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Abstract

Unconventional monetary policy (UMP) by the US Federal Reserve, Bank of England, Bank of Japan, and European Central Bank affects the geographical portfolio choice of international mutual fund managers. UMP prompts managers of mutual funds to rebalance their portfolios away from the country conducting UMP, and increase their geographical allocation to other developed markets; there is little evidence of rebalancing towards emerging markets. The international spillover effects from UMP announcement surprises are of small economic magnitude, in contrast to the effects of actual UMP operations in the form of large-scale asset purchases (LSAPs). The results imply that while not contributing to QE-induced capital flows to emerging markets, mutual fund managers play a role in the transmission of unconventional monetary policy, in particular LSAPs, across developed markets.

Key words: Unconventional monetary policy, portfolio rebalancing, international spillovers, asset allocation, mutual funds.

JEL classification: F30, G11, G15, G23.

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1 Introduction

Some market participants and policymakers argue that monetary policy can spill over beyond a country's borders, most notably through the international portfolio rebalancing of global investors. This possibility has taken centre stage in the policy debate given the unprecedented scale of unconventional monetary stimulus undertaken in several developed countries since the start of the global financial crisis in 2008. We look into this issue through the lens of the geographical portfolio choice of active mutual fund managers in response to unconventional monetary policy (UMP) announcement surprises, measured as the intraday change in government bond yields around UMP announcements, and actual UMP operations in the form of large-scale asset purchases.

While some authors have analysed the impact of monetary policy on the geographical reallocation of underlying investors, there is no study analysing the impact of UMP on the geographical allocation of financial intermediaries, in particular asset managers. We fill this gap in the literature by studying the impact of UMP on the international allocation of mutual fund managers. We look at the portfolio allocation of *active* fund managers only, that is, we exclude *passive* funds from the analysis, whose allocation may be mechanically driven by country weightings in benchmark indices. The main hypothesis that we test is whether UMP shifts the geographical allocation of fund managers away from the country where UMP is undertaken, and towards foreign countries, particularly riskier emerging markets.

Motivation for research question

The motivation for this research is three-fold. First, the reason for analysing fund managers is that financial stability regulatory bodies have been increasingly concerned about the asset management industry, particularly mutual funds (IMF 2014, 2015, 2016; and FSB 2016, 2017). The mutual fund industry is growing in absolute terms as well as relative to

the size of the economies in which the funds are domiciled. Since 1980, the industry's assets under management (AUM) in the United Kingdom, for instance, have grown from half to over three times the size of UK GDP. According to EFAMA (2017) and IIFA (2017) industry estimates, as of mid-2017, all worldwide regulated open-ended mutual funds combined have approximately $50.15 trillion in AUM, up from $43.86 trillion in 2015, of which 40.6% and 21.3% is managed by equity and bond funds respectively. This implies that a one percentage point (pp) increase in the weight of a county in the portfolio of equity (bond) funds represents approximately $200 bn ($100 bn) in capital flows to a country. The geographical portfolio allocation of mutual fund managers represents potentially sizable capital flows.

Second, we analyse the allocation to and from emerging markets (EMs) because of the intense interest of policy makers in UMP spillovers to EMs. Our analysis helps to establish whether fund managers have contributed to the "tsunami" of capital flows to emerging markets following the unconventional monetary policy response to the 2007/8 financial crisis. Identifying the source of QE-related capital flows matters to policy makers when considering to impose new capital flow management measures.

Third, we analyse fund managers' changes in portfolio country weights because the existing literature using mutual fund flow data in order to analyse international spillovers from UMP (Fratzscher et al., 2013, 2016; Curcuru et al., 2015; Banegas et al., 2016) implicitly assumes that the country portfolio weights are not adjusted by fund managers in response to UMP. Our paper is the first study providing empirical evidence that will help to assess the validity of this implicit assumption. This matters because if the country portfolio weights are adjusted in the same (opposite) direction of the portfolio reallocation of the underlying investors, it would understate (overstate) the estimated effect of QE on capital flows.

What we expect to find

Our prior expectation about the *direction* of the portfolio rebalancing by mutual fund managers in response to UMP is that funds managers (1) rebalance their portfolio away from the developed market whose central bank is conducting UMP, i.e. away from the US, UK, Japan, and euro zone, in order to (2) rebalance to other developed markets, as a substitute for the home market which funds are rebalancing away from, and (3) to emerging markets in a search for yield.

These priors are based on the theoretical considerations relating to the signalling, portfolio balance, and risk-taking channels of monetary policy transmission. UMP may induce investors to change their portfolio allocations across countries via several channels, including the risk-taking channel of monetary policy. Accommodative monetary policy may push economic agents, including financial intermediaries such as mutual funds, to tilt their portfolio allocation towards riskier assets in a search for yield (Rajan, 2006; Gambacorta, 2009; Adrian and Shin, 2010; Borio and Zhu, 2012). A distinct but related channel is the portfolio balance channel, via which central bank asset purchases induce the sellers of those assets to shift towards substitute assets.[1] Recent studies find some evidence in support of the risk-taking channel and portfolio balance channel across asset classes (e.g., Hau and Lai, 2016; Joyce et al., 2017). Another potential dimension of the reallocation to riskier assets, as highlighted by the international policy debate, is via the geographical reallocation from the domestic market to foreign markets, especially emerging markets, which are typically considered as relatively risky (e.g., Bekaert and Harvey, 2017). These priors are confirmed in empirical work by Fratzscher et al. (2013, 2016) who observe that fund investors rebalance away from mutual funds focused on the region conducting UMP towards other developed markets and emerging markets mutual funds.

[1]The portfolio balance channel explains how LSAPs have a financial market effect by assuming that the purchased assets are imperfectly substitutable for some investors facing institutional or other constraints on their portfolio choice. The reach for yield channel does not assume such constraints. The two channels can work in tandem when an investor searches for yield due to being restricted to investing in a specific asset class as constrained by one or several asset characteristics such as its maturity or risk profile.

Our expectations about the relative and absolute *economic magnitude* of the portfolio rebalancing by mutual fund managers in response to UMP is informed by prior empirical work. In our study on the portfolio rebalancing by mutual fund managers, we expect, similar to studies by Fratzscher et al. (2013 and 2016) on the portfolio rebalancing by fund investors, that UMP operations, in the form of LSAPs, should exert a larger effect than UMP announcement surprises. We also expect that, although the portfolio rebalancing effects can be relatively large in some instances, in particular by the US Fed's LSAPs, the economic size of the UMP-induced portfolio reallocations overall is relatively small when compared to the observed total changes in portfolio weights over the sample period. In other words, UMP is not expected to explain a large share of geographical portfolio reallocations by mutual fund managers.

How we answer the question

In order to test these hypotheses, we estimate a panel regression model with fund fixed effects. The sample period, from October 2008 to April 2014, covers the major QE programs in response to the financial crisis, including Operation Twist. In the benchmark regression, the dependent variable is the change in the weighting of a country or a region in the portfolio of a fund, measured at a monthly frequency. The portfolio weight refers either to the country or region in which the central bank is located ($HOME$); developed countries besides the home country ($DMexHome$); or Emerging Markets (EM). The main explanatory variables of interest are UMP operations in the form of large-scale asset purchases, expressed in percentage of GDP of the home country in which the central bank is located, and UMP announcement surprises, which are measured as the intraday change in government bond yields around the announcements, in line with Rogers et al. (2014). We control for macro push and pull factors including forecasts for GDP and the current account, industrial production, inflation, the cost of insurance against sovereign default (5-year sovereign CDS spreads), general macro country risk, liquidity (M2) and unem-

ployment. We account for global risk perceptions and funding liquidity by controlling for changes in the VIX and the TED spread. We control for potential passive reallocation by including the market return on a country index relative to the fund's portfolio return, similarly to Raddatz and Schmukler (2012). Furthermore, we carry out a battery of robustness checks.

Our results

In terms of the *direction* of portfolio rebalancing, we find that UMP measures indeed prompt managers of mutual funds to rebalance their portfolio away from the home country, and increase their geographical allocation to other developed markets. But we find little evidence for portfolio rebalancing towards emerging markets. In other words, our prior expectations are confirmed for two of the three hypotheses relating to the direction of UMP-induced geographical portfolio rebalancing. Funds rebalance away from home to other developed markets as a substitute for home assets (Hypotheses 1 and 2). This seems to support the idea that mutual fund managers' role in the international transmission of UMP operates mostly via the portfolio balance channel. We do not find evidence for rebalancing towards EMs (Hypothesis 3), which suggest that fund managers play a negligible role in the risk-taking channel of transmitting UMP across countries.

The reason why mutual funds managers do not rebalance towards EMs is not explained by their geographical fund mandate. In contrast to underlying fund investors, fund managers face institutional constraints on their portfolio choice, including a geographical investment mandate. This constraint restricts fund managers to be invested in with at least 75% of their AUM in countries prescribed in the geographical investment mandate. In practice, however, this constraint does not seem to be binding as we do not observe rebalancing towards EMs when running the regressions separately for developed market funds and emerging market funds.[2]

[2]A possible institutional constraint explaining the lack of rebalancing even by EM funds towards emerging markets is that some active EM funds we are considering might be "closet indexing" funds, implying

In terms of the *economic magnitude* of portfolio rebalancing, UMP *operations*, i.e. the implementation of asset purchases, have a much larger effect than UMP announcement *surprise*s, similar to the relative economic size Fratzscher et al. (2013, 2016) observe for UMP-induced portfolio rebalancing effects on mutual fund investors. The effect of UMP surprises is small both absolutely and relatively to the observed total changes in portfolio weights. For example, a UMP easing surprise by the US Fed associated with a 25bp fall in US Treasury yields leads managers of mutual bond funds to reduce their portfolio exposure to the US by 0.71pp, or $710 million in absolute terms, and increase it to other developed markets excluding the US ('DMexUS' in short) by 0.51pp, or $510 million. An easing surprise of the same size by the Bank of England (BoE) leads bond fund managers to reduce their portfolio exposure to the UK by 1.13pp, around $1.13 bn, and increase it to other developed markets excluding the UK ('DMexUK' in short) by about 1.1pp, that is $1.1 bn.

However, the cumulated effect of UMP operations, i.e. LSAPs, in terms of the overall change in country weights over the sample period is large. We find that LSAPs by all central banks have a large economic effect on the geographical portfolio allocation of fund managers. US Fed purchases of Treasury bills equivalent to 1% of US GDP prompt managers of bond funds to increase their portfolio exposure to other developed markets excluding the US by 0.43pp, while BoE LSAPs of the same relative size trigger bond fund managers to increase their portfolio exposure to DMexUK countries by 0.24pp. This seems small until one considers the total cumulated impact of LSAPs over the sample period. For instance, equity funds increased their portfolio allocation to the US by 6.14pp, or $12.3 billion, over the sample period.[3] The portfolio reallocation to the US would have been bigger in the absence of US Fed LSAPs, given that purchases of Treasuries and MBSAD exerted a -1.77pp (or -$3.5 billion in US dollar) and -1.04pp (-$2.1 bn) effect, re-

that the fund managers will change their country weights only after the index weight in their benchmark changes.

[3]These and the following dollar figures are based on the AUM of the whole industry applied to the changes in portfolio weights of our representative sample of international mutual funds.

spectively, on the weight of the US in the portfolios of equity funds. Similarly, the effects of US Fed purchases of Treasuries on bond fund managers' portfolio allocation is large: Treasury purchases prompt bond funds to increase their DMexUS portfolio weight by 5.25pp ($5.25 bn) and decrease the EM weight by 4.68pp ($4.68 bn) which is large relative to the overall portfolio reallocation over the sample period during which bond funds reduced their DMexUS weight by 10.52pp ($10.52 bn) and increased their portfolio allocation to EM countries by 15.57pp ($15.57 bn). Effects of similar relative magnitude can be observed for LSAPs by the BoE, BoJ and ECB.[4]

Contribution to the literature

Our paper goes further than existing papers in the literature on global spillovers from UMP in three key aspects.

First, and most importantly, we supply direct evidence on the portfolio rebalancing by mutual fund managers while the literature so far has focused exclusively on portfolio rebalancing by underlying client investors.[5] This difference is important because investors' wealth changes over time and investment in mutual funds is only a fraction of the complete portfolio of the underlying client investors, as pointed out by Curcuru et al. (2011) and Kroencke et al. (2015). This implies that capital flow patterns across regions following QE, as observed in Fratzscher et al. (2013 and 2016), might be partly driven by wealth effects rather than portfolio rebalancing on the part of the underlying client investors. Furthermore, capital flows intermediated via mutual funds are the outcome of the joint behaviour of the underlying fund investors, and the portfolio choice decisions of the managers of those funds, as emphasised by Raddatz and Schmukler (2012).[6] This mat-

[4]The small effects of the ECB's LSAPs on equity fund managers is the exception and may be due to the restricted sample period that does not account of the whole set of LSAP programmes by the ECB.

[5]See Banegas et al. (2016), Curcuru et al. (2015); Fratzscher et al., (2013, 2016); Kroencke et al. (2015). We focus on geographical portfolio rebalancing because we do not have high frequency data on mutual fund managers portfolio reallocation decisions across asset classes.

[6]Fratzscher et al. (2013) focus "not on analysing the portfolio allocation strategy of individual fund managers, but [instead focus on portfolio rebalancing by] individual firms or other institutional investors

ters because if the country portfolio weights are adjusted in the same (opposite) direction of the portfolio reallocation of the underlying investors, it would understate (overstate) the estimated effect of QE on capital flows.

Second, we study the portfolio rebalancing effects of both UMP surprises and UMP operations (asset purchases), while most papers ignore the effects of operations. The motivation for including operations in the analysis is that (i) asset purchases may lead to an unexpected demand for certain assets "due to a portfolio balance channel across market segments" according to Fratzscher et al. (2016) so that purchases of Treasuries, for instance, crowd out investors in the Treasury market who then move to substitute assets. The resulting portfolio rebalancing produces a knock-on effect on many asset prices. Also, (ii) UMP operations may have information content given that UMP announcements did not lay out the precise state-and-time contingency of the asset purchase programmes (see, e.g., Fratzscher et al., 2016); and (iii) UMP operations could ease financial constraints that were previously binding during times of market stress.[7] In other words, asset prices and quantities may not fully adjust following a policy announcement such that UMP operations can affect relevant expectations, risk and yields. This is corroborated by our finding that UMP operations are statistically and economically significant in causing geographical portfolio rebalancing in mutual funds.

