Belgian corporate sector liquidity and solvency in the COVID-19 crisis: a post-first-wave assessment

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Introduction

The coronavirus pandemic has led to a sharp fall in economic activity in Belgium. Many businesses have been forced to suspend (or severely downscale) their activities due to public health measures, supply chain disruptions, or the slump in demand for their products and services. Despite the fall in turnover, financial commitments (e.g. with respect to suppliers, employees, tax authorities, etc.) largely remain, depleting firms' liquidity buffers. Moreover, the accumulation of losses and growing indebtedness risk turning liquidity stress into a solvency problem. Due to the exceptional and unanticipated nature of the shock, no firm is immune to these concerns. Even firms that were profitable and had a solid financial structure prior to the pandemic are at risk of spiralling into bankruptcy.

Against the backdrop of a looming liquidity and solvency crisis, the Belgian Government set up the Economic Risk Management Group (ERMG). Its purpose was to document the impact of the COVID-19 crisis on economic activity. In the context of that mandate, the ERMG launched a survey which, *inter alia*, probes into firms' liquidity and solvency concerns. The survey responses were non-trivial: near the end of March 2020, half of the surveyed firms flagged an increased level of liquidity stress, with one in every ten indicating a higher risk of bankruptcy (ERMG, 2020a). In a follow-up survey in April 2020, one out of three firms in heavily affected sectors claimed insolvency to be very likely (ERMG, 2020b).

With a view to gaining a better understanding of the economic magnitude of these risks, the NBB has developed – in parallel with many other central banks and international policy institutions – an extensive monitoring framework to appraise the liquidity and the solvency concerns of Belgian non-financial corporations. The purpose of this framework is threefold. First, to quantify the pockets of liquidity and solvency risk in the real economy. Second, to provide relevant indicators to the public authorities in their efforts in designing and calibrating possible support measures (and conducting an *ex-post* policy assessment). Third, to monitor the implications for financial sector stability.

While the NBB is continuously updating and extending this framework, the purpose of this article is to provide an intermediate summary of the analyses conducted so far. As the framework requires input from an extensive

1 The authors are grateful for the valuable input and suggestions made by Saif Ben Hadj, Luc Dresse, Pelin Ilbas, Ilia Samarin, Thomas Schepens, Ruben Schoonackers, Stefan Van Parys, Pierre Wunsch and Economic Risk Management Group participants, as well as for the fruitful discussion of preliminary versions of this study.

set of granular data sources, updates follow in tandem with their availability. So, unless stated otherwise, the results presented in this article run up to September 2020, i.e. a few weeks before the start of the second wave of the pandemic. September presents itself as an appealing moment in time to take stock of the "as-is" situation in between waves. It enables us to document the destructive nature of the first wave, as well as to assess the situation at the onset of the second wave.

This article is structured as follows. In the first section, we present a high-level narrative of the impact of the COVID-19 crisis on firms' business operations. To that end, we leverage VAT returns which document monthly firm-level data on sales, procurement of intermediate goods and services, as well as acquisitions of investment goods. We highlight an important mismatch between revenue and cost dynamics as firms fail to downscale the latter in the face of declining revenues. This imbalance puts considerable pressure on firm liquidity and profitability in the short and medium run. In that context, we proceed with a quantitative assessment of the liquidity problems faced by firms. We first delineate the key features of the liquidity estimation framework and elaborate briefly on the data sources underlying the estimation. Based on a sample of around 400 000 non-financial corporations, we summarise the heterogeneous impact of the COVID-19 crisis on the cash position of Belgian firms in comparison to a business-as-usual counterfactual.

In the face of the heightened liquidity risk, a wide range of crisis measures were taken by public authorities in order to support firms' cash positions. Aside from accommodative monetary policy measures taken by central banks, other interventions include outright transfers, tax exemptions or deferrals from the various levels of government, as well as debt moratoria and an extension of State-guaranteed loans from the banking sector. In section 2, we investigate the extent to which (a sub-set of) policy interventions attenuated cash shortfalls of firms and assess the size of the remaining liquidity deficit. In contrast to the global financial crisis where a fragile banking system had been a significant catalyst of the crisis, we show that the banking sector has contributed to some extent to cushioning the impact of the current crisis through providing liquidity to a sub-set of firms.

Finally, as liquidity support to businesses is often provided through debt, it leads to increased leverage and default risk, leaving firms vulnerable with little room to invest and to grow. This predicament places solvency concerns at the top of the policy agenda. Therefore, section 3 investigates solvency risk arising from the initial (liquidity) impact of the crisis and examines the implications for the riskiness of banks' credit portfolios. We further show in this section that, while banks provided liquidity to firms during the first months of the pandemic, they seem to have taken little risk in the process.

The final section concludes and provides a set of policy implications. Relevant technical details underlying the framework are included in Annex A. The data used in the calibration/estimation exercises are detailed in Annex B. Annex C gauges the impact of the most important modelling assumptions.

1. The COVID-19 crisis and its impact on firm liquidity

The economic shock caused by the COVID-19 pandemic is unprecedented, both in its complexity and severity. Government-directed lockdowns in conjunction with the fear of falling ill not only caused disruptions in production, but also led to the largest collapse in demand for firms' output since WWII. In the first sub-section, we shed light on the impact of the COVID-19 crisis on the Belgian economy. Next, we take stock of the financial situation of firms prior to the pandemic and their operational response to the shock. Finally, we quantify the aggregate level of liquidity stress that ensued and highlight various pockets of liquidity risk in the Belgian economy[1].

1 Throughout this article, firms refer exclusively to non-financial corporations.

1.1 Impact of the COVID-19 crisis on firm operations

In March 2020, the rising number of infections prompted the Belgian authorities to take several measures to contain the COVID-19 outbreak and prevent a saturation of the health care system. Like in many other countries, a lockdown was put into effect, which involved an immediate closure of bars, restaurants, as well as non-essential retail stores and consumer services. At the same time, domestic and international travel was banned, and teleworking made compulsory for all businesses, except for activities requiring staff to be present on-site. Schools and higher education institutes also had to close, while physical social interactions were restricted to household bubbles. These containment measures were kept in place until early May and were gradually lifted for most sectors. Under stringent hygiene conditions, restaurants and bars were allowed to reopen in June. Some activities that involved close social contacts, such as cultural, recreational and sports events remained prohibited, unless certain severe capacity constraints were met.

While they were undoubtfully effective at curbing the pandemic and limit its consequences in terms of public health, the containment measures brought about an economic shock of unprecedented magnitude. Belgian GDP dropped by 13.9 % in the second quarter of 2020, compared to the corresponding period of 2019. According to the firm-level VAT return data illustrated in chart 1, the decline in economic activity was the most severe in April, when the median shock to firms' turnover amounted to –32 % on a year-on-year basis. However, the shock was not evenly distributed across sectors : those most affected by the lockdown recorded the steepest sales decline [1]. For establishments serving food and beverages, for instance, the median decline in turnover was 94 % compared to April 2019. The drop was also significant for firms active in the cultural sectors (–86 %), sport and recreation (–94 %), as well as for hairdressers and beauty and wellness centres (87 %). The biggest impact was felt by accommodation businesses (–96 %), as travel bans were imposed by other countries as well. Economic activity began to recover in June, thanks to the easing of the lockdown. While sales seemed to return to their pre-crisis levels in many sectors, a significant number of businesses were still running below capacity as the authorities maintained, and even reinforced, certain health and safety measures related to social interactions during the summer. These measures have clearly hindered a full recovery in the cultural and recreative sectors.

Overall, the economic activity shock has been broad-based within the most impacted industries. Chart 1 illustrates that, for these industries, the first and the third quartiles of the sales shocks moved in conjunction with the median value. For some other sectors, however, the extent of the shock was more heterogeneous across firms. This was, for example, the case in the construction sector and among retail businesses selling non-food products. As far as the latter is concerned, this is related to the fact that not all the businesses included in that sector were affected to the same extent by the containment measures (e.g. essential business – such as pharmacies, petrol stations, newspaper shops – were allowed to remain open during the lockdown) while others benefited from a change in consumption patterns (e.g. higher demand for teleworking equipment, gardening tools, bicycles and/or substitution towards firms with online shopping solutions).

1 Annex D summarises the NACE codes, as well as the number of entities contained within the sector classification.

Chart 1

Impact of the COVID-19 crisis on firms' monthly sales in a selection of sectors

(Quartiles of the percentage changes in the 2020 turnover compared to the corresponding month in 2019[1])

Sources: Federal Public Service Finance, NBB.

1 Series calculated for the population of firms filing monthly VAT returns.

Chart 1 (continued)

Impact of the COVID-19 crisis on firms' monthly sales in a selection of sectors

(Quartiles of the percentage changes in the 2020 turnover compared to the corresponding month in 2019[1])

Sources: Federal Public Service Finance, NBB.

1 Series calculated for the population of firms filing monthly VAT returns.

1.2 Pre-pandemic liquidity position of firms

The heterogeneity in the magnitude and persistence of the shock to economic activity, both across and within sectors, also leads to a pattern in which some businesses may find themselves running out of cash while others are not. But there are at least two other factors that determine whether firms might, at some point, experience a cash shortage, preventing them from meeting regular payments to their suppliers and their employees. These two factors are a firm's liquidity buffer prior to the shock and its capacity to downscale costs in the face of a decline in sales.

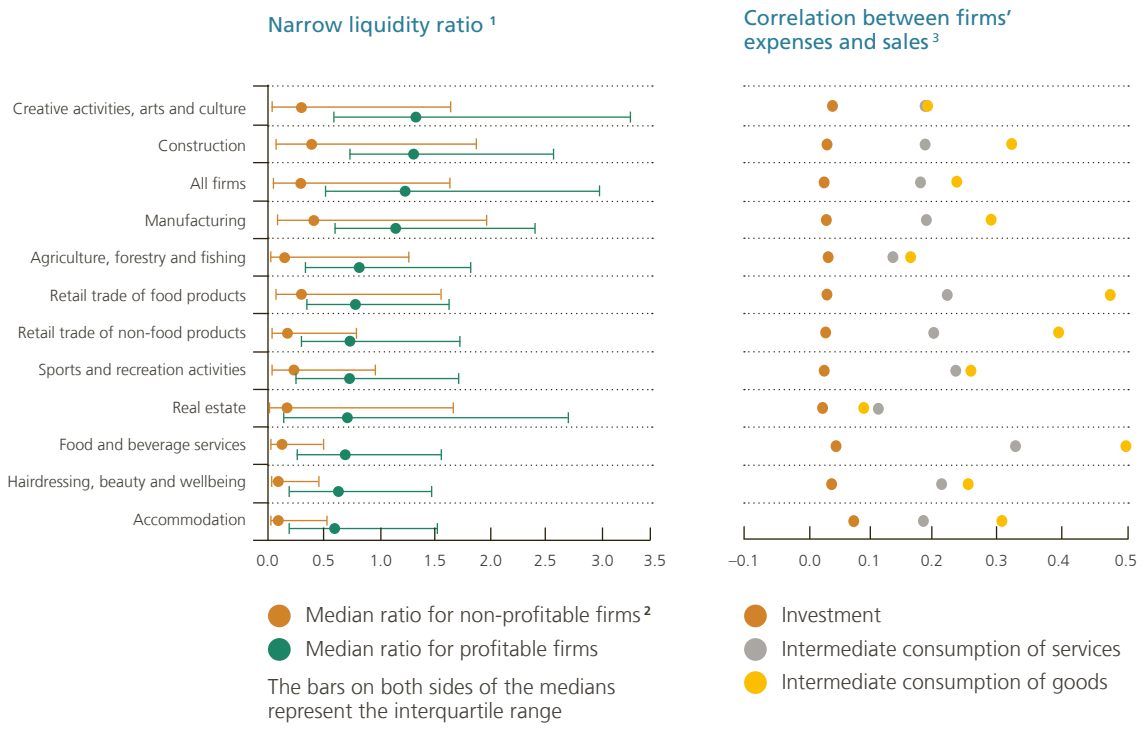
We first provide more insight into the first factor, i.e. the liquidity buffer built up before the shock, and how this buffer compares to companies' short-term liabilities. As in chart 1, there is a strong heterogeneity across firms, even within sectors. This is illustrated in the left panel of chart 2, which documents the interquartile ranges of the narrow liquidity ratio, i.e. the ratio of firms' most liquid assets to their short-term liabilities, calculated at the sector level. Strikingly, a relatively large fraction of firms exhibits a liquidity ratio below one, meaning that their short-term debt exceeded their liquidities at the closure of their last annual accounts. While this should not put them at risk in normal times (that is, when cash inflows from operating activities are usually sufficient for a firm to meet its short-term liabilities), it can become a major concern in the event of a sudden halt of these inflows, which is exactly what happened after the announcement of the lockdown.

The data reported in chart 2 additionally reveal that non-profitable firms are more likely to be affected by discontinued operations. Intuitively, profitable firms are generally more resilient as their pre-pandemic operating surpluses and retained earnings have enabled them to accumulate cash reserves. Nonetheless, even the liquid assets held by perfectly viable firms might prove insufficient to face the consequences of a prolonged period of inactivity. Pre-pandemic liquidity positions are relatively weak in those sectors that were most affected by the containment measures, even among profitable businesses. One very plausible explanation for this lies in the limited working capital requirements of the firms active in these sectors, i.e. the cash reserves they need for remunerating their staff and settling their suppliers' invoices, among other things, before they can deliver their production to their customers and receive their payment. Such requirements are generally lower for

business-to-consumer services like, for instance, in restaurants where the time lapse between the delivery of fresh food products and customers' payment is short. By contrast, liquidity ratios appear higher in industries characterised by longer production cycles, and therefore by higher working capital requirements, such as the manufacturing and the construction sector. Furthermore, chart 2 also indicates as strong heterogeneity of the liquidity position, whatever the sector considered. Various factors other than profitability can explain this heterogeneity like, for instance, the age of the firm (older businesses being more likely to have accumulated cash through their reinvested earnings), investment in financial assets (typically larger firms) or savings (to use for pending investment projects).

Chart 2

Firms' *ex-ante* liquidity position and cost adjustment with respect to sales fluctuations



Sources: Federal Public Service Finance, NBB.

1 The narrow liquidity ratio is defined as the ratio of the sum of trade credit and other loans granted by the firm, its cash reserves, and its current investment over its short-term debt.

2 A firm is considered non-profitable if it is aged 5 years or more and if its EBITDA (excluding extraordinary income and charges) has been less than its financial charges (or below zero if the firm has no financial charges) for three consecutive years.

3 Contemporaneous correlation between the shock to the variable considered (i.e. the monthly percentage change in 2020 compared to the corresponding month in 2019) and the shock to turnover over a period spanning from January to September 2020.

We now turn to the second factor affecting firms' resilience to a demand shock, which is their capacity to adjust their expenses to a sudden shock to their sales. If firms can reduce expenses immediately and proportionally whenever turnover drops, then the risk of running out of cash would be significantly mitigated. However, in practice, adjustments of expenses to turnover fluctuations are not instantaneous, irrespective of the sector considered. This is illustrated in the second part of chart 2 by the low (contemporaneous) correlation coefficients between the annual percentage changes in three types of expense categories – namely investment, consumption of services and purchase of intermediate goods – and sales. Consumption of intermediate goods turns out to be the most flexible expenditure component, while investment does not correlate with current sales. So, firms for

which investment decisions had already sunk by the time the crisis started were also among the most vulnerable to a depletion of cash reserves when the crisis hit.

1.3 Liquidity concept: cash requirements

In the previous sub-section, we showed how the pandemic led to sudden large drops in turnover in a large number of firms who were not always able to downscale costs in tandem with this decline. As a result, many firms experienced negative net cash flows. These negative net cash flows imply, mechanically, that their cash reserves are shrinking. Some firms might be able to overcome the pandemic-induced cashflow crunch solely by draining their cash reserves without making any other adjustments. Others may additionally choose to cut back on certain economic activities (such as advertising, investing and training of employees) or try to attract fresh external funding. For a number of firms, however, none of these actions suffice: the shock might be too large or too persistent, their initial cash balance might be too small, or they may fail to properly downscale activities. In all these cases, the firm would run out of cash.

In our framework, we focus on the firms' cash position as the key indicator of liquidity stress. More specifically, we produce an estimate of "free cash" at the end of each month, which reflects the cash balance that an individual firm has available after it has covered all of its operating costs (e.g. labour costs, intermediate inputs/services, rents, etc.), interest payments, taxes, debt repayments, etc. We refer to a company as having a "cash deficit" if its free cash turns negative: which we throughout also refer to as a cash "requirement" or "shortfall". Note that a cash deficit does not mean that the firm is bankrupt. It means that the firm currently has insufficient cash at its disposal to meet its current financial obligations (e.g. pay suppliers, landlords, etc.) and must resort to payment extensions and/or an additional funding.

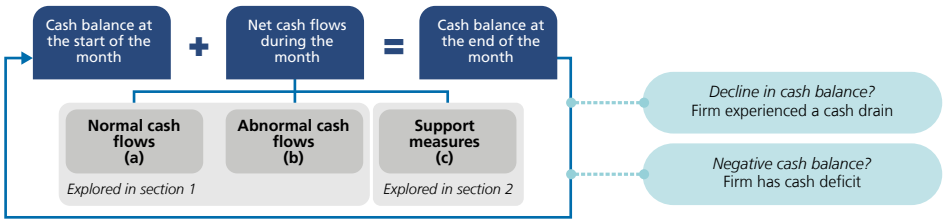
While there are various ways of quantifying liquidity stress of firms (see e.g. John (1993)), our notion of a "cash deficit" has – in the context of the pandemic – a few advantages over traditional measures (mostly accounting-based ratios). First, it is straightforward to interpret, transparent and quantified by other institutions, which allows for an international benchmarking of our results (see e.g. OECD (2020), European Commission (2020a,b), Bank of Italy (2020)). Such a comparison is included in the next section. Second, alternative liquidity stress measures typically rely on the discrepancy between the current liquidity position ("as is") and a desirable liquidity position (a steady-state target which ensures a medium/long-run going concern). The larger the discrepancy, the larger the liquidity stress. While useful, these measures implicitly involve two discretionary elements. On the one hand, they build on the subjective notion on what this desirable liquidity ratio should be. Since a cash deficit is by definition anchored around zero, our approach rules out that kind of discretionary choices. On the other hand, it is unclear over what time horizon this steady-state liquidity position should be attained. Imposing too short (long) a time frame overestimates (underestimates) the size of the liquidity problem caused by the pandemic. Finally, provided that a cash deficit quantifies the amount of cash to be replenished in order to secure the (short-run) survival of the firm, this liquidity concept is a more relevant (and uniform) benchmark to a policy-maker seeking to dampen the initial impact of the pandemic rather than to fully repair lost liquidity (and beyond).

