Banc Ceannais na hÉireann
Central Bank of Ireland
Eurosystem

Research Technical Paper

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Vol. 2019, No. 7.

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Abstract

Using a unique dataset, covering more than 40 percent of euro area money market funds by asset value, we assess monetary policy effects on fund behaviour and performance. We find a strong but heterogeneous association between fund performance and the policy rate of the currency in which funds report and from this we ascertain how different combinations of conventional and unconventional monetary policies affect fund behaviour. Evidence from the speed of response to policy changes indicates a shortening of investment term when policy is easing and vice versa. This has supply-of-funding implications across the first two years of the term structure. When euro area monetary policy is at its limit and when policy is expanded to include the use of unconventional measures, the gap between the rate earned at the ECB's deposit facility and the yield on short term debt securities widens. In these conditions euro-reporting funds make indirect recourse to the deposit facility and raise their investments in euro-denominated tradable certificates of deposits. This behaviour progressively reduces the impact of unconventional measures on MMF performance. Otherwise, heterogeneity in fund responses to the monetary policy mix can be attributed to differential mandates and involves some combination of increased risk-taking and diversification into assets issued by foreign entities.

JEL classification: E52, G15, G23, G28.

Keywords: Money Market Funds; Monetary Policy; Negative Interest Rates.

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Views expressed are those of the authors. We are grateful for comments from Governor Philip Lane, Robert Goodhead (our internal RTP reviewer), and our colleagues in Statistics, Financial Stability and Securities & Markets Supervision including; Kitty Moloney, Neill Killeen, Fiedor Pawel, Pierce Daly, Barra McCarthy, Daniele Bertocchi, Padraig O'Brien and John Rowe. We also thank participants at the Irish Economic Association Conference (2018).

Non-Technical Summary

Money market funds (MMFs) are key actors in money markets and play an important role in the transmission of monetary policy. They perform liquidity transformation by issuing redeemable shares while investing in high quality short-term assets such as treasury bills, repurchase agreements and certificates of deposit. Compared with MMFs in the US, MMFs in Europe tend to invest more heavily in bank-issued short term liabilities so their behavioural response to monetary policy has more relevance for banks' short term funding. During the Global Financial Crisis some MMFs struggled to maintain a constant net asset value and some sponsor banks provided support. Fund-sponsor linkages as a source of systemic risk has been greatly reduced due to regulatory changes in both the US and Europe. However, run risks may still have relevance for the smooth functioning of money markets depending on how MMFs respond to the challenging conditions brought about by extreme and unconventional monetary policies. It is the response to these challenging conditions that is the main focus of the present analysis.

We assess how the large population of Irish-domiciled MMFs have responded to quantitative easing and low interest rates. We categorise funds by reporting currency and investment mandate. The behavioural response is considered in two different ways. Firstly, we examine changes in the types of assets that MMFs choose to hold. Secondly, we examine MMF investment performance. In the case of the latter, we apply panel regression methods to reveal how policy rate changes and other risk factors transmit to annualised return performance.

Our descriptive analysis reveals that most MMFs domiciled in Ireland do not report in euros (about one quarter of the sample by invested amount is in the EUR-reporting category). Since MMFs, by regulation, may only invest in assets denominated in the currency in which they report, we are able to assess the effects of different monetary policies without the confounding effects of differential regulation. Unsurprisingly, MMF investment returns are strongly related to the policy interest rate of the currency of their investments. There is, however, evidence of heterogeneity in this relation depending on the direction of policy and the policy mix. We find a difference in the speed of performance response to policy consistent with a shortening of investment term when rates are declining and vice versa. This has supply-of-funding implications for the very short-end of the term structure of interest rates and could have implications for the funding risks of banks.

The other principal explanation for heterogeneity in responses to policy concerns the policy mix. Euro area unconventional monetary policy has been unusual in terms of its intensity and the timing of its implementation. Short term interest rates, unlike in the US or UK, were pushed into negative territory before unconventional measures were introduced. Being much closer to the true lower bound of conventional policy, asset purchases pushed short term bond yields below the negative policy rate. We find that EUR-reporting MMFs increased their investments in short term bank liabilities in these circumstances. They substantially increased the volume of their cash and near-cash transactions. Further examination of EUR-reporting MMF assets indicates a significant increase in holdings of euro-denominated Tradable Certificates of Deposit issued by UK banks (particularly by Constant Net Asset Value funds). These developments coincide with a reassertion of the link between performance and the conventional policy rate. Reducing these linkages should be a consideration when the mix of monetary policies is being renormalised.

Introduction

Since the Global Financial Crisis, an unprecedented range and scale of unconventional monetary policy has been undertaken by major central banks and this has been challenging for Money Market Funds (MMFs) that invest in money-like assets. In terms of interest rate policy the challenges have been greater in the euro area where deposit and lending rates were set significantly below zero (whereas they remained just above zero in the US and UK). Additional differences between the euro area and other regions concern the timing and intensity in the application of unconventional monetary policies. During the ECB's Expanded Asset Purchase Programme (EAPP), a significantly larger wedge emerged between the policy rate and yields on short-term debt securities compared with what occurred in the US or UK under similar QE programmes (see Figure 1 for a comparison of these rates over time). The aim of this paper is to assess how differences in the monetary policy mix across the currencies in which funds report (and invest), have affected the behaviour and performance of a large subset of MMFs resident in Europe. We focus on Ireland, the country where MMFs are most dominant within the euro area.[1] As far as we know, this paper is the first attempt to examine how the mix of monetary policies in such circumstances affects European MMF behaviour and performance.

Money market funds are key actors in money markets and they play an important role in the transmission of monetary policy. They perform liquidity transformation by issuing shares that are redeemable on demand and by investing in quality short-term assets like treasury bills, repurchase agreements and certificates of deposits. Their units may be viewed by investors as a safe alternative to bank deposits, especially in the case of funds that seek to maintain an unchanging face value (constant NAV).[2] During the Global Financial Crisis (GFC), however, it became evident that the bank-like features of MMFs and their susceptibility to investor runs, could be a source of systematic risk (i.e. McCabe (2010), Brunnermeier and Pedersen (2009), Moody's (2010), Gordon and Gandia (2014)). This is especially relevant in the EU context where MMFs invest a large part of their portfolio in banks' liabilities and where institutional investors - who would generally have a higher flight probability - account for a sizeable part of their investor base (Ansidei et al. (2012)).[3] In such a context, investor runs might not only impair liquidity but could also prompt significant short term funding problems for the banking sector. While the systemic risks associated with MMFs due to linkages with sponsors has largely been eliminated by recent regulatory changes in the US and Europe, run risks remain relevant given the current challenging circumstances. It is MMF behaviour at times of extreme monetary policy (both arriving and departing from the extreme) that is the main focus of the present analysis.

In an extreme negative interest rate environment, MMFs face two main options. On the one hand, they have a strong incentive to rebalance their investment portfolios

[1] MMFs domiciled and reporting in Ireland account for 42 percent of Total Asset Value of euro area MMFs at the end of 2017.

[2] Also, for policy analysis MMFs are included in the money-issuing sector and their shares are considered as cash equivalents. Such treatment makes them more attractive to corporates (Ansidei et al. (2012)) and to other mutual as a means of providing liquidity to their investors Chernenko and Sunderam (2016).

[3] At the end of 2017, Irish domiciled MMFs held, on average, 67 percent of their portfolio in instruments issued by banks.

towards riskier assets, *reaching for yield*, in order to attract more inflows and (in the case of Constant NAV funds) to keep returns above zero.[4] By definition, *reaching for yield* constitutes an increase in risk-taking and usually involves term-extension and illiquidity beyond what the typical end-holders of such funds would usually prefer. Thus, this kind of strategy, could expose MMFs to liquidity contractions and run risks that stem from 'first mover advantage' motives as described in Goldstein et al. (2017). On the other hand, MMFs could keep their risk profiles unchanged, move into deposit-like securities to preserve liquidity and accept lower (and even negative) returns. This, however, would force them to abandon efforts to maintain a stable net asset value and could ultimately lead to substantial investor redemptions if macroeconomic circumstances turn more negative or if forward guidance unexpectedly signals a more persistent low rate environment. If the low rate persists for too long this could lead funds to exit the industry.

There are, however, a number of more subtle changes that MMFs can make in their portfolio selection strategies in order to avoid and manage the risks associated with adverse monetary policy developments and a mix of such responses is probable. Firstly, MMFs can manage monetary policy uncertainty by spreading their investments across the liabilities of entities that are exposed to different macroeconomic and monetary policy circumstances. This would work if the credit risk premium of the liabilities issued by foreign entities in the reporting-currency of the fund was, to some extent, insulated from macroeconomic and monetary policy developments associated with the reporting currency. Secondly, since conventional monetary policy is usually implemented with inertia, alterations in the term of MMF investments can be used to modify how policy transmits to performance.

If the term structure inverts, it is possible to avoid the immediate effects of expected future low rates by shortening the term of investments (see, Stein and Sunderam (2018) who consider similar kinds of investor responses to policy gradualism). This delays the pass-through of policy to performance and it may enable an avoidance of the very low interest rate state if that turns out to be shorter-lived than was originally expected. Likewise, when rates are suddenly projected to rise, an upward sloping term structure may encourage a sudden lengthening of the term of investment so as to immediately take advantage of higher rates. The changes in term of investments by mutual funds in response to monetary policy surprises is addressed by Brooks et al. (2019) and its implications for bond pricing and the efficacy of conventional and unconventional policy are described by Greenwood and Vayanos (2010) and Vayanos and Vila (2009).

The mix of unconventional policies (and the imbalance in their intensities) may also be important for the interaction between banks and MMFs. Although MMFs do not have direct access to the deposit facility of the ECB, banks can mediate on their behalf. A valid hypothesis is that banks would choose to accept deposits from MMFs if the latter were willing to accept yields below the deposit facility rate. It is plausible to suggest that MMFs would be willing to deposit with banks at such low rates if alternative investments within their mandate were delivering even lower returns. This would occur if quantitative easing was sufficiently effective in driving the yield on short term debt

[4] La Spada (2018) provides evidence that the near-zero Federal Funds Rate led some US money market funds to adopt a low risk investment strategy so as to reduce the likelihood of 'breaking-the-buck'. However, this is only relevant when the policy rate remains positive. When the policy rate is significantly negative, the rate available on low volatility assets is also typically negative and breaking-the-buck becomes inevitable under the safe-asset strategy.

securities below the deposit facility rate. We show that these conditions indeed occur in the euro area case.

To shed light on how recent monetary policy developments impact the behaviour of MMFs, we consider the response of Irish MMFs in two different ways. Firstly, we examine changes in the types of assets that MMFs choose to hold. Secondly, we examine how target rate changes feed-through to MMF return performance. This, to some extent, follows the analysis of Di Maggio and Kacperczyk (2017) where a strong relationship is found to exist for the case of prime US based funds. Related literature on the reach for yield behaviour of MMFs includes the analysis of La Spada (2018) where it is found that some funds choose safety as a strategy to avoid 'breaking the buck' while Chodorow-Reich (2014) examines how funds adjust administration costs to avoid this fate. Our paper extends the extant literature in that we account for differences in the conventional and unconventional policy mix according to the three main reporting currencies of our sample, we examine the dynamics of pass-through to ascertain whether term of investment is used to avoid the most adverse monetary policy conditions and we assess the composition of investments for signs of diversification of monetary policy uncertainty. We also extend the previous literature by including a wider variety of MMFs (both 'Constant' and 'Variable' Net Asset Value funds).

We find that policy rate pass-through happens with a lag for EUR-reporting funds (and its delay is most pronounced for the case of EUR-reporting CNAV funds that have USD-reporting sibling funds). These funds were able to resist performance declines at the start of the negative rate policy and we explore the possible reasons for this by inspection of the differences in the compositions of portfolios of different groups of MMFs. It is most likely that this is achieved by rebalancing investments away from short-term debt securities and into even shorter-term Tradeable Deposits issued by banks. While these are usually liquid assets there is a chance that they would have to be sold at a loss as interest rates rise. While pass-through is slow in the EUR-reporting case we find that USD-reporting funds respond much more immediately to rate changes. The latter finding is consistent with a lengthening of the term of investment when the term structure tilts to positive as macroeconomic conditions improve and as expected policy normalisation feeds-into interest rate futures. We also found evidence that EUR-reporting funds manage exposure to monetary policy risks by increasing their holdings of euro-denominated liabilities issued by foreign entities.

As regards the differential effects of rate changes and asset purchases by monetary authorities, we find that the gap in the yield available from the deposit facility and that on short term debt securities (which is, in part, driven by quantitative easing) explains a significant proportion of the variability in the pass-through of the policy rate to fund performance. In the case of the euro-reporting sample we find a strong negative relation between the difference in fund return-performance (in excess of the policy rate) and the gap between the policy rate and the short term government yield. We regard this as evidence of possible round-tripping of investment between banks and MMFs. The optimal mix of policy deserves further analysis since it has implications for the true limits on unconventional policy.

We do not explore in detail the effects of performance on investment flows but the broad pattern of investment across funds according to their reporting currency is clear. While Irish MMFs as a whole have grown by almost 30% in the last three years of our sample, shifting from 391bn to 500bn euros of assets under management, investment inflows responsible for this growth have been almost entirely concentrated on MMFs

that report in (and invest in) non-euro denominated assets. In the case of the EUR-reporting funds, it is clear that MMF performance followed the interest rate targeted by policy into negative territory (and was, to some extent, also negatively affected by non-standard measures) and this likely explains the lack of growth of this part of the Irish domiciled MMF sector.

Our work contributes to a deeper understanding of how conventional and unconventional monetary policy transmits to real economic effects at the short-end of the term structure. While fund performance is mainly driven by the policy rate of the currency of the assets in which funds actually invest we find that non-standard measures can distort the normal relation and the deposit facility rate eventually prevails as the main determinant of performance. Despite their restrictive mandates MMFs also manage their exposure to monetary policy developments through changes in the term of their investments and by international diversification (albeit denominated in euro). These behaviours have implications for the conduct of monetary policy since they affect the term of funding to other systemically important entities such as banks.

The rest of the paper proceeds as follows. In the following section we discuss how our contribution fits into the extant literature. This is followed by a discussion of the regulatory setting and some stylized facts about the data used. The empirical methodology and results are then presented and this is followed by a discussion of robustness checks. A final section contains a summary and concluding comments.

