BIS Working Papers
No 854
A New Indicator of Bank Funding Cost

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Monetary and Economic Department

April 2020

JEL classification: E32, E44, E52.

Keywords: Bank funding risk, bank credit spreads, liquidity supply regimes, multi-curve environment, economic activity predictability.
A New Indicator of Bank Funding Cost*

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Abstract

The cost of bank funding on money markets is typically the sum of a risk-free rate and a spread that reflects rollover risk, i.e., the risk that banks cannot roll over their short-term market funding. This risk is a major concern for policymakers, who need to intervene to prevent the funding liquidity freeze from triggering the bankruptcy of solvent financial institutions. We construct a new indicator of rollover risk for banks, which we call the forward funding spread. It is calculated as the difference between the three-month forward rate of the yield curve constructed using only instruments with a three-month tenor and the corresponding forward rate of the default-free overnight interest swap yield curve. The forward funding spread usefully complements its spot equivalent, the IBOR-OIS spread, in the monitoring of bank funding risk in real time. First, it accounts for market participants’ expectations of how funding costs will evolve over time. Second, it identifies liquidity regimes, which coincide with the levels of excess liquidity supplied by central banks. Third, it has much higher predictive power for economic growth and bank lending in the United States and the euro area than the spot IBOR-OIS, credit default swap spreads or bank bond credit spreads.

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1 Introduction

Once again, as Covid-19 hits the global economy, liquidity threatens to dry up in money markets, credit markets and stock markets. The illusory belief that money markets can always provide reliable funding for financial institutions lay at the heart of the banking system’s fragility during the 2007–09 financial crisis. As funding liquidity evaporated, many solvent and well-capitalized financial institutions had to sell illiquid assets to meet their financial obligations, resulting in fire-sale externalities. These losses severely affected the ability of financial institutions and nonfinancial corporations to operate and created fears about their solvency. In such cases, public intervention is then warranted to curb market failures and to avoid the collapse of asset prices or the disruption of credit flows that result from liquidity crises (Brunnermeier, 2009; Aikman, Bridges, Kashyap, and Siegart, 2018; Bernanke, 2018).

Properly measuring and monitoring bank funding risk in real time is especially important for central banks when designing and implementing operations for liquidity support. Indeed, the Thornton (1802)–Bagehot (1873) principle states that central banks should lend early and freely to illiquid but solvent financial institutions. If a financial crisis rests on panic factors, central banks can then supply public liquidity when private liquidity vanishes (Holmström and Tirole, 1998; Brunnermeier and Sannikov, 2014; Freixas, Martin, and Skeie, 2011). A commonly used indicator for the funding conditions of large banks is the IBOR-OIS spread, defined as the difference between an InterBank Offered Rate (IBOR), which reflects the cost for a bank of issuing an unsecured interbank loan, and an Overnight Interest Swap (OIS) rate with the same maturity. While the IBOR-OIS spread encompasses both a funding liquidity risk and a credit (or default) risk, several authors provide evidence that funding liquidity risk is the predominant component during systemic crises, for short and medium horizons (Bianchetti and Carlicchi, 2012; Filipović and Trolle, 2013; Gallitschke, Seifried, and Seifried, 2017; Bernanke, 2018). However, as a difference in spot rates, the IBOR-OIS spread measures the current perception of funding costs. It is a spot funding spread that reflects the immediate risk for the lender of a market freeze or of a borrower default but does not account for the market participants’ expectations of how such costs

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1Bernanke (2018) shows that the depth of the financial crisis is mainly due to the supply side of the credit market and, specifically, to the liquidity drought in the money market. He demonstrates that panic factors – which reflect the fragility of the financial system – are much more capable than balance sheet factors – which reflect the deterioration of the balance sheets of borrowers and lenders – of predicting the real U.S. economy between 2006 and 2012. In other words, preventing liquidity from drying up in the market may have reduced the depth of the recession and the accumulation of the public debt needed to stabilize the economy through fiscal policy.
will evolve over time.

In this paper, we construct indicators of the *expected* cost of funding of large banks based on forward interest rates. These so-called *forward funding spreads* can be computed for different starting forward dates, different maturities, and different frequencies of payments (tenors). Forward funding spreads have several desirable properties as indicators of bank funding conditions: (i) they are available at a daily frequency for the dollar, the euro, and most of the major currencies; (ii) they are obtained from interbank market instruments and therefore reflect the funding cost of large banks (banks matter in particular because they are a key link in the transmission of monetary policy and in the funding of credit markets); (iii) they are based on widely traded interest contracts and hence accurately measure the market price of funding; and (iv) they are based on forward rates and hence reflect changes in the expected cost of funding. This may be especially important during periods when central banks saturate markets with liquidity and expected spreads may serve as better signals of the change in the stance of monetary policy than the spot IBOR-OIS.

We make three contributions. First we construct daily forward funding spreads, which measure the expected cost of bank funding. Spot and forward funding spread time series are available in a spreadsheet appendix to this paper and are updated every month. Second, we show that these indicators can be used to characterize central bank liquidity regimes. Third, we show that forward funding spreads have better predictive content for economic activity than the spot IBOR-OIS spread or indicators of credit risk.

Forward funding spreads contrast three liquidity regimes in the United States and the euro area since the 2007–09 financial crisis: (i) a *crisis* regime, associated with a lack of liquidity in the financial system and a strong connection between liquidity and credit risks, (ii) a regime of *abundant liquidity*, associated with massive central bank injections of liquidity with no uncertainty over the cost of liquidity and a disconnect between the two risks, and (iii) a regime of *moderate liquidity*, characterized by uncertainty over the expected cost of liquidity but little correlation between liquidity risk and credit risk. In the United States, the

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2 Several authors show that forward rates contain information about future yields and/or excess returns on bonds (Fama and Bliss, 1987; Stambaugh, 1988; Cochrane and Piazzesi, 2005). Recently, Engstrom and Sharpe (2018) use the difference between the six-quarter-ahead forward rate on U.S. Treasuries and the current three-month Treasury bill rate, which they call the “near-term forward spread.” Benzoni, Chyruk, and Kelley (2018) find that a change in the yield curve slope due to a monetary policy easing, measured by the current real interest rate level and its expected path, is associated with an increase in the probability of a future recession within the next year. Hansen, McMahon, and Tong (2019) and Nakamura and Steinsson (2018) also use forward rates on long-term government bonds.

3 Other indicators have been proposed to measure the funding cost of large banks. For instance, the Credit Default Swap (CDS) spread and the bank bond spread reflect different aspects of this cost of funding. In Section 4, we compare the predictive properties of the various indicators.
crisis regime corresponds to the period 2007–12, including both the 2007–09 financial crisis and the European sovereign debt crisis. The period 2013–15 is associated with the abundant liquidity regime, during which the Federal Reserve provided a massive amount of liquidity through its QE3 program. Since December 2015, the U.S. economy has been in a moderate liquidity regime, in which liquidity risk is independent of credit risk. In the euro area, the crisis period lasted until the end of 2012 with the announcement of the Outright Monetary Transactions programme. Since then, the liquidity provided by the European Central Bank (ECB) has been abundant. Fluctuations in credit risk, which resumed in 2015, were not reflected in the expected bank funding cost. The Covid-19 pandemic thus subsequently affected spot and forward funding spreads in very different ways on the opposite sides of the Atlantic – strongly in the United States and moderately in the euro area – as would be expected given the very different prevailing liquidity conditions.

We also provide evidence that forward funding spreads have substantial predictive power for U.S. and euro area real activity. They outperform the spot IBOR-OIS spread, indicating that the expectations of market participants regarding the future cost of funding matters more for the business cycle than the current cost. This might be particularly relevant when central banks supply large amounts of liquidity, crushing the spot IBOR-OIS spread, and the market shifts its attention to the persistence of such policies. Forward funding spreads also outperform bank credit risk measures (bank CDS and bond spreads) in forecasting economic activity. This result suggests that the information content of these indicators reflects the attitude of banks towards credit and that this attitude depends on their expected cost of funding. The forward funding spreads also perform very well at predicting bank lending, which suggests that reducing bank funding costs can help banks feed credit markets. Interestingly, our results highlight a funding channel of the business cycle. The supply of credit by financial intermediaries depends on the cost of funding both in the United States (where market finance dominates) and the euro area (where banks dominate the financial system). In turn, credit supply is correlated with future economic fluctuations.

The remainder of the paper is organized as follows. In Section 2, we precisely define forward funding spreads and explain how to construct them using interbank market data. In Section 3, we analyze the reaction of forward funding spreads to policy intervention in the United States and the euro area, particularly during the 2007–09 financial crisis and the European sovereign debt crisis. In Section 4, we compare the ability of the forward funding spread with some other well-established indicators of bank liquidity and credit risk to predict future real activity and bank lending. The final section concludes the paper.
2 Forward Funding Spreads

In this section, we describe the construction of forward funding spreads (hereafter, FFSs), present the interbank data that we use, and illustrate the temporal evolution of FFS over the recent period.

