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MONEY IN COVID TIMES

A primer on central bank response measures to COVID-19

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MONEY IN COVID TIMES: A PRIMER ON CENTRAL BANK RESPONSE MEASURES TO COVID-19

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Foreword

Since 2000, we have experienced an unprecedented number of market and economic disruptions of significant magnitude. As financial technology advances and the flow of economic information continues to accelerate, more frequent and sharper disruptions may be the new normal. The latest COVID-19 crisis exemplifies this as both market and prudential regulators were forced to take a more immediate and expansive approach to maintaining economic stability. That approach now includes a range of tools that challenge the boundaries of traditional fiscal and monetary policy actions.

The authors pose the right question—is central bank policy orthodoxy a thing of the past? If so, what are the new limits? If not, what is the path to normalization? We find ourselves at an important inflection point for the design of potential future global economic policy to deal with liquidity crises, global market contagion, or other systemic shocks. This report helps frame those key policy considerations.

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1. Executive Summary

This paper, "Money in COVID Times," is an analysis of how the role of central banks in the market and the economy has changed since 2008. From this perspective, the COVID-19 situation has only exacerbated the transformation of central banks into entities that act as lender and market maker of last resort, every time markets experience a level of stress that could reverberate across money markets, including credit and financial assets used as collateral. Together, the various stratums of money markets have replaced traditional banks as a supply chain for capital markets activity.

These questions are important for investment professionals and CFA® charterholders because of the impact monetary policy is now having on the market economy, the availability or scarcity of financial assets, and the natural price formation mechanism.

CFA Institute recently released the results of research focused on the effects of the COVID-19 crisis for capital markets and the investment industry.[1] This research was based on a survey of the CFA Institute global membership, constituted in large part of industry professionals whose expertise we sought to gauge more precisely how markets have reacted to the crisis and the authorities' response.

A significant portion of this research concentrated on the unprecedented nature and scale of the monetary stimulus enacted by central banks as a response to the market shock wave caused by the economic lockdown measures, which had been enacted by governments around the world to face the health crisis. Our research shows that market professionals, in general, and CFA Institute members, in particular, are divided on the new prominent role that central banks have assumed in the economy since the 2008 global financial crisis.

Several themes have emerged:

- At which point should central banks consider that the time is right to normalise monetary policy in line with the economic cycle?
- Should monetary policy and fiscal policy be coordinated?
- How important is central bank independence?
- Is there an objective limit to the extent of monetary stimulus?

[1] See CFA Institute, *Covid-19, One Year Later* (June 2021), https://www.cfainstitute.org/research/survey-reports/covid19-one-year-later-report.

Recent financial crises (2008, 2010, 2020) have shown that the typical maturity transformation process at the heart of the intermediation that the finance industry provides to the broader economy has shifted. Market-based finance has risen in prominence as a primary source of funding. Market-based finance – or non-bank financial intermediation – describes the funding of capital markets lending through short-term money markets, which constitutes the maturity transformation at the core of the market-based credit system. This system has also been called shadow banking.

Through an understanding of the hierarchy of money, we also appreciate how the shift to a market-based financial system has made crises more dependent on central banks assuming the role of market maker of last resort. Only central banks have the capacity to produce the most desirable type of money to stabilise collateral asset markets and keep the system afloat. In this paper, we posit that this is what happened in the spring of 2020 in the United States when the Federal Reserve intervened. We are lifting the veil on the origin, the nature, and the impact of modern central bank interventionism. Understanding the hierarchy of money in times of crisis along with the tenets of market-based finance may lead us to reconsider our traditional acceptance of central banks' role in financial markets and the economy at large. It may be the case that the current drive of accommodative monetary policy has simply become the new normal in a complex system that requires central banks to take on a more direct responsibility in the running and stabilisation of financial markets.

2. Introduction

In March 2020, for the second time in living memory, central banks around the world acted in concert to launch large policy response measures in reaction to a crisis. Many of the measures enacted in response to the COVID-19 pandemic in March 2020 were the same or similar to those created in response to the 2008 financial crisis. The size of these measures, however, was typically larger than in 2008, and they came in an environment in which the 2008 interventions had yet to be fully unwound in a sustainable way. In many quarters, this raised the level of concern regarding the increasing role central banks were playing in more and more markets.