1.4 The general logic of the framework

In order to analyse how the current pandemic might impact the firms' cash balance, we use the standard cash flow accounting identity depicted in chart 3. Starting from an initial cash position at the beginning of the month, we add the estimate of the evolution of cash flows during that month to arrive at a stock of free cash at the end of the month. Iterating across months (where the cash position at the end of the previous month equals the cash position at the start of the next month) enables us to flag individual firms with a cash requirement on a monthly basis. Moreover, firms with negative net cash flows are tagged to have a "cash drain". While the technical details of the framework are deferred to Annex A, a brief summary of the general logic is both instructive and instrumental for a correct interpretation of the quantitative results presented below.

Chart 3

Law of motion of the monthly cash balance



Source: NBB.

The monthly cash flows have three components: (a) cash flows that would accrue in normal (non-crisis) times, (b) abnormal cash flows that arise due to the COVID-19 crisis and (c) support measures received. Distinguishing normal cash flows (a) from abnormal cash flows (b) enables us to produce a counterfactual business-as-usual scenario. In this counterfactual scenario, firms sell, buy, borrow, invest, etc. at pre-pandemic rates. Assuming that many businesses will face cash deficits irrespective of the COVID-19 crisis, this counterfactual scenario makes it possible to isolate the marginal level of cash deficits caused by the pandemic. Component (c) enables us to identify the success of support measures in alleviating cash constraints.

In general, the outgoing cash flows in (a) and (b) encompass procurement of (intermediate) goods and services, wages, taxes, fixed assets, financial charges, reimbursements of bank loans, etc. Incoming cash flows typically include payments from customers, new bank debt, financial revenues, bond issues, etc. Support measures in (c) lead to incoming cash flows (or prevent outgoing cash flows).

How does one measure the various cash components (a), (b) and (c) in the face of lagged data availability? First, the no COVID-19 crisis cash flows in (a) for 2020 are estimated using standard techniques and represent a projection of historical incoming and outgoing cash flows into 2020. In order to quantify the support measures in (c), we rely on various granular and confidential data sources set out in section 2. Measuring (b), however, is more challenging. One prominent approach is to rely on a shock to firm revenues (e.g. taken from survey evidence) and simulate the impact of this revenue shock to all incoming and outgoing cash components (see Schivardi & Romano (2020) for a discussion). This perturbation procedure is prone to error for two reasons. First, Belgian accounting templates do not require small/micro firms (more than 95 % of the firm population) to report their sales and procurement of goods and services[1]. Second, properly estimating the extent to which firms can (or decide) to downsize costs/investment is challenging as it hinges, among many things, on the unobserved cost structure (fixed vs. variable), the ability of the firm to renegotiate pre-pandemic supply contracts, expectations about the future development of the crisis, etc. While we follow the aforementioned procedure for some minor cash components, we depart from this method in view of timely, confidential firm-level VAT declarations made available to us. In this data source, we directly observe monthly firm-level sales, procurement of intermediates/services and investment up to September 2020. This sidesteps the need to estimate these flows[2].

In order to ensure a correct interpretation of the quantitative results below, we close this section with a discussion of the sample selection. First, as the estimation of the framework requires information from the annual accounts, we focus exclusively on firms that file such accounts. This, by definition, excludes the self-employed who are not

1 Size criteria determine the format that should be used for filing annual accounts. Only large firms file full formats. In order to determine the size of a firm, three parameters are relevant: the size of the workforce (50 FTE), turnover (€ 9 000 000) and total assets (€ 4 500 000). A company is considered large if it exceeds either two or three of the thresholds or is listed on the stock exchange.

2 While property rent is not included in the VAT declarations, it enters the analysis through the normal cash flow component. This implies that we assume rents to remain fully due throughout 2020.

required to file annual accounts by Belgian generally accepted accounting principles (GAAP). Second, we exclude certain sub-sectors, if their behaviour is not properly accounted for by our framework. These sectors include, *inter alia*, financial and insurance activities, public administration, education, human health and social work activities [1]. Moreover, we exclude 'dormant' firms from the analysis (i.e. firms that have not filed VAT declarations in the last two years while legally required to do so) and drop companies as soon as they are formally declared bankrupt (so as not to mechanically compound liquidity needs of firms that no longer exist). The above selection criteria resulted in a sample of 403 770 non-financial corporations in March 2020.

1.5 Quantitative results (before taking into account policy measures)

This sub-section summarises the main quantitative results. It first takes an aggregate perspective, followed by a set of micro-level results. The monthly estimates run from March 2020 up to September 2020. They disregard policy support measures and therefore sketch the impact of the pandemic on firm liquidity needs in the absence of any attenuating policy measures. Their impact is studied in section 2.

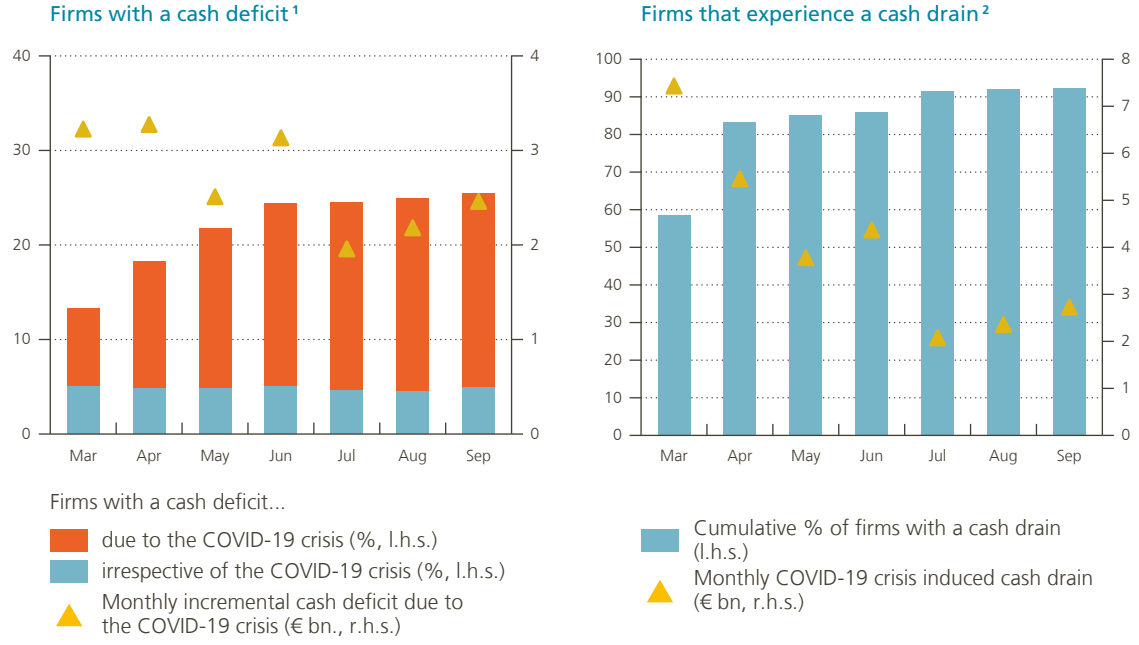
The left panel of chart 4 depicts, on a monthly basis, the share of firms flagged to have a cash deficit in the absence of policy interventions. The figure distinguishes between (a) the marginal cash flow deficit due to the

1 See Annex C for an exhaustive list.

Chart 4

Impact of the COVID-19 crisis on firm-level cash deficits

(Before taking support measures into account)



Source: NBB.

1 A firm has a cash deficit if its estimated cash balance turns negative.

2 A firm has experienced a cash drain if it had to draw down its pre-pandemic cash position.

COVID-19 crisis and (b) the counterfactual cash flow deficit that would have existed irrespective of the COVID-19 crisis. Under the latter scenario, chart 4 documents that around 5 % of the total number of firms will feature cash deficits irrespective of the COVID-19 crisis. Due to the pandemic, however, an additional 20 % of firms have drained their cash reserves to the point where they have a need for additional liquidity (by September 2020). These cash concerns built up very quickly during March and April and levelled off during the summer (the observed plateau is consistent with the ERMG survey responses).

Note that a cash requirement is a very narrow indicator of liquidity stress. It excludes firms for which liquidity is tight, but still sufficient to meet current liabilities. While the left-hand side figure remains mute on this issue, the right panel of chart 4 shows that, by September 2020, 90 % of the firms have, at least once during the period of analysis, dipped into their pre-pandemic cash reserves[1]. A little over 80 % of businesses had already addressed their reserves two months into the crisis. Quantitatively, the total drop in liquidity due to the COVID-19 crisis accumulates up to € 28.2 billion by September 2020, of which € 15.6 billion leads to an actual cash deficit.

The aggregate scenario conceals a significant amount of heterogeneity at the micro level. For instance, we noted in the left panel in chart 2 that many firms already exhibited a fragile liquidity position prior to the COVID-19 crisis. Given a weaker buffer, these firms are more likely to be cash-deprived due to the pandemic. How much more likely ? The upper left panel in chart 5 clusters firms in ten equally sized groups, per decile of pre-pandemic liquidity (defined as the working capital ratio). The 10 % least (most) liquid firms within each sector are contained in bin 1 (10). The binning focuses on relative liquidity compared to sector peers. This panel documents that the 10 % of firms with the least comfortable initial level liquidity were almost twice as likely to end up with cash problems than the median firm in that sector due to the COVID-19 crisis. Importantly, the figure conveys that having a more solid cash position than the sector peers does not guarantee avoiding a cash shortfall : +/-15 % of firms with an above median liquidity position (bin 6 to 10) still faced cash shortage. Were the illiquid firms hit especially hard by the COVID-19 crisis ? At first, it seems that the exceptional, unanticipated nature of the crisis makes this unlikely. While the pandemic hit certain sectors, or certain businesses, disproportionately, there is no obvious reason to expect that firms illiquid prior to the pandemic would be affected more. However, the chart indicates that, on average, firms with a weaker initial liquidity position also reported larger declines in turnover during the March-September period. Potentially a dire liquidity position constrained them in taking corrective action compared to their more liquid sector peers (e.g. set up an online web shop, invest in health and safety measures, etc.). Alternatively, it could indicate that poor pre-pandemic liquidity-management correlates with poor (crisis-)management.

The upper right panel reports the cash deficits due to COVID-19 on a sector-level basis (in the absence of policy measures). It turns out that 46 % of surveyed businesses operating in the personal service sectors, such as Hairdressing, beauty and wellbeing, are flagged to have a cash requirements in September 2020 due to the pandemic. Dire liquidity positions were also present in the Food and beverage service sector (44 %), Sports and recreation (37 %), Accommodation (36 %) and Creative activities, arts and culture (33 %). Not surprisingly, these sectors had experienced the largest (cumulative) drop in turnover by September. But this is not the whole story. The relatively large discrepancy between the cumulative turnover decline and cumulative drop in costs also highlights that these sectors were the least able to scale down the cost side of operations (e.g. because they have a larger fixed cost structure, non-negotiable long-term contracts, etc.). Other sectors (e.g. Manufacturing, Agriculture, Retail trade of food products) not only experienced smaller fallbacks in turnover, they were also more able to restrain their costs in line with turnover. Finally, cash-constrained sectors significantly reduced their investment. While this strategy saves on cash, it is likely to put a drag on future growth and productivity of firms within these sectors.

In terms of firm size, the lower left panel shows that approximately one out of five firms with less than five full-time equivalent employees faced urgent liquidity problems. At least two ingredients add to this result. First,

1 Note that it is difficult to link this result to the responses from the ERMG survey. In this survey firms are asked the question "Do you have liquidity problems ?". While a cash deficit by definition qualifies as a liquidity problem, this is not the case for a cash drain.

while small firms reported similar declines in turnover to large firms during the time frame under consideration, smaller firms seem to be less successful in downscaling costs (e.g. because they have less power to renegotiate contract terms with suppliers than larger firms). Second, small firms typically had a smaller pre-pandemic liquidity buffer to use up. While small firms disproportionately reduced their investment rates compared to larger firms, they were still more likely to end up with liquidity concerns.

Finally, the experience of the global financial crisis and sovereign debt crisis has shown that large-scale government interventions may enable firms to survive, but may also create 'zombies' – i.e. firms that in normal circumstances would exit due to poor performance (McGowan *et al.*, 2018 : De Jonghe *et al.*, 2020). While there are arguments for limiting business closures at least in the short run (supply chain disruptions, knock-on effects in banks' credit portfolios, massive unemployment), long-run unconditional blanket support measures can generate misallocation. After a large economic dislocation, unproductive firms are typically wiped out and replaced by new, more productive entrepreneurs – Schumpeterian creative destruction, in economic parlance (Restuccia and Rogerson, 2017). If too much unconditional support is offered for too long, this process of renewal and growth is undermined. In that context, the lower right-hand panel classifies firms according to their pre-pandemic labour productivity in ten bins (where the 10 % least (most) productive firms within each sector are contained in bin 1 (10)). The chart shows that the 10 % least productive firms within the sector were more than twice as likely to face cash problems than the median firm in that same sector. The pattern emerging in lower right panel indicates that exit of the most illiquid firms on average would imply exit of the least productive firms.

Chart 5

Cash deficits due to the COVID-19 crisis[1] and cumulative change in turnover/costs/investment[2]

Sources: Federal Public Service Finance, NBB.

1 A firm experiences a cash deficit if its cash balance is negative.

2 Cumulative sum of the monthly percentage change in 2020 compared the corresponding month in 2019.

3 We cluster firms according to their narrow liquidity ratio in deciles (first decile = least liquid ="1", tenth decile = most liquid ="10").

4 Defined as the ratio of value added over labour. We cluster firms according to their labour productivity in deciles (first decile = least productive ="1", tenth decile = most productive ="10").

2. Keeping the lights on: the impact of policy measures

"Christmas lights, when I was a kid, were wired in series. If one lightbulb blew, the whole string went dark. My Depression era parents taught me to fix it by checking each bulb, one-by-one, all one hundred of them. The tree was dark for a long time. But since bulbs were expensive and labour was cheap back then, the prolonged darkness was worth it. Today, I would do it differently. I would tend towards a 'costly but quick' option, say, replacing all bulbs at once. After all, goods are cheap, labour is expensive, and Christmas is short.

I suggest that policymakers think about the 'economic medicine' for the COVID-19 crisis in the same way. Governments should choose quick options that keep the economy's lights on without worrying too much about costs."

– Richard Baldwin, ex-President of the Centre for Economic Policy Research (March, 2020)

Belgian authorities have taken swift and decisive measures to alleviate the liquidity shortfall of non-financial firms. In this section, we assess to what extent these interventions have had an effect on firms' cash deficits, as measured and discussed in the previous section. For parsimony and practical considerations, we restrict the analysis to the set of measures that (i) can be quantified with reasonable accuracy, (ii) are currently in place (i.e. not tentative but cast and approved in legislation), (iii) are the most sizeable at the macro level and (iv) are taken at the federal/regional level (thereby excluding, *inter alia*, the EU Recovery and Resilience Facility, the European Investment Fund, etc.)[1]. Imposing this filter narrows the set of studied interventions which, in turn, bring forward the disclaimer that the results provide a lower bound on the impact of policy measures.

This section is structured as follows. We first discuss three broad classes of Belgian support measures (financial sector measures, outright transfers and fiscal interventions) and briefly highlight the policy measures not taken on board. The second subsection is devoted to a quantitative evaluation of the support packages and scrutinises the role of the banking sector as a lender of first resort. We subsequently take stock of the residual, post-intervention, liquidity problem and conclude this section with an international cross-country comparison.

2.1 Policy measures

2.1.1 Financial sector policy measures[2]

The financial sector constitutes a crucial lever for tackling and resolving the current crisis. Upon the initiative of the Minister of Finance and with the support of the National Bank of Belgium, the federal government has drawn up an agreement with the financial sector to help attenuate the impact of the coronavirus pandemic on firms through the introduction of two support schemes: a debt moratorium (for pre-COVID-19 existing credit facilities) and State-guaranteed loans (for new credit lines). In order to monitor use of both schemes, the NBB keeps an exhaustive list of all credit under moratorium and new loans granted under the State guarantee scheme. This new data source complements the Central Corporate Credit Register (CCCR), already in place prior to the pandemic, which documents all used and authorised loans from banks to non-financial corporations. Taken together, both data sources enable us to quantify the extent to which the financial sector support measures have supplemented traditional credit intermediation to attenuate businesses' cash shortfalls.

1 Criterion (i) is mainly driven by data availability. Criterion (ii) only applies for the projections considered in section 3. Criterion (iii) builds on an NBB in-house database which lists federal and regional policy measures as well as estimates of their budgetary implications. We qualify a measure as sizeable if its budgetary impact exceeds € 250 million. Finally, criterion (iv) reflects our aim to keep the analysis parsimonious and self-contained.

2 Extensive details on financial sector policy measures can be found in NBB (2020a).

Debt moratorium: debt rescheduling

Under the debt moratorium, viable firms can apply to their institutional lenders for a deferral of repayments on their business loans for a maximum of six months. The suspension only applies to the principal: the interest on these loans is still due. Once the deferral period has lapsed, payments have to resume. The duration of the loan will be extended by the deferral period and borrowers will finish repaying their loan a maximum of six months later than the original deadline. Credit institutions are not allowed to charge any application or administrative fees for the use of this deferral.