2.1 Definition of Forward Funding Spreads

A common indicator of stress on interbank markets is the spot IBOR-OIS spread. It is computed as the difference between the bank offered rate of a given tenor and the overnight interest swap rate with the same maturity, which is usually viewed as the risk-free rate for this maturity. The tenor of a financial contract refers to the frequency with which coupon payments are exchanged.\(^4\) Typical spreads are the one-month and three-month IBOR-OIS spreads (BOS) (see, e.g., Bernanke, 2018). For instance, we define the three-month IBOR-OIS spread as

\[ BOS_{3m}^{(3m)} = R_{3m}^{(3m)} - R_{3m}^{(ois)}, \]  

where \( R_{3m}^{(3m)} \) denotes the three-month spot rate with a three-month tenor and \( R_{3m}^{(ois)} \) denotes the three-month OIS contract, which reflects market expectations of the average overnight rate over the next three months.

Before the financial crisis, IBOR-OIS spreads were close to nil and were therefore neglected because large banks were not expected to default. During the financial crisis, there was a disconnection of the IBOR from the OIS rate with the same maturity, such that IBOR-OIS spreads are now considered indicators of market stress or panic. These spreads are usually interpreted as reflecting rollover risk, which combines funding liquidity risk and credit (or default) risk (Alfeus, Grasselli, and Schlögl, 2018).

To understand why the IBOR-OIS spread reflects rollover risk, we consider the two following strategies. On the one hand, bank A borrows at the three-month IBOR. At maturity, the bank repays the notional plus interest \( (R_{3m}^{(3m)}) \). On the other hand, bank B borrows cash on a daily basis at the overnight federal funds rate for three months and

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\(^4\)For instance, for a two-year swap with a three-month tenor, bank A will pay the fixed rate every three months for two years, whereas bank B will pay the floating three-month rate. The tenor therefore specifies the maturity of the floating rate and the frequency of the cash flows. Most contracts on interbank markets are linked to the IBOR rate of a specific tenor (typically, one, three, six or 12 months). For a given bank, interest rate instruments with the same maturity but different underlying tenors are characterized by different liquidity or credit risk premia, reflecting the different views and interests of the market counterparts.
simultaneously enters into an OIS swap, receiving the floating rate (the overnight effective federal funds rate) and paying the fixed rate (the OIS rate, \( R^{(ois)}_{3m} \)). In both cases, the interest rate for the three-month funding is set in advance, and therefore, no interest rate risk is involved. However, in a stressed market, banks A and B would face different situations. For bank A, the funding is guaranteed, as the contract runs until the end of the three months. Bank B, in contrast, may be unable to roll its funding and may become insolvent. This situation may happen in the event of a market freeze (funding liquidity risk) or if the lender demands a higher credit spread (credit risk). Because bank B may suffer from such rollover risk, it pays a lower interest rate than bank A. Therefore, the funding based on a three-month IBOR contract commands a higher interest rate, which generates the observed tenor spread between the IBOR and the OIS rate. Because liquidity and credit risks are negligible for OIS contracts, the three-month IBOR-OIS spread essentially measures the rollover risk coming from the three-month floating leg.

A potential limitation of the spot IBOR-OIS spread, called the spot funding spread (hereafter, SFS), is that it measures the current perception of the funding cost but does not incorporate any forward-looking component. In contrast, forward rates allow us to extract market participants’ expectations from the yield curve. We now explain how we compute the forward funding spread. Consider the three-month forward funding spread starting in three months for the three-month tenor, defined as

\[
FFS_{3m,3m}^{(3m)} = F_{3m,3m}^{(3m)} - F^{(ois)}_{3m,3m},
\]

where the forward rate \( F_{3m,3m}^{(3m)} = 2R^{(3m)}_{6m} - R^{(3m)}_{3m} \) is computed from the three-month tenor curve and the forward rate \( F^{(ois)}_{3m,3m} = 2R^{(ois)}_{6m} - R^{(ois)}_{3m} \) is computed from the OIS curve. The six-month rate is obtained from the three-month tenor curve in the former case and from the OIS curve in the latter case. As rollover risk is negligible for the OIS curve, the FFS measures the funding cost originating from the three-month tenor segment.

For some starting dates, maturities, and tenors, the forward rates can be obtained directly from market data when the relevant forward rate agreements (FRAs) or interest rate swaps (IRSs) are quoted. However, in general, as not all starting dates, maturities, and tenors are available on interbank markets, the best approach is to construct a complete yield curve for each tenor through numerical optimization. We briefly describe this approach in the next section.
2.2 Data and Construction of the Forward Funding Spreads

The FFS indicator measures the cost of funding of large banks. Therefore we use interbank data, through deposits, forward rate agreements, overnight index swaps, and interest rate swaps. For major currencies, these instruments correspond to very wide markets and exhibit extremely large turnover. As the BIS triennial report reveals (Bank of International Settlements, 2019), in the first half of 2019 the notional amount outstanding represented USD 89 trillion on the FRA market and 389.3 trillion on the swap market (including OISs and IRSs). Gross market values were equal to USD 232 billion and 7,793 billion, respectively.\footnote{For comparability, all foreign exchange contracts had a notional amount outstanding of USD 98.7 trillion and a gross market value of 2,229 billion.} Focusing on gross market values, USD and EUR instruments are by far the largest segments of the market: overall, interest rate contracts in USD and EUR represented 1,745 billion and 4,352 billion (22\% and 54\%, respectively). Daily turnover also posted impressive numbers. On a net-net basis, as of April 2019, the daily turnover on the FRA and swap segments amounted to USD 1,902 billion and 4,146 billion, respectively. USD and EUR markets corresponded to 52\% and 22\% of total turnover.

We collected from Bloomberg quotes for all USD and EUR interest rate instruments on the interbank markets starting in January 2005 and ending in March 2020. These instruments include bank deposits (unsecured EONIA and Fed funds) and FRAs, OISs, and IRSs (or basis swaps) for all available tenors.

To compute the forward yield curve of a given tenor in a given month, we rely on the literature dealing with the multicurve environment that ensued from the 2007–09 financial crisis (see, among others, Henrard, 2007, 2010; Bianchetti, 2009; Ametrano and Bianchetti, 2009; and Mercurio, 2009, 2010). Two types of yield curves are constructed: a discounting curve, which is used to compute the present value of future cash flows, and several forwarding curves, which are used to compute the future cash flows corresponding to a given tenor. The discounting curve is based on OIS contracts with different maturities (and sufficient liquidity). It can be interpreted as corresponding to the absence of liquidity and credit risks.\footnote{OIS discounting is relevant in the absence of counterparty risk or in the case of derivatives that are collateralized on a daily basis (Mercurio, 2009, 2010). Most derivatives traded over-the-counter have ISDA master agreements. These agreements usually include a credit support annex (CSA) that specifies the protections from which the derivatives benefit. Typical CSAs involve daily collateralization, which means that margin calls can take place on a daily basis. Alternatively, in the case of a contract with a general counterparty or without collateral, a discounting curve based on IBOR rates may be more relevant because it reflects the risk of the interbank sector as a whole (Bianchetti, 2009; Ametrano and Bianchetti, 2009). Hull and White (2013) provide theoretical arguments that, in all cases, OIS discounting should be preferred. We follow this advice and use the OIS curve as the unique discounting curve. The credit risk in an OIS} The forwarding curves, also called funding curves, correspond to different tenors...
(from one to 12 months). For instance, the three-month funding curve in the United States is based on the three-month IBOR, a sequence of three-month FRAs, and a sequence of IRSs with a three month tenor.

The discounting and forwarding curves are constructed using a standard optimization procedure. The estimation of the yield curve of a given tenor produces a sequence of three-month forward rates that minimize the difference between theoretical and market prices of the available instruments, while maintaining sufficient smoothing of the yield curve.\footnote{See the Online Appendix for additional details on the instruments and the methodology used for the interpolation of the tenor yield curves.}

Tenor yield curves up to a three-year maturity are available at a daily frequency from January 2005 for the United States and the euro area. Specifically, for the United States, the OIS, one-month, three-month, and six-month tenor curves are available on January 5, 2005, up to five years, on July 28, 2008, up to 10 years, and on September 27, 2011, up to 30 years. For the euro area, the OIS, three-month, and six-month tenor curves are available on January 5, 2005, up to three years, on April 20, 2005, up to seven years, on July 19, 2005, up to 10 years, and on May 28, 2008, up to 30 years. The one-month tenor curve is available on January 25, 2006, up to two years, on May 2, 2007, up to three years, and on June 16, 2008, up to 30 years.\footnote{For the United States, the 12-month versus three-month basis swaps are available only from August 2009 until the end of 2015 on Bloomberg. We assume that data collection stopped because of the lack of liquidity in this segment.} Data are available upon request and are updated regularly.