In this report, we explain why central banks (as an aggregate) intervened in the manner that they did both in 2008 and 2020, which subsequently will further understanding of the increasingly central role they play in the markets in which CFA charterholders work. Specifically, we will outline the following:

- The worldview of money as a form of hierarchical credit
- The importance of market-based finance in ensuring credit flow
- The key markets in market-based finance
- The theory and practice behind central bank interventions in these markets
- The way in which COVID-19 was an illustration of this worldview in action

These topics are of key importance for CFA charterholders to understand now that central banks will be intervening in markets for the foreseeable future.

3. The hierarchy of money

The hierarchy of money formalises a certain aspect of money that should be intuitive on a day-to-day basis, especially to those living in countries with unstable local financial systems. Specifically, that during almost any kind of crisis, different types of money take on noticeably different values than they did during calmer periods.[2] For example, during a banking crisis, cash can be said to be better than a bank deposit. This fact can be seen on display during a bank run. A bank deposit insured by certain governments, however, may be as good as cash and definitely better than a deposit in an uninsured bank account. Similarly, cash in the world reserve currency (the US dollar) is often more desirable (better) than cash in local currency. This fact can be observed in markets that have unofficially "dollarized." Although a crisis distils this hierarchy of money, it typically is blurred during prosperous periods when functioning money markets allow all of these types of money to be easily exchanged like for like (i.e., at purchasing power parity level).

The money hierarchy is critical to understand the inner workings of financial crises as well as government and central bank responses to those crises. As Mehrling (2012) notes, in the past, the bullion reserve and discount rate on bills were key inputs in determining the health of money and money markets. Today, however, investors need to know about repo liquidity and central bank swap facilities to understand what is happening in financial markets.

The hierarchy of money changes depending on the frame of the observer—that is, their location in that hierarchy. For example, retail savers would consider on-demand bank deposits as their primary means of settlement and thus of money (redeemable on demand), while their term deposits and debt securities holdings ultimately are a promise to be paid at a future date—these are all considered as forms of credit according to a given term structure. For their bank, however, the means of settlement is so-called high-powered money, which includes national currency and reserves at the central bank. For a typical country, national currency is of limited value to settle its accounts with other countries. Therefore, the US dollar, gold, or special drawing rights are the international means of settlement.

[2] P. Mehrling, "The Inherent Hierarchy of Money" (Barnard College, Columbia University, 2012), http://sites.bu.edu/perry/files/2019/04/Mehrling_P_FESeminar_Sp12-02.pdf.

It is true to say that, at this point in time, the US dollar, and particularly reserves at the Federal Reserve, are the ultimate source of settlement and thus of money for most participants in the global financial system. The power of the central bank, particularly the Federal Reserve, stems from the fact that its liabilities (i.e., national currency and reserves) are at the top of the money hierarchy. Only the Federal Reserve, in concert with the US Treasury, can create the highest form of money: US dollars in the form of currency and reserves.

4. Dealers as the stairs in the money hierarchy

At every level of the money hierarchy, market makers (i.e., dealers) quote two-way prices at which they will exchange credit (i.e., money-like claims lower down the hierarchy) for money (i.e., money-like claims at their level of the hierarchy).

For example, the familiar security dealer will buy or sell a security at a given price (the bid–ask spread) in terms of money. Similarly, banks can be thought of as security dealers that will buy or sell a deposit in terms of currency. Typically, the exchange rate in this case will be 1. Central banks during the era of the gold standard were security dealers that would buy or sell domestic currency in terms of gold.

In essence, this two-way quoting of prices (money) for assets or credit in the money hierarchy simply reflects the liquidity of the given asset or credit. Liquidity – the ease of converting something into cash – is the distinguishing characteristic of the different forms of credit in the money hierarchy.

The more liquid an asset or credit, the easier it is to convert into cash, and thus the more money-like it is. The liquidity of an asset or credit is a function of the breadth and depth of ready buyers and sellers in the given market. Market makers carrying inventory of a given financial instrument quote two-way prices that reflect the risk of carrying that inventory and the ease with which it can be converted into cash; the more liquid the asset, the narrower the spread between the bid and ask prices quoted by the market maker. Less liquid assets or credit (lower down the money hierarchy) have a narrower or shallower pool of ready buyers and sellers, and thus trade at wider quoted spreads to compensate dealers for the liquidity risk associated with their inventory management.