Third, we analyse the policies by four major central banks in developed markets (BoE, BoJ, ECB, and Fed). To the best of our knowledge, the only other paper to analyse UMP of the four major central banks is Curcuru et al. (2015), which however focuses on the effects of UMP surprises on the portfolio rebalancing behaviour of underlying investors instead

who invested in those funds following monetary policy actions." There is a link between the two as fund flows can affect portfolio managers' allocation decisions and, thus, fund performance, as highlighted by Rakowski (2010).

[7]Dedola, Karadi and Lombardo (2013) show that asset purchases can relax private-sector balance sheet constraints enabling it to exploit arbitrage opportunities once policies are implemented. This is also pointed out by Fratzscher et al. (2013) suggesting that, even if the path and pace of asset purchases were known in advance, the private sector might not have perfectly accurate forecasts about the effectiveness of the operations in restoring dysfunctional markets and boosting macroeconomic conditions at home and in the rest of the world.

of fund managers. Joyce et al. (2017) provide a detailed analysis of the impact of UMP by the BoE on large institutional investors. Carpenter et al. (2015) analyse the Fed's LSAP programmes, while Saito and Hogen (2014) and Koijen et al. (2016) assess the portfolio balance effects of QE policies by the BoJ and ECB.

Policy implications

The policy implication of our research is that the geographical asset allocation of mutual fund managers, in contrast to underlying mutual fund investors and other categories of investors, does not play an important role in the transmission of unconventional monetary policy to emerging markets via substitution effects in investors' portfolios, a transmission channel cited by many monetary policy makers (Bernanke, 2010; Bean, 2011; and Yellen, 2011).[8] This matters because, in most instances, we do not find much support for mutual funds increasing their portfolio exposure to emerging markets in the wake of UMP measures pursued by monetary authorities in developed markets. While in some instances, such as following BoJ announcement surprises, bond and equity funds rebalance towards EMs, the effect is of small economic magnitude. Also, looking at announcement surprises and LSAP operations of other central banks more generally, the rebalancing from developed markets to EMs is the exception rather than the rule. Our findings seem to go against the assertion that fund managers have contributed to the QE-induced 'tsunami' of capital flows to emerging markets.

The remainder of the paper is structured as follows. Section 2 derives the empirical specification. Section 3 describes the data. Section 4 elaborates on the theoretical considerations behind the hypotheses. Section 5 presents and discusses the main results. Section 6 discusses robustness checks. Section 7 concludes.

[8]This study, due to data limitations, does not analyse the reallocation into riskier assets within the same geographical location, a part of the risk-taking channel that mutual fund managers may be contributing to. Further the above result does not mean that UMP by central banks has been a failure, given that other financial market participants, including the underlying investors in mutual funds (Fratzscher et al. 2013, 2016) and large institutional investors (Joyce, Liu and Tonks, 2017), might have been more responsive to central bank policies.

2 Empirical specification

We build on the empirical specification of portfolio adjustment in Raddatz and Schmukler (2012). We extend the model by including a comprehensive set of macro push and pull factors and apply the specification to examine how unconventional monetary policy actions and policy surprises by the major central banks affect equity and bond mutual fund managers' geographical asset allocation. We focus on portfolio rebalancing along this dimension due of data limitations. The dataset does not allow us to make inferences about other dimensions of portfolio rebalancing, e.g. reallocations into riskier assets within the same geographical location, rebalancing between asset classes (equity vs. bonds), or about what type of bonds or stocks the fund is invested in.

The portfolio rebalancing effects of unconventional monetary policy is estimated by its effect on the weight of country or region X_{it} in the portfolio of fund i at month t:

$$\Delta X_{it} = \beta' \text{MP}_t + \mu R_{Xit} + \lambda' \text{Macrocontrols}_{Xt} + \phi_i + \epsilon_{it} \tag{1}$$

$$\text{with MP}_t \;=\; [\text{LSAP}_t,\ \text{policy surprise}_t]$$

The dependent variable ΔX_{it} represents the change in the weighting of a country or a region X in the portfolio of fund i at month t. The variable X refers either to the country or region in which the central bank is located ($HOME$); developed countries besides the home country ($DMexHome$); or Emerging Markets (EM). Depending on whether we analyse the unconventional monetary policies of the US Federal Reserve, Bank of England, Bank of Japan, or European Central Bank, the home country is the US, UK, JP, and EA, respectively. Accordingly, the $DMexHome$ weight would be $DMexUS$, $DMexUK$, $DMexJP$, and $DMexEA$. The portfolio weight X_{it} is constructed as follows:

$$HOME_{it} \;=\; \frac{w_{it}^{Home}}{100 - w_{it}^{cash}} * 100 \tag{2}$$

$$DMexHome_{it} = \frac{\sum w_{it}^{DM} - w_{it}^{Home}}{100 - w_{it}^{cash}} * 100 \quad (3)$$

$$EM_{it} = \frac{\sum w_{it}^{EM}}{100 - w_{it}^{cash}} * 100 \quad (4)$$

The underlying weight w_{it}^{X} is the portfolio weight of country or region X, where $Home \in \{US, UK, JP, \text{or } EA\}$. The portfolio weightings of all countries have been re-weighted to exclude a fund's cash holdings w_{it}^{cash} in order to isolate the portfolio reallocation between country weights.[9]

The policy vector $\text{MP}_t = [\text{LSAP}_t, \text{ policy surprise}_t]$ captures the direct effects of unconventional monetary policy on the portfolio weightings. The monetary policy vector comprises UMP operations in the form of large-scale asset purchases LSAP_t expressed in percentage of GDP of the home country in which the central bank is located. The same monetary policy vector also includes UMP announcement surprises $policy\,surprise_t$, which are measured as the intraday change in government bond yields around the announcements, in line with Rogers et al. (2014). See Section 3.1 for further details.

We include the return R_{Xit} of a country or region X relative to a fund i's return on its total portfolio at the end of month t. This relative return $R_{Xit} = r_{Xt} - r_{it}$ is constructed as the difference between the country index-return r_{Xt}, as measured by total return from MSCI indices for equity funds and by JP Morgan indices for bond funds, and the total net return r_{it} on the overall portfolio of fund i in month t. We include this term in the regression to control for potential passive reallocation due to a pass-through from relative returns to weights (similarly to Raddatz and Schmukler, 2012), and for potential effects of past performance on investors' risk-taking (e.g., O'Connell and Teo, 2009).

It is noteworthy that our mutual fund dataset, discussed in detail below, provides the rate of return on the whole portfolio but not the rates of return for a fund on a country-by-country basis. As with Raddatz and Schmukler (2012), this problem is here obviated by

[9] We also remove portfolio weights that are not classified by EPFR as belonging to any particular country.

proxying the monthly return, in any particular country, by the country index-return r_{Xt} which, by definition, is common to all funds. The inclusion of the relative returns is common in the literature, as can be seen in Hau and Rey (2008) and Raddatz and Schmukler (2012). It is motivated by the desire to measure the 'active' part of portfolio rebalancing by fund managers. An increase in the weighting of a country, or set of countries, in a fund portfolio can come about either passively or actively: passively from (i) an outperformance of a country relative to the rest of the portfolio, which mechanically pushes up the weighting of a country in a fund's portfolio; and actively from (ii) an increase in the exposure of the portfolio to the country affected by an active re-weighting of the country weightings by the portfolio manager.

The benchmark model also includes a vector of macro variables controlling for any determinants that are deemed to act as push and pull factors of portfolio allocations.[10] The macro control vector $Macrocontrols_{Xt}$ consists of the first principal component of the following variables: GDP and Current Account forecasts from Consensus Economics, industrial production, inflation (CPI), the cost of insurance against sovereign default (5-year sovereign CDS spreads), general macro country risk (EIU country-risk ratings), liquidity (M2) and unemployment rate (in %). These principal components are expressed in differences and serve as macro controls with respect to the domestic region (ΔZ_t^d) and the foreign region (ΔZ_t^f). We further include a macro control for the global environment (ΔZ_t^g), which captures changes in the VIX and the TED spread.[11]

[10] We focus on measuring UMP's direct effects. To measure both the direct and indirect effects of UMP, following Pesaran and Smith (2016), one could drop all elements of the Macrocontrols$_t$ that are not invariant to UMP. In the case of US quantitative easing, this would be all controls that could act as push and pull factors, such as GDP, the current account, inflation, and so on, given that they are very likely to respond to monetary policy by the US Fed. These controls may well be invariant to US unconventional monetary policy if we had data at a higher than monthly frequency. The same reasoning applies to fund-specific controls such as fund flows, which measure net redemptions from or net injections into a fund by its underlying client investors, which have been shown to be affected by quantitative easing. The results of this exercise are available upon request. This methodology of Pesaran and Smith (2016) is also implemented in Joyce et. al (2017).

[11] We first take the principal component of all the underlying variables Z_t, and then take the difference between the current and previous month to construct the macro control variable ΔZ_t. The amount of variation captured by the first principal components is generally about 50%.

The specification is a panel model estimated as a fixed effects regression with fund fixed effects ϕ_i. Choosing a first-differenced model with fixed effects, over a standard panel model in levels with fixed effects, has the benefit of accounting for any changes in the country or region weights that are due to unobservable time-invariant differences between funds such as fund-specific trends in country weights. This is most suitable to our research question focusing on explaining how UMP affects geographical portfolio reallocations. The intercept is μ and the error term ε_{it}. All significance levels are calculated using Driscoll-Kraay (1998) standard errors, which are robust to heteroskedasticity, cross-sectional and auto-correlation.

3 Data and summary statistics

Our data on global mutual funds are compiled by EPFR.[12] The dataset covers salient fund characteristics that include fund domicile, asset class focus (bonds or equity), style (active or passive investor), total net assets in $US terms, the change in net asset value (i.e. the rate of return on the fund, inclusive of dividends), cash holdings, and, most importantly, portfolio country weightings. The data frequency is monthly.[13] The sample period is 10/2008 to 04/2014, a total of 65 months. We focus on the period that starts with November 2008 which is a crucial date representing the commencement of the first quantitative easing programme in the US.

Figure 1 shows the AUM tracked in the sample. The amount of AUM tracked improves over time. The dataset covers $US 115 billion in AUM at the beginning of the sample, which increases to $US 335 billion by the end of the sample for equity funds. For

[12]Studies that use EPFR data include Jinjarak, Wongswan, and Zheng (2011), Jotikasthira, Lundblad, and Ramadorai (2012), Fratzscher, Lo Duca, and Straub (2012), Fratzscher (2012), Lo Duca (2012), Raddatz and Schmukler (2012), Puy (2016), Gauvin, McLoughlin and Reinhardt (2014), Kroencke et al. (2015) as well as by Koepcke (2013) and IMF (2013). The link between EPFR and balance of payment capital flow data is studied by Jotikasthira et al. (2012) and Pant and Miao (2012).

[13]Flows into and out of mutual funds in other studies are available at a higher frequency, such as weekly and daily. However, this is not the case for the fund portfolio country weights that are the focus of this study.

bond funds, the coverage increases from $US 16 billion to $US 103 billion. The AUM covered in our dataset is on the same order of magnitude as Raddatz and Schmukler (2012) and Raddatz et al. (2017).

Table 1 presents summary statistics for the cross-sectional coverage of the mutual fund dataset which improves over time. The average number of equity (bond) funds reporting portfolio weightings starts with 394 equity funds (56 bond funds) in the year 2008 and reaches 628 equity funds (90 bond funds) in 2014. The dataset contains 5275 equity fund-month (691 bond fund-month) observations for 2009, which increases to 6284 equity fund-month (899 bond fund-month) observations in 2014. Throughout the period 2007 to 2014, there is an average of 488 distinct equity funds (73 distinct bond funds) reporting portfolio country weightings each month.

Table 2 illustrates how long the funds survive in the sample. In the full sample, about 90% of equity and bond funds report monthly country allocations consecutively for two or more years. Approximately 70% (63%) of equity (bond) fund-month observations are from funds that report portfolio weightings, consecutively and continuously, for 4 years or more.

Tables 3 and 4 presents summary statistics on the fund domicile. 88% (90%) of the observations are from equity (bond) funds domiciled in Ireland, Luxembourg, UK or the US. About 19% (21%) of the observations in the equity (bond) sample come from US-domiciled funds. As for the economic size of the funds, 89% (78%) of the AUM tracked in the sample emanates from equity (bond) funds domiciled in Ireland, Luxembourg, UK and the US, with 42% (54%) of total AUM being tracked by the US-domiciled equity (bond) funds alone. Industry estimates by EFAMA (2016) show that US-domiciled funds manage 46.9% of the total global wealth invested in mutual funds, and funds domiciled either in Ireland, Luxembourg, UK or US in total manage 64.6% of fund assets. The EPFR dataset seems therefore representative of the global mutual fund management industry.[14]

[14]See Cerutti et al. (2015) and Puy (2016) for a discussion of EPRF as a reliable data source. Also refer to the discussion of EPFR country flows in Raddatz and Schmukler (2012), Jotikasthira et al. (2012) and

Tables 5 and 6 presents summary statistics on the fund investment mandate. The geographical aspect of the investment mandate restricts a fund manager to be invested with no less than 75% of AUM in the specific region prescribed by the fund mandate. For instance, under a Global DM ex-US mandate, the fund manager is required to be invested with no less than 75% of the assets under their management in developed markets (DMs) excluding the United States. Over 90% of AUM managed by bond and equity funds in our dataset comes from Global DM, Global DM ex-US and Global EM funds. For equity (bond) funds about 39% (82%) of observations in the dataset come from mutual funds with such a global investment mandate as opposed to regional investment mandates focusing on, for instance, Emerging Europe, Latin America or Asia ex-Japan.