Figure 1 displays the time series of the forward funding spreads for the United States and the euro area for tenors of one, three and six months. Before the start of the financial crisis in 2007, the difference between instruments with the same maturity but a different tenor was considered negligible. FFSs exploded in August 2007 and remain extremely high. They almost always increase with the tenor, although not linearly so. This result is illustrated by two episodes of particular interest in the euro area: during the 2007–09 crisis, the FFS was particularly high for the tenors of three and six months, with a spike above 100 bp for these spreads in January 2009. In contrast, during the sovereign debt crisis, FFSs increased in a more regular way. They increased up to 50, 75, and 120 bp for the one-, three- and six-month tenors, respectively, in November 2011. In the United States, the financial crisis also generated substantial differences between tenors. The FFS with a one-month tenor increased to 140 bp in January 2009, while FFSs with three- and six-month tenors jumped to 160 and 250 bp. Since the recent surge in spreads following the change in Federal Reserve interest is the risk of a possible default by one of the counterparties on an overnight loan and is usually viewed as negligible.
rate policy (December 2015), we do not observe such large differences between tenors.

In summary, FFSs are based on highly liquid instruments and cover a very large spectrum of maturities. The construction of the tenor yield curves is easily performed at a daily frequency, for the one-, three- and six-month tenors. In addition, the resulting curves closely match observed prices, so that FFSs are very accurate and timely. Finally, they allow us to investigate the effects of specific events at different horizons, an analysis that we consider in the next section.

3 Forward Funding Spreads and Liquidity Regimes

The evolution of forward funding spreads helps to contrast three liquidity regimes for central banks: (i) a crisis regime, associated with a lack of liquidity in the financial system and a strong connection between liquidity risk and credit risk, (ii) a regime of abundant liquidity, associated with massive central bank injections of liquidity, flat forward funding spreads and a disconnect between liquidity and credit risk, and (iii) a regime of moderate liquidity, characterized by uncertainty over the cost of liquidity that appears, but unrelated to credit risk. Figures 2 and 3 display the (spot and forward) funding spread indicators and the size of the central bank balance sheet. The latter provides an indication of changes in the supply of central bank liquidity. We also display the CDS spreads as indicators of banks’ credit risk and the uncertainty over short-term interest rates, measured as the sum of disagreement among forecasters and the perceived variability of future aggregate shocks (Istrefi and Mouabbi, 2018) in Figures 4 and 5. The central bank balance sheet, CDSs and uncertainty over short-term rates help us cross-check what FFSs reveal about liquidity regimes.

3.1 The United States

3.1.1 Crisis regime – Phase I: the U.S. financial crisis (Summer 2007–May 2010)

The first signs of stress on interbank liquidity appeared in the summer of 2007 with an increase in FFSs and SFSs to approximately 50 and 100 bp, respectively (see Panel A of
The Federal Reserve introduced the Term Discount Window Program (TDWP) in August 2007, a temporary program that offered discount window funds with maturities beyond overnight and created the Term Auction Facility (TAF) in December 2007. As argued by Berger, Black, Bouwman, and Dlugosz (2014), these facilities increased aggregate lending, enhancing lending by expanding banks and slowing the decline in credit supplied by contracting banks.

However, these measures were not sufficient in view of the severity of the crisis. The usual redistribution mechanisms for liquidity within the financial system were too much altered. By mid-September 2008, the FFS and SFS jumped to levels close to 150 bp and 300 bp, respectively. The Federal Reserve started to provide liquidity directly to market participants through several programs and facilities: the Temporary Guarantee Program for money market funds (TGP) and the Asset-backed Commercial Paper and Money Market Liquidity Facility (AMLF) in September 2008; the Troubled Asset Relief Program (TARP) and the Capital Purchase Program (CPP), which were intended to provide capital injections for financial institutions in October 2008; the Money Market Investor Funding Facility (MMIFF) and the Term Asset-backed securities Loan Facility (TALF) in November 2008. In March 2009, the Fed decided to purchase up to USD 300 billion of longer-term Treasury securities (a program called quantitative easing, QE1) and to increase the purchase of agency debt.

Overall, the Fed injected approximately USD 1.3 trillion in liquidity between the summer of 2007 and the end of QE1 in May 2010. All these monetary policy actions seem to have dramatically reduced the cost of bank funding: in early 2010, both funding spread indicators returned to their pre-crisis levels (approximately 10 bp). Note that over most of this period, the FFS was below the SFS, suggesting that market participants were anticipating an acute lack of funding liquidity but that the liquidity shortage would recede somewhat within three months.

3.1.2 Crisis regime – Phase II: between QE2 and QE3 (2010–2012)

The period 2010–2012 corresponds to the sovereign debt crisis in the euro area. The global integration of liquidity markets for large banks was clearly manifested during the second phase of the crisis. The Merkel-Sarkozy decision in October 2010 to impose losses on the private sector lenders to the Greek Republic perturbed money markets in both euros and
in dollars. U.S. banks and money market funds held large positions in securities issued by European banks or had direct exposure to banks with direct exposure to Europe.

Financial tensions started to increase in Spring 2010, as market participants started to question whether Greece, and possibly other highly indebted European countries, would be pushed to default and perhaps out of the euro area. Spot and forward funding spreads increased by 50 bp and 20 bp, respectively (see Panel B of Figure 6). In reaction, the Federal Reserve started a second round of quantitative easing (QE2) in November 2010, buying USD 580 billion of Treasury securities by July 2011. Both spreads decreased to a level close to 20 bp, suggesting that liquidity was sufficiently abundant in the U.S. market. However, after stopping QE2 and facing a broadening of the sovereign debt crisis to Italian and Spanish sovereign debt, the FFS increased to 35 bp, while the SFS remained essentially flat. It was only in August 2011 that the SFS started to react to events. The relatively high level of the FFS suggests that market participants expected the stress on money markets to resume.


In September 2012, the Federal Reserve decided to launch an open-ended bond-purchasing program for agency mortgage-backed securities (QE3). The period of this program was characterized by additional increases in the supply of liquidity by the Federal Reserve. As shown in Figure 2, the Federal Reserve’s balance sheet increased by USD 1.7 trillion to reach approximately 4.5 trillion in December 2015, a level five times larger than that before the crisis. Both the FFS and SFS stabilized at approximately 25 bp. A highly likely consequence of this larger scale of excess liquidity was that the funding costs of large U.S. banks (Panel C of Figure 6) were flat. During this period, bank CDS spreads decreased from above 150 bp to 60 bp (Panel A of Figure 4) and short-term interest rate uncertainty was extremely low (below 5%) (Panel B of Figure 4). Interestingly, the taper tantrum that hit global financial markets in Q2 and Q3 of 2013 had no effect on the expected cost of bank funding.

In October 2014, the Federal Reserve announced the end of large-scale asset purchases. With QE ending, the Federal Reserve laid out its exit strategy: monetary policy normalization would consist of gradually raising its target range for the federal funds rate to more normal levels and gradually reducing the Federal Reserve’s securities holdings. In reaction, the uncertainty associated with the interest rate increased.

In December 2015, the Federal Reserve raised the target range for the federal funds rate for the first time since December 2008, and continued to increase it until January 2019 (Panel D of Figure 6). It also began to gradually reduce its securities holdings from January 2018. As shown in Panel B of Figure 2, the Federal Reserve’s balance sheet was reduced to a level of USD 3.8 trillion in the summer of 2019.

Between December 2015 and September 2017, the spot and forward spreads evolved closely to one another, first increasing until autumn of 2016 and then decreasing until the end of 2017. However, from January 2018, the two indicators diverged, and we observe a greater variance of the spot IBOR-OIS.

On September 16, 2019, there was an incident on the interbank market: the market rate spiked because cash-rich banks preferred keeping excess liquidity on their books to lending on the market to smooth a short episode of higher demand from other market players. (Panel C of Figure 2). The Federal Reserve had to inject a massive amount of liquidity (over USD 50 billion) into the repo market the next day. The FFS had been rising in the few days before the panic. It almost instantaneously reverted on September 17 to a declining trend, suggesting that the event was due to a purely temporary lack of liquidity. In contrast, the spot IBOR-OIS spread fell below the FFS before the crisis but increased on September 17 and remained at a relatively higher level afterwards. Within a week after the incident, the Federal Reserve stepped up its liquidity supply to offer at least USD 75 billion in overnight repo funding and between 135 and 170 billion in term funding. Furthermore, additional monthly purchases of up to USD 60 billion of Treasury bills were announced, increasing its balance sheet again (Panel B of Figure 2).

3.2 The Euro Area

3.2.1 Crisis regime – Phase I: the interbank crisis (Summer 2007–May 2010)

Similar to the United States, the funding spreads were negligible, below 5 bp, until mid-2007 (Panel A of Figure 7). In the Fall of 2007, the FFS and SFS increased to approximately 50 bp and 80 bp, respectively. In September 2008, both indicators jumped again, although to a different extent. The FFS did not exceed 120 bp, whereas the SFS reached 180 bp.

The ECB’s reaction was first to carry out its main refinancing operations through a fixed rate tender procedure with full allotment (FRFA) in October 2008, so that all demand for liquidity would be satisfied as long as adequate collateral was available. The introduction
of the FRFA credit operations built up excess liquidity in the banking system. The FFS almost instantaneously reacted to this measure, returning to 60 bp, while the SFS hardly responded.

