

Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

Economic Modelling 115 (2022) 105958



Contents lists available at ScienceDirect

Economic Modelling

journal homepage: www.journals.elsevier.com/economic-modelling



Determinants and consequences of SME insolvency risk during the pandemic



Orcun Kaya

ZHAW School of Management and Law, Center for Corporate Finance & Corporate Banking, Technoparkstrasse 2, 8400, Winterthur, Switzerland

A R T I C L E I N F O

I am grateful to the editor Sushanta Mallick and an anonymous referee whose constructive and insightful comments helped me to improve the paper significantly. I also received useful feedback from conference and seminar participants at the Entfin Association Annual Meeting, European Economics and Finance Society Annual Conference, European Academy of Management Annual Conference, 37th International Conference of the French Finance Association, Qatar Center for Global Banking and Finance Conference. I wish to thank the European Central Bank for providing the data. An earlier version of this paper has been circulated under the title *Insolvency Risk of European SMEs during Pandemic*. All remaining errors are my own.

JEL classification:
G32
G33
G2
M1

Keywords:
Pandemic
SMEs
Insolvency risk
Access to finance
Innovation

A B S T R A C T

The COVID-19 pandemic posed an existential threat to European SMEs' financial resilience with significant consequences for the European economy. Using unique firm-level data on SME financing conditions, this paper proposes a new insolvency risk measure based on survey responses. We show that SME insolvency risk increased, on average, by approximately 21% during the pandemic. Problems with finding customers and the cost of production and labor contributed notably to SME insolvency risk during this period, and SMEs also saw deterioration in their access to finance. Innovation worked as a mitigating factor during the pandemic, and innovative SMEs were more resilient, maintained their client base, and saw favorable access to bank lending. Our results point out that SME innovation can prevent the number of insolvencies from rising significantly in the long term.

1. Introduction

In contrast to the previous financial crisis, the COVID-19 crisis has been unique in many ways, i.e., truly exogenous, uncertain, and global (Didier et al., 2021). Even though the economic upheaval caused by COVID-19 was unexpected and severe for a broad spectrum of economic agents, the hit was particularly hard for European small and medium-sized enterprises (SMEs), who are the backbone of the European economy. SMEs saw a massive drop in demand for their products and services due to nationwide lockdowns and changes in consumer behavior. While revenues decreased remarkably, SMEs' financial obligations remained primarily stable. Moreover, the depth and length of the pandemic downturn and the recovery trajectory have been uncertain. In such unpredictable times, SMEs' financial backdrop might deteriorate quickly if they lack the liquidity and collateral to bridge the financial upheaval or face their finance problems until the market conditions stabilize. This, meanwhile, might push a large number of SMEs into bankruptcy, with significant consequences for the European economy

E-mail address: orcun.kaya@zhaw.ch.

https://doi.org/10.1016/j.econmod.2022.105958
Received 5 December 2021; Received in revised form 7 July 2022; Accepted 8 July 2022
Available online 18 July 2022
0264-9993/© 2022 The Author. Published by Elsevier B.V. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

(Gourinchas et al., 2020). Indeed, 25 million SMEs in Europe employ 100 million people, generate approximately two-thirds of the total turnover, and make approximately half of the value added (EC, 2020). Therefore, European SMEs' bankruptcy risk around the time of the pandemic and the impact of this risk on SMEs' access to finance are of central importance for policymakers and market participants alike.

In this paper, we focus on the insolvency risk of European SMEs and their access to finance at the onset of and during the pandemic. In doing so, we utilize survey data on SMEs' perceptions and expectations around the pandemic and propose a new approach to estimate SMEs' bankruptcy risk based on categorical survey data. The survey data allow us to model the links between backward- and forward-looking SME-specific aspects such as SMEs' access to bank lending, growth prospects, or most pressing problems and SMEs' insolvency risk. Put differently, insolvency measures that rely on survey data provide flexibility beyond balance sheet items and complement existing research based on financial statements.[1] For our analysis, we utilize a large EU-wide dataset provided by the European Central Bank (ECB) and construct an insolvency risk measure based on individual SME survey responses. We select SMEs located in the largest euro area countries: Germany, France, Italy, Spain, and the Netherlands. Therefore, our sample consists of a large number of SMEs and a broad cross-section of countries. Moreover, as the ECB conducts the survey biannually, we are able to shed light on changes in SMEs' economic activities, financing conditions, and future expectations over time.

In our framework, microlevel responses proxy traditional financial ratios, which the previous literature has suggested as indicators of firms' health (Altman and Sabato, 2007; McGuinness et al., 2018). We utilize a data reduction technique based on polychoric correlations to build an insolvency risk score for each SME in our sample. By doing so, our approach takes the categorical nature of the survey responses into account. Our study extends the previous literature by providing an alternative estimation method and employing a new set of indicators to predict SME insolvency risk. The survey nature of the data allows us to relate insolvency risk predictions to various microlevel SME-specific information, such as the most pressing problems for SMEs or their access to finance trends. Moreover, as we focus on standardized questionnaire responses, our approach partly overcomes cross-country differences in legal and accounting reporting requirements as well as a lack of harmonization in balance sheet definitions across European countries.

The results of our paper show that the pandemic has led to a surge in European SMEs' insolvency risk. To be specific, SME insolvency risk increased, on average, by approximately 0.56 of its standard deviations or by 21% during the pandemic. This hike is robust to the inclusion of firm-specific controls, sector dummy variables, macro indicators, and time and country-specific fixed effects. To shed some light on which subgroups of SMEs have been hit the hardest, we focus on insolvency risk in subsamples. Our results indicate that small and medium-sized enterprises suffered from heightened insolvency risk more than microfirms. Due to their lower funding needs, microfirms could cover their costs more efficiently via public support measures. However, even though small and medium-sized firms also benefited from support measures, their higher fixed costs base is more vulnerable to a sudden drop in demand. This most likely resulted in a surge in insolvency risk. Exporting SMEs also saw a broad jump in insolvency risk at the onset of the pandemic. As export firms are more vulnerable to reduced global trade flows, the drop in demand or problems along the supply chain and transport and logistics hit them the hardest (OECD, 2020).

We also delve deeper into potential external factors that might increase the SMEs' insolvency risk. To do so, we focus on factors such as problems with finding customers, facing heightened competition, or employee costs. Our results indicate that, in general, SMEs that report that finding customers, competition, and employee costs are among their most pressing problems are more likely to face insolvency risks. During the pandemic, however, finding customers and the cost of production and labor have contributed notably to SME insolvency risk in Europe. Specifically, firms that reported finding customers or the cost of production and labor as a pressing problem during the pandemic were 10% and 5% more likely to face insolvency risk, respectively. Implementing strict and long lockdown measures to tackle the pandemic leads to a demand shock for SMEs in the services sector and to increased insolvency risk.

Next, we examine access to finance difficulties in conjunction with the pandemic outbreak and the insolvency risk. An estimation that involves current access to finance and insolvency risk might suffer from simultaneity drawbacks. Therefore, we focus on the expected access to finance of SMEs. We document that, in general, firms that have had solvency risks in the past are more likely to have external debt issues in the future. Our results on this front show that the onset of the pandemic led to a deterioration in expected access to finance channels across the board. In contrast, however, SMEs' expectations did not reflect access to finance problems during the pandemic. Turning to the terms of conditions of bank loans around the pandemic, SMEs seem to benefit from favorable interest levels and other costs. Public support measures such as government guarantees on loans during the pandemic could contribute these results.

Finally, considering the potential vital role of innovation performance on the probability of bankruptcy, we study the link between SMEs' innovation activities and their insolvency risk in general, as well as during the pandemic (Qing and Shaonan, 2020). Building on this, we further investigate the impact of innovation on SMEs' access to finance. Following previous literature, we focus on the SMEs that introduced a new or significantly improved product as a proxy of innovation (Santos and Cincera, 2022; Moro et al., 2020). Our results show that innovative SMEs have lower insolvency risk than their noninnovative counterparts. This relation also holds during the pandemic, where innovative SMEs were approximately 3% less likely to default compared to noninnovative firms. Moreover, innovative SMEs did not face issues finding customers during the pandemic. More importantly, innovative SMEs saw their access to expected bank lending actually improve during the pandemic. Put differently, banks opened their credit to innovative firms during this period. The main takeaway from our results is that innovative SMEs present a unique and robust group even in these turbulent times. Considering the close link between innovation, survival, and growth, innovative SMEs' resilience around the pandemic points to their importance in the real economy.

Our results have important policy implications. SME insolvencies might lead to severe spillover effects on other parts of the economy in the years to come. For example, SMEs might default on loans, lay off employees, and cancel already planned projects. Even more importantly, several SMEs might not survive the pandemic. Loan defaults weighing on banks' balance sheets might lead to negative transmissions into the banking sector. Employee layoffs might curb consumption, and the cancellation of projects might drag growth further down. Significant real economy transmissions, as a result, are inevitable. Therefore, targeted policy measures should be implemented to mitigate SMEs' liquidity shortages and to promote innovation to avoid unnecessary insolvencies.

The remainder of the paper proceeds as follows. Section 2 provides a literature review. Section 3 introduces the data and insolvency risk indicators. It also outlines our methodology. In Section 4, we present the empirical results of our analysis. The section begins with the determinants of SME insolvency risk, with particular attention given to the pandemic. It then focuses on the impact of insolvency risk and the

[1] A potential limitation of the survey data is that responses might partly be biased due to the state of mind of the respondents when they answered the survey. In this respect, while the information extracted from the survey is exclusive and timely, as soon as new information is available, i.e., balance sheet information of SMEs, these could be used to validate the proposed conclusions. Indeed, comparing manager survey data with firm balance sheets and income statements, Ma et al. (2020) reveal that at cases, survey responses might present forecast biases. Meanwhile, Martinez et al. (2020) provides a meta-analysis of the literature based on SAFE survey and its use in various papers.

pandemic on SMEs' expected access to finance, followed by particular attention given to innovative SMEs. Finally, Section 5 concludes the paper.

2. Literature

The European Commission (EC) recommendation from 2003 defines SMEs in Europe. The overarching criteria are that SMEs have fewer than 250 employees and a turnover of less than EUR 50 million or a balance sheet size of less than EUR 43 million.[2] Based on these criteria, 99% of all firms in Europe are SMEs. These firms are the backbone of the European economy and contribute significantly to employment, job creation, and value-added (EC, 2019). Therefore, the risk of bankruptcies and financial distress in the SME landscape and SMEs' access to finance trends have been a particular focus since Europe's sovereign crisis (Ferrando et al., 2017). As SMEs have been hit particularly hard by the pandemic, these trends become even more crucial and are closely monitored by policymakers in Europe. Against this background, our paper complements the literature by delving deeper into the measurement and evolution of SME insolvency risk throughout the pandemic and the joint impact of pandemic and insolvency risk on SMEs' access to finance.

The list of indicators that pinpoint bankruptcy risk, in general, is vast. Early literature dedicated enhanced attention to backward-looking accounting information to compute listed companies' insolvency risk. Altman (1968) and Ohlson (1980) were among the first to identify a set of financial ratios that point to weaknesses in a company's health and explain default risk. Building on their ideas, financial ratios measuring profitability, indebtedness, and self-financing capacity are often employed in both a static and a dynamic setting to predict corporate bankruptcy (Grice and Ingram, 2001; Altman et al., 2005; Pindado et al., 2008; Traczynski, 2017; Zhang et al., 2020). Over time, higher frequency information such as the market value of a firm compared to the face value of its debt has been utilized for insolvency risk prediction (Vassalou and Xing, 2004; Bongini et al., 2002; Shi et al., 2018). Recently, the role of judicial inefficiency has been addressed as an indicator of financial constraints, debt, and trade credit ratio as well (Falavigna and Ippoliti, 2022).