Table 7 presents the list of the developed and emerging markets in the sample.

We clean the data following Raddatz and Schmukler (2012) and Jotikasthira et al. (2012). (i) We remove passive, i.e. index funds whose geographical allocation is mechanically linked to the country weightings used in the composition of a benchmark, such as the Morgan Stanley MSCI index for equity funds, or the JP Morgan index for bond funds. (ii) We winsorise the fund returns at the -50% and +200% points in order to reduce the influence of potential outliers on the relative return variable.[15] (iii) We remove the fund-month observations from funds that report at a frequency other than monthly. (iv) We exclude the funds that report monthly portfolio weightings for less than 12 consecutive months in the entire sample, even if they are available at the end of the sample period. And (v) we remove funds that never allocate to the home country in which the central bank is located whose policies we are analysing.

Fratzscher (2012).

[15]This is a standard winsorisation in the mutual fund literature. In any case, there are only very few observations falling outside this window.

3.1 Monetary policy instruments

The major central banks adopted UMP measures in their quest for restoring financial market liquidity during the acute phases of the 2008/9 financial crisis and in order to boost economic activity in the subsequent recession. Conventional monetary policy targets the short-term interest rate, such as the US Federal Funds or the UK Bank rate. Once the short rate has been reduced to its effective lower bound, central banks start employing unconventional monetary policy. Fawley and Neely (2013) distinguish between pure quantitative easing targeting the quantity of central bank reserves held by commercial banks, especially during zero lower bound episodes, and credit easing, a policy of asset purchases aimed at improving liquidity in a specific market. Other forms of UMP include altering the maturity composition of the central bank balance sheet, and forward guidance about the likely future path of short-term interest rates. In this paper, we measure UMP surprises and actions as follows.

3.1.1 Announcement surprises

UMP surprises are measured as the intra-day change in government bond yields around policy announcements, covering unconventional monetary policy initiatives, such as forward guidance, asset purchases, and policies to alleviate stress in particular markets, being announced in statements after policy meetings, as well as at important policy speeches and other events. We use the policy surprise series from Rogers et al. (2014) i.e. the first principal component of the change in 2-, 5-, 10-, and 30-year of Treasury futures, using a 30-minute window bracketing Fed announcements. Policy surprises for the BoE, BoJ and ECB are defined in a similar way. Policy surprises are normalised to a 25 basis points (bps) surprise change in the yield and signed in a way that a positive number represents a surprise monetary policy easing. The signing of the shocks implies that a negative surprise represents a surprise tightening, instead of a 'less than expected' policy easing.

Movements in yields during these narrow intra-day 30-minute windows are likely to

be mostly due to unanticipated changes in the stance of monetary policy. This identification strategy assumes that no other economic news was released within this short interval to have a significant bearing on the treasury yields (Rogers et al., 2014).[16]

High frequency identification may not fully capture unconventional monetary policy surprises, given that it "may take considerable time for a policy shock to be properly reflected in yields" pertaining to bond futures as pointed out by Hosono and Isobe (2014). One solution would be to use inter-day data as in Hosono and Isobe (2014) who identify policy surprises in an event study by measuring the changes of asset returns from the day preceding a policy announcement to the day of the announcement and the three days after the announcement.[17] However, such an identification method would increase the likelihood that the recorded change in asset returns is partly due to factors other than the monetary policy announcement.

3.1.2 Large-scale asset purchases (LSAPs)

We gather data on large-scale asset purchase programmes and, as Fawley and Neely (2013), the data are at a monthly frequency and come directly from the four central banks. The programmes include the Fed's purchases of longer term Treasury securities, mortgage-back securities and agency debt (MBS), the BoE's purchases under the Asset Purchase Facility (APF), the BoJ's Asset Purchase Programme (APP) in the form of purchases of

[16]The unconventional monetary policy series may, however, not be entirely due to (i) news about the Fed's monetary policy stance as it may be confounded by (ii) news about the Fed's expectations as to the current state and the future path of the economy. To cleanly distinguish between the two, one could extract the central bank's private information about the economy by using the residual of the regression that regresses the Fed's staff Greenbook forecasts on the private sector's consensus forecasts, such as those from the Survey of Professional Forecasters. The difference between, on the one hand, the aforementioned residual, and, on the other hand, the UMP surprise series of Rogers et al. (2014) would yield a 'pure' monetary policy stance surprise series cleaned for the release of the central bank's private information about the future path the economy. See for example Barakchian and Crowe (2013). It is not possible to implement this procedure here as the Greenbook forecasts for our sample period are currently unavailable. This is due to the Federal Reserve releasing its staff's Greenbook projections to the public domain only with a 5-year lag.

[17]Another alternative might be to widen the window from 30 to 120 minutes as suggested in Rogers et al. (2014). The correlation between the narrow- and wide-window surprise series are, respectively: 0.87 for the Fed, 0.82 for the BoE, 0.86 for the ECB and 0.49 for the BoJ. The difference is thus not that significant at least for three of the four central banks involved.

private assets, government bills and government bonds, and, finally, for the euro area the ECB's purchases under its securities markets programme (SMP), its main refinancing operations (MROs) and long-term refinancing operations (LTROs).

In the benchmark model, we measure asset purchases in percent of the GDP of the region or country in which the central bank is located. The normalising variable (GDP) is sourced from Datastream and is measured at a monthly frequency. Its purpose is to capture the scale of the asset purchases programmes relative to the size of the economy. For instance for the United States, we construct the first difference of the US Fed's holdings of mortgage-backed securities, or Treasuries, divided by US nominal GDP. Similarly, for the UK we look at the change in APF assets divided by UK nominal GDP.

In a robustness check, and due to data availability reasons for the United States only, we also express UMP operations as the amount of assets purchased in percentage points of total debt outstanding in the US bond market, including municipal, Treasury, mortgage-related and corporate debt, as well as Federal Agency Securities, money market debt and asset-backed debt. This relates to the measure of 'asset scarcity' that the Fed may be contributing to by way of reducing the share of outstanding quantity of Treasuries, or MBS and agency debt, available to the private sector.[18]

4 UMP transmission channels

Monetary policy directly affects bond yields which are the sum of two components: (i) expected average short-term interest rates and (ii) a term premium that compensates investors for the risk of interest rate changes. The *signalling channel* primarily relates to how UMP affects the the first component, whereas the *portfolio balance channel* and the *risk-taking channel* relate to how UMP affects the term premium.

[18]This has been pointed out empirically by D'Amico et al. (2012), as well as theoretically by Greenwood and Vayanos (2014). We find that there is a negligible difference between expressing the amount of assets purchased in percentage of GDP as opposed to measuring it in percentage of the total amount of assets outstanding.

The following discussion of these three channels is based on Fratzscher et al. (2013) and Krishnamurthy and Vissing-Jorgensen (2011).[19]

4.1 Signalling channel

The signalling channel of UMP exerts downward pressure on bond yields by lowering the expected short-term rates. For instance, purchases of assets with a long duration can act as a commitment device to keep policy interest rates lower than otherwise anticipated because the monetary authority would incur losses on these assets if it were to increase interest rates prematurely.[20] While we do not expect this channel to have a direct impact on the active allocation of fund managers, it may have an impact on the passive reallocation component due to changes in prices.

4.2 Portfolio balance channel

The portfolio balance channel relates to UMP exerting pressure on the second part of bond yields, the term premium. The presence of the term premium may indicate the segmentation of asset markets, along the demarcations of maturity, default risk or other asset class characteristics, which might "reflect the specific needs of pension funds, other institutional investors, and arbitrageurs that are institutionally constrained," according to Bauer and Rudebusch (2013).[21]

In the first instance, LSAPs affect the relative supply, prices and return of the assets involved.[22] The private sector adjusts its portfolios by seeking alternatives, either at home or abroad, as substitutes for the assets that are purchased by the central bank. Following LSAPs, the yields of the securities purchased are likely to fall to incentivise the private

[19] An overview is provided in Joyce et. al. (2011), Woodford (2012), and Hosono and Isobe (2014).

[20] See Clouse et. al. (2003). Also see Krugman (1998), Eggertsson and Woodford (2003), Jung et. al. (2005), Jeane and Svensson (2007) and Woodford (2012).

[21] See Andrés et. al. (2004), Bernanke and Reinhart (2004), Vayanos and Vila (2009), Chen et. al. (2012), Ellison and Tischbirek (2014), Gagnon et. al. (2011), D'Amico and King (2011), Doh (2010).

[22] See Krishnamurthy and Vissing-Jorgensen (2010, 2012). This is also highlighted by D'Amico et. al. (2012) and Greenwood and Vayanos (2014).

sector to sell to the central bank a part of its holdings. But, in addition to lowering the instrument-specific term premium on long-term government bonds, central banks may also lower the term premium of interest rates with respect to other fixed-income securities, and not only those that have been purchased. That is because LSAPs alter the supply of bonds, thereby affecting the aggregate amount of maturity risk.[23]

In the second instance, when large-scale bond purchases crowd out bond investors, we expect this to have a knock-on affect on equity funds. The portfolio rebalancing of the directly affected investors will thus have additional price effects on a wide range of assets, including equities, not merely just on the bonds being purchases under an LSAP programme.

4.3 Risk-taking channel

Central bank announcements can release information about current macroeconomic conditions, impinging on risk-taking in financial markets by affecting the term premium on bond yields as well as risk premiums on a wide range of assets. By boosting confidence and lowering risk aversion, UMP may prompt asset managers, including equity funds, to reallocate their portfolio toward riskier assets so that they may increase the weight of emerging markets in their portfolio. See Rajan (2006), Gambacorta (2009), Adrian and Shin (2010) as well as Borio and Zhu (2012).

5 Main results

In the following we describe how UMP by the Fed, BoE, ECB, and BoJ affects the geographical portfolio choice of international mutual funds. For each central bank in turn, we report both how UMP surprises and large-scale asset purchases affects equity and

[23] Bauer and Rudebusch (2013) refer to the two components of the portfolio balance channel as (i) the 'local supply' sub-channel that reduces term premia only, or primarily, of those securities purchased by the central bank and (ii) the 'duration' sub-channel of portfolio rebalancing reducing the term premia on all fixed-income securities.

bond funds managers' portfolio allocation between the home country in which the central bank is located (US, UK, EA, and Japan), relative to the portfolio exposure to other developed markets (DMexHome) and emerging markets (EM).

We expect mutual funds managers to rebalance their portfolio away from the developed market whose central bank is conducting UMP, that is respectively the US, UK, Japan, and Eurozone. Mutual funds managers will rebalance toward other developed markets, as a substitute for the home market which funds are rebalancing away from, and increase the portfolio weight of emerging markets. These priors are based on the theoretical considerations relating to the aforementioned channels of monetary policy transmission.

Our key result is that the international spillover effects from UMP are statistically significant and persistent in some instances. Overall, we find that UMP prompts managers of mutual funds to rebalance their portfolio away from the home country, and increase their geographical allocation to other developed markets. Bond funds are statistically more significantly affected by UMP surprises than equity funds (with US Fed surprises being the most statistically significant).

Unconventional monetary policy operations in the form of large-scale asset purchases are found to have international portfolio balance effects, which underlines the importance of analysing the effect of UMP operations, especially because they, relative to UMP surprises, are found to exert a portfolio rebalancing effect that is of larger economic significance. While being statistically significant, the overall economic significance of the spillover effects from UMP announcement surprises, however, turns out to be relatively small. This contrasts with the larger effects of large-scale asset purchases (LSAPs) on the geographical portfolio allocation of mutual funds.

5.1 UMP surprises

Table 8 shows the effect of UMP surprises on mutual funds' portfolio choice.

Column 1 shows that bond funds rebalance away from the US and towards DMexUS countries following US Fed surprise easings. Column 2 shows that equity funds similarly decrease their allocation to the UK following BoE UMP surprise easings. Bond funds also decrease their portfolio exposure to the UK and increase it towards DMexUK after BoE UMP easing shocks, mirroring the effect of Fed easings. Column 3 shows that BoJ UMP surprises triggers equity and bond funds to to increase their portfolio allocation to emerging markets. Column 4 shows that ECB announcement surprises are statistically insignificant.

In sum, UMP surprises push mutual funds away from the home country conducting UMP, into other developed countries. In the case of BoJ surprises, funds also rebalance to emerging markets. US Fed surprises are the most statistically significant. The portfolio rebalancing effects are, however, of small economic magnitude. For instance, as can be seen from Columns 1 and 2, an UMP easing surprise associated with a 25 bps fall in US Treasury yields leads managers of mutual bond funds to reduce their portfolio exposure to the US by 0.71pp and increase it to other developed markets excluding the US by 0.51pp, while an easing surprise of the same size by the BoE leads bond fund managers to reduce their portfolio exposure to the UK by 1.13pp and increase it to other developed markets excluding the UK by about 1.1pp. As for UMP operations, US Fed purchases of Treasury bills equivalent to 1% of US GDP prompt managers of bond funds to increase their portfolio exposure to other developed markets excluding the US by 0.43pp, while BoE UMP operations of the same relative size trigger bond fund managers to increase their portfolio exposure other developed markets excluding the UK by 0.24pp. In many other instances, UMP announcement surprises have no statistically significant effect on the portfolio choice of mutual funds.

5.2 Large-scale asset purchases

Table 9 shows the effect of LSAPs on mutual funds' portfolio choice.

Column 1 shows that Fed purchases of US Treasury securities pushes bond and equity funds to increase their exposure to developed markets other than the US. Fed purchases of mortgaged-backed securities and agency debt does not seem to exert a statistically significant effect.

