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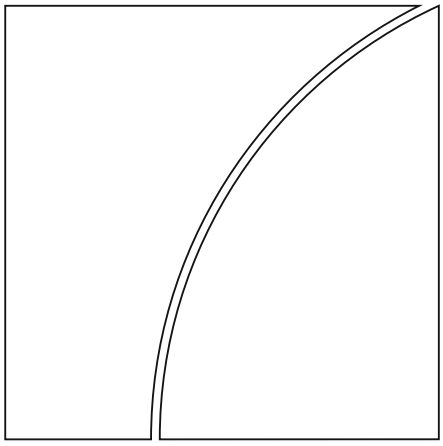

BIS Working Papers

No 578

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by Lawrence Kreicher and Robert McCauley

Monetary and Economic Department

August 2016

JEL classification: E43, E44, E52, F36, G23

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This publication is available on the BIS website (www.bis.org).

ISSN 1020-0959 (print)
ISSN 1682-7678 (online)

Asset managers, eurodollars and unconventional monetary policy

Lawrence Kreicher and Robert McCauley[1]

Abstract

An asset manager's rapid liquidation in the weeks around the end of September 2014 of a very large position in eurodollar futures, a huge derivatives market that allows traders to position on the future path of dollar money rates, raises two questions. What is the profile of asset managers in this key market? And how has the Federal Reserve's unconventional monetary policy, including forward guidance about policy rates, affected this market? Asset managers generally hold the largest eurodollar positions among buy-side traders but play a lesser role in day-to-day trading. Second, the Fed's unconventional policy saw the average maturity of eurodollar contracts traded between 2008 and 2014 double and it has remained at an elevated maturity since then. Moreover, from 2012 into 2015 eurodollar turnover responded more strongly to Federal Reserve announcements than to macroeconomic news, a finding analogous to that of Filardo and Hofmann (2014) for yields. In 2015 asset managers took a large short position in eurodollar futures; this unprecedented position would profit if the Federal Reserve's own projections of policy rates ("dots") were realised. Judging from eurodollar futures, asset managers now play an important role in facilitating or hindering the transmission of monetary policy to market rates.

Keywords: Asset managers, mutual funds, derivatives, unconventional monetary policy, forward guidance, money market, eurodollar futures.

JEL classification: E43, E44, E52, F36, G23.

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Introduction

In the weeks around the end of September 2014, asset managers (AMs) liquidated a very large long position in eurodollar futures. This position would have paid off in the event that the Federal Reserve's actual path of interest rate hikes proved to be slower to start and more gradual than foreseen by the rest of market participants and by policymakers in particular. At its peak during the first half of 2014, AMs' combined long holdings of $2.2 trillion in eurodollar futures represented one fifth of total open interest – outstanding bets in this huge derivatives market. Most of this long position was to be liquidated in a fortnight. This episode raises two questions.

First, what is the profile of AMs in this market? We discuss both overall positioning and trading activity of AMs relative to other buy-side investors, in particular leveraged funds (LFs). It turns out that AMs as a group regularly take on larger positions than do LFs. AMs took on particularly large long positions in eurodollar futures not only in 2014 but also in 2007–2008 and in 2011. Then in 2015 AM positions turned substantially short for the first time even as LFs were long; in effect, AMs were backing the Federal Reserve's anticipated interest rate trajectory while LFs and most other market participants were betting that rates would not rise so fast.

Second, how has the Fed's unconventional monetary policy affected the market for eurodollar futures? We examine daily data, but in so doing can only focus on transactors of all types, not just AMs. We analyse the maturity profile of turnover and define a new concept, *turnover duration*. We find that turnover duration doubled between 2008 and 2014 and remains elevated in comparison to the period 2000-2007. Our analysis of *quantities* in the eurodollar futures market complements the work of Filardo and Hofmann (2014) on the effect of forward guidance on *prices*. Those authors find that forward guidance led to a suppression of short-term money market responses to macroeconomic news, eg no response of one-year forward rates to US payroll news surprises in 2012–14. Analogously, we find that from 2012 into 2015 eurodollar turnover responded more strongly to Federal Reserve announcements than to employment data surprises.

This paper is structured as follows. Section 1 puts the rapid closeout of AMs' extremely large long position in eurodollar futures in the weeks surrounding 30 September 2014 into the broader context of the role AMs play in eurodollar futures. A box details the concentrated nature of this holding and its liquidation. The second section discusses the maturity profile of eurodollar futures trading and how it has changed since the financial crisis of 2007–08. The third section analyses how the maturity profile of eurodollar futures turnover has responded to the Federal Reserve's announcements of large-scale bond buying (so-called quantitative easing or QE) and forward guidance. Another box examines how the maturity profile of eurodollar futures trading has responded to monetary policy announcements by the European Central Bank (ECB), the Swiss National Bank (SNB) and the Bank of Japan (BoJ). The last section concludes.

1. Asset managers and eurodollar futures

AMs, as natural holders of bonds, may seem at first blush unlikely participants in the eurodollar futures market. The eurodollar futures market allows participants to take positions on the levels of three-month interest rates (Libor) occurring at quarterly intervals over the next ten years. A long position in a contract maturing on a certain date produces a profit if Libor is lower than priced, while a short position generates a profit if Libor is higher than priced. Eurodollar futures' daily turnover averages roughly $2 trillion notional, making it one of the largest derivatives markets in the world.

AMs have become major players in the huge eurodollar futures market alongside dealer banks (who accommodate customer positions and manage their own interest rate exposure) and LFs. This section highlights both the scale of AMs' positions and the speed with which those positions sometime change, underscoring AMs' demand for substantial immediate liquidity. AMs' major role in this market provides a critical background to our study of interactions between the eurodollar futures market and monetary policy expectations.

The 2007 edition of the classic *Stigum's Money Market* profiled the eurodollar futures market as one with bank dealers on the one side and firms with floating rate borrowing, mortgage originators and mortgage security investors on the other. This is no longer an adequate description. AMs and LFs have taken over on the buy-side, while bank dealers play a largely accommodative role, helping buy-side investors to take on and to exit positions.

A key source of information in this regard is the weekly release of the Commodity Futures Trading Commission (CFTC), "Traders in financial futures" or TFF, which reports positions held by large traders in financial markets including the eurodollar market. Positions are based on the concept of open interest – contracts entered into and not yet offset by other transactions, delivery, or exercise. Positions are categorised as "long," "short," or "spreading".[2]

Until 2010 such position data were reported in the CFTC's weekly "Commitment of traders" (COT) with a partition of traders into "commercial" (hedger) and "non-commercial" (speculator) categories. Beginning with the first release of the TFF in 2010, however, the CFTC provided an additional breakdown of traders into four functional categories: dealer/intermediary, AM/institutional, LFs and other reportables (which include *inter alia* corporate treasuries, central banks and smaller banks). The CFTC simultaneously released historical TFF data back to mid-2006 so that ten years of data with relevant functional detail are currently available.[3]

The four TFF categories divide eurodollar futures participants into "sell side" (dealer/intermediaries) and "buy side" (AMs/institutional, LFs and other reportables). Dealers are defined by the CFTC to "earn commissions on selling financial products, capturing bid/offer spreads and otherwise *accommodating clients* [emphasis added]". Examples given by the CFTC of AM/institutional traders include "pension funds, endowments, insurance companies, mutual funds and those portfolio investment

[2] A eurodollar trader holding both long and short contracts has both a spreading position (in an amount equal to the lesser number of long and short contracts) plus a residual long or short position.

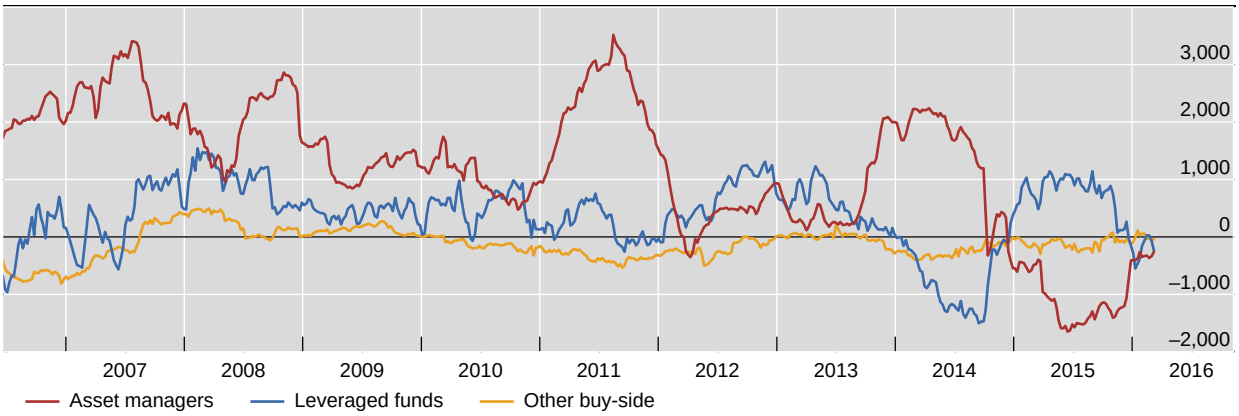
[3] The legacy COT report for financial futures continues to be published side-by-side with the TFF report; because total open interest is also available, both releases calculate "non-reportable" positions as residuals.

managers whose clients are predominantly institutional". LFs included hedge funds and "registered commodity trading advisors (CTAs)." CFTC staff use judgement in categorising the predominant activities of multi-functional organisations that have centralised futures trading. Finally, a given trader's classification may change over time because the Commission receives new information.