Despite the usefulness of these methods for predicting large firms' bankruptcy risk, they have significant limitations in the case of SMEs. Unlike large firms, only a very small fraction of the SMEs are listed, and market data such as equity, bond, or CDS prices do not exist for them (Altman et al., 2010). More importantly, SMEs are typically opaquer and provide less detailed accounting data than large firms. It is by now widely accepted that SME bankruptcy prediction requires alternative variables due to issues around data availability (Altman and Sabato, 2005). Against this background, our paper contributes to the literature by utilizing self-reported survey data to measure SME insolvency risk and by proposing a set of indicators from survey responses that proxy financial ratios. Even though micro survey data stemming from SMEs have been used in various other applications, to the best of our knowledge, they have not been used in the context of SME bankruptcy prediction.

In developing models to predict SME bankruptcy risk, the first attempts date back to the 1970s (Edmister, 1972). However, the literature on alternative approaches has gained particular momentum in recent years. Using a large sample of US SMEs, Altman and Sabato (2007) argued that original z-score models could be improved upon by transforming financial ratios. The sample used in their analysis covers relatively large SMEs located in the US. Ciampi and Gordini (2009) focused on manufacturing SMEs from Italy and concluded that quantitative and qualitative variables should be used for SME default prediction models. Ciampi and Gordini (2013) proposed artificial neural networks to model Italian SMEs' insolvency risk. In terms of the frequency of observations, Gupta et al. (2015) provided evidence that discrete-time models are superior to others in SME bankruptcy prediction. More recently, McGuinness et al. (2018) modified SME bankruptcy risk utilizing z-scores for a large sample of European SMEs. Taken together, existing studies build upon rather traditional estimation approaches. While these approaches are suitable with balance sheet information from conventional databases, they cannot be applied in the context of the survey data. It is also important to stress that the definition of balance sheet variables is not harmonized across European countries. Moreover, there are certain country-specific characteristics in the business environment and in the legal and accounting reporting requirements for SMEs, which lead to missing or incomplete observations (Gaganis et al., 2019). Pooling such information in traditional models might lead to insolvency results, which are not comparable across countries. The second contribution of our paper is to introduce an insolvency estimation method designed for survey data. In doing so, we estimate an insolvency measure where SME bankruptcy risk comparison in a cross-country setting is suitable.

There is also a growing body of literature on the impact of the COVID-19 crisis on SMEs. Fairlie and Fossen (2021) and Bloom et al. (2021) presented significant losses in sales around the pandemic outbreak, with SMEs being disproportionately affected by the drop. Didier et al. (2021) stated that the economic crisis triggered by the pandemic and its impact are radically different from past crises. Gourinchas et al. (2020) studied potential SME failures during the COVID-19 crisis in the absence of government support measures and showed that around 9% SME failures are prevented with government interventions. Gourinchas et al. (2022) argued that credit contraction poses a significant risk to SMEs, and it would disproportionately impact firms that could survive COVID-19 in 2020 without any fiscal support. On the other hand, focusing on the COVID-19 policy response in Germany, Dörr et al. (2022) revealed that these lead to a substantial supply of postponed SME insolvencies that is particularly pronounced among financially weak and small firms. We contribute to this strand of the literature and study the determinants and consequences of SME insolvency risk during and at the onset of the pandemic.

The accurate prediction of SME insolvency risk is of crucial importance for banks. Due to information asymmetries and the potential of adverse selection, SMEs might have limited access to bank lending (Neuberger and Rathke, 2009; Cao and Leung, 2020). Inline, Dierkes et al. (2013) stressed that due to insufficient information on SMEs' balance sheets, their credit risk is usually higher than that of large enterprises. However, for growth and survival, SMEs are primarily dependent on external finance, and the vast majority of this tends to come from banks (Robb and Robinson, 2014; Canales and Nanda, 2012; Gupta and Gregoriou, 2018). Even more, SME lending is often concentrated at a single institution, considering the small size of loans SMEs require (Petersen and Rajan, 1994; Sapienza, 2002). It has also been pointed out that SMEs maintain longer and closer banking relationships with their banks (Berger and Udell, 1995). In doing so, while SMEs benefit from favorable borrowing rates, banks possess more information on SMEs' credit risk. Inline (Bottazzi et al., 2014) argued that access to finance also reflects the risk of investment, and insolvency risk is a critical aspect in lending decisions. Berger and Frame (2007) showed that adopting information-rich insolvency models might help increase the availability of bank credit and access to finance conditions for SMEs. This paper contributes to the literature by establishing a well-identified causal link between SMEs' access to finance and their insolvency risk at the onset of the pandemic. This offers an essential angle for discussing bank lending channels functioning during the pandemic crisis.

[2] Those firms that have less than ten employees and a turnover or balance sheet of at most EUR 2 million are considered as microenterprises. Those with ten to fifty employees and a turnover or balance sheet of at most EUR 10 million are considered small firms. Firms with fifty to two hundred fifty employees with a turnover of less than EUR 50 million or a balance sheet of less than EUR 43 million make the group of medium-sized firms. EC maximum thresholds are only for individual firms, and the total number of employees and turnover figures are relevant for SMEs that are part of a larger group.

Some SMEs launched new products or services and adapted their work models to meet new market needs and mitigate the adverse effects of the pandemic. In other words, they used innovation to lower the detrimental consequences of the pandemic. In the eyes of observers, this type of innovative behavior is of central importance for SMEs' survival and long-term growth (Cucculelli and Peruzzi, 2020; Santos et al., 2021). For innovative activities, though, access to finance is necessary. Notwithstanding, bank financing may be limited for innovative projects, especially for young firms, due to the higher default risk (Czarnitzki and Hottenrott, 2011). Additionally, the nature of the innovation strategy might lead to financing constraints (Santos and Cincera, 2022). Considering the central role of innovative SMEs for sustained growth, access to finance for innovative SMEs requires a closer look (Peters et al., 2017). Although there is a wealth of literature on access to finance for innovative firms, this topic has not been analyzed around the pandemic for SMEs. The paper's last contribution is to scrutinize innovative SMEs' insolvency risk around the pandemic, their access to finance, and the financing conditions.

3. Data and methodology

In this paper, we exploit a unique dataset provided by the ECB and the EC. With the euro area-wide conducted *Survey on the access to finance of enterprises (SAFE)*, ECB aims to monitor the latest developments in euro area firms' financial conditions and their access to finance trends. *SAFE* includes detailed categorical questions on firm demographics, balance sheet position, most pressing problems, availability of finance and market conditions, and expected access to finance.[3] *SAFE* is conducted biannually since 2009 and published in May and November to cover the six months before the publishing months. In the first round of 2014, the weighting scheme and sample size of the *SAFE* Survey are substantially modified. Therefore, we use the waves conducted between H1-2015 and H2-2020 in our analysis. Furthermore, we selected SMEs incorporated in one of the five largest euro area countries: Germany, France, Italy, Spain, and the Netherlands in our final sample.

In addition to the size of the economies, our selection of countries also relates to the similar responses of these countries to the pandemic crisis. Indeed, Germany, France, Italy, Spain, and the Netherlands simultaneously imposed travel restrictions, mandatory coronavirus testing, self-isolation requirements, and vaccination. In addition, following the first lockdown measures in Italy, all countries implemented their first emergency packages as of mid-March. The fiscal responses in the form of emergency measures were relatively similar in terms of the size and scope of the instruments used (Haroutunian et al., 2021). To be specific, the four large euro area countries (Italy, Germany, France, and Spain) have mobilized the most resources, and the fiscal support packages of Germany and France were 3.9% and 4.4% of their GDPs, respectively (Ferreiro and Serrano, 2021). Indices that track and compare economic support measures during the pandemic present similar trajectories for the selected countries as well (Hale et al., 2020).

The 2020 waves of the SAFE survey are relevant to delving deeper into the pandemic crisis impact. The SAFE survey includes two types of horizons in data collection: backward-looking questions that cover the period six months before the survey and forward-looking questions that cover the next six months ahead. The data for H1-2020 of the survey was collected between mid-March and mid-April. Therefore, the backward-looking questions from this wave span the effects en route to the crisis and shed light on the onset of the pandemic. The backward-looking questions of the H2-2020 wave, collected between mid-September and mid-October, present trends in the middle of the pandemic. The forward-looking questions from H1-2020 capture SMEs' expectations regarding the anticipated worsening of the SMEs' expected access to finance during pandemic (Bańkowska et al., 2020). The forward-looking questions from H2-2020 provide a proxy for SMEs' expectations beyond the pandemic crisis.

Table 1 presents the summary statistics of our sample. SMEs from France, Italy, and Spain make slightly more than 20% of the sample each. One-fifth of the SMEs in our sample are from Germany and 13% from the Netherlands. In Spain, Italy, and the Netherlands, firms with less than ten employees make the largest share. In Germany, around 40% of the firms have 10 to 50 employees. Firms with less than EUR 2 million turnover are the largest group of SMEs in all countries. In Germany, though, the share of firms with EUR 2 to 10 million turnover is larger than in other countries. Indeed, German SMEs are documented to be more prominent in terms of their size compared to their European peers on average (EC, 2019). The share of exporting SMEs is more or less in line across the board, with French SMEs having a somewhat smaller exporting share. SMEs with one owner or more than one owner makes up 80–85% of SMEs in all countries. Unlike the US, SMEs owned by venture capital or business angel investors are almost negligible in Europe. Among different sectors, services, and retail trade sector SMEs are the largest in terms of their numbers and the most important ones in terms of value-added and employment in Europe (EC, 2019). In our sample, around 65%–75% of the enterprises are from these sectors. Taken together, our selection of SMEs maps the European SME landscape comprehensively, and the main characteristics of our sample are in line with the official statistics.

3.1. Insolvency risk indicators

With the pandemic crisis, the insolvency risk of non-financial corporations became the focus of attention. However, the measurement of SME insolvency risk is not straightforward due to data availability issues. Expressing differently, while balance sheet or capital markets

Table 1
Summary statistics.

Countries	DE	ES	FR	IT	NL	Total
% of total	20.4	22.2	20.5	23.8	13.1	100
# Employees < 10	23.9	45.1	37.5	52.1	38.2	40.0
10 ≤ # Employees < 50	38.6	32.6	33.7	30.7	32.1	33.5
50 ≤ # Employees < 250	37.5	22.4	28.7	17.2	29.7	26.5
Turnover < EUR 2 m.	41.7	60.2	49.7	61.4	47	52.8
2 ≤ Turnover < EUR 10 m.	33	24.6	27.2	23.3	28	27.0
10 ≤ Turnover < EUR 50 m.	25.4	15.2	23.1	15.3	25	20.2
Exporting firm	44.8	40.1	34.3	44.9	43.7	41.5
Sole owner	49.5	29.2	42.7	29.8	46	38.4
More than one owner	36.1	52.6	32.7	56.5	38.5	44.2
Other enterprise	8.8	13.6	18.6	9.3	9.9	12.1
Public firm	0.7	1.2	2.2	0.4	2.1	1.2
Venture capital firm	1.6	0.6	0.4	0.3	0.6	0.7
Industrial	25.2	20.4	25.7	31.2	15.6	24.4
Construction	14.8	9.8	13.9	8.1	12.2	11.6
Services	19.7	24.9	25.2	21.4	24.1	23.0
Retail trade	40.2	44.9	35.2	39.3	48.1	41.0

This table presents the summary statistics of the company-specific variables used in this paper. Presented values are the percent averages of the respective explanatory variables. In columns are countries. % of total refers to share of the sample from the respective country. # Employees < 10 refers to firms that have less than ten employees, 10 ≤ # Employees < 50 to those with ten to fifty employees and 50 ≤ # Employees < 250 to those fifty to two hundred fifty employees. Turnover < EUR 2 m refers to firms that have an annual turnover of less than two million euros, 2 ≤ Turnover < EUR 10 m refers to firms that have an annual turnover of more than EUR two million but less than EUR ten million and 10 ≤ Turnover < EUR 50 m refers to firms with an annual turnover of more than EUR ten million but less than EUR fifty million. The exporting firm refers to those firms that comprise sales of goods or the provision of services to non-residents. Sole owners and more than one owner refer to firms with one owner or more than one owner, respectively. Other enterprise means another firm owns the largest stake of the firm. Public firms are listed companies. Venture capital firms refer to firms whose largest stake is held by venture capitalists or business angels. Industrial, Construction, Services, and Retail trade are the respective sectors.

