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SME Financial Distress and the Macroeconomic Recovery: A Microsimulation Approach

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Abstract: This paper models the immediate impact of the COVID-19 pandemic on Irish SMEs and extrapolates forward their performance as restrictions ease. Our baseline scenario shows a steady recovery path for the median firm. However, indicators of financial difficulties remain persistently high with the share of highly distressed firms reaching twenty-one per cent in 2024 in scenarios without firm exit. With exit of the most financially distressed firms, the patterns of financial characteristics return to 2019 levels by 2023. We also model the impact of the policy supports available to firms. In the absence of government supports, the distress rate would have been seventy-two per cent higher during the pandemic. We find that supports have a persistent impact even after they expire. In 2024, the distressed rate without the supports would be twenty per cent higher than in the baseline scenario with supports.

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1 Introduction[1]

COVID-19 has had an unprecedented impact on the world economy. This paper examines the effect of the pandemic on small and medium enterprises (SMEs), focusing on identifying characteristics of firms where survival may be threatened. Despite the extensive policy supports, some level of firm exit would be expected to result from the pandemic, particularly amongst firms already in financial difficulties. Many papers are emerging documenting the major falls in turnover and employment across countries (Apedo Amah et al., 2020; Bartlett & Morse, 2020; Chetty et al., 2020), widescale and intermittent closures (Bartik et al., 2020), increased failure risks (Gourinchas et al., 2020) and lower productivity levels (Bloom et al., 2020). These studies highlight major uncertainties around future demand and recovery, with evidence from the US suggesting that firms expect demand to remain over 30 per cent lower than normal on an ongoing basis (Balla-Elliott et al., 2020).

This paper provides a range of scenarios to examine the extent to which SMEs in Ireland are at risk of serious financial difficulties as a result of the pandemic and the impact that policy supports have had in supporting firms throughout the period. This will include estimates of the extent and depth of firms' exposure to COVID-19, the resources they can draw on themselves and their financial health or weakness prior to the onset of the pandemic. The policy supports modeled in this paper include those announced up to Budget 2022.[2] One substantial contribution that we make comes from having data that was collected on firms experience of the pandemic rather than being based on pre-pandemic data sources which has been a limitation to much of the analysis of this issue to date.

Our approach is related to that of Demmou et al. (2020) and Gourinchas et al. (2020), focusing on the running down of firm liquidity in a period of turnover reduction and the potential for this to turn into solvency risk if continued long enough. Using cross-country firm-level data from 2018, Demmou et al. (2020) find that in the absence of government interventions,

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[2] Budget 2022 https://www.gov.ie/en/publication/7e491-taxation-measures/

20% of SMEs would run out of liquidity after a month and 35-38% after 3 months. Gourinchas et al. (2020) compare the share of insolvent firms in the top quartile of total factor productivity distribution to their before COVID-19 (non pandemic) share. Their study finds disruptuions during COVID-19 could result in viable and efficient firms exiting which is unlikely to occur in normal times. Their findings suggest that in normal economic environments, the share of insolvent firms in top productivity quartile is 3%. In lockdown, this share is multiplied by 10 in the most adversely affected sectors including hospitality and construction.

Carletti et al. (2020) projects that the firms most likely to be distressed are typically smaller and characterised by lower levels of both productivity and capitalisation. They are also likely to be relatively concentrated in more labour intensive industries. These characteristics will be important in evaluating the risk profile of SMEs in our work. The results from Demmou et al. (2020) are based on larger enterprises, with a cross country sample mean (median) employment of 39 whereas our sample of firms have mean employment of 22. We further examine the impact of a range of policies on the survival prospects of firms including access to credit supports. In contrast, Demmou et al. (2020) includes an assumption that firms are not able to tap into external sources of working capital such as short-term loans and trade credit for liquidity shortfalls.

A variety of factors that have been found to affect the survival prospects of firms in "normal" times are likely to be of relevance to the recovery profile exiting the pandemic restrictions. These include firm age (Berger & Udell (1998), Anyadike-Danes & Hart (2018)), size (Almeida et al., 2013), access to external finance (Berger & Udell (1998), Titman & Wessels (1988)) amongst other factors. Overall, Ferreira & Saridakis (2017) shows that smaller firms are typically more sensitive to demand shocks than larger firms and this results in a reduced likelihood of survival. Likewise, Nunes & Serrasqueiro (2012) finds that scale effects, financial situation and macroeconomic situation are important in explaining younger SMEs' survival, with technological intensity a more important factor for the survival of older SMEs. Financing options are typically much more limited for SMEs than for larger firms, with SMEs generally more dependent on bank finance and more vulnerable to financing constraints (Beck et al. (2008), Stiglitz & Weiss (1981), Casey & O'Toole (2014), Ferrando & Mulier (2013)). While in times of crisis, the financial position of the firm entering the crisis and access to a range of financing sources including trade credit are key determinants of survival for SMEs (McGuinness & Powell, 2018).

Using data from the same sequence of surveys we exploit, but collected prior to the pandemic, Lawless et al. (2020a) and McCann & Yao (2021) extrapolated the impact on firms' finances from the restrictions to economic activity. Lawless et al. (2020a) estimated a gap emerging between firm turnover and expenditure over the course of 2020 of between €8bn and €15bn. Offsetting the extreme size of the economic shock, however, McCann & Yao (2021) estimates that policy interventions in 2020 and early 2021 reduced the incidence of financial stress amongst SMEs by two-fifths of what it would otherwise have been.

This paper builds on this previous work using an expanded version of the survey containing greater detail on the composition of firm expenditures, which will help provide evidence on the targeting of policy supports. This data gives details on how firms have adjusted expenditure to deal with turnover reductions and also provides us with a benchmark against which policy actions (such as tax deferments, wage subsidies and rates holidays) may have different impacts across firms with different cost structures and other characteristics. The descriptive patterns of these survey are documented in O'Toole et al. (2021).

In this paper, we build a microsimulation model based on three blocks. We begin with a core calibration of the SME sector based on Credit Demand Survey (CDS) data on firm finances from before (2019) and during the pandemic (2020) which reports the direct impact of COVID-19 on firms. The second key building block is to extrapolate forward firm growth and financial indicators in link with macroeconomic projections of the Irish economy. The final building block is the modelling of the policy supports available to firms and the extent to which they offset some of the economic impact.

As the COVID-19 restrictions ease, our baseline scenario shows a steady growth path for the median firm, with turnover returning to pre-pandemic levels by approximately the first quarter of 2022. However, we find that there are about fifty per cent more loss-making firms than there were in 2019 and remain so on a sustained basis in the scenario when no exit is assumed. With exit of the most financially distressed firms, the patterns of financial characteristics return to 2019 levels by 2023. This is not, it should be emphasised, a forecast that this level of exit will occur as firms may well have options of restructuring their finances or adapting their business model that are beyond the scope of a technical simulation. However, it does give

an indication of the scale of the impact and steepness of the recovery path for the SME sector.

We find that the longer term risks of severe financial problems are closely linked to pre-existing loss-making and indebtedness of the firms. Firms that entered the pandemic period already making losses or with substantial debt burdens make up the majority of those modelled as encountering financial distress even though the initial impact of the pandemic on turnover was broadly spread across firms. In a counterfactual analysis of the impact of policy interventions, we estimate that the rate of financial distress would have been almost twenty per cent higher in the absence of government supports to firms.

The paper outline is as follows. Section 2 details the data used in this study along with the impact COVID-19 has had on SMEs. Section 3 detail the structure and calibration of the microsimulation model. Section 4 describes the various policy interventions towards firms of the Irish government and how these were incorporated into the microsimulation. Section 5 outlines the macroeconomic recovery scenarios and Section 6 discusses the output of the model's survival projections based on these scenarios and the counterfactual outcomes without policy supports. Section 7 concludes.

2 Data and COVID-19 impact

This section describes the survey of SMEs in Ireland that we use to examine the impact of COVID-19 on activity levels throughout the second and third quarters of 2020. It then provides summary statistics of the impact of the pandemic on turnover, expenditure and profits and how these varied by firm size and sector. The final subsection looks at the internal resources the firms had available to them at the start of the period. The evolution this liquidity buffer will then be examined further in the following section.

2.1 Credit Demand Survey and COVID-19

We use data from a regular survey of SMEs carried out twice a year by the Irish Ministry of Finance. The survey is designed to track firm performance and credit demand (see for example Lawless et al. (2020b)). In the light of the COVID-19 pandemic, the version of the survey scheduled for second half of 2020 was extensively reformulated to capture the impact of the pandemic and associated public health restrictions on firms.

For the COVID-specific survey round we concentrate on in this paper, the interviews were undertaken over the period August 25th 2020 to October 12th 2020.[3] The survey is carried out by telephone with a sample size of approximately 1,500 respondents. The sampling frame is stratified by firm size and sector as described in Fitzpatrick Associates (2020). O'Toole et al. (2021) provide a detailed description of the survey and distribution of responses.

2.2 Impact of COVID-19 on SME performance and costs

The effects of the pandemic on firm turnover and expenditure are summarised in Table 1. This shows the overall impact on the SME sector in the bottom row and also a breakdown across broad sectors and size groups. The first column gives the number of firms in each category. To measure the impact of the pandemic, respondents were asked to provide information on their levels of activity in 2019 and this is used for comparison with the period of the pandemic which the survey related to - between mid-March and October 2020 to the level of activity in 2019.

Looking first at turnover, we find a mean fall for the SME sector as a whole of over 26 per cent with the median very slightly below this. There is considerable variation across sectors, however, with the largest impact felt by the hotels and restaurants sector where mean turnover fell by almost 61 per cent. The wholesale trade sector and business services were amongst the least impacted, although in any other circumstances their reductions in output would be regarded as staggering. There is somewhat less variation in the size of the turnover falls across size groups compared to the heterogeneity across sectors with the exception being the larger reduction in turnover for the self-employed compared to the other size groups.

The survey responses show that expenditure also falls but by a much smaller magnitude than turnover. This is clear in Table 1 where the mean reduction in expenditure across all firms was 8.5 per cent while the median was no change in overall expenditure. O'Toole et al. (2021) provides detail on the structure of firm expenditure broken down into purchases, wages, taxes, utilities, rent, loan repayments, commercial rates and a miscellaneous category. Table 8 in Appendix A reproduces the average shares in broad

[3] Additional care was taken in this round to ensure that the quotas by size and sector matched the previous historical waves of the survey in order to minimise the risk of sample selection bias due to the closure of particular enterprises. As survey was undertaken mainly in early Autumn, when restrictions on economic had largely been eased before being reimposed later in October, most firms were likely to be operating.

expenditure categories. This information on the ex-ante cost structure of SMEs will play into the assessment in subsequent sections of the likely survival prospects and solvency positions of SMEs today.

The final column of Table 1 reproduces a simple estimate of the responsiveness of expenditure to the change in turnover from O'Toole et al. (2021). These report the slope coefficients (β_1) from the following regression of year-on-year expenditure changes on turnover changes for each group:

$$\%\Delta\text{Expenditure}_{it} = \beta_0 + \beta_1 \cdot \%\Delta\text{Turnover}_{it} + \epsilon_{it} \quad (1)$$

For all SMEs, this slope coefficient is 0.366 which indicates that for every one per cent fall in turnover, we estimate a 0.366 per cent fall in expenditure. Although this is a simple correlation and does not measure causation, these estimates will be useful parameters when we look at how recovery in turnover is also likely to necessitate some increased expenditures. This relationship is also shown in Figure 14, Appendix A.