Net positions (longs minus shorts) focusing on buy-side categories since 2006 are plotted in Graph 1. These data show that AMs usually hold long positions and that on occasion they hold extremely large long positions. We note in particular the accumulations by AMs of long holdings exceeding two million contracts in 2007, 2008, 2011, and 2013-14. Since the notional value of each contract is $1 million, these long positions represented notional values of more than $2 trillion.

Net positions on three-month eurodollar futures held by buy-side transactors

In thousands of contracts Graph 1



Sources: Commodity Futures Trading Commission; authors' calculations.

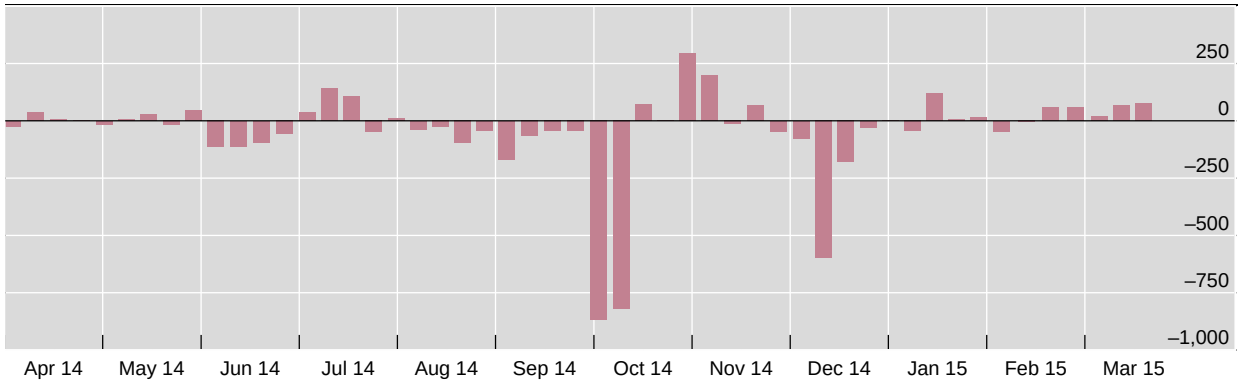
Position-taking by AMs in eurodollar futures contrasts with the behaviour of the other main buy-side group, LFs. On a point-by-point basis through time the net positions of AMs have tended to be larger than those of LFs; in fact, over the past ten years the net positions of AMs have exceeded those of LFs in absolute terms nearly 80% of the time. This dominance is worth noting because, while AMs generally run larger net positions, as we shall see below LFs dominate AMs in terms of trading activity with three to four times the average amount of weekly turnover.

The dramatic swings in AMs' combined position from late-2013 through the end of 2015 are particularly noteworthy and deserve additional analysis. Starting from a position of near-balance in the summer of 2013, AMs rapidly built a long position of more than two million contracts by year-end that they maintained through the middle of 2014. That position then began to shrink at an increasing rate, culminating in a dramatic liquidation of more than 1.5 million contracts in the two weeks around 30 September 2014 (Graph 2).

While AMs had liquidated very large long positions previously, the speed of the liquidation around 30 September 2014 was unprecedented: in just two weeks AMs turned a $1.2 trillion net long notional position into a -$0.3 trillion notional short position (Table 1). This was a more rapid liquidation than the one in December 2008 (Graph 1) when the Federal Reserve abruptly and effectively reduced its short-term policy rate to near zero.

Weekly change in asset managers' net long positions in eurodollar futures

In thousands of contracts Graph 2



Source: Commodity Futures Trading Commission; Bloomberg.

This liquidation was not only very large and rapid, but there is also evidence that it was very concentrated. The Box below discusses the derivative positions of the largest US bond mutual fund in late 2014, showing the dominance of the "big long" in eurodollar futures. The size, speed, and concentrated nature of the futures liquidation in 2014 highlight the demand for immediacy that AMs can impose on fixed income markets (Fender and Lewrick (2015)).

Shortly after the dramatic liquidation of long eurodollars described above came the "flash rally" in the US Treasury bond market of 15 October 2014. This rally saw one of the most liquid financial instruments in the world, the 10-year US Treasury note, trade (up and down in price and) down and up in yield by 16 basis points in the course of 12 minutes. In the week including that rally, both AMs and LFs reduced *short* positions in eurodollar futures. The US Treasury et al (2015, p 18), which might have had access to daily data, report that "levered short positions in shorter-term interest rate futures contracts, such as Eurodollar futures, had reached a record level by the end of September…Much [about 60%] of this unwind took place in the two weeks ahead of October 15, but the change was also significant on October 15 itself". As the last line on Table 1 shows, AMs reduced short positions that week by 188,405 contracts ($188.4 billion notional), while LFs reduced short positions that week by 305,848 contracts ($305.8 billion notional).

Whether the motivation was hedging or speculation, the consequence of AMs' long position during much of 2014 is straightforward: If rates were to have stayed lower longer than market participants overall were pricing, AMs would make money.[4] Moving into 2015, the CFTC data show AMs swung around to a combined, one-of-a-kind massive *short* position in eurodollar futures. This unprecedented short position effectively put AMs on the side of FOMC policymakers. That is, AMs made bets in line with the Fed's view that interest rates would rise sooner and go higher than market

[4] Since the beginning of 2014 the Fed's FOMC "dot plot," as measured by either the median or weighted-average forecast for the Fed funds rate, has exceeded market participants' pricing for that rate as reflected in either Fed funds futures or calculated from the OIS curve. The discrepancy is present at all forecast horizons and has generally fluctuated in the range of 25-100 basis points. Extending this reasoning to eurodollars futures, AMs' long position in 2014 put them on the opposite side of the market from Fed policymakers, resisting the FOMC's forward guidance.

participants overall had priced. AMs closed out these unusual short positions at the end of 2015.

Net long eurodollar futures positions by group, September-October 2014 Table 1

Report date	Dealer	Asset manager	Leveraged fund	Other reporter	Non-reporter
23.09.2014	994,347	1,194,209	-1,473,704	-166,223	-548,629
30.09.2014	1,467,631	402,408	-1,267,476	-53,945	-548,618
07.10.2014	1,698,247	-325,576	-839,252	-99,245	-434,174
14.10.2014	1,303,724	-218,423	-522,759	-101,988	-460,554
21.10.2014	757,572	-30,018	-216,911	-177,313	-333,330
Memo: net change, 23.09.14-07.10.14	*703,900*	*-1,519,785*	*634,452*	*66,978*	*114,455*
Memo: net change, 14.10.14-21.10.14	*-546,152*	*188,405*	*305,848*	*-75,325*	*127,224*

Source: CFTC.

Thus far we have discussed the positioning of AMs, but a full appreciation of their role in eurodollar futures benefits from an analysis of their transactions. Such an analysis is not easily performed on the available data, however. As indicated above, the CFTC's weekly TFF release reports *positions* – long, short and spreading – for the aggregate of traders in each functional group as of the close of business on Tuesday of each week. Thus, these data represent "stocks" and do not allow one to directly answer the key "flow" question of how much eurodollar trading AMs do relative to hedge funds and other LFs.

Fortunately, the CFTC has published a "one-off" data set of transactions – buys and sells – for traders using the TFF's functional groups for the period January 2009 through May 2011. In its "large trader net position change" calculations the CFTC took changes in daily open interest and derived daily measures of contract buying and selling for each trader group. Thus, the CFTC left out day-trades, but otherwise measured transactions. These daily data were then aggregated to produce daily averages of contract buying and selling on a calendar week basis. Using both this methodology and the TFF weekly (as-of-Tuesday) position data, we have constructed transaction (buy/sell) proxies for all four functional trader groups for the ten years of available TFF data.[5] Our proxies generally correlate quite well with the 29 months of one-off transactions data reported by the CFTC;[6] for AMs the correlations were 0.84 for the buys and 0.69 for the sells.