During calm financial periods, when liquidity is abundant, market makers ensure that these two-way markets blur the differences among the levels of the money hierarchy. Conversely, during turbulent financial periods, the desire to reduce one's own risk exposure (i.e., flight-to-safety) causes the exchange prices among these different levels of the hierarchy to vary more significantly. Put differently, for all assets or credit other than the most liquid (cash), spreads widen; the further down the money hierarchy, the wider the spread. This phenomenon is exacerbated in turbulent financial periods to the extent that demand for the most liquid of instruments (cash or money at the top of the hierarchy)

increases, while demand for credit lower down the hierarchy decreases. Consequently, the spread at each level of the hierarchy, and between levels of the hierarchy, increases.

Security dealers have position limits, however, and therefore cannot endlessly accommodate the sale of securities in exchange for money, whatever the price on offer. Banks similarly are not able to make markets in money when the order flow is all one way. For one thing, banks have their own risk tolerances, profit motives, and survival constraints. In addition, banks face prescriptive regulatory limits on the form of their assets and liabilities. During the gold standard era, central banks could not always honour gold convertibility in the face of significant international claims.

If the financial crisis is severe enough, the market maker may simply refuse to pick up the phone and banks may close their branches. Every market participant wants the best form of money at the same time and the market breaks down. This illiquidity uncovers the fact that what people thought of as money previously was actually only credit, and true money is in short supply.

Fortunately, what is money at one level in the hierarchy is credit for the level above. For this reason, the typical prescription for financial panics when every market participant wants the best form of money is expansion of the money-like claim at the highest level of the money hierarchy. Typically, this manifests itself as the central bank expanding the money supply, acting as the lender of last resort. In the most severe of financial circumstances, this situation can escalate even beyond the level of central bank liquidity provision to include state-backed capital injections (solvency provision) – the much-maligned bank bailout.

5. Market-based finance and the role played by non-bank financial intermediaries

A traditional bank is backstopped, in the case of the United States, by the Federal Deposit Insurance Corporation (FDIC), which insures the deposits and therefore the solvency of the bank. The Federal Reserve, as a lender of last resort, provides the liquidity backstop. In the modern financial system, however, large parts of the maturity transformation and capital funding traditionally conducted by banks is executed by a web of money market participants—collectively referred to as non-bank financial institutions or intermediaries (NBFI). This alternative financing system has also been referred to as shadow banking[3]. What, if any, are the backstops for this system?

Market-based finance is money market (wholesale) funding of capital market (local, foreign exchange [FX]) lending. It is one of the central channels of credit in the modern financial system, although not to the same extent as before the 2008 financial crisis, which has triggered a wave of prudential regulation aimed at curtailing banks' capacity to repurpose their balance sheets to fund their proprietary market activities.

Mehrling provides the following conceptual picture of the platonic market-based credit system (pre-2008):[4]

1. The non-bank financial intermediary funds its capital market lending (e.g., the ownership of residential mortgage-backed securities, RMBS) by raising finance in the short-term money markets. This is the maturity transformation at the heart of the market-based credit system. Because RMBS are not likely to be able to be used as collateral in short-term money market borrowing, some additional steps are required.

[3] The terms market-based finance and shadow banking refer to the same concept. Throughout this document, we rather use the former as well as the term non-bank financial institutions (NBFIs) when referring to the entities themselves. Yet, the authors we quote may use the term shadow banking.

[4] P. Mehrling, "Three Principles for Market-Based Credit Regulation" (Barnard College, Columbia University, 2012), https://ieor.columbia.edu/files/seasdepts/industrial-engineering-operations-research/pdf-files/Mehrling_P_feseminar_Sp12-01.pdf.

2. By purchasing protection against default and adverse interest rate or FX rate moves—credit default swaps (CDS), interest rate swaps (IRS), and foreign exchange swaps (FXS), respectively—the NBFI's RMBS holdings have been stripped of these risks and are left, in theory, with only the risks associated with rolling over the short-term funding that is financing these holdings.

3. The combination of RMBS, CDS, IRS, and FXS creates a quasi-risk-free security that is then used as collateral for money market funding. The funding source in the money market is an asset manager who holds customer capital that is getting risk exposure by investing in derivatives (such as CDS, IRS, and FXS).