In a second round, the ECB sought to satisfy the increased demand for liquidity by adjusting both the timing and the maturity of open market operations: three- and six-month full allotment LTROs were implemented in November 2008 (EUR 300 billion) plus 12-month LTROs in June 2009 (EUR 442 billion). Providing banks with large amounts of liquidity for one year at a favorable rate allowed them to build up liquidity buffers. The combination of these nonstandard monetary policy responses had a beneficial impact on the funding spreads albeit to different extents: by the beginning of 2009, the FFS and SFS decreased to 60 bp and 90 bp, respectively.

3.2.2 Crisis regime – Phase II: the sovereign debt crisis (2010–2012)

In reaction to the sovereign debt crisis, the ECB expanded its monetary outright portfolio in May 2010 through secondary market purchases of sovereign bonds under a new Securities Markets Programme (SMP). The SMP was effective at mitigating upward pressures on the interbank market: spot and forward funding spreads remained relatively low, close to 20 bp, suggesting that there was no lack of liquidity in the euro market at that time (Panel B of Figure 7). However, this program did not stop the rise in sovereign spreads. By July 2011, when markets started to question the status of Italian and Spanish sovereign debts, financial tensions intensified again and the crisis turned into a twin sovereign debt and banking crisis, as many banks were affected by considerable mark-to-market losses in their holdings of sovereign bonds (Hartmann and Smets, 2018) and the ability of sovereigns to recapitalize their banks became questionable. Concerns about the solvency of large European banks increased, as testified by the jump in banks’ CDS spreads in the second half of 2011. In August 2011, the FFS and SFS increased in parallel, from 25 to 60 bp at the end of the month. The FFS then stabilized while the spot indicator continued to rise.

At the end of 2011, the ECB intervened substantially, using several nonstandard measures designed to address funding risk: two LTROs of 12 and 13 months announced on October 2011, the second Covered Bond Purchase Programme (CBPP2), and the announcement in December 2011 of two 36-month very long-term refinancing operations (VLTROs) to give banks funding certainty and help them sustain credit lines to the private sector. The
ECB’s balance sheet increased from approximately EUR 2 trillion in mid-2011 to almost EUR 3 trillion in mid-2012. These measures likely explain the decline in banks’ funding costs. Spot and forward indicators started to fall at the beginning of 2012 and they reached a first plateau at 30 bp in April despite still-elevated bank CDS rates.9

The speech by Mario Draghi on July 26, 2012, in which he stated that “the ECB was ready to do whatever it takes to preserve the euro” and the announcement shortly after of the Outright Monetary Transactions Programme (OMT) (with the option for governments to request the purchase of short-term sovereign bonds in secondary markets in unlimited amounts, under strict conditions) put the ECB in the position of lender of last resort for sovereigns. In turn, the funding costs of banks stabilized: by end-2012, the SFS went below 10 bp, and the FFS was close to 15 bp.

### 3.2.3 Abundant liquidity (2013–February 2020)

After the OMT announcement, the euro area entered a persistent regime with very little uncertainty over the expected funding cost of banks. Remarkably, liquidity was low but the CDS spreads were still high. However, the combined effects of the FRFA of the ECB and the off-balance-sheet option character of the OMT kept the FFS flat at a low level (Panel C of Figure 7).

Given the lack of inflation and the persistence of low real growth in the area, the ECB adopted additional conventional and nonconventional measures. The deposit facility rate was put into negative territory in June 2014, and the Asset Purchase Programme (APP) was launched in 2015 (EUR 60 billion per month). In March 2016, the ECB took several measures to add further monetary stimulus (Hartmann and Smets, 2018): the APP was expanded to EUR 80 billion in monthly purchases, a Corporate Sector Purchase Programme (CSPP) was launched, and Targeted Longer-Term Refinancing Operations (TLTRO-II) were announced with a maturity of four years.

This new package of measures allowed funding spreads to decrease considerably (Panel D of Figure 7). The FFS declined from an already low 15 bp to 5 bp. The SFS even went negative in March 2017. We note that a persistent positive gap was created between the

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9A substantial literature has evaluated these measures, in most cases finding that the programs worked as intended. For instance, Pelizzon, Subrahmanyam, Tomio, and Uno (2016) show that LTROs weakened the sensitivity to the credit risk of market-makers’ liquidity provision, highlighting the importance of funding liquidity measures as determinants of market liquidity. Carpinelli and Crosignani (2017) show that banks more affected by the liquidity drought used central bank liquidity to restore credit supply, while less affected banks increased their holdings of high-yield government bonds. Being unable to completely switch away from affected banks during the drought, firms benefited from the intervention.
spot and forward funding spreads. One reason is that the FFS never went negative during the sample period, as it represented a pure funding risk premium.

The liquidity injected into the financial system increased rapidly by EUR 2.5 trillion between 2015 and 2019 (Panel B of Figure 3), and the interest rate uncertainty fell below 2% (Panel B of Figure 5), notably under the influence of the commitment to the future path of interest rates (forward guidance) implemented from July 2013.

3.3 The Covid-19 Pandemic

With over 1.5 million cases confirmed and more than 90,000 deaths registered around the globe – and both of those figures continuously increasing – the Covid-19 outbreak/pandemic has unleashed a worldwide economic and financial crisis. Stock markets have already lost more than 30% of their value in 2020, and the issue of financial stability has returned to the fore. Figure 8 displays the SFS and FFS from January 2020 to March 31, 2020. While Covid-19 is now understood to have appeared in late 2019, the World Health Organization did not raise the risk of Covid-19 going global from high to very high until February 28, 2020. The vertical bar denotes the date of the related statement.

By the time Covid-19 appeared, the United States was in a regime of moderate liquidity while the euro area was in a regime of abundant liquidity. The pandemic has thus hit the bank funding cost spreads in very different proportions on the two sides of the Atlantic. In the euro area, the spike in the forward IBOR-OIS spread has been moderate, reaching approximately 13 bp as of March 31. This impact is consistent with remaining in an abundant liquidity environment. The March 18 announcement by the ECB of a new temporary Pandemic Emergency Purchase Programme (PEPP) that will have an additional envelope of EUR 750 billion until the end of 2020 confirms the continuation of this regime. Beyond the size of the envelope, the ECB experience also shows that making liquidity available through differentiated instruments helps target various forms of funding stress. For instance, the asset purchase programs (corporate sector, public sector, asset-backed securities and covered bonds), the Targeted Longer-Term Refinancing Operations (TLTROs) and the broadening of eligible assets accepted as collateral by the Eurosystem can prove more helpful for specific categories of euro area banks.

The situation is clearly different in the United States. Spot and forward IBOR-OIS spreads jumped to 140 and 45 bp, respectively. The increase in the spot funding spread is already higher than the previous maximum reached in this moderate liquidity regime.
experienced in March 2018. Now, the rise in the forward funding spread (FFS) is correlated with those of measures of bank credit risk (spreads on bank corporate bonds and CDSs on bank debt), a worrying feature already observed during the crisis environment that characterized U.S. money markets between 2007 and the beginning of QE3 in September 2012.

The Federal Reserve announced several extraordinary measures to increase liquidity on U.S. money markets between March 12 and 23: (i) an injection of up to USD 1.5 trillion in the repo market; (ii) the purchase of at least USD 500 billion of Treasury securities and at least USD 200 billion of mortgage backed securities; (iii) encouraging banks to use the discount window and intraday credit from the Federal Reserve; (iv) the establishment of the Primary Dealer Credit Facility (PDCF), the Commercial Paper Funding Facility (CPFF), and the Money Market Mutual Fund Liquidity Facility (MMFLF) to support credit needs with a broader range of collateral; (v) the primary market corporate credit facility (PMCCF) for new bond and loan issuance and the Secondary Market Corporate Credit Facility (SMCCF) to provide liquidity for outstanding corporate bonds; and (vi) the Term Asset-backed Securities Loan Facility (TALF) to support the flow of credit to consumers and businesses. These multiple measures will most likely provide the U.S. money market with abundant liquidity conditions, and low and flat spot and forward IBOR-OIS spreads. Indeed, as the ECB experience shows, it is important to combine a large envelope of excess liquidity and multiple channels that target market participants confronted with specific forms of liquidity shortage. Beyond the short-term trauma, the more muted increase in the forward IBOR-OIS spread, and its plateau since March 19 signal the market’s expectation that this bout of liquidity stress will recede.