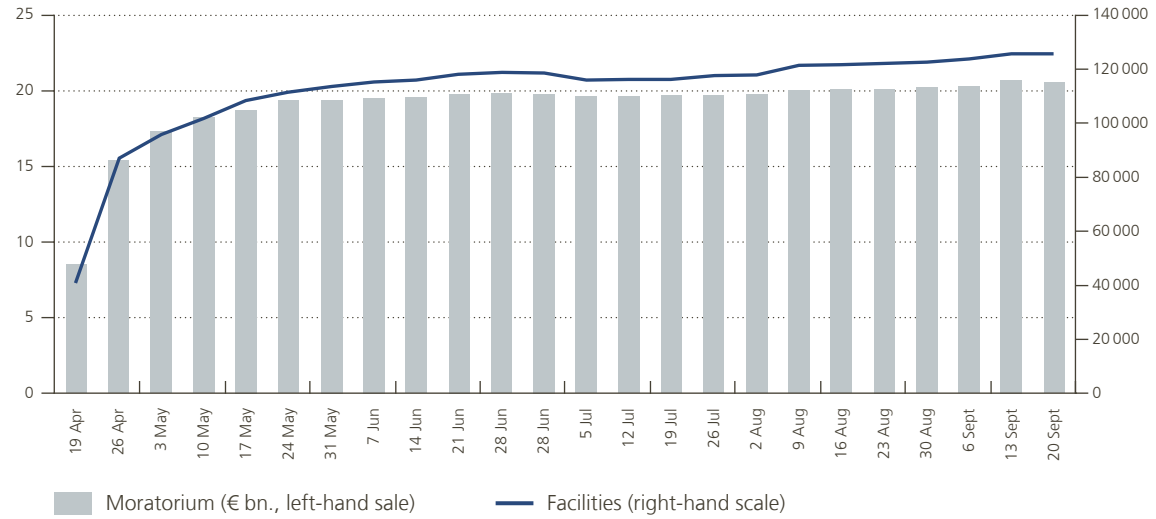
Not all firms can ask for a moratorium on their debt as important eligibility criteria apply[1]. These include, *inter alia*, that payment problems should be caused by the COVID-19 crisis, i.e. through (i) a drop in turnover or activity, (ii) recourse to (temporary) unemployment, or (iii) the obligation imposed by governmental authorities to close the company or organisation. Moreover, the requesting firm may not have been in arrears on 1 February 2020 with its outstanding loans, tax or social security contributions (or it was less than 30 days late in paying them on 29 February). In addition, it must have fulfilled its contractual credit obligations with all credit institutions in the last 12 months prior to 31 January 2020 and is not undergoing an active credit restructuring process.

From its inception in mid-April, this instrument was often solicited by Belgian firms. Chart 6 shows that, already by the end of April, 86 000 debt facilities were placed under moratorium which concerned a total amount of € 15 billion (excluding self-employed and public entities). Near the end of September 2020, 115 000 loans were under moratorium, with a total worth of € 22.5 billion. For a correct interpretation of our results presented below: what firms save on outgoing cash flows, however, is not the principal but the size of the now postponed monthly reimbursement.

1 See NBB (2020a) for an exhaustive list.

Chart 6

Use of debt moratorium[1]



Source: NBB.

1 Excluding self-employed and public entities.

State-guaranteed loans

A first guarantee scheme was activated for all new loans and credit lines with a duration of up to 12 months that credit institutions granted to resident firms for their activities in Belgium. It was possible to apply for the scheme from the start of April 2020 up to 30 September 2020 and a € 50 billion buffer has been set aside for cases where instalments cannot be paid. This guarantee scheme was later extended in order to include loans – exclusively to SMEs – with a duration up to 36 months. As with the debt moratorium, several eligibility criteria apply, the most important of which relates to the viability of the firm[1]. Uptake of this support measure has remained relatively limited.

2.1.2 Outright transfers

Nuisance premiums/compensation premiums

Firms forced to cease operations by law were eligible to receive a one-off nuisance premium. The eligibility criteria varied across Regions and the premiums ranged between € 2 000 and € 5 000. Moreover, businesses that were not legally required to halt operations but nonetheless experienced a significant decline in turnover (i.e. more than a 60 % decline in sales) were entitled to a one-off compensation premium. Both premiums are mutually exclusive. Based on firms' monthly VAT returns and location data, we infer the size of premium received. Note that we do not observe firms soliciting this premium. Below, we assume rationality on the side of the firm and assume it applies for it when eligible.

Temporary unemployment

In general, when a firm files for temporary unemployment, its employees receive benefits from the unemployment authority, and the firm can save on wage outlays. In the context of the COVID-19 crisis, a simplified procedure for temporary unemployment was approved by the government on 20 March 2020. All temporary lay-offs due to COVID-19 are considered as a case of *force majeure*, and the company is not required to cease activities completely. In practice, this means that some employees may be temporarily unemployed, and others may not. Our analysis makes use of data on firm level temporary unemployment received from the national unemployment office to proxy savings on the wage bill.

2.1.3 Fiscal measures

A one-off carry-back regime

For the first time in Belgian tax history, a general one-off carry-back regime was introduced by law for losses incurred by Belgian firms. Provided that certain conditions are met, this crisis measure enables taxpayers to speed up the use of their losses, by offsetting (estimated) COVID-19 losses against taxable profits (if any) from the prior financial year, i.e. the "pre-COVID-19 year". For one financial year (the pre-COVID-19 year), taxpayers will be able to temporarily exempt (part of) their taxable profit by the amount of the estimated COVID-19 losses[2]. In doing so, the tax burden for the pre-COVID-19 year will be lower and any tax pre-payments made in excess of this tax burden will be reimbursed in the course of the COVID-19 year. This is expected to improve the liquidity position of firms. However, in order to reclaim advance payments on part of their pre crisis profits, companies have to predict their losses as a result of the COVID-19 crisis. Penalties apply if losses are overestimated by 10 %. In our analysis, we make use of VAT data (up to September 2020) to proxy losses due to the crisis (and extrapolate them to the full COVID-19 year). We subsequently assume that firms fully apply for the carry-back system.

1 In this context, viable firms are firms that are not considered as 'undertakings in difficulty', within the meaning of the EU Regulation No. 651/2014.

2 The exemption cannot exceed the result for the tax period and is subject to a limit of € 20 million. If there is no loss in the next tax year, or if the loss is less than the amount for which exemption was requested, a penalty may be imposed in the form of a tax increase (10 % tolerance is applicable).

Exemption of the withholding tax

In severely affected industries that had to resort to temporary unemployment (see above), firms are granted a partial exemption from payment of withholding taxes[1]. This provides an incentive to have employees, who are currently temporarily laid off, returning to workplace. More specifically, from June to August, 50 % of the increase in withholding taxes compared to what was paid in May 2020, will be forgiven.

Investment deductibility

To encourage investment, firms subject to corporate taxes are usually eligible for an investment deduction. Conceptually, this comes down to an additional tax deduction on top of that on amortisations. In the context of the COVID-19 crisis, the standard investment deduction has been raised from 8 % to 25 % for investment made between 12 March 2020 and 31 December 2020. Based on VAT declarations, we can quantify the size of this support measure.

2.1.4 Other measures not taken into account

A set of policy measures fall outside the scope of the analysis. This list includes a moratorium on bankruptcies, introduced to give firms a better opportunity to survive. Moreover, a "recovery reserve" enables companies to reduce their accounting profits from tax years 2022, 2023 and 2024 by creating a tax-free reserve up to the losses incurred in 2020. Such measures are expected to strengthen the solvency position of firms and affect liquidity (beyond the time horizon of the current analysis). Furthermore, this article shares a common thread with the current literature in the sense that it focuses exclusively on policy measures directly targeted towards firms. While support packages that target households also fuel demand for goods/services (and therefore indirectly support firm liquidity), we refrain from quantifying these indirect effects.

Acknowledging that the crisis affects some sectors disproportionally, various levels of government have advanced a set of sector-specific support measures. While these support measures potentially play an important role in alleviating liquidity stress in particular segments of the economy (most notably in Creative activities, arts and culture, Sports and recreation, Food and beverage services), they are both numerous and their exact allocation among firms is unobserved which makes it impractical accounting for them.

Finally, some crucial measures fall outside the scope of our analysis as they only apply to businesses we do not consider. Most importantly, the self-employed (who are not required to file annual accounts, according to Belgian law) are entitled to a replacement income, exempt from social security contributions (which implies that they do not build up social rights for the exempt period), bridging loans, etc. Although the self-employed account for 17 % of total employment, we refrain from incorporating their liquidity requirements as the absence of annual accounts renders such an estimation prone to error.

1 A withholding tax is the amount that an employer withholds from employees' wages and pays directly to the Federal Public Service Finance. The amount withheld is a credit against the income taxes the employee must pay during the year.

2.2 Quantitative results

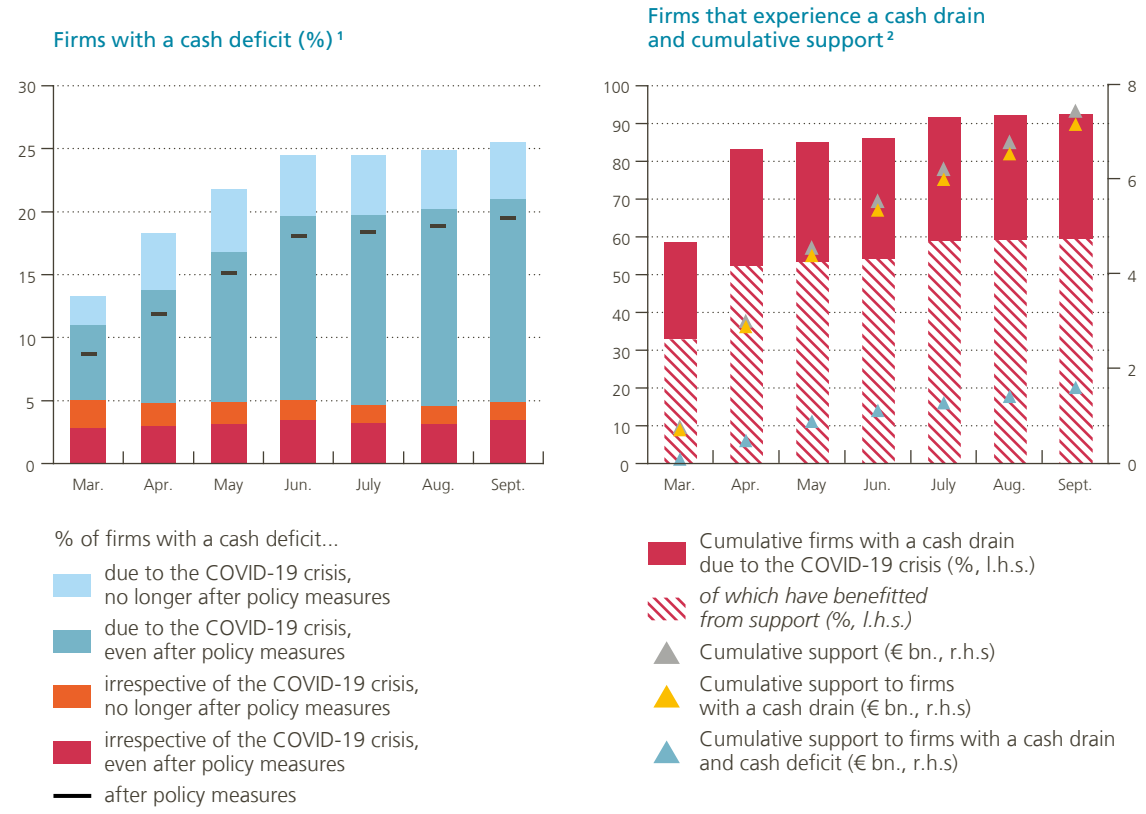
2.2.1 Impact of support measures

The first panel of chart 7 extends the analysis of the previous section and quantifies the share of firms that are no longer cash-constrained after they have benefited from policy interventions. While the COVID-19 crisis caused an acute cash deficit for 20 % of the firms in September 2020, 15 % still have a cash shortfall after receiving policy support. The bulk of the measures are documented to have a benign effect early in the crisis (underscoring the speed of the intervention), which persisted over the summer. Moreover, policy support only marginally solves the cash deficit of firms that would have developed cash shortages irrespective of the COVID-19 crisis. This is true, both because these firms proportionally receive less aid (as they are not eligible : see the discussion above) or have developed too large a cash shortfall that cannot be dampened by the level of support made available in the COVID-19 crisis.

The second panel of chart 7 shows that, by the end of September 2020, € 7 billion of policy support was provided to the business population under consideration (markers in grey). Importantly, the minor discrepancy between the grey and yellow markers reveals that virtually all of this support accrues to firms that effectively experienced a cash drain. This follows naturally from the fact that most of the support measures are conditional

Chart 7

Impact of support measures



Source : NBB.

1 A firm has a cash deficit if its estimated cash balance turns negative.

2 A firm has experienced a cash drain if it had to reduce its pre-pandemic cash position.

on being negatively affected by the COVID-19 crisis[1]. Not surprisingly, only a fraction of total support accrues to firms with a cash shortfall as none of the studied support measures require the firm to have an effective cash deficit.

Finally, while 90 % of the firms under consideration had experienced a cash drain by September (red bars), approximately two out of three firms with a cash drain have benefited directly from (at least one type of) support measures (shaded red area). So, support either solves or reduces the size of a cash deficit (as shown in the first panel of chart 7) or, in the absence of a cash deficit, it strengthens the liquidity position of those that experienced a cash drain, potentially preventing a cash shortfall in the future (as is clear from the second panel of chart 7).

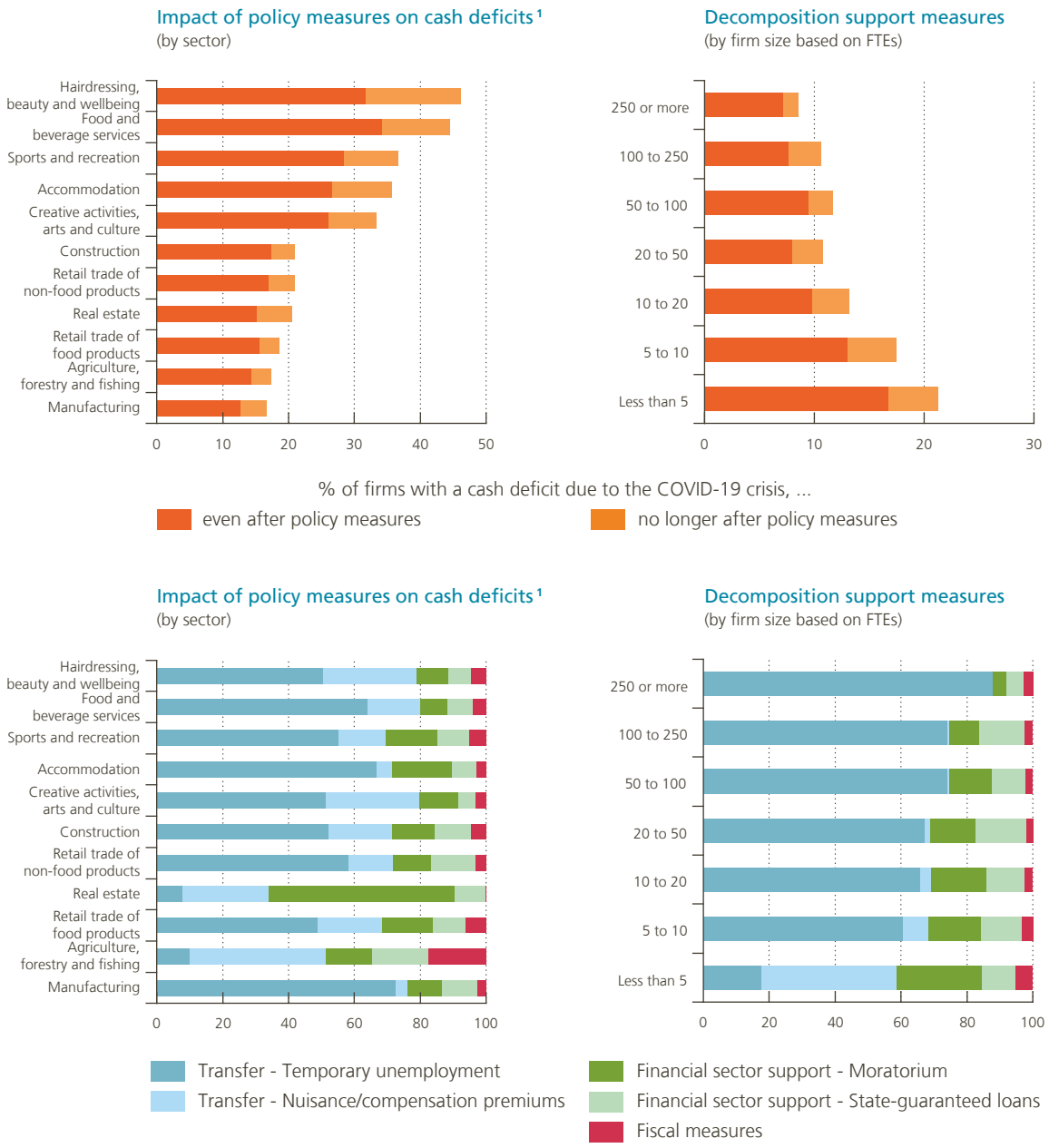
The upper left panel of chart 8 documents that policy interventions have had a heterogenous effects across sectors. While the severely impacted sectors (Creative activities, arts and culture, Accommodation, Sports and recreation,Food and beverage services and Hairdressing, beauty and wellbeing) would have developed more severe cash shortfalls without any intervention, policy support has successfully attenuated liquidity concerns in a large number of establishments in these sectors (disproportionately more so compared to other sectors). These highly affected sectors are typically populated by relatively small firms, with – on average – a limited nominal cash shortfall, albeit substantial relative to their size. In that case, support measures that are not tailored to firm size (such as the nuisance or discomfort premiums) succeed in alleviating cash concerns of many small entities in these sectors. This is attested in the top right panel, where liquidity stress was attenuated proportionally more in smaller firms than large firms.

