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THE EFFECTS OF COVID-19 ON FIRMS' LIQUIDITY: EVIDENCE FROM THE ATHENS STOCK EXCHANGE

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Abstract. Motivated by the recent study of De Vito and Gómez (2020), this paper examines how the COVID-19 pandemic could influence the liquidity of Greek listed firms. It also explores the main factors that drive the level of operating cash flow (OCF). By simulating a decrease of 50% and 75% in sales, we perform stress-tests on three liquidity ratios for 154 listed firms on Athens Stock Exchange considering their degree of flexibility. For these firms, we also investigate if industry sector matters. Finally, OLS and quantile regression analysis is performed to gain a more detailed and complete picture of the determinants of the OCF. The findings show that on average a firm with limited flexibility, in the worst scenario, would consume its cash reserves in about two months. Furthermore, approximately 9% of all firms would become illiquid in about one year, whereas about 12% would become illiquid within two years. It is also observed that liquidity does not significantly variate across sectors. On average, as revealed by OLS method, the findings support that Total Governance, ROA and Female board significantly affect the OCF. The paper enables policymakers to perceive the magnitude of liquidity risk and improve their decision making.

Keywords: Greek firms, liquidity, stress test, financial shock, quick flexibility, quantile regression.

JEL Classification: G32, G33, H32, M41.

Introduction

The last 100 years were characterised by four large pandemics, the "Spanish Flu" in 1918, the "Asian Flu" in 1957, the "Hong Kong Flu" in 1968, and the swine flu in 2009 (Wu & Metcalf, 2014). In addition to this is "COVID-19", a catastrophic pandemic (of 83.5 million infected cases and 1.82 million deaths at the end of 2020) affecting both global health and economies. Thus, it has been labelled as a black swan event and likened to the economic period of World War II (Nicola et al., 2020). Pandemics are uncontrollable and difficult to manage

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for local governments when they occur suddenly (Wen et al., 2021). According to the World Bank, the outbreak of the COVID-19 pandemic came as the largest financial shock that the world has experienced in the last decades, affecting both developed and developing countries (Jones & Comfort, 2020). The imposition of soft or hard lockdowns in the countries, starting with China's stringent measures (Min et al., 2020), has caused disruption in production and service supply chains as well as a reduction in consumer demand for products and services. Moreover, the pandemic of COVID-19 has caused a recession for most countries in 2020 owing to considerable loss of jobs, which drove the demand further downwards (OECD, 2020). In particular, the World Bank (2020) states that a 5.2% reduction in global GDP is expected at the end of 2020.

This looming economic recession may leave lasting scars because it drives investors' and stakeholders' expectations regarding liquidity in stock markets (Haroon & Rizvi, 2020). This is also verified by the Global Financial Crisis (2007–2009), which showed that cash and leverage had a significant impact on business performance as it has caused a shock to companies' access to credit. Both the global financial crisis and any looming crisis, such as the COVID-19 crisis, are expected to affect firms' financial position. The importance of liquidity and cash liquidity has already been noted by Keynes (1936). Thereafter, as Ramelli and Wagner (2020) mention, the role of cash as a buffer of liquidity has been studied by numerous scholars and has received great attention during the Great Recession. In such cases, financially constrained firms are motivated to hold more cash to avoid costly access to external finance and financial distress (Chen et al., 2010; Famiglietti & Leibovici, 2020; Vo, 2018; Wasiuzzaman, 2014). Therefore, cash acts as an important asset when the credit cycle turns (Joseph et al., 2020).

In addition to the global financial crisis, the financial consequences of infectious diseases, such as the Variant Creutzfeldt-Jakob, bird flu (H5N1), swine flu (H1N1), and severe acute respiratory syndrome (SARS), have attracted considerable scientific interest (Keogh-Brown et al., 2010; Smith, 2006). Overall, although there are insights that the economic impact of these pandemics may be huge, empirical research examining the impact of a pandemic on firms' liquidity is limited. For instance, Haroon and Rizvi (2020), using a sample of 23 emerging markets across three regions, find that when the number of confirmed COVID-19 cases decreases (increases), the liquidity in financial markets is improved (deteriorated). Fassas et al. (2021) using a sample of 3,300 US firms and conducting textual analysis on the management reports, find that during COVID-19 era firms are primarily concerned for liquidity, supply chains and economic recession. In a case study, Almeida (2021), for example, illustrates the impact of the COVID-19 pandemic on US firms' profits and the changes to the credit lines on banking sector; indicating the significant role of government in mitigating the effects of the shock. Similarly, Ebeke et al. (2021), focusing on Europe, find that country's policies mitigate both corporate liquidity and solvency risk if they implemented as they designed. Moreover, considering the German's context, Dörr et al. (2022) find that COVID-19 pandemic has causedmany insolvencies especially in the case of financially weak and small firms. De Vito and Gómez (2020), focusing on a multi-country level, show that a firm's liquidity is affected by the COVID-19 pandemic. Similarly, Khan (2022) uses an international dataset of small and medium-sized enterprises from 19 countries and 14 industries and finds that previous bank-lending credit constraints have intensified the effects of COVID-19

pandemic regarding credit risk. He also illustrates that financially constrained firms were more likely to use alternative financing sources (i.e., government grants, trade credit), than traditional ones. In the same direction, there are studies that have been conducted on emerging markets. For instance, in the Slovakian context Lalinsky and Pál (2022) find that, despite receiving government support, many companies use their equity to mitigate declines in sales. They also illustrate that insolvency risk decreases as firm size increases. Karim et al. (2021), examining the banking sector of Bangladesh, find that liquidity conditions have worsened and all listed banks belonged to the red zone. Wieczorek-Kosmala (2021), examining the impact of COVID-19 on the hospitality industry in four emerging markets (the Czech Republic, Hungary, Poland and Slovakia), finds that, in terms of liquidity, the hospitality business was severely affected because of the consequences of operating discontinuities.