4 Predictive Content of Forward Funding Spreads

In this section, we assess the relevance of forward funding spreads by evaluating their ability to predict the evolution of indicators of real activity and bank lending. To investigate whether these variables are mainly driven by liquidity or credit risks, we compare the predictive ability of the forward spreads with that of widely used indicators of bank credit and default risks.
4.1 Bank Credit Risk Indicators

We consider two indicators of bank credit and default risks: the credit default swap (CDS) spread and the bank bond credit spread. The first measure relies on banks’ CDS contracts. As they directly measure the risk of default of banks, these contracts are a standard way to measure the extent of a bank’s credit risk. One limitation of the approach is that CDS contracts are usually written on individual institutions and the aggregation over banks may introduce some biases because of the interdependence between banks. As an index representative of banks’ CDS spreads, we use data from ICE Credit Market Analysis (CMA), which collects quotes from the largest and most active credit investors in the OTC market. These indexes are based on five-year maturity senior unsecured debt, as these contracts are usually considered the most liquid. The data start in January 2004.\(^\text{10}\)

The second measure relies on bonds issued by banks and is calculated as the difference between the corporate yield of a given maturity and the corresponding government bond yield with similar maturity. This approach was initiated by Gilchrist and Zakrajšek (2012a) (GZ) for U.S. data and Gilchrist and Mojon (2018) (GM) for European data. The challenge of this approach is related to the structure of the bond market for banks because it may suffer from some lack of liquidity, at least for some financial intermediaries. Indeed, total debt securities represent a relatively small fraction of total bank financing.\(^\text{11}\) The GZ index is constructed as follows. For a given month \(t\) and a given firm \(i\), the market price of the outstanding bond security \(k\) is used to compute its yield \(y_{i,t}[k]\). Then, the individual credit spread is computed by subtracting the yield of a Treasury security of the same maturity \(y_{f,t}[k]\), so that the credit spread is written as: \(S_{i,t}[k] = y_{i,t}[k] - y_{f,t}[k]\). Finally, the index is the (unweighted) average over maturities and over firms of the individual credit spreads: \(S_{t}^{GZ} = \frac{1}{N_t} \sum_{i} \sum_{k} S_{i,t}[k]\), where \(N_t\) is the number of bond/firm observations in month \(t\). For the GM index in the euro area, the individual credit spread is calculated by subtracting the German Bund zero coupon interest rate of a similar maturity. The GM credit risk indicator is then calculated as the (weighted) average of the individual credit spreads, where weights correspond to the ratio of the market value of the security relative to the total market value of all bonds in the sample.\(^\text{12}\)

\(^{10}\) Gefang, Koop, and Potter (2014) compare several databases collecting CDS prices. They report that CMA quotes lead the price discovery process. We also estimated predictive regressions with Thomson Reuters indexes, starting in December 2007, and reached very similar conclusions.

\(^{11}\) Long-term debt securities represent on average less than 2% of commercial banks’ total liabilities in the United States.

\(^{12}\) The GZ spread for banks covers the period from January 1985 to December 2012 and has not been updated since, while the spread for nonfinancial firms covers the period from January 1973 to November
Figure 9 displays the monthly evolution of the three-month forward (three-month tenor) (denoted by $FFS_{3m-3m}^{(3)}$) and six-month forward (six-month tenor) spreads ($FFS_{6m-6m}^{(6)}$), the CDS spread, and the GZ and GM spreads for the United States and the euro area between 2005 and 2019. We observe some substantial differences between the indicators across the two zones. In the United States (Panel A), the four indicators exhibit a peak during the financial crisis but with different timings. The three-month forward tenor spread reaches its maximum in October 2008 just before the GZ spread (November), while the six-month forward tenor spread and the CDS spread peak in March 2009. The four indicators also substantially increase in November–December 2011 with very similar timings. We note, however, that the CDS spread and the six-month tenor spread are almost as high as the maximum attained in 2008–09. Finally, there is a surge in the GZ spread in January 2016 that is not associated with significant movement in the other spreads. Note that the three-month forward and six-month forward spreads display different correlation patterns. The three-month forward spread is highly correlated with the GZ spread (close to 80%), while the six-month forward spread is more correlated with the CDS spread (56%). All this evidence suggests that the indicators may capture different phenomenons.

In the euro area (Panel B), the CDS and GM spreads have similar levels and temporal evolutions: both indicators sharply increase during the 2008–09 crisis (to a maximum of 300 bp in March 2009), and they experience an even more pronounced increase in 2011–12 during the sovereign debt crisis (from 200 bp to a maximum of 500 bp in November-December 2011). We note that the CDS spread also jumps at the end of 2015, with a peak in February 2016, while the GM spread barely increases. Both tenor spreads also increase substantially during the subprime crisis (with a maximum of 120 bp and 60 bp for the three-month forward and six-month forward spread, respectively). The impact of the sovereign debt crisis is much more limited, as the spreads do not exceed 120 bp. In the recent period, the evolution is smoothed, and the tenor spreads do not exceed 25 bp. In contrast to the United States, the correlation between the three-month forward tenor spread and the credit spreads is relatively low (below 50%). In contrast, for the six-month tenor spread, the correlation is as high as 70% with the GM spread. As expected, the correlation between the CDS and GM spreads is much higher, approximately 90%.

In summary, in the United States, the similarity between the series suggests that predictive ability should be more similar across indicators. In contrast, in the euro area, they are

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2019 (Gilchrist and Zakrajšek, 2012a). We have estimated the linear relation between the two indicators between 2005 and 2012 and used this relation to update the bank spread between 2013 and 2019. We investigated other approaches and obtained similar results.
likely to exhibit different predictive properties because of their different temporal evolution.


4.2 Methodology

We now adopt the following methodology to measure the ability of liquidity and credit spreads to predict real economic activity (Gilchrist and Zakrajšek, 2012a, and Gilchrist and Mojon, 2018). Let \( y_{t+h} = \Delta^h \log Y_{t+h} \) measure the \( h \)-quarter ahead percent change in the variable of interest \( Y_t \). The predictive equation is written as:

\[
y_{t+h} = \alpha_0 + \beta S_t + \varepsilon_{t+h},
\]

where \( S_t \) is the spread indicator and \( \varepsilon_{t+h} \) is an error term. For all predictive regressions, we report results for the (spot and forward) funding spreads, the CDS spread, and the GZ/GM spread. Given data limitations, we perform our analysis from January 2005 to November 2019. Regarding funding spreads, we investigate the role of their tenor and maturity in determining their predictive ability. First, we report the spot funding spread, which corresponds to the standard IBOR-OIS spread. Second, we report results for the one-, three- and six-month tenors, for different starting dates and maturities. Specifically, we test three-, six-, and 12-month FFSs with \( x \)-month tenor, denoted by \( F_{(3m,3m)}^{(x)}, F_{(6m,6m)}^{(x)}, \) and \( F_{(12m,12m)}^{(x)} \). We also consider alternative combinations of starting dates and maturities such as a 12-month forward spread starting in 6 months \( (F_{(6m,12m)}^{(x)}) \) or a 12-month forward spread starting in 24 months \( (F_{(24m,12m)}^{(x)}) \), to investigate the importance of the forward-looking component. We do not report all of the results for the sake of space, but they are available upon request.

Finally, for the spot IBOR-OIS spread, we report results for the one-month to six-month spreads, which are the most widely used indicators. We also investigate the 12-month spread

\[
y_{t+h} = \Delta^h \log Y_{t+h} = \alpha_0 + \alpha_1 r_t + \alpha_2 \text{term}_t + \beta S_t + \varepsilon_{t+h},
\]

where \( r_t \) measures the real short-term interest rate and \( \text{term}_t \) measures the term premium. The real interest rate is measured as the short-term rate (federal funds rate in the United States, Eonia rate in the euro area) minus the 12-month inflation rate. The term spread is measured as the difference in yields on 10-year AAA sovereign bonds minus the short-term interest rate (federal funds or Eonia rates). These variables have limited predictive content, except for the United States for long horizons. Therefore, we do not report results with these variables in the main text.

\[13\] We also investigated the extended regression:

\[
y_{t+h} = \Delta^h \log Y_{t+h} = \alpha_0 + \alpha_1 r_t + \alpha_2 \text{term}_t + \beta S_t + \varepsilon_{t+h},
\]

where \( r_t \) measures the real short-term interest rate and \( \text{term}_t \) measures the term premium. The real interest rate is measured as the short-term rate (federal funds rate in the United States, Eonia rate in the euro area) minus the 12-month inflation rate. The term spread is measured as the difference in yields on 10-year AAA sovereign bonds minus the short-term interest rate (federal funds or Eonia rates). These variables have limited predictive content, except for the United States for long horizons. Therefore, we do not report results with these variables in the main text.
but they never outperform forward tenor spreads. For the sake of space, we do not report results based on these indicators, but again, they are available upon request.

We consider several real activity variables (real GDP, real consumption, real investment, and unemployment rate) and several measures of bank lending (total bank lending, consumer loans, and commercial and industrial loans). The results related to real activity are reported in Tables 1 and 2 for the United States and the euro area, respectively. The results related to bank lending are reported in Tables 3 and 4. For reasons that we explain below, we do not report the same predictive spreads for real activity and bank lending. In all tables, we focus on one-quarter, two-quarter, and four-quarter predictability.