Literature Review

It is known that monetary policy surprises (and central bank purchases of assets) alter the composition of the securities holdings of broad sectors of the economy (see for example, Koijen et al. (2017) and Bubek et al. (2017)). The reaction of European investment funds (those domiciled and reporting in Ireland) to such policy has recently been considered by Bua and Dunne (2019) but this analysis excludes the MMF category. Overall, there is surprisingly little systematic research on the impact of monetary policy on European money market funds despite the EU being the second most important global location for MMFs in terms of assets managed. The existing empirical evidence focuses almost exclusively on the US market.[5] As far as we know, this paper is the first attempt to examine how the mix of monetary policies affect European MMF performance.

The only papers studying the impact of unconventional monetary policy on MMFs performace are Di Maggio and Kacperczyk (2017), Chodorow-Reich (2014) and La Spada (2018). They look at reach for yield behaviour in low interest rate environments accounting for affiliation to financial conglomerates, administrative costs and cost of default, respectively. Di Maggio and Kacperczyk (2017) assess the impact of the zero lower bound interest rate policy on the performance and industrial organization of US prime MMFs using a micro-level database. They show that funds respond fully to

[5]The aggregate dollar amount of investments of US MMFs at the end of 2017 was 3trillion USD. Most studies focus on prime MMFs which account for 700billion USD. (Source: https://www.federalreserve.gov/releases/efa/efa-project-money-market-funds-investment-holdings-detail.htm). The total asset value of MMFs resident in the Euro Area at the end of 2017 was 1.1trillion EUR. (Source: https://sdw.ecb.europa.eu/reports.do?node=1000005719).

changes in short term interest rates. They also provide evidence that a sustained low interest rate policy, changes the structure of the whole MMF industry, forcing managers to invest in riskier assets, causing exits from the market and generating a reallocation of resources across fund families. Affiliated money funds are found to be more likely to exit the market than those that are not part of a fund family. Chodorow-Reich (2014) finds that MMFs with higher administrative costs were more likely to reach for higher returns in the 2009-2011 period, but not thereafter when the return differential from investing in different asset classes compressed.

Contrasting somewhat with the broader tendency for increased risk taking in response to unconventional policies by the MMF sector as a whole, La Spada (2018) provides evidence that lower risk-free rates cause MMFs to tilt their portfolios toward safer asset classes. This channel of monetary policy is peculiar to MMFs and comes from the need of CNAV MMFs to adopt a low risk investment strategy so as to reduce the likelihood of 'breaking-the-buck'. He also disentangles the direct effect of monetary policy from that of the risk premia and finds that when risk premia increased, funds with lower default costs face a higher competitive pressure and therefore take more risk. Our paper extends their work in that: i) we focus on MMFs resident in the Euro Area; ii) we include both CNAV and VNAV funds in our analysis; iii) we consider the behavioural responses of funds according to reporting currency which allows a comparison of the different policy combinations (timings, intensities and economic circumstances); and iv) we consider the interaction between MMFs and banks.

We consider the timing of responses to policy actions in more detail than previous literature. This leads to new evidence on the adjustment in investment term by MMFs when faced with a change in the slope of the term structure of interest rates at the short end (over the 2-year horizon). When policy is becoming more accommodative MMFs may decrease the term of the funding they supply to banks and the opposite is true in up-turns. Changes in the term of funding could increase the speed of the transmission from policy rates to interbank rates but this will also involve increased funding roll-over risks during the accommodative phase. At times of a turnaround towards a tightening of policy, there may be a sudden switch by MMFs into longer term liabilities that would dampen the pass-through of the policy move. Our analysis of this behaviour can be considered as a contribution to literature on market reaction to policy gradualism such as in Stein and Sunderam (2018) and Drechsler et al. (2018). A role for these types of demand effects on the term structure and transmission of monetary policy is described in the *preferred habitat* model of Vayanos and Vila (2009).[6] The behaviour that we uncover may also explain the unusual short-rate forecast error variance discussed in Cieslak (2018).

While our paper focuses mainly on monetary policy transmission, it has some relevance for the wider literature on flights-to-safety and investor runs within the MMF sector (seee, for example, McCabe (2010), Ansidei et al. (2012), Kacperczyk and Schnabl (2013), Bengtsson (2013), Gordon and Gandia (2014), Jank and Wedow (2015), Witmer (2016), Bellavite-Pellegrini et al. (2017)).[7] McCabe (2010) and Kacperczyk and

[6] Li and Wei (2013) find evidence for supply effects of US Fed Large Scale Asset Purchases consistent with the model outlined by Vayanos and Vila (2009).

[7] Before the GFC, MMFs were typically recipients of flight-to-quality. Thanks to their relative safe portfolio and sponsor's practise of absorbing losses, they were perceived as enhancing financial stability (McCabe (2010), Miles (2001)). However, during the financial crisis, it became

Schnabl (2013), examining the run rate of US MMFs, find that MMFs exert a potentially destabilizing effect on financial markets. This follows from the strong incentives acting on MMFs to 'chase yield' - which makes them extremely vulnerable to runs whenever risks materialize - and from sponsor risk. Witmer (2016) deepens this analysis and finds that this effect is stronger for funds with constant share price structure. Bellavite-Pellegrini et al. (2017) reach an opposite conclusion. Looking at the contribution of the MMF sector to the systemic risk in the UK from October 2005 to December 2013, they find that UK domiciled MMFs are likely to have decreased rather than increased systemic risk during the Global Financial Crisis.

On a broader level, this paper also belongs to the literature on performance of MMFs. The persistence of MMF returns is a well-known fact in the literature and it is generally attributed to the strong persistence of expense ratios (e.g. Domian and Reichenstein (1997) Christoffersen and Musto (2002); Dahlquist et al. (2003)). Other studies, however, argue that fund expenses are not the only determinant of returns. Koppenhaver (1999) shows that, along with expenses, fund managers can enhance returns by increasing credit or interest rate risk. More recently, Jank and Wedow (2015) show that the relation is not constant over time and, for German MMFs, they observe that fund managers enhance their returns by investing in riskier assets in times of abundant liquidity but also experience higher withdrawals when market liquidity declines. Baba et al. (2009) also highlight how US dollar MMFs (domiciled in the US and the Euro Area) compete for market share. They show that in the run-up to the financial crisis, prime funds moved toward less risky investments to meet investor demand and, they increased maturity to maintain positive yield.

Money Market Funds

Regulation and Institutional Setting

Money market funds intermediate on behalf of agents with short-term borrowing needs and serve investors who desire low-risk, market-based, liquid investments. In contrast to banks, MMFs invest in a diversified portfolio of short-term assets and maintain a high level of liquidity. There are some notable differences between EU and US MMFs. The former invest a larger proportion of their portfolio in banks' liabilities. At the end of 2017, Irish domiciled MMFs held, on average, 67 percent of their portfolio in instruments issued by banks. In the US, MMFs are mainly dedicated to channelling funds from non-financial entities to non-financial borrowers including government agencies.[8]

During our sample period, MMFs can be broadly categorised as either Constant Net Asset Value (CNAV) or Variable Net Asset Value (VNAV) funds, depending on the kind of shares they offer. CNAV funds aim to preserve a stable value of investors' shares, e.g. 1 euro per share at which investors subscribe or redeem. In contrast, VNAV funds allow subscription and redemption at a price equal to the fund's net asset value per share,

evident that interlinkages between the shadow banking and other financial institutions could hamper financial stability. Since then, a growing literature has tried to uncover direct and indirect channels of contagion between shadow banking and the wider financial system (for example Abad et al. (2017), Claessens and Ratnovski (2014)).

[8] https://www.federalreserve.gov/releases/efa/total-money-market-funds-investment-holdings.pdf.

where the value is computed by subtracting the liabilities of the fund from the market value of its assets.

During the financial crisis, the liquidity and stability of both US and EU domiciled MMFs deteriorated to the point of becoming a systemic risk. It is known that some CNAV funds received funding from their parent firm (some of which were systemically important banks) to prevent losses that would imply breaking of the constant NAV. This prompted a debate on how to make MMFs less systemically important and ultimately gave rise to new regulatory frameworks on both sides of the Atlantic. The new regulation introduced in August 2014 in the US forced 'prime' funds to become VNAVs (allowing negative returns to be passed on to investors). Similar regulation was passed in the EU in July 2017 and is scheduled to become effective between mid-2018 and mid-2019. This is leading to the conversion of many CNAV funds into a new category to be denoted 'Low-Volatility' funds (LVNAV). Our sample and analysis is applied under the old EU regulatory regime.

Stylized facts

Our analysis focuses on MMFs domiciled and reporting in Ireland, which account for 42 percent of Total Asset Value of euro area MMFs at the end of 2017.[9,10] The overall sample includes 91 different funds and it spans from October 2014 to January 2018 (this stops before the new EU regulations begin to affect the designations of the funds as VNAV or CNAV). We focus our analysis on the 84 funds reporting in Euro, USD or GBP. This selection includes the three most representative groups and encompasses more than 93% of the whole sector. In addition, this selection of reporting currencies includes important economies that experienced the zero lower bound and unconventional monetary policies after the global financial crisis. Among this selection of MMFs the preferred currencies of denomination are USD, chosen by the 35% of the funds, followed by the GBP, 32% and by the Euro, 26%. The breakdown of the sample of funds used is outlined in Table 1.

Since MMFs, by regulation may only invest in assets denominated in the currency in which they report, it seems reasonable therefore to expect that MMF return performances would correlate with the policy rate of the currency in which their investment is undertaken rather than the policy rate of the geography in which they are resident. To get a sense of this, Table 2 provides the mean and standard deviation comparisons between the annualized fund return and the policy rate of each currency area.[11] Not surprisingly, euro denominated funds experienced negative returns on

[9] https://sdw.ecb.europa.eu/reports.do?node=1000005719.

[10] The Central Bank of Ireland's Statistics Division collects monthly balance sheet information through Monthly Money Markets and Net Asset Value returns. This data provides a comprehensive overview of all single funds' monthly accounts characteristics, including the Gross and the Net Asset Value (NAV), share/unit holder of investment into the Fund, issuance and redemption of shares and the currency of denomination of asset and liabilities. Each entity reports in the base currency of the fund *(reporting currency)*. In addition, these two data sets report the various sources of revenues, like the amount of income from debt securities, loans, derivatives, capital gains and expenses (including the amount due to management fees and to operational costs, at fund level).

[11] Annualized fund return is calculated as the sum of income on debt securities, income on deposits and loans, and capital gains and losses divided by NAV at the beginning of the period.

average (consistent with a negative policy rate) while performance in the case of USD and GBP funds was on average positive.

The relation between the total annualized percentage return performance for each MMF currency group is depicted over time in Figure 2 against the relevant policy rate (and a 3-month sovereign bond yield).[12] It is clear that the pattern of the total return performance in each group (by reporting currency) closely tracks that of the policy rate in the respective currency. Figure 3 shows the total Assets Under Management (AUM) for the same groups and it is perhaps not surprising that USD and GBP funds (that on average experienced positive returns) also experience growth in AUM, while euro denominated funds show both negative returns and flat AUM. It should be noted that the growth in AUM of the USD and GBP funds has practically nothing to do with retained income (MMFs seldom retain earnings and even if all investment income were retained and reinvested, the resulting growth in AUM would fall far short of that observed - the growth is in fact due to net issuance due to investment inflows).

Interestingly, Figure 2 highlights an ability by EUR-reporting funds to maintain a positive total return for a couple of quarters after the rate available at the deposit facility became negative and despite the very negative yield on short term government debt securities and this may be a reflection of a shortening in the term of investment. However, when the gap increased between the yield on short term government bonds and the deposit facility, the average return performance was driven increasingly into-line with fluctuations in the ECB's deposit facility rate. This, as we shortly describe, is consistent with the increasing use of direct lending to banks (through both short-term deposits and tradable deposits) to earn returns better than those available on assets affected by quantitative easing.

To get a better understanding of the sources of these performance outcomes, Figures 4 and 5 plot the average end-of-month proportional portfolio compositions of the three fund samples according to asset type and issuer.[13] We see that, on average, the three currency categories have strong similarities in terms of their portfolio choices. All are heavily invested in debt securities/(or other liabilities) mostly issued by deposit taking corporations (DTCs).[14] The time profile of proportional holdings exhibits limited movement, suggesting in the first instance, persistent preferences. *Cash, deposits and loans* shows a mild but noticeable upward trend in the euro sample, while it is clear

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We considered a more inclusive measure of income and the results remained broadly similar. One reason to prefer the narrow definition concerns confusing income from charges to investors with income directly related with investment performance.

[12]The returns on the three broad investment categories that contribute to the overall performance is also presented. These categories include income from debt securities, income from deposits and loans, and income from capital gains.

[13]The stock position is the share of the asset class x in which fund i invests at the end of period t over total asset of fund i at the end of period t. The asset types are; tradable certificates of deposit (TradableDeposit), other debt securities (OtherSec), security borrowing (securityborrowing), cash, deposit and loans (cash), overdraft (overdr), equity (equity), other assets (othass). The issuer types are: Government (Gov), Investment Funds (IFs), Money Market funds (MMF), Financial Auxiliaries and Other Financial Institutions (FA_OFI), Financial Vehicle Corporations (FVC), Non-financial corporations (NFC), Deposit Taking Corporations (DTC).

[14]The terms *banks* and *deposit taking corporations* (DTCs) are used interchangeably across the paper.

that tradable deposits become a more significant proportion of investment generally for euro-reporting funds in the later part of the sample.[15]

CNAV funds are under more pressure to maintain a stable valuation of their share units than VNAV funds and this could explain differences in investment strategies and performances. Figure 6 shows the annualised return on the sector portfolio of CNAV and VNAV funds (and both types combined) in the euro sample and this reveals that, despite the predominance of limited upside investment opportunities, CNAV funds are able to maintain a positive return for much longer than VNAV funds. This suggests that CNAV funds pursued a different investment strategy from VNAV funds. It is clear that tradable deposits become a more significant proportion of investment generally for euro-reporting funds in the later part of the sample. Moreover, the change in relative importance of tradeable deposits compared with short-term debt securities is much greater for CNAV funds.