As for the other central banks, we find that BoE LSAPs under the asset purchase facility (APF) trigger equity fund managers to rebalance away from the UK and towards DMexUK countries (see Column 2). Equity funds increase the weight of DMexJP in their portfolio, and reduce their EM weight, following Bank of Japan purchases of Japanese private assets (Column 3). Column 4 shows that the most statistically significant effects of the ECB's LSAPs are from its long-term refinancing operations (LTRO) which push equity funds away from euro-area countries into other developed markets. The main refinancing operations (MRO), for equity funds, and the securities markets programme (SMP), for bond funds, have the effect of increasing the weight of DMexEA countries in mutual fund portfolios.

In sum, we find some evidence for portfolio rebalancing away from the home country conducting LSAPs into other developed markets. The magnitude of the portfolio rebalancing effects seems small: Treasury purchases by the US Fed equivalent to 1% of US GDP prompts managers of equity funds to increase their portfolio exposure to developed markets other than the US by about 0.4pp, while BoE operations under the Asset Purchase Facility lead bond funds to reduce their UK exposure by 0.16pp, while rebalancing to other developed markets by 0.23pp. These effects seem small until one considers the total cumulated impact of LSAPs relative to the total changes in portfolio weights observed over the sample period, which is calculated in Section 5.4.

5.3 Persistence of portfolio rebalancing effects

To analyse the persistence of UMPs portfolio rebalancing effects, we use Jorda's (2005) local projection method to construct impulse responses with a horizon of one year and regress the change in the portfolio weight ΔX_{it+h} for h-steps ahead on the benchmark model for $h = 1, ..., 12$.

See Figure 2 for the persistence of portfolio rebalancing effects due to LSAPs by the US Fed, which are persistent for equity funds. See Figures 3 to 6 for an analysis of the persistence of the portfolio rebalancing effects from UMP surprises. They show no clearly persistent effects of UMP announcement surprises on mutual funds portfolio choice.

5.4 Economic significance

A natural question concerns the total impact of UMP measures on the geographical allocation of fund managers in terms of economic significance. Similarly to Fratzscher et al. (2013, 2016), we proceed to calculate the total impact of UMP operations as the cumulated size of asset purchases of a particular central bank, expressed in percentage of its host country's GDP, multiplied by the estimated regression coefficients of the baseline model in Section 2. The total impact of UMP announcement surprises is similarly obtained by cumulating the surprises in bond yields over the sample period and multiplying that number by the regression coefficients of the baseline model.

Tables 10 and 11 show the total impact of UMP announcements and LSAPs on the geographical portfolio allocation of international mutual funds. The total impact of the US Fed's LSAP operations is larger than the total impact of its UMP announcement surprises. For equity funds, the expected effect of US Fed announcement surprises in terms of the total change in allocation to the US is -0.25pp, to DM is 0.01pp, and to EM is 0.24pp; for Treasury purchases: US -1.77pp, DM, 5.06pp, EM -3.29pp; and for MBS purchases: US -1.04pp, DM 0.73pp, EM 0.31pp. For bond funds, the figures are of a similar economic

significance: for Fed announcement surprises, the total expected change in the allocation to the US is -1.29pp, to DM is -0.92pp, and to EM is 0.36pp; for Treasury purchases: US -0.57pp, DM, 5.25pp, EM -4.68pp; and for MBS purchases: US 1.25pp, DM -2.62pp, EM 1.37pp.

Tables 10 and 11 also express the economic significance in terms of the absolute dollar value of the portfolio reallocations. Of the global AUM managed by regulated open-ended mutual funds managed, bond funds and equity funds manage $10.68 trillion and $20.36 trillion respectively. When bond (equity) fund managers jointly increase the weight of a county in their portfolio by one percentage point (pp), this represents approximately $100 bn ($200 bn) flows to the country.[24] Thus, we can express the above results in absolute terms noting that, for instance, following Fed announcement surprises, the total expected change of bond funds in their allocation to the US is -$1.29bn, to DM is - $920 million, and to EM is $360 million; for Treasury purchases: US -$570 million, DM $5.25bn, EM -$4.68bn; and for MBS purchases: US $1.25bn, DM -$2.62bn, EM $1.37bn. The large size of the portfolio reallocation effects of LSAPs relative to that of announcement surprises by the US Fed also holds true for UMP by the BoE, BoJ and ECB.

After having established that LSAPs exert a larger effect than UMP announcement surprises on mutual fund managers' geographical portfolio allocation, one needs to compare UMP-induced portfolio reallocations to the change in country weights over the sample period in order to assess whether LSAP-induced portfolio reallocations are also overall economically significant. Tables 10 and 11 present the size of the portfolio reallocation over the sample period, calculated as the difference between the average portfolio weights across funds at the beginning and the end of the sample period. We find that LSAPs by all central banks, not just the US Fed, have a large economic effect on the geographical portfolio allocation of fund managers.[25] For instance, equity funds increased

[24]Mutual fund industry estimates by the EFAMA (2017).

[25]The small effects of the ECB's LSAPs on equity fund managers is the exception and may be due to the restricted sample period that does not account of the whole set of LSAP programmes by the ECB.

their portfolio allocation to the US by 6.14pp, or $12.3 billion, over the sample period. This portfolio reallocation to the US would have been significantly bigger in the absence of US Fed LSAPs, given that purchases of Treasuries and MBSAD exerted a -1.77pp (or -$3.5 billion in absolute terms) and -1.04pp (-$2.1 bn) effect, respectively, on the weight of the US in the portfolios of equity funds. Similarly, the effects of US Fed purchases of Treasuries on bond fund managers' portfolio allocation is large: Treasury purchases prompt bond funds to increase their DMexUS portfolio weight by 5.25pp ($5.25 bn) and decrease the weight of EM countries in their portfolios by 4.68pp ($4.68 bn) which is large relative to the overall portfolio reallocation over the sample period during which bond funds reduced their DMexUS weight by 10.52pp ($10.52 bn) and increased their portfolio allocation to EM countries by 15.57pp ($15.57 bn). Effects of similar relative magnitude can be observed for LSAPs by the BoE, BoJ and ECB.

Our findings on the economic significance of LSAP-induced portfolio reallocation by mutual fund managers contrast with those of Fratzscher et al. (2013, 2016) in their studies on UMP-induced portfolio reallocations by underlying fund investors. Fratzscher et al. (2013) note that although the "effects of Fed policies obviously constitute sizable magnitudes in absolute terms, they are moderate compared to the total cumulative changes in portfolio allocations [...] when taking a longer-term perspective over the entire sample period" and conclude that "Fed non-standard measures account for only a small share in the changes in portfolio allocations and capital flows."

The above method to estimate the total impact of UMP assumes that the announcement surprises and asset purchases have permanent effects, as noted by Fratzscher et al. (2016). We formally analysed the persistence of the portfolio rebalancing effects in the previous section and established that the portfolio effects of UMP surprises in many cases have low persistence, while there is some evidence for persistence of the effects from LSAPs.

6 Robustness checks

This section presents robustness checks to see whether the benchmark model's results continue to hold when: controlling for institutional constraints on mutual fund managers; controlling for UMP by other major central banks; measuring Fed asset purchases in percentage of the assets outstanding; measuring the UMP policy stance by changes in the shadow short rate; and varying the number of control variables.[26]

6.1 Institutional constraints on mutual fund managers

A potential explanation for why the economic significance of the portfolio rebalancing effects emanating from UMP announcement surprises is small is that mutual fund managers may be institutionally constrained. For instance, a fund might be constrained by the geographical focus prescribed in the fund mandate or benchmark the fund might be tracking (e.g., see Chen and Pennacchi, 2009). We have addressed the latter point in our empirical specification by having removed passive funds that are mechanically following a benchmark. As shown by Raddatz et al. (2017), however, a number of such explicitly 'active' fund managers may be in fact 'closet indexing' or only mildly active, which could be due to concerns about their performance relative to a benchmark based on country or region weights that are outside of the control of the mutual fund manager.[27]

Another institutional constraint in the form of mutual fund investment mandates may help to explain why UMP surprises lead to only small portfolio rebalancing in fund managers. Of particular interest is the geographical aspect of the investment mandate which restricts a fund manager to be invested with no less than 75% of AUM in the specific re-

[26] Unless otherwise noted, detailed results of all robustness checks are available in the Web Appendix.

[27] To address this point more formally, one could compare the portfolio rebalancing behaviour of truly active with closet indexing fund managers. There are two complementary empirical measures of closet indexing funds. One measure to identify closet indexing is via the active share of a fund, i.e. the share of portfolio holdings that differ from the holdings specified by the benchmark. Another measure is the tracking error of a fund, i.e. the deviations of the fund's returns from the benchmark returns. For both see Cremers and Petajisto (2009). We are unable to implement either measure due to data limitations.

gion prescribed by the fund mandate. Raddatz and Schmukler (2011) find that mutual fund managers do vary their country weights, but the coefficient of variation for country weights in their portfolio is low for countries in their geographical target region, as specified by their investment mandate, relative to countries outside their target region. Yet the small size of the portfolio rebalancing observed in our study implies that the remaining 25% of the portfolio, which the fund manager is free to choose, should render the institutional constraint imposed by a geographical fund mandate slack.

To formally investigate whether fund mandates constrain portfolio rebalancing, we group the mutual funds in our dataset into developed markets (DM) funds, that is those with a Global DM or Global DM ex-US fund mandate, and emerging markets funds, with Global Emerging Markets or other regional emerging and frontier market fund mandates. If fund mandates restrict the portfolio rebalancing, then we should observe DM funds, who are significantly more invested in developed markets conducting UMP, to be significantly more affected by UMP measures than EM funds.

Our findings imply that there is no clear way in which the geographical fund mandate affects the portfolio rebalancing of mutual funds in response to UMP. First, the results in the benchmark specification about the rebalancing effects of UMP do not appear to be solely driven the investment mandate. While in many instances DM funds are more affected than EM fund managers by UMP of developed market central banks, there are a number of instances where EM fund managers respond more significantly than DM funds. Secondly, while in some instances funds classified into EM or DM funds respond to UMP measures, this finding that does not always carry over to the benchmark model which pools observations across funds of all investment mandates. Thirdly, and most importantly, although the economic significance of the rebalancing effects is occasionally significantly larger when considering funds differentiated by their investment mandate, overall the economic significance of portfolio rebalancing induced by UMP surprises remains small. This therefore does not challenge the results of our benchmark model.

6.2 Controlling for global UMP

To control for unconventional monetary policy by the main central banks other than the 'home' central bank, we build a control variable to account for 'global ex-home' UMP. For instance for the US Fed, any joint simultaneous unconventional monetary easing by the other developed markets' monetary authorities (BoE, ECB and BoJ) aside from the home central bank (US Fed) is captured by the first principal component of (i) changes in the size of the balance sheet of the BoE, ECB and BoJ; and (ii) the surprise component of unconventional monetary policy announcements of these central banks.

For the US Fed, the results of the benchmark model continue to hold, but some UMP portfolio rebalancing effects become either statistically more significant, such as Fed Treasury purchases increasing the DMexUS weight in bond funds, or less significant, as in UMP surprises leading to rebalancing away from the US to DMexUS countries in bond funds. The portfolio rebalancing effects emanating from the BoE's unconventional monetary surprises and LSAPs on bond funds become much more statistically significant once we control for global ex-home UMP. One possible interpretation for this result is that some of the monetary surprises and asset purchases by the BoE occurred simultaneously with UMP by other developed markets, which makes controlling for global ex-UK UMP important.

For the ECB, the effects of the global ex-home UMP control is mixed. While the effects of its Securities Markets Programme asset purchases on bond funds become much more statistically significant, the opposite is the case for the effects on its LTRO purchases on equity funds. The portfolio rebalancing effects of LSAPs by the Fed and BoE become more significant. However, the opposite is the case for BoJ UMP surprises. The finding that the BoJ surprises leads to a rebalancing towards EMs does not continue to hold once we control for global UMP. This strengthens our key finding that there is hardly any consistent evidence that UMP prompts mutual fund managers to shift their funds to EMs.

6.3 Alternative measure of monetary policy stance at the ZLB

Instead of using the intra-day change in government bond yields around policy announcements from Rogers et al. (2014), one can instead use changes in shadow short rates as a measure of the monetary policy stance at the zero lower bound (ZLB). Krippner (2013) estimates these from term structure models.

Table 12 show the results of the regression when we replace the UMP announcement surprises in the benchmark model by the change in the shadow short rates for each central bank. The results of this exercise further strengthen our finding in the benchmark regression, namely that UMP measures lead to portfolio rebalancing away from the country conducting UMP towards other developed markets. With the exception of bond funds for ECB easings, the additional finding is that a UMP shadow short rate easing leads to a rebalancing away from EMs, which applies to both bond and equity funds across all central banks. This serves as additional evidence against mutual fund managers playing a significant role in the risk-taking channel of UMP.

6.4 Alternative measure of Fed LSAP operations

Asset purchases by the Fed can be measured in terms of the change in the monetary value of Treasuries, MBS and agency debt. Expressing the US Fed's asset purchases as a percentage of GDP, thereby relating unconventional monetary operations to the size of the US economy, is what we do in the benchmark model.

An alternative measure of LSAPs is to express asset purchases in percentage terms of the outstanding amount of the asset purchased. This has the advantage of accounting for the amount of debt instruments that expire each month and captures the level of 'asset scarcity' that the Fed may be contributing to by reducing the share of outstanding quantity of Treasuries, or MBS and agency debt. The importance of accounting for the amount of debt instruments that expire each month has been pointed out empirically by D'Amico

et al. (2012) and theoretically by Greenwood and Vayanos (2014).

We find that the level of statistical significance, and more importantly, the sign of the portfolio rebalancing effects from US unconventional policies continue to carry over from the benchmark specification with the exception that, for bond funds, Treasury purchases become statistically insignificant. UMP surprises remain significant in terms of pushing bond funds out of the US and into DMexUS markets. In addition, the size of the statistically significant coefficients on the UMP surprises and LSAP operations become somewhat smaller, suggesting that the effect of UMP on mutual funds' geographical portfolio allocation is smaller than suggested in the benchmark model once taking into account the amount of debt instruments that expire each month.[28]

6.5 UMP announcement surprise tightenings vs. easings

We find that there is an asymmetry between the portfolio rebalancing effects of surprise easings compared to surprise tightenings.