In Mehrling's (2012) conceptual picture, the asset manager's assets (customer capital) are the funding liabilities of the NBFI, while the asset manager's liabilities (derivatives exposures) are the derivatives assets of the NBFI system.[5]

Between the NBFI and asset manager are the market makers who enable this funding scheme to exist, described by Mehrling (2014) as the global money dealer (GMD) and the derivatives dealer (DD).[6] In Mehrling's conceptual model, both GMDs and DDs are "matched book" dealers that do not engage in proprietary trading:

> "The global money dealer makes two-way repo markets that enable the shadow bank to borrow from the asset manager using its quasi-risk-free security as collateral. The derivatives dealer makes two-way markets in CDS, IRS, and FXS that enable the shadow bank to purchase insurance and the asset manager to purchase exposure."

The point of this conceptual model is to show that in the system of market-based finance it would not be possible for this funding and maturity transformation to occur without the central role of dealers that make two-way markets.

The question naturally arises: if either was to cease making markets and enabling the NBFI to roll over its funding, what would happen to the NBFI's RMBS holdings?

[5] P. Mehrling, "Three Principles for Market-Based Credit Regulation."
[6] P. Mehrling, "Why Central Banking Should Be Re-imagined," in "Re-Thinking the Lender of Last Resort," BIS Paper #79, Monetary and Economic Department (Bank for International Settlements, 2014), p. 108–118, http://www.bis.org/publ/bppdf/bispap79.htm.

The answer was given, of course, by the events of 2008 and is outlined neatly in Mehrling (2011).[7] AIG, the DD in Mehrling's conceptual model, ceased to make markets in CDS in September 2008 once it realised it had been mispricing this risk. This mispricing meant that the quasi-risk-free securities were no longer quasi-risk free, which in turn meant that the big banks (the GMDs) were no longer willing to make markets in short-term funding using this synthetically derisked RMBS as collateral, which in turn meant that NBFIs (often the same parent groups to which the GMDs belonged) could not roll over the financing used to hold RMBS assets. This ordinarily would mean fire sales of these RMBS assets; however, the extent of the panic was such that there was no market in which to sell these assets at any price.

[7] P. Mehrling, *The New Lombard Street* (Princeton, NJ: Princeton University Press, 2011).

6. Central banks as dealers of last resort

The 2008 crisis revealed that central banks, in general, and the Federal Reserve, in particular, had to become not so much the lender of last resort but rather the liquidity provider of last resort (i.e., the dealer of last resort). In the age of deposit insurance, a modern bank run is more likely to occur through funding liquidity constraints, when collateral asset prices decline, rather than occur because savers line up to withdraw cash from a bank branch.

Note that dealers set prices, in part, to manage their inventory risk so that significant order flow imbalances may cause dealers to set prices unjustified by fundamentals simply to manage their matched-book inventory posture.[8] In a panic, dealers may simply refuse to make markets or set prices that achieve the same result, which could cause large fluctuations of asset collateral prices and begin to threaten the financial system as a whole.

When the value of assets held by banks dislocate as a result of panic, a dealer of last resort is needed to set a floor price on these assets and maintain their value as collateral for secured borrowing.[9] After all, it is rarely the case that all or even a majority of assets crushed by a panic are fundamentally impaired to the extent implied by the panicked mood of the market. This "value-based trader," according to Mehrling (2016),[10] is today the central bank. As the dealer of last resort, the central bank buys onto its own balance sheet the excess inventories of these panicked dealers in exchange for reserves—hence, the common refrain about the Fed's expanding balance sheet.

It is not quite a bailout in the popular sense. The price paid by such a dealer of last resort—known as the outside spread, according to Mehrling (2016)—is unattractively low by the standards of normal market conditions.[11] This is the dealer-of-last-resort equivalent of

[8] Z. Pozsar, "Shadow Banking: The Money View" (Office of Financial Research, 2014), https://www.financialresearch.gov/working-papers/files/OFRwp2014-04_Pozsar_ShadowBankingTheMoneyView.pdf.
[9] P. Mehrling, Z. Pozsar, J. Sweeney, and D. Neilson, "Bagehot Was a Shadow Banker: Shadow Banking, Central Banking, and the Future of Global Finance" (5 November 2013), http://dx.doi.org/10.2139/ssrn.2232016.
[10] P. Mehrling, "The Economics of Money and Banking" (Barnard College, Columbia University, 2016), https://www.studocu.com/en-us/document/columbia-university-in-the-city-of-new-york/money-and-banking/lecture-notes/economics-of-money-and-banking-lecture-notes/1048781/view.
[11] Mehrling, "The Economics of Money and Banking."

the "lend freely at a high rate of interest"[12] policy for a lender of last resort. Once the central bank "dealer" thus absorbs the order flow imbalance, the dealers restore their balance sheet freedom to continue their market-making activities.