The breakdown of tradable deposit positions according to the country of the issuer is provided in Figure 7.[16] This shows that CNAV funds are bigger lenders through tradable deposits (issued in euro) to UK banks than other funds. We regard the greater increase overall in the stock of tradable deposits for the euro-reporting MMFs as consistent with increased short-term lending to banks. The more prominent lending through tradeable deposits issued by UK banks is a possible explanation for the better performance of CNAV funds. Overall, the increased use of tradable deposits reflects a good compromise between increasing the term of lending while at the same time maintaining liquidity (or, at least, saleability) of the portfolio of assets.[17]

The end-of-month proportional portfolio compositions may not fully explain the returns that can be achieved by MMFs through repeated short term lending to banks at higher frequency (see Anbil and Senyuz (2018)). To uncover this activity we examine the reported transactions activity of funds in respect of short term lending to banks. Figure 8 plots the proportional daily transactions of *cash, deposit and loans* issued by banks (note that banks that issue liabilities in euros are not necessarily resident, or lending, in the euro area).[18] It is evident that CNAV MMFs have increased their short term lending activity with EA banks, probably benefiting from the positive gap between the rate on the ECB's deposit facility and the yield on short term government bonds.

[15] Other notable features of the holdings statistics by asset type include: (i) the decline in proportional holdings of debt securities and security borrowing by EUR-reporting funds, (ii) the appearance of equity security holdings by USD-reporting funds from the beginning of 2016 and (iii) the move into more secure investments (security borrowing, cash and tradable deposits) by GBP-reporting funds following the Brexit vote in June 2016. The asset holdings in terms of issuer also reveal that GBP-reporting funds tend to divest from their small holdings of assets issued by NFCs from the end of 2016.

[16] In our sample banks are almost the only issuer. We provide the end-of-month stock position which captures tradable deposits with term-to-maturity that traverses the month-end.

[17] Of course there is no certainty that certificates of deposit would remain marketable during a funding crisis but this deserves further exploration beyond the scope of our present analysis.

[18] In particular the gross transaction are the share of purchases and sales for asset class x at the end of period t for fund i divided by 2 and by the number of trading days in the month as a fraction of total asset at the *beginning* of period t for fund i. Transactions are the market value of purchases and sales of a security on the dates of each transaction. A purchase implies an increase in the position and sales imply a decrease in the position.

Empirical Analysis

To assess the degree to which individual MMF return performance is affected by the policy rate of the currency in which MMFs invest we implement an augmented version of the analysis by Di Maggio and Kacperczyk (2017). Specifically, we estimate the following regression (where panels of funds are grouped by reporting currency (Euro, USD, GBP) and then by VNAV/CNAV category)

$$R_{it} = \beta_1 Rate_t + \sum_{j=1}^{\mathbf{J}} \beta_{1+j}\ Risk(j) + \sum_{k=1}^{\mathbf{K}} \beta_{1+\mathbf{J}+k}\ QE(k) + \sum_{l=1}^{\mathbf{L}} \beta_{1+\mathbf{J}+\mathbf{K}+l}\ X(l)_{t-1} + u_i + \varepsilon_{it} \tag{1}$$

where R_{it} represents the annualised return on NAV of fund i at time t; $Rate_t$ is the (1 or 3 month) swap/interbank rate most closely aligned with the short term interbank rate targeted by the relevant monetary authority, $Risk(j)$ represents macro risk indicators commonly used in asset pricing models to reflect risk premiums earned for exposure to term risk and corporate-bond credit risk (i.e., the *term spread* between long and short term government bond yields and the *corporate spread* between corporate and government bond yields), $QE(k)$ includes the monthly intervention amounts associated with quantitative easing (these include public sector asset purchases and, in the case of EUR and GBP reporting funds, corporate bond purchases), $X(l)_{t-1}$ represents an array of lagged control variables (including asset supplies and fund characteristics), u_i is a fund-specific fixed effect that could be regarded as the funds' *alphas*, and ε_{it} is the residual term. We regard the policy rate as strictly exogenous (monetary policy is unlikely to be related/reacting to MMF performance). Further details of the sources and construction of the right hand side variables (including a set of macro and fund-level controls) are provided in Appendix A.

Lagged Transmission

We extend the specification in Equation 1 to include a lag of the policy rate on the right hand side. This facilitates an exploration of the speed of transmission from policy rate changes to MMF performance. Implicitly we assume that policy rate changes are exogeneous and not simply correlated with some other variable that might be the true cause of fund performance. The most obvious macroeconomic variables that could be correlated with performance and monetary policy include growth, inflation, systematic risk and risk aversion. Unfortunately, given the small amount of variation in performance over the short sample used (and given the large number of controls already included in the regressions) it was not possible to identify performance changes linked with macroeconomic conditions due to collinearity with the policy rate. Without including such potential omitted variables our analysis already produces very high levels for goodness of fit statistics and what we regard as plausible relations with the policy rate variable. These match closely our prior that the policy rate is the most relevant and most proximate source of variation in fund performance. This is supported by the information we have presented on asset holdings. For these reasons we rely on the more parsimonious specification that includes lagged policy rate and omits other macroeconomic variables. Results should be interpreted subject to this caveat.

Policy Mix

In a third step of our empirical analysis we focus on a specification that is designed to reflect how the mixture of non-standard monetary policies at the ZLB (and below) transmit to fund performance as a spread over the risk free return (this in analogous to asset pricing specifications that includes risk factors). The policy rate is the conventional policy tool but QE interventions can independently affect the yield on short term debt securities. Imbalance in the application of these policy tools could have consequences for MMF behaviour. The dependent variable in this specification is therefore not simply the return performance of funds but rather, the gap between the return performance of funds and the policy rate. This takes cognisance of the fact that the policy rate is closely aligned with the return available to commercial banks by using the central bank's deposit facility. We assume that this return (with some additional charge) is indirectly available to funds when they choose to deposit funds with commercial banks or hold certificates of deposit (CDs) issued by commercial banks.

The main causal variable in this specification is the difference between the policy rate and the yield available on short term government debt securities.[19] We assume that as the return on short term debt securities decreases relative to the policy rate due to quantitative easing, there is an increased incentive to deposit with commercial banks (directly or indirectly by use of CDs). In the extreme case of a very negative yield on short term debt securities (below the policy rate) fund return performance would increasingly be driven into line with the policy rate as funds choose to deposit with banks rather than invest in debt securities. Given that in our sample period, the FED was already tapering and that the Bank of England interventions are difficult to distinguish from Brexit dummy, we concentrate this part of the analysis on the EUR-reporting sample.

To this end we estimate the following regression:

$$(R_{i,t} - Rate_t) = \beta_1^*(Rate - Gov3M)_t + \sum_{l=1}^{\mathbf{L}} \beta_{1+l}^* X(l)_{t-1} + u_i^* + v_{i,t} \tag{2}$$

where, at time t, $(R_{i,t} - Rate_t)$ is the return performance of fund-i in excess of the deposit facility rate, $(Rate - Gov3M)_t$ is the excess yield earned on deposits at the ECB deposit facility over the yield available from investing in short term government securities. All other controls are the same as those in Equation 1 and we include u_i^* as a fund-specific fixed effect. The model is applied to the overall sample and to the subsets of VNAV and CNAV funds. We expect to find a negative β_1^* parameter implying that the gap between performance and the policy rate declines in response to an increase in the gap between the policy rate and the return on short term debt securities.

The specification in Equation 2 can easily be augmented by inclusion of the macro *Risk* and *QE* variables as in Equation 1. In our empirical results we show that replacing $(Rate - Gov3M)$ with *Risk* or *QE* variables implies a similar alignment between fund performance and the policy rate (which again can be interpreted as being due to the low returns on investment in debt securities relative to depositing with banks). Including *Risk* and *QE* variables **along with** the $(Rate - Gov3M)$ variable produces results that are challenging to interpret due to the indirect nature of the transmission from policy to both yields on different types of assets and to portfolio composition.

[19] Studies that use a similar settings (i.e. Jank and Wedow (2015)) include as risk factor the difference between the Euribor and the 6-month government rate. Our focus, however, it is not market distress but the misalignment between monetary policies.

Summary statistics for the dependent variables (including the 'within' and 'between' standard deviations) and the policy rates for the three samples are provided in Table 2. The correlation statistics are provided in Table 3.

Results

Tables 4 to 6 report the fixed-effects panel regression results for several variants of Equation 1. The most basic regression specification contains the policy rate - or a closely related short-term interbank rate - as the principal explanatory variable (and controls for time varying fund characteristics and assets supplies).

The results in general confirm a strong relation between fund returns and the policy rate in the currencies in which funds report (based on $\bar{R}^2$) but this relation is stronger (more than proportionate) for the EUR-reporting funds. In the EUR-reporting case, shown in Table 4, there is evidence that performance declined more sharply than the conventional policy rate movement and this reflects the additional effects of non-standard policy measures that pushed yields on short term debt securities even more negative than the policy rate. Although the hypothesis of a unitary relation between the policy rate and fund performance is not rejected for EUR-reporting funds (see the p-values associated with the test statistic of $\beta_1 = 1$) the point estimates generally reflect a more than proportional relation for the full sample and for VNAV funds (the point estimates reflect a less than proportionate relation for CNAV funds). Policy rate pass-through is in evidence for the USD-reporting funds, see Table 5, and this is in line with the findings of Di Maggio and Kacperczyk (2017). In this case the point estimates are very close to unitary. The test of a unitary coefficient on the policy rate is never supported for the case of GBP-reporting funds (see Table 6).

As suggested by our initial assumption, it is reasonable to argue that returns on assets held by MMFs are highly correlated with the level of the policy rate that pertains in the currency of denomination of MMF investments but this is even stronger when MMFs face a more negative yield on short term debt securities. In the case of the EUR-reporting funds it is clear that MMF performance followed the policy interest rate into negative territory and this constitutes a serious challenge for the whole sector (but particularly those following a constant NAV strategy). Given the challenges faced it is surprising that other risk factors explain such a small proportion of performance variation (a comparison of the R-squared statistics between the specification that includes the policy rate as the sole explanatory variable (with an $\bar{R}^2$ of 0.528 for the full EUR-reporting sample) and the more general specifications (where the highest $\bar{R}^2$ is 0.586 for the full EUR-reporting sample in column (3) of Table 4) indicates that variation in the de-facto policy rate is by far the dominant driver of variation in MMF fund performance - MMFs clearly tend to avoid the risks and illiquidity associated with investing in non-money-like assets.

Despite the limited explanatory power of additional variables it is still plausible that MMFs would seek slightly higher returns through investment in non-money-like assets when monetary policy drives returns on money-like assets into negative territory. This would only be possible by including in their portfolios a larger proportion of highly-rated corporate debt securities that are nearer to the margin of an acceptably high credit rating, or of assets that have terms-to-maturity that are close to what is permitted by MMF mandates whilst having sufficient liquidity. According to this logic, to the extent that MMFs move into non-money-like assets they would be expected to earn 'term' and 'credit-risk' premiums and variation in these premiums would explain some of the

variation in MMF return performance (they may also earn a liquidity risk premium that is implicit in the term and credit spreads which we do not try to capture separately).

In normal circumstances (when the term structure is upward sloping) and for more widely diversified portfolios of investment, 'credit' and 'term' risk premiums usually appear with positive parameters in a performance relation, but it is important to acknowledge that this is not likely when the term structure is flat or negative and it may not be the observed outcome when portfolio adjustments occur. We therefore face additional challenges in interpreting regression relations that include these variables. It turns out that the euro area and UK term-spreads are close to zero or slightly negative for the majority of our sample. This implies that there is actually a negative or zero extra return to be gained by extending the term of investments out to the 2-year horizon (or to the one-year horizon to which most MMFs are restricted).

Contrary to what would be expected in more normal circumstances, we find in both the EUR-reporting sample and GBP-reporting samples, a negative and significant relation between variation in the term-spread and fund performance. This is clearly related to the fact that the term spread is almost entirely driven by movements in the very short term yield which impacts directly on the return performance of funds that keep their holdings focused on short term instruments. This suggests that MMFs (investing in assets denominated in these two currencies) stay short term in their investment focus when the term premium is negative or flat. It is worth noting that the spread between 2-year and 3-month yields is not only either extremely small or negative, it is also quite variable and it is negatively correlated with the 3 month government bond yield. The term effect is consistent with our findings below from analysis of the dynamics of the pass-through of rate changes to performance.

In contrast with the anomalous results for the term-spread, the corporate-spread (or credit-risk factor) is actually positive throughout the samples studied and it is more stable than the term spread. The regression analysis confirms exposure to this source of risk (with a significant positive relation between variation in the corporate bond spread and variation in MMF return performances) and is evidence that MMFs earn some amount of a premium for taking this additional risk.

The more than proportionate relation between performance and the policy rate for the EUR-reporting funds is an indirect reflection of the influence of unconventional policy measures. Columns 3, 6 and 9 of Tables 4 to 6 represent a more direct attempt to capture the possibility that the return performance of MMFs is influenced by the interaction of conventional monetary policy and other types of policy actions. To assess these effects (particularly those from quantitative easing) we include the amount of asset purchases.

We find, in the case of EUR-reporting funds, that CSPP purchases are associated with a decline in return performance of MMFs. This is in line with our expectations that the purchases of non-bank corporation's securities depresses yields (this effect remains even if we exclude capital gains from earnings - since these may be earned through price rises of assets not held to maturity). Although MMFs mainly hold instruments issued by banks (which are not eligible for purchase under the CSPP) the CSPP intervention is negatively correlated with the yield on the S&P Eurozone Investment Grade Corporate Index which includes corporate debt of deposit-taking corporations.

While the coefficient on CSPP purchases is of the expected sign, we find that PSPP purchases have a positive and significant relation with the return performance of MMFs. Since the flow effects of PSPP on yields is unambiguously non-positive the only way that

PSPP could be associated with improved performance of MMFs is through a portfolio reallocation (one that is correlated with PSPP) towards higher yielding investments. Similar results are obtained in the GBP sample. However, in the GBP case we note that PSPP and CSPP variables are indistinguishable from a temporary Brexit dummy. Simple correlation for such a temporary situation gives an inadequate description of the basic relations at play. There is also a problem of simultaneity in the application of policies. Both conventional and unconventional monetary policy measures were shifted to a very accommodative stance simultaneously in the wake of the Brexit vote. There is really no way to unambiguously separate their effects. In the case of USD-reporting funds, during our sample period, interventions in the Bills market remained positive while those in the Notes were tapering. In the tabulated results we show the case of the Bills interventions since this is the segment of the market where MMFs invest. In this case the effects of interventions are negatively associated with fund returns as expected (though this is a small contribution to explanatory power of the regression).