Table 1: Impact of COVID-19 on turnover and expenditure

	No. of	ΔTurnover		ΔExpenditure		Expenditure
	firms	Mean	Median	Mean	Median	elasticity
Manufacturing	181	-20.4	-20	-8.7	0	0.560*
Construction	134	-25.3	-30	-8.6	0	0.351*
Wholesale	466	-19.6	-25	-6.2	0	0.326*
Hotels & restaurants	167	-60.8	-65	-18.4	-10	0.512*
Business services	333	-25.0	-25	-11.1	0	0.419*
Other	211	-22.9	-15	-1.6	0	0.198*
Self-employed	155	-33.9	-35	-13.2	0	0.370*
Micro	424	-25.9	-25	-8.3	0	0.360*
Small	567	-25.0	-27	-7.5	0	0.357*
Medium	346	-26.6	-20	-8.3	0	0.355*
Total	1492	-26.5	-25	-8.5	0	0.366*

The estimated elasticity column reports the slope coefficients from an OLS regression of expenditure change on change in turnover reported in O'Toole et al. (2021). Underlying data from 2020 Credit Demand Survey. Significance levels (* p<0.01) were estimated using robust standard errors. Regressions exclude outliers with changes greater than 100%.

Thus far, we have examined how the impact of the pandemic varied across firms by sector and size group. An important question for the longer-term impact and recovery of SMEs is whether the impact was greater on firms that were already in a weaker position. However, when we compare the

broad profitability of firms in 2020 with that of 2019, no such relationship is apparent. Firms making a profit in 2019 are almost equally likely to make losses, break even or make a profit in 2020.

Table 2: Profitability cross-tabulation

	Profitability in mid-2020			
Profitability in 2019	Loss	B/E	Profit	Total
Made a loss	3.2	2.2	1.9	7.3
Broke even	10.2	9.0	9.7	28.3
Made a profit	22.8	19.8	21.9	64.4
Total	36.1	30.9	33.0	100.0

Originally published in O'Toole et al. (2021). Underlying data from 2020 Credit Demand Survey.

In Table 2 the firms profit category (profitable, breaking even or loss-making) is shown for 2019 along with the category they moved into in 2020.[4] This shows the widespread nature of the economic effects of the pandemic and associated restrictions with essentially no correlation evident between prior performance and profitability during this period.

2.3 Liquidity buffers prior to the pandemic

Although our profitability correlation matrix shows the widespread nature of the economic shock had little link with prior performance, the ability of firms to absorb such an enormous shock to turnover is still likely to be influenced by the strength of their finances prior to the pandemic. This section presents some data on the liquidity (cash and cash equivalents) that firms reported having to hand at the end of the 2019 financial year and how these compare to average weekly expenditures. The figures in Table 3 calculate the number of weeks of normal expenditure that firms were in a position to cover from their existing resources entering the pandemic. The amount of liquidity reported by firms is highly skewed so we report both the mean and median ratios of cash to expenditure. As well as the comparison of liquidity to all expenditures, we also make use of the detailed composition

[4] Note that the survey did not directly ask about 2019 profits: The profitability categories in 2020 are directly from the data, and profitability in 2019 is calculated from the information collected on expenditures and turnover. Cross-checking of these profitability group estimates show that the aggregated numbers are closely comparable to data collected from 2019 survey.

of expenditures described in O'Toole et al. (2021) in order to calculate how long firms could cover their fixed costs only.

Table 3: Liquidity buffers in 2019: Ratios of cash and cash equivalents to weekly expenditures

	Cash/All Expenses*		Cash/Fixed Costs*	
	Mean	Med.	Mean	Med.
Manufacturing	11	3	139	30
Construction	7	2	143	24
Wholesale	12	3	185	33
Hotels & restaurants	20	3	119	18
Business services	20	5	179	46
Other	20	4	127	27
Self-employed	16	1	141	23
Micro	17	2	177	27
Small	12	3	173	29
Medium	17	4	127	41
Total	15	3	161	31

* Average weekly total expenditures, average weekly fixed-cost expenditures. Originally published in O'Toole et al. (2021). Underlying data from 2020 Credit Demand Survey.

For SMEs overall, average cash balances at the end of 2019 would have been sufficient to cover 15 weeks of total expenditure. As fixed costs represent a minority of average expenditures (see Table 8 in Appendix A), cash reserves could cover these for much longer. On average, SMEs would be able to cover 161 weeks' worth of fixed costs in cash. However, the skewed distribution of cash holdings gives a much shorter amount of time that the median firm would be able to cover all expenditure (3 weeks) or fixed costs (31 weeks). It is noteworthy that the most impacted sector in terms of turnover decline, the hotels and restaurants sector, has one of the lowest levels of cash reserves relative to fixed costs.

3 Microsimulation structure

In this section, we outline the broad set-up of the microsimulation model built to examine the impact to date of COVID-19 on SMEs and to extrapolate their performance into the near-term. The structure of the model relies on three main blocks: The first is the core calibration of the model based on

Credit Demand Survey (CDS) data on firm finances and reports of direct impact of COVID-19 which are used to establish a baseline of the distribution of firm performance. The second key building block is the choice of scenario on future growth which we link to macroeconomic projections of the Irish economy. The final building block is the modelling of the policy supports available to firms. This section focuses on the first of the building blocks and the main indicators of firm financial health. Sections 4 and 5 describes the main policy interventions along with macroeconomic projections for the scenarios presented in the paper respectively.

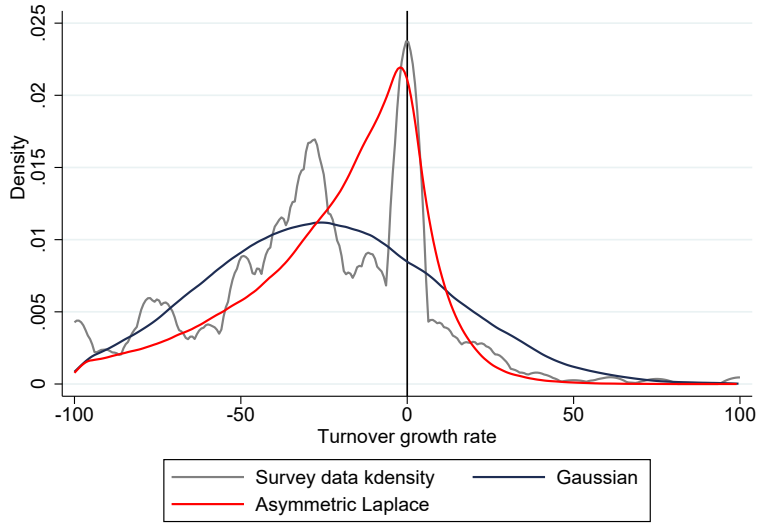
3.1 SME model components

This section describes how the microsimulation model was built using the survey data from the CDS to provide the baseline distribution of firm financial information and calibration for how they would be likely to evolve depending on the macroeconomic scenario fed into the model.

To calibrate the model, the main inputs are the survey information from 2019 and the first half of 2020 as described in Section 2. We exclude self-employed without employees from our modelling in this paper, primarily because of to the differences in policy supports available to that group and the numbers of observations available. Similarly, because of very low number of firms in the sample, we also exclude the agricultural sector. Some data cleaning was undertaken to remove outliers by winsorising the financial information at 5 per cent and imputing missing values for expenditure and assets based on sector and size group averages. To allow the model to evolve in a way that reflects the usual variability of the firms we use the survey weights and expand the dataset by ten replications. In total there are 13,120 observations that enter the microsimulation.

How the pandemic impacted firm turnover and expenditure and how these variables will evolve underpins much of the model's projections. Beginning with turnover, the initial levels of turnover for each firm are based on their reported 2019 average. The initial impact of the pandemic during the second quarter of 2020 is also based on the survey responses and reported growth rates are converted to log-growth rates. From then, the model links further changes in turnover on the macroeconomic scenarios discussed in Section 4. As having all firms grow at the same rate taken from the macroeconomic scenarios would be clearly unrealistic, a firm-specific random factor is added to the turnover path. This is calibrated to match either the observed standard deviation of the turnover growth across firms

Figure 1: Distribution of growth rates at the beginning of the pandemic



Firm data from DoF Autumn 2020 Credit Demand Survey. Plotted asymmetric Laplace and Gaussian distribution fitted with mean and variance equal to those observed in the survey.

in 2020Q2 or the pre-pandemic standard deviation observed in previous CDS survey.[5]

To match as closely as possible the observed turnover growth distribution in the data which has a considerable mass around zero, the firm growth takes the shape of an asymmetric Laplace distribution as described by Arata (2019). Appropriateness of asymmetric Laplace distribution to model firm growth rates is also confirmed on the CDS survey data as shown in Figure 1.

Furthermore, the simulations allows for the partial persistence of growth rates over time. To achieve this, future turnover growth of firm i in quarter t is modelled using autoregressive process:

$$\text{Turnover growth}_{i,t} = \varphi \cdot \text{Turnover growth}_{i,t-1} + e_{i,t} \tag{2}$$

Where is φ is a persistence parameter with value between 0 and 1 and $e_{i,t}$ is randomly generated noise. ε has properties which ensure that firms' growth rates will always have the asymmetric Laplace distribution with mean determined by the recovery scenario (described in Section 5) and sector variance as described above. Appendix C provides a more detailed and technical summary of the AR(1) process.

[5] For period between 2020Q3 and 2021Q4 the standard deviation is assumed to decline linearly from 2020Q2 level back to pre-pandemic level.

As the survey contains considerable information on different components of expenditure, these are modelled at as granular a level as possible. This facilitates the modelling of policy interventions more accurately as some are targeted at particular expenditure items (particularly wages) and also allows flexibility in how expenditure evolves given some items are more adjustable than others. Changes in employment were calibrated from a regression using the survey data which found a on per cent change in turnover is typically associated with a 0.232 per cent change in employment.

To simulate some stickiness in the employment response to turnover growth, the number of employees is restricted to being a positive round number. To convert employment numbers into the corresponding wage expenditure by the firm, is simply calculated by multiplying each new level of employment by the average wage. Implicit in this structure is an assumption that all vacancies can be filled by the firm as they arise, and that there are no fixed cost of hiring or firing. The average wage within each firm is assumed to have remained at 2019 levels. All other prices in the model remain constant as well.

Purchases of goods and services, as the most variable of expenditure items, are assumed to grow and fall in line with turnover based on their observed share of turnover in the pre-pandemic data for each firm. Other fully adjustable expenditure item in the microsimulations are taxes. Taxes are also calculated on the basis of the survey responses on tax payments as a share of turnover from the pre-pandemic data although tax warehousing is included as a policy intervention on this item as will be discussed in Section 4.

Commercial rates are included in the baseline expenditure projections as fixed at their initial level, but again some policy interventions are linked to this item. Other operating expenditures such as utilities, rent and other expenditures not specified in the survey are also assumed to be fixed in nominal terms at in 2019 level.

In line with existing studies, including Demmou et al. (2020) no new investment decisions are modelled although some depreciation expenses are calibrated at a rate equivalent to five per cent of fixed assets. For firms with outstanding debt prior to the pandemic, their repayment schedule is assumed to be fixed at the same level as in 2019 (until they fully repay all their existing debt).

Appendix A includes additional information on the expenditures. Figure 13 shows the structure of expenditures, how it evolves over time, and how it compares to survey data from 2019. Figure 14 compares the survey data and the microsimulation's elasticity in total expenditures relative to turnover. Both figures shows that the microsimulation successfully replicates key features observed the survey data.