[3] See https://www.ecb.europa.eu/stats/ecbsurveys/safe/html/index.en.html for the latest questionnaires.

information is available for large corporations, these are seldom available for SMEs. Meanwhile, important inferences on SME balance sheets can be gained from self-reported survey responses.

For predicting insolvency risk, one of the most well-known models, thanks to its predictive power and convenience, is Altman's z-score (Altman, 1968). In a nutshell, the z-score integrates a small set of financial ratios that proxy different aspects of firm health and provide information on insolvency risk. In doing so, it employs profitability, liquidity, solvency, leverage, and firm activity financial ratios. This paper follows a similar approach to Altman's z-score to construct an insolvency risk indicator for SMEs. The key deviation of our approach is to use SME survey responses that proxy financial ratios of the z-score and not necessarily the balance sheet values themselves. Specifically, we utilize SME responses to the SAFE questionnaire from sections two and four of the survey. In section two, the SAFE survey directs questions about the firm's current situation, referring to the changes experienced by the SME over the past six months. The second question asks:

Have the following company indicators decreased, remained unchanged or increased over the past six months?

1) *turnover*;
2) *profit*;
3) *inventories and other working capital*;
4) *debt compared to assets.*

Responses for each of these questions are given on a scale of three where 1) stands for *increased*; 2) *remained unchanged* and 3) *decreased*.[4] In our selection of variables, turnover and profit reflect the changes in profitability, inventories, and other working capital, the changes in liquidity and debt compared to assets the changes in the solvency ratio of an SME. Panel A of Table 2 presents responses for these indicators where presented values are the percentage of SMEs who responded as "decreased" to the respective question. Starting with turnover, an extreme deterioration is observable in all countries in H2-2020 or at the height of the pandemic crisis. The deterioration was already visible at the pandemic onset, with twice the number of SMEs reporting a decreased turnover already in H1-2020 compared to 2019. Yet, with the intensification of lock-down measures, among others, SMEs see a huge setback in their turnover, and H2-2020 presents an all-time high worsening across the board. A similar trend like turnover is observable in terms of SMEs' profit. The number of SMEs reporting a deterioration points to an all-time high, with 70% of SMEs seeing decreased profitability in the euro area. SMEs from southern euro area countries such as Italy and Spain report the most considerable drop for both indicators. This is because Southern Europe was affected by the pandemic earlier and adopted lock-down measures before Germany or the Netherlands. Therefore, SMEs in southern Europe were confronted with a more severe demand shock and saw their turnover and profits deteriorate markedly already in March. Concerning inventories and working capital, a smaller number of SMEs reported deterioration. Turning to debt to assets, the changes from 2019 to H2-2020 are not particularly high. Indeed, in almost all euro area countries, supportive measures have been introduced to ease SMEs' liquidity constraints even before the pandemic.

Section four of the SAFE survey delves deeper into the SME's experience and view on their financing and market conditions. To be specific, question eleven asks:

For each of the following factors, would you say that they have improved, remained unchanged or deteriorated over the past six months?

1) *Your enterprise-specific outlook with respect to your sales…*;
2) *Your enterprise's own capital.*

Responses for each of these questions are given on a scale of three where 1) stands for *improved*; 2) *remained unchanged*, and 3) *deteriorated*. In our selection of variables, SME's outlook concerning sales reflects the changes in activity, and the enterprise's own capital reflects the changes in leverage. Panel B of Table 2 presents responses for these indicators where presented values are the percentage of SMEs who responded as "deteriorated" to the respective question. Starting with the outlook in sales, from 2019 to H2-2020, the share of SMEs who saw deterioration in sales have more than doubled in all countries. This shows that euro area SMEs perceive a deep demand shock with recovery in the risk of being stubbornly slow due to continued anxiety and potential changes in consumer habits. The setback was already observable in H1-2020, but with the pandemic's intensification and associated lockdown measures, SMEs perceive a rather gloomy outlook. Turning to capital positions, while the number of SMEs reporting a deterioration increased in H2-2020, the change from 2019 is not particularly large. Nevertheless, a persistent decline on this front might translate into access to finance problems in the future.

3.2. Composite insolvency risk indicator

The standard z-score approach applies a multiple discriminate analysis and builds a final score based on specific coefficients for each of the financial ratios. It then compares the final score with predefined thresholds. This approach is not applicable for our sample, considering the categorical nature of survey responses. A possible way to create a composite insolvency score based on survey responses is to use a data reduction technique such as the principal component analysis (PCA). Yet, standard PCA techniques are suitable for continuous or dummy variables only (Josse et al., 2011). To maintain and control the categorical nature of SME insolvency risk indicators of the SAFE survey, we employ a polychoric PCA approach.

The polychoric PCA method relies on polychoric correlations rather than Pearson correlations. To compute polychoric correlations, it is assumed that there is an underlying unobserved normally distributed variable for each categorical response. Observed categorical responses are an aggregate representation of these unobserved continuous variables. Moreover, the correlation of underlying unobserved variables follows a binomial normal distribution. The correlation coefficients between these are the polychoric correlations and take the form in Equation (1).

Lets assume that x_1^* and x_2^* are jointly bivariate normally distributed variables with a correlation of ρ. The ordinal $x1$, $x2$ are obtained by discretizing x_1^* and x_2^* according to the set of thresholds α_{k1}, …, $\alpha_{k,Kk-1}$

$$x_k = r \; if \; \alpha_{k,r-1} < x^* < \alpha_{k,r} \tag{1}$$

where $\alpha_{k,0} = -\infty$ and $\alpha_{k,Kk} = +\infty$. If these variables follow a bivariate normal distribution, then the maximum likelihood estimate of polychoric correlation can be obtained by maximizing:

$$LogL(\rho, \alpha; X) = \sum_{1}^{n} log\pi(x_{i1}, x_{i2}; \rho, \alpha) \tag{2}$$

To estimate a polychoric PCA empirically, we follow the steps by Kolenikov and Angeles (2009). Building on the estimated polychoric correlations, we transform our variables into a linear combination of components in which each component represents a proportion of the total variance. We then perform a standard PCA analysis based on the eigenvectors where the variance-covariance matrix defines the weights. In doing so, we control for the categorical nature of the data for PCA analysis and compute the composite insolvency risk indicator for each

[4] Firms can also choose not applicable to my firm or do not respond at all.

Table 2
Deterioration in SMEs' position with respect to different indicators.

		2015		2016		2017		2018		2019		2020	
PANEL A													
Turnover	DE	15	13	14	12	12	11	11	12	13	15	29	54
	ES	26	19	23	20	18	17	18	18	18	20	33	67
	FR	35	33	33	30	28	23	22	20	24	17	33	67
	IT	35	25	26	23	28	18	21	19	23	23	43	56
	NL	21	19	15	16	14	11	12	14	13	15	27	57
Profit	DE	25	22	22	21	22	21	22	23	25	25	35	57
	ES	35	27	30	28	28	24	26	29	31	31	40	67
	FR	46	43	43	39	39	36	34	34	34	27	38	63
	IT	49	37	36	33	38	30	32	29	35	35	50	66
	NL	30	23	21	22	20	19	17	21	22	22	32	56
Inventories and working capital	DE	13	11	11	10	10	10	12	10	10	10	13	19
	ES	16	13	16	12	12	8	12	9	10	10	18	11
	FR	27	23	24	20	21	17	17	14	19	12	19	16
	IT	24	14	15	15	13	12	13	11	13	12	19	12
	NL	21	18	13	12	15	11	10	7	9	10	14	22
Debt to Assets	DE	23	24	26	25	26	29	23	23	25	25	24	26
	ES	29	29	27	28	26	27	26	24	24	21	24	31
	FR	28	26	28	28	29	24	27	24	23	27	28	30
	IT	20	20	20	21	22	21	19	22	21	18	17	28
	NL	38	37	36	37	39	40	33	34	32	31	31	25
PANEL B													
Outlook with respect to sales	DE	14	14	12	12	11	11	9	12	15	19	37	42
	ES	14	12	15	17	11	12	12	18	18	24	44	61
	FR	35	34	32	31	24	21	18	22	22	22	35	47
	IT	22	15	17	17	14	13	13	12	14	18	37	35
	NL	12	14	13	11	8	7	5	9	11	16	36	46
Capital	DE	9	7	8	6	6	5	9	8	7	7	15	24
	ES	10	8	5	5	3	3	4	4	4	4	7	10
	FR	24	23	24	19	15	14	13	15	16	11	20	26
	IT	19	11	12	12	9	8	6	7	9	7	18	20
	NL	12	11	10	9	6	7	8	9	9	11	19	29

This table presents the responses to selected questions of the SAFE survey. Panel A includes responses to section two while panel B responses to section four. Presented values are percentage of SMEs who responded as "decreased" and "deteriorated" to the respective question in Panel A and Panel B respectively. Columns present the changes over time and in rows are different euro area countries. In Panel A, turnover; profit; inventories and working capital; and debt to assets are the responses to section two, question two, subquestion (c), (e), (h) and (j) respectively. In Panel B, outlook with respect to sales; and capital are the responses to section four, question eleven, subquestion (c) and (d) respectively. First half of 2020 presents the results for the onset of the pandemic and second half during the pandemic.

SME in our sample. We normalize the final index by subtracting the mean and dividing by the standard deviation for ease of interpretation.[5]

Fig. 1 presents the pairwise correlations between composite insolvency indicator and each of its underlying categorical components. Other than the debt-to-equity ratio, all indicators are positively correlated with the composite insolvency indicator. As already mentioned, responses to question two of SAFE survey are 1) *increased*; 2) *remained unchanged* and 3) *decreased* and to question eleven are 1) *improved*; 2) *remained unchanged*, and 3) *deteriorated*. In this respect, a positive correlation indicates that a decrease in profit, turnover, or working capital increases the insolvency risk. Especially, a deterioration in SMEs' profit and turnover is strongly correlated with the default risk.[6] Contrary to these, a decrease in SMEs' debt-to-equity ratio is negatively correlated with the composite insolvency risk indicator. This is also in line with the expectations that a decline in SMEs' debt reduces the default risk. A deterioration in SMEs' sales and owners' equity is positively correlated with insolvency risk, too. A reduction in SMEs' sales negatively impacts turnover and profit and increases the default risk. Meanwhile, a decline in owners' equity would make it difficult to honor short-term liabilities, especially increasing the insolvency risk.

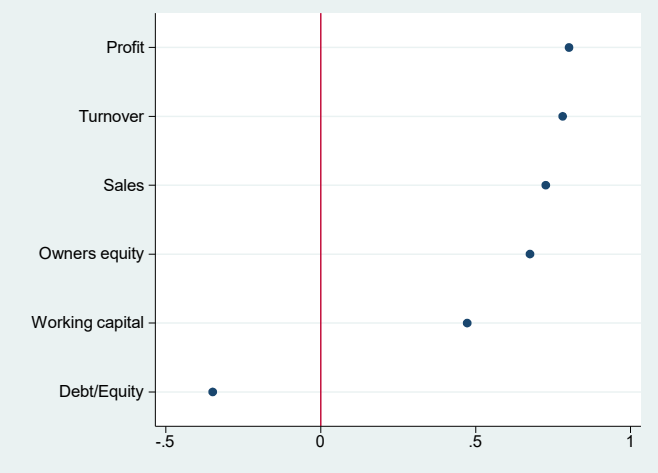


Fig. 1. Correlation with composite insolvency risk indicator. This figure presents the correlation of categorical variables with the composite insolvency risk indicator. Presented values are pooled pairwise correlations for the entire sample.