Our weekly transaction proxies (Graph 3) indicate that AMs' transactions, unlike their positions, generally take second place behind those of LFs. In particular, over our long sample period 2006-16, AMs' share of trading has held steady at around 20% of all trading – buying and selling – by buy-side entities. LFs accounted for nearly

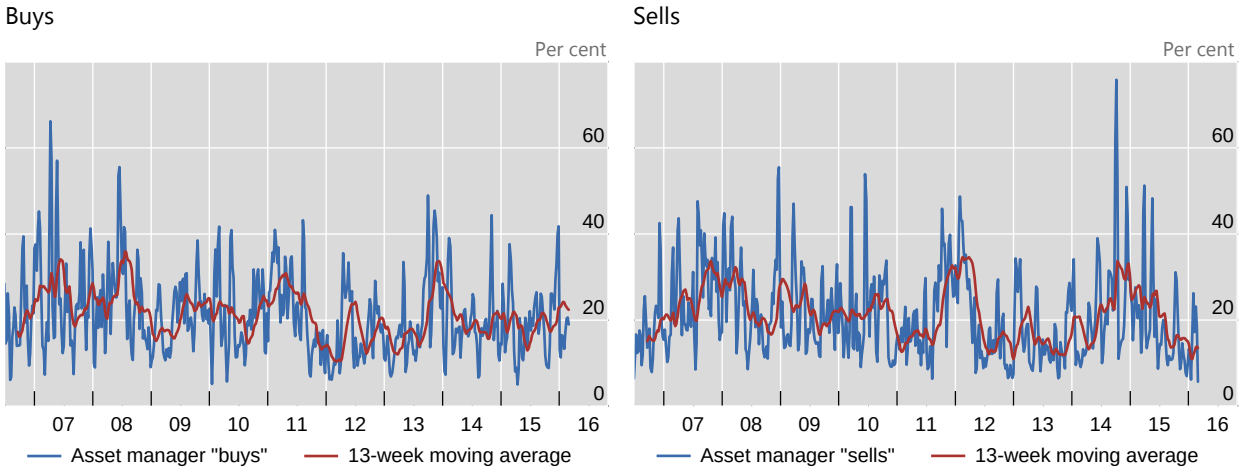
[5] Construction of an individual proxy is as follows. For each week we calculate changes in the longs, shorts, and spreads for a functional trader group. A positive change in longs or a negative change in shorts are counted as buys; a negative change in longs or a positive change in shorts are counted as sales; any change in spreads is counted as both a buy *and* a sale.

[6] Buys/sells correlations were: for dealers 0.62/0.61, AMs 0.84/0.69, LFs 0.72/0.74, and other reportables 0.58/0.65.

70%, while "Other reportables" accounted for a fairly consistent 10% share. In other words, there has been no clear trend increase or decrease in the share of trading attributable to AMs in the eurodollar futures market, either as buyers or sellers of contracts, over the past ten years.

Asset manager transactions

As a percentage of total transactions by buy-side traders — Graph 3



Source: Commodity Futures Trading Commission; authors' calculations.

For short periods of time the share of trading activity attributable to AMs has spiked to 40%–50%, even reaching more than 75% during the previously mentioned liquidation of eurodollar contracts in the weeks around the end of September 2014. However, in general the AM share stays between 10% and 30%.

In sum, AMs tend to dominate the *positioning* in eurodollar futures. However, LFs out-trade AMs in this instrument. Episodically, AMs run very long positions in this instrument, and in 2015 they demonstrated a capacity collectively to go short in size as well.

Box 1

PIMCO's Total Return Fund and eurodollar futures

This box profiles the derivative positions, especially a eurodollar futures position, built up in 2014 by what was then the largest US bond mutual fund. The derivatives position that received most attention at the time and, apparently since (US Treasury et al (2015)), was an option position that was structured to pay off in the event of a continuation of a placid bond market. This position is known to market participants as a "short volatility" position. The derivatives position that received much less attention was a "big long" in eurodollar futures that would pay off if the lift-off of monetary tightening proved later than anticipated.

PIMCO's Total Return Fund (PTRF) peaked in size at $293 billion in April 2013, then the largest US bond mutual fund accounting for about 10% of the net asset value of US bond mutual funds. Its benchmark is the Barclays US aggregate index, which tracks investment-grade US bonds. Its underperformance of this benchmark and later its leadership change in late September 2014 led to investor redemptions from May 2013 onwards.

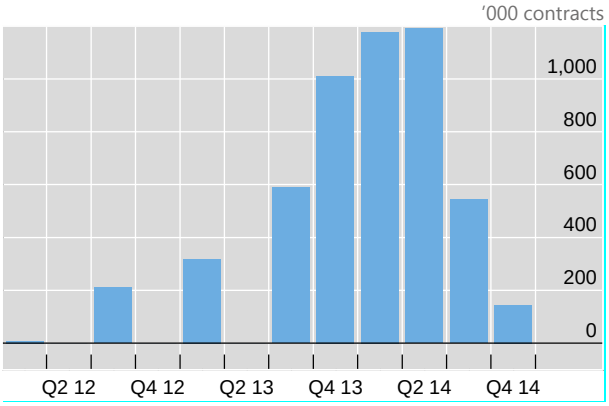
In mid-2014, PTRF's manager flagged its core strategy of selling insurance against interest rate moves (Foley and Mackenzie (2014); Gross (2014)). The premise is that portfolio hedgers' demand for insurance pushes implied volatility in option prices above realised volatility, so that option writers can profit much like auto insurers (Rennison and Pedersen (2012) Chan (2015)). Indeed its 30 June 2014 disclosure shows that PTRF had sold put and call options on floating to fixed swaps to the extent of $94 billion in notional value, 41% of PTRF's net asset value (NAV). These over-the-counter (OTC) contracts would expire worthless if rates remained stable, allowing PTRF to keep the option premiums. While much discussed, these contracts represented just 2.5% of the $3.9 trillion in US dollar OTC interest rate options sold by financial customers at the end of June 2014, according to the semi-annual BIS statistics.[①]

Elsewhere in the PTRF portfolio were massive long positions in eurodollar futures (Graph A, upper left-hand panel). PIMCO (2014c) notes that eurodollar futures are "used to manage exposures at the short end of the yield curve and express PIMCO's expectations for short-term rates". From 250,000 contracts in March 2013, the outstanding long positions hit almost 1.2 million contracts in March and June 2014. Since the notional value of each contract is $1 million, the notional value of this position was $1.2 trillion. Every basis point rise in dollar Libor would cost the PTRF shareholders $47.5 million. In a fund of $200 billion plus in assets, each basis point in higher Libor would translate into a two basis point loss.

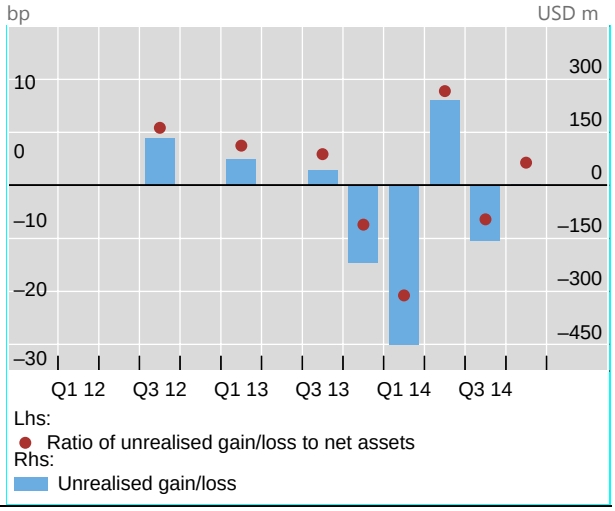
PIMCO Total Return Fund holdings of eurodollar futures

Graph A

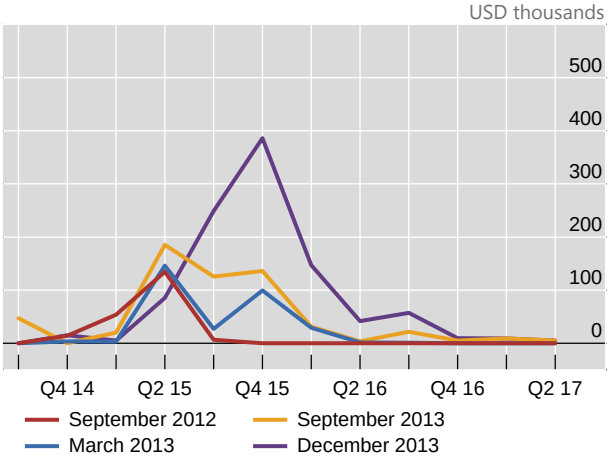
Holdings of eurodollar futures, 2012–14



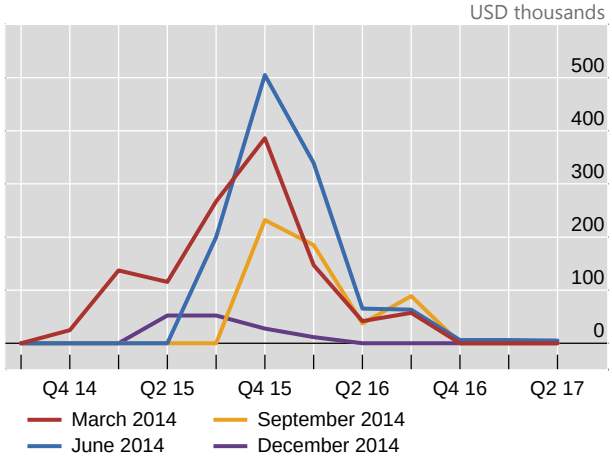
Unrealised gains and losses on eurodollar futures, 2012–14



Term structure of eurodollar holdings, 2012–13



Term structure of eurodollar holdings, 2014



Sources: PIMCO (2012a,b-2014a,b).