Table 13 shows that easings by the Fed leads bond fund managers to rebalance from the US towards DMexUS and EM countries, with equity funds also rebalancing towards EM countries following surprise easings by the Fed. The table also shows that an easing surprise by the BoE leads equity fund managers to reduce their allocation to the UK, while a surprise tightening leads bond fund managers to rebalance from the UK to DMexUK markets. Surprise easings by the BoJ, however, lead bond fund managers to increase their portfolio allocation to EMs, while a BoJ surprise tightening prompts equity fund managers to reduce their exposure to Japan and rebalance to developed countries other than Japan. BoJ surprise easings trigger equity funds to shift funds away from DMexJP and towards EM, while surprise tightenings trigger a rebalancing away from Japan. However, surprise tightenings also lead bond funds to shift funds towards EM countries. We also

[28] We keep our benchmark specification in order to keep the regressions comparable between the US Fed, BoE, BoJ and ECB, and because the change to the coefficients when accounting for the amount of debt instruments that expire each month is economically of small magnitude.

note that a surprise easing by the ECB leads equity fund managers to tilt their asset allocation in favour of emerging markets (EMs), and trigger bond fund managers to decrease their portfolio exposure to developed countries excluding the euro area.

6.6 Role of fixed effects and macro controls

The benchmark model includes macro controls and fund fixed effects. We examine to what extent the benchmark results hold for different combinations of these controls. The main finding is that once we remove fixed effects and macro controls, most of the portfolio rebalancing effects that were significant in the benchmark model become statistically insignificant, implying that accounting for capital flow push and pull factors as well as unobserved differences among funds is important for observing any portfolio reallocation in response to UMP surprises.

7 Conclusion

We find that unconventional monetary policy affects the geographical portfolio choice of international mutual fund managers. UMP measures prompt managers of mutual funds to rebalance their portfolios away from the country conducting UMP, and increase their geographical allocation to other developed markets. We find hardly any evidence that UMP prompted international mutual fund managers to increase their allocation to emerging markets. If at all, it seems that mutual fund managers rebalancing to EMs in response to UMP is the exception rather than the rule. The overall economic significance of the spillover effects from UMP announcement surprises turns out to be relatively small and of low persistence, in contrast with the relatively large effects induced by UMP operations in the form of LSAPs.

These findings imply, first, that the geographical portfolio choice of fund managers contributed little to the 'tsunami' of capital flows to emerging markets following the un-

conventional monetary policy response to the 2007/8 financial crisis (e.g., Fratzscher et al., 2013, 2016). Fund managers play a negligible role in the risk-taking channel of transmitting UMP across countries. Instead we observe evidence for the portfolio balance channel when UMP induces fund managers to rebalance their portfolio towards other developed markets and away from the developed country whose monetary authority is conducting UMP. Second, our paper helps to assess the validity of the implicit assumption used in the empirical literature that country portfolio weights are not adjusted by fund managers in response to unconventional monetary policy (Fratzscher et al., 2013 and 2016; Curcuru et al. 2015; Banegas et al., 2016). This matters because if the country portfolio weights are adjusted in the same (opposite) direction of the portfolio reallocation of the underlying investors, it would understate (overstate) the estimated effect of QE on capital flows. Our results imply that the assumption in the literature seems to be more valid when assessing the portfolio rebalancing effects from UMP announcement surprises, but less appropriate when analysing the effects of LSAPs, for which we observe large portfolio reallocation effects.

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Table 1: **Mutual fund data set coverage**

Mth/Yr	2007	2008	2009	2010	2011	2012	2013	2014	Avg (mth)
1	359	395	413	454	456	514	583	635	476
2	379	366	425	452	486	507	596	642	482
3	356	388	427	448	484	511	595	636	481
4	383	371	426	435	482	514	608	639	482
5	389	389	449	458	489	505	605	634	490
6	380	383	451	452	492	496	602	626	485
7	379	386	451	470	498	491	616	627	490
8	389	389	457	479	506	501	606	625	494
9	400	410	450	481	498	534	623	618	502
10	399	408	436	470	509	562	639	602	503
11	379	425	449	479	514	576	641	n/a	495
12	377	413	441	464	510	590	637	n/a	490
Average	381	394	440	462	494	525	613	628	488
Total	4569	4723	5275	5542	5924	6301	7351	6284	

(a) Equity funds

Mth/Yr	2007	2008	2009	2010	2011	2012	2013	2014	Avg (mth)
1	65	57	56	60	70	78	96	101	73
2	63	56	56	58	73	78	101	90	72
3	61	56	55	58	72	81	102	90	72
4	64	56	52	56	73	81	104	89	72
5	65	56	60	62	77	81	97	90	74
6	62	56	59	63	77	81	98	90	73
7	59	57	59	59	74	83	99	87	72
8	57	56	61	66	78	84	96	88	73
9	59	59	57	70	76	88	98	89	75
10	60	56	59	69	77	91	100	85	75
11	58	54	58	74	78	94	97	n/a	73
12	57	56	59	73	77	96	101	n/a	74
Average	61	56	58	64	75	85	99	90	73
Total	730	675	691	768	902	1016	1189	899	

(b) Bond funds

Table 1 presents summary statistics for the coverage of the mutual fund dataset. The cross-sectional coverage of the dataset improves over time. The average number of equity (bond) funds reporting portfolio weightings starts with 394 equity funds (56 bond funds) in the year 2008 and reaches 628 equity funds (90 bond funds) in 2014. The dataset contains 5275 equity fund-month (691 bond fund-month) observations for 2009, which increases to 6284 equity fund-month (899 bond fund-month) observations in 2014. Throughout the period 2007 to 2014, there is an average of 488 distinct equity funds (73 distinct bond funds) reporting portfolio country weightings each month.

Table 2: **Fund survival in the sample**

Equity funds

Fund survival	Observations	in %
1-2 years	6,437	9.25%
2-4 years	14,313	20.56%
4-6 years	15,627	22.45%
6+ years	33,229	47.74%
Total	69,606	100%

Bond funds

Fund survival	Observations	in %
1-2 years	952	10.59%
2-4 years	2,305	25.65%
4-6 years	2,285	25.43%
6+ years	3,445	38.33%
Total	8,987	100%

Table 2 illustrates how long the funds survive in the sample. In the full sample, only approximately 10% of funds report consecutively less than two years. In other words, about 90% of equity and bond funds report monthly country allocations consecutively for two or more years. Approximately 70% (63%) of equity (bond) fund-month observations are from funds that report portfolio weightings, consecutively and continuously, for 4 years or more.

Table 3: **Domicile of equity funds**

Fund Domicile	Obs.	(in %)	Funds	(in %)	AUM (Mio. $)	(in %)
Australia	291	0.42%	5	0.47%	238,584	0.39%
Austria	697	1.00%	9	0.85%	154,035	0.25%
BVI	550	0.79%	6	0.57%	168,277	0.27%
Bahrain	210	0.30%	4	0.38%	13,008	0.02%
Belgium	583	0.84%	9	0.85%	70,056	0.11%
Bermuda	237	0.34%	2	0.19%	22,817	0.04%
Canada	2,244	3.22%	31	2.94%	822,722	1.34%
Cayman	442	0.64%	7	0.66%	123,097	0.20%
Denmark	1,045	1.50%	15	1.42%	121,608	0.20%
Estonia	123	0.18%	1	0.09%	7,592	0.01%
Finland	313	0.45%	7	0.66%	32,661	0.05%
France	2,129	3.06%	39	3.70%	1,080,556	1.77%
Germany	1,247	1.79%	27	2.56%	2,129,377	3.48%
Guernsey	929	1.33%	12	1.14%	314,932	0.51%
Hong Kong	57	0.08%	4	0.38%	24,709	0.04%
Ireland	5,687	8.17%	79	7.50%	2,052,050	3.35%
Japan	55	0.08%	3	0.28%	2,382	0.00%
Jersey	216	0.31%	6	0.57%	16,301	0.03%
Luxembourg	25,840	37.12%	378	35.90%	18,861,948	30.82%
Mauritius	105	0.15%	2	0.19%	55,608	0.09%
Netherlands	292	0.42%	5	0.47%	53,154	0.09%
Norway	294	0.42%	8	0.76%	589,590	0.96%
Singapore	171	0.25%	3	0.28%	26,051	0.04%
Sweden	154	0.22%	7	0.66%	85,152	0.14%
Switzerland	1,344	1.93%	18	1.71%	299,698	0.49%
USA	12,930	18.58%	220	20.89%	25,907,588	42.33%
United Kingdom	11,421	16.41%	146	13.87%	7,926,086	12.95%
Total	69,606	100%	1053	100%	61,199,639	100%

Table 3 presents the domicile of equity funds. 88% of the observations are from equity funds domiciled in Ireland, Luxembourg, UK or the US. About 19% of the observations in the equity sample come from US-domiciled funds. As for the economic size of the funds, 89% of the total assets under management tracked in the sample emanates from equity funds domiciled in Ireland, Luxembourg, UK and the US, with 42% of total AUM being tracked by the US-domiciled equity funds alone.

Table 4: **Domicile of bond funds**

Fund Domicile	Obs.	(in %)	Funds	(in %)	AUM (Mio. $)	(in %)
Austria	39	0.43%	1	0.62%	9,404	0.09%
Bahamas	42	0.47%	2	1.23%	1,198	0.01%
Canada	105	1.17%	1	0.62%	99,851	0.92%
Cayman	70	0.78%	1	0.62%	160,569	1.48%
Denmark	479	5.33%	8	4.94%	193,658	1.79%
Germany	44	0.49%	1	0.62%	3,445	0.03%
Guernsey	349	3.88%	3	1.85%	657,263	6.08%
Ireland	1,048	11.66%	19	11.73%	572,486	5.29%
Japan	18	0.20%	1	0.62%	8,205	0.08%
Luxembourg	4,281	47.64%	85	52.47%	2,989,416	27.64%
Singapore	17	0.19%	1	0.62%	107	0.01%
USA	1,898	21.12%	28	17.28%	5,839,302	54.00%
United Kingdom	597	6.64%	11	6.79%	279,458	2.58%
Total	8,987	100%	162	100%	10,814,362	100%

Table 4 presents the domicile of bond funds. Regarding fund-domicile, 90% of the observations are from bond funds domiciled in Ireland, Luxembourg, UK or the US. About 21% of the observations in the bond sample come from US-domiciled funds.
As for the economic size of the funds, 78% of the total assets under management tracked in the sample emanates from bond funds domiciled in Ireland, Luxembourg, UK and the US, with 54% of total AUM being tracked by the US-domiciled bond funds alone.

Table 5: **Geographical focus of equity funds**

Investment mandate	Obs.	(in %)	Funds	(in %)	AUM (Mio. $)	(in %)
Africa	370	0.53%	9	0.85%	35,309	0.06%
Asia ex-Japan	13,699	19.68%	176	16.70%	6,886,943	11.25%
BRIC	894	1.28%	13	1.23%	952,324	1.56%
Emerging Europe	7,429	10.67%	81	7.69%	2,285,283	3.73%
Europe	5,724	8.22%	125	11.86%	3,856,185	6.30%
Europe ex-UK	4,199	6.03%	83	7.87%	3,210,566	5.25%
EMEA	1,207	1.70%	22	2.04%	254,410	0.41%
Global DM	7,824	11.24%	154	14.61%	11,168,409	18.25%
Global DM ex-US	14,809	21.28%	191	18.12%	15,545,326	25.40%
Global EM	4,370	6.28%	74	7.02%	13,534,217	22.11%
Latin America	5,531	7.95%	80	7.59%	2,165,012	3.54%
Middle East	579	0.83%	9	0.85%	66,946	0.11%
Pacific	2,971	4.27%	37	3.51%	1,238,710	2.02%
Total	69,606	100%	1,054	100.00%	61,199,640	100%

Table 5 presents the geographical focus of equity funds as prescribed in their investment mandate which the fund manager is required to be invested in with no less than 75% of the assets under management.

Table 6: **Geographical focus of bond funds**

Investment mandate	Obs.	(in %)	Funds	(in %)	AUM (Mio. $)	(in %)
Asia ex-Japan	620	6.9%	14	8.64%	493,809	4.57%
Emerging Europe	390	4.34%	7	4.32%	78,050	0.72%
Europe ex-UK	45	0.5%	1	0.62%	138,329	1.28%
Global DM	1,876	20.87%	35	21.60%	4,942,998	45.71%
Global DM ex-US	62	0.69%	1	0.62%	4,805	0.04%
Global EM	5,417	60.28%	96	59.26%	5,067,297	46.86%
Latin America	577	6.42%	8	4.94%	89,075	0.82%
Total	8,987	100%	162	100%	10,814,363	100%

Table 6 presents the geographical focus of bond funds as prescribed in their investment mandate which the fund manager is required to be invested in with no less than 75% of the assets under management.