Focusing on Table 4 we note that there is a marked difference between the policy rate parameter for VNAV and CNAV funds in the euro sample. The policy rate pass-through is lower for CNAV funds regardless of the regression specification (although the estimate of the parameter on the policy rate is measured with low precision). A lower parameter on the policy rate would be consistent with CNAV funds being able to resist performance declines at the start of the negative rate policy and following a different investment strategy in order to avoid breaking the buck. Most likely this was achieved by rebalancing investment away from debt securities and into short term tradable deposits (issued in euro) to UK banks and also by increasing their short term activity in EA banks (benefiting from the positive gap between the rate on the ECB's deposit facility and the yield on short term government bonds). For the GBP and USD-reporting funds the difference is not significant (see Table 6).

Results from a regression pertaining to performance of EUR-Reporting CNAV funds that includes both the UK and euro area corporate spreads as explanatory variables indicates that the UK spread shows a more positive and more statistically significant relation. This validates the findings from our holdings analysis showing that EUR-Reporting CNAV funds increased their exposure to corporate debt issued by UK banks.

Fixed effects tests are shown in Table 7 for all of the regressions analysed above with and without fund-level control variables. In each case the average of the fixed effects is shown and this is accompanied by t-tests and p-value from a test of its difference from zero. The number of significant fund-specific fixed effects is also shown in the final column. It is clear that in all but one case the number of significant fund-specific fixed effects declines to zero when fund level controls are included in the regression.

When the fixed effect is not included, the most frequently significant fund characteristic is the proxy for recent variability in investment flows. This was negative and significant in 25% of regressions (never positive). So a higher propensity for outflows actually produces a negative effect for performance (probably a reluctance to take risk). The Expense ratio was positive and significant in 12.5% of cases. Of the macro controls (supplies of assets) the most significant one is the supply of corporate debt by MFIs.

Lagged Transmission

The speed of policy rate pass-through to performance (and, by association, the investment term response) is address by including a lag of the policy rate and the relevant regression results are contained in Tables 8 and 9. In each table we show 3 specifications

for each reporting currency. The first specification only has the policy rate and its lag. The second specification includes the term spread and the corporate spread. The final specification includes the PSPP flows in all cases and the CBPP flows for the EUR and GBP reporting funds.

Our main focus is the difference in the policy rate pass-through by reporting currency and this is reflected in the significance and size of the coefficients on the policy rate and its lag. It is very clear that the coefficient on the lag of the policy rate for EUR-reporting funds is much larger than the coefficient on the contemporaneous rate (in all three specifications for EUR-reporting funds the coefficient estimates on the contemporaneous rate are small and in two cases they are statistically insignificant). This delay in pass-through is consistent with evidence from the observed shortening of the duration of asset holdings.

In the first two specifications for the EUR-reporting sample the coefficient on the lagged rate are greater than unitary. This implies that rate changes feed through with a lag to EUR-reporting fund performance but they eventually produce a more than proportionate change in performance. The coefficient on the lagged policy rate declines markedly when the PSPP and CBPP variables are included and this points to unconventional measures explaining the more than proportional pass-through to performance that was found in the first two regressions. It is interesting that the test for a unitary long run effect from policy to EUR-reporting fund performance is never rejected.

Moving to the USD-reporting sample we observe a very different pattern of coefficient size and significance across policy rate variables. In this case the contemporaneous rate has a larger and more significant coefficient and the coefficients on the lagged rate are never statistically significant. With less of a difference between the conventional policy rate and the return on assets due to QE in the USD case we see a very small impact on the policy pass-through coefficient when the PSPP variables is added to the regression reported in column (6). In the USD-reporting case a unitary long-run pass through from policy to performance is not supported. A plausible explanation for this is a lengthening in the duration of investments to take advantage of higher longer term rates as a result of expected future policy tightening.

The case of GBP-reporting funds is not straightforward. The sample covers a period when policy was turning from accommodative to expansionary but this was then halted by the surprising Brexit vote and a very accommodating response (both conventional and unconventional) by the Bank of England. Mostly we observe a higher coefficient on the lagged policy rate variable, just as in the EUR-reporting case, indicating shortening of the term of investment. In this case there is also a rejection of a long run unitary pass-through of the policy to performance. Overall however, the GBP-case is very similar to the EUR-reporting case. Table 9 omits the 3 funds from each sample that most improve the regression goodness of fit. This does not appear to alter the main conclusions that can be drawn from the results.

Policy Mix - EUR-Reporting Funds

Turning to the alternative model, which focuses on the changing degree of alignment between EUR-reporting fund performance and the conventional policy rate, Table 10 shows the results for the EUR-reporting sample. The negative relationship between the difference in fund return-performance (in excess of the policy rate) and the gap between

the policy rate and the short term government bond yield signifies that a round tripping of investment may be at work between banks and MMFs.

The significant negative β_1^* parameter signifies that the gap in performance (relative to the policy rate) declines in response to the short term government bond yield going further below the deposit facility rate. This is consistent with banks increasingly facilitating access to the ECB's deposit facility as the effects of asset purchases increases. The result holds when we include the term spread and the corporate spread. The signs of these two variables confirm the results of the previous regressions.

Robustness and Direction of Future Analysis

We make changes to our sample to assess whether our results are sensitive to the presence of autocorrelation in the error term. We exclude from each sample the three funds with the most autocorrelated error terms. This is also done for the regressions that include a lag of the policy rate variable. Results remain practically unchanged (i.e., signs of coefficients remain the same and they usually remain as statistically significant as they were when all funds were included). A further change in the sample involved dropping the three funds that most affected the panel goodness of fit measure (the funds dropped are those with the least similar regression relation to that of a fixed effects regression for the whole sample). The results for the case of including the lag of the policy rate while dropping such outlier funds are in Table 9. The main changes are improved fit and more significance of parameters but the essential message remains as it was for the whole sample.

An additional concern is whether our results are sensitive to the definition of fund return-on-investment that we use. Annualized fund return is calculated as the sum of income on debt securities, income on deposits and loans and capital gains and losses divided by NAV at the beginning of the period. We deliberately excluded from this definition income from charges to investors in order to avoid confusing it with an income more directly related with investment performance. When we use a more inclusive measure of income, the results remain broadly similar. We also consider a narrower definition. We in fact suspect that the positive sign of the PSPP coefficient may be driven by gains earned through price rises of assets not held to maturity as a result of QE interventions. However, excluding capital gains and losses from our measure of return-on-investment does not change our results significantly.

We ran additional regressions that included volatility indexes as additional controls. In these regressions we used the VIX associated with EUROSTOXX50 (VSTOXX-50), S&P100 (VIX) and FTSE100 (VLSE) for the EUR, USD and GBP regressions respectively. We did not find significant changes in the estimates of the main parameters of interest to our analysis as a results of these additional controls. All the associated regression results are available from the authors on request.

An issue of interest to policy makers concerns the spillovers of monetary policies to and from other currency regions. The currency in which a security is denominated (issued) does not necessarily proxy for the residency (or location of economic activities) of the issuer. Investment in assets issued by a foreign entity therefore represent diversification opportunities. In our sample, on average, 50 percent of the assets of each currency-reporting group are issued by entities residing (and operating) in a different

currency region.[20] This suggests that MMFs return performances may also be correlated with macroeconomic and risk factors of the currency areas in which the issuers operate.

We address this by running a set of supplementary regressions in which the residuals from our standard model become the dependent variable. We use as independent variables the cross-currency policy rate, term spread, corporate spread, QE indicators and risk factors (each variable assessed separately). Overall, we find that these variables seldom provide any additional explanatory power and the results are therefore not presented. The main exception is the US-corporate spread which adds 5 percent to the adjusted R-squared for the VNAV EUR-reporting funds performance. This group of funds therefore achieve significant additional risk diversification benefits from their exposure to foreign entities without incurring currency risk. We focused our exploration on contemporaneous spillovers but it is plausible that these may occur with a lag. Introducing lagged cross-effects would naturally lead to a more general dynamic specification of own-effects (including endogenous feedback) which goes beyond the scope of the current analysis.

It is of interest to policy makers whether euro area forward guidance affects behaviour of MMF investors (or has indirect effects through the investment choices of MMF managers mindful of investor behaviour). Credible guidance may cause disappointment for MMF investors who were hopeful of an earlier end to the poor performance of their investments. Some of them may be prompted to redeem their investments earlier than planned on hearing such guidance. Redemptions, in our view, would have to be quite large (and reduce fee income substantially or be an existential threat) before they change the investment behaviour of the fund. We can report that there is no noticeable spike in redemptions following the main revisions of forward guidance during our sample. This suggests that investors were not fleeing in response to rates staying lower for marginally longer than they had already expected.

A plausible effect from forward guidance would be changes in the term of investments to ensure that the fund continues to benefit from higher expected future interest rates. Fund managers will likely seek to invest at a term that terminates later than the horizon communicated as the end of the low rate policy. This, however, requires that the expected horizon of the policy change, and guidance on this, are both within the mandated term of the fund when the policy is introduced or revised. The first use of forward guidance in the euro area was in July 2013 which is outside of the sample we study. Several changes to forward guidance occurred during our sample but these mainly involved changes in the horizon for the end of the low rate policy beyond the investment term in the mandate of most MMFs. The most significant change was in March 2016 when the intention to maintain the low rate was stated as remaining in place until "*well past the horizon of our net asset purchases*".

Looking at the analysis of this event (see Chart 3 in the analysis by Eskelinen and Kortela (2017)) the effects of the revision in March 2016 on the expected duration to an upturn in rates, changed from about 24 to 33 months. Since both of these horizons are beyond the term at which MMFs have a mandate to invest, it is unlikely that we would observe a significant change in the investment behaviour of EUR-reporting MMFs

[20] On average, of the assets held by the EUR-reporting sample 22 percent are issued by UK entities and 7 percent by US entities; of the assets held by GBP-reporting sample 32 percent are issued by EA entities, 4 percent by US entities and 22 percent by entities from other countries; of the assets held by the USD-reporting sample 7 percent of are issued by UK entities, 20 percent by EA entities and 18 percent by entities in other countries.

around the time of the guidance change. The expected duration to a turn-around in rates gets shorter as the end of the net asset purchases gets nearer. However, this only enters into the two year time-frame in the last year of our sample. Since most EUR-reporting funds are constrained to a one year investment term, it is in our view, not likely that forward guidance effects would be large enough to be detectable using our sample. We nevertheless regard this as an important avenue for future analysis.

Conclusions

After the financial crisis of 2008 many central banks reached (or breached) the zero lower bound on short-term interest rates and proceeded to engage in large scale asset purchases in order to extend low rates over longer term horizons. This paper investigates whether this kind of unconventional monetary policy significantly affected money market fund portfolio composition and investment performance.

Our work contributes to a deeper understanding of how conventional and unconventional monetary policy transmits to real economic effects at the short end of the term structure. We firstly show that fund performance is mainly driven by the policy rate of the currency of the assets in which funds actually invest. This may seem obvious but it is seldom recognised when the behaviour of this sector, and its reaction to European policy, is described in market-based research and traditional capital flows analysis based on residency. It also suggests that (for the purposes of policy analysis) the most meaningful categorisation of MMF activity is by reporting currency.

We find a strong but heterogeneous association between fund performance and the policy rate of the currency in which funds report. A proportion of this heterogeneity is explained by mandates that result in different combinations of increased risk-taking and diversification. These behaviours are unlikely to have dramatically affected systemic risks. The amount of international diversification at a fund level implies that international transmission of monetary policy through investment behaviour of such funds is weak. However, investment flows are clearly affected by differences in monetary policy across the reporting currencies of funds. Over the sample period studied, the substantial growth in assets under management of Irish domiciled MMFs is entirely located among USD and GBP reporting funds.

Overall, in the EUR-reporting sample, there is evidence of a more than proportional relation between the policy rate and fund performance which is not in evidence for the USD- and GBP-reporting funds. We regard this as evidence that the pass-through effect is stronger when MMFs face a very negative return on alternative investments. Investment mandate also explains some of the heterogeneity of performances within currency groupings. EUR-reporting CNAV funds perform noticeably better (for longer) than VNAV funds. We argue that this was achieved by rebalancing investment away from short-term debt securities and into tradable deposits (issued in euro) to UK banks and also by increasing their short term activity in EA banks.

We found a significant difference across reporting currencies in the speed of the performance response to policy rate changes. In the case of euro-reporting funds, the pass-through from policy to performance occurs with a lag (the coefficient on the contemporaneous rate being small in all cases and insignificant in the more generalised specifications) while all of the reaction to policy changes is immediate in the case of USD-reporting funds (the coefficient on the lag being always small and insignificant). This

suggests that the term of investments shortens when policy is easing (i.e., when the short end of the term structure of interest rates is tilted downwards) and vice versa. This evidence is merely suggestive of a response in the term of investment and it deserves additional analysis beyond the remit of the current study. One interesting extension of this analysis would be to assess how forward guidance affects this behaviour. Unfortunately our sample includes only minor changes to the expected timing of rate rises as a result of such guidance and these changes were at a more distant horizon than the typical term of MMF investments.

Finally, we find that the gap in the yield available from indirectly accessing the ECB's deposit facility and that on short term debt securities (which is, in part, driven by quantitative easing) explains a significant proportion of the variability in the pass-through of the policy rate to fund performance. The gap between yields on short term government securities in the euro area and the rate available at the ECB's deposit facility became much more negative during the asset purchase programme than it had in the case of the US and UK. In the case of the euro sample we regard the strong negative relation between the difference in fund return-performance (in excess of the policy rate) and the gap between the policy rate and the short term government yield, as evidence of round tripping of investment between banks and MMFs. This implies that the policy mix is important for the transmission of unconventional monetary policy.

The optimal mix of policy deserves further analysis since it has implications for the true limits on unconventional policy. The strains produced by unconventional policy could lead to financial innovation in a way that satisfies the needs of both banks and MMFs but also producing unintended consequences. Banks could extend credit for longer if they were able to attract longer-term deposits. These term-deposits could be made more attractive to MMFs if they were sufficiently liquid and marketable. An obvious innovation that satisfies these needs is the issuance of Tradable Certificates of Deposit. We provide evidence consistent with this type of financial innovation. Additional research on the supply of tradable deposits by banks would help to identify to what extent this funding source is replacing traditional sources and whether there are any associated financial stability concerns for MMFs or banks. A risk we would highlight is the potential illiquidity of tradable deposits as interest rates rise. Higher rates would make deposits less attractive for early redemption by banks.