A final building block of the the microsimulation is to allow for entry of new firms into the model. However, not all results reported in this paper include the entrants, as in some cases it will be more appropriate to examine the impact of the pandemic on the firms that were in operation at the start of the period of public health restrictions. The inclusion of entrants is however useful in contextualising some of the results towards the end of the projection period. For example, expressing the share of distressed firms amongst total SMEs in 2023 would likely be biased upwards if entrants unaffected by the pandemic impacts were not included. The number of new firms added into the microsimulation is calibrated from previous Credit Demand Surveys which included a question on firm age. Previous surveys are also used to determine baseline financial information for the entrants. Using only data on SMEs that were operating for four years or fewer at the time of the survey, we calculate means, standard deviations, and a correlation matrix of key financial variables (turnover, expenditure, employment, debt, assets). New firms are then randomly drawn from the joint distribution of these five variables. The methods and underlying parameters are described in more detail in Appendix B.

3.2 Indicators of SME financial state

This section outlines the key metrics that we use to evaluate the financial state of the SMEs at the time of the survey being carried out and as we roll forward along our later macroeconomic recovery scenarios.[6]

Our measures of financial difficulties are split across those indicators which attempt to measure liquidity issues (ongoing losses and cash constraints) and typical solvency indicators (based on debt metrics). In the subsequent analysis, the following indicators are tracked (as a % of all firms in the sample:

[6] We deliberately focus on easily measurable indicators available in our survey data. While more complex metrics have been used in the literature on drivers of firm bankruptcy and financial distress, such as the Altman Z-score (Altman and Sabato, 2007), these are typically more suitable for analysis of full financial accounts and it is difficult to apply them to survey-based data such as the source used here.

- Share of loss making firms (% of total firms);
- Share of firms with no cash (% of total firms);
- Share of firms whose indebtedness is rising (nominal debt balances are increasing);
- Share of firms whose debt/asset ratio > 1
- Share of highly financially distressed firms.

The final indicator is critical and determines the share of firms which are unlikely to survive. It is defined as the percentage of firms who have at least 6 quarters of losses, have no cash and whose debt to asset ratio is greater than 1.

4 Modelling policy interventions

The unprecedented speed and depth of the economic shock triggered by the public health priority of containing COVID-19 was responded to by the rapid introduction of a range of non-traditional policies. Internationally, the World Bank identified 1,607 policies that were introduced across 135 countries to deal with the economic fallout from the pandemic, the majority of which were employment cost support, debt instruments or tax measures (Cirera et al., 2020). These headings were also those where the policy response was concentrated in Ireland. In this section, we outline the main policy interventions of the Irish government, either for the business sector as a whole or targeted at SMEs, and how we link these to the survey data. We model the use and impact that six different policies (or policy groups) had on SMEs and will discuss each in turn: wage subsidisation, cost subsidies, tax warehousing, grants, loans and the waiving of commercial rates.

For each policy measure, there are two steps that we follow. The first is to identify the supports used by firms up to the point at which the survey was carried out. In the survey, we have direct evidence of the usage by firms of a number of the policy supports and can infer some others from the turnover and expenditure structure of the firm. The second step is to extrapolate forward the likely incidence and value of the policy supports to firms throughout 2021. This involves modelling when firms cease to be eligible for certain supports as the economy re-opens (in line with our recovery scenarios described in Section 5) and further scenarios on the winding down of the supports also in line with overall economic recovery.

4.1 Wage subsidy schemes

In order to mitigate the labour market impacts of widespread closure of some sectors, a wage subsidy scheme was introduced at the outset of the pandemic. The initial version of this scheme was the *Temporary Wage Subsidy Scheme (TWSS)* which was in place from March to August 2020 and then replaced by the *Employment Wage Subsidy Scheme (EWSS)*. Qualification for both schemes was the same with employers who had faced a fall in turnover of greater than 25 per cent able to apply for a payment to offset their wage cost if they agreed to keep the employee. A key difference in the schemes was that the TWSS could only be claimed for existing staff but the EWSS subsidy could be used for new hires as well.

The other substantive difference between the schemes was in how the rates were calculated. For the TWSS, the payment was initially set as 70 per cent of pre-pandemic wage levels per employee up to a maximum of €410 per person per week. This was then adjusted in May 2020 to have a more graduated payment structure.[7] The EWSS payment structure was based on a flat-rate subsidy of four different amounts to qualifying employers, based on the numbers of eligible employees and gross pay to employees. In October 2021, a gradual phase out of the subsidies was announced that will last until the end of April 2022.[8] All rates, including future rates as announced at the time of writing, are shown in Appendix A, Table 7.[9] O'Toole et al. (2021) showed that approximately 60 per cent of firms used one of these wage subsidy schemes (shown across sectors and size groups in Appendix A Table 9) and almost all were aware of the scheme.

In the model, we assume that all firms that are eligible for these employment support schemes avail of them. Therefore all firms with a turnover fall of thirty per cent or more throughout the pandemic period, we apply the appropriate rates of support based on their employment numbers. As described in Section 3, employment growth evolves in line with turnover growth. Due to lack of data on within-firm wages, the amount of subsidy in the model will only depend on the average wage and applies to all employees equally. When the change in subsidy rates occurs in the middle of the quarter the quarterly subsidy is calculated as weighted average based on the number

[7] Full details of the scheme are available from the Revenue Commissioners at https://www.revenue.ie/en/jobs-and-pensions/twss/index.aspx.

[8] The gradual phasing out of the EWSS supports were included in Budget 2022 https://www.gov.ie/en/publication/7e491-taxation-measures/.

[9] Full details of the scheme are available from the Revenue Commissioners at https://www.revenue.ie/en/employing-people/ewss/index.aspx.

of days. We continue to apply the subsidy to firms until the point at which their turnover recovers above 70 per cent of the 2019 level or until the scheme is expected to expire in April 2022 in line with government announcements.

4.2 Direct cost subsidy

As the pandemic has progressed, further public health restrictions that required business closures were in place from September 2020 onwards. The government established a 5 level plan of varying levels of restrictions which could be introduced depending on the epidemiological situation. In line with this time varying public health plan, the Government moved to expand the range of supports available. Of particular note was the *Covid Restrictions Support Scheme* (CRSS) which provided direct payments to businesses forced to close due to mandated public health restrictions. However, turnover must have fallen by 75 per cent to qualify.

We apply this scheme from when it was launched in the final quarter of 2020 and continue it through to the planned expiry date at the end of the second quarter of 2021. To qualify, turnover must be more than 75 per cent down on 2019 levels and, as with the wage subsidy schemes, we assume that all eligible firms avail of the supports. The payment to each eligible firm is calculated as being ten per cent of the average weekly turnover of the business in 2019 up to a maximum €20,000 plus five per cent on turnover over €20,000. This calculation is then subject to a maximum weekly payment of €5,000.

4.3 Tax warehousing

Another key policy support offered to firms during the pandemic was the provision of a warehousing facility for tax liabilities (VAT and PAYE tax liabilities) which incorporated the postponement of interest collection on late payments. This policy was available to all firms experiencing a fall in turnover. However, O'Toole et al. (2021) found that it was not taken up by all potentially eligible firms with 20 per cent of enterprises reporting using tax warehousing in the 2020 CDS data. This was not due to lack of knowledge of the scheme as 60 per cent of firms to the survey responded that they were aware of the facility. Our modelling of the tax warehouseing supports therefore assumes that the firms already availing of it at the time of the 2020 survey continue to do so as long as they remain eligible but that there are no new joiners of the scheme. The scheme was launched in the second quarter of 2020 and was in place until the end of the third quarter of 2021.

To establish the value of the tax warehousing scheme for firms reporting using the scheme, we make the following calculations: we first establish their tax payments as a share of turnover in 2019 to provide a baseline for the calibration. This rate is then applied to their turnover as it evolves through 2020 and 2021 with cross-checking against the survey information on the extent of tax payment reductions. The ability of firms to warehouse taxes is assumed to stop when their turnover returns to its 2019 level or when the scheme is scheduled to end in the fourth quarter of 2021 (even if turnover is still below 2019 levels).

The tax warehousing scheme by design delays tax liabilities which are built up over the time period that the firm avails of the facility. The current guidance on the structure of the scheme has a repayment phase which begins either after the firm's average turnover has been greater than the 2019 level over a period of five quarters or from the first quarter of 2023 (whichever is sooner). No interest payments are applied until repayment starts, after which a rate of 3.973 per cent of total to be repaid each quarter is applied.[10] There are no explicit requirements on the length of time the repayments can be structured over. For the purposes of the model, we assume a standard repayment schedule for all firms of 28 fixed quarterly instalments guided by the average bank loan period for SME credit.

4.4 Commercial rates waiver

Another policy support to reduce the fixed expenditure commitments of firms during the pandemic was the introduction of a commercial rates waver. This was initially provided to all firms for 2020 and the extended for specific sectors into the first half 2021. The eligible sectors for the 2021 waiver were those most impacted by public health restrictions, namely retail, hospitality (including hotels, pubs and restaurants, leisure and entertainment), personal services (for example hairdressers and barbers) and health services. The amount of the waiver is calculated on the basis of the reported expenditure share of firms on commercial rates in 2019.

4.5 Grants

In addition to the expenditure-reducing supports already described, a number of direct grant supports were also made available to firms to help redesign business towards COVID related products and to help address the

[10] This equals to a repayment schedule over 28 quarters to a loan with 3% interest rate.

cost of COVID-related public health changes to the business.[11] For modelling purposes, it would be excessively complex to model each of the multiple individual schemes so we restrict the model to having a single grant scheme that can be availed of by firms, most similar to that of the Restart Grant, and assume that this is taken up by all firms with the appropriate degree of turnover reduction.

The direct grants are introduced into the model in two tranches, following the pattern of the rollout of the Restart Grants. The first tranch is applied to firms with a turnover decline of more than 25 per cent by the third quarter of 2020 relative to their pre-pandemic level. A one-off payment is then made to all firms with fewer than 50 employees. The amount is based on the firm's commercial rates expenditures in 2019 and ranges from €4000 to €25,000. The second tranch of grants has the same structure but applied at a later date of the second quarter of 2021. In the model set-up, firms can avail of both grants provided they have the qualifying reduction in turnover in both periods.

4.6 Loan instruments

As is the case with grant supports, a range of loan schemes with different criteria have been introduced to help firms access credit during the pandemic period. These include lending initiatives from the Strategic Banking Corporation of Ireland (SBCI) such as a COVID-19 Working Capital Scheme and a COVID-19 credit guarantee scheme and COVID-19 specific loans available for micro enterprises from Micro-finance Ireland.

As it is not feasible to model all of the individual offerings, we again take the approach of modeling a single umbrella loan instrument which essentially allows firms to always have access to some credit stream that allows them to accumulate their liquidity shortfalls as debt. Firms are assumed to not have to make any repayments until they return to profitability.[12] These loans have interest rate equal to the sector average rate for SMEs for new loans.[13]

[11] These include the Covid-19 Products Scheme, Covid-19 Business Financial Planning Grant, and the Lean Business Continuity Voucher.