Table 7: **Countries and regions in the sample**

Developed markets	**Emerging markets**		
Australia	Albania	Hungary	Paraguay
Austria	Algeria	Iceland	Peru
Belgium	Angola	India	Philippines
Canada	Argentina	Indonesia	Poland
Denmark	Azerbaijan	Iran	Qatar
Finland	Bahrain	Iraq	Romania
France	Baltic Republics	Israel	Russian Federation
Germany	Bangladesh	Ivory Coast	Rwanda
Greece	Belarus	Jamaica	Saudi Arabia
Ireland	Bolivia	Jordan	Serbia
Italy	Bosnia-Herzegovina	Kazakhstan	Sierra Leone
Japan	Botswana	Kenya	Singapore
Netherlands	Brazil	Korea North	Slovakia
New Zealand	Bulgaria	Korea South	Slovenia
Norway	Cambodia	Kuwait	South Africa
Portugal	Chile	Latvia	Sri Lanka
Spain	China	Lebanon	Swaziland
Sweden	Colombia	Liberia	Taiwan
Switzerland	Congo-Kinshasa	Libya	Tajikistan
United Kingdom	Costa Rica	Lithuania	Tanzania
United States	Croatia	Macedonia	Thailand
	Cuba	Madagascar	Trinidad and Tobago
	Cyprus	Malawi	Tunisia
	Czech Republic	Malaysia	Turkey
	Dominican Republic	Mauritius	Turkmenistan
	Ecuador	Mexico	Uganda
	Egypt	Moldova	Ukraine
	El Salvador	Mongolia	United Arab Emirates
	Estonia	Morocco	Uruguay
	Gabon	Mozambique	Venezuela
	Georgia	Namibia	Vietnam
	Ghana	Nicaragua	Yemen
	Guatemala	Nigeria	Zambia
	Honduras	Oman	Zimbabwe
	Hong Kong	Pakistan	
		Panama	
		Papua New Guinea	

Table 8: **Unconventional monetary policy (UMP) surprises and mutual fund portfolio choice**

(a) Equity funds

Portfolio reallocation due to:	**Fed surprise**	**BoE surprise**	**BoJ surprise**	**ECB surprise**
Home	-0.135	-0.185*	-0.524	-0.096
	(0.107)	(0.105)	(0.418)	(0.063)
DMexHome	0.004	0.377	-0.390	0.088
	(0.122)	(0.279)	(0.459)	(0.089)
EM	0.131	-0.192	0.915*	0.050
	(0.131)	(0.254)	(0.473)	(0.042)
Observations	11,320	17,036	8,846	21,387
Number of funds	281	451	239	567

(b) Bond funds

Portfolio reallocation due to:	**Fed surprise**	**BoE surprise**	**BoJ surprise**	**ECB surprise**
Home	-0.709**	-1.130*	-0.779	0.076
	(0.341)	(0.584)	(0.502)	(0.124)
DMexHome	0.508**	1.094*	-1.506	-0.070
	(0.240)	(0.592)	(1.684)	(0.095)
EM	0.201	0.037	2.285*	0.003
	(0.149)	(0.151)	(1.294)	(0.034)
Observations	1,659	1,315	898	3,428
Number of funds	45	38	26	86

Table 8 presents results of fixed effects regressions examining the effect of unconventional monetary policy on the portfolio choice of international mutual funds. We estimate the following model: $\Delta X_{it} = \beta' \text{MP}_t + \mu R_{Xit} + \lambda' \text{Macrocontrols}_{Xt} + \phi_i + \epsilon_{it}$ with $\text{MP}_t = [LSAP_t, policy\,surprises_t]$. Our dependent variable represents the change in the portfolio weighting of a country or a region X_{it} in fund i and month t. The main explanatory variables of interest are large-scale asset purchases $LSAP_t$ by a central bank, expressed in percentage of GDP of the domicile of the central bank, and UMP surprises $policy\,surprises_t$. Here we present the estimation results about the effect on mutual fund portfolio choice from UMP surprises identified by Rogers et al. (2015) as the first principal component of the change in 2-, 5-, 10-, and 30-year of government bond futures. Policy surprises are normalised to a 25 basis points surprise change in the yield and signed in a way that a positive number represents a surprise monetary policy easing. A negative surprise represents a surprise tightening, instead of a 'less than expected' policy easing. R_{Xit} is fund i's rate of return in a country or region X relative to its total portfolio at the end of month t. Macro controls$_{Xit}$ is a vector to account for any determinants that are deemed to act as push and pull factors of portfolio allocations. All significance levels are calculated using Driscoll-Kraay (1998) standard errors, which are robust to heteroskedasticity, cross-sectional correlation as well as auto-correlation. Additionally, regressions include fund fixed effects ϕ_i to control for unobservable time-invariant differences between funds. *** p<0.01, ** p<0.05, * p<0.1.

Table 9: **Large-scale asset purchases (LSAPs) and mutual fund portfolio choice**

(a) Equity funds

Portfolio reallocation due to:	Fed		BoE	BoJ			ECB		
	Treasuries	*MBSAD*	*APF assets*	*Gov't Bills*	*Gov't Bonds*	*Private Assets*	*MRO*	*LTRO*	*SMP*
Home	-0.145	-0.094	0.017	0.070	-0.027	-0.218	-0.030	-0.018**	-0.007
	(0.131)	(0.121)	(0.035)	(0.054)	(0.062)	(0.393)	(0.019)	(0.009)	(0.047)
DMexHome	0.414**	0.066	-0.048	0.033	0.066	1.375**	0.043*	0.020**	0.036
	(0.157)	(0.166)	(0.039)	(0.086)	(0.087)	(0.564)	(0.026)	(0.009)	(0.060)
EM	-0.269	0.028	0.031	-0.103	-0.039	-1.157*	-0.014	-0.010	0.028
	(0.169)	(0.214)	(0.034)	(0.092)	(0.063)	(0.629)	(0.015)	(0.007)	(0.044)
Observations	11,320	11,320	17,036	8,846	8,846	8,846	21,387	21,387	21,387
Number of funds	281	281	451	239	239	239	567	567	567

(b) Bond funds

Portfolio reallocation due to:	Fed		BoE	BoJ			ECB		
	Treasuries	*MBSAD*	*APF assets*	*Gov't Bills*	*Gov't Bonds*	*Private Assets*	*MRO*	*LTRO*	*SMP*
Home	-0.047	0.113	-0.160**	0.019	0.186	-1.363**	-0.036	-0.007	-0.156*
	(0.242)	(0.242)	(0.065)	(0.117)	(0.128)	(0.597)	(0.036)	(0.014)	(0.084)
DMexHome	0.430*	-0.237	0.234**	-0.136	-0.051	-0.267	0.046	0.008	0.158*
	(0.243)	(0.287)	(0.106)	(0.158)	(0.201)	(1.747)	(0.049)	(0.016)	(0.083)
EM	-0.383	0.124	-0.074	0.117	-0.135	1.629	0.000	-0.003	0.013
	(0.291)	(0.224)	(0.091)	(0.073)	(0.119)	(1.252)	(0.022)	(0.017)	(0.047)
Observations	1,659	1,659	1,315	898	898	898	3,428	3,428	3,428
Number of funds	45	45	38	26	26	26	86	86	86

Table 9 presents results of fixed effects regressions examining the effect of unconventional monetary policy on the portfolio choice of international mutual funds. We estimate the following model: $\Delta X_{it} = \beta' \text{MP}_t + \mu R_{Xit} + \lambda' \text{Macrocontrols}_{Xt} + \phi_i + \epsilon_{it}$ with $\text{MP}_t = [LSAP_t, policy\,surprises_t]$. Our dependent variable represents the change in the portfolio weighting of a country or a region X_{it} in fund i and month t. The main explanatory variables of interest are large-scale asset purchases $LSAP_t$ by a central bank, expressed in percentage of GDP of the domicile of the central bank, and UMP surprises $policy\,surprises_t$. Here we present the estimation results about the effect on mutual fund portfolio choice from the Fed's purchases of longer term Treasury securities, mortgage-back securities and agency debt (MBSAD), the BoE's purchases under the Asset Purchase Facility (APF), the BoJ's Asset Purchase Programme (APP) in the form of purchases of private assets, government bills and government bonds, and, finally, for the euro area the ECB's purchases under its securities markets programme (SMP), its main refinancing operations (MROs) and long-term refinancing operations (LTROs). R_{Xit} is fund i's rate of return in a country or region X relative to its total portfolio at the end of month t. Macro controls_{Xit} is a vector to account for any determinants that are deemed to act as push and pull factors of portfolio allocations. All significance levels are calculated using Driscoll-Kraay (1998) standard errors, which are robust to heteroskedasticity, cross-sectional correlation as well as auto-correlation. Additionally, regressions include fund fixed effects ϕ_i to control for unobservable time-invariant differences between funds. *** p<0.01, ** p<0.05, * p<0.1.

Table 10: **The cumulated impact of UMP announcement surprises on mutual fund portfolio choice**

(a) Equity funds

Portfolio reallocation due to UMP announcement surprises by: (Portfolio reallocation over sample period)									
Portfolio weight		**Fed**	(Sample)	**BoE**	(Sample)	**BoJ**	(Sample)	**ECB**	(Sample)
Home	in % of AUM	-0.25%	(6.14%)	0.08%	(2.84%)	0.20%	(-5.82%)	-0.22%	(2.70%)
	in Million USD	-500	(12,278)	160	(5,681)	400	(-11,647)	-440	(5,391)
DMexHome	in % of AUM	0.01%	(-2.59%)	-0.17%	(2.87%)	0.15%	(9.55%)	0.2%	(9.30%)
	in Million USD	20	(-5,180)	-340	(5,742)	300	(19,091)	400	(18,599)
EM	in % of AUM	0.24%	(-3.55%)	0.09%	(-5.71%)	-0.35%	(-3.72%)	0.12%	(-12.01%)
	in Million USD	480	(-7,099)	180	(-11,424)	-700	(-7,445)	240	(-24,018)

(b) Bond funds

Portfolio reallocation due to UMP announcement surprises by: (Portfolio reallocation over sample period)									
Portfolio weight		**Fed**	(Sample)	**BoE**	(Sample)	**BoJ**	(Sample)	**ECB**	(Sample)
Home	in % of AUM	-1.29%	(-5.05%)	0.5%	(-0.90%)	0.29%	(-6.33%)	0.18%	(-2.72%)
	in Million USD	-1,290	(-5,046)	500	(-899)	290	(-6,334)	180	(-2,715)
DMexHome	in % of AUM	-0.92%	(-10.52%)	-0.49%	(18.22%)	0.57%	(9.25%)	-0.16%	(-2.58%)
	in Million USD	920	(-10,521)	-490	(18,215)	570	(9,249)	-160	(-2,578)
EM	in % of AUM	0.36%	(15.57%)	0.02%	(19.11%)	-0.86%	(15.58%)	0.01%	(7.25%)
	in Million USD	360	(15,566)	20	(19,113)	-860	(15,582)	10	(7,247)

Table 10 presents the cumulated impact of UMP announcement surprises. It is calculated by cumulating the surprises in bond yields over the sample period and multiplying that number by the regression coefficients of the benchmark regression model. The table also expresses the economic significance in terms of the absolute dollar value of the portfolio reallocations using industry data from EFAMA (2017) on the worldwide assets under management (AUM) managed by regulated open-ended mutual funds. The economic significance of the portfolio reallocation induced by UMP surprises can be assessed by comparing it to the size of the portfolio reallocation over the sample period, as expressed in brackets.

Table 11: **The cumulated impact of LSAPs on mutual fund portfolio choice**

(a) Equity funds

		Portfolio reallocation due to LSAPs by: (Portfolio reallocation over sample period)											
Portfolio reallocation		**Fed**		(Sample)	**BoE**	(Sample)	**BoJ**			(Sample)	**ECB**			(Sample)
		Treasuries	*MBSAD*		*APF assets*		*Gov't Bills*	*Gov't Bonds*	*Private Assets*		*MRO*	*LTRO*	*SMP*	
Home	in % of AUM	-1.77%	-1.04%	(6.14%)	0.39%	(2.84%)	0.37%	-0.69%	-0.40%	(-5.82%)	0.04%	-0.14%	-0.06%	(2.70%)
	in Million USD	-3,543	-2,080	(12,278)	782	(5,681)	735	-1,381	-804	(-11,647)	81	-273	-127	(5,391)
DMexHome	in % of AUM	5.06%	0.73%	(-2.59%)	-1.10%	(2.87%)	0.17%	1.69%	2.53%	(9.55%)	-0.06%	0.15%	0.33%	(9.30%)
	in Million USD	10,117	1,460	(-5,180)	-2,208	(5,742)	347	3,376	5,069	(19,091)	-116	303	654	(18,599)
EM	in % of AUM	-3.29%	0.31%	(-3.55%)	0.71%	(-5.71%)	-0.54%	-1.00%	-2.13%	(-3.72%)	0.02%	-0.08%	0.25%	(-12.01%)
	in Million USD	-6,573	619	(-7,099)	1,426	(-11,424)	-1,082	-1,995	-4,266	(-7,445)	38	-152	509	(-24,018)

(b) Bond funds

		Portfolio reallocation due to LSAPs by: (Portfolio reallocation over sample period)											
Portfolio reallocation		**Fed**		(Sample)	**BoE**	(Sample)	**BoJ**			(Sample)	**ECB**			(Sample)
		Treasuries	*MBSAD*		*APF assets*		*Gov't Bills*	*Gov't Bonds*	*Private Assets*		*MRO*	*LTRO*	*SMP*	
Home	in % of AUM	-0.57%	1.25%	(-5.05%)	-3.68%	(-0.90%)	0.10%	4.76%	-2.51%	(-6.33%)	0.05%	-0.05%	-1.42%	(-2.72%)
	Million USD	-574	1,250	(-5,046)	-3,680	(-899)	100	4,756	-2,513	(-6,334)	48	-53	-1,418	(-2,715)
DMexHome	in % of AUM	5.25%	-2.62%	(-10.52%)	5.38%	(18.22%)	-0.71%	-1.30%	-0.49%	(9.25%)	-0.06%	0.06%	1.44%	(-2.58%)
	in Million USD	5,254	-2,622	(-10,521)	5,382	(18,215)	-714	-1,304	-492	(9,249)	-62	61	1,436	(-2,578)
EM	in % of AUM	-4.68%	1.37%	(15.57%)	-1.70%	(19.11%)	0.61%	-3.45%	3.00%	(15.58%)	0.00%	-0.02%	0.12%	(7.25%)
	in Million USD	-4,680	1,372	(15,566)	-1,702	(19,113)	615	-3,452	3,003	(15,582)	0	-23	118	(7,247)

Table 11 presents the cumulated impact of large-scale asset purchases (LSAPs). It is calculated as the cumulated size of asset purchases of a particular central bank, expressed in percentage of its host country's GDP, multiplied by the estimated regression coefficients of the benchmark regression model. The table also expresses the economic significance in terms of the absolute dollar value of the portfolio reallocations using industry data from EFAMA (2017) on the worldwide assets under management (AUM) managed by regulated open-ended mutual funds. The economic significance of the portfolio reallocation induced by LSAPs can be assessed by comparing it to the size of the portfolio reallocation over the sample period, as expressed in brackets.