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A Sources and Construction of Variables Used in Panel Regressions

For the policy rates in the regressions pertaining to EUR reporting funds we use a 3-month EONIA Swap (i.e., the Overnight Index Swap (OIS) Rate). In the USD case we use a 3 month OIS based on the Federal-Funds Rate. For the GBP case we use a 1 month interbank rate. Since MMFs are typically very short maturity investors, we use the difference between the 2 year and 3 month government bond yields as the *term spread* (for the euro area we use the end-of-month yields for the 3-month and 2-year terms extracted from the term structure of euro area bond yields estimated by the ECB and available from the ECBs website, for the USD case we use the 2 year Treasury yield minus 3 month T-bill yield available from the FRED Database and for the GBP sample we use constant maturity 3-month and 2-year Gilt yields available from the Bank of England). The *corporate bond spreads* used in the EUR, USD and GBP regressions respectively are the ICE B-of-AML Euro Corporate Investment Grade Index Option-Adjusted Corporate Bond Spread, the ICE B-of-AML US Master Option-Adjusted Corporate Bond Spread and a UK Investment Grade Corporate Bond Spread compiled by S&P. The EUR and GBP QE variables are the monthly corporate bond purchases under the auspices of the Corporate Sector Purchase Programme (CSPP) and monthly sovereign bond purchases under the Public Sector Purchase Programme (PSPP).[21] In the case of the USD regression we include only T-bill purchases (there were no Fed purchases of corporate bonds during our sample period). All QE amounts are rescaled. As compared to other studies that exclude interventions that target the long-term part of the yield curve, we believe that government bond purchases can independently affect the yield on short term debt and the return of MMFs.

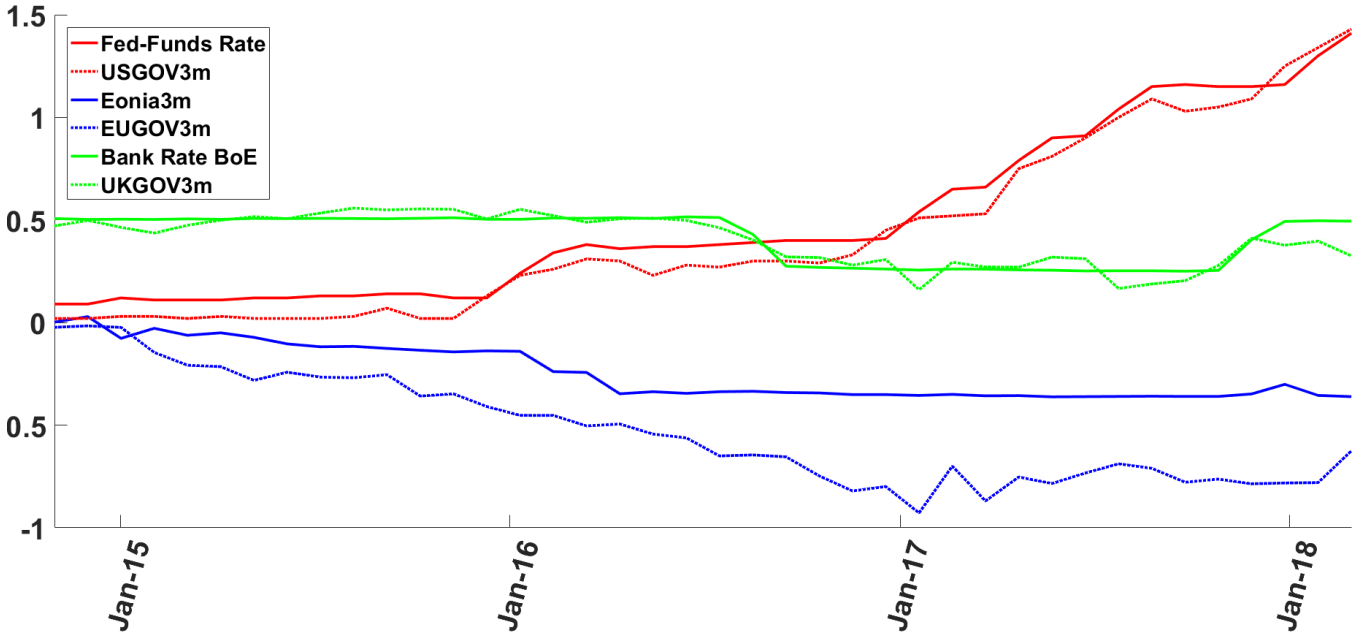
The regression analysis is also augmented by inclusion of control variables. The first group of control variables cater for heterogeneity in fund characteristics as in Di Maggio and Kacperczyk (2017). These include the Expense-Ratio, the Size of each fund measured as log(NAV) and a proxy for the size of recent investor flights in and out of the fund (this is calculated as the median of absolute flows over the previous 5 month period).[22] The selection of variables in the second group of controls is influenced by the analysis of portfolio rebalancing by Joyce and Tonks (2012), Joyce et al. (2015) and Carpenter et al. (2015). These capture effects from the changes in the supplies of assets usually held by MMFs (i.e., the change in outstanding amount of government short term debt, change in outstanding monetary financial institutions' short term debt, change in outstanding supply of commercial paper, change in outstanding non-financial corporates' short term debt. The outstanding issued short term debt of NFCs in the US and UK was not available and is omitted in these cases). Since we found evidence of increased holdings of Certificates of Deposit by EUR-reporting funds (issued by UK Banks) we include the change in euro-denominated tradeable certificates of deposit issued by UK banks in the regression involving EUR-reporting funds.

[21] These correspond to the Corporate Bond Purchase Scheme (CBPS) and Asset Purchase Facility (APF) for the Bank of England.

[22] The flightiness of investment is included to identify whether fund managers avoid risk to prevent surprises in performance that may lead to sudden withdrawals

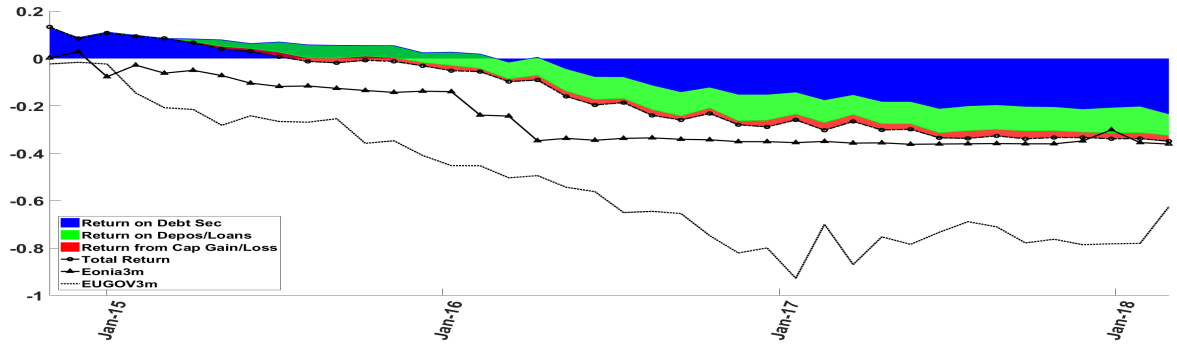
B Figures

Figure 1: Policy interest rates and yields on short-term government securities. Backlink to page 1.

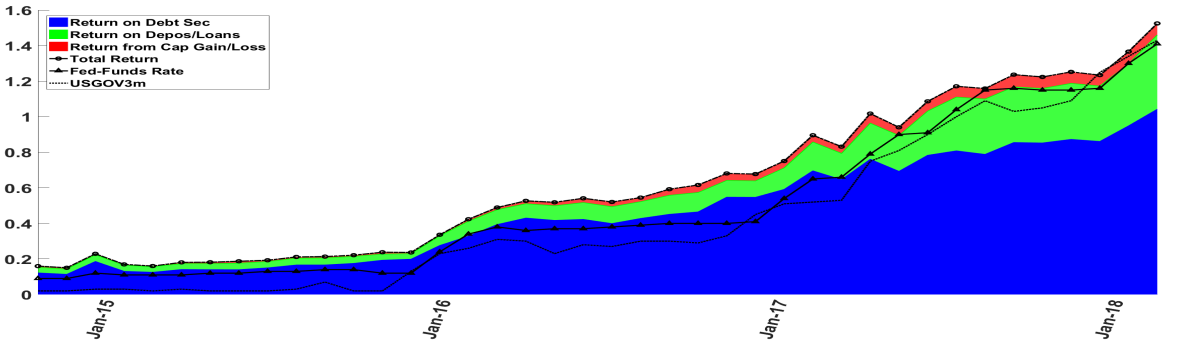


Note: Policy rates are the relevant overnight rates targeted by monetary authorities while the government bond yields are for a 3-month government security in each currency obtained from Bloomberg.

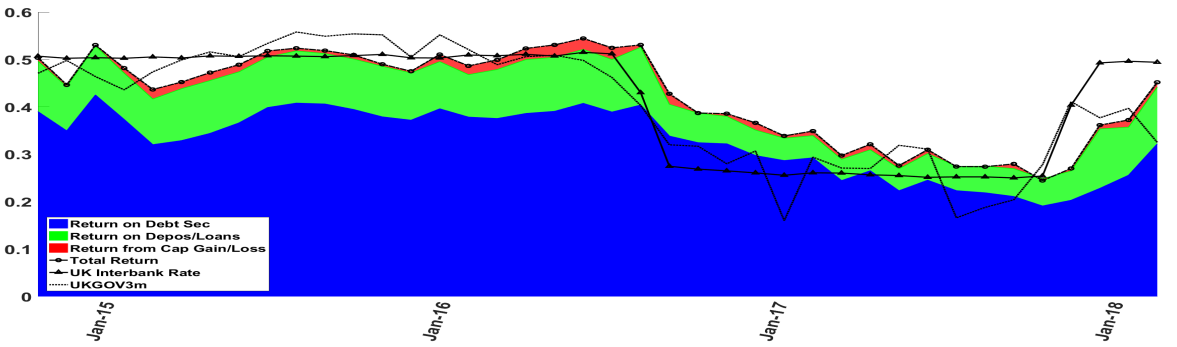
Figure 2: MMF Return Performance (%). Backlink to page 8.



(a) EUR Reporting MMFs



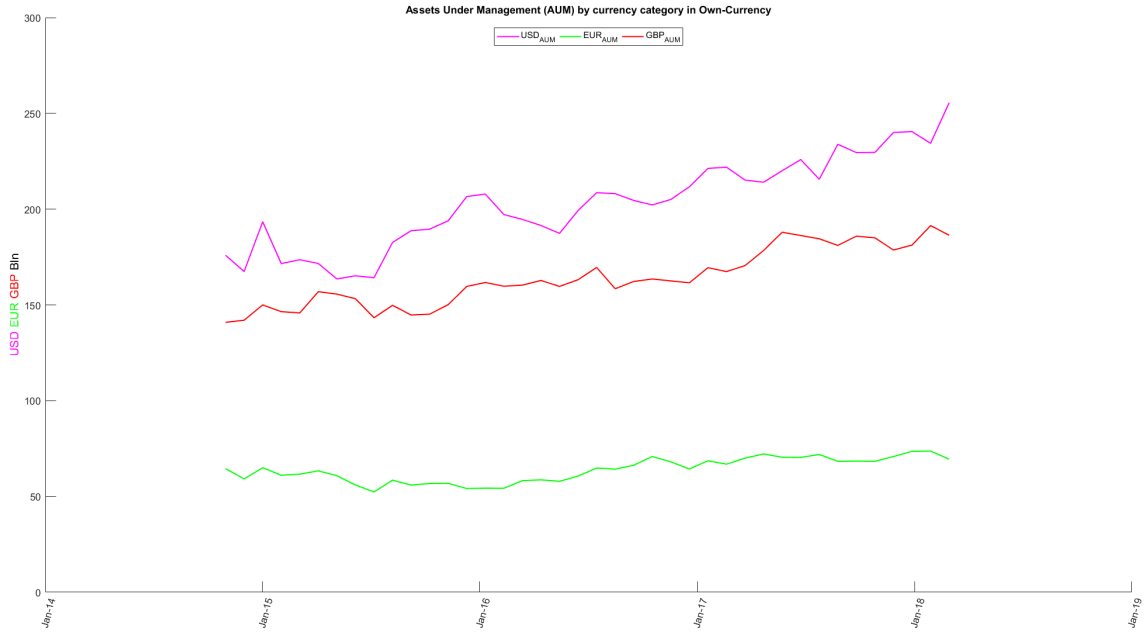
(b) USD Reporting MMFs



(c) GBP Reporting MMFs

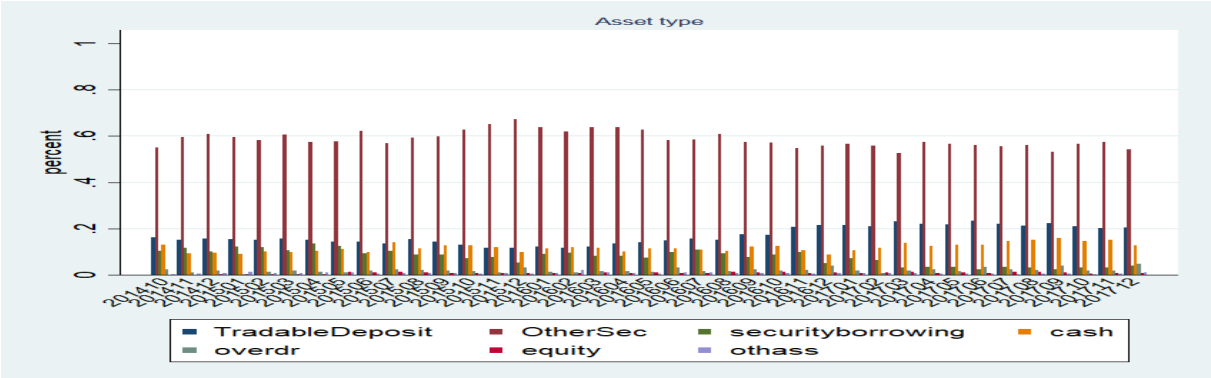
Note: The components of total annualised returns are shown for money market funds categorised by reporting currency. Returns of each group are the sum of each type of income from investment summed across the entire portfolio of all funds in each category as a percentage of the NAV of the fund category at the beginning of each period. The fund-segment performance is comparable with the policy rate and the annualised yield-to-maturity available on sovereign bonds with a term to maturity of 3 months.