4.3 Predicting Real Activity

GDP growth. We begin with the ability of the spread indicators to predict real GDP growth. As Table 1 (Panel A) reveals, FFSs are the best predictors of U.S. GDP growth. The three-month forward spread (one-month tenor) has the highest predictive power for GDP growth. The adjusted $R^2$ values are equal to 43% and 49%, for the one- and two-quarter horizons, respectively. On average, an increase of 1% in the one-month tenor spread predicts a decrease of 2.25% and 4% in the subsequent quarters. The parameters are all highly significant. They increase with the forecast horizon and decrease with the tenor. The one-month IBOR-OIS spread also has a relatively high adjusted $R^2$ values but they remain below the $R^2$ obtained with the three-month forward and six-month forward funding spreads (with one-month tenor) for one- and two-quarter horizons. The CDS and GZ spreads have a lower predictive ability: The adjusted $R^2$ values range between 14% and 20% for the one- and two-quarter horizons. For the one-year horizon, the adjusted $R^2$ values are close to 10%, and the parameters have high $p$-values.\(^{14}\)

In the euro area, the best predictors are again the FFSs but with a higher tenor and a more distant starting date. For instance, the adjusted $R^2$ values are equal to 54.7%, 61.7%, and 57.4%, for the one-, two- and four-quarter horizons, respectively, for the three-month FFS (three-month tenor). The spreads based on other starting dates and other tenors exhibit similar results, with negative and highly significant coefficients (all $p$-values are below 0.1%). On average, an increase of 1% in the three-month FFS predicts a decrease in GDP of 2.3%, 4.4%, and 7.2% in the subsequent quarters. The CDS and GM spreads again have lower

\(^{14}\)For the United States, when the real short-term rate and the term spread are introduced into the regression, the adjusted $R^2$ improves for longer horizons. This increase is, to a large extent, due to the higher predictive ability of the short-term rate and term spread at longer horizons.
predictive performance. Credit spreads do not perform as well as funding spreads. For the GM spread, the adjusted $R^2$ is approximately equal to 20%, 16%, and 9%, for the one-, two- and four-quarter horizons, respectively, also with highly significant parameters. For CDS spreads, the adjusted $R^2$ values are all below 6%. The better prediction generated by the FFSs is due to the ability of these indicators to anticipate the magnitude of the recession during the subprime crisis. Tenor spreads predict a more severe recession in 2008–09 than in 2012. In contrast, the CDS and GM spreads predict a more severe recession in 2012.

[Please Insert Tables 1 and 2 here]

Consumption growth. We now consider the ability of spread indicators to predict real consumption growth. The results reported in Panel B indicate that the FFSs also dominate the other indicators. Regarding the United States, we find that the three-month FFS (one-month tenor) produces the best forecasts, with an adjusted $R^2$ close to 41%, 49% and 39% for the one-, two- and four-quarter horizons. The CDS and GZ spreads exhibit lower predictive ability, between 20% and 33% for all horizons.

In the euro area, the three-month FFS (three-month tenor) and the six-month FFS (six-month tenor) strongly outperform the spot IBOR-OIS, CDS, and GM spreads for all horizons. For instance, for the one-quarter horizon, the adjusted $R^2$ values are as high as 50% and 52%, respectively, whereas they are all below 45% for the spot IBOR-OIS and credit spreads.

Investment growth. Panel C reports that in terms of predicting U.S. investment growth, the spot one-month IBOR-OIS spread and the one-month FFS (one-month tenor) dominate the other indicators for all horizons: for both variables, the adjusted $R^2$ values are close to 58% and 50% for the one- and two-quarter horizons. The GZ spread produces a relatively high $R^2$, but it is on average 25%-35% below the $R^2$ of the FFS. The CDS spread has a lower performance at all horizons (below 5%). It is worth emphasizing that the spot IBOR-OIS spread performs well for investment growth whereas the FFS clearly dominates for consumption growth. This result suggests that expectations play a different role for these two variables. Investment seems to be more reactive to the most recent information, while consumption is based on more forward-looking expectations.

For the euro area, the gain of using the FFS is not as large for predicting investment as for predicting consumption but it is still substantial. The adjusted $R^2$ values of the three-month
FFS (three-month tenor) are equal to 26%, 59%, and 66% for the one-, two- and four-quarter horizons but 26%, 54%, and 52% for the spot IBOR-OIS spread and only 9%, 15%, and 12% for the GM spread. The results with the CDS spread are even worse (adjusted $R^2$ below 5%). A 1% increase in the three-month FFS (three-month tenor) predicts, on average, a decline in investment of 5.6%, 11%, and 18.9% in the subsequent quarters.

**Unemployment rate.** For the unemployment rate (Panel D), the predictive ability of the FFS is again very strong. For the two- and four-quarter horizons, the three-month FFS (one-month tenor) produces adjusted $R^2$ values equal to 72% and 55% for the United States. The performance is similar to that obtained with the spot BOS. The GZ spread also performs well for short horizons, while the CDS spread generates adjusted $R^2$ values below 20%.

In the United States, the three-month FFS is considerable with adjusted $R^2$ values ranging between 60% and 70%. The adjusted $R^2$ values are between 8% and 15% for the GM spread and below 5% for the CDS spread.

In summary, these results indicate that banks’ funding cost (measured by the FFS) has a substantial predictive ability for real activity in the United States and the euro area. In general, the tenor of the FFS is longer for the euro area than for the United States (three months versus one month). This result is probably partly driven by the way expectations are formed in the two areas. In particular, the dynamics of the monetary policy in the euro area during the sovereign debt crisis may have impacted the expectations process.

### 4.4 Predicting Bank Lending

Tables 3 and 4 present the results of the predictive regressions for bank lending for the United States and the euro area, respectively. We investigated several specifications of the forward funding spreads and we found that predicting lending relies on relatively long expectations. Predictions are improved when we consider a distant starting date (such as a 12-month or 24-month FFS) and a longer maturity (such as 12 months). Therefore, to save space, we do not report the results obtained with the three-month and six-month FFS but instead focus on the 12-month FFS. Note that the spot IBOR-OIS spreads usually fail at producing accurate forecasts of bank lending variables, while CDS and GZ/GM spreads perform much better.

In the United States, the 12-month forward spread for one year (with a six-month tenor)
has by far the highest predictive ability. The adjusted $R^2$ is as high as 36% and 66% for the
two- and four-quarter horizons. In comparison, CDS and GZ spreads generate $R^2$ values
close to 33% and 51% for these horizons. Interestingly, the standard spot IBOR-OIS spread
has relatively lower $R^2$ values.

In the euro area, we obtain similar results: The best predictions are obtained with credit
spreads (CDS and GM spreads), with adjusted $R^2$ values above 50%. Among FFSs, the
best predictions are obtained by the 12-month forward spread for two years (with a six-
month tenor) with adjusted $R^2$ values close to or higher than 30% for all horizons. The spot
IBOR-OIS spread does not help to predict bank lending ($R^2$ below 10%).

We now decompose bank lending into its main components: consumer loans and com-
mercial and industrial loans. In the United States, we find that the GZ spread and the
12-month FFS for one year usually provide good performance. For consumer loans, the
adjusted $R^2$ of the GZ spread is higher. For commercial and industrial loans, the CDS
spread again slightly dominates. The $R^2$ values are in the same ballpark. For the FFS, the
adjusted $R^2$ values are close to 35–40% for the two-quarter horizon and close to 64% for
the four-quarter horizon. It is remarkable that the two indicators have similar predictive
ability, despite being built on different types of information.

For the euro area, the 12-month FFS for two years (six-month tenor) produces the best
performance for consumer loans and real estate loans, although predictions provided by the
GM spread are in a similar range of values. In both cases, the adjusted $R^2$ values produced
by the FFS are remarkably high, between 50% and 70% for consumer loans. For commercial
and industrial loans, CDS and GM spreads are similar to one another and slightly dominate
the FFS. In all cases, the spot IBOR-OIS spread fails at predicting bank lending.

In summary, we have explored two categories of variables: (1) real activity variables
rely on relatively short expectations, so the spot IBOR-OIS spread and the short horizon
tenor spreads perform quite well, while CDS and GZ/GM spreads fail at predicting real
activity; (2) bank lending variables rely on relatively long expectations, so the spot IBOR-
OIS spread fails but long-horizon FFSs and CDS and GZ/GM spreads perform well. The
main advantage of the tenor curves is that they allow us to adapt the spread indicator to the
length of the expectations needed. Short horizons (typically three-month forward spreads)
are sufficient for real activity variables; long horizons (typically 12-month forward spreads)
are necessary for inflation and bank lending variables.
5 Conclusion

In this paper, we build a new indicator of bank funding costs, called the forward funding spread, using transaction data from dollar and euro interest rates of various maturities. Our forward funding spreads capture the market expectations of future IBOR-OIS spreads and are consistent in terms of the underlying tenors associated with the interest rate contracts. This is crucial because different frequencies of payments imply different underlying rollover risks.

We show that forward funding spreads are useful in at least two respects. First, they provide central banks with an indication of the market perception of bank funding stress. In crisis times, the forward funding spread is typically smaller than the spot IBOR-OIS, which is consistent with market participants expecting that funding stress will be short lived. We actually characterize liquidity regimes (crisis, moderate and abundant) that coincide with the levels of excess liquidity supplied by either the Federal Reserve or the European Central Bank. We show in particular how liquidity regimes strongly impacted the forward funding spread response to the Covid-19 pandemic on both sides of the Atlantic. Second, forward funding spreads are better predictors of economic and banking activity than alternative spreads either on rollover risk or on credit risk. This is consistent with the view that bank funding stress can influence macroeconomic outcomes only if the market participants expect them to persist. Forward funding spreads also rely on an estimation that can easily be performed at a daily frequency for most of the major currencies to perform real-time analyses. Our results confirm that banks’ funding costs are an important driver of both real activity and bank lending. This evidence suggests that there is room for monetary authorities to respond in a financial crisis mainly driven by a liquidity drought. Providing public liquidity to financial institutions can help mitigate the lack of private liquidity and the subsequent increase in funding costs.