The bottom left panel decomposes the total support received within each sector by type. It documents that most aid is provided through temporary unemployment and nuisance or compensation premiums. Financial sector support measures are of second-order importance (with debt moratorium typically more important than State-guaranteed loans). Finally, fiscal measures are of marginal importance and mainly reflect the exemption of withholding taxes. As higher investment deductibility only works if firms effectively invest, this package is of limited size in an environment of falling investment. Moreover, the carry-back tax system is only expected to improve liquidity in the last quarter of 2020, which falls outside the scope of the analysis. Finally, while the bottom right panel unveils the obvious message that firms with more employees relied disproportionally more on temporary unemployment, it also indicates that nuisance premiums were the second source of support obtained by small firms. For large firms, alongside the temporary unemployment scheme, financial sector support was the key source of liquidity relief.

1 This is true for State-guaranteed loans (see paragraph 3.30 in NBB (2020a)), with minor exceptions (see paragraph 3.15 in NBB (2020a)). For the moratorium on debt, eligibility criteria require that payment problems should be caused by COVID-19, i.e. through (i) a drop in turnover or activity, (ii) recourse to (temporary) unemployment, or (iii) the obligation imposed by governmental authorities to close the company or organisation (NBB (2020a), paragraph 2.2). So, firms have access to this relief programme if they experience a cash drain (but not necessarily have a cash deficit).

Chart 8

Impact of the COVID-19 crisis on firm-level cash deficits and policy mix decomposition



Source: NBB.

1 A firm has a cash deficit if its estimated cash balance turns negative.

2.2.2 Banks: lenders of first resort

In chart 8, both State guarantees and debt moratoria are classified as policy-coordinated support packages accruing from the banking sector. Credit obtained from banks through normal, market-based, financial intermediation procedures is not classified as a support mechanism. The question remains as to what extent this market-based (as opposed to policy-coordinated) financial intermediation has eased liquidity concerns of firms.

This question is important, provided that considerable policy action has been taken to support the capacity of the banking sector to fulfill that role, e.g. through monetary policy actions (see Boeckx et al., 2020) and macroprudential interventions through the release of the full Pillar 2 Guidance buffer, the capital conservation buffer (ECB, 2020) and the countercyclical capital buffer (NBB, 2020c).

In order to investigate the role of banks as liquidity providers during the COVID-19 crisis, we quantify the share of businesses that would be cash-constrained had they not received fresh funding from banks (even though they did benefit from the various support measures discussed above). To that end, we classify each firm according to the type of new bank loan it has received:

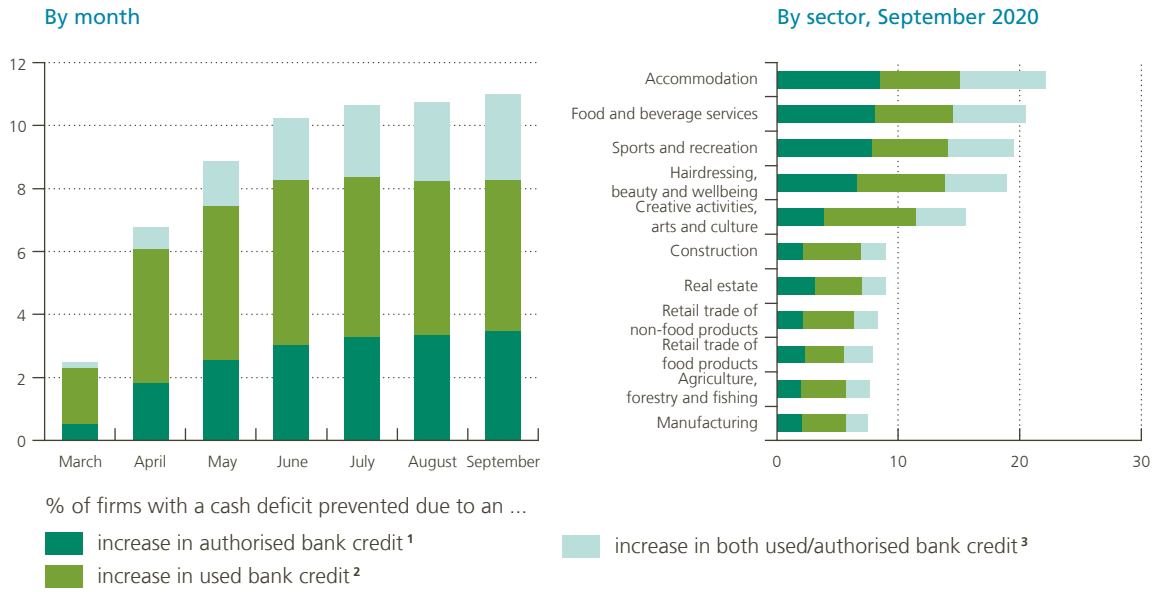
- First, firms that exclusively draw on credit lines that existed prior to the pandemic. This reflects use of credit lines that were already authorised by their incumbent bank(s) but were not fully exhausted before the pandemic. Such authorised amounts reflect prior commitments by banks to lend to the firm at pre-specified rates, up to pre-specified limits and conditional on a set of debt covenants. Hence, these drawdowns purely reflect firms' demand and, in principle, involve no active intervention from the bank.
- Second, firms that obtained new (or expanded pre-pandemic) authorised credit lines and subsequently partially/fully drew on this higher authorised amount. This includes both firms expanding existing credit contracts with incumbent banks or firms establishing one or multiple new banking relationships. This category of credit represents active supply behaviour of banks and directly speaks to the question whether banks actively helped firms in attenuating liquidity shortfalls.
- Third, firms that combine both actions (i.e. a hybrid category).

Chart 9 shows that the Belgian banking sector has contributed to dampening the liquidity deficits of firms. First, passively, through drawdowns of pre-pandemic authorised lines by mainly large non-financial corporations.

Chart 9

Impact of bank credit on cash deficits

(% of firms)



Source: NBB.

1 If the firm exclusively draws within the authorised limits of credit lines that already existed before the pandemic.

2 If the firm exclusively draws on new authorised credit lines that did not exist prior to the pandemic.

3 If the firm draws both on pre-pandemic authorised lines and also on new authorised lines of credit (combination of other categories).

By the end of April 2020, an additional 5 % of Belgian firms would have faced a cash deficit had they been unable to intensify use of pre-pandemic borrowing limits. Note that such drawdowns of authorised credit during COVID-19 is not specific to the Belgian context (see Li *et al*., 2020)[1]. Second, banks have contributed by raising authorised amounts. By the end of September 2020, an additional 5 % of firms averted a cash deficit by expanding and subsequently drawing on expanded/new authorised lines. These effects already emerged in March and April and came to standstill afterwards[2].

The second panel delves deeper in the underlying sectoral heterogeneity. It documents that the 'Manufacturing', 'Construction' and 'Retail trade sector' disproportionately drew on pre-pandemic credit lines. These patterns to a large extent reflect pre-COVID-19 utilisation rates. More precisely : prior to the pandemic, firms in these sectors typically reported lower utilisation rates compared to firms in other sectors (NBB, 2020b). As such, these firms had more slack in their credit lines to exhaust compared to other firms. Moreover, we find that mainly larger firms extensively drew on authorised credit lines to satisfy their cash requirements (proportionally more so than smaller businesses), which again reflects pre-COVID-19 utilisation rates. Chart 9 also reveals that market-based bank credit inflows to firms were more important than new State-guaranteed loans.

Taken together, in contrast to the situation at the time of the 2007-2008 financial crisis, when the fragility of banks' balance sheets had been a significant catalyst of the crisis, during COVID-19 the banking sector has cushioned the initial impact of the pandemic on the liquidity needs of (particularly large) firms in March-April, while this role attenuated afterwards. While the moratorium on bank debt was a successful tool to diminish outgoing cash outflows, the bulk of fresh incoming bank credit was produced under regular market forces and rather than under the State guarantee.

2.3 Who has received what type of support ?

A budget-constrained policy-maker should aim to support firms that (a) have been deprived of cash by the pandemic and (b) have business models that are sustainable after the COVID-19 crisis. The first criterion implies that scarce resources should target firms with a cash drain that is actually attributable to the pandemic (and not replenish liquidity needs existing prior to/irrespective of the crisis). The second objective should allow for some degree of creative destruction so that firms with non-viable business models are either reorganised or liquidated. As per the quote in the introduction, the support measures during the first wave mostly aimed to keep firms afloat in order to "keep the lights of the economy on". It is insightful to investigate to what extent the policy measures taken meet these two criteria.

To investigate the first dimension, the first bar in the top panel of chart 10 classifies firms according to whether they experienced a cash drain and highlights the sub-set of firms for which the pandemic-induced cash drain has led to a cash deficit (without policy interventions). The centre part shows, per type of support measure, the share of each category in the total number of firms that received each support measure. The last part quantifies, per type of support measure, the proportion in total support received by each firm category. The centre and right-hand part of the chart show that debt moratoria are disproportionately used by firms that faced a cash deficit due to the pandemic : while 20 % of the corporate population flagged up a cash requirement due to the COVID-19 crisis, these firms reflect 32 % of total firms that benefited from the moratorium and 47 % of the total moratorium volume. In terms of volume, virtually all debt under moratorium is held by firms that have experienced a cash drain. The observation that firms without a cash drain have close to zero usage is hardwired in the eligibility criteria : it is only available to firms with payment problems clearly attributed to the COVID-19

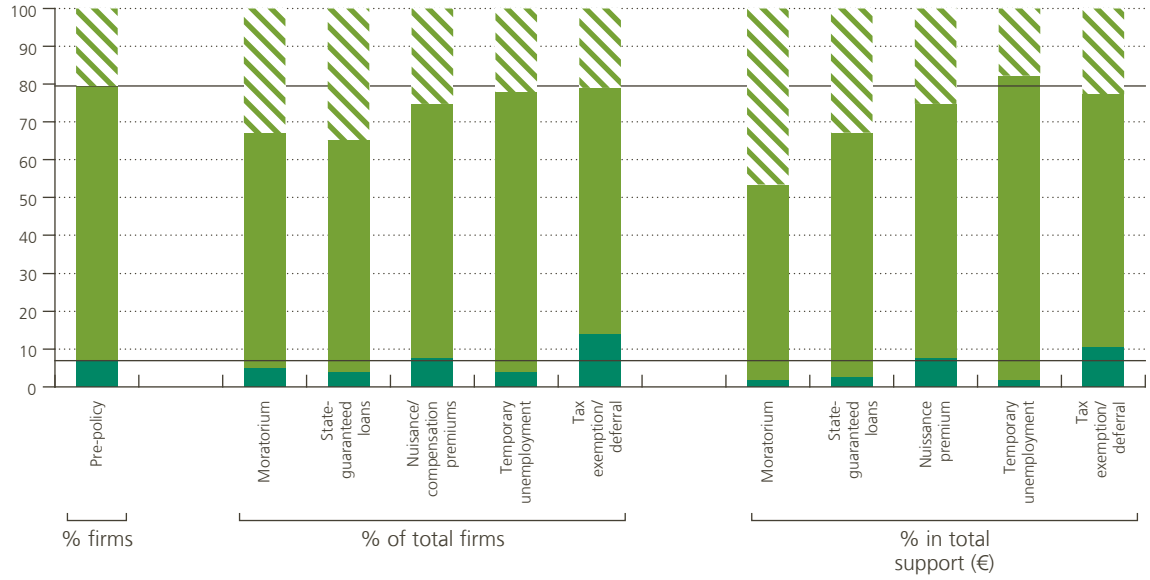
1 Moreover, such behaviour was also observed during the global financial crisis, both in Belgium (NBB, 2010) and internationally (e.g. Ivashina & Scharfstein, 2008).

2 Note that this pattern is consistent with the Survey on the access to finance of enterprises (SAFE), in which Belgian SMEs, in line with the rest of the EA, flag up a deterioration in access to bank finance during the April-September period.

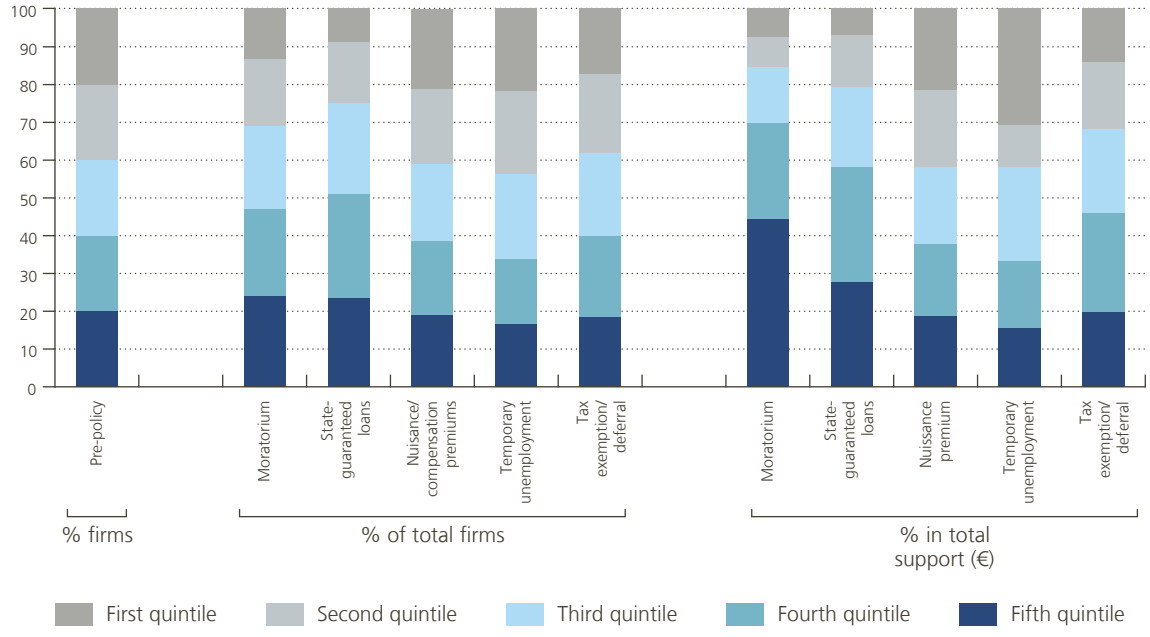
Chart 10

Allocation of support measures

Allocation of support over firms facing a cash drain or not (without support) over the period March 2020 to September 2020



Allocation of support over deciles of labour productivity 3



Source : NBB.

1 A firm has experienced a cash drain if it had to reduce its pre-pandemic cash position.

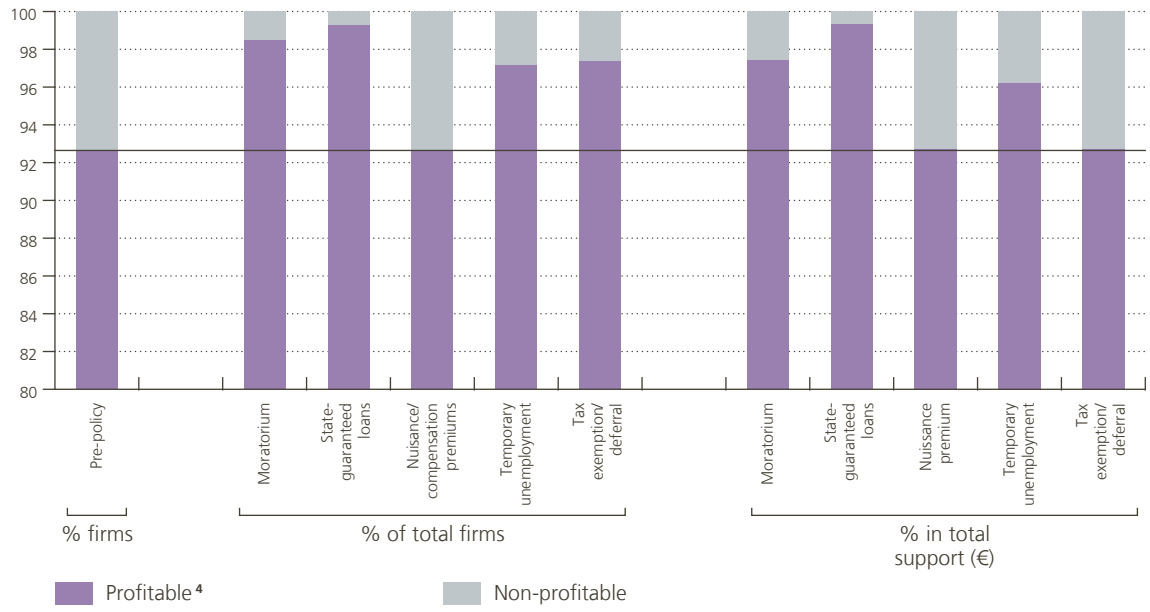
2 A firm has a cash deficit if its estimated cash balance turns negative.

3 Labour productivity. Quintile five (one) contains the most (least) productive firms in their sector.

Chart 10 (continued)

Allocation of support measures

Allocation of support over profitable and non-profitable firms



Source: NBB.

4 A firm is considered non-profitable if it is aged five years or more and if its EBITDA (excluding extraordinary income and chargers) has been less than its financial charges (or below zero if has no financial charges) for three successive years.

crisis (see above). A similar message applies to State-guaranteed loans, where the liquidity deprived firms reflect 35 % of all State-guaranteed loans and 33 % of its volume.