Table 12: **Shadow short rate changes and mutual fund portfolio choice**

(a) Equity funds

Portfolio reallocation due to:	**Fed ΔSSR**	**BoE ΔSSR**	**BoJ ΔSSR**	**ECB ΔSSR**
Home	-0.014	-0.045	0.344*	-0.138*
	(0.071)	(0.037)	(0.181)	(0.077)
DMexHome	0.306***	0.118**	0.209	0.216**
	(0.073)	(0.054)	(0.205)	(0.086)
EM	-0.292***	-0.073*	-0.553***	-0.176**
	(0.076)	(0.043)	(0.156)	(0.072)
Observations	11,320	17,036	8,846	21,387
Number of funds	281	451	239	567

(b) Bond funds

Portfolio reallocation due to:	**Fed ΔSSR**	**BoE ΔSSR**	**BoJ ΔSSR**	**ECB ΔSSR**
Home	-0.153	-0.084	0.083	0.153
	(0.204)	(0.096)	0.022	-0.038
DMexHome	0.374**	0.286*	0.483**	-0.173
	(0.185)	(0.152)	-0.132	0.048
EM	-0.221***	-0.203**	-0.565***	-0.066
	(0.081)	(0.087)	0.110	-0.000
Observations	1,659	1,315	898	3,428
Number of funds	45	38	26	86

Table 12 presents results of the benchmark regression with the UMP announcement surprises being replaced by changes in Krippner's (2013) estimates of the change in the shadow short rates (SSR) for each central bank.

Table 13: **Unconventional monetary policy surprise tightenings vs. easings**

(a) Equity funds

Portfolio reallocation due to:	**Fed surprise**		**BoE surprise**		**BoJ surprise**		**ECB surprise**	
	Easing	*Tightening*	*Easing*	*Tightening*	*Easing*	*Tightening*	*Easing*	*Tightening*
Home	-0.196	0.102	-0.303***	0.019	0.437	-2.197**	-0.113	-0.074
	(0.145)	(0.294)	(0.077)	(0.292)	(0.553)	(0.919)	(0.114)	(0.047)
DMexHome	-0.047	0.200	0.478	0.202	-1.500**	1.542	0.161	-0.008
	(0.118)	(0.429)	(0.381)	(0.277)	(0.583)	(0.982)	(0.113)	(0.044)
EM	0.243*	-0.302	-0.175	-0.221	1.064*	0.656	0.026	0.080*
	(0.142)	(0.380)	(0.369)	(0.144)	(0.625)	(0.995)	(0.043)	(0.043)
Observations	11,320	11,320	17,036	17,036	8,846	8,846	21,387	21,387
Number of funds	281	281	451	451	239	239	567	567

(b) Bond funds

Portfolio reallocation due to:	**Fed surprise**		**BoE surprise**		**BoJ surprise**		**ECB surprise**	
	Easing	*Tightening*	*Easing*	*Tightening*	*Easing*	*Tightening*	*Easing*	*Tightening*
Home	-0.899**	0.072	-1.061	-1.248***	-0.764	-0.805	-0.021	0.196
	(0.423)	(0.735)	(0.907)	(0.345)	(0.887)	(0.876)	(0.118)	(0.128)
DMexHome	0.587*	0.184	0.893	1.434**	-1.161	-2.112	0.014	-0.175**
	(0.315)	(0.535)	(0.982)	(0.605)	(2.895)	(1.601)	(0.131)	(0.070)
EM	0.312*	-0.256	0.168	-0.186	1.926	2.917**	-0.053	0.072
	(0.175)	(0.451)	(0.209)	(0.532)	(2.159)	(1.412)	(0.063)	(0.082)
Observations	1,659	1,659	1,315	1,315	898	898	3,428	3,428
Number of funds	45	45	38	38	26	26	86	86

Table 13 presents results of the benchmark regression with UMP announcement surprises differentiated into surprise tightenings and surprise easings.

Figure 1: Assets under management

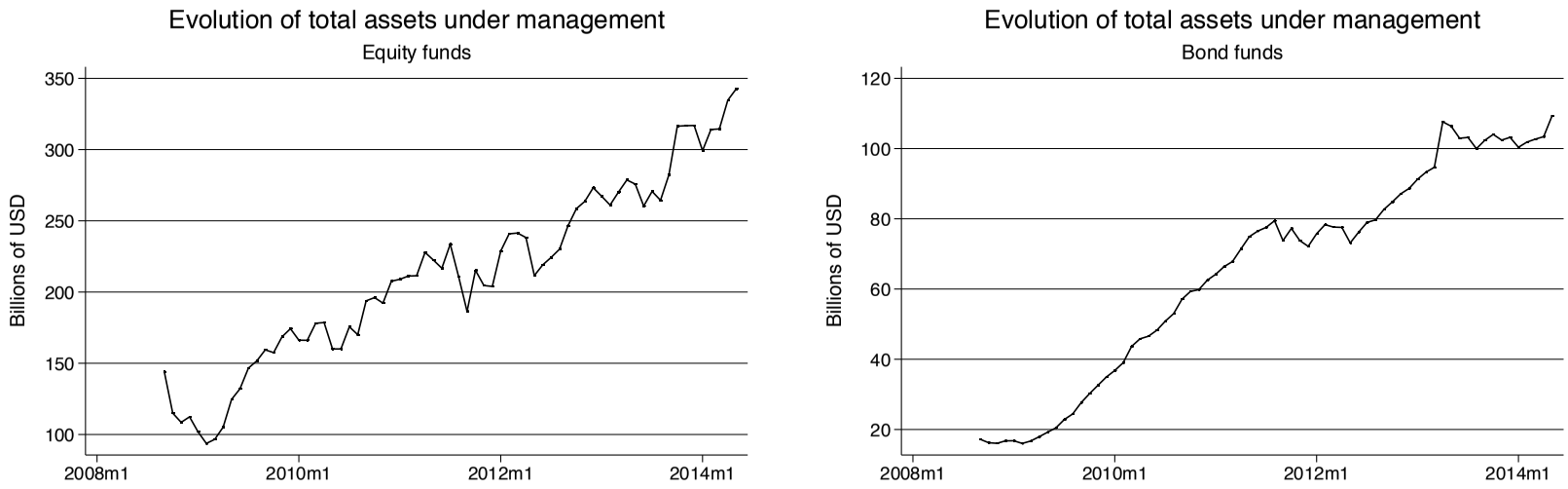
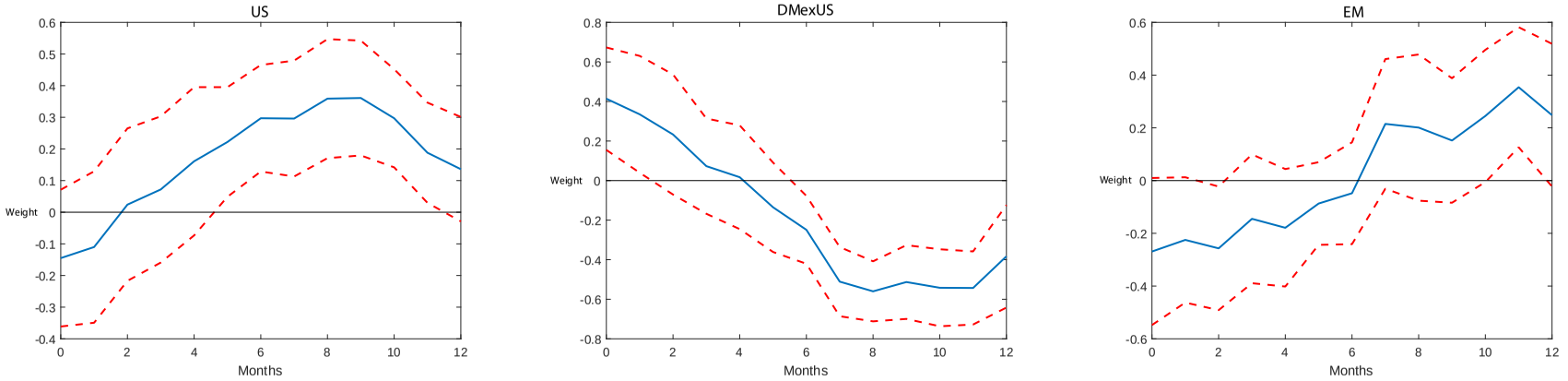


Figure 1 shows the assets under management tracked in the sample.

Figure 2: **Persistence of portfolio effects following Fed LSAPs of US Treasuries**

(a) Equity funds



(b) Bond funds

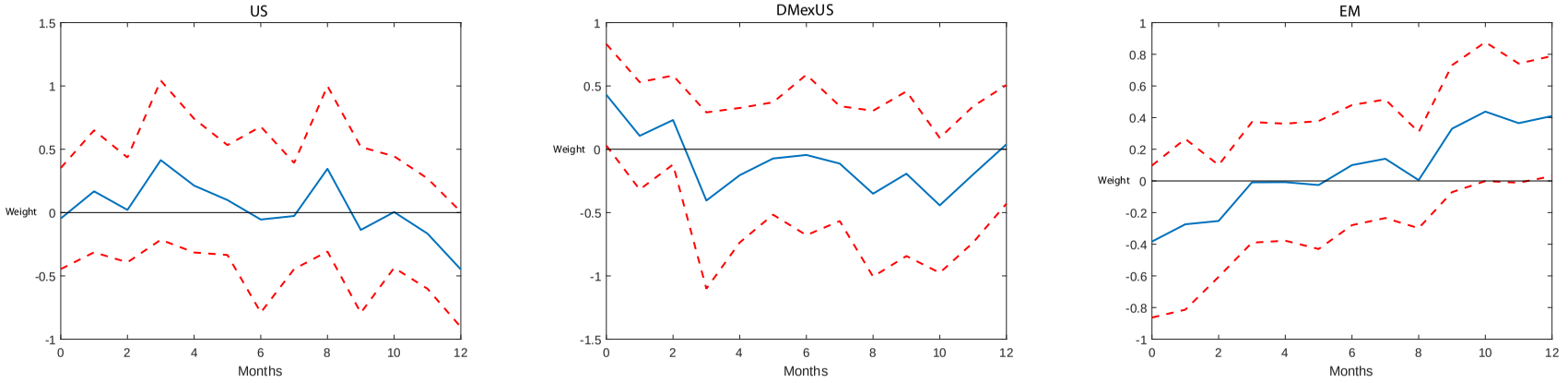


Figure 2 presents impulse responses functions (IRF) of the change in the mutual fund portfolio weights $X \in [US, DMexUS, EM]$ following the implementation of Fed's LSAPs. Using the benchmark model, the IRFs are constructed by regressing the changes in the portfolio weight ΔX_{it+h}, for h-steps ahead with $h = 1, ..., 12$ on the benchmark model variables.

Figure 3: **Persistence of portfolio effects following Fed UMP surprises**

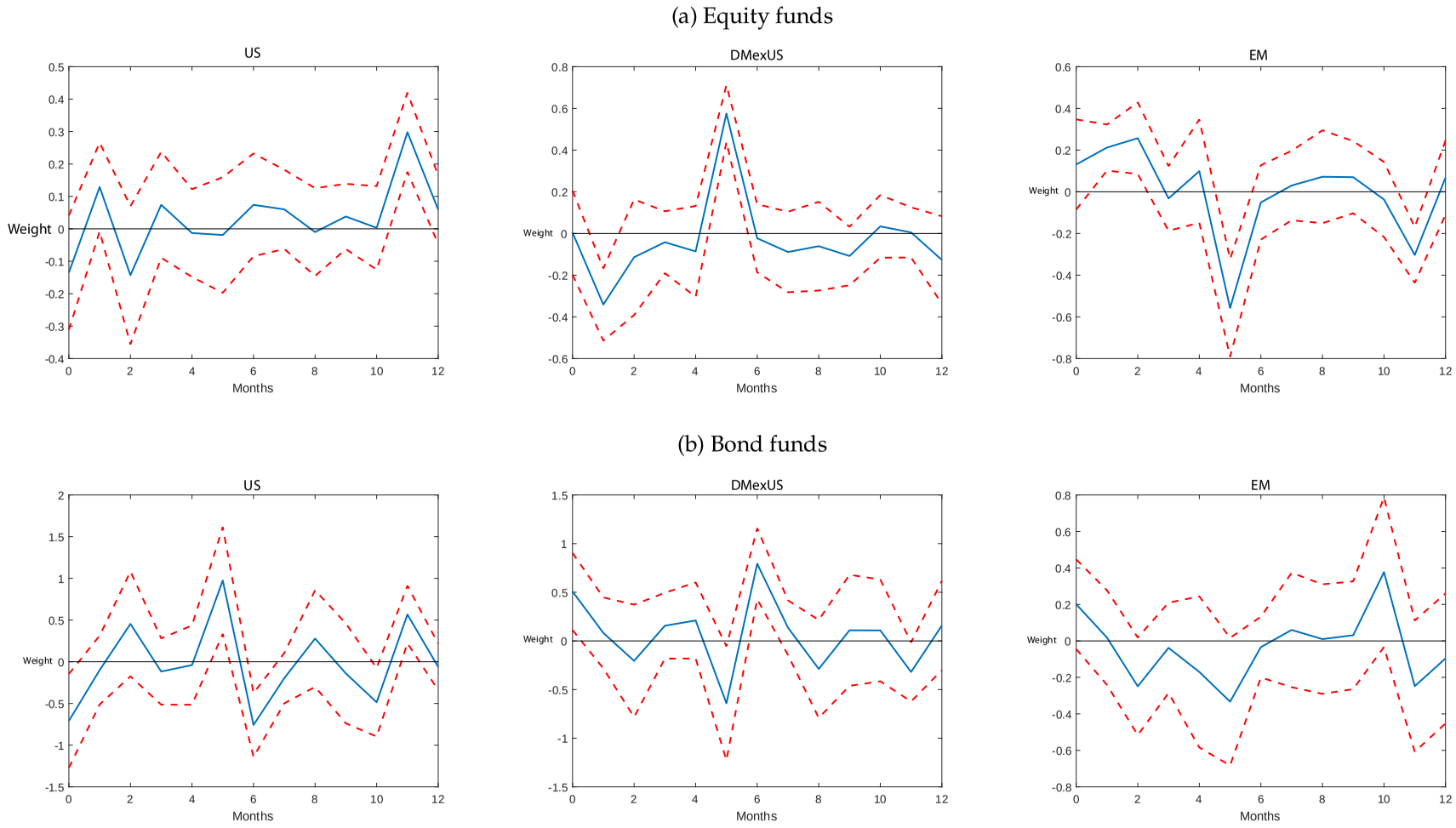
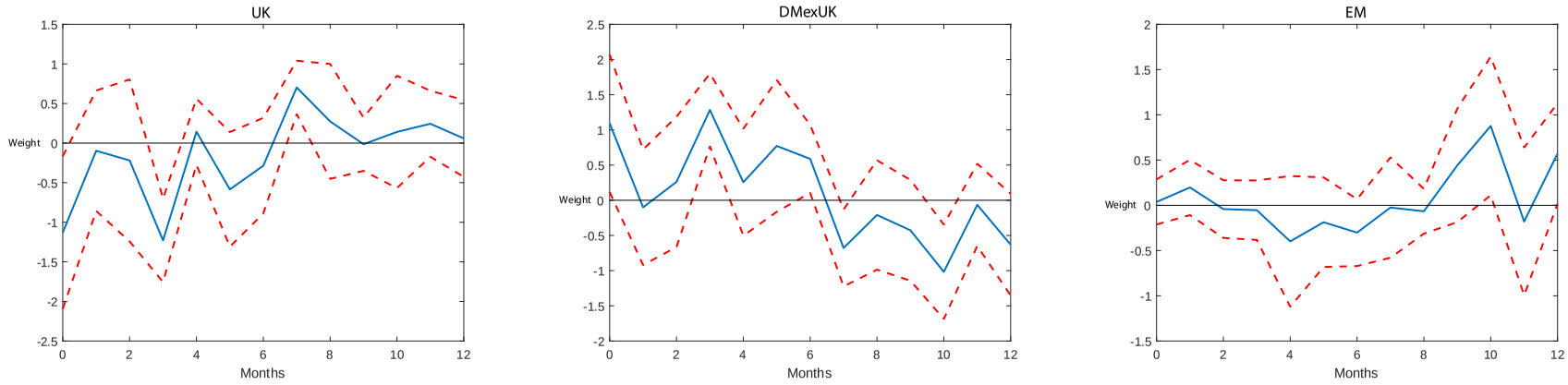