Figure 3: Assets Under Management (AUM) by currency category in own-currency Backlink to page 8.

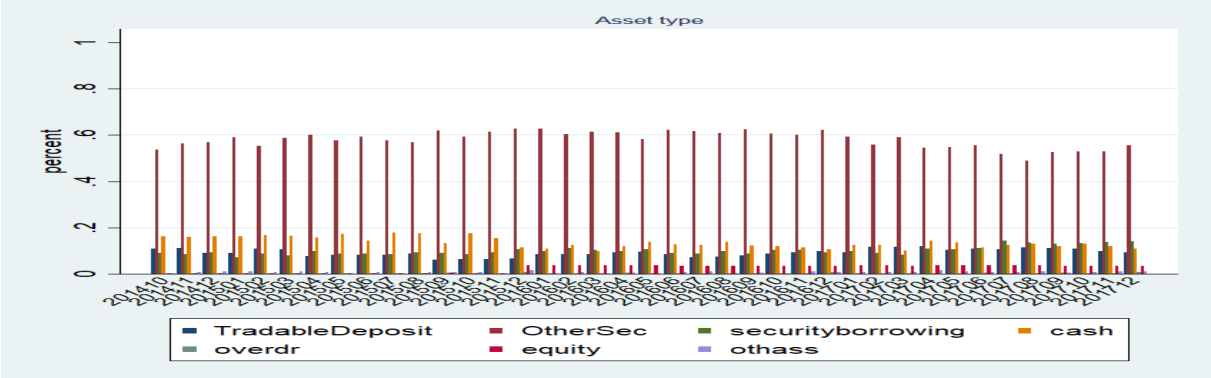


Note: Assets under management are calculated in own-currency

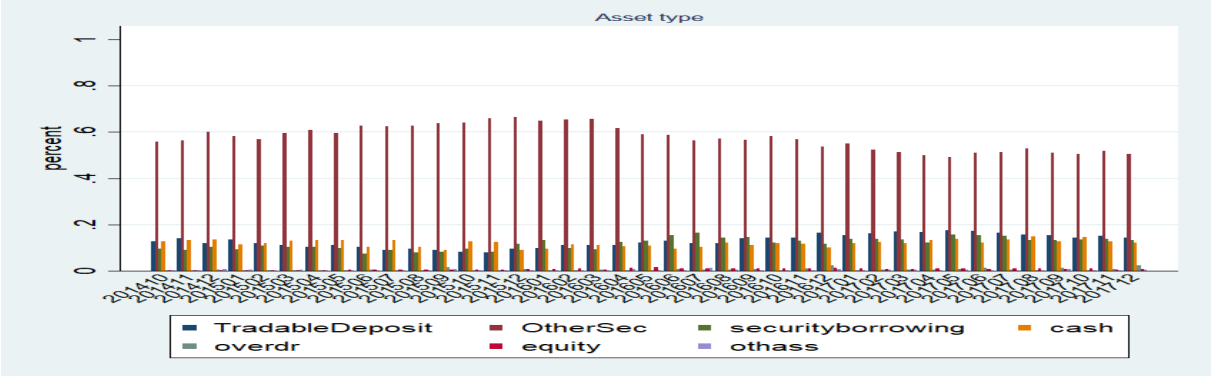
Figure 4: Asset type. Backlink to page 8.



(a) EURO



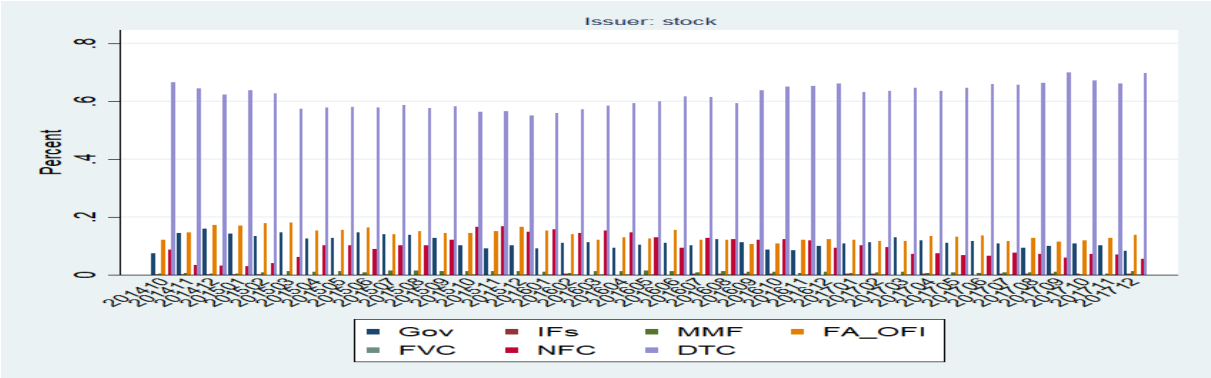
(b) USD



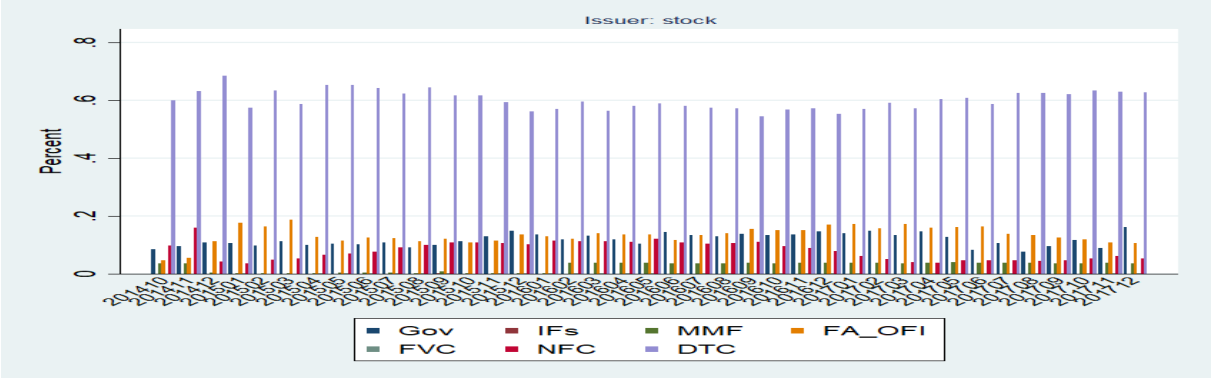
(c) GBP

Note: This figure shows the average proportional month-end holdings by all MMF funds in each of the three currency groupings according to the types of assets held. It is estimated as the share of the asset class x in which fund i invests at the end of period t over total asset of fund i at the end of period t. The asset types are: tradable certificates of deposit (TradableDeposit), other debt securities (OtherSec), security borrowing (securityborrowing), cash, deposit and loans (cash), overdraft (overdr), equity (equity), other assets (othass).

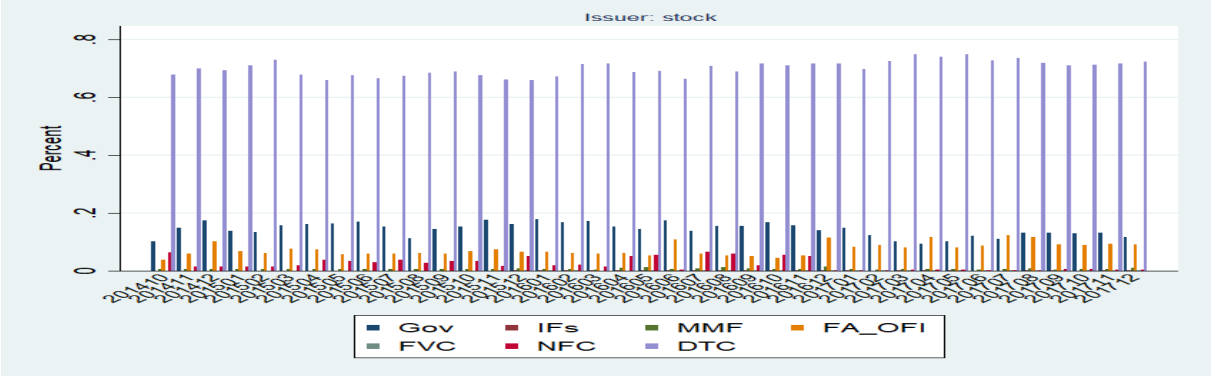
Figure 5: Issuer. Backlink to page 8.



(a) EURO



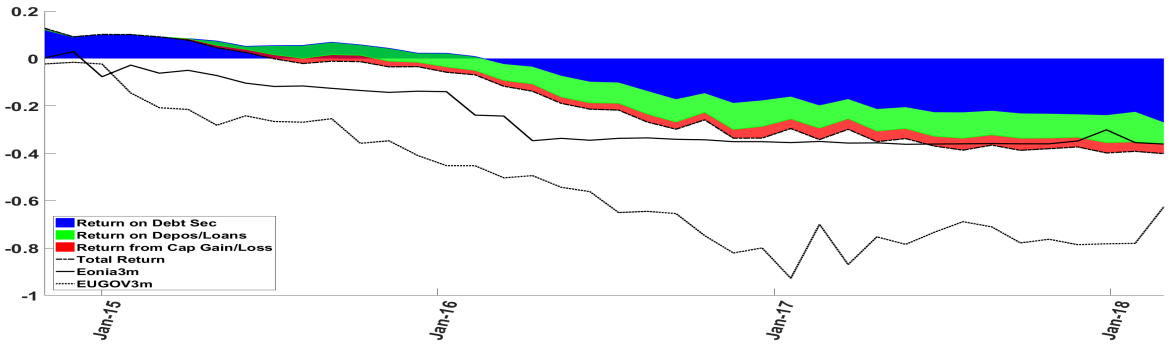
(b) USD



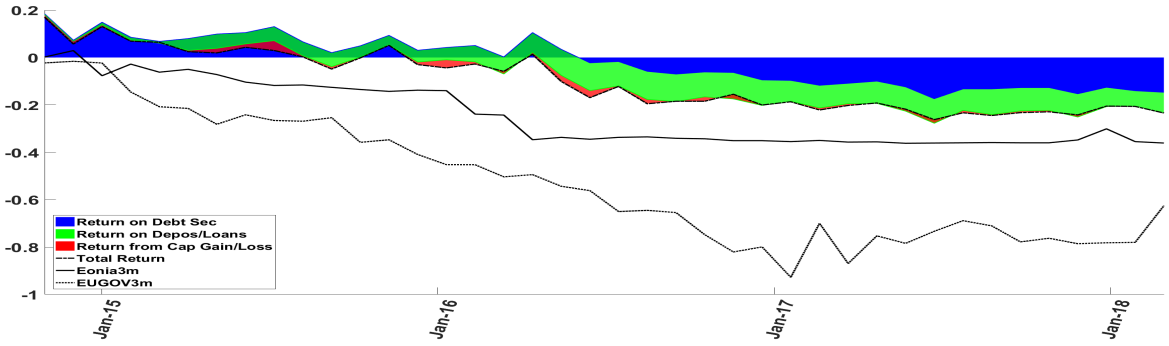
(c) GBP

Note: This figure shows the average proportional month-end holdings by all MMF funds in each of the three currency groupings according to the issuer of the assets held. It is estimated as the share of the asset class x in which fund i invests at the end of period t over total asset of fund i at the end of period t. The issuer types are: Government (Gov), Investment Funds (IFs), Money Market funds (MMF), Financial Auxiliaries and Other Financial Institutions (FA_OFI), Financial Vehicle Corporations (FVC), Non-financial corporations (NFC), Deposit Taking Corporations (DTC).

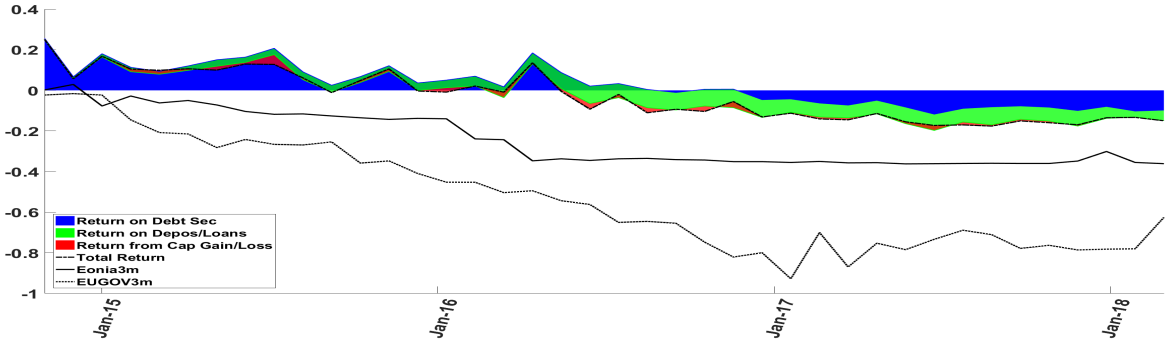
Figure 6: MMF Return Performance: EUR reporting (%). Backlink to page 9.