Moreover, while nuisance and discomfort premiums by and large accrue to firms which experienced a cash drain, 8 % of its volume flows to firms that have not experienced a decline in its cash position since the start of the pandemic. Two non-mutually exclusive explanations apply. First, it can simply mean that nuisance/discomfort premia accrue to firms that do not necessarily need them (e.g., firms are eligible because their sales drop breached the –60 % threshold due to an exceptional good reference period last year). Alternatively, they accrue to firms that are affected by the COVID-19 crisis, but which have taken corrective action so as to avert a cash drain (e.g., firms that have taken up bank credit, downscaled investments, downscaled costs, etc.). Finally, while the total volume of temporary unemployment payments has typically dampened a cash drain, tax exemptions benefit disproportionately firms that have not seen their liquidity position deteriorated by the crisis. The reason is that preferable tax treatment of investments only accrues to firms that effectively keep investing throughout 2020. These firms have on average a healthy cash balance.[1]

In addition, the two other panels of chart 10 investigate whether support was channeled to pre-pandemic productive and profitable firms, respectively. Both panels focus on the subset of firms with a cash deficit without

1 It should be recalled that the carry-back tax system is only expected to lead to liquidity support as of October and falls outside the scope of the time frame considered.

support measures. The middle panel classifies firms in bins of decreasing pre-pandemic labour productivity. The bottom panel categorizes firms according to whether they were profitable prior to the pandemic. The pattern in the center of both panels shows that debt moratoria were used disproportionately more by productive and profitable firms. The 40 % most unproductive firms account for only 15 % of the total debt moratorium volume. Similarly, while we classify 8 % of currently cash-deprived firms as non-profitable before the crisis, they only represent 0.7 % of total volume of State-guaranteed loans. This pattern follows naturally from the eligibility criteria which bar firms with payment arrears (the incidence of which is high among nonprofitable firms). As nuisance/discomfort premia are received irrespective of whether the firm is productive or profitable, they accrue to these firms in proportion to their size in the population. Temporary unemployment, by construction, is received more by the relatively unproductive (measured by labour productivity) firms in each sector.

In sum, State-guaranteed loans and debt moratoria disproportionately amass to firms that need cash due to the COVID-19 crisis. Moreover, the volume of debt moratoria and State-guaranteed loans is asymmetrically provided to profitable and productive firms. Compensation premiums have some leakage to firms that do not need it. It is a brute force policy measure which aims to keep firms afloat, irrespective of the viable nature of the beneficiary. While good arguments exist for such measures (avoid supply chain disruptions, knock-on effects in banks credit portfolios, slump in demand due to large unemployment), additional conditionality might be warranted.

2.4 The post-policy-intervention problem

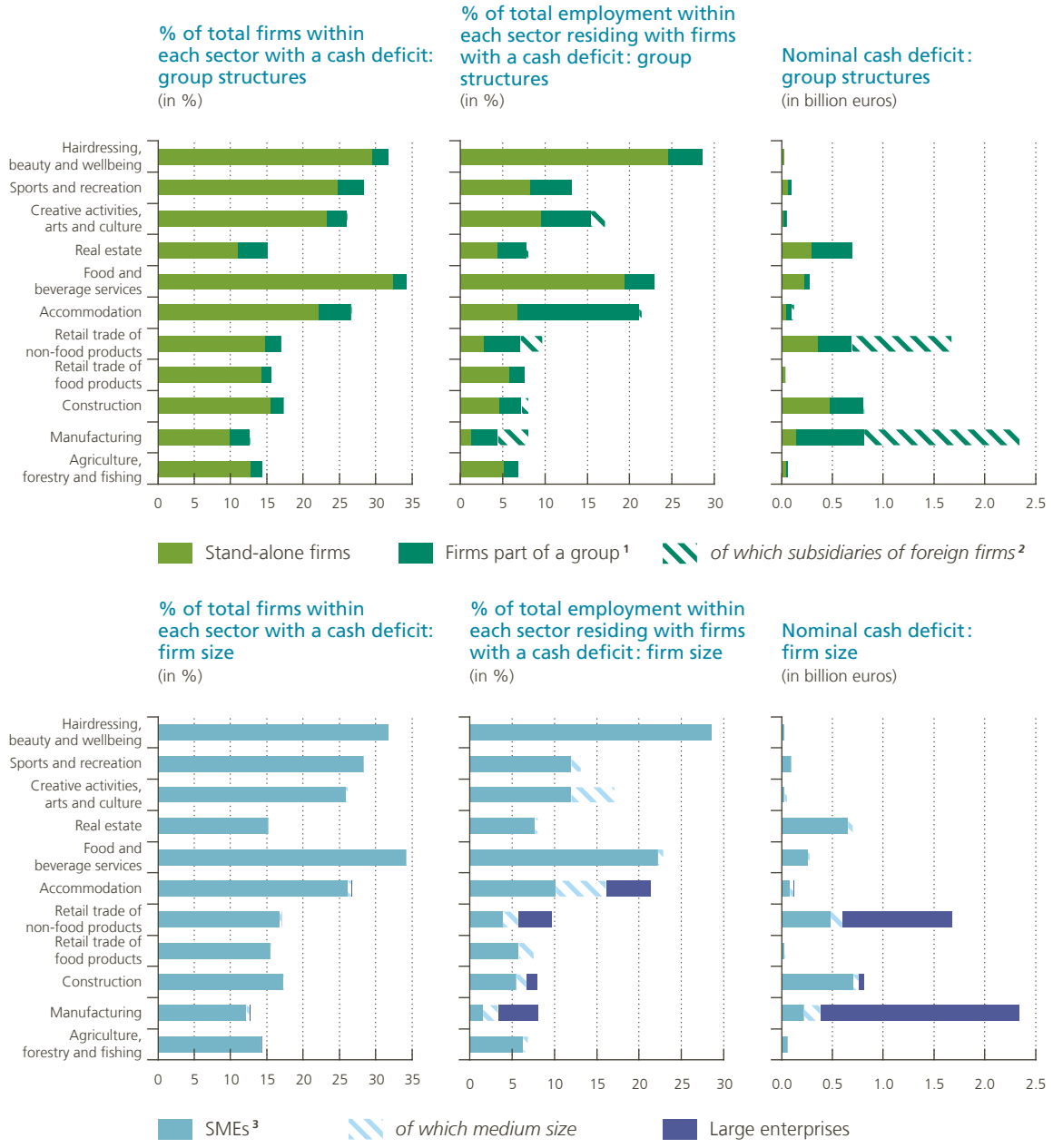
Even with policy measures, acute liquidity problems due to the COVID-19 crisis remain for 15 % of firms. This residual cash shortfall can be addressed through various mechanisms that are not part of our estimation framework. They are discussed below.

First, many corporate groups, in which multiple companies are organized under the management of a controlling parent company, have installed cash pooling systems. Although the individual companies are legally independent, the group as a whole acts as a strategic unit for which mutual financial support and distribution of liquidity among group members is in the interests of all parties involved. In the context of the COVID-19 crisis, intra-group mobilisation of cash through cash pools has the potential to transfer cash surpluses from an entity with ample liquidity to a cash deprived group-member[1]. Drawing from common liquidity reserves to meet working capital requirements, rather than using bank loans, is typically a common practice among Belgian corporations affiliated to a parent company. In particular, Piette and Zachary (2016) show that there is a high elasticity between the outstanding amount of non-bank loans in the balance sheets of subsidiaries and their working capital requirement, which suggests an intensive use of intragroup financing to meet their liquidity needs. The quantitative link between the outstanding amount of their bank loans and their working capital requirement is, by contrast, very weak whereas it is significant for stand-alone firms. In that context, the top panel of chart 11 isolates the share of firms with a cash problem which are part of a group (and highlights the subset of firms that are subsidiaries to a foreign parent). It reveals that the incidence of group structures among cash constrained firms is very low (only few are foreign owned subsidiaries). Its incidence is the largest in 'Accommodation' and the smallest in Retail trade of food products. The second graph in the top panel, however, reveals that across sectors, a large part of sectoral employment resides with cash-deprived firms that are part of a group structure. As above, this is most outspoken in Accommodation (15 %), Retail trade of non-food products (7 %), but also Creative activities, arts and recreation (7 %) and Manufacturing (7 %). Importantly, the last panel reveals that the bulk of the nominal cash shortfall in most sectors originates with firms that are part of an (inter)national group. Taken together, there is potentially a large scope for intra-group cash mobilisation in the presence of more liquid firms in each group.

1 On the other hand, a parent-subsidiary relation entails the risk of one-sided appropriation of liquidity by the parent from its subsidiaries.

Chart 11

Firms running out of cash, employment of firms running out of cash and nominal size of cash deficit



Source: NBB.

1 Identified based on the annex of the annual accounts.

2 Identified based on the NBB Foreign Direct Investment Survey.

3 EU definition.

Chart 11 (continued)

Firms running out of cash, employment of firms running out of cash and nominal size of cash deficit

Source: NBB.

4 Firm buyer/suppliers structure relies on the 2018 vintage of the B2B database. A firm is tagged to have a potential supplier (buyer) problem if more than 10 % of its supplier (buyer) portfolio volume is also estimated to have a cash deficit in September.

Second, the figures at the center of chart 11 decompose the residual cash problem along small, medium and large firms. The decomposition highlights that only few large and medium-sized firms have cash problems. However, those experiencing a cash shortfall account for a sizeable fraction of sector-wide employment in Creative arts and culture (5 %), Accommodation (11 %) and Manufacturing (6 %). Moreover, as shown by the third graph in the central panel, larger firms are also responsible for the bulk of the nominal cash shortage. A decomposition by size is informative because many relevant firm characteristics correlate with firm size. For instance, medium and large firms on average have significant financial assets they can liquidate in order to meet their cash shortfall. They are also more likely to have access to the bond market, attract outside equity and maintain credit relationships with foreign banks.

Third, for most firms, a significant fraction of working capital is categorized as "accounts receivable" on the asset side of the balance sheet – the money owed by customers downstream in the supply chain. Accounts receivable are, to some extent, matched by "accounts payable" on the liabilities side of the balance sheet – the money owed to upstream suppliers. Trade credit has often proved to be a resilient source of funding during crisis period, including the global financial crisis and the sovereign debt crisis – see Coulibaly *et al.* (2011). The pandemic presents a perfect storm for supply chains as the COVID-19 shock is more synchronized across sectors, with buyers and suppliers being affected simultaneously. In such settings, the scope for inter-firm lending in the form of trade credit to cushion cash problems is likely to be severely diminished. To gauge this, the last panel in chart 11 quantifies the share of firms for which at least 10 % of the supplier (customer) portfolio volume is flagged to

have a cash deficit. The patterns reveal that the scope for more trade credit beyond traditional payment delays is limited given that cash-deprived firms typically have a large fraction of their supplier base with cash problems themselves. These problems are most outspoken in fragile sectors such as the Food and Beverages services and Creative activities, arts and culture sectors. Moreover, the final panel reveals that most of the cash shortfall in the manufacturing sector resides with firms with a fragile supplier base. While these results hint at limited use of supplier trade credit to cushion cash problems, they also reveal the risk of cascade failures of firms as trade credit chains are known to act as a vehicle for the propagation of corporate bankruptcies and financial distress (Jacobson & von Schedvin (2015), Tielens & Van Hove (2019)).

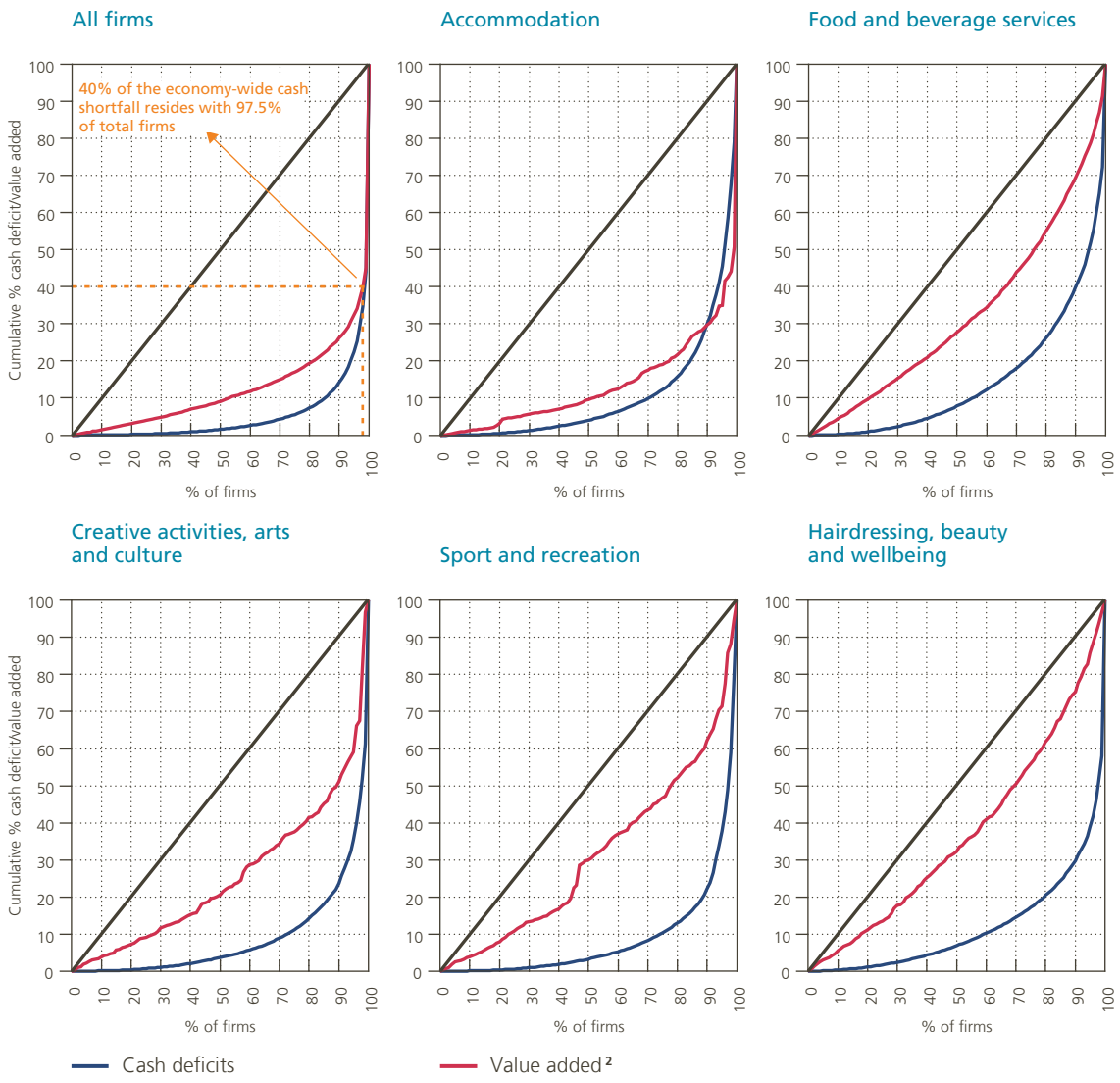
At the end of September, a total cash deficit of € 15.6 billion remains (on top of € 1.6 billion that would have arisen irrespective of the pandemic). The bulk of this aggregate cash shortfall resides with only a handful of large firms. To quantify this, Chart 12 draws Lorenz curves for a selection of sectors and the aggregate economy. While Lorenz curves are typically used to illustrate inequality in society's income/wealth, we use them here to measure how unequal the total cash deficit within each sector is spread across firms. To compute a Lorenz curve, we first order the firms by the magnitude of their cash shortfall, starting with the lowest : and then plot, against the cumulative proportion of the firms so ordered (running from 0 to 1 along the horizontal axis), the cumulative proportion of the sectoral cash shortfall that originates with these firms. If all firms had the same cash deficit, the Lorenz curve would run along the 45-degree line. The deviation from this 45-degree lines highlights that the aggregate cash-shortfall (in blue) is unequally distributed across firms within a sector. E.g. in 'Creative activities, arts and culture' around 70 % of the entities account for 10 % of the total cash shortfall. In 'Food and beverage service', 40 % of the nominal cash shortfall can be traced to 5 % of individual firms.

The Lorenz curves elicit the message that the total cash shortfall is very concentrated among a small subset of entities in the economy. While this implies that a policy support package – with a size well below the total aggregate sectoral cash shortfall – can directly keep a large number of firms afloat, it sidesteps the observation that the bulk of value added is also distributed asymmetrically among firms with a cash deficit. E.g. while the upper left panel in chart 12 indicates that close to 60 % of the nominal economy-wide cash shortfall resides with only 2.5 % of firms with a cash deficit (blue curve), this small group of firms also produces 60 % of value added (red curve). In various sectors, this asymmetry is less apparent. E.g. in Hairdressing and wellbeing around 80 % of firms represent 20 % of that sectors' cash need and account for 60 % of value added in that sector. Similarly, in Sports and recreation, 80 % of firms account for 15 % of that sector's aggregate cash deficit but at the same time represent 50 % of value added. Policy-makers can exploit these asymmetries to set up well-tailored and calibrated programs that maximally support value added and support as much firms as possible at a minimum cost.

Chart 12

Lorenz curves for businesses' cash deficits & value added [1]

(Based on September 2020 estimates of cash deficits)



Source: NBB.

1 The Lorenz curve for cash deficits is a way of showing the distribution of cash requirement within sectors. The Lorenz curve plots the percentage of total cash requirements of firms when firms are ordered by the size of their cash requirement.

2 The value added curves quantify the cumulative percentage of value added (in economy-wide value added) of the group of firms on the horizontal axis.