Figure 3 presents impulse responses functions (IRF) of the change in mutual fund portfolio weights $X \in [US, DMexUS, EM]$ following Fed UMP surprises. Using the benchmark model, the IRFs are constructed by regressing the change in the portfolio weight ΔX_{it+h} for h-steps ahead with $h = 1, ..., 12$ on the benchmark model variables.

Figure 4: **Persistence of portfolio effects following BoE UMP surprises**

(a) Equity funds



(b) Bond funds

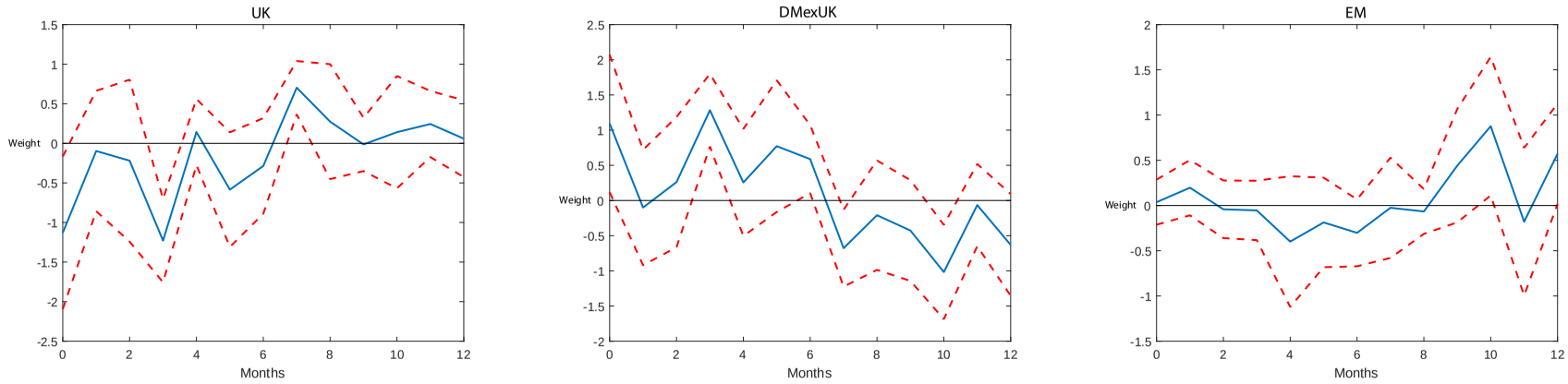


Figure 4 presents impulse responses functions (IRF) of the change in the mutual fund portfolio weights $X \in [UK, DMexUK, EM]$ following BoE UMP surprises. Using the benchmark model, the IRFs are constructed by regressing the change in the portfolio weight ΔX_{it+h} for h-steps ahead with $h = 1, ..., 12$ on the benchmark model variables.

Figure 5: **Persistence of portfolio effects following BoJ UMP surprises**

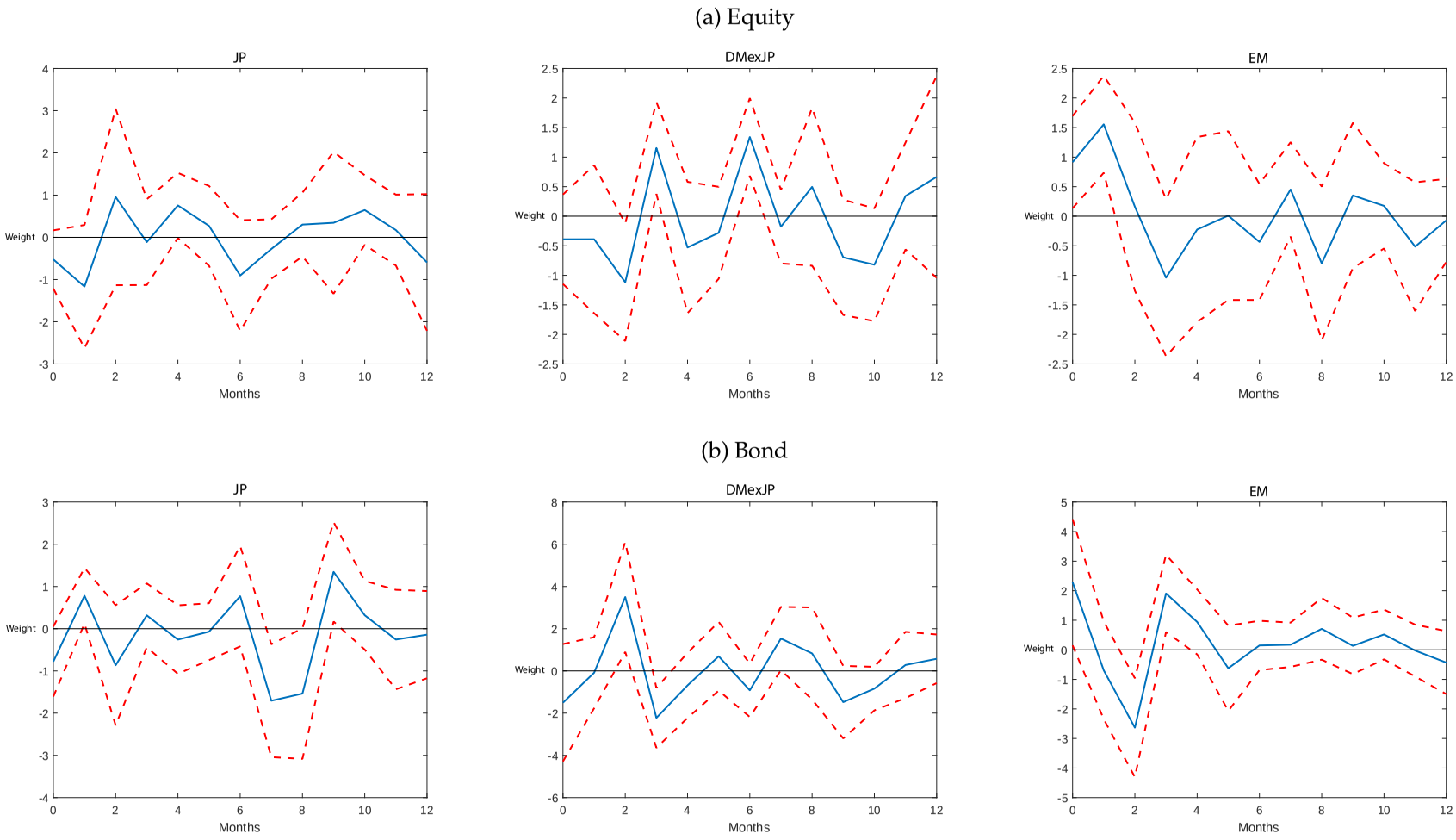


Figure 5 presents impulse responses functions (IRF) of mutual fund portfolio weights $X \in [JP,\ DMexJP,\ EM]$ following BoJ UMP surprises. Using the benchmark model, the IRFs are constructed by regressing the portfolio weight X_{it+h} for h-steps ahead where $h = 1, ..., 12$.

Figure 6: **Persistence of portfolio effects following ECB UMP surprises**

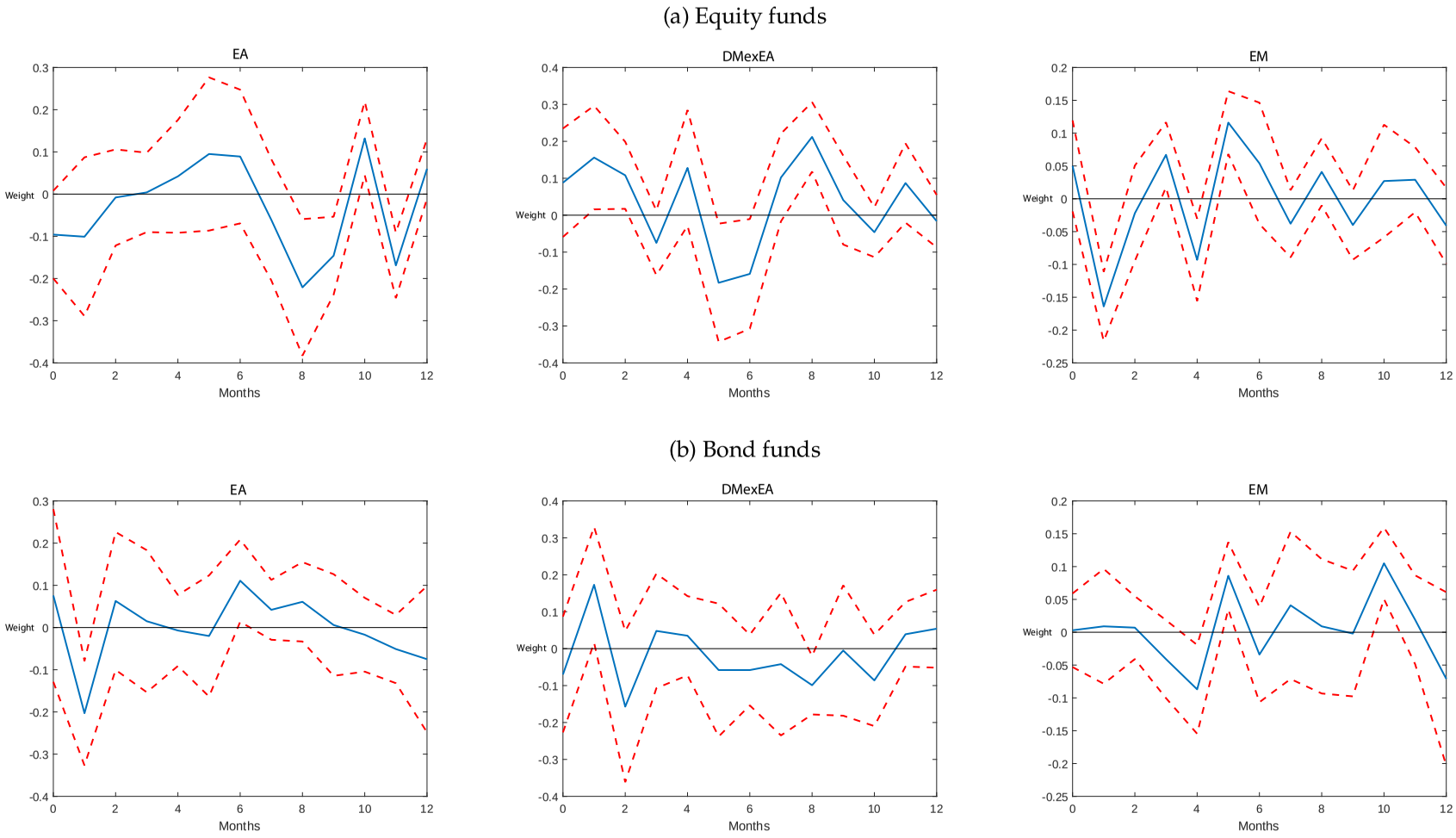


Figure 6 presents impulse responses functions (IRF) of the change in the mutual fund portfolio weights $X \in [EA, DMexEA, EM]$ following ECB UMP surprises. Using the benchmark model, the IRFs are constructed by regressing the change in the portfolio weight ΔX_{it+h} for h-steps ahead with $h = 1, ..., 12$ on the benchmark model variables.