This "big long" position represented a big share of the huge eurodollar futures market. Since open interest, defined as the sum of all long (or short) positions, at the time was about $11 trillion, PTRF held a tenth of all the long eurodollar positions. A large player in swaptions, PTRF was a huge player in eurodollar futures.

Was PTRF's derivatives position unusually large in relation to its NAV? This turns out not to be an easy question to answer. As noted by a recent SEC staff white paper on derivatives holdings by SEC-registered mutual funds (Deli et al (2015)), the basis of disclosure to assess the exposure of mutual funds to derivatives suffers from several drawbacks.[2] After ruling out better alternatives as impractical, the white paper offered the ratio of notional value of certain derivatives (futures, forwards, swaps and written options) plus borrowing to net asset value. Deli et al (2015) recognise the limitations of this measure but also make clear the Herculean effort to compute it from the 2014 disclosures of a randomly selected sample of 10% of all mutual funds in the Morningstar universe (numbering 1,188).

If this measure, its calculation and the sample are accepted, PTRF's use of derivatives and debt exceeded that of more than 99.5% of "traditional" mutual funds.[3] Following the Deli et al (2015) procedures, we measure PTRF's ratio at 30 June 2014 at 291%.[4] This ratio would be substantially higher had we not followed the "apparent industry convention" employed by Deli et al (2015, p 11)) of dividing eurodollar futures notional amounts by four to account for the 90-day term of the underlying.[5] The resulting 291% would put PTRF at the number three position in the Deli et al (2015) ranking of "traditional" mutual funds by the ratio of derivatives to NAV (behind the 400% of a Japan stock fund and the 375% of a "world bond" fund, both of which may be presumed to use currency derivatives to hedge foreign securities into the US dollar). Since the sample of "traditional funds" numbered 899, PTRF was in the top 0.5% tail of derivatives to NAV in this sample. (Indeed, PTRF's use of derivatives would put it in the top quartile of "alternative strategies" mutual funds as sampled by Deli et al (2015)).

Relying on these results, the SEC (2015) has proposed that derivatives plus borrowing be limited to 150% of NAV.[6] Hodge (2016) of PIMCO responded: "…the white paper concluded that fewer than 1% of 'Traditional Mutual Funds,' and no 'Closed-End Funds,'…, exceed the 150% exposure based portfolio limit. We believe that the white paper significantly understates the use of derivatives by mainstream fixed income funds, and that many of these funds would be required to reduce their use of derivatives…if the Proposed Rule is adopted…." Deli et al (2015) found a positive relationship between size and use of derivatives, so perhaps a sampling stratified by size would have produced a different result. IMF (2015, pp 23-24) and Cortes (2015) associate large bond mutual funds and active use of derivatives.

Focusing back to PTRF's eurodollar portfolio alone, PTRF centred the maturity of its position eight calendar quarters out the eurodollar yield curve. For instance, in December 2013, the fund had its largest position in the December 2015 contract (Graph A, lower left-hand panel). This contract remained the modal eurodollar futures holding in March 2014 and June 2014 (Graph A, lower right-hand panel), even as longer maturity contracts were added to the portfolio.

Contemporary reporting (Mackenzie and Meyer (2014)) is backed by circumstantial evidence that PTRF's new managers liquidated most of this long eurodollar position in a matter of days around the end of the third quarter of 2014.

As was widely reported, the PIMCO co-founder and PTRF manager quit the firm on 26 September 2014. By end-quarter the eurodollar position had fallen to half its end-June level (Graph A, upper left-hand panel). While market-wide open interest in the September 2015 contract declined gradually in the third quarter, open interest in the December 2015 and March 2016 contracts dropped very rapidly around the end of the quarter, consistent with the liquidation of PTRF's "big long" position. Certainly, the mutual fund's position was much reduced to minimal levels by the end of the fourth quarter (Graph A, upper left-hand panel).

While the overall decline in AMs' net positions in the two weeks around the end of the quarter (Graph 2) exceeded PTRF's maximum quarter-end position, the fund might have had a larger intra-quarter maximum holding and accounted for the entire change in net positions. (Or smaller PIMCO funds may have held positions like that of PTRF and liquidated them at the same time.) In any case, the net liquidation of AM holdings was very concentrated.

A possible motivation for the new PTRF managers to liquidate can be seen in the reported gains and losses on the eurodollar futures position over time. The position showed an unrealised loss of $219 million at end-December 2013, about 10 basis points in a $200 billion plus fund (Graph 1, upper right-hand panel). By March 2014, the loss had

more than doubled to $450 million. By the end of June, the month in which the manager had bragged of the fund's recent performance to a Morningstar conference (Gross (2014)), the position was showing a gain of $240 million. But by 30 September, the halved position was showing a loss of $157 million.

Whatever the motivation, if the inference that a very large and concentrated position was liquidated in a fortnight is correct, it epitomises AMs' demand for immediacy in the fixed income market (Fender and Lewrick (2015)). The irony is that a more measured pace of liquidation would have allowed the fund to profit from the bond market "flash rally" of 15 October 2014. In any case, it appears that a huge long eurodollar position could be and was liquidated in a fortnight.

By contrast, PTRF's liquidation of its "short volatility" position may have contributed to the "flash rally". According to the inter-agency *Staff report* (US Treasury et al (2015)), "Some market participants have speculated that a change in the distribution of certain options-specific risk factors among certain firms could have been a contributing factor. In particular, anecdotal commentary suggested that some dealers had absorbed a portion of the sizable 'short volatility' position believed to have been previously maintained by large asset managers. As volatility spiked on October 15, these positions would have prompted some dealers to dynamically hedge this exposure, exacerbating the downward move in yields".⑦

In sum, the story of the "big long" in eurodollar futures is one of an AM apparently expressing a view on monetary policy by taking a position that was very substantial even by the standards of one of the largest and most liquid fixed income instruments in the world. The AM appears to have liquidated the position in a matter of days, demanding immediacy from other market participants. In the text, we demonstrate that collectively AMs had run even larger long positions before 2014 and, moreover, in 2015 showed that they can take on a very substantial short position as well.

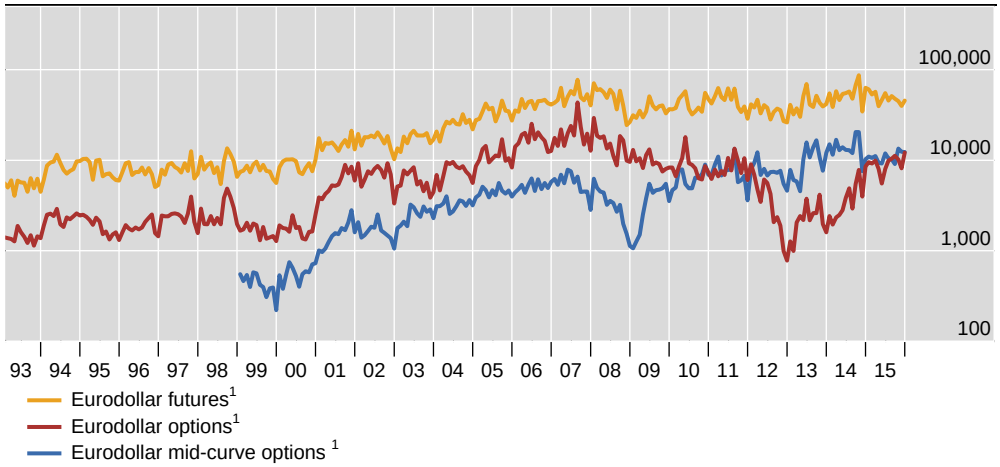
① See http://stats.bis.org/statx/srs/table/d7?p=20141&c=, second column (USD), row 16 (other financial institutions). ② "First, a significant percentage of funds do not clearly report the notional amounts for various derivatives or provide precise description of notional amounts. For options and futures, for example, we manually looked up the contract size… Second, there is no standardized reporting of derivatives. For example, some funds reported numbers without units. In some cases the number of contracts for some options was reported in the same column as the notional amount for other options…Third, when notional amounts were reported, there were instances where they were not consistent with other parameters of derivatives" (Deli et al (2015, p 10)). SEC (2015) discusses its "Investment Company Reporting Modernization Proposal" of 20 May 2015, which would address these drawbacks. ③ Deli et al (2015) graphed the mix of derivatives of the 60 "traditional" mutual funds with the greatest exposure to derivatives, which probably did not include the largest fund in the absence of a stratified sample. However, they suppressed their identities. ④ This is composed of eurodollar futures, $299 billion (132% of NAV), Treasury futures, $63 billion (28%), swaptions, $111 billion (49%), inflation options, $8 billion (3%), currency forwards and options, $104 billion (46%), credit default swaps, $58 billion (26%), net liabilities, $13 billion (6%). If eurodollar futures were not divided by four, then the ratio would be 688%. The SEC (2015, p 88) invited comment on whether its ruling should allow the notional value of eurodollars to be divided by four. ⑤ Also we neglected money market basis swaps in the dollar, Brazilian real and Mexican peso, so our estimate should be viewed as a minimum. ⑥ The limit could go as high as 300% if the fund could demonstrate that its portfolio including the derivatives makes for a lower value-at-risk for the fund than its portfolio without the derivatives. The rationale is that the lower value at risk would indicate that, in aggregate, the derivatives were being used to reduce market risk. ⑦ To the extent that such hedging took place in eurodollar futures, it would have contributed to the all-time high turnover recorded for 15 October (see below). See Gabaix et al (2006) and Coval and Stafford (2007) for equity volatility owing to large transactions by AMs.