[5] After the normalization, the insolvency metric has a value range between −1.92 and 2.28 and a median of 1.8%. With a skewness of 0.14 and kurtosis of 2.3, the insolvency metric is reasonably symmetrical and does not involve outliers. Taken together, a ten percentage point increase in insolvency indicator corresponds to around 4% increased insolvency risk. Last but not least, all results presented in this paper also hold for the not standardized index variable.

[6] This is in line with the Altman's z-score where the earning ratios have largest coefficients for the computation of the final score.

Fig. 2 presents the average insolvency risk over time in each country in our sample. The average composite indicator points to a jump and all-time high insolvency risk during the pandemic in all countries. Still, significant cross-country differences are observable. In northern European countries such as Germany and the Netherlands, the insolvency risk indicator changes sign with the pandemic's onset in H1-2020. This points to a potential regime change in SME's insolvency risk. Unlike the sovereign crisis, where German SMEs face a minor hit, they now become much more similar to their southern counterparts. In Spain, meanwhile, already in 2019, SMEs' insolvency risk started to increase. With the pandemic's beginning, though, SMEs' insolvency risk in Spain might take a new dimension. Lastly, SMEs in Italy have faced persistent insolvency problems with different degrees since the sovereign crisis. The pandemic crisis might render these problems to a level where a full-fledged SME crisis occurs in Italy. The main takeaway is that the pandemic outbreak has hit the already problematic SME landscape in Italy particularly hard and exacerbates the Spanish and French SMEs' solvency problems. Now SMEs in France present significant similarities in their insolvency risk to Italian and Spanish SMEs. Moreover, the relatively stable SMEs in Northern countries might be shaken and converge partly to southern SMEs strongly in years to come as well.

4. Results

4.1. Determinants of SME insolvency risk

In addition to potential external shocks such as the pandemic, the firm specific-risks, macroeconomic factors, and country-specific characteristics might determine the insolvency risk of SMEs. In this subsection, we take a closer look at these determinants and their joint impact with the pandemic crisis. To do so, we start with the role of the pandemic outbreak in specific and delve deeper into the further factors in general. For estimation, we utilize a panel OLS with time and country fixed effects as in Equation (3):

$$Y_{itj} = \alpha + \beta X_{itj} + \theta Z_{tj} + \rho_t + \delta_t + \varepsilon_{itj} \quad (3)$$

where Y_{itj} stands for the composite insolvency risk indicator for firm i in year t at country j, X_{itj} for firm-specific characteristics for firm i in year t at country j, Z_{tj} for macro factors in year t at country j, ρ_t biannual time fixed effects and δ_j country fixed effects. ε_{itj} is the error term. In our specifications, we begin with a smaller set of covariates and increase them step by step.

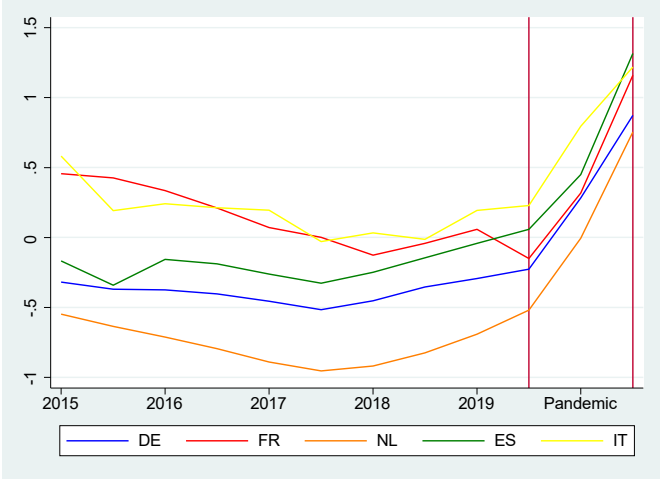


Fig. 2. SME insolvency risk by country over time. This table presents the average of composite insolvency risk indicator in each wave with respect to different countries. A ten percentage point increase in insolvency indicator corresponds to around 4% increased insolvency risk.

Model 1 of Table 3 presents the impact of the pandemic outbreak on the SME insolvency risk, controlling for time and country fixed effects. To do so, it includes two dummy variables:

1) the onset of the pandemic, which covers the period en route to the crisis, and 2) during the pandemic, which covers the ongoing crisis. Both pandemic dummy variables enter the regression with a positively significant coefficient, which is large in magnitude. At the onset of the pandemic, SME insolvency risk increased, on average, by around 0.25 of its standard deviations or by some 10%. This shows that the slowdown in economic activity before and heading to the pandemic has already led to severe difficulties for SMEs in the largest euro area countries. During the pandemic, SME insolvency risk increased, on average, by around 0.56 of its standard deviations or by some 21%. The tremendous decline in demand, which slashed the cash flows and revenues, led many otherwise sound SMEs to face significant solvency problems.

In Model 2 of III, we include standard indicators of firm sizes, such as the number of employees and the turnover in the model. Our results indicate that microfirms with less than 10 employees have a higher risk of insolvency in general. To be specific, they, on average, have around 0.14 standard deviations or some 6% higher insolvency risk within the SME landscape. Firms with 10–50 employees are not necessarily at higher risk of insolvency than the reference group of firms with 50–250 employees. Both turnover coefficients enter the regression with a positively significant coefficient. Being in the smallest turnover group leads

Table 3
Determinants of SME insolvency risk.

	Model 1	Model 2	Model 3	Model 4
Onset of the pandemic	0.249***	0.246***	0.245***	0.180***
	(0.021)	(0.021)	(0.021)	(0.024)
Pandemic	0.711***	0.709***	0.708***	0.563***
	(0.021)	(0.021)	(0.021)	(0.051)
# Employees < 10		0.138***	0.125***	0.125***
		(0.016)	(0.016)	(0.016)
10 < # Employees < 50		0.004	−0.002	−0.002
		(0.013)	(0.013)	(0.013)
Turnover < 2		0.217***	0.210***	0.210***
		(0.016)	(0.017)	(0.017)
2 < Turnover < 10		0.082***	0.079***	0.079***
		(0.013)	(0.014)	(0.014)
Exporting firm			−0.068***	−0.068***
			(0.009)	(0.009)
Subsidiary			0.024*	0.024*
			(0.013)	(0.013)
Public Firm			0.047	0.047
			(0.038)	(0.038)
Venture Capital			−0.030	−0.029
			(0.052)	(0.052)
Construction			−0.023	−0.023
			(0.015)	(0.015)
Services			0.018	0.019
			(0.013)	(0.013)
Trade			−0.020*	−0.020*
			(0.011)	(0.011)
GDP growth				−0.024***
				(0.009)
Inflation				0.055***
				(0.012)
Constant	−0.113***	−0.261***	−0.216***	−0.216***
	(0.017)	(0.018)	(0.021)	(0.023)
$_R2$	10.5%	12.5%	12.6%	12.6%
Sample size	52,475	52,475	52,475	52,475
Time fixed effects	✓	✓	✓	✓
Country fixed effects	✓	✓	✓	✓

This table presents the OLS estimates for the determinants of SMEs' insolvency risk. Dependent variable is the standardized composite insolvency indicator. All specifications include country fixed effects and bi-annual time fixed effects. Standard errors robust to heteroskedasticity are in parentheses. Three stars denote significance at 1%; two stars denote significance at 5%; one star denotes significance at 10%.

to the insolvency risk being 0.22 standard deviations more than otherwise. The main takeaway from Model 2 is that especially microfirms with less than 10 employees who have a turnover of less than EUR 2 Mio have higher insolvency risk in general. As firms grow, the insolvency risk decreases.

In Model 3, we include firm ownership indicators, export company dummy variables, and sector dummy variables. Our results indicate that being an export firm decreases insolvency risk by some 0.07 standard deviations or around 3%. Exporting firms have higher resilience to local shocks as they can switch between domestic and foreign markets more easily. Turning to different sectors, only SMEs from the services sector have a higher insolvency risk. Most likely, they are affected the most by the pandemic demand shock as well. Firm ownership variables do not enter the regression with statistically significant coefficients.

In Model 4 of Table 3, we add macro-economic controls such as GDP growth and inflation. Both variables enter the regression with statistically significant coefficients. GDP growth has a negative sign, and one standard deviation increase in GDP growth reduces the SMEs' insolvency risk by around 0.04 standard deviations. During periods of high GDP growth, SMEs might see favorable demand dynamics for their services and products. As a result, they have higher revenues and profitability and thereby have lower insolvency risk. On the contrary, heightened inflation increases the insolvency risk. A one standard deviation increase in inflation raises the insolvency risk by around 0.05 standard deviations. This is most likely due to SMEs' increased funding costs and the detrimental market conditions during high inflation periods.

We include country-fixed effects in all our specifications, which are not reported for conve-nience but worth mentioning. Our reference country is Germany, and in our models, we include fixed effects for France, Italy, Spain, and the Netherlands. Dummy variables for Italy and Spain are positively significant in all specifications. SMEs from Italy and Spain have around 0.32 and 0.12 standard deviations higher insolvency risk, respectively than the German SMEs. Indeed, SMEs' problems in southern Europe have been persistent since the sovereign crisis, which is reflected as a higher insolvency risk in our analysis. On the contrary, in the Netherlands, SMEs' insolvency risk is 0.25 standard deviations less than in Germany. Especially in recent years, SMEs from the Netherlands were strong performers on many fronts in Europe.

All in all, the sign and significance of SME insolvency risk determinants of this subsection are by and large in line with the expectations. The pandemic outbreak increased insolvency risk significantly. However, there is significant heterogeneity in its impact concerning some SME characteristics.

4.2. SME insolvency risk with respect to SME characteristics at the onset and during the pandemic

The previous subsection presents the impact of single indicators on SME insolvency risk. To delve deeper into these indicators' contributions around the pandemic outbreak and during its peak, we split our sample into different subsamples.[7] In doing so, we replicate Model 4 of Table 3 by excluding the split variable from our analysis.[8] For convenience, we report the coefficients of the pandemic dummy variables only.

Fig. 3 presents the onset of the pandemic and the pandemic dummy variable's coefficient when the sample is split according to firm size. The intuition behind this differentiation is the potential heterogeneity in the pandemic impact on business operations and the financial backdrop within the SME spectrum. Among different firm sizes, the coefficient of the pandemic dummy variable takes the smallest value for the microfirms subsample both at the onset of the pandemic and during the pandemic. The coefficients for small and medium-sized firm subsamples are remarkably larger in both cases. Even though microfirms generally have higher insolvency risk, it seems that small and medium-sized enterprises were the ones to be hit the hardest at the onset of the pandemic. Shedding some more light on this conclusion, Fig. 4 presents a similar result when the firm size is measured with turnover. The coefficient of the pandemic dummy variable is smaller both at the onset of the pandemic and during the pandemic for SMEs that have the lowest turnover. SMEs with EUR 2 to 10 Mio and EUR 10 to 50 Mio turnover have higher insolvency risk around the pandemic's outbreak and during its intensification. Microfirms with few employees and low turnover usually have lower funding needs and fixed costs within the SME spectrum. During the pandemic, public support measures might cover these costs more efficiently, and microfirms' insolvency risk increased less than that of small or medium-sized firms.