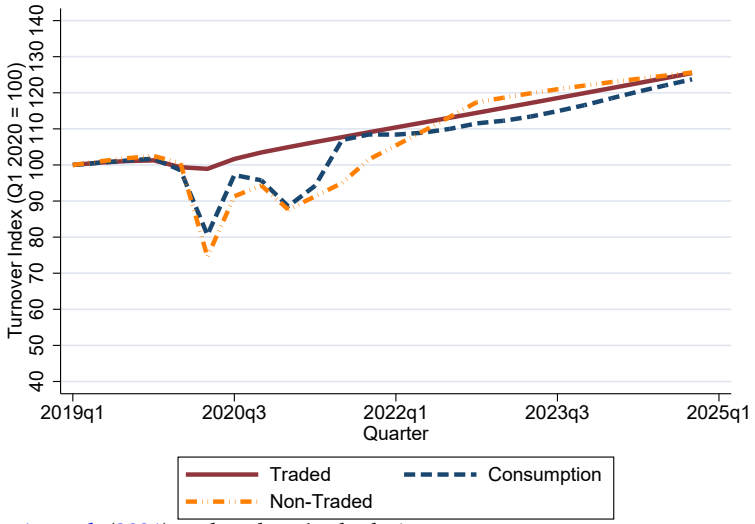
[12] As noted in Section 3, payments on pre-existing debts are assumed to continue.

[13] Based on Central Bank of Ireland data from https://www.centralbank.ie/statistics/data-and-analysis/credit-and-banking-statistics/sme-large-enterprise-credit-and-deposits.

5 Modelling recovery scenarios

To project the model forward over time in order to gauge the impacts of the pandemic on firm survival, a critical input is the assumptions regarding the overall growth of the economy. As our baseline scenario, we base the central growth path of each broad sector to the macroeconomic modelling work undertaken by Bergin et al. (2021) using the COSMO structural model of the Irish economy. The theoretical foundations and econometric specification of the COSMO model are detailed in Bergin et al. (2017). It is designed to be used for medium-term economic projections and policy analysis. The projections in the research provide for a reasonably quick return to growth over the period 2021Q2 onwards as public health guidelines are more permanently relaxed and the vaccination programme allows a return to many aspects of pre-COVID economic and social life. The specific trend paths are presented below:

Figure 2: Sectoral recovery paths - Upside scenario



Source: Bergin et al. (2021) and authors' calculations.

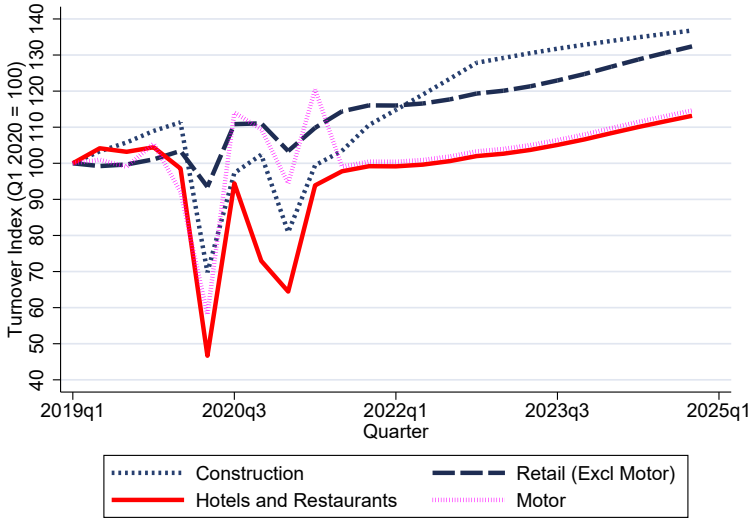
It can be seen that the economic disruption caused by the pandemic has been concentrated in domestically non-traded sectors and affected household consumption. However, a robust recovery in economic activity is expected and, the experience of the first half of 2021 as documented in the most recent Irish national accounts suggests a broad based recovery is underway.

For this research, we aimed to provide as close a matching between sectors and the macroeconomic projections as possible. Given the very heterogeneous impact of the crisis across sectors, and the impact of changing

public health regulations over time, we matched firms to broad sectoral recovery paths based on whether the firm indicated in the CDS they were an exporter and what main sector of activity the were operating in. Furthermore, for four specific sectors that were particularly impacted by the changing nature of public health restrictions, we provided differential paths through to 2021Q2 based on information from other national sources. These sectors are: construction; retail (excluding motor trade); Motor trade; and hotels and restaurants. The full mapping to sectors and the uprating sources are presented in table 4 below. The quarterly growth profile from the overall COSMO growth scenario is then appended on for each of these sectors based on its matched grouping. For example, construction follows the growth in non-traded output while retail follows household consumption.

The specific paths for the sectors are presented in Figure 3. The sector-level paths show the variation of the size of the impact with the hospitality sector experiencing the most substantial decline in activity as also identified in the patterns amongst SMEs. This sector is also projected to recover rapidly to the pre-COVID trend growth. Further scenarios will test the sensitivity of our baseline estimates of the impact on SMEs of adjusting these broad recovery paths. Variability of firm growth rates around the sector mean growth is introduced with a firm-specific shock element as described in Section 3.

Figure 3: Bespoke Uprating paths + Upside scenario



Source: Bergin et al. (2021) and authors' calculations.

Table 4: Sectoral Mappings

Sectors	Firm Type	Uprating	Recovery	
Manufacturing - Processing & Food etc	Exporter	-	Traded	
Manufacturing - Processing & Food etc	Domestic	-	Non-Traded	
Manufacturing - High Tech	Exporter	-	Traded	
Manufacturing - High Tech	Domestic	-	Non-Traded	
Manufacturing - other.	Exporter	-	Traded	
Manufacturing - other.	Domestic	-	Non-Traded	
Construction - General construction.	Domestic	CSO Completions	Non-Traded	
Construction - All other	Domestic	CSO Construction Index	QNAs	Non-Traded
Real estate activities	Domestic	CSO Construction Index	QNAs	Non-Traded
Wholesale	Domestic	No	Non-Traded	
Retail Trade & Repairs (non-motor)	Domestic	Retail Sales	Consumption	
Retail Trade & Repairs (motor only)	Domestic	Retail Sales	Consumption	
Hotels & restaurants	Domestic	CBI Credit Card Data	Consumption	
Transport, storage & communications	Domestic	-	Non-Traded	
Financial & Insurance Activities	Domestic	-	Non-Traded	
Professional, scientific & technical	Domestic	-	Non-Traded	
Professional, scientific & technical	Exporter	-	Traded	
Other	Domestic	-	Non-Traded	
Other	Exporter	-	Traded	

6 SME survival and recovery projections

This section describes the main outputs of the model's projections for key financial indicators of the SME sector. The baseline scenario uses the paths from the macroeconomic modelling work of Bergin et al. (2021) as described above and setting the persistence parameter $\varphi = 0.5$. A cohort of firms are identified as consistently remaining in high levels of financial distress and we examine how financial indicators for the SME sector as a whole look both including and excluding these firms. We further provide counterfactual evidence on how these indicators and distress shares might have evolved in the absence of government support for firms.

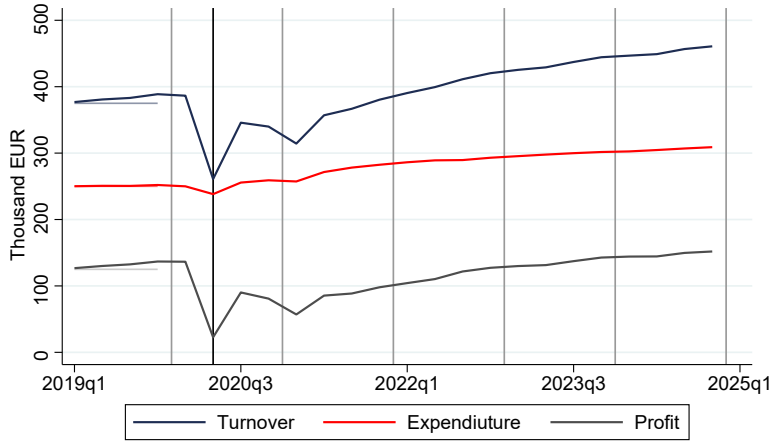
6.1 Baseline scenario

This section runs the micro simulation model of the SME sector, applying recovery paths at a broad sectoral level from the COSMO macroeconomic projections from Bergin et al. (2021). Figure 4 shows how the median firm in the SME sector was impacted by the pandemic and recovers under our baseline scenario. The sharp falls in turnover and profits documented by O'Toole et al. (2021) are evident in the second quarter of 2020. This is followed by a slight recovery as restrictions eased in the summer of 2020 with a second, albeit less severe, reduction in activity in the first quarter of 2021. As discussed above, the sharp falls in turnover also saw reductions in expenditure but the scale of these are more muted, with the fall in turnover translating closely to a reduction in profit for the median firm. As the COVID-19 restrictions ease, our baseline scenario shows a steady growth path for the median firm, with turnover returning to pre-pandemic levels by approximately the first quarter of 2022. Profit also begins to recover, although it takes somewhat longer for it to reach its pre-pandemic level as expenditures also increase with the pickup in turnover. This is an illustrative example of how the recovery scenarios map onto firm variables. In the microsimulation model itself, variation in the growth path across sectors and also across firms within sectors are important components that reflect the heterogeneity of the overall SME sector.

6.2 Baseline evolution of financial indicators

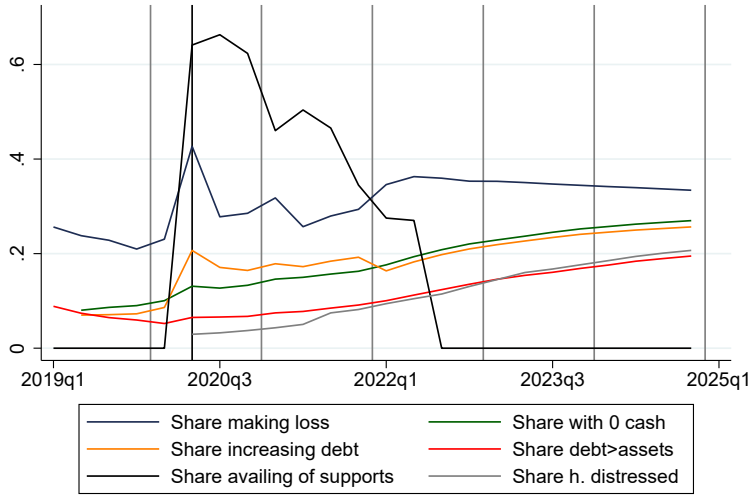
The key results of our baseline scenario for the SME sector as a whole are graphed in Figure 5. This shows the share of firms that are estimated as having different types of potential financial difficulties over time as outlined earlier in the paper. We do not include new entrants in this baseline scenario

Figure 4: Median firm path of turnover, expenditure and profits



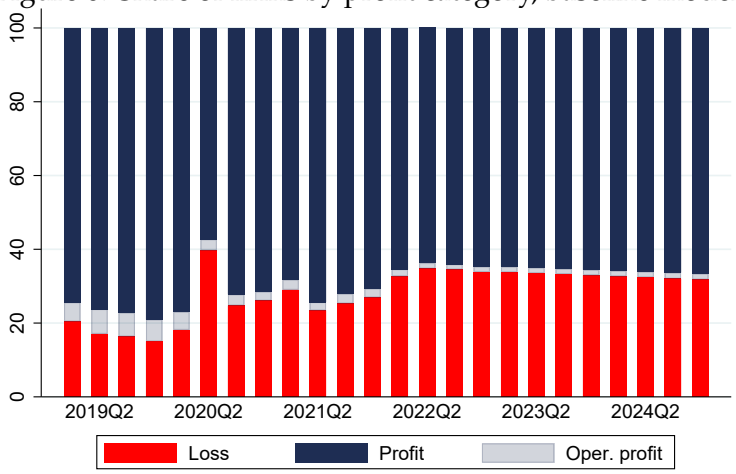
so all of the results are shares of the existing cohort of firms at the onset of the pandemic. The figure includes for context the share of firms using any type of government supports. The share of firms availing of government supports is estimated to peak at around 65 per cent in the middle part of 2020 when the restrictions on economic activity were at their most stringent. In our baseline scenario, all pandemic-related supports are phased out by April 2022 in line with announced government policy.