(a) VNAV



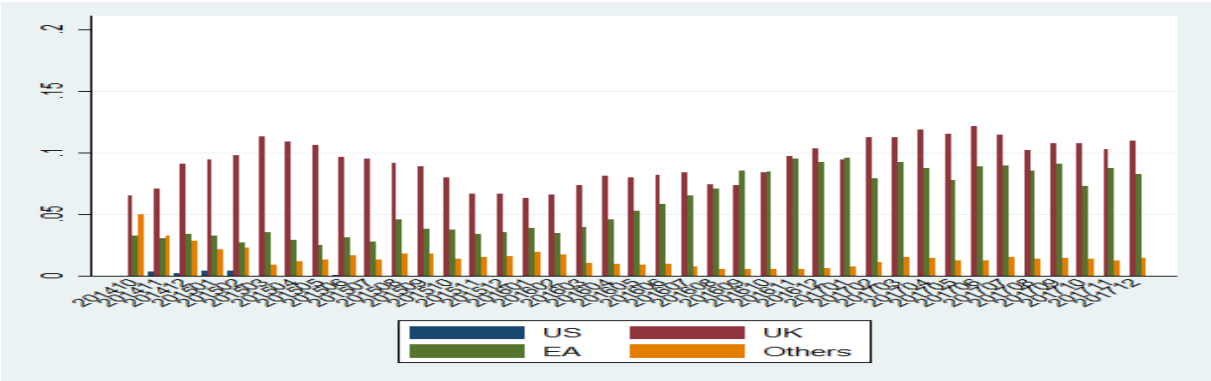
(b) CNAV



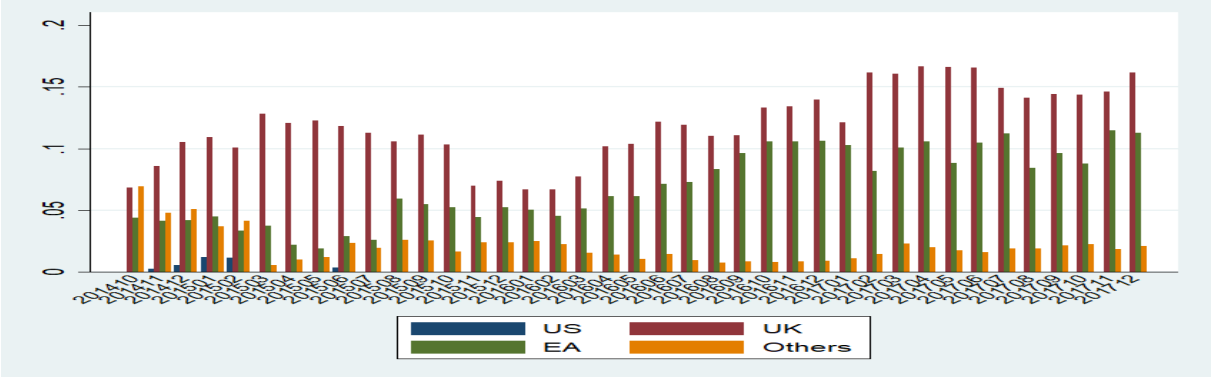
(c) CNAV: three currencies

Note: The components of total annualised returns are shown for money market fund categories according to their reporting currency. Returns of each type are simply the sum of income across all funds in the category as a percentage of the NAV of the entire fund category at the beginning of the period.

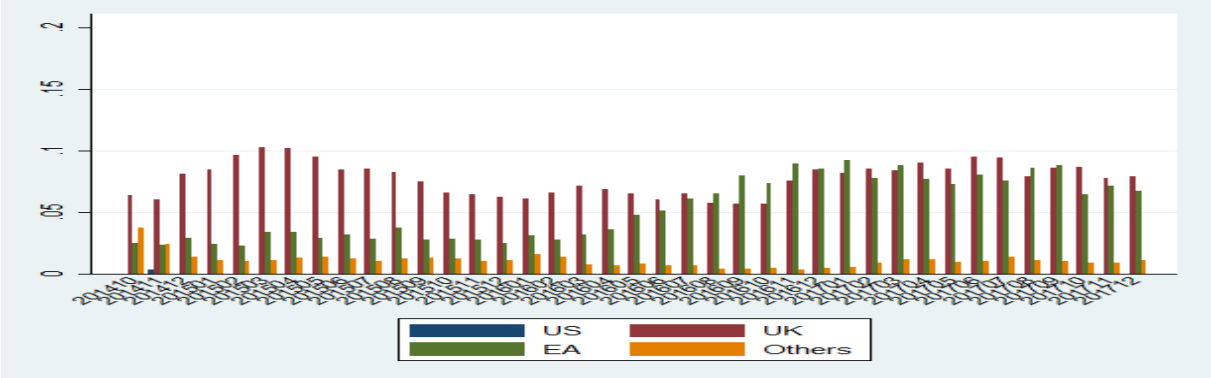
Figure 7: Portfolio composition : tradable certificate / stock: Euro sample
Backlink to page 9.



(a) Overall



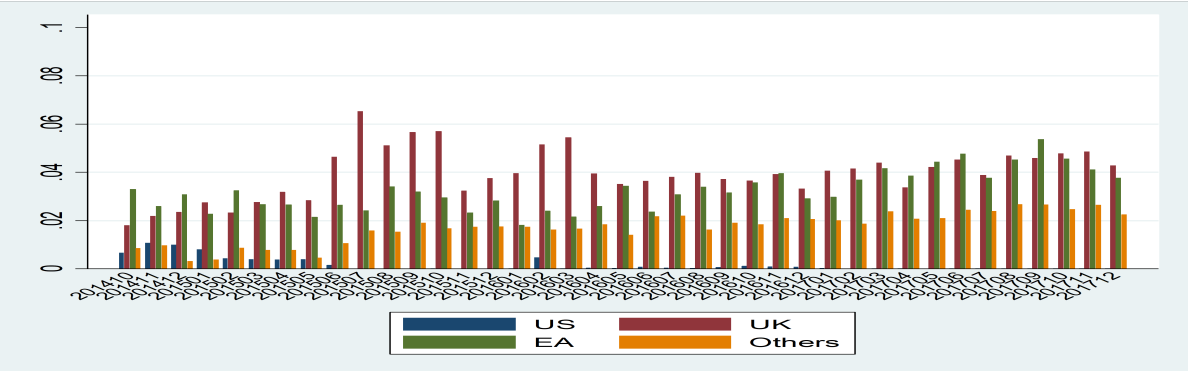
(b) CNAV



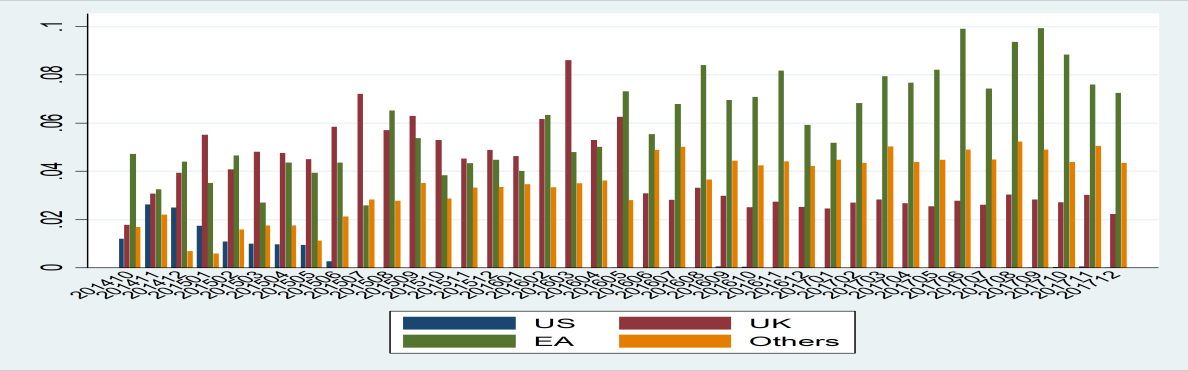
(c) VNAV

Note: This figure shows the breakdown of the average proportional month-end holdings of tradable deposit according to the country of the issuer for the Euro sample. It is estimated as the share of tradable deposit issue by country x in which fund i invests at the end of period t over total asset of fund i at the end of period t.

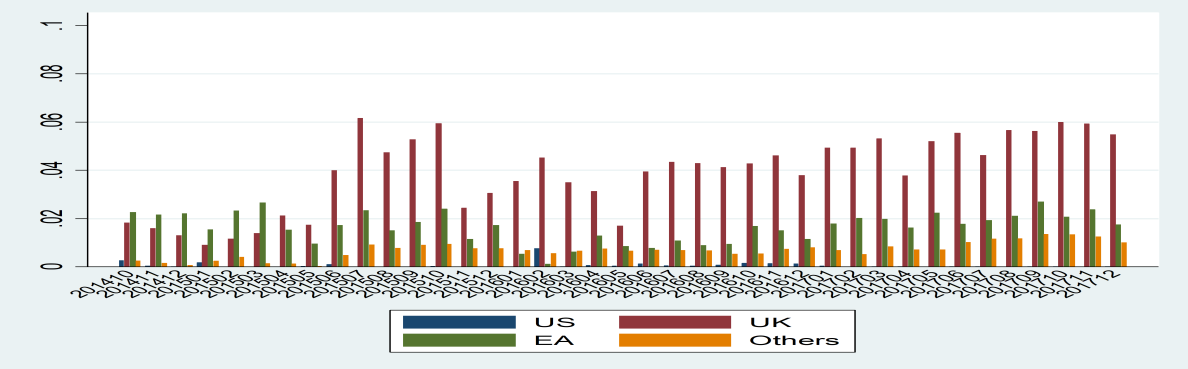
Figure 8: Portfolio composition : cash, deposit and loans issued by banks / gross transactions: euro sample Backlink to page 9.



(a) Overall



(b) CNAV



(c) VNAV

Note: This figure shows the average proportional daily gross transactions of cash, deposit and loans for the Euro sample. It is estimated as the share of purchases and sales for cash, deposit and loans at the end of period t for fund i divided by 2 and by the number of trading days in the month as a fraction of total asset at the *beginning* of period t for fund i. Transactions are the market value of purchases and sales of a security on the dates of each transaction. A purchase implies an increase in the position and sales imply a decrease in the position.

C Tables

Table 1: **Sample by fund type, reporting currency & family ties.** Backlink to page 12

		VNAV				CNAV				ALL
		EUR	GBP	USD	All VNAV	EUR	GBP	USD	All CNAV	TOTAL
Siblings' currencies	USD/GBP/EUR	13	10	13	36	5	7	7	19	55
	USD/GBP	0	1	1	2	0	2	3	5	7
	USD/EUR	0	0	0	0	0	0	0	0	0
	GBP/EUR	0	1	0	1	4	4	0	8	9
	USD-Only	0	0	3	3	0	0	5	5	8
	GBP-Only	0	1	0	1	0	3	0	3	3
	EUR-Only	1	0	0	1	0	0	0	0	1
	Total:	14	13	17	44	9	16	15	40	84

Table 2: **Descriptive Statistics.**[1] Backlink to page 12.

	Main variables - Mean & Standard Deviations					
	Return_EUR	Return_USD	Return_UK	Policy rate_EUR	Policy rate_US	Policy rate_UK
Mean	-0.157	0.589	0.445	-0.249	0.478	0.413
σ_o	0.255	0.436	0.222	0.125	0.385	0.117
σ_b	0.166	0.229	0.118			
σ_w	0.201	0.391	0.193			

[1] This table reports the descriptive statistics for the dependent and policy rate variables used in Equation (1) for monthly observations from Q1 2014 to Q1 2018.

Table 3: **Correlations.**[1] Backlink to page 12.

			Sample Euro		
	EONIA	TERM-SPREAD	CORP-SPREAD	CSPP flows	PSPP flows
EONIA	1				
TERM-SPREAD	-0.3638	1			
CORP-SPREAD	-0.5294*	0.5256*	1		
CSPP flows	0.2905	-0.4205	-0.2427	1	
PSPP flows	-0.2981	-0.2566	0.0250	0.2736	1

			Sample USD	
	FF Rate	TERM-SPREAD	CORP-SPREAD	BILLS flows
FF Rate	1			
TERM-SPREAD	-0.3385	1		
CORP-SPREAD	-0.7165*	0.1568	1	
BILLS flows	0.0982	-0.0541	-0.2680	1

		Sample GBP	
	BANK RATE	TERM-SPREAD	CORP-SPREAD
BANK RATE	1		
TERM-SPREAD	0.3527	1	
CORP-SPREAD	0.6505*	0.4223*	1

[1] The correlation with monetary policy interventions is omitted in the UK-sample. Those variables are indistinguishable from a temporary Brexit dummy. Simple correlation for such a temporary situation gives an inadequate description of the basic relations at play.

Table 4: **Euro-Reporting Sample** [1] Backlink to page 12.

	Full Sample			VNAV			CNAV		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
EONIA	1.132	1.168	0.895	1.253	1.269	1.012	0.890	0.910	0.736
	(0.148)***	(0.147)***	(0.123)***	(0.163)***	(0.158)***	(0.135)***	(0.185)***	(0.188)***	(0.160)***
TERM-SPREAD		-0.494			-0.531			-0.362	
		(0.075)***			(0.120)***			(0.146)**	
CORP-SPREAD		0.128			0.113			0.108	
		(0.030)***			(0.052)**			(0.054)*	
CSPP_flow			-1.712			-1.745			-1.218
			(0.202)***			(0.175)***			(0.367)**
PSPP_flow			0.065			0.071			0.053
			(0.028)**			(0.039)*			(0.055)
Fund Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Supply Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj-R-sq	0.528	0.543	0.586	0.575	0.587	0.624	0.544	0.562	0.591
p($\beta_1 = 1$)	0.383	0.267	0.400	0.145	0.115	0.931	0.569	0.647	0.137
N	764	764	764	463	463	463	301	301	301
n	22	22	22	13	13	13	9	9	9
Tmin	9	9	9	14	14	14	9	9	9
Tmean	35	35	35	36	36	36	33	33	33
Tmax	40	40	40	40	40	40	40	40	40

[1] The dependent variable is the annualised percentage return on investment for each fund and period. The explanatory variables of most interest to our analysis include an interest rate closely related to the policy rate (3 Month EONIA), the term spread between 2 year and 3 month government bond yields, the corporate bond spread (specifically, the S&P European Investment Grade Corporate Bond Index minus 3 month Gov-yield), corporate bond purchases under the auspices of the Corporate Sector Purchase Programme (CSPP) and sovereign bond purchases under the Public Sector Purchase Programme (PSPP). Control variables are included in each regression. The first group of control variables cater for heterogeneity in fund characteristics (i.e., the Expense-Ratio, the Size of each fund measured as log(NAV), reported % returns from occasional Capital Gains and the median of the absolute value of Investment-Flows into and out of each fund over the previous 3 month period relative to NAV). The second group of controls captures developments that are driven by changes in the supplies of assets usually held by MMFs (i.e., the change in outstanding amount of government short term debt, change in outstanding monetary financial institutions' short term debt, change in outstanding supply of euro area commercial paper, change in outstanding non-financial corporates' short term debt, change in euro-denominated tradeable certificates of deposit issued by UK banks. In the last row of results p($\beta_1 = 1$) is the p-value for a Wald test of the coefficient on the policy rate variable being significantly different from 1 (implying a perfect pass-through of policy rate changes to fund performance).

Table 5: **USD-Reporting Sample.**[1] Backlink to page 12.