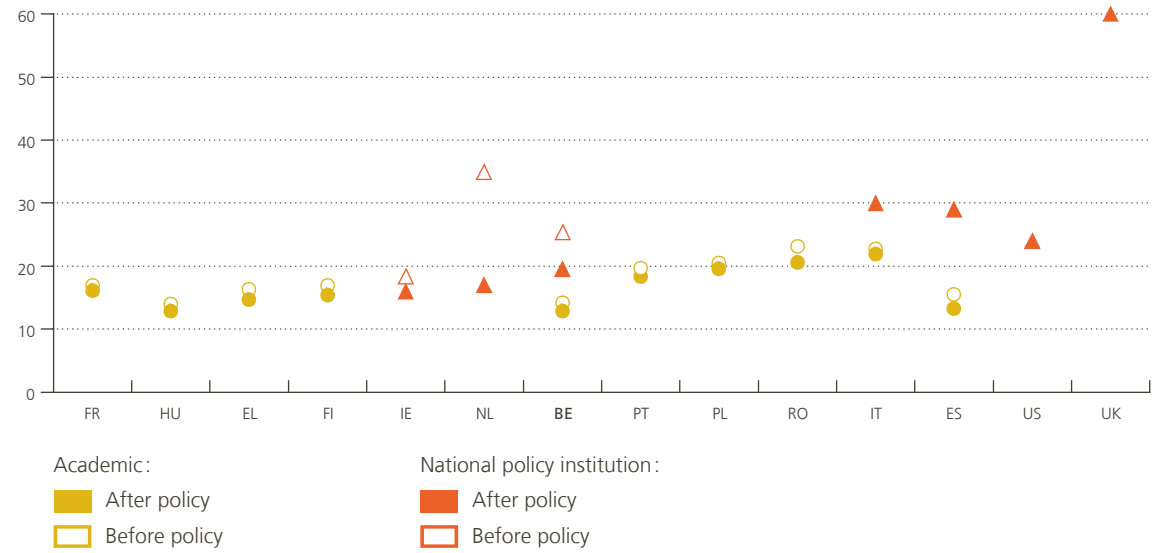
2.5 Cross-country comparison

Since the start of the pandemic, academics, international institutions and the private sector have attempted to estimate the size of businesses' liquidity stress within various countries. While it is appealing to benchmark Belgium with results available for other countries, two caveats render such a comparison intricate. First, the

Chart 13

International comparison of cash requirements

(% of firms with cash requirements before and after policy interventions)



Academic:
After policy
Before policy

National policy institution:
After policy
Before policy

Sources: Academic: Gourinchas *et al*. (2020). Policy institutions: US: Crouzet & Gourio (2020) – Spain: Blanco *et al*. (2020) – Italy: Bank of Italy (2020) – The Netherlands: CPB (2020) – UK: Bank of England (2020) – Ireland: Lambert *et al*. (2020) – Belgium: NBB.

underlying methodology often targets a different liquidity concept[1]. Second, even if these studies offer an estimate of firms' liquidity similar to ours (i.e. a cash deficit), any comparison is typically plagued by the fact that the estimates (a) are developed at different points in time (i.e. the information set on which each study is performed varies), (b) rely on data sources of varying breadth and depth (e.g. exclusively annual accounts data vs. complementary confidential data), (c) have a varying coverage of the corporate sector (e.g. exclusively public firms vs. exclusively SMEs), (d) and rely on different modeling assumptions (e.g. expected duration of the lockdown), etc.

With these caveats in mind, chart 13, positions the Belgian liquidity needs with those estimated for other countries. Estimates are taken from a countrywide study by Gourinchas *et al*. (2020) from September 2020 (which, to the best of our knowledge, is currently most exhaustive and detailed in terms of country results). If available, estimates of the relevant national authority (national central bank, statistical agency) are also reported. Taken at face value, the order of magnitude shows that liquidity needs are similar across countries, ranging between 10 % (Hungary) to 22 % (Italy). The share of Belgian cash constrained businesses closely matches that of neighbouring countries (France, the Netherlands). Note that the figure is uninformative with respect to the impact of support measures (the discrepancy in 'before' and 'after' shares) because the set of policy measures taken on board varies.

1 E.g. shocks on financial ratios (Alstadsæter, *et al.* 2020) or cash buffer days/months which quantifies the number of days/months before the firm runs out of cash (Didier *et al.* (2020), CPB (2020), Renkin (2020)).

3. Solvency problems in the making?

Beyond the liquidity shortfalls discussed in the previous sections, the COVID-19 crisis will undoubtedly have a strong negative impact on many firms' financial health, hampering their future ability to bear their interest charges and amortise the principal. These concerns are discussed in this section. More precisely, we first document the implications of the COVID-19 crisis on firm profitability and quantify the ensuing impact on firm solvency. To that end, we take two routes. The first is to infer firm solvency positions from a (hypothetical) balance sheet at the end of September 2020. The second is to simulate the ability of firms to service additional debt taken out to address their cash deficit. The final sub-section maps the solvency risk to the bank credit portfolios.

3.1 Firm profitability during the COVID-19 crisis

Based on the VAT returns filed between March and September 2020, we estimate that – without support measures – around 26 % of firms incurred losses over that period, in the sense that their earnings before interest payment, taxes, depreciation and amortisation (EBITDA) would be either negative or insufficient to cover their financial charges[1]. This is 8 percentage points more than during the corresponding period in 2019 (note that this number remains mute on the numerous firms that saw their revenue decline while remaining profitable). At the same time, 6 percent of the total firm population became profitable in 2020 after they incurred losses in 2019, which emphasizes the fact that, while some sectors and businesses have been severely impacted by the COVID-19 crisis, others continued their development. Additionally, 48 % of total employment resides with firms that incurred losses during March up to September 2020.

Chart 14 furthermore illustrates the impact of the various support measures on firms' profitability. According to our estimates, 2 % of the total number of firms (i.e. approximately 8 000 businesses) became profitable in 2020 due to the combination of tax exemptions, premiums, and an easier recourse to temporary unemployment. These firms account for around 1 % of the total employment of the population of non-financial corporations considered in this exercise.

3.2 Solvency position in September 2020

Measuring the impact of COVID-19 on firms' solvency is a challenging task as it is not straightforward to assess, at the time of writing this article, how firms have addressed their liquidity problems. For instance, as discussed in section 2, some of them might have sold real or financial assets to meet their most immediate liquidity needs, while others could have made an agreement with the landlord of the premises they occupy to reduce or postpone rent payments. Likewise, we do not have indications on the extent to which firms belonging to a Belgian or a multinational group – which account for 69 % of the estimated total amount of liquidity requirement in September 2020 – have tapped cash pooling arrangements with related companies to obtain the funds they need to cope with the crisis.

With this caveat in mind, we assume, as in Crouzet and Gourio (2020), that any cash shortfall in September is addressed by taking out additional debt, for instance a bank credit or a subordinated loan from private or public investors. We then assess firms' solvency based on a hypothetical balance sheet for September (see Annex A for details). Chart 14 documents that such a funding scenario would entail many firms with a debt-to-asset (DTA) ratio exceeding unity. In other words, the amount of their total debt – i.e. their pre-existing debt plus the debt incurred since the onset of the crisis and the hypothetical debt taken out to close the cash deficit – would be larger than the book value of their total assets, which is equivalent to negative equity. This does not necessarily

1 This also does not account for rent payment (not subject to VAT).

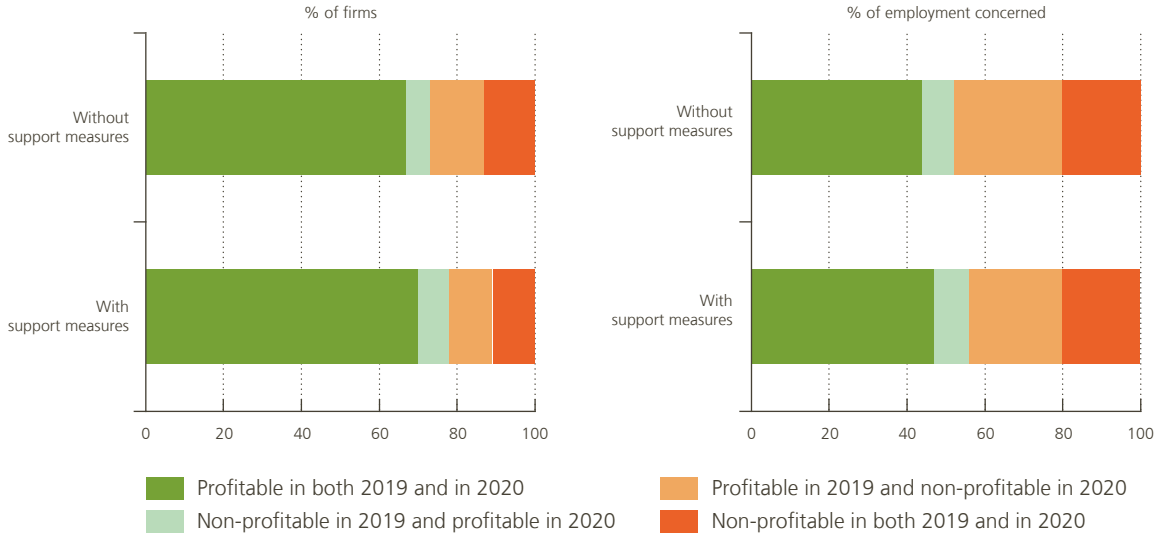
mean that they would all run an immediate bankruptcy risk, insofar as the equity might be replenished with retained earnings at some point in the future, provided that the firms concerned manage to regain their profitability. It nonetheless implies that they would be in fact hardly eligible for the hypothetical additional debt financing we simulate here, since they would not have enough collateral to pledge, making them insolvent in the event of a default.

Chart 14

Impact of the crisis on firms' profitability and solvency

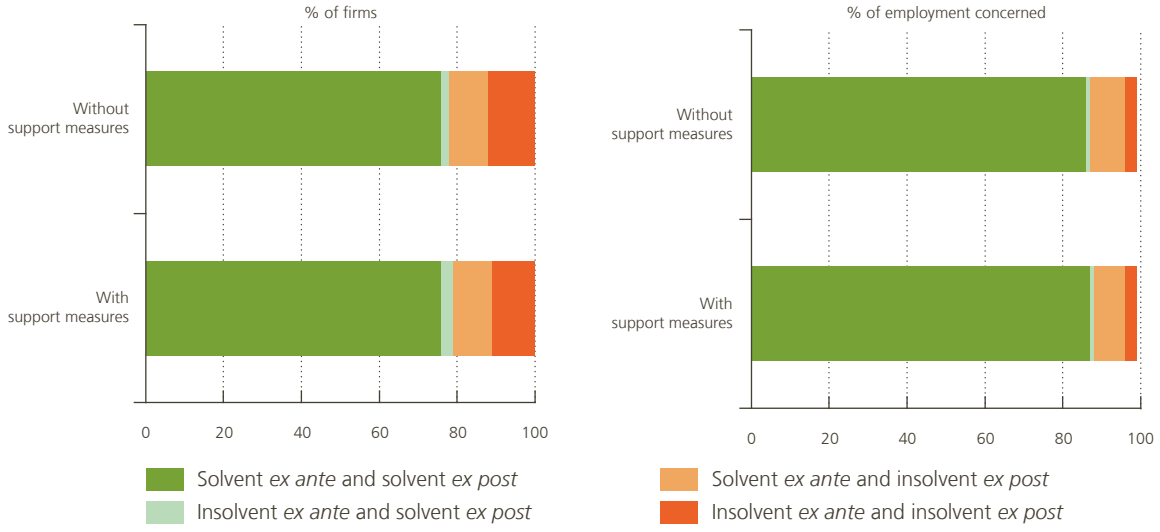
Population of profitable and non-profitable firms in 2019 and in 2020 [1]

(estimates for the period spanning from March to September 2020, and the corresponding period in 2019)



Solvent and insolvent firms before the crisis and in September 2020 [2]

(*ex-ante* values are based on the most recent annual account data; *ex-post* values for September 2020 are projections assuming cash deficits are solved by means of a debt instrument)



Source: NBB.

1 A firm is considered profitable if its interest coverage ratio, i.e. the ratio of the EBITDA over the interest payment, is equal to or larger than 1, and non-profitable if it is lower than 1. If a firm does not report any interest payment in its income statement, then it is considered non-profitable it its EBIDTA is negative

2 A firm is considered solvent if its debt-to-assets ratio is equal or less than 1 and insolvent if it is more than 1.

Quantitatively, our results suggest that the magnitude of this debt overhang problem resulting from the COVID-19 crisis would be sizeable: 21 % of the firms would end up with a DTA ratio higher than 1 under the assumption of a debt financing of their liquidity requirement at the end of September 2020. This is 7 percentage points more than the *ex-ante* situation such as reflected in the most recent annual account data. Moreover, this impact is barely alleviated by the support measures, which were devised to patch firm liquidity without the goal of addressing solvency. Even before the onset of the COVID-19 crisis, most firms recording structural losses (i.e. firms with structurally negative earnings[1] or earnings that persistently do not cover their financial charges) are characterised by a DTA ratio larger than 1 (i.e. their equity has been entirely consumed by accumulated losses). However, one significant consequence of the crisis is that even businesses that used to be profitable in the previous years and require a large amount of additional financing to offset their liquidity shortfall, would become insolvent. In fact, only a relatively limited part of the firms projected to lack the liquidities needed to meet their regular payments in September 2020 – around 6 600 out of 79 000 – may be considered non-profitable and therefore not able to sustain additional debt.

The fact that a liquidity shortfall might turn into a solvency problem for numerous profitable and, by extension, viable firms is clearly a major economic policy issue. Indeed, in addition to the immediate rise in unemployment and the defaults on trade and bank credits they might cause, bankruptcies of otherwise healthy businesses would also deteriorate the productive fabric of the economy and, ultimately, its potential growth and job creation.

3.3 Is additional debt sustainable?

In this subsection we investigate whether the hypothetical loan from the previous subsection would be sustainable (i.e. whether the firm is able to service monthly interest payments and repay the principal when it comes due) and, if so, what the minimum term of that loan should be. Irrespective of its solvency position in September 2020, the idea is that a firm would need a certain amount of time to generate the cash flows required to bear the interest charges and repay the loan at maturity. Of course, determining this maturity at the firm-level involves a certain number of assumptions, most importantly with respect to the future evolution of its cash flows. More specifically, we assume that the sales recovery path is analogous to the latest GDP forecasts after September 2020. We also assume that an additional debt would in any case not be sustainable for firms active for at least five years and having recorded losses over the past three accounting years. Other methodological details related to this simulation are given in the last part of Annex A.

The results of these simulations are reported in chart 15. They suggest that a short-term loan, i.e. a loan with a maturity of up to one year, would be enough to ensure the survival of a large proportion of (profitable) firms that are expected to have run out of cash in September 2020. Nonetheless, 59 % of them, which account for 64 % of the total liquidity need, would require funding with a maturity longer than one year in order to absorb the shock of the crisis. A similar pattern emerges if only stand-alone firms are taken into consideration. Moreover, many firms in this group have experienced a deterioration of their financial health due to the crisis, and their DTA ratio will exceed 1 if they take out a loan to replenish their cash reserves. As already mentioned above, this weakened solvency might make it difficult for them to obtain such a loan from a credit institution, even though their level of profitability, such as observed from their last income statements, might suggest their ability to generate a sufficient amount of cash flows to service their debt.

1 We measure firms' earnings based on earnings before interest, taxes, depreciation and amortisation (EBITDA).

Chart 15

Sustainability of a hypothetic new debt taken out to solve the cash deficits estimated for September 2020

Source: NBB.

1 Stand-alone firms are corporations that are not related to a Belgian or a multinational group.

2 The evaluation of whether a loan with a certain maturity is sustainable for a given firm is based on the assumption that the growth of its sales follows the same recovery path until the fourth quarter of 2023 as that of GDP, such as it is forecasted in the December 2020 macroeconomic projections. Beyond that horizon, a convergence to a long-run steady-state growth is imposed at the sector level. The dynamics of the support measures reflects the information currently cast and approved in legislation. The loan is assumed to be unsustainable for non-profitable firms.

3 A firm is considered insolvent if its debt-to-assets ratio is larger than 1.

3.4 Banks: prudent lenders of first resort

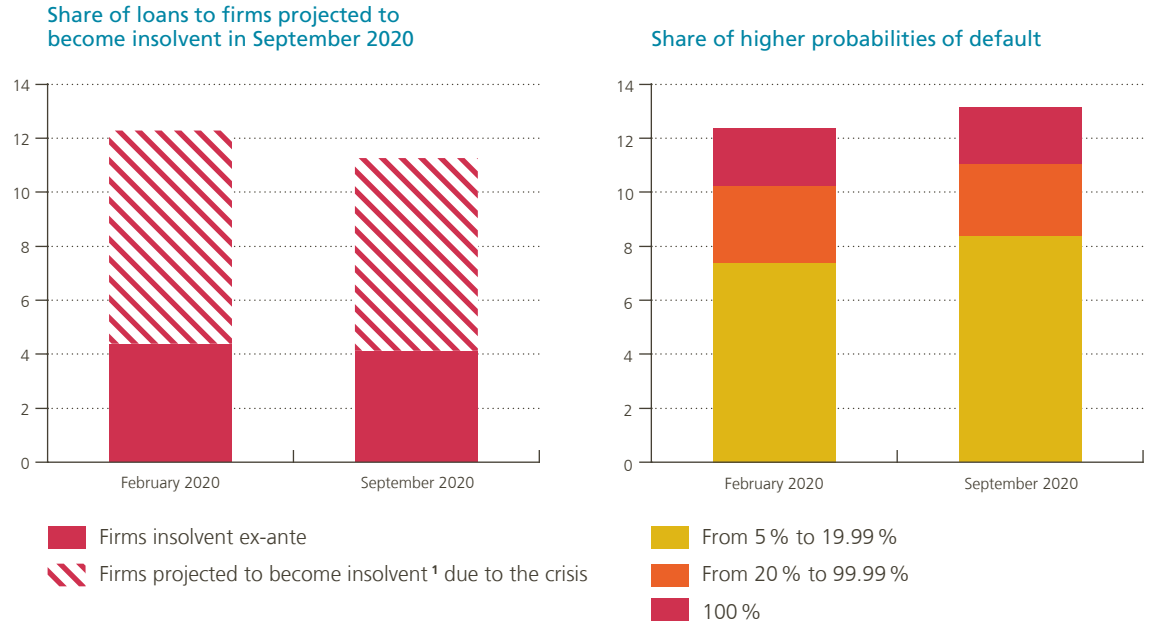
The data from the Central Corporate Credit Register corroborate the difficult access to bank finance by firms likely to be rendered insolvent due to the crisis. The share of these firms in the total outstanding amount of loans granted by Belgian banks to non-financial corporations has slightly declined during the first wave of the pandemic, from 7.9 % in February 2020 to 7.1 % in September (see chart 16). Hence, while banks have been important in keeping many firms afloat by providing the cash needed during the first wave of the pandemic, they seem to have contained the share of those characterised by negative equity in their credit portfolio. This apparent conservatism is not surprising as credit institutions are subject to prudential rules designed to mitigate the risk entailed by poorly collateralised loans and associated with a high probability of default. Moreover, firms considered as 'undertakings in difficulty', according to the definition set by the EU that includes a threshold on accumulated losses, are explicitly excluded from the second State-guarantee scheme adopted in July 2020. Of course, firms whose equity has turned negative due to accumulated losses (and whose DTA ratio is therefore larger than 1) are *a fortiori* undertakings in difficulty within the meaning of the EU definition.