Note that central banks typically will "pay" for these securities by crediting central bank reserves into the selling banks' accounts at the central bank. These reserves, in some sense the ultimate form of high-powered money, cannot be used by the banks other than in interbank markets.[13] The reserves, however, replace impaired assets on the bank's balance sheet with "robust" central bank reserves against which the bank can more easily meet its capital adequacy requirements and thus continue normal operations.

The extent to which central banks can conduct these domestic currency-denominated asset swaps is technically unlimited in a fiat currency world, in which the central bank (with the Treasury) creates domestic currency and reserves. Thus, in a crisis, central banks can absorb, as a technical matter, any amount of dealer imbalances.

The practical limit to this is external to the central bank, likely coming from increased inflationary expectations, which leads to observed inflation or external investors losing confidence in the national currency liabilities of the central bank and to some kind of political intervention in the workings of the central bank. For the Federal Reserve, as issuer of the world's reserve currency, the threat of a loss of external confidence in that currency has been much predicted since 2008 but has yet to be observed.

This loss of confidence likely has not occurred for two reasons. First, central bank reserves will affect only the real economy if banks use their new-found balance sheet freedom to create more money through the extension of credit. Ultimately, however, it is the act of customers coming to the bank and requesting credit that creates the majority of the money supply (as the bank will create a deposit liability against that loan asset). If demand for credit is lacking in a weak economy, banks will struggle to lend into that low demand, whatever the state of their central bank reserves. Second, the global reserve currency status of the US dollar means a seemingly permanent source of US dollar demand comes from outside the Federal Reserve's regulatory perimeter (the so-called eurodollar market).

[12] W. Bagehot, "Lombard Street: A Description of the Money Market" (History of Economic Thought Books, McMaster University Archive for the History of Economic Thought, 1873).
[13] M. McLeay, A. Radia, and R. Thomas, "Money Creation in the Modern Economy," *Quarterly Bulletin* (2014 Q1), Bank of England.

The limits of the Federal Reserve balance sheet expansion likely have not yet been tested. The question, however, as to how those assets eventually will leave that balance sheet and reenter the private dealers' balance sheets has been neither demonstrated nor answered in the decade since the 2008 financial crisis. This question is critical to CFA charterholders as many fundamental concepts important to investment managers (such as fundamental value) are overridden, to some extent, in an environment in which central bank interventions play a recurring and large role in market evolution.

7. Repos as a key level of the money hierarchy

Since 2008, the excesses of market-based finance have been curtailed, but the practice of money markets funding capital-market lending remains an important element of the financial system. Some commentators argue that the dysfunction in the post-2008 non-bank financial markets is an overlooked cause for the weak economic growth following the financial crisis and the recurring market dislocations in seemingly liquid money markets.

CFA charterholders need to be familiar, therefore, with the modern hierarchy of money so that they may better understand the health of significant funding sources as well as why central banks are intervening in those markets.

Although we have described the existence of a hierarchy of money, we have not yet presented the hierarchy itself. A useful exposition of the hierarchy of money is provided by Pozsar (2014),[14] who lists central banks, banks, dealer banks, and money market funds (MMFs) as the four key institutions to understand. In this case, central banks issue reserves, banks issue deposits, dealer banks issue repos (i.e., repurchase agreements) and MMFs issue shares.

What makes these instruments comparable in their money-like nature is that they typically will trade at par with each other and will do so on demand. For example, units in a CNAV MMF could be redeemed for an equivalent amount of bank deposits (i.e., converted at par) at short notice.

Pozsar (2014) notes that the extent to which this conversion is frictionless depends on the availability of liquidity and solvency backstops in the respective markets.[15] This will depend, particularly in extreme situations, on the extent of direct and indirect credit and liquidity support from the central banks.

For example, when assessing the credit protection (i.e., protection against default) underlying the money-like claims issued or traded by the four noted institutions, Pozsar (2014) presents the following ranking, considering the situation in the United States:[16]

[14] Pozsar, "Shadow Banking: The Money View."
[15] Pozsar, "Shadow Banking: The Money View."
[16] Pozsar, "Shadow Banking: The Money View."