2. The eurodollar futures market amid forward guidance

This section starts by describing the eurodolllar futures market, highlighting changes in it. Then we show how Federal Reserve guidance that short-term rates would remain low shifted trading from short-term maturities to medium-term maturities. Available data limits our ability to demonstrate that this shift characterised the activity of AMs. However, the case study above, their substantial share of the market and the strength of the observed shift leave it highly unlikely that they did not participate in it.

Turnover of eurodollar futures and options

Monthly, in billions of notional US dollars, logarithmic scale — Graph 4



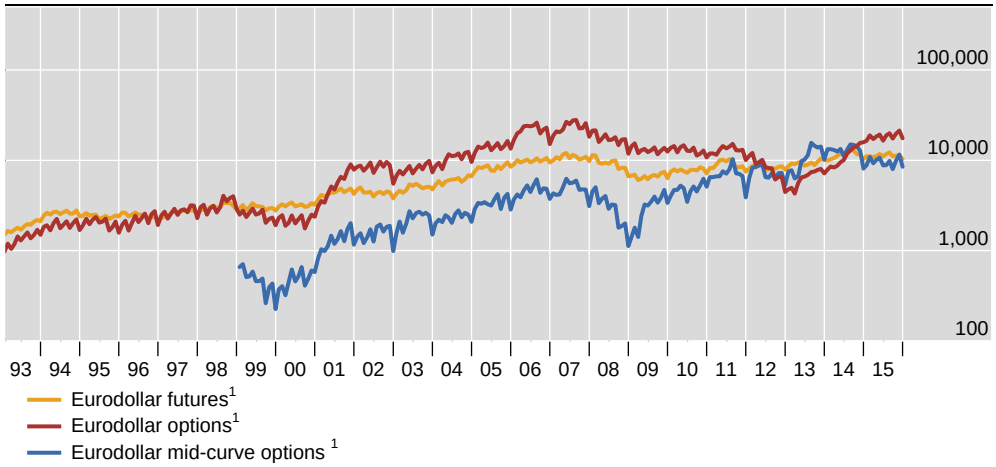
[1] Traded on the Chicago Mercantile Exchange.

Source: FOW trade data.

In the years since 2000, turnover in the eurodollar futures market has increased. Monthly turnover is plotted on a logarithmic scale in Graph 4 and the yellow line shows that it grew strongly in 2000–2007. A notable development is that of eurodollar mid-curve options (blue line on Graph 4), short-dated options on medium-term eurodollar maturity dates. Their turnover surpassed that of normal eurodollar options on near-term contracts (red line in Graph 4) in 2012. This observation anticipates our finding below that the eurodollar derivatives market was then reflecting market participants' focus on monetary policy in the medium term rather than the immediate future. The convergence of turnover in the two option maturities in 2015 likewise anticipates our finding below of some movement in the direction of a more normal market.

Open interest in eurodollar futures and options

End of month, in billions of US dollars, logarithmic scale — Graph 5



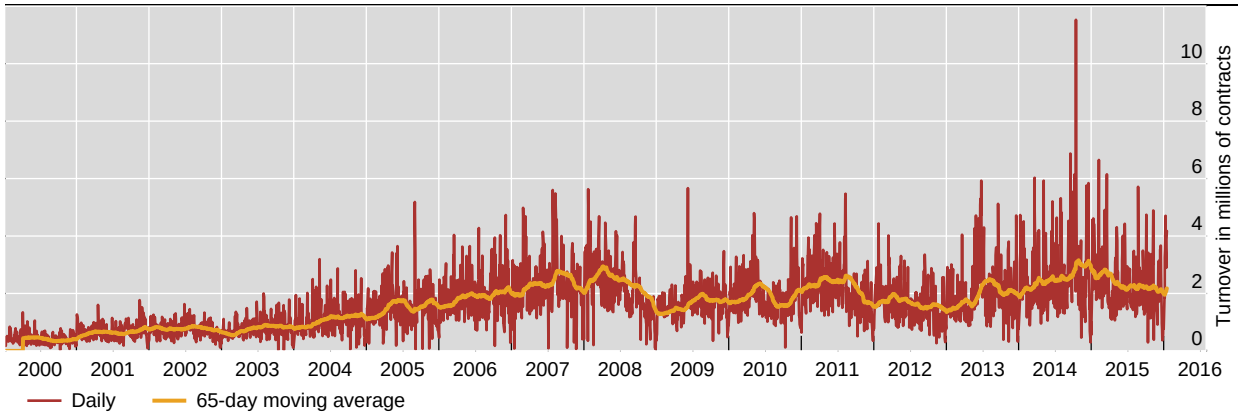
[1] Traded on the Chicago Mercantile Exchange.

Source: FOW trade data.

Another dimension of activity in eurodollar futures and options is open interest (Graph 5). As noted above, the number of contracts in existence at any time indicates the extent of positioning, both on the long side and the short side. This perspective on the market suggests options on near-term contracts (red line on Graph 6) play a relatively larger role in relation to futures. Parallel to the turnover data in Graph 5, open interest in mid-curve options (blue line in Graph 5) surpassed the open interest in options on near-term maturities in 2012. However, the Federal Reserve's signaling and implementing a higher policy short-term rate in 2015 have returned open interest in the near-term options to the top position.

Daily eurodollar futures turnover

Number of contracts of notional value $1 million, all quarterly maturities — Graph 6



Source: Chicago Mercantile Exchange; Bloomberg; authors' calculations.

A more granular view of turnover on a daily basis since 2000 suggests that eurodollar futures turnover is unevenly pro-cyclical (Graph 6). It rose into 2007, then fell in 2008, recovered in 2009–11, only to fall back again in 2012. It set a record on 15 October 2014, the day of the flash rally in the US Treasury bond market. In addition to cyclic influence, structural change in the derivatives markets encouraged by post-crisis regulatory change is also at work. However, it is unclear whether and to what extent the regulatory push to get derivatives like interest rate swaps traded and cleared centrally is contributing to stronger turnover in eurodollar futures.[7]

The eurodollar futures market has changed not only in terms of participants (Section 2), but also maturity and automation of trading. Regarding maturity, this section introduces a new summary measure of the maturity profile of eurodollar futures trading. This new measure (in Section 2.1) shows that under the influence of forward guidance, the average maturity of traded eurodollar contracts increased to an unprecedented five quarters in 2009 and continued to increase unevenly until it reached eight quarters in 2013. A major finding is that this maturity measure reached its peak in late 2013, well after the taper tantrum that started in May and lasted into the autumn.

[7] Labuszewski (2013) discusses the use of eurodollar futures to proxy or to hedge interest rate swap exposures.