Figure 5: Evolution of key financial indicators in baseline scenario



The share of firms making losses and increasing their debt levels increase sharply at the onset of the pandemic. The loss-making share reduces somewhat in the later part of 2020 and first half of 2021, with a further shift upwards in early 2022 as supports are withdrawn. As many firms

Figure 6: Share of firms by profit category, baseline model



Grey are represent firms that have operational profit, but are overall loss-making when investment expenditures are included.

had some financial buffers in place at the time of the initial impact of the pandemic, other indicators of financial difficulties, such as zero cash or debt levels greater than assets, evolve more slowly. A striking feature of this baseline scenario is the sustained rates at which all of the indicators of financial difficulties level off towards the end of the simulation time horizon in 2024. The majority of the indicators show rates that are around double those reported in 2019, while the share of highly distressed firms grows from less than 5 per cent in mid-2020 to up to twenty per cent in 2024.[14] The structure of the baseline version of the model, which does not allow for the exit of any firms regardless of their degree of financial distress, shows no return to the pre-pandemic rates of performance amongst firms in the SME sector despite a considerable recovery in the macroeconomy. This is also evident in Figure 6 which shows the level shift in loss-making firms from before to after the pandemic period.[15]

6.3 Highly financially distressed firms

Focusing in more closely on the highly distressed firms, Figure 7 shows that the total share of these firms continues to grow throughout the simulation time period, reaching over twenty per cent of SMEs by the end of 2024. Running a counterfactual exercise (that we will discuss in more detail later)

[14] Note that our definition of highly distressed firms requires six quarters of losses so there is no estimation of distress made for firms in 2019.

[15] This graph also shows a narrowing of the share of the firms that break even as the spike at zero profit reported in the survey data is difficult to replicate in the model structure.

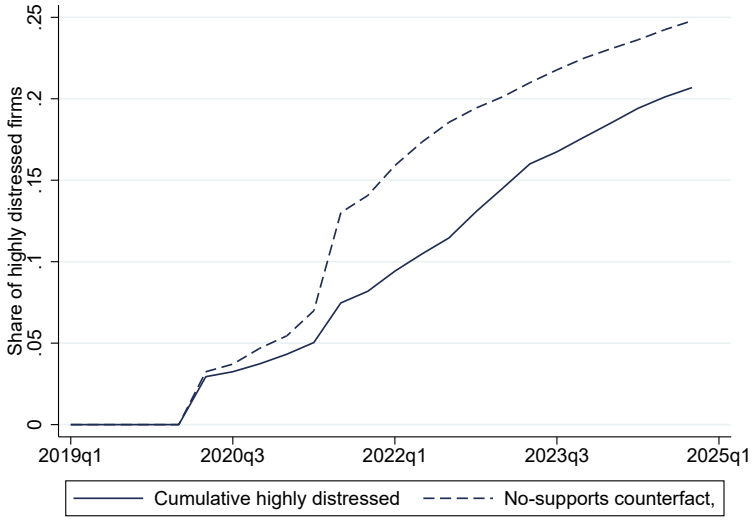
in which no policy supports had been made available to firms during the pandemic shows the extent to which this rate was lowered by government intervention. In the absence of supports, the distress rate would have been almost twenty per cent higher that it was (4.1 percentage points greater).

Figure 8 shows the time path underlying when firms reached the point of being classified as highly distressed firms (entering the stock in Figure 7). This shows three distinct peaks at which firms become highly distressed: the first is at the initial arrival of the pandemic (2020Q2) and the second corresponds to the period of stringent restrictions early in 2021. The extent of the final (lower) peak coming later is a function of the definition applied to the simulation that firms must have experienced losses for at least six quarters to be classified as highly distressed. It therefore picks up firms that do not recover in profitability after supports are removed. The concentration in terms of exact timing is therefore largely an artefact of the distress indicator definition. The first two spikes in the highly distressed rate each represent over two per cent of SMEs while the third is somewhat below this level. Following the final spike, the rate declines levels off to below one per cent of SMEs becoming distressed in subsequent time periods. Again, we can examine how this might look in the counterfactual scenario without the use of any government supports. Without supports, the share of firms that would have become highly distressed exceeds six per cent at its highest. Note that in this counterfactual, there is no third spike as these firms would have already become distressed earlier in the absence of the supports. Both the baseline scenario and no-supports counterfactual converge to a similar rate at the end of the model horizon. While these rates are substantial, they are considerably lower than those found in recent research on the impact of COVID-19 on French firms (Bénassy-Quéré et al., 2021). Across the period from March to December 2020, they estimated that 6.6 per cent of firms encountered financial distress levels high enough to become insolvent and that this rate could have been as high as 11.9 per cent in the case without public support for firms.[16]

Table 5 examines the risk profile of these highly distressed firms across a range of firm characteristics. We would emphasise that this is a risk flag within the constraints of the model structure and therefore should not be interpreted as a prediction on the level of eventual insolvency in any of these groups. There are two major sources of such a caveat. The first is that many factors exist that are impossible to incorporate into a

[16] Note that this research covered the entire French corporate sector and was not focused specifically on SMEs.

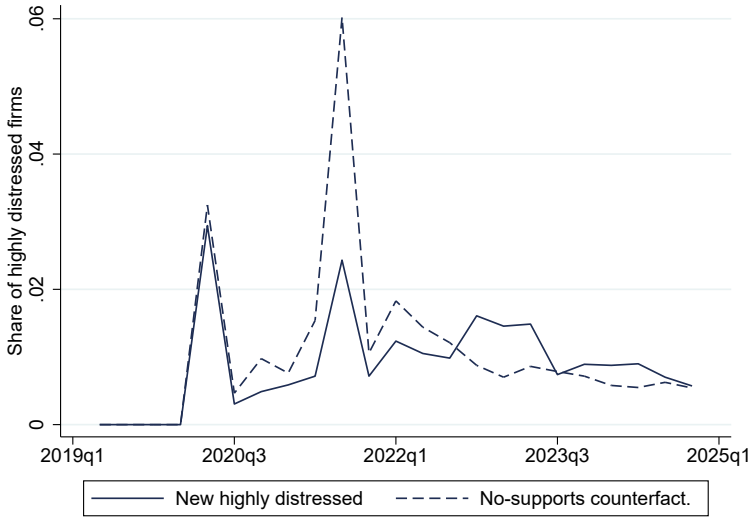
Figure 7: Cumulative share of highly distressed firms



computational model but which would be important in translating risk of financial difficulties into firm insolvency or exit in reality. These range from access to external financing to ability to restructure the business' finances to changes and innovation in their business model. The second source of caveat is uncertainty on the assumptions fed into the recovery scenario of the model. These have been designed and calibrate to match as closely as possible the macroeconomic projections and distributions of overall SME performance prior to the pandemic as described. Out-performance of these benchmarks in the aftermath of the pandemic could substantially reduce the share of firms at risk of financial difficulties. This could occur from a number of sources including faster aggregate growth (especially in consumption spending which underpins much of the demand in the SME sector), lower dispersion in the rate of recovery (so fewer firms recover slower than the sector average) or productivity improvements resulting in expenditure increasing more slowly than our modeled link to turnover recovery.

With these caveats in mind, the first column of Table 5 reports the share of the sample in each group to identify where groups are potentially disproportionally represented amongst in the high risk category. Columns (2) and (3) report calculations for the share of firms within each of the sector, size, profit and debt groups that are flagged by the microsimulation as being at risk of being highly distressed. These calculations are done at two different points in time – for the fourth quarter of 2021 (i.e. immediately after government supports expire) and at the end of the simulation horizon

Figure 8: Share of highly distressed firms



in 2024. These are cumulative shares assuming no exit of firms from the sample at any time and also without any entry of new firms. Essentially therefore the model is following the cohort of firms that existed in 2019 rather than necessarily reflecting the SME structure of 2024. Before looking at any of the individual characteristics, a striking aspect of the table is how much higher the rates are in 2024 compared to those at the end of 2021. The share of the overall SME sector at high risk of financial distress at the end of 2021 is estimated as just over 8 per cent. By the end of 2024, this has increased to over twenty per cent of firms (as also shown in Figure 7). This reflects a combination of some firms growing more slowly than the sector average, removal of government supports and increased expenditure pressures from requirements imposed in the model that repayments begin on debts accumulated throughout the pandemic period.[17]

Across sectors, hotels and restaurants have the greatest probability of being in financial distress with over one quarter of firms in this group flagged as being at risk by the end of the simulation period. In columns (4) and (5), the distribution of all at-risk firms shows that hotels and restaurants account for 15 per cent of the entire at-risk group, despite accounting for just over 12 per cent of SMEs. The lowest risk of severe financial distress is in the

[17] Recall that there are no credit constraints in the model so all pandemic-related losses are assumed to have been rolled into debt obligations. This is one area where unobserved access to other sources of financing to cover the losses would be likely to be important and perhaps to make the estimated rates of distress something of an upper bound.

construction sector followed by those in wholesale and retail trade. Across firm size groups, we find limited variation with the risk of distress by the end of the period reasonably similar across size groups and the shares of the total distressed group almost exactly reflecting their shares of the overall sector. [18]

The next characteristics we look at are profitability and debt in 2019. Although the impact of the pandemic itself in terms of the initial hit to turnover was broad based and almost completely uncorrelated with prior profitability (see Table 2), the same is not the case with the probabilities of longer term risk of severe financial problems much more closely linked to pre-existing loss-making and indebtedness. Our model suggests that close to 58 per cent of firms that made losses in 2019 are at high risk of experiencing financial distress by 2024 compared to a 12 per cent risk for firms that entered the pandemic making profits. Likewise, the probability of encountering severe distress over the coming years increases systematically with pre-existing debt burdens.

6.4 Scenario including firm entry and exit

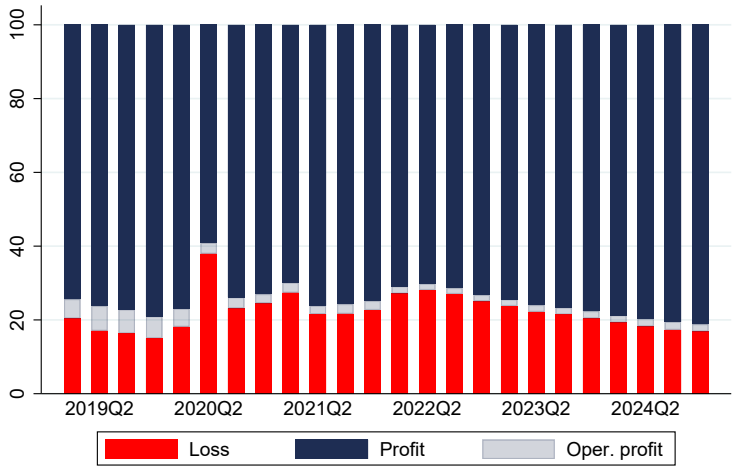
In this section, we examine how the financial characteristics of the SME sector as a whole would look if the firms identified as highly distressed in the baseline scenario were to exit and new firms begin to enter.[19] It is important to note however that this model would not allow for the prediction of exit by individual firms as a range of factors beyond the scope of the model would also have to be taken into consideration (such as access to new equity injections and business model changes to suggest just two). For the purposes of this scenario, we make the more simplistic assumption that all firms in sustained (at least six quarters) of financial difficulties exit and remove them from the model. We then calculate the performance indicators for the surviving and new firms within the SME sector. Figure 9 shows that, with exit incorporated, the distribution across profit and and loss categories gradually returns to similar levels as those observed in the actual pre-pandemic survey data. Likewise, the main indicators of financial problems shown in Figure 10 return to levels that are reasonably in line with those observed in the data from 2019. This is in contrast to the patterns in

[18] No size variation in turnover recovery was included in the simulation scenario where growth differences were entirely calibrated on sector.