	Full Sample			VNAV			CNAV		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
FF_RATE	0.936	0.958	0.939	0.961	0.983	0.962	0.856	0.870	0.859
	(0.054)***	(0.055)***	(0.054)***	(0.089)***	(0.094)***	(0.090)***	(0.087)***	(0.085)***	(0.087)***
TERM-SPREAD		0.078			0.077			0.073	
		(0.030)**			(0.050)			(0.035)*	
CORP-SPREAD		0.031			0.031			0.013	
		(0.021)			(0.044)			(0.023)	
PSPP(T-Bills)_flow			-0.097			-0.090			-0.088
			(0.024)***			(0.044)*			(0.026)***
Fund Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Supply Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj-R-sq	0.833	0.833	0.834	0.795	0.795	0.796	0.891	0.891	0.892
p($\beta_1 = 1$)	0.249	0.452	0.268	0.672	0.856	0.678	0.120	0.150	0.129
N	1040	1040	1040	489	489	489	551	551	551
n	30	30	30	15	15	15	15	15	15
Tmin	6	6	6	6	6	6	8	8	8
Tmean	35	35	35	33	33	33	37	37	37
Tmax	40	40	40	40	40	40	40	40	40

[1] The dependent variable is the annualised percentage return on investment for each fund and period. The explanatory variables of most interest to our analysis include an the policy rate (Fed-Funds Rate), the term spread between 2 year and 3 month Treasury yields, the corporate bond spread (specifically, the ICE BofAML US Corporate Master Option-Adjusted Spread), Purchases of Treasury Bills under QE. Control variables are included in each regression. The first group of control variables cater for heterogeneity in fund characteristics (i.e., the Expense-Ratio, the Size of each fund measured as log(NAV), reported % returns from occasional Capital Gains and the median of the absolute value of Investment-Flows into and out of each fund over the previous 3 month period relative to NAV). The second group of controls captures developments that are driven by changes in the supplies of assets usually held by MMFs (i.e., the change in outstanding amount of short term Treasuries, change in outstanding monetary financial institutions' short term debt, change in outstanding supply of commercial paper). In the last row of results p($\beta_1 = 1$) is the p-value for a Wald test of the coefficient on the policy rate variable being significantly different from 1 (implying a perfect pass-through of policy rate changes to fund performance). All standard errors are robust to heteroscedasticity and clustered by fund.

Table 6: **GBP-Reporting Sample.**[1] Backlink to page 12.

	Full Sample			VNAV			CNAV		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
BANK_RATE	0.742	0.676	0.851	0.746	0.713	0.877	0.705	0.647	0.784
	(0.061)***	(0.046)***	(0.057)***	(0.078)***	(0.054)***	(0.076)***	(0.076)***	(0.072)***	(0.067)***
TERM-SPREAD		-0.188			-0.185			-0.165	
		(0.018)***			(0.035)***			(0.025)***	
CORP-SPREAD		0.072			0.058			0.064	
		(0.012)***			(0.021)**			(0.011)***	
CSPP_flow			-7.801			-8.463			-6.995
			(0.723)***			(1.339)***			(0.790)***
PSPP_flow			1.536			1.693			1.295
			(0.073)***			(0.106)***			(0.080)***
Fund Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Supply Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj-R-sq	0.485	0.539	0.559	0.476	0.513	0.551	0.550	0.599	0.611
p($\beta_1 = 1$)	0.000	0.000	0.015	0.009	0.000	0.139	0.002	0.000	0.006
N	930	930	930	420	420	420	510	510	510
n	26	26	26	11	11	11	15	15	15
Tmin	9	9	9	29	29	29	9	9	9
Tmean	36	36	36	38	38	38	34	34	34
Tmax	40	40	40	40	40	40	40	40	40

[1] The dependent variable is the annualised percentage return on investment for each fund and period. The explanatory variables of most interest to our analysis include the policy rate (BoE Bank Rate), the term spread between 2 year and 3 month gilt yields, the corporate bond spread (specifically, U.K. Investment Grade Corporate Bond Spread compiled by S&P), corporate bond purchases and purchases of gilts under QE. Control variables are included in each regression. The first group of control variables cater for heterogeneity in fund characteristics (i.e., the Expense-Ratio, the Size of each fund measured as log(NAV), reported % returns from occasional Capital Gains and the median of the absolute value of Investment-Flows into and out of each fund over the previous 3 month period relative to NAV). The second group of controls captures developments that are driven by changes in the supplies of assets usually held by MMFs (i.e., the change in outstanding amount of short term gilts, change in outstanding monetary financial institutions' short term debt, change in outstanding supply of commercial paper). In the last row of results p($\beta_1 = 1$) is the p-value for a Wald test of the coefficient on the policy rate variable being significantly different from 1 (implying a perfect pass-through of policy rate changes to fund performance). All standard errors are robust to heteroscedasticity and clustered by fund.

Table 7: **Fixed Effects Analysis.**[1] Backlink to page 14.

Currency	Sample	No. Funds	Fund Controls	Average FE	T-Stat	P-Value	Non-Zeros
EUR	ALL	22	No	0.108	3.054	0.006***	4
EUR	ALL	22	Yes	-0.483	-0.325	0.748	0
EUR	VNAV	13	No	0.111	2.417	0.033**	2
EUR	VNAV	13	Yes	-0.914	-0.612	0.552	0
EUR	CNAV	9	No	0.105	2.011	0.079*	2
EUR	CNAV	9	Yes	0.412	0.279	0.788	0
USD	ALL	30	No	0.089	2.787	0.009***	6
USD	ALL	30	Yes	0.489	0.83	0.413	1
USD	VNAV	15	No	0.106	2.004	0.065*	2
USD	VNAV	15	Yes	-0.486	-0.555	0.587	0
USD	CNAV	15	No	0.072	1.84	0.087*	3
USD	CNAV	15	Yes	0.99	1.221	0.242	0
GBP	ALL	26	No	0.132	5.48	0.000***	12
GBP	ALL	26	Yes	0.209	0.38	0.707	0
GBP	VNAV	11	No	0.141	4.757	0.001***	3
GBP	VNAV	11	Yes	1.447	1.851	0.094*	11
GBP	CNAV	15	No	0.129	3.365	0.005***	6
GBP	CNAV	15	Yes	-0.507	-0.939	0.363	0

[1] Fixed effects tests are shown for all of the level regressions analysed above with and without fund-level control variables. In each case the average of the fixed effects is shown and this is accompanied by T-tests and p-value from a test of its difference from zero. The number of significant fund-specific fixed effects is also show in the final column. It is clear that in all but one case the number of significant fund-specific fixed effects declines to zero when fund level controls are included in the regression.

Table 8: **All Funds (EUR, USD, GBP) - LAG OF POLICY RATE** [1] Backlink to page 14.

	EUR-Reporting			USD-Reporting			GBP-Reporting		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Policy-Rate Proxy	-0.241	-0.025	0.185	0.847	0.848	0.798	-0.298	-0.273	-0.105
	(0.113)**	(0.120)	(0.141)	(0.092)***	(0.092)***	(0.093)***	(0.073)***	(0.052)***	(0.081)
Policy-Rate Proxy(Lag)	1.324	1.122	0.744	-0.009	-0.000	0.047	1.095	0.993	0.951
	(0.211)***	(0.212)***	(0.187)***	(0.079)	(0.081)	(0.082)	(0.068)***	(0.056)***	(0.076)***
TERM-SPREAD		-0.304			0.047			-0.106	
		(0.069)***			(0.029)			(0.018)***	
CORP-SPREAD		0.059			0.009			0.057	
		(0.022)**			(0.020)			(0.012)***	
CBPP_flow			-13.488						-1.551
			(2.349)***						(0.754)*
PSPP_flow			0.867			-0.082			0.519
			(0.292)***			(0.020)***			(0.078)***
Fund Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Supply Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj-R-sq	0.590	0.594	0.628	0.860	0.860	0.861	0.654	0.673	0.662
p($\beta_1 + \beta_2 = 1$)	0.614	0.535	0.605	0.014	0.023	0.018	0.002	0.000	0.013
N	742	742	742	1010	1010	1010	904	904	904
n	22	22	22	30	30	30	26	26	26
Tmin	8	8	8	5	5	5	8	8	8
Tmean	34	34	34	34	34	34	35	35	35
Tmax	39	39	39	39	39	39	39	39	39

[1] The dependent variable is the annualised percentage return on investment for each fund and period. The explanatory variables of most interest to our analysis include an interest rate closely related to the policy rate, the term spread between 2 year and 3 month government bond yields, the corporate bond spread, corporate bond purchases and sovereign bond purchases (except for the USD case where this is just Treasury Bill purchases). Control variables are included in each regression. The first group of control variables cater for heterogeneity in fund characteristics (i.e., the Expense-Ratio, the Size of each fund measured as log(NAV), reported % returns from occasional Capital Gains and the median of the absolute value of Investment-Flows into and out of each fund over the previous 3 month period relative to NAV). The second group of controls captures developments that are driven by changes in the supplies of assets usually held by MMFs (i.e., the change in outstanding amount of government short term debt, change in outstanding monetary financial institutions' short term debt, change in outstanding supply of euro area commercial paper, change in outstanding non-financial corporates' short term debt, change in euro-denominated tradeable certificates of deposit issued by UK banks. In the last row of results p($\beta_1 + \beta_2 = 1$) is the p-value for a Wald test of the coefficients on the policy rate variable adding to an effect significantly different from 1 (implying a perfect pass-through of policy rate changes to fund performance). All standard errors are robust to heteroscedasticity and clustered by fund.

Table 9: **All Funds (EUR, USD, GBP) - LAG OF POLICY RATE DROP 3 OUTLIER FUNDS** [1] Backlink to page 14.

	EUR-Reporting			USD-Reporting			GBP-Reporting		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Policy-Rate Proxy	-0.237	-0.081	0.132	0.894	0.870	0.839	-0.247	-0.344	-0.086
	(0.089)**	(0.101)	(0.071)*	(0.100)***	(0.093)***	(0.104)***	(0.058)***	(0.046)***	(0.059)
Policy-Rate Proxy(lag)	1.332	1.192	0.881	0.034	0.060	0.097	1.065	1.069	0.936
	(0.176)***	(0.160)***	(0.101)***	(0.087)	(0.086)	(0.091)	(0.067)***	(0.063)***	(0.067)***
TERM-SPREAD		-0.263			0.119			-0.061	
		(0.096)**			(0.065)*			(0.033)*	
CORP-SPREAD		0.050			0.016			0.047	
		(0.020)**			(0.021)			(0.013)***	
CBPP_flow			-10.888						-1.150
			(2.244)***						(0.836)
PSPP_flow			1.070			-0.092			0.524
			(0.233)***			(0.022)***			(0.086)***
Fund Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Supply Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj-R-sq	0.745	0.750	0.778	0.890	0.890	0.891	0.679	0.687	0.672
p($\beta_1 + \beta_2 = 1$)	0.468	0.401	0.899	0.128	0.127	0.169	0.004	0.000	0.008
N	635	635	635	893	893	893	787	787	787
n	19	19	19	27	27	27	23	23	23
Tmin	8	8	8	5	5	5	8	8	8
Tmean	33	33	33	33	33	33	34	34	34
Tmax	39	39	39	39	39	39	39	39	39

[1] The dependent variable is the annualised percentage return on investment for each fund and period. The explanatory variables of most interest to our analysis include an interest rate closely related to the policy rate, the term spread between 2 year and 3 month government bond yields, the corporate bond spread, corporate bond purchases and sovereign bond purchases (except for the USD case where this is just Treasury Bill purchases) . Control variables are included in each regression. The first group of control variables cater for heterogeneity in fund characteristics (i.e., the Expense-Ratio, the Size of each fund measured as log(NAV), reported % returns from occasional Capital Gains and the median of the absolute value of Investment-Flows into and out of each fund over the previous 3 month period relative to NAV). The second group of controls captures developments that are driven by changes in the supplies of assets usually held by MMFs (i.e., the change in outstanding amount of government short term debt, change in outstanding monetary financial institutions' short term debt, change in outstanding supply of euro area commercial paper, change in outstanding non-financial corporates' short term debt, change in euro-denominated tradeable certificates of deposit issued by UK banks. In the last row of results p($\beta_1 + \beta_2 = 1$) is the p-value for a Wald test of the coefficients on the policy rate variable adding to an effect significantly different from 1 (implying a perfect pass-through of policy rate changes to fund performance). All standard errors are robust to heteroscedasticity and clustered by fund.

Table 10: **EUR-Reporting Sample: Excess Return Regression** [1] Backlink to page 15.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(EONIA-Gov3M)	-0.295	-0.289		-0.276		-0.373		-0.046
	(0.112)**	(0.113)**		(0.117)**		(0.105)***		(0.112)
TERM-SPREAD			-0.440	-0.067				
			(0.158)**	(0.083)				
CORP-SPREAD					-0.004	0.134		
					(0.054)	(0.026)***		
CSPP_flow							-1.411	-1.249
							(0.410)***	(0.208)***
Fund Controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Supply Controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj-R-sq	0.065	0.089	0.032	0.088	0.006	0.111	0.115	0.114

[1] The dependent variable, for each fund and period, is the difference between the annualised percentage return on investment and the policy rate. The explanatory variables of most interest to our analysis include the difference between the policy rate and the yield on short term government securities (EONIA-Gov3M), the term spread between 2 year and 3 month EA Sovereign bond yields, the corporate bond spread (specifically, the S&P European Investment Grade Corporate Bond Index minus the 3 month Gov-Bond yield) and QE-related corporate bond purchases under the auspices of the Corporate Sector Purchase Programme (CSPP). The first group of control variables cater for heterogeneity in fund characteristics (i.e., the Expense-Ratio, the Size of each fund measured as log(NAV), reported % returns from occasional Capital Gains and the median of the absolute value of Investment-Flows into and out of each fund over the previous 3 month period relative to NAV). The second group of controls captures developments that are driven by changes in the supplies of assets usually held by MMFs (i.e., the change in outstanding amount of short term EA sovereign bonds, change in outstanding monetary financial institutions' short term debt, change in outstanding supply of commercial paper). In the last row of results p($\beta_1 = 1$) is the p-value for a Wald test of the coefficient on the policy rate variable being significantly different from 1 (implying a perfect pass-through of policy rate changes to fund performance). For all regression results in this table the following sample characteristics apply:N=762, n=22, Tmin=9, Tmean=35, Tmax=40. All standard errors are robust to heteroscedasticity and clustered by fund.

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