Manual versus automated trading by product on Chicago Mercantile Exchange

In per cent, for 12 November 2012 to 31 October 2014 Table 2

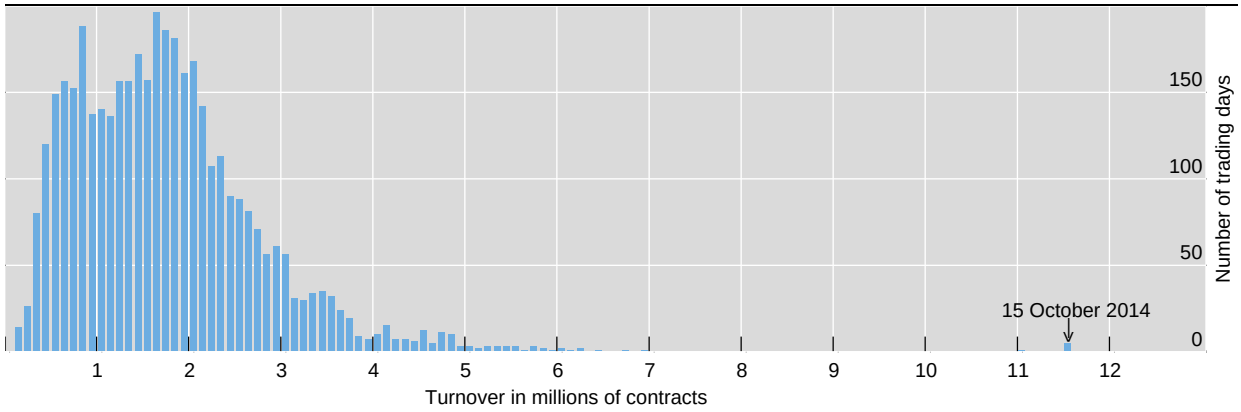
Product (asset class)	Non-electronic	Automated	Manual	*Memo: % total CME volume*
Foreign exchange	3.4	79.9	16.8	*7.2*
Equities	0.9	66.6	32.5	*21.5*
Interest rate	4.2	62.3	16.8	*47.6*
US Treasury bond	5.9	64.0	30.2	*25.9*
Eurodollars	2.2	60.3	37.5	*21.6*

Source: Haynes and Roberts (2015, Tables 2 and 3).

Regarding automation, the image of banks calling brokers to trade eurodollar futures also needs updating. Since October 2012, the Chicago Mercantile Exchange has required that every order through its trading platform Globex be identified as entered manually or automatically. Orders are identified as automated if they are "generated and/or routed without human intervention".[8] Three fifths of eurodollar orders are entered automatically, which is lower than the proportion for US Treasury bond, equity or foreign exchange futures (Table 2). The lagging automation in eurodollars has been ascribed to the high proportion of manually entered spread trades (eg long March 2016 eurodollar future against a short December 2015).[9]

Histogram of eurodollar futures turnover

January 2000–January 2016 Graph 7



Sources: Chicago Mercantile Exchange; Bloomberg; authors' calculations.

[8] "This set of orders is not restricted to those that are directly generated by algorithms, or those associated with HFT firms. Instead, it includes a much broader category, such as those which are generated manually but make use of automated spreading functionality, or even those where manual traders use the order submission management of third-party trading systems" (Haynes and Roberts (2015, p 3)).

[9] The "Eurodollar contract is unique relative to peers. Though it is the most active futures product, it has a low automated participation rate relative to other active products….this is largely because Eurodollars have a similarly exceptional level of spread trading, where manual traders are more active" (Haynes and Roberts (2015, p 6)). It is not clear why the automated percentages in Table 2 for US Treasury bond and eurodollars are lower than the 90% reported by Markets Committee (2016, p 9).

Automated trading was probably a necessary condition for the high turnover of eurodollar contracts on 15 October 2014 (Graph 7). That day saw record turnover at 5-6 times the mode for the 16 years 2000–2016. The US Treasury et al (2015) find that turnover in US Treasury cash and futures market also hit records on that day.

2.1 Introducing turnover duration

At any time, the eurodollar futures market trades contracts out to ten years, with 40 quarterly contracts maturing in March, June, September and December. At writing in April 2016, the March 2016 contract has expired and has been settled in cash and a new March 2026 contract has come into existence. However, turnover volume is not evenly distributed over the 40 quarters, and a measure of the *average* maturity of contracts being traded can provide useful information about the focus and positioning of investors in the key time dimension. To this end we construct a weighted average of the 40 quarterly maturities where the weights in the average are the fractions of total daily turnover occurring at each contract maturity. Borrowing from the fixed income lexicon, we call this measure *turnover duration*.

A few simple examples may help to illustrate the use of this measure. If on a particular day all the trading occurs in the eurodollar contract maturing four quarters out, we would calculate the turnover duration as four quarters and note the evident focus of traders on the level of the eurodollar rate at that one-year horizon. If trading in the next daily session splits evenly between the two contracts maturing two quarters and six quarters into the future, respectively, we would again calculate a turnover duration equal to four, concluding that investors, *on average*, remain preoccupied with interest-rate developments at the one-year horizon. However, if in the next session trading is concentrated solely in the eurodollar contract six quarters out, our turnover duration for that day would be six quarters and we would conclude that traders on that day had shifted their focus to the level of short-term interest rates 18 months into the future.

2.2 The baseline for turnover duration

From January 2000 to end-2007, daily turnover was heavily skewed to shorter-maturity contracts. The first five contracts were the most heavily traded, with the greatest amount of activity, on average, occurring in the contract three quarters out.

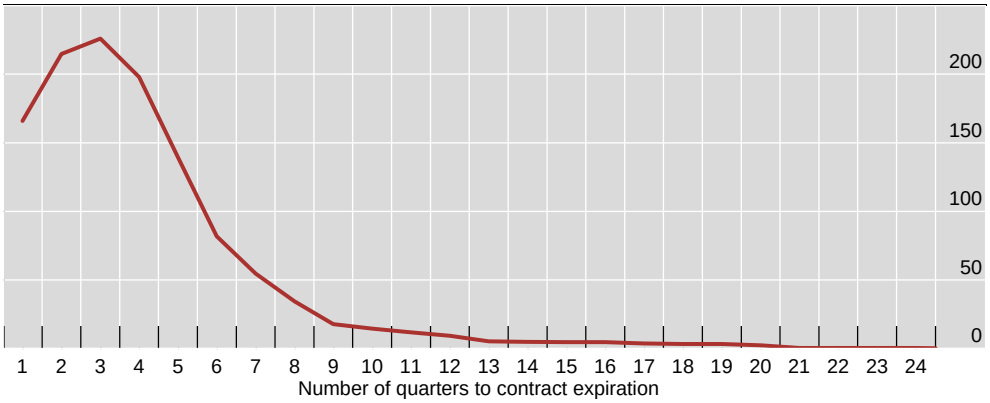
Beyond that point, average turnover tended to fall off quickly and monotonically, dipping below 10,000 contracts/day at the three-year horizon and below 1,000 contracts/day five years out (Graph 8).

During 2000–2007 turnover declined with term rapidly enough so that the weighted average of contract maturities – turnover duration – averaged just over four quarters. In particular, the average maturity of contracts traded was 4.23 quarters. Graph 9 below plots the daily turnover duration of eurodollar contracts from the period January 2000 through January 2016; the dotted line shows the average for 2000-2007.

The baseline of turnover duration at about four quarters sits well with several findings regarding rates. Monetary surprises have a strong and positive effect on yields of one-year maturity, but not for yields at the five-year maturity (Gurkaynak et al (2005)). Thus, in normal times, eurodollar futures as a hedge against monetary

Eurodollar futures turnover term structure, 2000–07 daily average

In thousands of contracts Graph 8

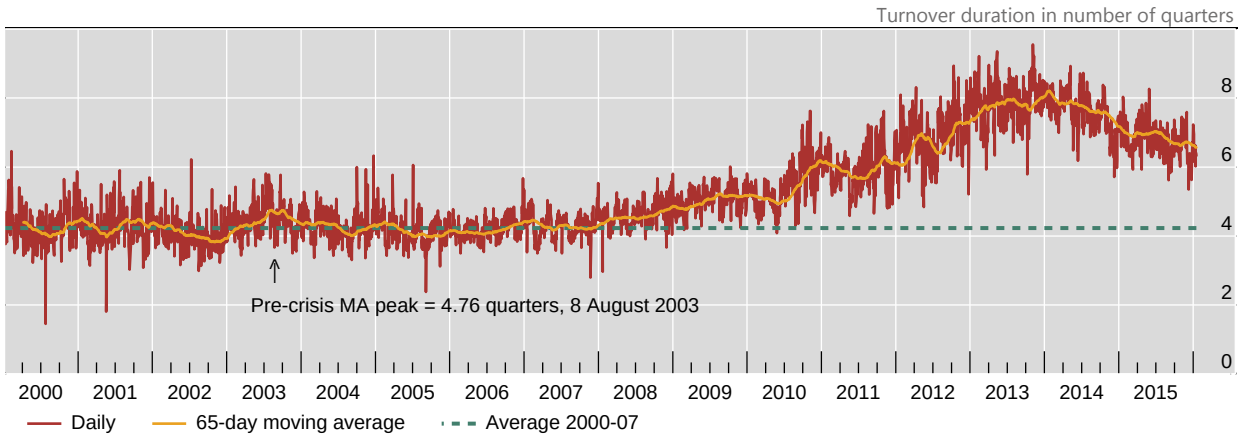


Source: Chicago Mercantile Exchange; Bloomberg; authors' calculations.

surprises need to do much of their work within four quarters. In a related finding, Gurkaynak et al (2002) found that eurodollars are the best predictors for changes in the targeted federal funds rates at horizons longer than 5 or 6 months – unlike at shorter horizons up to 4 months where the federal funds rate has a better track record. Finally, Ballochi et al (1999) report that basis-point volatility of eurodollar futures prices peaks at the third contract forward, with the contract four quarters out a runner-up.