1. Treasury bills, which are backed by the government, are the most money like.

2. Insured deposits, which are issued by retail banks, are insured by the government (or the FDIC) up to $250,000.

3. Repos, which are secured by collateral, could be used to further stratify this level of the hierarchy into sublevels according to the nature of the counterparty and the collateral involved.

4. MMFs, which depending on the nature of the investments (e.g., secured or unsecured, government-only, or prime funds), can further stratify this level of the hierarchy.

5. Uninsured bank deposits (those bigger than $250,000), which are unsecured and undiversified private credit claims, are at the bottom of the hierarchy.

In turn, assessing the liquidity protection available to these institutions (and thus the likelihood of them having to fire-sale assets to fund themselves), Pozsar (2014) concludes the following:[17]

1. Governments have the ultimate liquidity backstop through the monetary backstop provided by their central bank and Treasury (e.g., lender-of-last-resort facilities).

2. Retail and wholesale banks can borrow against assets (in private markets) or post them as collateral to the central bank for last-resort borrowing.

3. Dealers have relatively less ability to borrow against their assets in a panic than do retail or wholesale banks.

4. At the bottom of the hierarchy are MMFs as they can raise only limited amounts of funding through securities lending and committed or uncommitted credit lines from banks.

In the case that no private counterparty is willing to lend, Pozsar (2014) notes that both dealers and MMFs may be forced to sell at fire-sale prices.[18] MMFs' and dealers' ability to raise liquidity by borrowing against collateral or selling assets depends on private market participants' (i.e., other dealers and banks) ability to provide funding and market liquidity, respectively.

[17] Pozsar, "Shadow Banking: The Money View."
[18] Pozsar, "Shadow Banking: The Money View."

Pozsar (2014) thus defines the following four categories of money in the modern context, which are ranked by the strength of the ability to convert at par on demand:[19]

1. Public money, including currency and reserves issued by the central bank and Treasury bills issued by the government

2. Private-public money (or insured money), including insured bank deposits

3. Public-private money (or public shadow money), including government repos and the CNAV shares of government-only money funds

4. Private money (or private shadow money), including private repos, the CNAV shares of prime funds, and uninsured bank deposits

The key takeaway from this section on the modern money hierarchy is the central role of repos and MMFs as a money-like claim. Thus, these categories of money would prove to be key priorities for central bank response measures to the COVID-19-induced financial crisis in March 2020.

[19] Pozsar, "Shadow Banking: The Money View."

8. Coronavirus policy responses

In March 2020, the crisis response mechanisms developed during the 2008 crisis were called upon to stabilise the functioning of the financial system. The previous discussion on the hierarchy of money places in context the dealer-of-last-resort measures taken by central banks around the world and, in particular, those of the Federal Reserve.

8.1. Repo markets

The repo market is critical for the financial system as it is a key venue for the shifting of liquidity from surplus (particularly MMFs) to deficit agents. In this market, primary dealers[20] are key players who both act as market makers (hence, dealers) as well as fund their own portfolios by posting collateral (mostly Treasury securities and agency MBS) in exchange for funds.[21] The importance of the repo market is further emphasised by the fact that the market price for funding in the repo market—that is, the secured overnight financing rate (SOFR)—is also the chosen replacement for US dollar LIBOR.

In March 2020, term repo markets (i.e., repos that are longer than overnight) came under significant strain. As Treasury and agency MBS inventories of primary dealers expanded,[22] following large sales of these instruments by economic agents seeking to raise cash in the face of economic uncertainty, dealers' balance sheet capacity to intermediate in the term repo market (as well as in other market segments) became impaired. To discourage further inventory accumulation, primary dealers raised bid–ask spreads in term repo markets (as per the discussion in section 6). This, in turn, led to second-order effects on popular trading strategies, which exacerbated the Treasury sell-off.