Under this notion, the challenges that arise from these studies are that future research should focus on the cultural and attitudinal effects of the COVID-19 pandemic since cross-country models cannot capture them (Elmarzouky et al., 2021; Albitar et al., 2021, 2022). Our study is motivated by the need for research on country-specific settings (Li et al., 2022; Liu et al., 2013). Thus, by contributing to a specific country case study, we recognise the need to discuss the Greek context and provide assistance to practitioners and/or policymakers. In addition, our study is pertinent beyond the Greek setting, and our results guide other settings with similar markets and/or corporate governance systems characteristics where Type II agency problems dominate (Charitou et al., 2016; Nerantzidis & Tsamis, 2017).

To evaluate the liquidity conditions of Greek listed firms, we use all non-financial firms (i.e., 154 firms), and apply financial ratios with reference to liquidity. These are the cash burn rate (hereafter: CBR) (i.e., the period a firm can cover its operating costs without claiming cash from suppliers of finance), the operating cash flow[1] (hereafter: OCF) to current liabilities (hereafter: CL) [i.e., the liquidity of each firm, comparing cash flow (hereafter: CF) with CL], and the OCF to total debt (hereafter: TD) (i.e., the extent to which firm can cover all of its liabilities through the OCF) (see, De Vito & Gómez, 2020). Indeed, the first two ratios measure the firm's short-term liquidity risk, and the third measures its long-term. Subsequently, we perform stress tests for two different simulating cases of 50% and 75% decrease in sales, representing the conservative and extreme scenario respectively. The principal scenario refers to the sales of 2018 fiscal year as actually are.

Regarding our principal scenario, our findings illustrate that sample firms have cash for approximately one year. Also, in the case of a 50% decrease in sales (i.e., conservative scenario), our findings suggest that the average firm with limited flexibility would consume its cash reserves in a quarter of the year, approximately. Furthermore, we observe that the consuming period of cash would further contract and it would last about sixty days in the extreme scenario (i.e., if sales decrease by 75%). Our analysis shows that the average firm can cover about 34% of its CL in the principal scenario using its CFO. Firms with limited flexibility seem to have more difficulties in financing their CL than firms with quick flexibility. However, they would both have a negative ratio of OCF to CL in conservative and extreme scenarios. Further, as revealed by OLS method, the findings support that Total Governance,

[1] The (operating) cash flows provide important information for all stakeholders (Chiang et al., 2021). For more about cash flow sensitivity see Li and Song (2018).

ROA and Female board significantly affect the OCF. In particular, using the quantile regression (QR) method and choosing eight representative quantiles (5%, 10%, 25%, 50%, 75%, 85%, 90% and 95%) we illustrate that the relationship between OCF and 5 explanatory variables is heterogenous across the quartiles, while for the 75% quantile and above, the findings are comparable to OLS regression.

The rest of the paper proceeds as follows. Section 1 outlines the Athens Stock Exchange (hereafter: ASE) characteristics. Section 2 presents the theoretical framework and data and Section 3 comments on the results. Finally, the paper concludes by summarising the findings and implications of the results.

1. Athens Stock Exchange characteristics

The ASE is characterised as small compared to other European stock exchanges and is also referred to as an emerging market by the MSCI index[2]. This illustrates that ASE is small in terms of capitalisation and the number of listed companies (Sikalidis & Leventis, 2017; Kollias et al., 2011) and is indicated by oligopolistic behaviour a few large commercial banks dominate (Papachristou et al., 2018).

On that basis, the financial system is classified as "bank oriented" or "insider system" with primary sources of funding to be internal finance and corporate debt (Sikalidis &Leventis, 2017). In such a system, market liquidity is low, and family business members are directly involved in companies' management, and agency problems arise between the controlling families and minority shareholders (La Porta et al., 1998; Agyemang et al., 2019). Consequently, stakeholders have less protection due to weak enforcement of legal requirements (Sikalidis & Leventis, 2017; Caramanis et al., 2015). Thus, the characteristics of ownership concentration and organisational structure in Greece are the same as in Mediterranean countries (Italy, Spain), categorised in the Continental Europe system of corporate governance (Weimer & Pape, 1999). This suggests that CG quality in Greece is quite low considering the international best practices (Lazarides & Drimpetas, 2011; Nerantzidis & Tsamis, 2017; Vadasi et al., 2021). As illustrated by Nerantzidis (2015) the efficacy of the "comply or explain" principle[3] in Greek context is limited. This could be attributed to different features, such as in the corporate governance system, the financial reporting environment and the institutional structure including the law system.

Regarding the law system, LaPorta et al. (1998) categorize Greece among the so-called French law countries (civil law). In this context, French Civil law countries have the lowest law enforcement quality, and minority shareholders and creditors have less protection (La Porta et al., 1997, 2000). This low protection can lead to high firm-level liquidity uncertainty and high exposure to systematic liquidity risk (Sadka, 2011). This argument assumes that corporate governance system and institutional structure affects transparency and thus firm's liquidity. Therefore, it is challenging to evaluate the impact of the COVID-19 health crisis

[2] This is known as Morgan Stanley Capital International equity index and is used by scholars for cross-regional comparisons (Nerantzidis et al., 2022).