Fig. 5 presents the results when the sample is split with respect to being a domestic or export firm. The intuition behind this split is that domestic firms are more prone to restrictions in international demand. The coefficient of the pandemic dummy is insignificant for the domestic firm subsample at the onset of the pandemic. In contrast, it becomes positively significant during the pandemic. The bankruptcy risk of domestic SMEs increased by 0.4 standard deviations or by 14% during the pandemic. This finding indicates that while domestic firms were somewhat more resilient to insolvency risk in the first months of the pandemic, their insolvency risk also increased with national pandemic measures taking place. The coefficient of the pandemic onset and pandemic dummy variables are positively significant and large in magnitude for export firms. Specifically, exporting SMEs were 0.3 standard deviations or around 12% more likely to become insolvent at the onset of the pandemic. With the crisis's intensification, the risk became immense: i.e., exporting firms became 20% more likely to go bankrupt. This is probably because export firms are more vulnerable to reduced global trade flows. The global recession inevitably leads to weaker

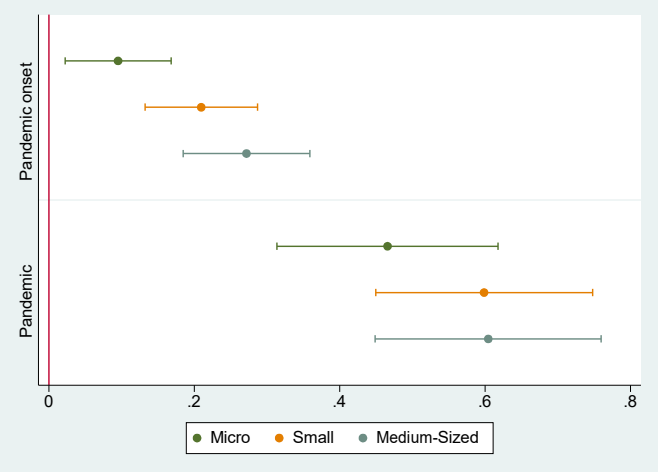


Fig. 3. Insolvency risk with respect to firm size. This figure presents the impact of pandemic on insolvency risk with respect to firm size. Presented results are the coefficients of onset of the pandemic and pandemic dummy variables in respective subsample. Micro refers to firms that have less than 10 employees, small to firms that have more than (or equal to) 10 but less than 50 employees, Medium-Sized to firms that have more than (or equal to) 50 but less than 250 employees.

[7] Our specifications have multiple inter-linked firm characteristics, i.e., micro, small, and medium-size dummy variables as indicators of the number of employees. Therefore, multiple interaction terms between the time dummy variables and the respective firm characteristics are needed simultaneously in each regression, complicating the interpretation. Running regressions on subsamples is less restrictive and more straightforward to interpret. Moreover, direct inferences on the reference groups can also be presented with the sample split. In this vein, we split the data into subsamples according to the firm characteristics of interest rather than running the regression on a pooled sample and allowing for multiple interaction terms.

[8] We only focus on subsamples where the split variable has a significant coefficient in Model 4.

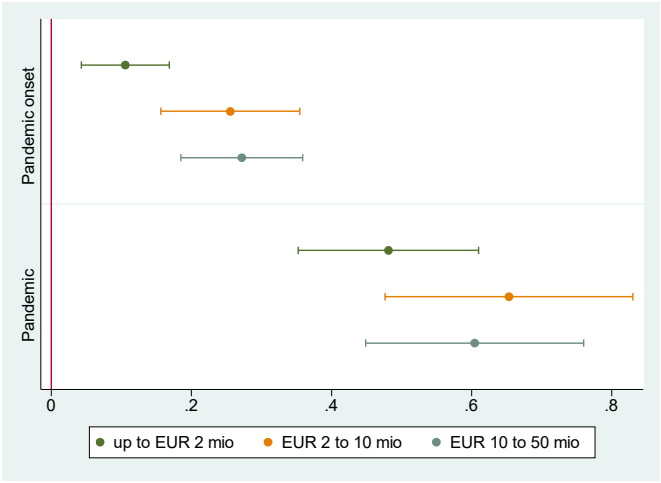


Fig. 4. Insolvency risk with respect to firm turnover. This figure presents the impact of pandemic on insolvency risk with respect to firm turnover. Presented results are the coefficients of onset of the pandemic and pandemic dummy variables in respective subsample. Up to EUR 2 mio refers to firms that have less EUR 2 mio turnover, EUR 2–10 mio refers to firms that have more than EUR 2 mio. but less than EUR 10 mio. turnover, EUR 10 to 50 mio refers to firms that have more than EUR 10 mio. but less than EUR 50 mio. turnover.

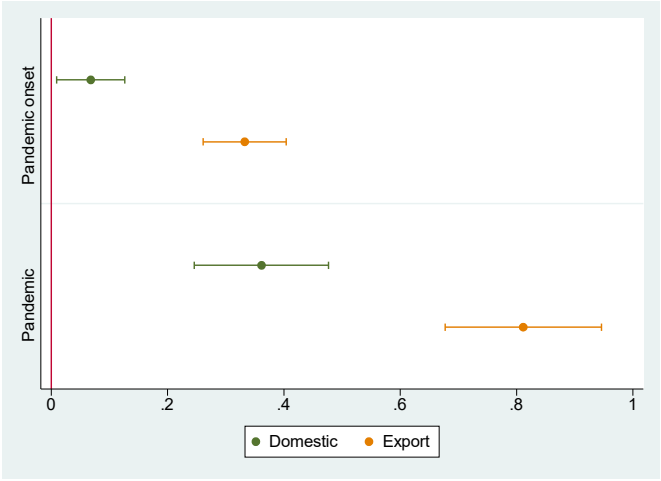


Fig. 5. Insolvency risk differentiating for domestic and exporting firms. This figure presents the impact of pandemic on insolvency risk differentiating between domestic and exporting firms. Presented results are the coefficients of onset of the pandemic and pandemic dummy variables in respective subsample. Domestic refers to firms that do not export and export otherwise.

foreign demand and disruption of supply chains, impacting export firms more.

Fig. 6 shows the differentiation concerning sector subsamples. Indeed, some sectors such as tourism and transport were hit by the pandemic much harder than others. Nevertheless, the onset of the pandemic variable is positively significant for all sectors. This finding points out that firms across the board have higher insolvency risks to different degrees. Meanwhile, the construction sector's insolvency risk decreased at the onset of the pandemic and was negligible during the pandemic. While the construction sector has been in a good position for the last ten years or so, it is noteworthy to observe that it actually benefited from the pandemic. This could indicate that the construction industry entered the pandemic crisis in a much stronger position thanks to low mortgage rates, among other reasons.

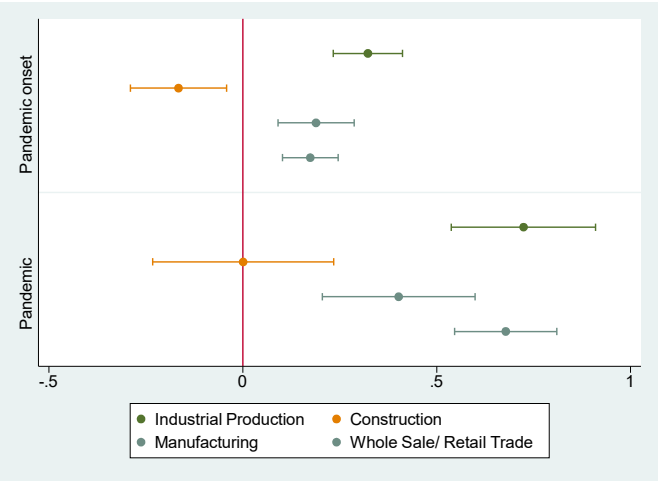


Fig. 6. Insolvency risk with respect to sector. This figure presents the impact of pandemic on insolvency risk with respect to main activity of the SMEs. Presented results are the coefficients of onset of the pandemic and pandemic dummy variables in respective subsample.

4.3. Most pressing problem and insolvency risk

In addition to SME characteristics, several external challenges might have increased European SMEs' bankruptcy risk at the pandemic's onset. To examine these factors, Section 2 of the SAFE questionnaire includes a question on the enterprises' most pressing problem. Specifically, it asks if finding customers and the cost of production/labor, among others, were problems for the SMEs during the last six months. Responses to these questions are given on a scale ranging from 1 to 10, with 1 representing "not important at all" and 10 representing "extremely important." For ease of interpretation, we generate a dummy variable that takes the value of one for responses larger than five and zero otherwise. We include each most pressing response dummy variable separately in our regressions. Tables 4 and 5 present the results of this analysis.

Panel A of Table 4 shows the impact of finding customers as the most pressing problem on insolvency risk. During periods of subdued economic activity, especially, SMEs face problems on this front. With SME clients under lockdown, this was likely the most relevant problem in the pandemic context, too. In the first column of Panel A, we include the dummy variable of facing difficulties in finding customers only. The dummy variable is positively significant, and SMEs that face difficulties finding customers are 0.20 standard deviations more likely to face insolvency risk in general than their counterparts. Panel B presents the results for the cost of labor and production as the most pressing problem. If SMEs have higher fixed costs, it becomes harder to generate high-profit margins. This, meanwhile, might translate into higher insolvency risk. In line with these arguments, labor and production cost as the most pressing problem increases the insolvency risk by around 0.16 standard deviations. Meanwhile, the onset of the pandemic and pandemic dummy variables in all models of Table 4 are positively significant and similar in magnitude to those in Table 3.

To shed some light on the impact of the most pressing problems at the pandemic outbreak, we interact each most pressing problem dummy variable with the onset of the pandemic and pandemic dummy variables. The first interaction term in Panel A is positively significant. As the pandemic erupted, SMEs faced difficulty finding customers, which, as a result, added approximately 0.10 standard deviations to their insolvency risk. Due to lockdown and several additional measures, finding customers became a central problem for SMEs during the pandemic. This is reflected in the third column of Panel A of Table 4 where the difficulty in finding customers adds around 0.25 standard deviations to insolvency risk. We include both interaction terms in column four of Panel A to present their joint impact. If an SME reported finding customers as the

Table 4
Most pressing problem during pandemic.

	Panel A: Finding Customers				Panel B: Cost of production and labor			
Onset of the pandemic	0.197***	0.146***	0.193***	0.127***	0.183***	0.172***	0.182***	0.161***
	(0.024)	(0.030)	(0.024)	(0.030)	(0.024)	(0.033)	(0.024)	(0.033)
Pandemic	0.593***	0.591***	0.447***	0.440***	0.581***	0.580***	0.506***	0.504***
	(0.050)	(0.050)	(0.053)	(0.053)	(0.050)	(0.050)	(0.053)	(0.053)
Finding customers	0.199***	0.192***	0.178***	0.168***				
	(0.009)	(0.009)	(0.009)	(0.009)				
Interaction onset of the pandemic		0.080**		0.105***				
		(0.032)		(0.032)				
Interaction pandemic			0.253***	0.263***				
			(0.033)	(0.033)				
Cost of production and labor					0.162***	0.160***	0.149***	0.147***
					(0.009)	(0.009)	(0.009)	(0.010)
Interaction onset of the pandemic						0.016		0.030
						(0.033)		(0.033)
Interaction Pandemic							0.145***	0.147***
							(0.034)	(0.034)
Constant	−0.370***	−0.366***	−0.356***	−0.351***	−0.337***	−0.337***	−0.332***	−0.330***
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
$_R2$	13.5%	13.5%	13.6%	13.6%	13.2%	13.2%	13.2%	13.2%
Sample size	52,223	52,223	52,223	52,223	52,223	52,223	52,223	52,223
Controls			✓				✓	
Time fixed effects			✓				✓	
Country fixed effects			✓				✓	

This table presents OLS estimates of the relationship between insolvency risk and most pressing problem of the SMEs. The dependent variable is the composite insolvency indicator. All specifications include SME specific controls, country and time fixed effects. Standard errors robust to heteroskedasticity are in parentheses. Three stars denote significance at 1%; two stars denote significance at 5%; one star denotes significance at 10%.

Table 5
Most pressing problem during pandemic cont.