Overall, the riskiness of Belgian banks' corporate loans did not appear to have risen significantly during the first wave of the pandemic. Chart 16 documents that the share of riskiest loans, i.e. those with a probability of default higher than 5 % rose barely from 12 % to 13 % between February and September 2020, which points to a recent, but very moderate, rise in credit risk. Furthermore, the share of high-risk loans (with probability of default equal to 20 % of more) and non-performing loans (to which a probability of default of 100 % is assigned) has remained stable over that period.

Chart 16

Share of riskier loans in Belgian banks' corporate credit portfolio

(% of total used credits)



Source: NBB.

1 A firm is considered insolvent if its debt-to-asset ratio is larger than 1.

Conclusion

The COVID-19 crisis has taken its toll on the Belgian corporate sector. A sudden drop in revenues and imperfect downscaling of costs has put considerable pressure on firms' cash buffers. In order to alleviate liquidity concerns, Belgian policy-makers have acted swiftly to support the corporate sector and stepped up efforts as the pandemic unfolded.

In this article, we document the pockets of corporate liquidity and solvency risk and examine the role of various policy measures taken to keep businesses afloat. We show that the support measures taken have successfully dampened cash outflows of firms. Temporary unemployment alleviated liquidity stress across the board. Nuisance/compensation premia mostly relieved liquidity concerns of small firms whereas initiatives involving the financial sector (mainly debt moratoria) principally supported larger firms. While the support measures successfully patched liquidity concerns in the short run, part of this aid has leaked to firms that strictly did not need support or did not run viable business operations prior to the pandemic. In parallel to government-coordinated policy measures, the private banking sector is shown to have acted to some extent as a (prudent) lender of first resort. Despite these observations, approximately one out of six non-financial firms are estimated to remain with pressing cash deficits attributable to the pandemic prior to the start of the second wave. These firms had to resort to payment extensions and/or an additional non-bank funding (e.g. through intra-group mobilisation of funds through cash pooling).

Our analysis documents a non-trivial rise in solvency risk. Losses caused by the COVID-19 crisis have severely eroded many firms' equity in the most affected sectors, and replenishing their cash reserves would involve a substantial rise in their indebtedness in the absence of alternative financing sources. Importantly, even profitable firms with a solid balance sheet prior to the pandemic are not immune to this concern and might spiral into bankruptcy should they not obtain an additional financing. It is therefore very likely that a large share of Belgian firms will start the recovery period with deleveraging pressures, which can have negative consequences on these companies' ability to carry out investment plans, dragging down productivity and growth. In this context, and in the face of the second wave of the pandemic, the policy focus should gradually shift from safeguarding firms' liquidity to maintaining their solvency. The purpose should be to secure debt restructuring where it is appropriate and/or access to external long-term financing they might need for the continuation of their operations, as well as for their future development.

Furthermore, to effectively accompany the recovery phase, current policies in place to ease access to credit should be matched with enhanced instruments for (long-term) equity-type financing. However, in the Belgian context it is not straightforward to find effective equity instruments, especially for SMEs whose owners are often reluctant to allow external ownership. Alternative financing vehicles and instruments such as long-term subordinated loans can be considered for strengthening viable firms' solvency and enabling them to invest and grow further. In that regard, the initiatives recently taken by Regional governments to increase the lending capacity of their investment vehicles are a first step in that direction. Moreover, in order to stimulate equity investment, the current notional interest deduction framework could be revisited.

Finally, from an economic policy point of view, there is scope for a more discretionary approach to ensure an effective use of the public funds intended to support businesses: on the one hand, in order to avoid allocating real and financial resources to non-viable firms – a phenomenon known as 'zombification' – and, on the other hand, to support viable businesses that would not be able to obtain the funds they require from other financing channels, such as traditional bank lending, due to a potential debt overhang. Support could also be tailored in such a way that it is larger for firms injecting additional capital and firms that have business plans anchored to the 'new normal'. Such 'smart conditionality' – linking support to steps that enhance firms' longer-term resilience, like digitalisation or the adoption of new business processes – can be a way to preserve activity while strengthening firms' perspectives going forward.

Annex A: Analytical framework

This annex sketches the main ingredients of the liquidity and solvency analysis. The framework parallels other policy work (OECD (2020), European Commission (2020a,b), Bank of Italy (2020), Centraal Planbureau (2020)) and is related to a set of academic contributions (De Vito & Gomez (2020), Schivardi & Romano (2020), Mirza *et al.* (2020), Carletti *et al*. (2020)). We improve on these existing frameworks in view of (i) the rich and timely nature of the available Belgian data and (ii) the specific Belgian context (e.g. support measures, Belgian accounting templates, etc.). For the sake of tractability, we focus on the conceptual nature of the framework and sidestep many operationalisation details. The data used for calibration/estimation of the framework are detailed in Annex B. Annex C gauges the impact of the most important modelling assumptions.

A.1 Liquidity

At the core of the liquidity analysis is the following firm-level dynamic equation (where the firm identifier is implicitly understood and subscript m refers to the end of a particular month):

$$\begin{aligned} & Cash\,balance_{m-1} \\ & + Normal\,cash\,flows_m \\ & + Abnormal\,cash\,flows_m \\ & + Support\,measures_m \\ & = Cash\,balance_m \end{aligned} \tag{1}$$

This equation iteratively produces the cash balance available at the end of the month, starting from a cash position at the end of the previous month and accounting for three types of net cash flows that accrue throughout the month. First, $Normal\,cash\,flows_m$ are monthly net cash flows that materialize in normal (non-crisis) times. Second, $Abnormal\,cash\,flows_m$ are monthly net cash flows that arise in the context of an unexpected shock (*in casu*, the COVID-19 crisis). Third, $Support\,measures_m$ are net cash flows obtained by the firm through various policy interventions. If the cash balance turns negative at the end of the month, the firm is flagged to have a cash requirement. Formally,

$$Cash\,requirement_m = -Min\{0, Cash\,balance_m\} \tag{2}$$

Equations (1) and (2) have a few interesting features. First, a firm can structurally 'burn cash' (as would be captured by a negative $Normal\,cash\,flows_m$) and therefore might start to signal a cash crunch irrespective of the COVID-19 crisis. Second, a firm can be severely affected by the crisis (i.e. feature a large negative $Abnormal\,cash\,flows_m$) but would not show liquidity strains if it had started out from a comfortable initial cash position. Third, a cash requirement points to a shortage of sufficient cash, but a firm might also have a fragile liquidity position despite not having a formal cash requirement in equation (2). Fourth, by including the term $Abnormal\,cash\,flows_m$, we can isolate the marginal impact of the COVID-19 crisis which is not confounded with liquidity concerns that would arise for some firms in 2020 without the occurrence of the crisis.

The analysis starts with an initial amount of cash held by firms at the end of February 2020 (the start of the crisis in Belgium – see subsection 1.1). For that purpose, we make the reasonable assumption that the last available annual accounts data (for most firms, 31st December 2019) reflects the financial situation at the end of February 2020. The remaining challenge of the framework is to estimate/infer the three net cash flow entries in equation (1). Below, we discuss their measurement.

Normal cash flows

Conceptually, the purpose is to quantify the monthly normal cash flows that would have accrued in 2020. The qualification 'normal' implies that these cash flows would have reasonably materialized had the COVID-19 outbreak not occurred. By and large, they are a mapping of historical cash flows (2019 and earlier) to 2020. In view of this objective, we decompose $Normal\,cash\,flows_m$ as follows:

$$\begin{aligned} Normal\,cash\,flows_m &= Sales_m \\ &- Inputs_m \\ &- Wages_m \\ &+ Financial\,revenues_m \\ &- Interest\,payments_m \\ &- Current\,taxes_m \\ &+ Deferred\,taxes_m \\ &- \Delta Working\,capital\,requirement_m \\ &- Investment_m \\ &+ \Delta Debt_m \end{aligned} \tag{3}$$

where $Sales_m$ reflects turnover from normal business operations (selling of goods and services) and $Inputs_m$ captures an array of various cash outflows (procurement of intermediates, services, commodities, etc.). $Wages_m$ is set to capture the monthly wage bill, including social security contributions. $Financial\,revenues_m$ encompasses financial revenues (e.g. interests accruing from a bank account or dividends paid to a mother company by its affiliates). $Interest\,payments_m$ denotes interest payments on debt. The change in working capital requirement corresponds to the difference between the changes in current assets and current liabilities (i.e. $\Delta Working\,capital\,requirement_m = \Delta Current\,assets_m - \Delta Current\,liabilities_m$) and accounts, among other things, for deferred payments and receivables. $Current\,taxes_m$ reflects current taxes due whereas $Deferred\,taxes_m$ captures taxes due but which have not yet been paid. The former is defined as

$$\begin{aligned} Current\,taxes_m = (&Sales_m - Inputs_m - Wages_m + Financial\,revenues_m - Interest\,payments_m \\ &- Depreciation_m) \times \tau \end{aligned} \tag{4}$$

with τ as the applicable corporate income tax (CIT) rate and CITs are paid only when earnings are positive [1]. While the aforementioned summands in equation (3) are subject to forces that typically fall outside the discretion of the firm (e.g. drop in demand, disrupted supply, distorted production capacities due to social distancing/telework, etc.), cash accumulation is also partly determined by its investment expenditures ($Investment_m$) and the changes in its outstanding bank debt $\Delta Debt_m$, which to a larger extent reflect autonomous strategic decisions by the firm.

Abnormal cash flows

The notion of 'abnormality' refers to an unexpected or abnormal change in sales in month t ($\partial Sales_t$), which perturbs the various components of firms' $Normal\,cash\,flows_m$ in month m (with $t \leq m$) [2]. Hence, to construct $Abnormal\,cash\,flows_m$, we first take the first derivative of (3) with respect to $Sales_m$, which yields the following contemporaneous (i.e. $t = m$) expression:

1 Different CIT rates apply for large and smaller firms.

2 In the theoretical development of the framework, we take an exclusively backward-looking perspective, i.e. expectations of future shocks do not drive current decisions (e.g. a decline in investment). Nonetheless, when we bring the framework to the data, such forward-looking behaviour enters the measurement of some of the cash flows already observed.

$$\frac{\partial Normal\,cashflows_m}{\partial Sales_m} = 1 - \frac{\partial Inputs_m}{\partial Sales_m} - \frac{\partial Wages_m}{\partial Sales_m} + \frac{\partial Financial\,revenues_m}{\partial Sales_m} - \frac{\partial Interest\,payments_m}{\partial Sales_m} - \frac{\partial Current\,taxes_m}{\partial Sales_m} + \frac{\partial Deferred\,taxes_m}{\partial Sales_m} - \frac{\partial \Delta Working\,capital\,requirement_m}{\partial Sales_m} - \frac{\partial Investment_m}{\partial Sales_m} + \frac{\partial \Delta\,Debt_m}{\partial Sales_m} \quad (5)$$

The left-hand side expression in (5) denotes the change in $Normal\,cashflows_m$ in month m (expressed in euro) for a one euro abnormal change in $Sales_m$ in month m. On the right-hand side, we make a few assumptions going forward. First, we assume that $\partial \text{Wages}_m / \partial Sales_m = 0$, implying that firms cannot hire/fire labour in the short run. Such an approach seems reasonable in view of the limited time frame of our analysis. As detailed below, lower wage outlays through temporary unemployment enters the analysis via support measures ($Support\,measures_m$ in equation (1)). Second, in a similar vein, $\partial \Delta\,Debt_m / \partial Sales_m$ is stripped from the amounts pertaining to the debt moratorium and state guarantees. Finally, deferred taxes do not change with respect to the current shock ($\partial \text{Deferred taxes}_m / \partial Sales_m = 0$).

Aside from contemporaneous effects in equation (5), one needs to account for changes in future cash flows that arise from a sales shock in the current period. First, todays' variation in investment in equation (5) leads to a change in the size of future fixed-asset depreciation (which impacts future taxes and therefore future cash flows). Second, a change in debt in equation (5) causes a change in future interest charges. This dynamic implication of an unexpected shock to sales in month t on future cash flows in month m $(m > t)$ is given by the differential

$$\frac{\partial Normal\,cashflows_m}{\partial Sales_t} = -\frac{\partial Current\,taxes_m}{\partial Sales_t} - \frac{\partial Interest\,payments_m}{\partial Sales_t} \frac{\partial Investment_t}{\partial Sales_t} \times \delta \times \tau - \frac{\partial Interest\,payments_t}{\partial Sales_t}(1-\tau) \quad (6)$$

where δ is the depreciation rate of fixed assets and is assumed to be constant. Subsequently, adding the derivatives in equations (5) and (6) yields (compactly):

$$Abnormal\,cashflows_m \overset{\text{def}}{=} \sum_{t=1}^{m} \frac{\partial Normal\,cashflows_m}{\partial Sales_t} \quad (7)$$

Or, more elaborate (after rearranging):

$$
\begin{aligned}
Abnormal\,cash\,flows_m = {} & \partial Sales_m \\
& - \frac{\partial Sales_m}{Sales_m} \times \varepsilon_{in} \times Inputs_m \\
& - \frac{\partial Sales_m}{Sales_m} \times \varepsilon_{ct} \times Current\,taxes_m \\
& - \frac{\partial Sales_m}{Sales_m} \times \varepsilon_{ip} \times Interest\,payments_m \\
& + \frac{\partial Sales_m}{Sales_m} \times \varepsilon_{fr} \times Financial\,revenues_m \\
& - \frac{\partial Sales_m}{Sales_m} \times (\varepsilon_{\Delta ca} \times \Delta Current\,assets_m - \varepsilon_{\Delta cl} \times \Delta\, Current\,liabilities_m) \\
& - \frac{\partial Sales_m}{Sales_m} \times \varepsilon_i \times Investment_m \\
& + \frac{\partial Sales_m}{Sales_m} \times \varepsilon_{\Delta dbt} \times \Delta\, Debt_m \\
& - \sum_{t=1}^{m-1} \frac{\partial Sales_t}{Sales_t} \times \varepsilon_{ip} \times Interest\,payments_t \times (1-\tau) \\
& + \sum_{t=1}^{m-1} \frac{\partial Sales_t}{Sales_t} \times \varepsilon_i \times Investment_t \times \delta \times \tau
\end{aligned}
\qquad (8)
$$

Equation (5)

Equation (6)

where the left-hand side captures the change in cash flows in month m, expressed in euro, due to abnormal shocks to sales in all months running up to (and including) month m. The scalar ε is the elasticity of the subscripted variable with respect to $Sales_m$ (e.g. ε_{in} quantifies the percentage change in $Inputs_m$ for a 1 % shock to $Sales_m$).[1] It is instructive to reflect on equation (8).

First, if (a) all the firm's operating costs were fixed ($\varepsilon_{in} = 0$), (b) changes in financial revenues, interest payments and working capital were fully independent from sales ($\varepsilon_{fr} = \varepsilon_{ip} = \varepsilon_{\Delta cl} = \varepsilon_{\Delta ca} = 0$) and (c) the shock to sales did not prompt any change in the firms' investment or borrowing decision ($\varepsilon_i = \varepsilon_{\Delta dbt} = 0$), then the cash flows before taxes would decrease by the same amount as the decrease in sales. However, if the firm can scale down its production, reduce its operating costs, decrease its working capital requirement and modify its investment strategy when sales decrease, it can partially offset outgoing cash flows. In sum, the elasticities measure the degree of a firm's flexibility to adjust to an adverse shock.

Second, in order to quantify equation (8), one can take two routes. The first one is to estimate the elasticities, impose a sales shock and multiply it by the historical (i.e. last observed) value of each cash flow element. The second approach is to acknowledge that each summand essentially reflects the abnormal nominal change in each cash flow in month m. If the data are available in a timely manner, one directly observes the summands, sidestepping the need to infer them. Hence, if possible, preference is given to the second approach (discussed in Annex B). Nonetheless, when we simulate the equation beyond the last observable data point (as is done in section 3), we rely on the specification delineated above.

1 In general, an elasticity is defined as $(\partial x/x)/(\partial y/y) \approx (\Delta x/x)/(\Delta y/y)$. See Varian (2014) for a textbook treatment.

Support measures

We consider a set of broad-based support measures that aim to improve firm-level liquidity/solvency. Let $Support\,measures_m$ be defined as follows,

$$\begin{aligned} Support\,measures_m = {} & Credit\,moratorium_m \\ & + State\,guarantee_m \\ & + Tax\,policy\,exemptions_m \\ & + Nuisance/compensation\,premia_m \\ & + Temporary\,unemployment_m \end{aligned} \tag{9}$$

where $Credit\,moratorium_m$ captures a loan repayment delay (i.e. an otherwise outgoing cash flow had the loan not been under moratorium). $State\,guarantee_m$ reflects new loans and credit lines granted under the State guarantee. $Tax\,policy\,exemptions_m$ encompass a non-exhaustive set of tax exemptions (such as the one-off carry-back regime, the exemption of the withholding tax and the additional investment deductibility). $Nuisance/compensation\,premia_m$ and $Temporary\,unemployment_m$ capture cash flows granted in the context of forced closure (or material sales declines) and temporary idle personnel, respectively. While the policy details are discussed in the body of the text, additional information on their operationalisation is included in Annex B.