[3] The "comply or explain" principle has been adopted by European Union as a mechanism that allows flexibility in the application of CG practices (for more see Nerantzidis, 2015).

on a firm's liquidity since investors consider firms with high liquidity in a better position (Rahman et al., 2021).

2. Theoretical framework and data

2.1. Theoretical framework

We examinehow the COVID-19 pandemic could influence the liquidity of Greek listed firms. In the first step, we consider a hypothetical firm to illustrate how a reduction in sales influences a firm's OCF and its CL. The theoretical background of equations (not included here for reasons of brevity[4]) is based on the process of De Vito and Gómez (2020). In the next step, we used three indicators of liquidity risk, as presented below, to show how each of them reacts to every percentage change in sales.

1) CBR

This ratio has been widely used in literature to compare the burn rate in relation to the cash available and shows the health of a firm or its capability to maintain its current rate of cash burn (Chaplinsky & Haushalter, 2010; Mudambi & Treichel, 2005; Demers & Lev, 2001). This proxy measures how fast a firm uses cash and is critical during cash consumption periods (Edwards, 2014). In other words, it provides a time measure that reflects the speed at which a firm's current OCF consume its cash reserves and is calculated as follows:

$$CBR = \frac{Cash}{OCF + \partial OCF}. \tag{1}$$

2) OCF to CL ratio

This ratio shows the firm's ability to meet its CL by annual OCF. The higher the OCF, the lower the probability that a firm suffers from financial distress (De Vito & Gómez, 2020; Giarto & Fachrurrozie, 2020; Lakshan & Wijekoon, 2013). Hence, the OCF to the CL ratio is calculated as follows:

$$OCF\ to\ CL\ ratio = \frac{OCF + \partial OCF}{CL + \partial CL}. \tag{2}$$

3) OCF to TD ratio

This ratio indicates the firm's ability to cover the TD with CF and is essential for predicting financial distress (Kim & Upneja, 2014; Yang & Lau, 2010). The higher the ratio, the higher the debt absorption capacity, and the lower the financial risk (Chadha & Sharma, 2015). Alternatively, to put it differently, it measures the firm's long-term liquidity risk and is calculated as follows:

$$OCF\ to\ TD\ ratio\ = \frac{OCF + \partial OCF}{TD}. \tag{3}$$

In the third step, we stress-test these three financial ratios for firms with quick and limited flexibility[5] under two scenarios: the first one, characterised as conservative, includes a

[4] The computational formulas can be found at De Vito and Gómez (2020, pp. 12–13).

[5] We call firms that can quickly respond to adverse shock, limiting their capacity, as firms with quick flexibility. On the contrary, we call firms that have difficulty to respond as firms with limited flexibility.

decrease in sales of 50%, and the second one, characterised as extreme, includes a decrease in sales of 75%.

Finally, we perform the ordinary least square (OLS) and quantile regression analysis to gain a more detailed and complete picture of the determinants of the OCF, as described in section 4.

2.2. Data

The sample consists of firms listed on the ASE for the year 2018. On 31 December 2018, 196 companies were listed on the ASE. We excluded eight financial institutions and three financial services from this initial population because they are subject to different regulations (see De Vito & Gómez, 2020). In addition, we excluded five firms with non-positive cash reserves, sales, or total assets. A further 9 firms were excluded because they were suspended, and 17 firms had not published annual reports at the time of data collection. All data were hand-collected from the annual reports of the year-end 2018 sourced from the ASE website[6]. The final sample consists of 154 companies, representing 78.6% of all companies listed on ASE. The sample is divided into 14 industries to understand and research the turmoil effect on each industry. The 14 industries are presented in Panel B of Table 1.

Panels A and B of Table 1show the descriptive statistics for all main variables considered in the paper. In Panel A, a sample company has, on average, cash reserves corresponding to 10.17% of its total assets. In addition, the mean value of the gross margin and return on assets (hereafter: ROA) is –4.61% and –5.2%, respectively. The leverage ratio is, on average, approximately 78%. Furthermore, the average firm size (Ln of total assets) is 18.47. In Panel B, the industries of transport services and health have, on average, the largest amounts of cash reserves equivalent to 20.25% and 19.26% of their total assets, respectively. Moreover, firms operating in public utility services and personal and household goods have the lowest (31.91%) and highest (135.60%) leverage ratios, respectively.

3. Results

In this section, we analyse the results of our scenarios. The principal scenario (Panel A), along with the findings of conservative and extreme scenarios, for firms with quick flexibility (Panels B to C) and with limited flexibility (Panels D to E), are presented in Table 2. First, we analyse the results concerning the CBR. Findings of the principal scenario suggest that an average firm would have cash reserves that account for about one year of annual OCF (see column 1 – Panel A). This is quite an interesting evidence in contrast to De Vito and Gómez's (2020) study, which shows that cash reserves cover approximately four years and eight months. In the conservative scenario, if we assume that firms have quick flexibility, we observe that the average firm has cash reserves for approximately one month of annual OCF (see column 1 – Panel A). In contrast, De Vito and Gómez's (2020) study shows that each firm would have cash reserves for approximately 30 months.