Looking forward, one potential issue with the use of funding indicators based on interbank markets is the announced end of the LIBOR market. We should note that our indicators are based on USD LIBOR and EURIBOR rates. For the United States, USD LIBOR may be replaced by the USD Bank Yield Index proposed by ICE. For the euro area, the EONIA will be replaced by ESTR.
References


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### Table 1. Predicting U.S. Real Activity Variables using Funding and Credit Spreads

<table>
<thead>
<tr>
<th>Tenor x</th>
<th>IBOR-OIS 3-month FFS $(F_{3m,3m})$</th>
<th>6-month FFS $(F_{6m,6m})$</th>
<th>CDS spread</th>
<th>GZ spread</th>
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</thead>
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<tr>
<td></td>
<td>1m</td>
<td>3m</td>
<td>6m</td>
<td>1m</td>
</tr>
<tr>
<td>Variables in $t - 1$</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Param.</td>
<td>-1.638</td>
<td>-1.111</td>
<td>-0.888</td>
<td>-2.252</td>
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<tr>
<td>Adj. $R^2$</td>
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<td>0.360</td>
<td>0.309</td>
<td>0.430</td>
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<tr>
<td>Variables in $t - 2$</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Param.</td>
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<td>-1.883</td>
<td>-1.463</td>
<td>-4.003</td>
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<tr>
<td>Adj. $R^2$</td>
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<td>0.304</td>
<td>0.457</td>
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<tr>
<td>Variables in $t - 4$</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Param.</td>
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<td>-1.685</td>
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<tr>
<td>Adj. $R^2$</td>
<td>0.319</td>
<td>0.232</td>
<td>0.139</td>
<td>0.260</td>
</tr>
</tbody>
</table>

### Panel A: Real GDP growth

| Variables in $t - 1$ |
| Param. | -1.638 | -1.111 | -0.888 | -2.252 | -1.631 | -0.940 | -2.284 | -1.608 | -1.090 | -0.379 | -0.173 |
| Adj. $R^2$ | 0.385 | 0.360 | 0.309 | 0.430 | 0.372 | 0.304 | 0.401 | 0.331 | 0.266 | 0.146 | 0.204 |

### Panel B: Consumption growth

| Variables in $t - 1$ |
| Param. | -1.110 | -0.792 | -0.696 | -1.704 | -1.269 | -0.755 | -1.727 | -1.260 | -0.892 | -0.392 | -0.155 |
| Adj. $R^2$ | 0.385 | 0.360 | 0.309 | 0.430 | 0.372 | 0.304 | 0.401 | 0.331 | 0.266 | 0.146 | 0.204 |

### Panel C: Investment growth

| Variables in $t - 1$ |
| Adj. $R^2$ | 0.385 | 0.360 | 0.309 | 0.430 | 0.372 | 0.304 | 0.401 | 0.331 | 0.266 | 0.146 | 0.204 |

### Panel D: Unemployment rate change

| Variables in $t - 1$ |
| Param. | 1.179 | 0.878 | 0.721 | 1.609 | 1.195 | 0.754 | 1.625 | 1.211 | 0.858 | 0.235 | 0.161 |
| Adj. $R^2$ | 0.385 | 0.360 | 0.309 | 0.430 | 0.372 | 0.304 | 0.401 | 0.331 | 0.266 | 0.146 | 0.204 |

Note: This table reports predictive regressions for U.S. real activity variables. Predictive horizons are 1 quarter, 2 quarters, and 1 year. Presented are the parameter estimates, Newey-West adjusted $t$-statistics in parentheses, and adjusted $R^2$ values. The sample period runs from January 2005 to November 2019.
Table 2. Predicting Euro Area Real Activity Variables using Funding and Credit Spreads

<table>
<thead>
<tr>
<th>Variables</th>
<th>Real GDP growth</th>
<th>Consumption growth</th>
<th>Investment growth</th>
<th>Unemployment rate change</th>
</tr>
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<tbody>
<tr>
<td>Panel A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variables in t – 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Param.</td>
<td>-2.703</td>
<td>-1.650</td>
<td>-1.404</td>
<td>-4.147</td>
</tr>
<tr>
<td>t-stat</td>
<td>(4.876)</td>
<td>(5.055)</td>
<td>(4.189)</td>
<td>(4.652)</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.512</td>
<td>0.543</td>
<td>0.540</td>
<td>0.556</td>
</tr>
<tr>
<td>Panel B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variables in t – 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>t-stat</td>
<td>(6.754)</td>
<td>(5.714)</td>
<td>(4.781)</td>
<td>(5.400)</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.381</td>
<td>0.465</td>
<td>0.455</td>
<td>0.514</td>
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<tr>
<td>Panel C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variables in t – 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Param.</td>
<td>-6.809</td>
<td>-4.426</td>
<td>-3.583</td>
<td>-13.062</td>
</tr>
<tr>
<td>t-stat</td>
<td>(3.675)</td>
<td>(3.573)</td>
<td>(3.812)</td>
<td>(4.678)</td>
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<tr>
<td>Adj. R²</td>
<td>0.328</td>
<td>0.401</td>
<td>0.356</td>
<td>0.574</td>
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<tr>
<td>Panel D</td>
<td></td>
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<td>Variables in t – 4</td>
<td></td>
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<tr>
<td>Param.</td>
<td>-3.521</td>
<td>-2.451</td>
<td>-2.221</td>
<td>-6.694</td>
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<tr>
<td>t-stat</td>
<td>(2.897)</td>
<td>(3.141)</td>
<td>(3.466)</td>
<td>(4.671)</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.281</td>
<td>0.397</td>
<td>0.446</td>
<td>0.484</td>
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<tr>
<td>Panel E</td>
<td></td>
<td></td>
<td></td>
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<td>Variables in t – 5</td>
<td></td>
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<tr>
<td>Param.</td>
<td>-5.032</td>
<td>-3.323</td>
<td>-2.907</td>
<td>-8.422</td>
</tr>
<tr>
<td>t-stat</td>
<td>(2.907)</td>
<td>(3.141)</td>
<td>(3.466)</td>
<td>(4.671)</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>0.281</td>
<td>0.397</td>
<td>0.446</td>
<td>0.484</td>
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Note: This table reports predictive regressions for euro area real activity variables. Predictive horizons are 1 quarter, 2 quarters, and 1 year. Presented are the parameter estimates, Newey-West adjusted t-statistics in parentheses, and adjusted R² values. The sample period runs from January 2005 to November 2019.
Table 3. Predicting U.S. Bank Lending Variables using Funding and Credit Spreads

<table>
<thead>
<tr>
<th>Tenor x</th>
<th>IBOR-OIS (SFS) spread</th>
<th>12-month FFS ($F_{12m,12m}^{(x)}$)</th>
<th>12-month FFS ($F_{24m,12m}^{(x)}$)</th>
<th>CDS spread</th>
<th>GZ spread</th>
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<tr>
<td></td>
<td>1m</td>
<td>3m</td>
<td>6m</td>
<td>1m</td>
<td>3m</td>
</tr>
</tbody>
</table>

**Panel A: Bank credit growth**

**Variables in t − 1**
- Param: -0.687, -0.902, -1.201, -1.916, -2.085, -2.046, -1.466, -2.712, -2.798, -0.754, -0.315
- t-stat: (1.448) (2.422) (2.987) (1.828) (2.520) (3.485) (0.941) (1.885) (2.807) (2.401) (3.125)
- Adj. $R^2$: 0.000, 0.046, 0.136, 0.042, 0.098, 0.179, 0.001, 0.051, 0.104, 0.149, 0.172

**Variables in t − 2**
- Param: -1.826, -2.307, -2.832, -4.889, -5.092, -4.721, -4.565, -7.292, -6.901, -1.816, -0.703
- Adj. $R^2$: 0.029, 0.134, 0.293, 0.123, 0.234, 0.364, 0.047, 0.163, 0.253, 0.332, 0.325

**Variables in t − 4**
- Adj. $R^2$: 0.162, 0.332, 0.537, 0.365, 0.515, 0.657, 0.172, 0.375, 0.491, 0.514, 0.513

**Panel B: Consumer loan growth**

**Variables in t − 1**
- Param: 1.661, 0.646, 0.021, 0.803, 0.164, -0.411, 0.292, -0.079, -0.798, -0.650, -0.264
- t-stat: (2.805) (1.085) (0.036) (0.499) (0.139) (0.470) (0.127) (0.041) (0.569) (1.508) (1.408)
- Adj. $R^2$: 0.047, 0.002, -0.018, -0.012, -0.017, -0.013, -0.017, -0.018, -0.012, 0.058, 0.063