As repo-market pricing deteriorated rapidly in mid-March 2020, the Federal Reserve (specifically, the New York Fed) became the dealer of last resort. It expanded its overnight and term repo operations with primary dealers both in the amounts offered as well as in

[20] Primary dealers are trading counterparties of the New York Fed in its implementation of monetary policy through temporary and permanent open-market operations.
[21] T. Adrian, C. R. Burke, and J, J. McAndrews, "The Federal Reserve's Primary Dealer Credit Facility," *Current Issues in Economics and Finance* 15, no. 4 (August 2009), https://www.newyorkfed.org/medialibrary/media/research/current_issues/ci15-4.pdf.
[22] K. Clark, A. Martin, and T. Wessel, "The Federal Reserve's Large-Scale Repo Program" (Federal Reserve Bank of New York Liberty Street Economics, 3 August 2020), https://libertystreeteconomics.newyorkfed.org/2020/08/the-federal-reserves-large-scale-repo-program.html.

the length and frequency of the loans. This expansion, however, did not fully address an important cause of the pricing dislocation—that is, the primary dealer balance sheet constraints in the face of one-way order flow. To address this issue, the Primary Dealer Credit Facility,[23] which was established during the 2008 financial crisis, acted as a lender-of-last-resort facility, allowing primary dealers to exchange excess Treasury and agency MBS for term funding of up to 90 days.

This tandem of increased Federal Reserve market making in the Treasury market – or directly into the repo market – and absorption of excess inventories onto its own balance sheet resulted in repo markets stabilising quickly and returning to normal function.

8.2. Money market fund turmoil and the commercial paper/certificate of deposit markets dysfunction

Another dynamic observed in the market at this time was the reduction in lending by MMFs (MMFs raising cash exacerbated the Treasury's sell-off) as they experienced an increase in redemptions by investors who also were seeking to raise liquidity.[24] MMFs are key lenders not only to secured repo markets[25] but also to short-term unsecured funding markets, notably commercial paper (CP) and certificates of deposit (CDs). Both CP and CDs are important sources of US dollar funding for banks (particularly for non-US banks) and corporates.

As costs rose in these funding markets and issuance of new CP/CDs reduced dramatically, the Federal Reserve announced the Money Market Mutual Fund Liquidity Facility (MMLF). Through this lender-of-last-resort facility, the Federal Reserve extended loans to dealers to purchase high-quality assets (such as asset-backed CP and unsecured CP)

[23] A. M. and S. McLaughlin, "The Primary Dealer Credit Facility" (Federal Reserve Bank of New York Liberty Street Economics, 19 May 2020), https://libertystreeteconomics.newyorkfed.org/2020/05/the-primary-dealer-credit-facility.htm.

[24] E. Eren, A. Schrimpf, and V. Sushko, "US Dollar Funding Markets during the Covid-19 Crisis—The Money Market Fund Turmoil," *BIS Bulletin*, no. 14 (12 May 2020), https://www.bis.org/publ/bisbull14.pdf.

[25] S. P. Kothari, "U.S. Credit Markets Interconnectedness and the Effects of the COVID-19 Economic Shock" (US Securities and Exchange Commission, October 2020), https://www.sec.gov/files/US-Credit-Markets_COVID-19_Report.pdf. Money market funds (MMFs) are the main lenders in the repo market. MMFs, however, reduced their repo lending (both with dealers and in the cleared repo segment) following large investor redemptions because of the COVID-19 shock, thus adding further strains in repo-market liquidity.

from MMFs seeking to raise cash. These securities were then pledged as collateral to the Federal Reserve.

In addition to the MMLF, the Federal Reserve's Commercial Paper Funding Facility acted as a dealer of last resort to restore the functioning of the CP market. Specifically, this facility promised to purchase a range of CP from eligible issuers, thus ensuring that dealers did not need to avoid this market for fear of being stuck with unwanted inventory.

8.3. Dysfunction in other markets

The waterfall of market seizures continued with corporate credit markets also being severely hit.[26] Issuance in primary markets ground to a halt, and credit spreads widened both in the United States and Europe because of dealers' limited balance sheet capacity to accommodate a large sell-off of corporate bonds and increased risk-aversion. Corporate bond exchange-traded funds (ETFs) were experiencing NAV discounts as ETF prices dropped below the value of their portfolio (or NAV).

The Federal Reserve announced the Primary Market Corporate Credit Facility and the Secondary Market Corporate Credit Facility. These dealer-of-last-resort facilities made loans by purchasing bonds from eligible issuers in both the primary and secondary markets. After the announcement of the facilities, credit spreads on bonds narrowed, liquidity in secondary markets improved, and issuance in the primary market rebounded. Furthermore, flows into bond mutual funds and ETFs turned positive, whereas NAV discounts reverted.