Daily eurodollar futures turnover duration

Average maturity in quarters of contracts traded, weighted by turnover Graph 9



Source: Chicago Mercantile Exchange; Bloomberg; authors' calculations.

It is worth noting how the time profile of turnover in eurodollar futures responded to the Federal Reserve's forward guidance in 2003. Turnover duration rose steadily during the first half of 2003 and daily peaks hit 5½ quarters by mid-year, a year before June 2004 when the Federal Reserve lifted its target policy rate from 1% (in what proved to be 17 successive quarter-point moves). The 65-day moving average hit a corresponding pre-crisis peak on 8 August 2003, at a level one-half a

quarter (ie six weeks) longer than the 2000-2007 baseline. This was just before the August FOMC meeting invoked the phrase "considerable period" to describe how long it would maintain accommodation at 1%.[10] This phrase gave way to "patient" in January and March 2004, which in turn yielded to "accommodation can be removed at a pace that is likely to be measured" in May 2004. In sum, within our base period of 2000–2007, the Federal Reserve's forward guidance lengthened turnover duration significantly in 2003.

2.3 Forward guidance and turnover duration

In recent years, forward guidance has had an unprecedented effect on eurodollar turnover duration. During the period when the Federal Reserve targeted a federal funds rate of 0–25 basis points and policy depended on a varying combination of signalling low rates for a long time and large-scale bond purchases, the average maturity of eurodollar futures trading extended into contracts as much as twice the maturity of the 2000–2007 baseline.

In the event, the maximum extension of the term structure of eurodollar turnover occurred in early 2014. As market participants began to anticipate the withdrawal of exceptional accommodation by the Federal Reserve, eurodollar turnover duration dropped almost two full quarters. Recent observations have stalled near the six-quarter mark as market participants have revised their view of the Federal Reserve's tightening, and the FOMC has revised its view of the same trajectory.

The US money market appears to be well along in the process of becoming more normal, but it has a way to go. In particular, turnover duration is quite elevated by historic standards. In the 2003–04 episode of forward guidance, eurodollar turnover duration reached a peak in the summer of 2003, about a year before the Federal Reserve's first step to tighten in June 2004. In this episode, eurodollar turnover duration peaked in early 2014, nearly two years before the December 2015 rate hike. However, with the durability and pace of the tightening cycle a matter of debate, the process of normalisation has proven much slower.

3. Eurodollar turnover, Federal Reserve policy and news

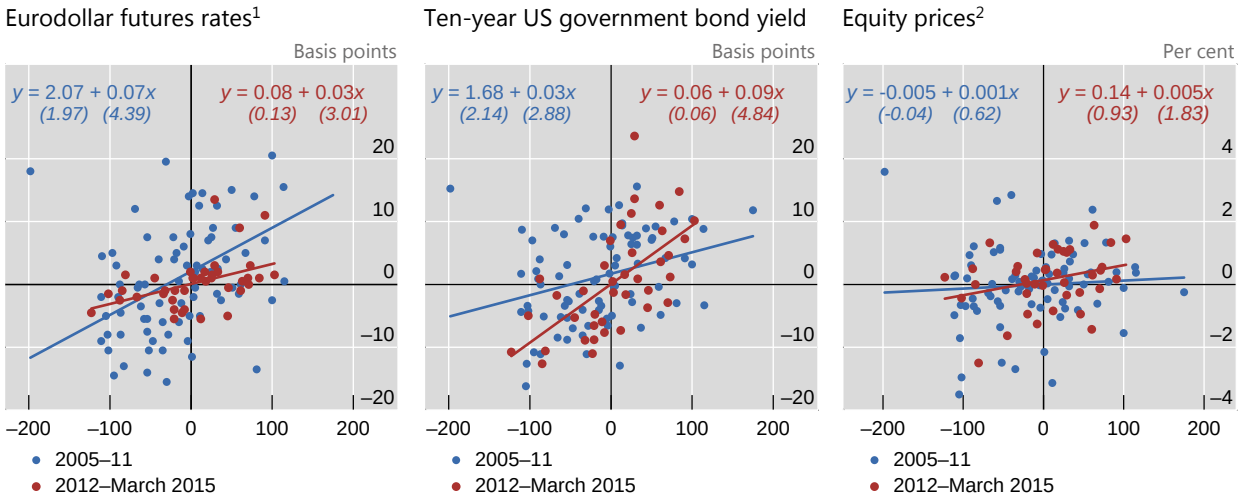
Our starting point is an update of a remarkable graph of Filardo and Hofmann (2014, Graph 4; here Graph 10). Their original finding was that forward guidance had suppressed the response of one year eurodollars to surprises on the monthly non-farm payroll. We have updated their graph and there has been some counterclockwise rotation of the red line in the left-hand panel, indicating more of a response of one-year rates to employment surprises in 2014–15. But it remains well below the blue line that summarises the 2005–11 data.

We continue by re-examining the Filardo-Hofmann dates using the lens of turnover duration. For each of their seven dates we compute the average term

[10] "…the change in federal funds rate futures contracts suggested that market observers interpreted the language to be a commitment by the FOMC that it would not increase its target level of the federal funds rate for at least six months, perhaps longer. The FOMC repeated this language in the press releases following its subsequent three meetings" (Anderson and Thornton (2004)).

Market response to US non-farm payroll employment surprises

Graph 10



The x-axis shows the surprise in the change in non-farm payrolls, calculated as the difference between the actual value and the survey value, in thousands. The y-axis shows the one-day change, calculated as the end-of-day value at the release date minus the end-of-day value on the previous day. The t-statistic is shown in brackets.

[1] Eurodollar futures contract expiring in one year. [2] S&P 500.

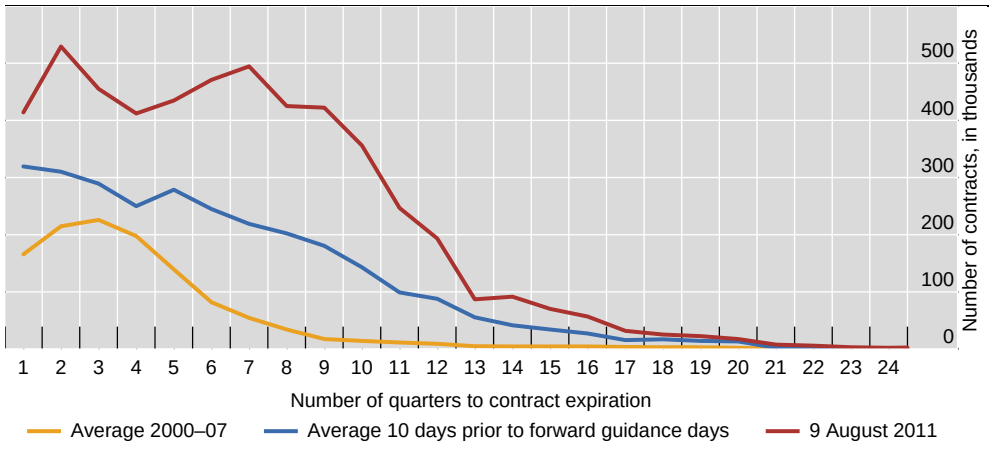
Sources: Bloomberg; BIS calculations.

structure of eurodollar turnover in the previous 10 working days as a base of comparison. For instance, following the Fed's monetary policy statement released on 9 August 2011 in which it stated that the Fed funds rate would remain exceptionally low for two years, trading in eurodollar contracts of all maturities surged to more than five million contracts with trading especially active in the December 2011, December 2012, and March 2013 contracts (Graph 11). In contrast, total trading during the previous 10 trading sessions averaged less than three million contracts per day, while trading during the 2000–07 period averaged only 1.2 million contracts per day.

Response of eurodollar futures turnover to Federal Reserve forward guidance

9 August 2011

Graph 11

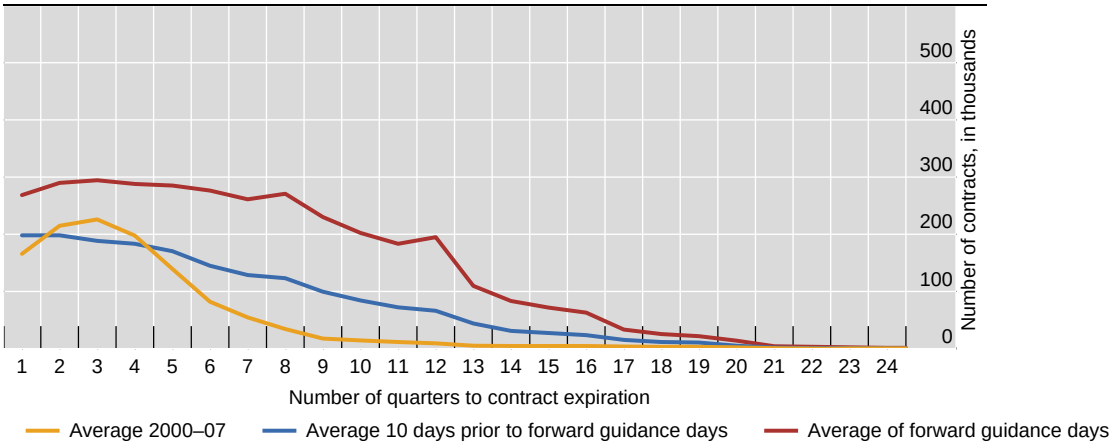


Sources: Filardo and Hofmann (2014); Chicago Mercantile Exchange; Bloomberg; authors' calculations.

