferrable, whereas we cannot expect financial income from dividends if a company generates a loss.

The second limitation is the assumption about the linear relationship between the reduction of net sales and the reduction of stressed liquid assets. This is an incorrect assumption because we know that liquid assets in stress are a narrower category than liquid assets in a normal business environment. In addition, after the period of seasonal sales, liquid assets increase over-proportionally in comparison to the increase of net sales. And finally, each company within an industry uses a different policy for the management of working capital, which in turn provides the number of liquid assets that are in a non-linear relationship with net sales. What is the actual relationship between net sales and stressed liquid assets supersedes the purpose of this paper.

We also assume linear shrinkage of the balance sheet in times of an economic crisis, which is unlikely. In times of stress, companies typically adjust their operations and sometimes also their business models, which in turn changes ratios between balance sheet items. Further, we also assume a linear impact of an economic crisis on the cash flow, which is also unlikely. What is more likely is that the change in the operating model will change the value and structure of the cash flow. Analysis of the linearity assumption supersedes the purpose of this paper and offers an opportunity for further research, which will provide knowledge to increase the accuracy of the TTW model explained in this paper.

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The research paper passed the review process. | Received: September 22, 2021**; Revised:** April 26, 2022**; Accepted:** April 27, 2022**; Pre-published online:** June 13, 2022**; Published in the regular issue:** March 20, 2023.