The asset-backed securities (ABS) market also suffered the same dislocations with new issuance declining dramatically and costs of funding increasing.[27] ABS markets are an important funding source for bank and nonbank lenders, and thus their functioning is critical to the flow of credit to households and business.[28]

[26] S. Aramonte and F. Avalos, "The Recent Distress in Corporate Bond Markets: Cues from ETFs," *BIS Bulletin*, no. 6 (14 April 2020), https://www.bis.org/publ/bisbull06.pdf.
[27] "Annual Economic Report" (Bank for International Settlements, June 2020), https://www.bis.org/publ/arpdf/ar2020e.pdf; S. P. Kothari, "U.S. Credit Markets Interconnectedness and the Effects of the COVID-19 Economic Shock" (US Securities and Exchange Commission, October 2020), https://www.sec.gov/files/US-Credit-Markets_COVID-19_Report.pdf.
[28] "FAQs: Term Asset-Backed Securities Loan Facility," Federal Reserve Bank of New York, 2 November 2020, https://www.newyorkfed.org/markets/term-asset-backed-securities-loan-facility/term-asset-backed-securities-loan-facility-faq.

The Federal Reserve's lender-of-last-resort Term Asset-Backed Securities Loan Facility provides fully secured (by eligible ABS), nonrecourse, three-year loans to private investors (including asset managers, mutual funds, insurance companies, and hedge funds). This facility encourages these investors to purchase newly issued AAA-rated ABS backed by various consumer and small business loans, leveraged loans, and commercial mortgages.

The final major funding market to experience dislocations as a result of the COVID-19 pandemic was the municipal securities market. Interest rates spiked as prices of the securities fell due to a large sell-off of municipal securities by large mutual funds trying to meet redemptions from their own investors. Once again dislocation was caused not so much by changes in underlying credit risk of municipalities but by structural illiquidity in the municipal securities market.

In response, the Federal Reserve announced that it would accept US municipal short-term debt as eligible collateral in its MMLF. Subsequently, a dedicated Municipal Liquidity Facility was established to purchase municipal securities directly from eligible issuers (i.e., US cities, counties, and states that meet certain conditions).

For the various US funding markets, the Federal Reserve response measures were a matter of using the dealer-of-last-resort approach for any funding market experiencing a breakdown. This spread of facilities therefore is not so much an indicator of the complexity of the response measures, as it is an indicator of the complexity of the funding market ecosystem.

One incredibly important response measure remains, however, that is often overlooked—that is, the Federal Reserve's implicit backstopping of global-dollar funding outside of the United States.

8.4. International US dollar funding strains

Non-US banks' scarcer access to a stable dollar retail deposit base implies greater dependency on CP and CDs' US money market funding to finance dollar assets. US MMF's portfolio rebalancing during the earlier phases of the crisis, following large investor redemptions, had a substantial impact on both the volumes and maturities of CP and CDs' funding for non-US banks and subsequently on "offshore" US dollar funding costs.[29]

[29] E. Eren, A. Schrimpf, and V. Sushko, "US Dollar Funding Markets during the Covid-19 Crisis—The International Dimension," *BIS Bulletin,* no. 15 (12 May 2020), https://www.bis.org/publ/bisbull15.pdf.

The FX swap market, an alternative to raising funds directly in core US dollar money markets and in which dollars are borrowed from banks (and other financial intermediaries) by pledging another currency as collateral, also became noticeably more expensive.

The Federal Reserve acted as global lender of last resort by making important changes to its US dollar swap lines with its main central bank counterparties (e.g., Bank of England, European Central Bank, Bank of Japan, Swiss National Bank). The Federal Reserve supplied US dollar liquidity to these central banks, which, in turn, were able to supply US dollar liquidity to their local financial system.

9. Conclusion

In the bank-based credit system, central banks act as lender of last resort by providing funding liquidity to the banking system. In the market-based credit system, it is asset markets that require central banks' backstop in times of stress, not banking institutions.

By acting as dealers of last resort, central banks support the price of capital asset collateral and the price of money market funding, thus providing market liquidity, while also enhancing dealers' ability to supply market liquidity.

Mehrling (2014) notes that when acting as dealer of last resort, the central bank should apply the "modern version" of the classic Bagehot rule for the lender of last resort.[30] This rule advocates for lending freely at a high rate against security that would be good in normal times. In a market-based credit system, the rule should be "trade freely at a wide bid–ask spread against good securities."

[30] Mehrling, "Why Central Banking Should Be Re-imagined."

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