[19] As the share of entrants in each quarter is low relative to the existing stock of SMEs, most of the difference between the results of this scenario and the baseline are driven by the exit margin. Results without entry are available on request.

Figure 5 where no exit was included, with the result that the share of firms encountering some element of financial difficulty remained persistently high over time.[20]

Figure 9: Share of firms by profit category including entrants and excluding highly distressed firms



Grey are represent firms that have operational profit, but are overall loss-making when investment expenditures are included.

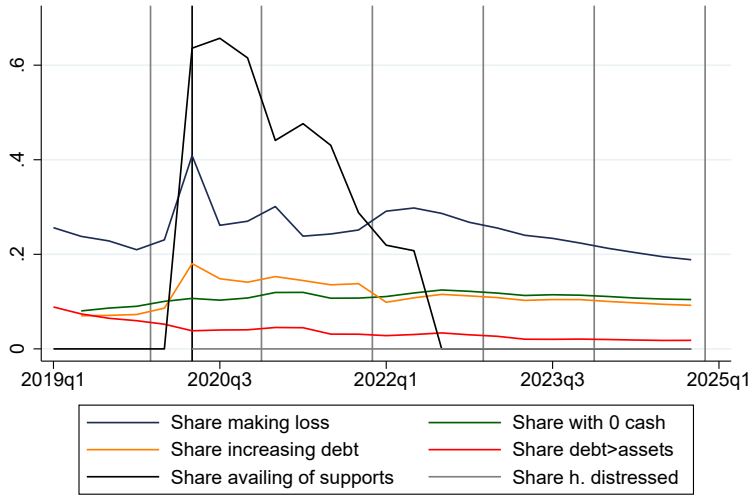
6.5 Impact of policy supports

In describing the share of firms categorised as being highly financially distressed in Figures 7 and 8, we included a counterfactual calculation with the estimates of the model when all policy supports to the firms were excluded. In this section, we look at how the policy supports affected the full set of financial indicators that we have used so far.

Beginning with the baseline scenario, which does not allow for firms to exit, Figure 11 compares the outcomes for each indicator with policy intervention (solid lines) and without any supports to firms (dashed lines). The share of firms availing of supports by construction stays at zero throughout. In the absence of these supports, the share of firms making losses throughout 2020 and 2021 is estimated to have been around seventy per cent higher (approximately six percentage points) than when supports were available. The impact of the losses is also reflected in the considerably higher share

[20] One of the indicators - share of firms with debt greater than assets - actually ends the model horizon at a lower level than in 2019 but this is largely due to the absence of new investment, and hence new debt (apart from to cover pandemic losses) in the model.

Figure 10: Evolution of key financial indicators in baseline scenario including entrants and excluding highly distressed firms



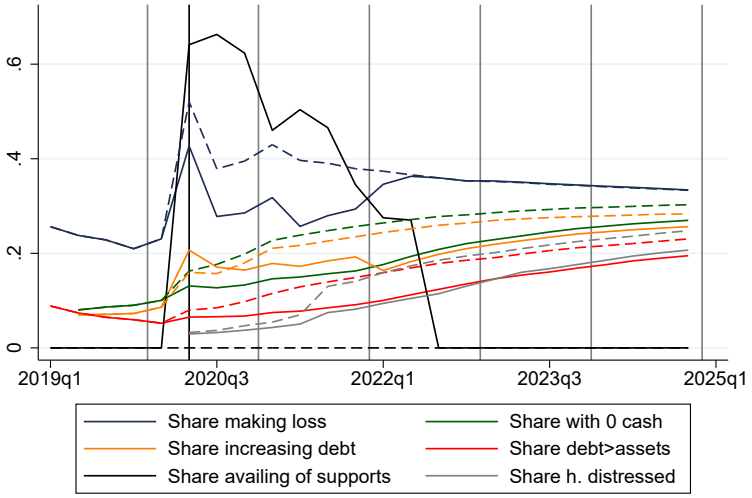
of firms running their cash resources down to zero when is around sixty per cent higher in the counterfactual scenario. As firms may have had some internal financial buffers, the impact of policy supports on the shares of firms with debt greater than assets or increasing their debt is rather smaller. A key finding is that, although the impact of the pandemic on turnover was broad based, the longer term risks of severe financial problems are closely linked to pre-existing loss-making and indebtedness of the firms.

Figure 12 adds the further element of firm exit to the no policy support counterfactual. The impact in this case of removing the policy supports is almost identical during the period of the pandemic itself but, with exit included, shows a reversion of most indicators of financial difficulty returning to levels comparable with their pre-pandemic norms in the baseline scenario with policy supports. Without supports, there is a longer term shift upwards in the shares of firms encountering financial difficulties even amongst the group where financial problems are not severe enough to place amongst the exitors.

6.6 Comparison of policy supports

In previous subsections the role of policy supports was discussed from an overall perspective. For example, in Figure 7 the cumulative share of highly distressed firms without any supports is compared to the share with all supports in place. This subsection examines the relative contributions of

Figure 11: Counterfactual evolution of key financial indicators without policy supports



the individual policies to the estimated reduction in the share of highly distressed firms relative to the no-policy counterfactual. To do this, we run our simulation with each individual policy in place separately and with each potential combination. This gives us some insight into the relative impacts of the different components of the policy package. However, we would make the caveat that there may be complementarities and intersections between the supports that cannot be fully accounted for by this type of technical decomposition.

The model was run on all 32 possible policy combinations where individual policies were turned either on or off. The size of the subsidies was not changed. Using the Shapley value method, the contribution of each policy is calculated as the average marginal contribution of the policy to the lower rates of firms' distress. Table 6 shows results of the decomposition results for 2021Q4 and 2024Q4. The simulation predicts that among the firms that existed in 2019, 8.19 per cent of them are financially highly stressed in (or before) 2021Q4. However, in the absence of the policy supports the share would have increased to 14.07 per cent, which is 5.88 percentage points or 72 per cent more. Based on the decomposition results, the TWSS/EWSS subsidies explains almost 80 per cent of this decrease. The other four policies each have contributions below 7 per cent of the total with the CRSS fixed cost contribution and commercial rates waivers making somewhat larger contributions than the grants and tax warehousing facilities.

Columns (3) and (4) contain similar results for 2024Q4, the last quarter of the simulation. Some firms that were initially supported by the COVID-related policies during the pandemic eventually become highly distressed when the supports expire so the cumulative share of distressed firms is higher at this point as discussed earlier in the paper. However, by 2024Q4 there are still 4.10 per cent of the firms from the initial 2019 sample that do not ever become highly distressed but would have done so without the supports. In the medium run, the relative contributions of each policy are not substantially different from the short-run estimates with the wage subsidy schemes accounting for the majority of the reduction in distress. The exception in the contribution of the other schemes by the end of 2024 is tax warehousing as, by this point, the scheme is in the repayment phase. Firms that availed of this policy are repaying their delayed taxes, thus temporarily increasing their expenditures.

Column 5 gives estimated costs of operating each policy. From the simulation data the value of the subsidy is summed across all firms and all periods and expressed as a share. The wage subsidy schemes and the CRSS have costs roughly proportional to their contribution to lowering of the distress rates. For tax warehousing the calculation does not account for repayments so the ultimate fiscal costs will be substantially lower than the calculated sum of deferments presented here.

The commercial rates waiver was initially given to all firms, and later to all firms within certain sectors, regardless of the change in their turnover. For that reason, the share of the scheme in total subsidies is considerably larger than its estimated contribution to the reduction in distress. There were several advantages to this universal approach, particularly in an emergency setting, such as being less distortionary and having lower administrative costs. However, on this particular metric the policy was less cost-effective than the other policies. Meanwhile, Restart (and other) grants were a very small share of the supports, but had a disproportionately high contribution to the survival rate.

7 Conclusion

This paper examines the impact of COVID-19 and the associated economic restrictions on SMEs, utilising survey data from before and during the pandemic to calibrate a microsimulation model. This is then used to extrapolate recovery paths and financial outcomes for the firms from macroeconomic projects and policy scenarios. As the COVID-19 restrictions ease, our baseline

scenario shows a steady recovery path for the median firm. However, indicators of financial difficulties remain persistently high for many firms with the share of highly distressed firms reaching twenty per cent. These scenarios are based on the epidemiological and policy environment of October 2021.

The share of firms making losses and increasing their debt levels increase sharply at the onset of the pandemic. As many firms had some buffers at this initial point, other indicators of financial difficulties, such as zero cash or debt levels greater than assets, evolve more slowly. The share of firms availing of government supports peaked at around 65 per cent in the middle part of 2020 when the restrictions on economic activity were at their most stringent. We find that indicators of financial difficulties continue at sustained rates that are around double those reported in 2019. The share of highly distressed firms in the overall SME sector grows to around twenty per cent in 2024.

In a scenario where these highly distressed firms exit the market, we find the distribution of financial indicators gradually returns to approximately the levels of pre-pandemic survey data. Again, we would re-iterate that this is not to suggest that this level of exit would actually occur. We emphasise that firms, even if highly distressed in our scenario, may have access to outside options that are not possible to model in our framework such as restructuring of their finances, access to additional external equity, or adapting their business model or scale of operations.

While the levels of severe financial stress found in the microsimulation are considerable, counterfactual analysis finds that they would have been higher still in the absence of extensive government supports to the SME sector. In a scenario without access to supports, the distress rate would have been seventy percent higher during the pandemic, and around twenty per cent higher in 2024 than was found in the baseline case. The share of firms making losses throughout 2020 and 2021 could have been around one-third higher than when supports were available (40% compared to 30% of the firm).