**Variables in t − 2**
- Param: 0.628, -0.404, -1.255, -1.331, -1.806, -2.372, -1.335, -2.142, -2.943, -1.510, -0.706
- t-stat: (0.409) (0.339) (1.250) (0.443) (0.885) (1.647) (0.333) (0.652) (1.132) (1.931) (2.431)
- Adj. $R^2$: -0.015, -0.016, 0.014, -0.013, -0.001, 0.033, -0.015, -0.010, 0.008, 0.110, 0.165

**Variables in t − 4**
- t-stat: (0.814) (1.510) (2.902) (2.191) (2.770) (3.291) (1.275) (1.392) (1.623) (2.975) (4.486)
- Adj. $R^2$: -0.008, 0.029, 0.112, 0.068, 0.095, 0.157, 0.031, 0.057, 0.086, 0.261, 0.360

**Panel C: Commercial and Industrial loan growth**

**Variables in t − 1**
- t-stat: (1.303) (2.570) (3.690) (2.196) (3.142) (4.091) (0.986) (2.035) (2.575) (1.590) (3.559)
- Adj. $R^2$: 0.003, 0.075, 0.208, 0.064, 0.139, 0.253, 0.012, 0.086, 0.152, 0.153, 0.382

**Variables in t − 2**
- t-stat: (2.672) (3.992) (5.178) (3.172) (4.157) (5.005) (1.332) (2.232) (2.567) (1.829) (4.856)
- Adj. $R^2$: 0.049, 0.181, 0.362, 0.155, 0.264, 0.400, 0.056, 0.166, 0.237, 0.242, 0.527

**Variables in t − 4**
- Adj. $R^2$: 0.222, 0.425, 0.629, 0.395, 0.524, 0.641, 0.167, 0.325, 0.364, 0.371, 0.704

Note: This table reports predictive regressions for U.S. bank lending variables. Predictive horizons are 1 quarter, 2 quarters, and 1 year. Presented are the parameter estimates, Newey-West adjusted $t$-statistics in parentheses, and adjusted $R^2$ values. The sample period runs from January 2005 to November 2019.
### Table 4. Predicting Euro Area Bank Lending Variables using Funding and Credit Spreads

<table>
<thead>
<tr>
<th>Tenor x</th>
<th>IBOR-OIS spread (SFS)</th>
<th>12-month FFS ($F_{12m,12m}^{(x)}$)</th>
<th>12-month FFS ($F_{24m,12m}^{(x)}$)</th>
<th>CDS spread</th>
<th>GM spread</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1m</td>
<td>3m</td>
<td>6m</td>
<td>1m</td>
<td>3m</td>
</tr>
<tr>
<td><strong>Panel A: Bank credit growth</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variables in $t - 1$</td>
<td>Param.</td>
<td>0.218</td>
<td>-0.238</td>
<td>-0.644</td>
<td>-2.253</td>
</tr>
<tr>
<td>t-stat</td>
<td>(0.214)</td>
<td>(0.411)</td>
<td>(1.348)</td>
<td>(1.366)</td>
<td>(1.941)</td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>-0.017</td>
<td>-0.014</td>
<td>0.024</td>
<td>0.032</td>
<td>0.045</td>
</tr>
<tr>
<td>Variables in $t - 2$</td>
<td>Param.</td>
<td>-0.035</td>
<td>-0.792</td>
<td>-1.533</td>
<td>-5.256</td>
</tr>
<tr>
<td>t-stat</td>
<td>(0.019)</td>
<td>(0.750)</td>
<td>(1.656)</td>
<td>(1.727)</td>
<td>(1.843)</td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>-0.018</td>
<td>-0.006</td>
<td>0.045</td>
<td>0.062</td>
<td>0.077</td>
</tr>
<tr>
<td>t-stat</td>
<td>(0.501)</td>
<td>(1.332)</td>
<td>(1.942)</td>
<td>(2.024)</td>
<td>(2.190)</td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>-0.015</td>
<td>0.015</td>
<td>0.088</td>
<td>0.110</td>
<td>0.138</td>
</tr>
</tbody>
</table>

**Panel B: Consumer loan growth**

| Variables in $t - 1$ | Param. | -0.774 | -0.946 | -1.219 | -3.486 | -2.945 | -2.837 | -6.954 | -5.285 | -4.929 | -0.592 | -0.895 |
| t-stat | (0.917) | (1.550) | (2.162) | (2.033) | (2.772) | (4.302) | (3.259) | (4.545) | (7.415) | (6.864) | (7.174) |
| Adj. $R^2$ | -0.002 | 0.051 | 0.138 | 0.106 | 0.217 | 0.346 | 0.285 | 0.357 | 0.511 | 0.417 | 0.458 |

**Panel C: Commercial and Industrial loan growth**

| Variables in $t - 1$ | Param. | 1.125 | 0.028 | -0.707 | -1.743 | -1.599 | -2.600 | -5.508 | -5.027 | -0.903 | -1.288 |
| t-stat | (0.843) | (0.033) | (0.938) | (0.660) | (0.948) | (2.116) | (1.720) | (1.596) | (3.367) | (4.045) | (3.730) |
| Adj. $R^2$ | 0.001 | -0.018 | 0.011 | -0.001 | 0.020 | 0.151 | 0.087 | 0.073 | 0.287 | 0.542 | 0.528 |

Note: This table reports predictive regressions for euro area bank lending variables. Predictive horizons are 1 quarter, 2 quarters, and 1 year. Presented are the parameter estimates, Newey-West adjusted t-statistics in parentheses, and adjusted $R^2$ values. The sample period runs from January 2005 to November 2019.
Figure 1. Forward Funding Spreads for the United States and the Euro Area

Note: Panel A displays the 3-month FFS for tenors 1 month, 3 months, and 6 months for the United States. Panel B displays the 3-month FFS for tenors 1 month, 3 months, and 6 months for the euro area. The series are smoothed using a 5-day moving average. The sample periods run from January 2005 to March 2020.
Figure 2. Funding Spreads in the United States and Federal Reserve Total Assets

Note: Panel A displays the 3-month FFS (3-month tenor), the spot 3-month IBOR-OIS, and the difference between the two spreads. Panel B displays the Federal Reserve total assets (in USD trillion). The spread series are smoothed using a 5-day moving average. The sample periods run from January 2007 to March 2020.
Figure 3. Funding Spreads in the Euro Area and ECB Total Assets

Note: Panel A displays the 3-month FFS (3-month tenor), the spot 3-month IBOR-OIS, and the difference between the two spreads. Panel B displays the ECB total assets (in EUR trillion). The spread series are smoothed using a 5-day moving average. The sample periods run from January 2007 to March 2020.
Figure 4. Bank CDS Spreads and Uncertainty in Short-term Interest Rates in the United States

Note: Panel A displays the bank CDS spread. We also add the 3-month FFS for comparability. Panel B displays the uncertainty in 3-month interest rates in 3 months, as measured as the sum of disagreement among forecasters and the perceived variability of future aggregate shocks. See Istrefi and Mouabbi (2018). The spread series are smoothed using a 5-day moving average. The sample periods run from January 2007 to March 2020.
Figure 5. Bank CDS Spreads and Uncertainty in Short-term Interest Rates in the Euro Area

Note: Panel A displays the bank CDS spread. We also add the 3-month FFS for comparability. Panel B displays the uncertainty in 3-month interest rates in 3 months, as measured as the sum of disagreement among forecasters and the perceived variability of future aggregate shocks. See Istrefi and Mouabbi (2018). The spread series are smoothed using a 5-day moving average. The sample periods run from January 2007 to March 2020.
Figure 6. 3-month Spot and Forward Funding Spreads for the United States – Subsamples

Note: The figure displays the 3-month FFS (3-month tenor), the spot 3-month IBOR-OIS, and the difference between the two spreads for the United States for four subsamples. The series are smoothed using a 5-day moving average.
Figure 7. 3-month Spot and Forward Funding Spreads for the Euro Area

Note: The figure displays the 3-month FFS (3-month tenor), the spot 3-month IBOR-OIS, and the difference between the two spreads for the euro area for four subsamples. The series are smoothed using a 5-day moving average.
Figure 8. Funding Cost Indicators in the United States and the Euro Area in 2020

Note: The figure displays the 3-month FFS (3-month tenor), the spot 3-month IBOR-OIS, and the difference between the two spreads for the United States (Panel A) and the euro area (Panel B) in 2020. The vertical bar corresponds to the announcement by the World Health Organization that the global Covid-19 outbreak risk is very high on February 28, 2020. The series are smoothed using a 5-day moving average.
Figure 9. Funding and Credit Risk Indicators

Note: Panel A displays the bank credit risk indicators for the United States: the 3-month and 6-month FFS, the CDS spread, and the bank GZ spread (Gilchrist and Zakrajšek, 2012b). Panel B displays the bank credit risk indicators for the euro area: the 3-month and 6-month FFS, the CDS spread, and the GM spread (Gilchrist and Mojon, 2018). The sample periods run from January 2005 to November 2019.
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<td>Bryan Hardy and Can Sever</td>
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