[6] Annual reports are available at https://www.athexgroup.gr

Table 1. Descriptive statistics. This table shows the summary statistics for all variables used in the paper

Panel A: Descriptive statistics – Full sample					
	Obs	Mean	Median	Std. dev.	P25	P75
Cash reserves	154	0.1017	0.0610	0.1309	0.0206	0.1299
Leverage	154	0.7771	0.6023	0.8673	0.4290	0.8332
Gross margin	154	–0.0461	0.2426	2.7462	0.1285	0.4138
ROA	154	–0.052	0.0138	0.2636	–0.0237	0.0526
Size	154	18.4681	18.2970	1.7476	17.2216	19.6237

Panel B: Descriptive statistics – by industry															
		Constructions & construction & raw materials	Transport services	Food & drinks	Agriculture forestry & Fishing	Utilities	Oil & gas	Chemically	Technology & Telecommunications	Personal and household goods	Health	Services	Hotels & Real Estate	Textile products	Industrial equipment
Cash reserves	Mean	0.0769	0.2025	0.0488	0.0988	0.1535	0.1014	0.0661	0.1741	0.0628	0.1926	0.0984	0.1082	0.4006	0.0971
	Median	0.0463	0.1368	0.0243	0.0259	0.1321	0.0836	0.0498	0.1461	0.0411	0.1590	0.0767	0.4223	0.0203	0.1152
	Std. dev	0.1479	0.2094	0.0496	0.1422	0.1684	0.0736	0.0680	0.1521	0.0863	0.1874	0.0904	0.0549	0.0473	0.0757
Leverage	Mean	1.1066	0.5615	0.6781	0.8350	0.3191	0.5719	0.5949	0.6303	1.3560	0.8465	0.4391	0.5363	0.7162	0.7879
	Median	0.7203	0.5710	0.7365	0.7729	0.2780	0.6373	0.6188	0.5082	0.7818	0.7125	0.4226	0.4332	0.7456	0.7747
	Std. dev	1.5256	0.2948	0.2402	0.4660	0.3096	0.2794	0.2475	0.4467	1.2870	0.4311	0.3429	0.4619	0.2552	0.2848
Gross Margin	Mean	–0.7048	0.2480	0.3134	–0.5675	0.3006	0.1730	0.2005	0.3831	0.2443	0.4395	0.4665	–0.0163	0.2818	0.2295
	Median	0.1230	0.1959	0.3747	0.1302	0.3742	0.0927	0.2142	0.3447	0.3641	0.3869	0.3611	0.0051	0.3344	0.1888
	Std. dev	5.0214	0.1679	0.1153	1.9313	0.1861	0.1606	0.0793	0.2169	0.3458	0.2532	0.3627	0.1038	0.2263	0.0803
ROA	Mean	0.0211	0.0639	0.0029	–0.0311	0.0416	0.0574	0.0374	0.0034	–0.2717	0.0723	–0.0163	0.0314	–0.0025	0.0207
	Median	0.0014	0.0638	0.0026	–0.0513	0.0634	0.0453	0.0432	0.0130	–0.0255	0.0653	0.0051	0.0422	0.0088	0.0047
	Std. dev	0.1910	0.0758	0.0868	0.1318	0.0706	0.0415	0.0642	0.0617	0.8506	0.0441	0.1038	0.0549	0.0647	0.0293
Size	Mean	18.5590	19.5182	18.4707	18.6056	20.9590	20.0359	18.1879	17.8206	18.2192	18.4563	18.3436	18.6511	17.0513	18.5731
	Median	18.0431	19.7053	18.3155	18.6798	20.6518	19.7600	18.4319	17.3706	18.3026	18.5029	18.1581	18.6401	17.1070	18.5472
	Std. dev	1.7768	1.0366	1.5492	1.3524	1.8010	19.7600	1.1916	1.8011	1.8741	1.3105	2.2044	1.3394	0.0647	1.0733
Obs.		32	6	11	6	4	8	8	22	12	4	13	11	10	7

On the other hand, if firms have limited flexibility, we observe that their average CBR is negative. Specifically, the average firm facing a conservative scenario would consume its cash reserves in about a quarter of a year (see column 1 – Panel D). In the extreme scenario, firms with quick flexibility have a consuming period of cash that lasts approximately three months. Moreover, the average firm with limited flexibility would consume its cash reserves in two

Table 2. Stress tests of the CBR, the OCF to CL ratio, and the OCF to TD ratio for the two simulated distress scenarios of 50% and 75% sales decrease

Panel A: Principal scenario – no sales decrease

CBR (years)		OCF to CL (%)		OCF to TD (%)		Illiquid firms	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mean	Median	Mean	Median	Mean	Median	Number	Percentage
0.8807	0.4890	34.1917	1.2851	10.8812	0.6774	3	1.95

Quick flexibility

Panel B: Conservative scenario – 50% decrease in sales

CBR (years)		OCF to CL (%)		OCF to TD (%)		Illiquid firms	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mean	Median	Mean	Median	Mean	Median	Number	Percentage
0.0777	0.3515	2.4923	0.0415	1.6473	0.9103	4	2.60

Panel C: Extreme scenario – 75% decrease in sales

CBR (years)		OCF to CL (%)		OCF to TD (%)		Illiquid firms	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mean	Median	Mean	Median	Mean	Median	Number	Percentage
–0.2129	0.3114	–6.4511	0.0316	–0.4428	1.0351	7	4.54

Limited flexibility

Panel D: Conservative scenario – 50% decrease in sales

CBR (years)		OCF to CL (%)		OCF to TD (%)		Illiquid firms	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mean	Median	Mean	Median	Mean	Median	Number	Percentage
–0.2551	0.3433	–8.9781	0.0826	–1.7385	0.9055	8	5.19

Panel E: Extreme scenario – 75% decrease in sales

CBR (years)		OCF to CL (%)		OCF to TD (%)		Illiquid firms	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mean	Median	Mean	Median	Mean	Median	Number	Percentage
–0.1464	0.2669	–14.0882	0.1409	–2.0435	1.2238	13	8.44

Note: This table shows the principal scenario (Panel A) and the results of the stress tests for the conservative scenario (Panels B and D) and the extreme scenario (Panels C and E) considering the degree of flexibility.

months approximately (see column 1 – Panel E). On this basis, the impact of the COVID-19 pandemic on sales directly affects the liquidity of Greek listed firms.