	Panel A: Competition				Panel B: Skilled staff availability			
Onset of the pandemic	0.196***	0.181***	0.197***	0.183***	0.191***	0.169***	0.191***	0.171***
	(0.024)	(0.029)	(0.024)	(0.029)	(0.024)	(0.032)	(0.024)	(0.032)
Pandemic	0.612***	0.612***	0.621***	0.620***	0.563***	0.563***	0.591***	0.590***
	(0.050)	(0.050)	(0.052)	(0.052)	(0.051)	(0.051)	(0.054)	(0.054)
Competition	0.237***	0.235***	0.239***	0.236***				
	(0.008)	(0.009)	(0.009)	(0.009)				
Interaction onset of the pandemic		0.026		0.025				
		(0.031)		(0.031)				
Interaction pandemic			−0.023	−0.020				
			(0.032)	(0.032)				
Skilled staff availability					−0.088***	−0.090***	−0.084***	−0.086***
					(0.009)	(0.009)	(0.009)	(0.009)
Interaction onset of the pandemic						0.034		0.030
						(0.033)		(0.033)
Interaction pandemic							−0.043	−0.040
							(0.033)	(0.033)
Constant	−0.377***	−0.376***	−0.378***	−0.377***	−0.149***	−0.148***	−0.152***	−0.151***
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
$_R2$	13.9%	13.9%	13.9%	13.9%	12.8%	12.8%	12.8%	12.8%
Sample size	52,223	52,223	52,223	52,223	52,223	52,223	52,223	52,223
Controls			✓				✓	
Time fixed effects			✓				✓	
Country fixed effects			✓				✓	

This table presents OLS estimates of the relationship between insolvency risk and most pressing problem of the SMEs. The dependent variable is the composite insolvency indicator. All specifications include SME specific controls, country and time fixed effects. Standard errors robust to heteroskedasticity are in parentheses. Three stars denote significance at 1%; two stars denote significance at 5%; one star denotes significance at 10%.

most pressing problem at the onset of the pandemic and during the pandemic, it is thus 14% more likely at the risk of insolvency. The reductions in customer demand are assumed to be disruptive to SMEs' solvency. Considering that the normalization of customer demand might require a prolonged period, finding customers might remain a vital issue during subsequent years.

The second column of Panel B includes the interaction term between the onset of the pandemic and the cost of production and labor, which is not statistically significant. This indicates that at the start of the pandemic, the cost of production being the most pressing problem did not contribute to the insolvency risk over and above its contribution during normal times. The third column of Panel B includes interaction with the pandemic dummy, which is positively significant. High costs increase the SME insolvency risk by around 6% during the pandemic. Indeed, at the onset of the pandemic, public support measures such as furlough schemes or rental support lowered the negative spillover of the crisis. However, these measures were plausibly not enough to cover the cost base as time passed. As a result, many SMEs saw their revenues and profits erode while their costs remained essentially constant. The demand shock they faced, combined with ongoing costs, might pose an

existential threat to many SMEs in years to come.

In Panel A of Table 5 we add the variable of competition as the most pressing problem. In a market where many SMEs compete, it becomes challenging to set higher product prices. Competitive pressure becomes even more relevant during times of weak aggregate demand, leading to higher insolvency risk. In line with these expectations, SMEs that report competition as the most pressing problem have a higher insolvency risk of 0.25 standard deviations. In Panel B of Table 5, we add skilled staff availability as the most pressing problem. Interestingly, skilled staff availability decreases the insolvency risk by 0.08 standard deviations. When SMEs face difficulty finding qualified staff, the economy is probably in good shape with a low unemployment rate. Households and customers have stable incomes to spend, which most likely increases SMEs' revenues and reduces insolvency risk.

We interact the competition as the most pressing problem with the onset of the pandemic and pandemic dummy variables. The intuition behind this is that competitive pressure might actually increase due to lockdown measures; i.e., providers of online services or products capture market share from more traditional SMEs that do not offer online products. Interaction terms for this exercise are presented in Panel A of Table 5 which, however, are not statistically significant. This finding indicates that while heightened competition in general increases insolvency risk, this was not necessarily the case during the pandemic. Finally, we interact the pandemic dummy variables with finding skilled staff as the most pressing problem. Indeed, due to the home office being the new normal during the pandemic, some SMEs might have had significant difficulties finding skilled staff. In Panel B, the interaction terms on this front are also insignificant. Overall, unlike finding customers or the cost base, competition or skilled staff availability did not contribute to SME insolvency risk around the pandemic over and above their contribution during regular times.

The main takeaway from this subsection is that a sudden and extreme drop in demand resulted in a considerable loss in revenues of European SMEs. These effects compounded with ongoing fixed costs might lead to severe liquidity shortages. The lack of liquidity is especially problematic for SMEs and increases insolvency risk because of their lower resilience related to their size. Therefore, external or internal financing alternatives during the pandemic crisis are of pivotal importance to bridge their liquidity needs. That said, insolvency risk might hinder SME' expected access to finance and require a closer look.

4.4. *Impact of insolvency risk and pandemic outbreak on the expected availability of finance*

Bank loans, credit lines, and trade credit are crucial external funding alternatives for European SMEs. Therefore, SMEs' access to these funding channels during the pandemic needs particular attention. Deterioration in the economic outlook due to pandemic shock might lead to limited availability of external funding at a point when SMEs have higher funding needs. This might translate into a vicious circle where a lack of external financing leads to higher insolvency risk and even more enhanced external funding needs.

An inherent problem is the potential reverse causality in modeling the impact of insolvency risk on access to finance. While current access to finance might be a function of insolvency risk, the lack of external financing in the current period might increase insolvency risk simultaneously. To address potential endogeneity concerns, we focus on expected access to finance instead of the current access to finance.[9] The SAFE survey includes forward-looking access to finance questions to shed light on the SMEs' expectations on this front. To be specific, question 23 asks "*If SMEs expect the availability of different* funding *alternatives to improve, deteriorate or remain unchanged over the next six months*". The responses to this question are given on a scale ranging from 1 to 3, with 1 representing "will improve", 2 representing "will remain unchanged", and 3 representing "will decrease". For ease of interpretation, we recode the dependent variables as −1 for "will decrease", 0 for "will remain unchanged," and 1 for "will improve" responses. In Table 6, we present the results for this analysis. For the sake of brevity, the table shows the impact at the onset of the pandemic and during the pandemic, the role of insolvency risk, and macro-economic factors in the expected access to finance of SMEs. However, we control for SME characteristics, country, and time-fixed effects in all specifications. Dependent variables are SMEs' perception regarding the expected availability of bank loans, credit lines and overdrafts, and trade credit.[10]

In Column one of Table 6, we start with the determinants of expected access to bank lending. The pandemic dummy variable is negatively significant, indicating that the pandemic's outbreak points to a deterioration in SMEs' expectations regarding bank loan availability by approximately 17%. Interestingly though, during the pandemic, SMEs did not expect any difficulties in bank loan availability. Indeed, many of the policy measures implemented to support SMEs during the pandemic were through bank lending channels. In line with this, OECD (2020) reports that bank lending to SMEs has rapidly increased to EUR 71 bn, EUR 103 bn, and EUR 91 bn in March, April, and May of 2020, respectively, in Europe. Therefore, SMEs' expectations regarding bank loan availability are justified. Insolvency risk also enters the regression with a negatively significant coefficient. A one-standard-deviation increase in insolvency risk leads to an approximately 16% deterioration in expected access to bank loans. This suggests that, in general, firms that have had insolvency problems in the past are more likely to have bank lending problems in the future. The dependent variables in Columns three and five are credit line and overdraft and trade credit, respectively. For both columns, the sign and magnitude of the onset of the pandemic and during the pandemic and insolvency risk variables are similar to those of bank loan availability. This shows that insolvency risk as a general factor is detrimental to access to external finance. While the onset of the pandemic pointed to a deterioration in external funding expectations, negative expectations were somewhat normalized during the pandemic crisis due to public support measures.

Additionally, presented in Table 6 is the impact of macro variables such as GDP growth and inflation on different funding alternatives. GDP growth has a positively significant coefficient across the board. In terms of the access to finance and growth nexus, economic growth seems to have a supportive role in access to finance. Meanwhile, inflation enters the regressions with a negatively significant coefficient for bank lending. For other dependent variables, inflation is either weakly significant or insignificant. An increase in inflation leads to a reduction in the availability of bank lending and credit lines due to banks' risk aversion and deleveraging during inflationary periods.

In Columns two, four, and six of Table 6, we add interaction terms for the onset of the pandemic and the pandemic dummy variables with insolvency risk. Interaction terms are positively significant for bank loans, credit lines and bank overdrafts. This points to the fact that SMEs with higher insolvency risk foresee their access to bank lending improving at the onset of and during the pandemic. Meanwhile, the interaction term is either insignificant or weakly significant for the trade credit-dependent variable. This is a noteworthy observation in the sense

[9] It is essential to stress that our approach does not rely on lagged variables. The dependent variable is obtained in the current period yet, by definition, is based on SMEs' expectations. Forward-looking identification alleviates the endogeneity by disentangling present insolvency risk from current financing problems.

[10] Bank loans refer to a precise amount of loan where repayment dates are fixed. In the case of credit lines and overdrafts, SMEs can draw only part of the funds at discretion up to an agreed maximum balance. The interest of the credit lines is charged only on the amount withdrawn. Trade credit indicates that SMEs can pay their suppliers at the later agreed date after delivering the purchased goods or services.

Table 6
Impact of insolvency risk and the pandemic on expected availability of external funding.

	Bank loans		Credit line		Trade Credit Bank overdraft	
Onset of the pandemic	−0.170***	−0.186***	−0.159***	−0.173***	−0.271***	−0.277***
	(0.020)	(0.021)	(0.021)	(0.022)	(0.025)	(0.026)
Pandemic	−0.009	−0.026	0.018	−0.000	0.081	0.066
	(0.037)	(0.038)	(0.036)	(0.037)	(0.052)	(0.052)
Insolvency risk	−0.163***	−0.171***	−0.158***	−0.165***	−0.151***	−0.155***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)
GDP growth	0.033***	0.034***	0.029***	0.031***	0.044***	0.046***
	(0.006)	(0.006)	(0.007)	(0.007)	(0.009)	(0.009)
Inflation	−0.038***	−0.034***	−0.024**	−0.020**	−0.007	−0.005
	(0.009)	(0.009)	(0.010)	(0.010)	(0.011)	(0.011)
Interaction onset of the pandemic		0.051***		0.041***		0.016
		(0.015)		(0.016)		(0.020)
Interaction pandemic		0.035***		0.040***		0.037**
		(0.013)		(0.013)		(0.018)
Constant	0.110***	0.106***	0.061***	0.057***	−0.015	−0.017
	(0.017)	(0.017)	(0.018)	(0.018)	(0.023)	(0.023)
R^2	10.4%	10.5%	10.5%	10.6%	11.9%	11.9%
Sample size	34,236	34,236	28,740	28,740	18,153	18,153
Company controls		✓		✓		✓
Time fixed effects		✓		✓		✓
Country fixed effects		✓		✓		✓

This table presents OLS estimates for the determinants of the expected access to external finance. The dependent variable in column one and two is bank loans, in column three and four credit lines and bank overdraft and in column five and six trade credit. All specifications include SME specific controls, country and time fixed effects. Standard errors robust to heteroskedasticity are in parentheses. Three stars denote significance at 1%; two stars denote significance at 5%; one star denotes significance at 10%.

that unprofitable firms with high indebtedness expect banks to widen credit lines to them. In contrast, they do not foresee the same from their suppliers or trading counterparts. A potential explanation for this might be the expectations of government support via the banking sector. In Europe, governments have introduced several measures to support lending to SMEs during the pandemic as public guarantees, among others.

4.5. Terms and conditions of bank loans around the pandemic

As a further step, we extend our analysis by studying whether insolvency risk, in addition to expected access to finance, also affects the price and non-price terms and conditions of bank financing around the pandemic. For this purpose, we utilize question 10 of the SAFE survey. Q10 asks SMEs about the terms and conditions of the bank financing they had received over the past six months. Since these loan have already been received, this question refers to a subsample of SMEs that were already eligible for bank lending. Q10 has five main categories: i) the level of interest of the loan received; ii) the level of other costs, such as charges and fees; iii) the size of the loan; iv) the maturity of the loan; and v) the collateral requirements such as guarantees, information requirements or loan covenants. SMEs could choose responses from among three different options: 1) was increased; 2) remained unchanged; and 3) was decreased by the bank. For ease of interpretation, we recoded the dependent variables as −1 for "was decreased", 0 for "remained unchanged," and 1 for "was increased". The explanatory variables remain the same as in the benchmark regression in column four of III.