A.2 Solvency

Our assessment of firms' potential solvency issues is based on a hypothetical snapshot of their balance sheet at the end of month M (*in casu* $M = 7$, September 2020, i.e. seven months after the initial activity shock in March). For that purpose, we derive the end of period M entries of an aggregated balance sheet and simplified profit and loss statement. Their calculation – as well as some of the underlying assumptions – are detailed below.

First, iterating on equation (1) yields

$$\begin{aligned} Cash\,balance_M = {} & Cash\,balance_0 \\ & + \sum_{m=1}^{M} (Normal\,cash\,flows_m + Abnormal\,cash\,flows_m + Support\,measures_m) \end{aligned} \tag{10}$$

where subscript '0' stands for the value before the shock (February 2020). Formally, combing eq. (3), eq. (8) and eq. (10) delivers

$$
\begin{aligned}
Cash\,balance_M = Cash\,balance_0 \\
&+ \sum_{m=1}^{M} EBITDA_m && + \sum_{m=1}^{M} \partial EBITDA_m \\
&- \sum_{m=1}^{M} Interest\,payment_m && - \sum_{m=1}^{M} dInterest\,payment_m \\
&- \sum_{m=1}^{M} Current\,taxes_m && - \sum_{m=1}^{M} dCurrent\,taxes_m \\
&- \sum_{m=1}^{M} \Delta\, Working\,capital\,requirement_m && - \sum_{m=1}^{M} \partial\,\Delta\, Working\,capital\,requirement_m \\
&- \sum_{m=1}^{M} Investment_m && - \sum_{m=1}^{M} \partial Investment_m \\
&+ \sum_{m=1}^{M} \Delta\, Debt_m && + \sum_{m=1}^{M} \partial\,\Delta\, Debt_m \\
&+ \sum_{m=1}^{M} Support\,measures_m && + Loan_M
\end{aligned}
\tag{11}
$$

where $EBITDA_m \left(= Sales_m - Inputs_m - Wages_m + Financial\,revenues_m \right)$ stands for the earnings before interest, taxes, depreciation and amortisation. If $Cash\,balance_M < 0$, additional funding is needed to close the cash deficit which exists at time M. We assume this additional funding takes the form of bank debt, denoted $Loan_M$, with maturity T. The interests on $Loan_M$ are paid each month and determined by fixed rate, i, and the principal will be repaid in one lump-sum at the maturity $M + T$. The various terms of equation (11) affect other items of the balance sheet as well. Provided that the earnings resulting from the cash flows accumulated over the period considered are not distributed to shareholders, and also taking into account that capital depreciation is deducted from profits, the first term in equation (11) corresponds to the increase or decrease in equity that takes place through the retained earnings:

$$
\begin{aligned}
Equity_M = Equity_0 \\
&+ \sum_{m=1}^{M} EBITDA_m && + \sum_{m=1}^{M} \partial EBITDA_m \\
&- \sum_{m=1}^{M} Interest\,payment_m && - \sum_{m=1}^{M} dInterest\,payment_m \\
&- \sum_{m=1}^{M} Current\,taxes_m && - \sum_{m=1}^{M} dCurrent\,taxes_m \\
&- \sum_{m=1}^{M} Depreciation_m && - \sum_{m=1}^{M} \partial Depreciation_m \\
&+ \sum_{m=1}^{M} Support\,measures_m && - \sum_{m=1}^{M} State\,guarantee_m \\
&- \sum_{m=1}^{M} Moratorium_m
\end{aligned}
\tag{12}
$$

The projected values for the current assets and liabilities are, respectively[1]

$$Current\,assets_M = Current\,assets_0 + \sum_{m=1}^{M} \Delta Current\,assets_m + \sum_{m=1}^{M} \mathbf{I}\left(\partial \Delta Working\,capital\,requirement_m > 0\right) \partial \Delta Working\,capital\,requirement_m \quad (13)$$

and

$$Current\,liabilities_M = Current\,liabilities_0 + \sum_{m=1}^{M} \Delta Current\,liabilities_m - \sum_{m=1}^{M} \mathbf{I}\left(\partial \Delta Working\,capital\,requirement_m < 0\right) \partial \Delta Working\,capital\,requirement_m \quad (14)$$

where $\Delta Current\,assets_m$ and $\Delta Current\,liabilities_m$ denote the monthly changes in current assets and liabilities in normal times. They are unobserved and assumed to be equal. $\mathbf{I}(.)$ is an operator equal to 1 if the condition between parentheses is true and to 0 otherwise. Equations (13) and (14) are formulated this way to avoid negative outstanding amounts.

The bank loans under moratorium are treated as an additional debt, and the outstanding amount of debt at the end of month M is therefore:

$$Debt_M = Debt_0 + \sum_{m=1}^{M} (\Delta Debt_m + \partial \Delta Debt_m + Moratorium_m + State\,guarantee_m) + Loan_M \quad (15)$$

Finally, the stock of non-financial fixed assets is determined by both investment and depreciation:

$$Non\text{-}financial\,fixed\,assets_M = Non\text{-}financial\,fixed\,assets_0 + \sum_{m=1}^{M} \left(Investment_m - Depreciation_m\right) \quad (16)$$

As mentioned above, $Depreciation_m$ is based on a constant depreciation rate, δ, such that $Depreciation_m = \delta Non\text{-}financial\,fixed\,assets_{m-1}$. Financial fixed assets are assumed to remain constant over the projection period. Finally, using (11)-(16), one can show that assets and liabilities balance:

$$Non\text{-}financial\,fixed\,assets_M + Financial\,fixed\,assets_M + Current\,assets_M + Cash\,balance_M = Equity_M + Debt_M + Current\,liabilities_M$$

The projections for the main balance sheet items at the end of month M provide the input needed to compute the debt to assets ratio after the activity shock caused by the pandemic,

$$Debt\text{-}to\text{-}assets\,ratio_M = \frac{Debt_M + Current\,liabilities_M}{Non\text{-}financial\,fixed\,assets_M + Financial\,fixed\,assets_M + Current\,assets_M + Cash\,balance_M}$$

The firm is qualified as insolvent if the value of this ratio exceeds 1. Moreover, note that $Loan_M$, i.e. the additional funding needed to close the cash deficit, at time M, could cause a debt sustainability issue if the firm is unable to generate enough cash flows to service that debt. In order to assess the proportion of these

1 In our simulations, the changes in working capital requirement is entirely attributable to the shock, which means that the 'normal' change that would be observed without the shock is equal to zero ($\Delta Working\,capital\,requirement_m = 0$).

potentially insolvent firms, we project $Cash\,balance_m$ up to time $T+M$ in order to see whether it suffices to repay $Loan_M$ when it comes due. This projection can be written as[1]

$$Cash\,balance_{M+T} = \sum_{m=M}^{M+T} (\overbrace{Normal\,cash\,flows_m}^{Eq.\ (3)} + \overbrace{Abnormal\,cash\,flows_m}^{Eq.\ (8)} + \overbrace{Support\,measures_m}^{Eq.\ (9)} - i \times Loan_M) \qquad (17)$$

The additional debt is considered unstainable if $Cash\,balance_{M+T} < Loan_M$, i.e. if the cash flows generated by its activity between M and $M+T$ exceed the reimbursement of the principal when due at time $M+T$.

1 In the absence of observed data beyond M, a few additional assumptions are required. First, with respect to $Support\,measures_m$, we account for the dynamics of support measures currently known to us (subject to change in the face of the second wave). Second, as regards $Abnormal\,cash\,flows_m$, we by and large rely on eq. (17), which is determined entirely by a projected path of sales growth. To that end, we impose the GDP recovery path as projected by the December 2020 NBB BMPE (broad macroeconomic projection exercise) on firm-level sales growth.

Annex B: Data and variable measurement

This section describes how we quantify the summands of the equations in our framework. To that end, we join a large set of publicly available and confidential data sources.

Table B.1

Equation	Summand	Measurement / Source
(3)	$Financial revenues_m$; $Interest payments_m$; $Current taxes_m$; $Deferred taxes_m$; $Wages_m$; $\Delta Current liabilities_m$; $Current assets_m$	Taken from the annual accounts.
(3)	$\Delta Debt_m$	Taken from the central corporate credit register.
(3)	$Sales_m$; $Inputs_m$; $Investment_m$	Taken from the annual accounts. Most firms are not required to report $Sales_m$, $Inputs_m$, $Investment_m$. For these firms we rely on confidential VAT filings to impute missing values.

We assume that the last observable annual cash flow is representative for the annual cash flow in 2020 (results are similar when using alternative projection methods). However, provided that most of the entries in (3) are reported on an annual basis, we need to map the annual flow to the monthly frequency. To that end, we impose monthly seasonality factors obtained by monthly VAT returns. Such seasonality corrections are instrumental. They account for the fact that the business volumes of many firms are not equally spread over the year, but biased towards particular periods (e.g. the airline sector during the summer, retail during the regulated 'sales season' organised in January/July, indoor playgrounds during the winter/fall, etc.).

Table B.2

Equation	Summand	Measurement / Source
(8)	$Sales_m + \partial Sales_m$ $Inputs_m + \frac{\partial Sales_m}{Sales_m} \times \varepsilon_{in} \times Inputs_m = Inputs_m + \partial Inputs_m$ $Investment_m + \frac{\partial Sales_m}{Sales_m} \times \varepsilon_i \times Investment_m =$ $Investment_m + \partial Investment_m$	Directly observed from monthly confidential firm-level VAT data running up to September 2020. Importantly, observing $Inputs_m + \partial Inputs_m$ implies that we do not need to take a stand on which costs are fixed and which are variable, a non-trivial issue in the Belgian annual accounts (Abraham *et al.*, 2020). Observing $Investment_m + \partial Investment_m$ implies that we observe the (mostly) downscaling of investment decisions. $\partial Sales_m$, $\partial Inputs_m$ and $\partial Investment_m$ are inferred by subtracting the values from table B.1.
(8)	$\frac{\partial Sales_m}{Sales_m}$	Directly observed from firm-level confidential VAT data.
(8)	$\varepsilon_{\Delta ca}; \varepsilon_{\Delta cl}; \varepsilon_{\text{fr}}$	Firm-level estimates based on historical annual accounts data. Elasticities are month specific to account for seasonal factors.
(8)	$\Delta Current assets_m; \Delta Current liabilities_m;$ $Financial revenues_m$	Annual accounts data (table B.1).
(8)	$\partial Depreciation_m = \delta \times \partial Investment_m$	δ is estimated based of firm-level medians using annual accounts data
(8)	$\frac{\partial Sales_m}{Sales_m} \times \varepsilon_{ct} \times Current taxes_m = \tau \times (\partial Sales_m - \partial Inputs_m - \partial Depreciation_m - \partial Interest payments_m)$	Directly inferred from firm-level confidential VAT data.
(8)	$\Delta Debt_m + \frac{\partial Sales_m}{Sales_m} \times \varepsilon_{\Delta dbt} \times \Delta Debt_m = \Delta Debt_m + \partial \Delta Debt_m$	The Central Corporate Credit Register documents all new bank credit on a monthly basis.
(8)	$\frac{\partial Sales_m}{Sales_m} \times \varepsilon_{ip} \times Interest payments_m = \partial Interest payments_m = i \times \partial \Delta Debt_m$	The interest rate is the geometric mean of the MIR-MFI interest rate statistic.
(8)	$\frac{\partial Sales_t}{Sales_t} \times \varepsilon_{ip} \times Interest payments_t \times (1-\tau) =$ $i \times (1-\tau) \times \partial \Delta Debt_t$	Cf. supra.
(8)	$\frac{\partial Sales_t}{Sales_t} \times \varepsilon_i \times Investment_t \times \delta \times \tau = \tau \times \delta \times \partial Investment_t$	Cf. supra.

Various measures taken by the Belgian authorities in order to prevent businesses from running out of cash are also accounted for:

Table B.3

Equation	Summand	Measurement / Source
(9)	$Credit\ moratorium_m$ $State\ guarantee_m$	Firm-level credit under moratorium as well as new State-guaranteed credit are reported in BECRIS (Belgian Extended Credit Risk Information System), as well as the accompanying date. $State\ guarantee_m$ is defined as the new credit volume under the guarantee scheme. $Credit\ moratorium_m$ is the amount of the monthly loan repayment that is postponed. For details, see NBB (2020a).
(9)	$Temporary\ unemployment_m$	The total firm-level number of firm-level FTEs is taken from the most recent social balance sheet of firms. The number of firm-level FTEs that are temporary unemployed are obtained from the National Employment Office. We apply the fraction of the temporary unemployed workforce to the wage bill reported in 2019Q4.
(9)	$Nuisance/compensation\ premia_m$	Firms which (i) experienced a reduction in turnover of more than 60 % (vis-à-vis the same period last year) or (ii) are forced to fully close down for security measures are entitled to a nuisance premium. We do not observe these payments, but assume firms apply for the premium if they are eligible to do so. As such, we tag firms in the category (i) if their sales-drop, as reported in VAT filings, is more than 60 %. Firms are allocated to category (ii) if the firm experiences a sales-drop of 100 % or files for temporary unemployment of the full workforce. The size of the premium varies across regions.
(9)	$Tax\ policy\ exemptions_m$	*Loss carry back regime.* Companies' expected losses in income year 2020 can be deduced from the positive result of the prior financial year. This reduces the CIT payable in 2020. In order to apply, firms are required to estimate these income losses. We extrapolate the already observed losses from the VAT data to the full accounting year and assume the firm maximally files for this carryback scheme if eligible to do so. *Exemption withholding taxes.* To incite re-employment of temporary unemployed in heavily affected sectors, employers are subsidized through an exemption of the payment of part of the withholding tax on wages. More specifically, in June, July and August, 50 % of the increase in withholding taxes compared to what was paid in May 2020, will not have to be paid to the government. This amount can be inferred directly from the firm-level temporary unemployment data. *Investment deduction.* We apply the increased investment reduction on new procurement of investment goods.

Annex C: Main assumptions

We state a set of limiting factors to our analysis and gauge their impact on our estimates.

Assumptions that lead to an overestimation of the cash deficit

i. While we account for temporary unemployment, we impose that the size of the incumbent labour force cannot be adjusted in the short run by firing/hiring. Such an assumption seems reasonable given the limited time frame of our analysis but implies that the framework would be unsuitable for long run projections.

ii. As per the discussion in the body of the text, we only consider a subset of the support packages. While we focus on those measures with the largest budgetary impact, other (niche) support measures can potentially alleviate cash deficits for firms as well.

iii. While we (a) *ex ante* exclude 'dormant firms' from the analysis (i.e. firms that have not filed VAT declarations in the last two years while legally required to do so) and (b) drop entities from March onwards as soon as their bankruptcies are reported in the crossroads-bank-of-firms, we mechanically compound liquidity needs of firms that are formally not yet bankrupt but have nonetheless decided so cease operations.

Assumptions that lead to an underestimation of the cash deficit

i. We focus on firm listed in sector S11 (ESA definition, p.16, 2008), broadly defined as "[…] institutional units which are independent legal entities and market producers, and whose principal activity is the production of goods and non-financial services". In addition, as their behavior is likely not to be governed by the framework developed in this article, we further exclude entities in NACE section K (Financial and insurance activities), O (Public administration and defence: compulsory social security), P (Education), T (Human health and social work activities), Q (Activities of households as employers) and U (Activities of extraterritorial organisations and bodies). Finally, due to data constraints, we focus on entities that file annual accounts. Given these restrictions, a set of entities who have legitimate liquidity and solvency concerns fall outside the scope of the analysis.

ii. The "COVID-19 crisis scenario, without policy interventions" scenario in section 1 aims to quantify the incidence of cash deficits among firms without policy measures (taken in board in section 2). However, our analysis relies on actual sales data running up to September, which reflects indirect policy measures that stimulated household demand (e.g. moratorium for mortgage debt, consumption cheques, etc.). This potentially contaminates the "COVID-19 crisis without policy interventions" scenario with indirect policy measures and therefore already attenuates the liquidity concern.

Assumptions with an ambiguous effect on the cash deficit

i. The analysis takes as a starting point the latest available annual accounts data as a proxy for the actual situation at the start of the crisis. While such an assumption is reasonable for firms that have filed their annual accounts in 2019, for one out of four firms we rely on more outdated annual accounts filed in 2018.

ii. Part of the analysis relies on estimated elasticities. Provided that elasticities reflect historical behaviour, the question remains as to what extent current behaviour is still governed by these point estimates. E.g. $\varepsilon_{\Delta ca}$ reflects the firms trade credit policy vis-à-vis customers. It might be that, in the context of the COVID-19 crisis, firms tighten their trade credit policy beyond what is implied by the estimated elasticity.

iii. We focus on incumbent firms. New firms, which have entered in the course of 2019 and 2020 which have not yet filed annual accounts, are not included in the estimation.

Annex D: Sector classification

The next table lists the NACE codes and number of firms within each sector.

Sector	NACE code	Number of firms (March 2020)
Agriculture, forestry and fishing	01, 02, 03	5 874
Manufacturing	10-33	22 045
Construction	41-43	54 492
Retail trade of food products	472	4 490
Retail trade of non-food products	451, 453, 454, 471, 473-479	41 733
Accommodation	55	2 413
Food and beverage services	56	22 240
Real estate	68	35 901
Creative activities, arts and culture	90-91	2 196
Sports and recreation	93	3 462
Hairdressing, beauty and wellbeing	9602, 9604	4 043

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