Table 5: Characteristics of potentially highly distressed firms

	(1)	(2)	(3)	(4)	(5)
	Share of	Prob. of high dist.		Share of total	
	sample	2021Q4	2024Q4	2021Q4	2024Q4
Sector					
Manufacturing	13.4	11.0	21.8	17.9	14.1
Construction	9.2	6.1	15.7	6.9	7.0
Wholesale & retail	30.3	7.3	16.8	27.1	24.6
Hotels & restaurants	12.3	7.5	24.2	11.2	14.3
Business Services	21.6	8.4	23.8	22.2	24.8
Other	13.3	9.1	23.6	14.8	15.1
Size category in 2019					
Micro	31.4	8.8	20.2	33.9	30.7
Small	42.4	8.3	21.6	43.1	44.2
Medium	26.2	7.2	19.9	23.0	25.2
Profitability in 2019					
Loss	7.2	49.6	59.5	43.8	20.7
Brake even	26.5	11.7	34.2	37.9	43.8
Profit	66.3	2.3	11.1	18.3	35.4
Debt/Assets in 2019					
No debt	34.6	5.4	17.1	23.0	28.6
Low debt	44.5	5.0	16.5	27.2	35.4
Medium	12.1	13.9	30.6	20.6	17.9
High debt	8.9	27.0	42.2	29.2	18.1
Total	100	8.2	20.7	100	100

Figure 12: Counterfactual evolution of key financial indicators without policy supports, excluding highly distressed firms

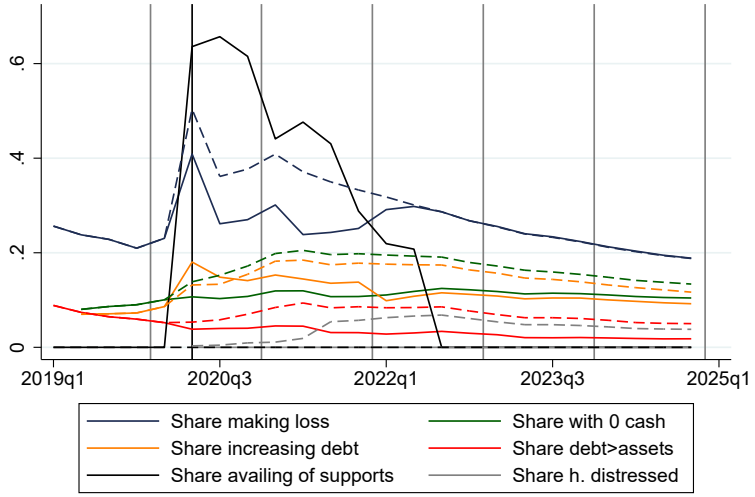


Table 6: Comparison of policy supports

	2021Q4		2024Q4		
	(1)	(2)	(3)	(4)	(5)
Cumulative share of highly-distressed firms:					
Without any supports	14.07		24.79		
With all supports	8.19		20.69		
Difference	5.88		4.10		
Decomposition of the difference:					Sub-sidy share
TWSS/EWSS	4.69	79.6%	3.17	76.8%	74.1
CRSS	0.40	6.8%	0.25	6.1%	5.3
Com. Rates Waiver	0.36	6.2%	0.36	8.9%	13.0
Grants	0.27	4.6%	0.28	6.8%	0.6
Tax Warehousing	0.16	2.8%	0.06	1.3%	7.0*
Total	5.88	100.0%	4.10	100.0%	100.0%

Calculation excluding entry of new firms. Subsidy share is policy's share of total nominal supports given to SMEs based on the microsimulation estimates. Tax Warehousing does not include repayments. Contribution calculated as Shapley values.

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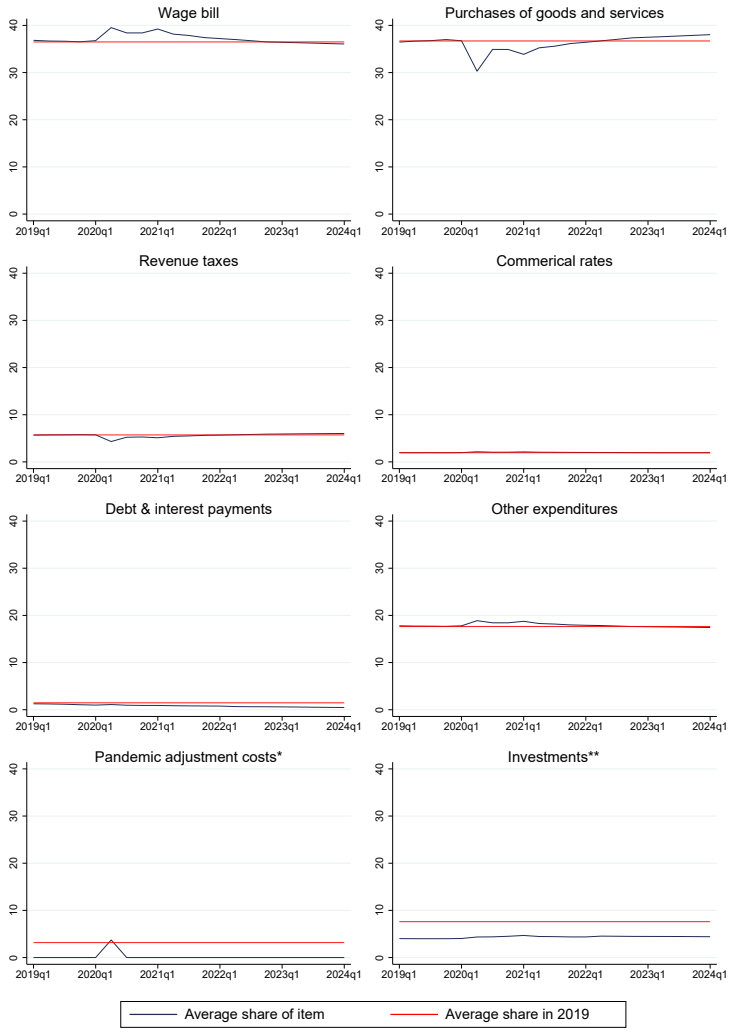
A Additional summary statistics and results

Table 7: Temporary Wage Subsidy Scheme (TWSS) and Employment Wage Subsidy Scheme (EWSS) rates

Gross weekly pay from to ...	26-Mar-20 19-Oct-20	20-Oct-20 30-Nov-21	01-Dec-21 28-Feb-22	01-Mar-22 30-Apr-22
Less than €151.50	€0	€0	€0	€0
€151.50 – €202.99	€151.50	€203	€151.50	€100
€203 - €299.99	€203	€250	€203	€100
€300 - €399.99	€203	€300	€203	€100
€400 - €1,462	€203	€350	€203	€100
Over €1,462	€0	€0	€0	€0

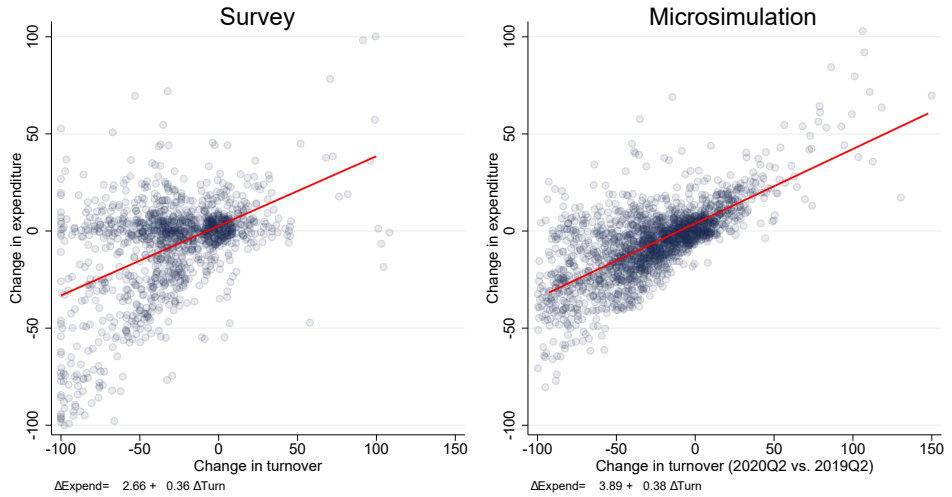
Source: Revenue Commissioners https://www.revenue.ie/en/employing-people/ewss/how-to-claim-for-employees-and-subsidy-rates.aspx

Figure 13: Average expenditure structure in the microsimulation



Red horizontal lines represent average expenditure share relative to operating expenditures in 2019 as a reference. *Reference pandemic adjustment costs (reported for 2020Q2) is relative to 2019 operating expenditures. **Microsimulation includes only investments to cover depreciation, while the red reference line includes all investments.

Figure 14: Total expenditure elasticity comparison



Compared to results Table 1 regressions here exclude agriculture sector. For both graphs the calculation include only operating expenditures.

Table 8: SME's expenditure structure in 2019

	Variable costs				Fixed costs					
	Purch.	Wages	Taxes	All	Util.	Rent	Debt	Com.	All	Misc.
Manufacturing	47	28	5	81	5	2	1	2	10	9
Construction	38	36	7	81	4	1	2	2	9	10
Wholesale	52	24	6	82	4	3	2	2	11	7
Hotels & restaurants	29	37	7	73	7	4	2	3	16	11
Business services	23	46	8	76	5	4	1	2	12	12
Other	28	45	4	77	5	2	1	1	10	13
Self-employed	44	22	9	75	7	5	2	2	15	9
Micro	37	34	7	79	5	4	2	2	13	9
Small	36	38	6	80	5	2	2	2	11	9
Medium	37	37	4	78	4	2	1	1	9	13
Total	37	35	6	79	5	3	2	2	11	10

Means of item's share in total expenditures. Purch.=purchases of goods and services, Com.= commercial rates. Originally published in O'Toole et al. (2021). Underlying data from 2020 Credit Demand Survey.

Table 9: Share of firms aware about possible support policies and their uptake

	Awareness					Uptake			
	TWSS	Tax w.	SBCI	Other	None	TWSS	Tax w.	SBCI	None
Manufacturing	95.5	65.8	51.2	95.7	2.3	58.7	14.6	9.8	37.6
Construction	90.6	48.3	34.5	94.0	3.3	70.4	13.4	5.3	28.8
Wholesale	91.8	53.6	41.1	95.1	2.9	55.8	15.7	5.1	42.3
Hotels & restaurants	94.4	74.3	50.7	91.4	3.9	85.9	48.4	9.4	12.2
Business services	96.5	66.3	49.4	96.8	1.1	61.1	20.7	3.6	35.9
Other	95.0	59.0	52.3	97.1	1.8	49.1	12.8	3.8	44.4
Self-employed	85.7	38.5	23.9	94.6	3.6	27.3	3.7	1.8	71.0
Micro	90.3	49.3	40.0	93.5	4.2	53.3	11.1	4.3	43.7
Small	95.9	65.5	48.5	95.3	1.6	72.5	21.6	5.8	25.6
Medium	98.9	76.0	60.4	97.8	1.1	67.0	34.4	8.8	28.0
V. large decrease	92.3	56.8	40.2	90.9	5.5	67.1	26.3	5.9	31.4
Large decrease	92.5	61.5	43.9	94.4	2.5	71.9	29.1	8.4	25.6
Medium decrease	98.1	62.8	48.2	96.9	1.0	86.6	24.7	8.3	12.1
Small decrease	95.1	67.2	51.3	97.8	0.7	50.3	13.8	2.7	45.5
Remained	89.9	58.0	42.4	95.5	2.7	41.4	15.3	3.0	52.6
Increase	90.8	52.1	48.7	93.0	4.7	22.0	4.7	3.6	75.5
Total	93.9	60.5	46.2	95.3	2.4	61.0	19.7	5.7	36.1

TWSS=Temporary Wage Subsidy Scheme, Tax w. =Tax warehousing option, and SBCI=Strategic Banking Corporation of Ireland. Awareness of other includes: Supporting SMEs Online Tool, Credit Guarantee Scheme, Microfinance Loan Fund, Enterprise Ireland, LEOs, Credit Review Office, payment breaks, non-bank finance, or other support. Uptake of the SBCI support includes firms that applied before the pandemic. Avail of none of the policy refers only to the none of three listed policy (TWSS, tax warehousing or SBCI). Originally published in O'Toole et al. (2021). Underlying data from 2020 Credit Demand Survey.