In Table 7, we report the results of this analysis for the pandemic

Table 7
Terms and conditions of bank loans around the pandemic.

	Level of interest		Other costs		Size of the loan		Maturity of the loan		Collateral requirements	
Onset of the Pandemic	0.125***	0.137***	0.033	0.046	0.021	0.013	0.023	0.022	−0.079***	−0.061**
	(0.028)	(0.029)	(0.026)	(0.027)	(0.023)	(0.024)	(0.017)	(0.018)	(0.021)	(0.021)
Pandemic	−0.032	0.019	−0.231***	−0.175**	0.113*	0.093	0.088*	0.060	−0.221***	−0.192***
	(0.065)	(0.066)	(0.059)	(0.059)	(0.054)	(0.055)	(0.041)	(0.042)	(0.048)	(0.049)
Insolvency risk	0.101***	0.111***	0.080***	0.092***	−0.076***	−0.081***	−0.031***	−0.036***	0.077***	0.085***
	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.003)	(0.004)	(0.004)	(0.004)
Interaction onset of the pandemic		−0.040*		−0.043*		0.025		0.005		−0.050***
		(0.019)		(0.018)		(0.016)		(0.012)		(0.015)
Interaction pandemic		−0.084***		−0.091***		0.034*		0.045**		−0.049***
		(0.018)		(0.017)		(0.016)		(0.014)		(0.014)
Constant	−0.367***	−0.362***	0.196***	0.201***	0.176***	0.174***	0.073***	0.071***	0.120***	0.123***
	(0.029)	(0.029)	(0.027)	(0.027)	(0.024)	(0.024)	(0.018)	(0.018)	(0.021)	(0.021)
Company controls		✓		✓		✓		✓		✓
Time fixed effects		✓		✓		✓		✓		✓
Country fixed effects		✓		✓		✓		✓		✓
$_R2$	8.9%	9.1%	5.0%	5.2%	3.5%	3.5%	2.4%	2.5%	5.4%	5.6%
Sample size	16,709	16,709	16,753	16,753	16,746	16,746	16,613	16,613	16,476	16,476

This table presents OLS estimates for the determinants of the terms and conditions of bank loans around the pandemic. In column one and two dependent variable is the level of interest. In column three and four other costs related to bank loans. Column five and six, the size of the bank loan and column seven and eight the maturity. Finally, the last two columns refer to the collateral requirements associated with this loan. All specifications include SME specific controls, country and time fixed effects. Standard errors robust to heteroskedasticity are in parentheses. Three stars denote significance at 1%; two stars denote significance at 5%; one star denotes significance at 10%.

dummy variables, insolvency risk, and their interactions. Columns 1 and 2 show that the level of interest in bank loans increased at the onset of the pandemic because of the risk aversion of banks at the beginning of the crisis. However, during the pandemic, there were no further changes. Insolvency risk, in general, increases the interest rates that banks demand from SMEs. The interaction terms indicate that pandemic onset and insolvency risk were not jointly significant. However, firms with higher insolvency risk seem to enjoy tightened interest margins during the pandemic. Banks did not increase fees and commissions at the pandemic's onset and actually decreased these during the pandemic. While SMEs with a higher insolvency risk face higher charges and fees in general, they seem to benefit from reduced costs during the pandemic. This indicates that banks ease price terms and conditions of loans to firms with higher insolvency risk during the crisis.

Turning to the size and the maturity of loans, pandemic onset and its intensification do not significantly affect these variables. Meanwhile, the insolvency risk shortens the loan's maturity in general and leads to a smaller number of loans being available for SMEs. The results for collateral requirements point to an interesting trend. Both at the onset of the pandemic and during the pandemic, banks reduced their collateral requirements by approximately 6% and 20%, respectively. While they demand higher collateral for those SMEs with higher insolvency risk by approximately 8%, banks significantly reduced their requirements during the pandemic. Expressing differently, firms with higher insolvency risk enjoyed reduced collateral requirements than those that do not suffer from this risk. Combined with the results from the previous section, this subsection points out that price and non-price terms and conditions of bank loans are improved for SMEs with higher insolvency risk.

4.6. Innovative SMEs' insolvency risk and access to finance

SMEs' ability to introduce new products and services during economic upheavals might help them adjust to changing market conditions more rapidly. Put differently, SMEs that are able to innovative are more likely to overcome the negative consequences of the pandemic. Therefore, they might face lower insolvency risks, maintain their client base and have enhanced access to finance.

The link between firms' innovative activity and financial constraints has been intensively researched to date. However, the evidence on innovative SMEs' sensitivity to economic volatility around the pandemic and their ability to adjust in the context of their access to finance is limited. To address these potential dynamics, we study the insolvency risk of innovative SMEs around the pandemic, their most pressing problems and access to finance separately. To identify the innovative SMEs in our sample and following the literature, we refer to the first question of section five of the SAFE survey (Moro et al., 2020; Santos and Cincera, 2022). To be specific, the question asks, “During the past 12 months have you introduced a new or significantly improved product or service to the market?” The response categories are either yes or no (or no response).[11] We divide our sample into two groups based on their answers and define SMEs that respond yes to this question as innovative SMEs. Our measure of innovation is relatively conservatively defined and does not include firms that simply adopt new innovations from elsewhere.

Table 8 shows our first set of results where we focus on determinants of the insolvency risk for the full sample as well as innovative and non-innovative subsamples. In the first and second columns, we start with the full sample. Our results show that innovative firms are approximately 8% less likely to default on average than their counterparts. This finding is robust to the inclusion of company specific indicators, time and country fixed effects. In the second column, we interact the pandemic and the innovation dummy variables to shed some light on the joint impact of innovation and the pandemic on insolvency risk. The results on this front reveal that innovative SMEs are around 3% less likely to default compared to noninnovative SMEs. This might point to their ability to overcome pandemic associated problems by adjusting changing market conditions and requirements more swiftly.

The impact of the most pressing problems on the insolvency risk of innovative SMEs helps delve deeper into their ability to deal with this external shock. To address this, in Columns three to six, we include interaction terms similar to those in Table 4.[12] Columns three and four show the role of finding customers. For the noninnovative subsample, the impact is positively significant. Noninnovative SMEs face higher insolvency risk if they face difficulties in finding customers, which became even more prominent during the pandemic. Meanwhile, innovative SMEs did not face issues in finding customers. Turning to the impact of the cost of production on insolvency risk around the pandemic, Columns five and six show that both innovative and noninnovative firms face similar obstacles. Taken together, while innovative SMEs are able to overcome the lack of customer problems, most likely via digital solutions, they are prone to the same obstacles around production costs.

Turning to the differences in the availability of finance, Table 9 presents the differences with particular attention given to lending. The first two columns are for access to bank lending. In line with the previous results, the pandemic did not lead to a particular worsening in expected access to bank lending, while insolvency risk does so for both innovative and noninnovative firms. For innovative firms that face heightened insolvency risk due to the pandemic, however, approximately 3% saw their access to expected bank lending actually improve during the pandemic. In other words, banks widened their credit to innovative firms during the pandemic. Turning to shorter-term loans such as bank overdraft and trade credit, the differences become less visible and largely insignificant. Overall, the pandemic had a relatively more severe impact on noninnovative firms.

Compared to the previous crisis that began in the financial sector in 2008, COVID-19 is unique in many ways. Given the truly exogenous, uncertain, and global nature of the pandemic, SMEs have been faced with unprecedented obstacles related to their activities. Although both innovative and noninnovative firms have been affected by the COVID-19 crisis, our results show that innovative SMEs fared better during the pandemic than noninnovative ones. For them, their insolvency risk was lower, they were more successful in reaching their clients, and they had easier access to bank loans. In light of these results, it is evident that innovation remains at the center of competitiveness, economic recovery, and resilience and becomes even more central during economic upheavals such as the pandemic.

5. Conclusion

With their customers under lockdown, businesses closed, and cash flows dwindling, the COVID-19 pandemic has posed an existential threat to European SMEs' financial resilience. This paper uses unique firm-level survey data on SMEs' financing conditions and a new approach to estimate their insolvency risk during the pandemic outbreak. We find that SME insolvency risk increased, on average, by approximately 10% at the outbreak of the pandemic and by 21% during the pandemic. In particular, small and medium-sized exporting firms have been affected by the shock. Finding customers and ongoing fixed costs have notably contributed to SME insolvency risk during this period. Our results show that heightened insolvency risk gives rise to a deterioration in expected access to finance channels in general. However, innovative SMEs proved to be more resilient, maintain their client base, and see favorable access to bank lending during the pandemic. These results are robust to the inclusion of a rich set of firm-specific controls, macroeconomic factors, and country-

[11] The sample size becomes smaller for the analysis because the innovation question is asked once per year.

[12] We exclude the indicators that do not present statistically significant results in Tables 4 and 5 for convenience.

Table 8
Insolvency risk of innovative SMEs.

	Full sample		Noninnovative	Innovative	Non innovative	Innovative
Pandemic	0.600***	0.567***	0.443***	0.721***	0.519***	0.675***
	(0.059)	(0.059)	(0.068)	(0.137)	(0.068)	(0.136)
Innovative	−0.209***	−0.231***				
	(0.014)	(0.014)				
Innovative during the pandemic		0.154***				
		(0.040)				
Finding customers			0.180***	0.233***		
			(0.014)	(0.026)		
Finding customers during the pandemic			0.296***	0.093		
			(0.039)	(0.076)		
Cost of production					0.151***	0.149***
					(0.014)	(0.027)
Cost of production during the pandemic					0.131***	0.199***
					(0.040)	(0.075)
Constant	−0.226***	−0.224***	−0.392***	−0.582***	−0.370***	−0.513***
	(0.026)	(0.026)	(0.031)	(0.061)	(0.032)	(0.061)
Company controls		✓		✓		✓
Country fixed effects		✓		✓		✓
Time fixed effects		✓		✓		✓
$_R2$	14.8%	14.8%	15.3%	16.3%	14.6%	15.9%
Sample size	29,268	29,268	22,053	7215	22,053	7215

This table presents OLS estimates for the determinants of insolvency risk, with particular attention given to innovative SMEs. Column one and two includes the full sample. Columns three to six include innovative and noninnovative subsamples separately. All specifications include SME-specific controls and country and time-fixed effects. Standard errors robust to heteroskedasticity are in parentheses. Three stars denote significance at 1%; two stars denote significance at 5%; one star denotes significance at 10%.

Table 9
Access to finance of innovative SMEs.

	Bank loans		Credit line, bank overdraft		Trade credit	
	Noninnovative	Innovative	Noninnovative	Innovative	Noninnovative	Innovative
Pandemic	0.060	0.062	0.096**	−0.055	0.041	0.241*
	(0.049)	(0.088)	(0.048)	(0.089)	(0.070)	(0.124)
Insolvency risk	−0.172***	−0.184***	−0.162***	−0.186***	−0.157***	−0.159***
	(0.006)	(0.010)	(0.006)	(0.010)	(0.007)	(0.012)
Interaction	0.029*	0.067***	0.037**	0.059**	0.035	0.041
	(0.015)	(0.025)	(0.017)	(0.025)	(0.022)	(0.032)
Constant	0.073***	−0.029	0.033	0.008	−0.004	−0.122**
	(0.022)	(0.041)	(0.023)	(0.043)	(0.030)	(0.056)
Company controls		✓		✓		✓
Country fixed effects		✓		✓		✓
Time fixed effects		✓		✓		✓
R^2	11.4%	11.9%	10.9%	12.5%	12.3%	10.9%
Sample size	14,205	5033	11,951	4138	7365	2914

This table presents OLS estimates for the determinants of the expected access to external finance, with particular attention given to innovative SMEs. The dependent variables in columns one and two are bank loans, in columns three and four, credit lines and bank overdraft, and in columns five and six, trade credit. All specifications include SME-specific controls and country and time-fixed effects. Standard errors robust to heteroskedasticity are in parentheses. Three stars denote significance at 1%; two stars denote significance at 5%; one star denotes significance at 10%.

specific and time-specific trends.