Similarly, Mdaghri et al. (2020), using a sample of 314 listed firms operating in 6 Middle East and North African (MENA) countries, demonstrate that the COVID-19 pandemich as a significant and negative impact on stock market liquidity. In addition, Haroon and Rizvi (2020), using a sample of 23 emerging markets across 3 regions, indicate that the COVID-19 health crisis has a negative impact on liquidity in financial markets.

Next, we analyse the results concerning the OCF to CL. We observe that in the principal scenario the average firm covers 34% of its CL using OCF (see column 3 – Panel A). If sales decreased by 50%, firms with quick flexibility would cover about 3% of their CL using OCF. At the same time, this ratio becomes negative for firms with limited flexibility. If sales decreased by 75%, the OCF to CL ratio would also have negative values. This holds for both firms with quick flexibility and firms with limited flexibility (see column 3 – Panel C and column 3 – Panel E, respectively). Firms with limited flexibility appear to have more difficulties in financing their CL than firms with quick flexibility. However, both types of firms would have a negative OCF to CL ratio in the extreme scenario.

Regarding OCF to TD concerns, we find that firms in the principal scenario and those in the conservative scenario with quick flexibility would have a positive ratio. On the contrary, firms in the conservative scenario with limited flexibility and firms in the extreme scenario should increase their non-CL. Specifically, in the conservative scenario firms with limited flexibility should increase non-CL by about 2%, while in the extreme scenario firms should increase non-CL by about 0.5%, if they display quick flexibility in their response to shock, and by 2%, if their flexibility is limited. Then, we focus on firms that have a high-shortage liquidity risk and limited flexibility in their response to shock. First, we estimate how many firms are *illiquid;* they have a CBR between –1.0 and 0. As shown in Table 2, the firms that would consume their cash reserves in one year are 8 in the conservative scenario (see column 7 – Panel D) and 13 in the extreme scenario (see column 7 – Panel E).

In Figure 1, the first bin corresponds to the principal scenario, the second and the third bin to the conservative scenario, and the last two bins to the extreme scenario. The second and the fourth bins refer to firms with quick flexibility, while the third and the fifth bins

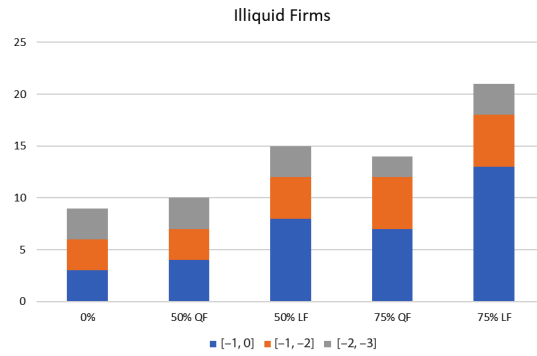

Figure 1. Firms, with quick and limited flexibility, that would become illiquid in the principal scenario, the conservative scenario and the extreme scenario in one, two and three years

are firms with limited flexibility. We observe that when the CBR is between –1.0 and –2.0, two to five firms are added to each bin, while during the third year, three more firms would become illiquid in all simulated distress scenarios. Overall, we show that within two years in the extreme scenario, approximately 12% of all sample firms, assumed to be limited flexible, would become illiquid. Similarly, in the conservative scenario, 12 firms with limited flexibility would become illiquid within two years.

Next, we focus on the extreme scenario, and we examine the differences between illiquid and liquid firms with limited flexibility on five main firm characteristics. In particular, we test for normality of the distribution of our observations employing the Kolmogorov-Smirnov test (see Table 3). This test examines as the null hypothesis the normal distribution of covariates. A variable is not normally distributed if "Sig." is lower at the significance level of 1%, 5% or 10%, respectively (reject the null hypothesis). Hence, we will further implement the Mann-Whitney test, which is a non-parametric test. The specific test results are shown in Table 3. The null hypothesis shows that two variables are equal. If "Sig." is lower at the significance level of 1%, 5% or 10%, respectively, we reject the null hypothesis.

Further, we perform the ordinary least square (OLS) and quantile regression analysis (see, Chi et al., 2015; Ebersberger & Herstad, 2013) to gain a more detailed and complete picture of the determinants of the OCF (see Table 4). The computational function for the classical OLS estimator can be defined by the following formulation:

$$R_i = e_0 + K_i e_i + w_i \tag{4}$$

in Eq. (4) R_i is the dependent variable $\left(CFO\right)$ whilst Ke_i denotes a vector of independent variables (ROA – Return on Assets, which is measured as the ratio of net income to total assets; Female Board – which denotes the number of women in Boards of Directors; Total Governance – which denotes the quality of Corporate Governance; RISK – which is measured as the ratio of Current liabilities to Current assets; Meet Board – which denotes the annual number of Board meetings). Koenker and Bassett (1978) based on this framework established the QR model. The crucial advantage of QR estimator is the various quantile calculations in a conditional distribution (QR is robust to outliers). Briefly, a linear QR model can be obtained as follows:

$$Q\left(R_i / K_i\right) = K_i' \; e_q + z_i \tag{5}$$

in Eq. (5) $Q\left(R_i / K_i\right)$ depict the q^{th} conditional quantile for the dependent variable R_i deemed K_i independent variables. The quantile parameter $q\left(0 < q < 1\right)$ can be solved minimizing the below linear function:

$$Q\left(e_q\right) = \sum_{i:R_i \geq K_i' e}^{N} q\left|R_i - K_i' e_q\right| + \sum_{i:R_i < K_i' e}^{N} \left(1-q\right)\left|R_i - K_i' e_q\right|. \tag{6}$$

The results are shown on Table 4. In particular, the OLS regression shows that for average company both ROA and Total Governance have positive individual effects on OCF while Female Board has negative.