B Simulating firm entry

Entry rate

Each quarter new observations are randomly generated and added into the microsimulation sample. The number of firms that are added depends on the initial number of firms in each sector and a sector-specific firm entry rate.

Firm entry rate is estimated from previous Department o Finance Credit Demand surveys from 2013 to 2019. The surveys regularly included a question on how many years has the business been operating. As shown in Table 10, there appears to undersampling of one- and two-year old firms. This likely due to delays between when a new firm starts operating and when it becomes listed in the businesses registry from where the firms are sampled.

To compensate for the undersampling we estimate firm entry rate as a fraction of firms that have been in business for either 0, 1, 2, 3 or 4 years (whichever age is the highest). Sector-level estimated entry rates are show in Table 11. Finally, annual entry rate is divided by 4 to get quarterly entry rate.

Our criteria for high-distressed firms (a proxy for market exit) requires debt larger than assets and 6 consecutive quarters of losses. Because of that there is no entry in the first 5 quarters either. After that, the entry rate is constant over time. Figure 15 shows the resulting number and composition of firms in the microsimulation over time.

Table 10: Firm age distribution from DoF Credit Demand Surveys 2013-2019

Age	Freq.	Per cent	Cum.	Age	Freq.	Per cent	Cum.
0	11	0.06	0.06	6	331	1.68	9.20
1	205	1.04	1.10	7	410	2.09	11.29
2	261	1.33	2.43	8	467	2.38	13.67
3	299	1.52	3.95	9	335	1.71	15.37
4	295	1.50	5.45	10	906	4.61	19.98
5	406	2.07	7.52	11+	15,719	80.02	100.00

Characteristics of entrants

There are 5 main characteristics of entrants required for the microsimulation: total turnover, expenditures, employment, assets, and debt. These questions were not asked in all surveys; thus, we are limited to data reported from

Table 11: Estimated entry rates per sector

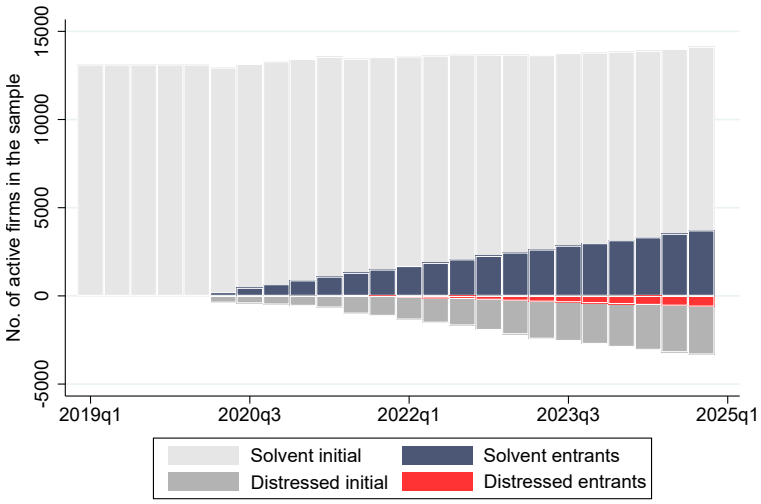
Sector	Entry rate
Manufacturing - Food & Processing	3.13%
Manufacturing - High Tech	1.34%
Manufacturing - Other	0.63%
Construction - General	1.09%
Construction - Other	1.97%
Wholesale	0.95%
Retail Trade & Repairs (non motor)	1.75%
Retail Trade & Repairs (motor only)	1.99%
Hotels & restaurants	3.20%
Transport, storage & communications	1.36%
Financial & Insurance Activities	1.62%
Real estate activities	1.58%
Professional, scientific & technical	1.74%
Administrative & Support Service Activities	1.79%
Human Health & Social Work Activities	2.28%

2017 to 2021. Using only sample of firms aged 0 to 4 from these survey we take: means, standard deviations and correlation matrices of the natural log of the five variables. In few sectors with fewer than 10 observations, the correlation matrix is taken from all young firms. Results for entire sample of young firms are shown in table 12.

Characteristics of entrants are randomly drawn from the distribution to match the means, standard deviations, and correlation matrix. The distributions are assumed to be log-normal. Exception is total debt which equals to zero with probability of no-debt observed for the young firms in the data, and log-normal otherwise. The scope of survey is limited to firms with under 250 employees and turnover under €50 million. If a firm got extreme draw above these thresholds, then all its characteristics were redrawn again.

The randomly drawn log-values are converted to nominal values. Because expenditures and turnover were reported on annual levels, they are divided by 4 to get values for first quarter of firm's existence. In case of number of employees is also round to closest positive integer. Additionally, the simulation needs information on structure of assets and expenditures. These data are only available in 2020 survey. Thus, we use firms of all ages and randomly assign their structure to simulated entrants. Those entrants with

Figure 15: Number of observation in the microsimulation



no debt are assigned expenditures structure of firms without debt and interest payments.

Finally, all entrants are given nonexporters's macroeconomic average growth path (when applicable) and their implied growth rate used as X_{t-1} in the AR(1) process is assumed to be 2.5%. This gives entrant higher expected growth rate in first few quarters compared to the older business.

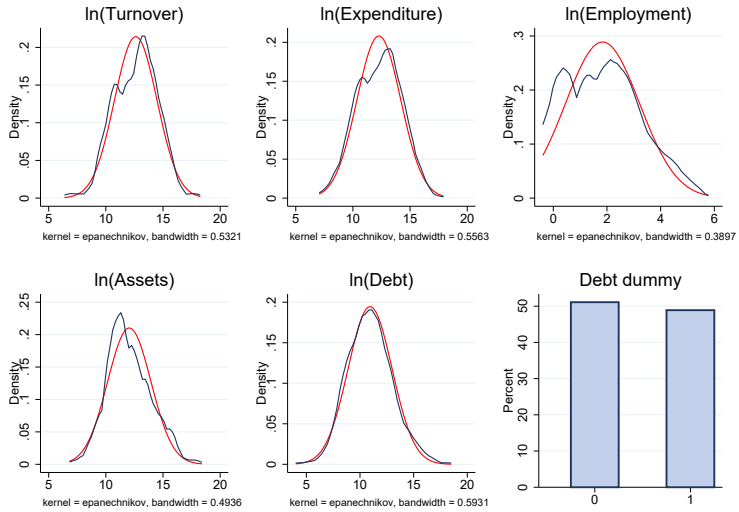
Table 12: Firms which operated for 4 years of fewer, combined data of 2017-2021 surveys

Variable	Obs	Mean	Std. dev.	Min	Max
ln(turn)	310	12.62	1.86	6.91	17.73
ln(expd)	287	12.27	1.92	7.60	17.37
ln(empl)	330	1.83	1.38	0	5.39
ln(assets)	292	12.05	1.90	7.31	17.91
ln(debt)	292	10.95	2.05	4.61	17.91
Debt dummy	272	0.49	0.50	0	1

Correlation matrix

	ln(turn)	ln(expd)	ln(empl)	ln(asse.)	ln(debt)	Debt d.
ln(turn)	1					
ln(expd)	0.906	1				
ln(empl)	0.789	0.785	1			
ln(assets)	0.719	0.702	0.707	1		
ln(debt)	0.698	0.712	0.667	0.684	1	
Debt dummy	0.303	0.291	0.280	0.195	0.207	1

Figure 16: Key variables with approximation for Gaussian distribution, firms 4 years or young from combined data of 2017-2021 surveys



C Simulating firms' turnover growth

This appendix describes the process of simulating firm-level growth. The goal is to provide realistic aggregate outcomes by combining macroeconomic time series forecast and microeconomic cross-sectional data from the Credit Demand Survey. Resulting panel data can then be used to investigate possible firm-level outcomes.

Firstly, we assume that firm growth rate will follow asymmetric Laplace distribution in every period. The peak of such distribution is always around 0, while the tail of the distribution is heavier on either positive or negative side, which determines the mean of the distribution. The distribution has only one more parameter which corresponds to the variance. Laplace distribution has been used in the literature on firm growth before (e.g. Arata (2019)). Figure **??** shows that growth rates from the survey for 2020Q2 are much closer to asymmetric Laplace than to the Gaussian distribution. For general overview and the properties of the distribution see Kotz et al. (2001).

Secondly, the aim is to model firm growth such that the mean value od the distribution ($E[X_t]$) will be equal the macroeconomic scenarios in every period. The scenarios are already described in Section 5.

Thirdly, to fully parameterise asymmetric Laplace distribution, the model also requires a path of the variance ($Var[X_t]$). The variance of growth rates at the beginning of the pandemic can be directly calculated from the survey data. However, the within-sector variances during the pandemic are much higher than variance observed in the previous surveys. Thus, we assume that the standard deviation will reduce linearly between 2020Q3 and 2022Q1 when it reaches pre-pandemic level. Variance form previous surveys is also used for modelling five quarters before 2020Q2.

Fourthly, we use autoregressive process to allow for some persistence of quarterly growth rates over time:

$$X_{it} = \varphi \cdot X_{i,t-1} + e_{it} \tag{3}$$

Where X is log-growth rate of firm i at time t and e is independent randomly generated noise. In the baseline model the inter-temporal correlation coefficient φ is set to 0.5. This corresponds to the coefficient of 0.0625 on annual basis. Thus, there is some persistence in the short run, but it is negligible in the long run. For 5 quarters before 2020Q2, the values are generated without the persistence.

Term e is randomly generate noise in such way that all X_t will have asymmetric Laplace distribution with the predetermined means and variances. This is achieved by simulating e as a mixture of 0, one positive and one negative exponential distribution (Kuttykrishnan, 2006):

$$e = \begin{cases} 0 & \text{with probability } \varphi^2 \\ +\text{ExpDist}[\sigma_e/\kappa_e] & \text{wwith probability } p_1 \\ -\text{ExpDist}[\kappa_e \cdot \sigma_e] & \text{wwith probability } p_2 \end{cases} \tag{4}$$

Where $p_1 = (1-\varphi)\left(\varphi + \frac{1-\varphi}{1+\kappa_e^2}\right)$ and $p_2 = (1-\varphi)\left(\varphi + \frac{1-\varphi}{1+\kappa_e^2} \cdot \kappa_e^2\right)$.

Parameters κ_e and σ_e are found by numerically solving nonlinear system of equations:[21]

$$E[e] = E[X_t] - \varphi \cdot E[X_{t-1}] \tag{5}$$
$$Var[e] = Var[X_t] - \varphi^2 \cdot Var[X_{t-1}] \tag{6}$$
$$E[e] = p_1 \cdot (\sigma_e/\kappa_e) + p_2 \cdot (-\kappa_e \cdot \sigma_e) \tag{7}$$
$$Var[e] = p_1 \cdot 2(\sigma_e/\kappa_e)^2 + p_2 \cdot 2(-\kappa_e\sigma_e)^2 - (E[e])^2 \tag{8}$$

Not all combinations of $E[e]$ and $Var[e]$ are possible when $\varphi > 0$. Namely: $\varphi < \frac{Var[e]-(E[e])^2}{Var[e]+(E[e])^2}$. If such situation occurs value of parameter φ is changed. In other words, after a large change in either mean or variance (e.g. such as at the start of the pandemic), the simulated inter-temporal correlation has to be lower.

[21] First two equations are derived from equation 3 describing the AR(1) process. The last two equations are derived from equation 4 describing the properties of e. Note that p_1 and p_2 are themselves function of κ_e and σ_e.