Our results have important implications for designing relevant policy measures to avoid SME failures in Europe. For many SMEs with a profitable and stable business model, the sudden nature of the outbreak gave them very little time to adjust and figure out how to sail through a prolonged downturn. Public support programs and changes in insolvency laws were vital to protect SMEs' resilience and prevent an insolvency tsunami. For example, in several European countries, the liquidity support programs that cover operating costs affected SMEs in some breathing space during the lockdown. Nevertheless, many otherwise financially stable SMEs will find themselves overindebted after the pandemic is over. As innovative SMEs present a unique and robust group even in these turbulent times, targeted measures for SME innovation might contribute to quick recovery and prevent the number of insolvencies from rising significantly in the long term.

The availability of external funding is of central importance for SME investment decisions and sustainable recovery in the aftermath of the pandemic crisis. Therefore, policymakers should prioritize measures that address the high indebtedness of SMEs. For example, governments might consider investing equity directly in profitable SMEs to lower their debt levels. In addition, efforts that provide companies time to reorganize their business and implement restructuring measures would also be beneficial. Meanwhile, SMEs need to keep an even better eye on their financial and liquidity planning than they did before the pandemic. In doing so, the threat of follow-on insolvencies might be avoided in the years ahead.

Declaration of competing interest

There are no conflicts of interest associated with this publication and there has been no financial support for this work that could have influenced its outcome.

Appendix

Table 10
Variable definitions.

Insolvency indicators	
General information on the type and situation of the enterprise: Question 2: Have the following company indicators decreased, remained unchanged or increased over the past six months?	
Turnover	Increased (1), Remained unchanged (2), Decreased (3), Don't Know (9)
Profit	Increased (1), Remained unchanged (2), Decreased (3), Don't Know (9)
Inventories and other working capital	Increased (1), Remained unchanged (2), Decreased (3), Don't Know (9)
Debt compared to assets	Increased (1), Remained unchanged (2), Decreased (3), Don't Know (9)
Availability of finance and market conditions: Question 11: For each of the following factors, would you say that they have improved, remained unchanged or deteriorated over the past six months?	
Your enterprise-specific outlook with respect to your sales and profitability or business plan	Increased (1), Remained unchanged (2), Decreased (3), Don't Know (9)
Your enterprise's own capital	Increased (1), Remained unchanged (2), Decreased (3), Don't Know (9)

References

Altman, E.I., 1968. Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. J. Finance 23 (4), 589–609.
Altman, E.I., Brady, B., Resti, A., Sironi, A., 2005. The link between default and recovery rates: theory, empirical evidence, and implications. J. Bus. 78 (6), 2203–2228.
Altman, E.I., Sabato, G., 2005. Effects of the new basel capital accord on bank capital requirements for SMEs. J. Financ. Serv. Res. 28 (1), 14–42.
Altman, E.I., Sabato, G., 2007. Modelling credit risk for SMEs: evidence from the U.S. market. Abacus 43 (3), 332–357.
Altman, E.I., Sabato, G., Wilson, N., 2010. The value of non-financial information in small and medium-sized enterprise risk management. J. Credit Risk 6 (2), 1–33.
Bańkowska, K., Ferrando, A., Garcia, J.A., 2020. The COVID-19 pandemic and access to finance for small and medium-sized enterprises: evidence from survey data. In: Economic Bulletin Issue 4/2020. ECB.
Berger, A.N., Frame, S.W., 2007. Small business credit scoring and credit availability. J. Small Bus. Manag. 45 (1), 5–22.
Berger, A.N., Udell, G.F., 1995. Relationship lending and lines of credit in small firm finance. J. Bus. 68 (3), 351–381.
Bloom, N., Fletcher, R., Yeh, E., 2021. The Impact of COVID-19 on US Firms. Working Paper 28314. NBER.
Bongini, P., Laeven, L., Majnoni, G., 2002. How good is the market at assessing bank fragility? A horse race between different indicators. J. Bank. Finance 26 (5), 1011–1028.
Bottazzi, G., Secchi, A., Tamagni, F., 2014. Financial constraints and firm dynamics. Small Bus. Econ. 42 (1), 99–116.
Canales, R., Nanda, R., 2012. A darker side to decentralized banks: market power and credit rationing in SME lending. J. Financ. Econ. 105 (2), 353–366.
Cao, S., Leung, D., 2020. Credit constraints and productivity of SMEs: evidence from Canada. Econ. Modell. 88, 163–180.
Ciampi, F., Gordini, N., 2009. Default prediction modeling for small enterprises: evidence from small manufacturing firms in northern and central Italy. Oxford J. 8 (1), 13–29.
Ciampi, F., Gordini, N., 2013. Small enterprise default prediction modeling through artificial neural networks: an empirical analysis of Italian small enterprises. J. Small Bus. Manag. 51 (1), 23–45.
Cucculelli, M., Peruzzi, V., 2020. Post-crisis firm survival, business model changes, and learning: evidence from the Italian manufacturing industry. Small Bus. Econ. 54, 459–474.
Czarnitzki, D., Hottenrott, H., 2011. R&D investment and financing constraints of small and medium-sized firms. Small Bus. Econ. 36 (1), 65–83.
Didier, T., Huneeus, F., Larrain, M., Schmukler, S.L., 2021. Financing firms in hibernation during the COVID- 19 pandemic. J. Financ. Stabil. 53, 100837.
Dierkes, M., Erner, C., Langer, T., Norden, L., 2013. Business credit information sharing and default risk of private firms. J. Bank. Finance 37 (8), 2867–2878.
Dörr, J., Licht, G., Murmann, S., 2022. Small firms and the COVID-19 insolvency gap. Small Bus. Econ. 58, 887–917.
EC, 2019. Annual Report on European SMEs 2018/2019. SME Performance Review, 2018/2019. European Commission.
EC, 2020. Unleashing the Full Potential of European SMEs. Press Release. European Commis- sion.
Edmister, R.O., 1972. An empirical test of financial ratio analysis for small business failure prediction. J. Financ. Quant. Anal. 7 (2), 1477–1493.
Fairlie, R., Fossen, F., 2021. The Early Impacts of the COVID-19 Pandemic on Business Sales. Small Business Economics, Forthcoming.
Falavigna, G., Ippoliti, R., 2022. Financial Constraints, Investments and Environmental Strategies: an Empirical Analysis of Judicial Barriers. Business Strategy and the Environ- ment, Forthcoming.
Ferrando, A., Popov, A., Udell, G., 2017. Sovereign stress and SMEs' access to finance: evidence from the ECB's safe survey. J. Bank. Finance 81 (3), 65–80.
Ferreiro, J., Serrano, F., 2021. The COVID health crisis and the fiscal and monetary policies in the Euro Area. Int. J. Polit. Econ. 50 (3), 212–225.
Gaganis, C., Pasiouras, F., Voulgari, F., 2019. Culture, business environment and SMEs' profitability: evidence from European Countries. Econ. Modell. 78, 275–292.
Gourinchas, P.O., Kalemli-Ozcan, S., Penciakova, V., Sander, N., 2020. COVID-19 and SME Failures. Working Paper 27877. NBER.
Gourinchas, P.O., Kalemli-Ozcan, S., Penciakova, V., Sander, N., 2022. COVID-19 and small- and medium-sized enterprises: a 2021 “time bomb”? AEA Pap. Proc. 111, 282–286.
Grice, J.S., Ingram, R.W., 2001. Tests of the generalizability of Altman's bankruptcy prediction model. J. Bus. Res. 54 (1), 53–61.
Gupta, J., Gregoriou, A., 2018. Impact of market-based finance on SMEs failure. Econ. Modell. 69, 13–25.
Gupta, J., Gregoriou, A., Healy, J., 2015. Forecasting bankruptcy for SMEs using hazard function: to what extent does size matter? Rev. Quant. Finance Account. 45 (4), 845–869.
Hale, T., Webster, S., Petherick, A., Phillips, T., Kira, B., 2020. Oxford COVID-19 Govern- Ment Response Tracker. Blavatnik school of government, Oxford Unviersity.
Haroutunian, S., Osterloh, S., Slawinska, K., 2021. The Initial Fiscal Policy Responses of Euro Area Countries to the COVID-19 Crisis, vol. 1. ECB Economic Bulletin. ECB.
Josse, J., Pages, J., Husson, F., 2011. Multiple imputation in principal component analysis. Adv. Data Anal. Classif. 5 (3), 231–246.
Kolenikov, S., Angeles, G., 2009. Socioeconomic status measurement with discrete proxy variables: is principal component analysis a reliable answer? Rev. Income Wealth 55 (1), 128–165.
Ma, Y., Ropele, T., Sraer, D., Thesmar, D., 2020. A Quantitative Analysis of Distortions in Managerial Forecasts. Working Paper 26830. NBER.
Martinez, L.B., Guercio, M.B., Bariviera, A.F., 2020. A meta-analysis of SMEs literature based on the survey on access to finance of enterprises of the european central bank. Int. J. Finance Econ. (Forthcoming).
McGuinness, G., Hogan, T., Powell, R., 2018. European trade credit use and SME survival. J. Corp. Finance 49 (C), 81–103.
Moro, A., Maresch, D., Fink, M., Ferrando, A., Piga, C., 2020. Spillover effects of government initiatives fostering entrepreneurship on the access to bank credit for entrepreneurial firms in Europe. J. Corp. Finance 62, 101603.
Neuberger, D., Rathke, S., 2009. Microenterprises and multiple relationships: the case of professionals. Small Bus. Econ. 32, 207–229.
OECD, 2020. Coronavirus (COVID-19): SME policy responses. In: Policy Note on Tackling Coronavirus. OECD.
Ohlson, J.A., 1980. Financial ratios and the probabilistic prediction of bankruptcy. J. Account. Res. 18 (1), 109–131.
Peters, B., Roberts, M.J., Vuong, V.A., 2017. Dynamic R&D choice and the impact of the firm's financial strength. Econ. Innovat. N. Technol. 26 (1–2), 134–149.
Petersen, M., Rajan, R., 1994. The benefits of lending relationships: evidence from small business data. J. Finance 49 (1), 3–37.

Pindado, J., Rodrigues, L., De la Torre, C., 2008. Estimating financial distress likelihood. J. Bus. Res. 61 (9), 995–1003.
Qing, B., Shaonan, T., 2020. Innovate or die: corporate innovation and bankruptcy forecasts. J. Empir. Finance 59, 88–108.
Robb, A.M., Robinson, D.T., 2014. The capital structure decisions of new firms. Rev. Financ. Stud. 27 (1), 153–179.
Santos, A., Cincera, M., 2022. Determinants of financing constraints. Small Bus. Econ. 56, 1427–1439.
Santos, A., Haegeman, K., Moncada-Paterno-Castello, P., 2021. The impact of Covid-19 and of the earlier crisis on firms' innovation and growth : a comparative analysis. In: Working Papers on Territorial Modelling and Analysis, vol. 3. European Commission.
Sapienza, P., 2002. The effects of banking mergers on loan contracts. J. Finance 57 (1), 329–367.
Shi, B., Chi, G., Li, W., 2018. Exploring the mismatch between credit ratings and loss-given-default: a credit risk approach. Econ. Modell. 85, 420–428.
Traczynski, J., 2017. Firm default prediction: a bayesian model-averaging approach. J. Financ. Quant. Anal. 52 (3), 1211–1245.
Vassalou, M., Xing, Y., 2004. Default risk in equity returns. J. Finance 59 (2), 831–868.
Zhang, X., Ouyang, R., Liu, D., Xu, L., 2020. Determinants of corporate default risk in China: the role of financial constraints. Econ. Modell. 92, 87–98.