Next, we estimate Eq. (5) using the QR method. The QR (illustrated graphically in Figure 2) provides a more detailed analysis. We choose eight representative quantiles (5%, 10%,

Table 3. Differences between illiquid and liquid firms with limited flexibility in the extreme scenario

	Illiquid firms				Liquid firms				Mann-Whitney U[c]	Wilcoxon W[c]	Z[c]	Asymp. Sig. (2-tailed) [c]
	One-Sample Kolmogorov-Smirnov Test		Mean rank	Sum of ranks	One-Sample Kolmogorov-Smirnov Test		Mean rank Sum of ranks					
	Test statistic	Asymp. Sig. (2-tailed)			Test statistic	Asymp. Sig. (2-tailed)						
Cash reserves	0.314	0.006 [a]	38.90	389.00	0.213	0.000[a]	80.18	11546.00	334.000	389.000	−2.830	0.005
Leverage	0.366	0.000 [a]	91.10	911.00	0.261	0.000 [a]	76.56	11024.00	584.000	11024.000	−0.997	0.319
Gross margin	0.288	0.019 [a]	39.90	399.00	0.463	0.000 [a]	80.11	11536.00	344.000	399.000	−2.757	0.006
ROA	0.472	0.000 [a]	67.50	675.00	0.166	0.000 [a]	78.19	11260.00	620.000	675.000	−0.733	0.463
Size	0.118	0.200 [ab]	77.00	770.00	0.090	0.006 [a]	77.53	11165.00	715.000	770.000	−0.037	0.971
Obs	10				144							

Notes: a. Lilliefors Significance Correction. b. This is a lower bound of the true significance. c. Grouping variable: illiquidity.

Table 4. Determinants of OCF using OLS and quantile regression

	OLS regression	Quantile regression							
		Q0.05	Q0.10	Q0.25	Q0.50	Q0.75	Q0.85	Q0.90	Q0.95
Constant	2.485***	4.174***	4.187***	4.601***	3.934***	3.416***	3.598***	4.021***	4.527***
ROA	1.344**	0.579*	0.452**	0.337	0.248	0.509*	0.541**	0.690**	1.097***
Female Board	−0.405*	−0.265	−0.385	−0.588**	−0.464*	−0.375	−0.419*	−0.315	−0.284*
Total Governance	1.430***	0.906**	0.681***	0.602***	0.796***	1.382***	1.420***	1.381***	1.218***
RISK	−0.089	−0.491	−0.628**	−0.384	−0.098	0.973*	0.900	1.019*	2.052***
Meet Board	−0.118	−0.633	−0.473	−0.316	−0.031	0.491*	0.420	0.337	0.172
R^2/Pseudo R^2	0.531	0.725	0.692	0.657	0.641	0.671	0.709	0.727	0.754

Notes: ***, **, and * significant at the 1, 5, and 10% levels, respectively. ROA denotes Return on Assets and is measured as the ratio of net income to total assets (Hoitash & Hoitash, 2009); Female board denotes the number of women in Boards of Directors; Total Governance denotes the quality of Corporate Governance and is adapted by Osma and Guillamón-Saorín (2011); Risk is measured as the ratio of Current liabilities to Current assets (Sultana et al., 2015); Meet Board denotes the annual number of Board meetings.

25%, 50%, 75%, 85%, 90% and 95%) and examine whether the relationship between OCF and 5 explanatory variables is heterogenous across the quartiles. For the 75% quantile and above, the findings are comparable to OLS regression. The only difference that we observe is that Risk has positive and significant effect on OCF. On average, as revealed by OLS method, the findings support that Total Governance, ROA and Female board significantly affect the OCF.

Finally, in Tables 5 and 6, the means of CBR (see column 2 – Panel A), OCF to CL (see column 2 – Panel B), and OCF to TD (see column 2 – Panel C) are presented for each of the 14 sectors assuming firms with quick and limited flexibility. In the third column of Panel A of Table 5, the mean of the remaining firms' CBR with quick flexibility is presented. It is compared to that of the firms of each sector with a statistical significance of 5%. In the third column of panel A of Table 6, a similar comparison is performed assuming firms with limited flexibility. Means of OCF to CL and of OCF to TD of the remaining firms are given in the third column of panels B and C of Table 5, respectively, and are compared to those of the firms in each sector with statistical significance 5%. According to the results, no difference in means is observed apart from agriculture, forestry, fishing, and the sector of services. Thus, our conclusion strengthens the policy that the government can apply universal financial measures to all sectors.

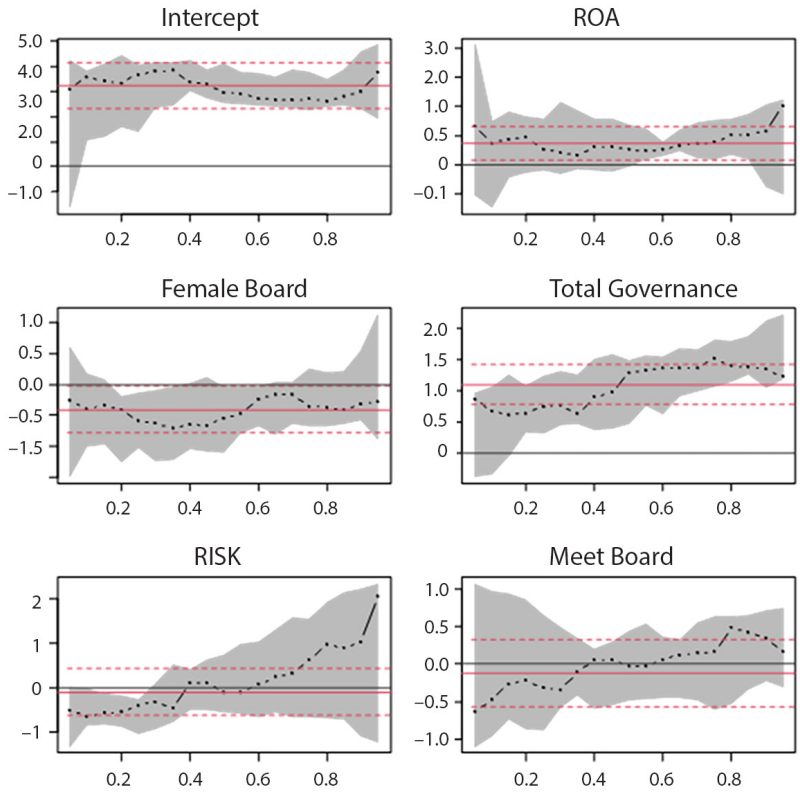

Figure 2. Quantile regression plots

Table 5. Means of CBR, OCF to CL and OCF to TD of firms with quick flexibility in different sectors

Panel A: Means of CBR			
Sectors	Mean of CBR	Mean of CBR: remaining sectors	Statistical significance
Constructions & construction & raw materials	0.4178	–0.0115	0.5606
Transport services	0.4981	0.061	0.502
Food & drinks	0.3565	0.0562	0.6291
Agriculture & forestry & Fishing	–7.4345	0.6192	1.36109E-06***
Utilities	1.5068	0.0396	0.1135
Oil & gas	–0.0934	0.087	0.791
Chemically	0.3288	0.0639	0.6635
Technology & Telecommunications	0.9777	–0.0723	0.2984
Personal& household goods	0.1875	0.0684	0.8518
Health	1.1466	0.0492	0.3091
Services	0.5599	6.0766	0.002
Hotels & Real Estate	2.0438	–0.0735	0.345
Textile products	0.404	0.055	0.5745
Industrial equipment	0.1784	0.0729	0.8678
Panel B: Means of OCF to CL			
Sectors	Mean of OCF to CL	Mean of OCF to CL: remaining sectors	Statistical significance
Constructions & construction & raw materials	0.0539	3.1319	0.3189
Transport services	0.0499	2.5914	0.3178
Food & drinks	0.0769	2.6782	0.3232
Agriculture & forestry & Fishing	0.0659	2.5907	6.6992E-11***
Utilities	34.1862	0.556	0.3217
Oil & gas	0.1225	2.6222	0.3325
Chemically	0.0771	2.6247	0.3232
Technology & Telecommunications	0.0579	2.8981	0.3196
Personal& household goods	0.0364	2.6999	0.3152
Health	–0.0191	2.5593	0.3044
Services	0.041	5.7184	0.0017
Hotels & Real Estate	0.0557	2.6798	0.319
Textile products	0.0454	2.6623	0.317
Industrial equipment	0.0425	2.609	0.3164

End of Table 5

Panel C: Means of OCF to TD			
Sectors	Mean of OCF to TD	Mean of OCF to TD: remaining sectors	Statistical significance
Constructions & construction & raw materials	1.3314	1.8057	0.7724
Transport services	1.4921	1.6536	0.9138
Food & drinks	1.3143	1.6729	0.7962
Agriculture & forestry & Fishing	2.2892	1.6213	5.87371E-11***
Utilities	4.5505	1.6669	0.7606
Oil & gas	1.0402	1.5074	0.3459
Chemically	2.1867	1.6177	0.701
Technology & Telecommunications	1.6130	1.653	0.9791
Personal& household goods	0.9884	1.7029	0.6105
Health	0.0219	1.6906	0.2268
Services	3.4720	0.511	0.003
Hotels & Real Estate	0.5718	1.7193	0.4098
Textile products	0.9785	1.6937	0.6063
Industrial equipment	1.2113	1.668	0.7463

Note: Statistical significance of 0.01, 0.05 and 0.1 (two tailed) are denoted by ***, ** and * respectively.

Table 6. Means of CBR, OCF to CL and OCF to TD of firms with limited flexibility in different sectors

Panel A: Means of CBR			
Sectors	Mean of CBR	Mean of CBR: remaining sectors	Statistical significance
Constructions & construction & raw materials	–0.824	–0.1059	0.5906
Transport services	0.475	–0.2847	0.1197
Food & drinks	0.3412	–0.301	0.1285
Agriculture & forestry & Fishing	–5.5485	0.2768	1.25E-06***
Utilities	1.3208	–0.2971	0.053
Oil & gas	–0.12475	–0.2622	0.3713
Chemically	0.3239	–0.2868	0.14
Technology & Telecommunications	–1.554	–0.0456	0.4359
Personal& household goods	0.1185	0.2355	0.3802
Health	0.647	0.7745	0.2406
Services	0.5517	0.3411	1.33E-06***
Hotels & Real Estate	1.0397	–0.2835	0.5327
Textile products	0.3748	0.5433	0.1118
Industrial equipment	–0.7128	–0.6647	0.6841

End of Table 6

Panel B: Means of OCF to CL			
Sectors	Mean of OCF to CL	Mean of OCF to CL: remaining sectors	Statistical significance
Constructions & construction & raw materials	–4.6474	0.1155	0.3249
Transport services	–23.252	0.1141	0.36319
Food & drinks	–12.1228	0.11	0.3411
Agriculture & forestry & Fishing	–23.207	0.1123	4.57E-05***
Utilities	48.0114	–9.1591	0.1234
Oil & gas	–17.8307	0.1097	0.2894
Chemically	–17.8853	–11.27	0.7724
Technology & Telecommunications	–6.5331	–5.5841	0.8611
Personal& household goods	–11.6025	–3.4883	0.3084
Health	–0.0126	0.7486	0.9165
Services	–10.6057	–2.3455	4.78E-04***
Hotels & Real Estate	–12.1716	–5.7743	0.1125
Textile products	–13.9175	–2.4567	0.4212
Industrial equipment	–19.9166	–11.33	0.3004
Panel C: Means of OCF to TD			
Sectors	Mean of OCF to TD	Mean of OCF to TD: remaining sectors	statistical significance
Constructions & construction & raw materials	–1.8116	–1.7133	0.9765
Transport services	–15.25909	–1.1904	0.4457
Food & drinks	–7.7961	–1.2725	0.4995
Agriculture & forestry & Fishing	–14.406	–1.2249	3.46E-05***
Utilities	30.5177	–1.7876	0.3907
Oil & gas	29.8355	–1.1383	0.3663
Chemically	–10.9876	–1.2317	0.4702
Technology & Telecommunications	–2.9189	–0.7784	0.7781
Personal& household goods	–7.4016	–0.6233	0.4847
Health	0.1333	–0.1711	0.1805
Services	6.4612	1.0288	1.19E-03**
Hotels & Real Estate	–8.5591	–1.1134	0.4449
Textile products	–9.0543	–2.0051	0.4621
Industrial equipment	–13.09245	–3.5004	0.4447

Note: Statistical significance of 0.01, 0.05 and 0.1 (two tailed) are denoted by ***, ** and * respectively.

Conclusions

The COVID-19 pandemic constitutes an unprecedented challenge for firms, managers, investors, and policymakers. This study examines how the COVID-19 pandemic could influence the liquidity of Greek listed firms with quick and limited flexibility. For this reason, we use a hand-collected dataset of 154 listed firms on the ASE and calculate three liquidity ratios that are primarily used in literature. We stress-test these indicators in two simulated distress scenarios. The first scenario represents a 50% decrease in sales, and the second scenario is a 75% decrease in sales.

Our results indicate that, in the conservative scenario, the average firm with quick flexibility has cash reserves for about one month of annual OCF, while the average firm with limited flexibility has a negative average CBR. Moreover, in the extreme scenario, the average firm with quick flexibility would consume its cash reserves in about three months, while the average firm with limited flexibility would consume its cash reserves in about two months. In addition, in the case of a 50% decrease in sales, the average firm with quick flexibility would cover about 3% of its CL using OCF, while this ratio is negative for the rest 3 cases (i.e., conservative scenario for limited flexibility, extreme scenario for quick flexibility, and extreme scenario for limited flexibility). Consequently, firms with limited flexibility appear to encounter more difficulties in financing their CL than firms with quick flexibility. Further, as revealed by OLS method, the findings support that Total Governance, ROA and Female board significantly affect the OCF.

Overall, we argue that this research has important implications for academics, firms, policymakers, and regulators. First, it is essential to researchers since it provides evidence of Greece's emerging market and can open new research paths. For instance, emerging markets may suffer the worst from such a pandemic because they have limited reserves to confront its impacts; therefore, it is vital to advance existing knowledge. Second, our results enable practitioners to perceive the magnitude of liquidity risk arising from such a pandemic. This is quite interesting since our findings may help board directors adopt are structuring approach (i.e., survival-oriented strategies) that underlie the organisational capability to change and resolve financial distress. Under this notion, a more informative board could make better decisions to increase shareholders' wealth. Further, the users of financial statements could benefit from this study by understanding the influence of liquidityon the firm's going concern status. Third, another implication might be the contribution to the discussion about the choices that policymakers and regulators can make to ensure financial stability during the COVID-19 pandemic. This is quite interesting since may help policy makers to implement a better reform agenda. For instance, they could devise target-oriented bailout programmes to help firms (micro/meso level) to boost their sales and maintain liquidity. At the macro level, they could follow at least three channels to impact stock market liquidity: infrastructure channel, portfolio channel, and public information campaigns. Consequently, we believe that further action(s) need(s) to be taken by policymakers and regulators before the next wave of the COVID-19 pandemic to sustain the firm's and market's liquidity.

Finally, the present study is subject to some limitations. First, we only collected and analysed data for firms listed on the ASE for the year 2018. Future studies could extend our

results by focusing on more recent data. Second, our analysis is also limited to non-financial firms, thus we invite researchers to concentrate on financial institutions and financial services to provide an alternative perspective. Further, our study is based on scenario analysis, so future studies could emphasize on different methodologies to estimate liquidity risk.

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