Below we aggregate the event days and the baselines across the seven key forward guidance events (Graph 12). We find a very substantial response of eurodollar turnover to the forward guidance. In particular, turnover is 90% higher than the two-week baseline. The money market did not disappear during event days; rather, it traded particularly strongly out at longer maturities.

Response of eurodollar futures turnover to Federal Reserve forward guidance

2008–13[1] Graph 12

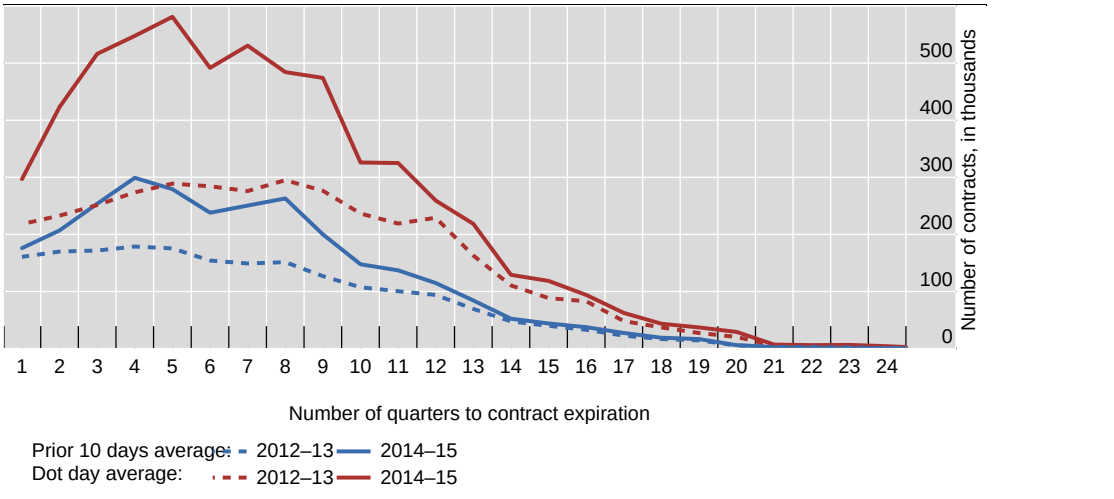


[1] 16 December 2008, 18 March 2009, 9 August 2011, 25 January, 13 September, 12 December 2012, and 18 December 2013.

Sources: Filardo and Hofmann (2014); Chicago Mercantile Exchange; Bloomberg; authors' calculations.

Impact of Federal Reserve dot plots on eurodollar turnover

2012–13[1] versus 2014–15[2] Graph 13



[1] Dot days are 25 January, 25 April, 20 June, 13 September and 12 December, 2012 and 20 March, 19 June, 18 September and 18 December 2013. [2] Dot days are 19 March, 18 June, 17 September and 17 December 2014 and 18 March 2015.

Sources: Chicago Mercantile Exchange; Bloomberg; authors' calculations.

In 2014 and into 2015, the Federal Reserve's forward guidance embodied more and more the form of the "dots" whereby the FOMC members' forecasts for the policy rate over several years are plotted. To be sure, the publication of these dots is generally a joint event, alongside the FOMC statement and the chair's press conference. That said, what is clear is that turnover in eurodollar futures is elevated on those days (Graph 13).

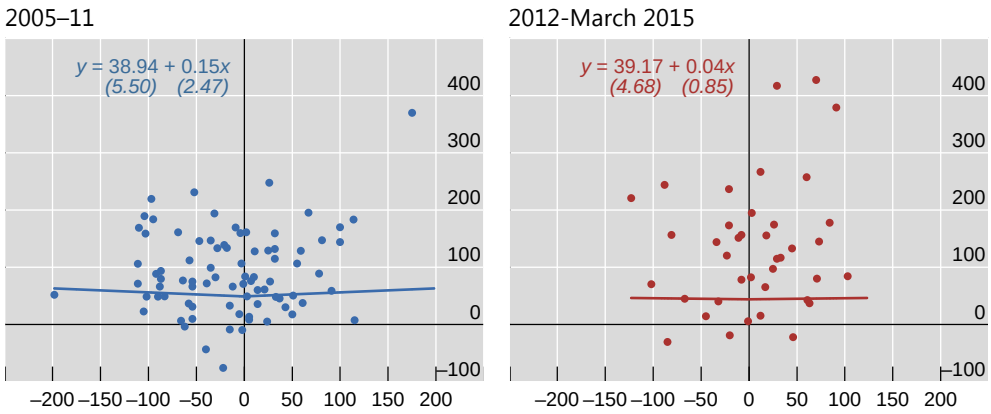
Moreover, if one compares the days on which the dot plot was published in 2012–13 with those days in 2014-15, the response was larger in the latter period. In 2014–15, turnover on days when interest rate projections were released exceeded by 110% the average turnover over the previous two weeks, versus by 84% in 2012–13.

By contrast, eurodollar turnover seems to respond less to news about the economy than formerly. Like Filardo and Hofmann, we find that forward guidance has robbed surprises on the previously major news event of the month, the non-farm payroll release, of its significance. For Filardo and Hofmann, eurodollar rates one year forward were the focus, for us the rise in eurodollar turnover. Whereas in 2005-11, larger surprises on non-farm payrolls led to higher turnover relative to the previous 10 trading days, since 2012 this relationship no longer holds (Graph 14).

Response of eurodollar futures turnover to US non-farm payroll surprises

In thousands of contracts

Graph 14



The x-axis shows the surprise in the change in non-farm payrolls, calculated as the difference between the actual value and the survey value, in thousands. The y-axis shows the difference between the turnover on the release date and the average turnover on the 10 days previous to the release date. The regression line plotted is from a regression of the turnover change on absolute value of the surprise; it is by construction symmetric about the vertical axis. The t-statistic is shown in brackets.

Sources: US Department of Labour; Chicago Mercantile Exchange; Bloomberg; authors' calculations.

Box 2

Eurodollar turnover and the ECB, Swiss National Bank and Bank of Japan

Observers like El Erian (2015) and Fischer (2015) have cited the influence of European monetary policy on US fixed income markets in 2014–15. This has been called reverse causation owing to the long-standing view that the US bond market exerts a strong influence on global bond markets and that the relationship is asymmetric. In this Box, we analyse the relationship between more or less surprising policy moves by the ECB, SNB and the BoJ, on the one hand, and eurodollar turnover, on the other. We find mixed evidence in favour of the reverse causation hypothesis.

Much recent work has supported the view that the US Treasury market moves global bond markets. Neely (2015) finds that the 20–70% of the announcement effects of Federal Reserve bond buying diffused to mature bond markets. Bauer and Neely (2014) find that the effect worked through shared term premium (ie through channels other than correlated expectations of future short-term rates) in the larger German and Japanese markets. Rogers et al (2014) confirm Neely's findings using high-frequency futures data. Obstfeld (2015) reports long-term level (co-integration) regressions that suggest that major government bond markets move in synch with the US Treasury market, with a median half-life of adjustment around one year.

The integration measured by Obstfeld (2015) is easily read as the influence of the largest, deepest and most liquid government market on other bond markets. But this reading does not just draw on size but is informed by persuasive episodes.

The global bond market strains of 1994 stand out (Borio and McCauley (1996), BIS (2015, Chapter V)). The Federal Reserve started a tightening cycle in February 1994, even as the Bundesbank, then the European anchor policymaker, extended a long easing. In the bond market, US Treasury yields rose, and contrary to the direction of actual and expected policy rates in Europe, German bund yields and French OAT yields rose more or less in step. In other words, US and European monetary policy diverged, but US and European bond yields tracked each other higher. If one breaks down US and European bond yields into expected future rates and the term premium, most of the rise in US rates reflected expected future policy rates (Adrian and Fleming (2013)). By contrast, European bond yields rose on wider term premia. Central banks were not playing follow-the-leader, but bond market investors were.

Some of those engaged in constructing the euro anticipated, or at least hoped, that the larger euro-denominated bond market would have more ballast and thus would sail more steadily and prove less subject to being tossed about by waves moving east across the North Atlantic. Until 2013, these hopes proved largely unfulfilled as euro bond yields tended to follow dollar bond yields closely.

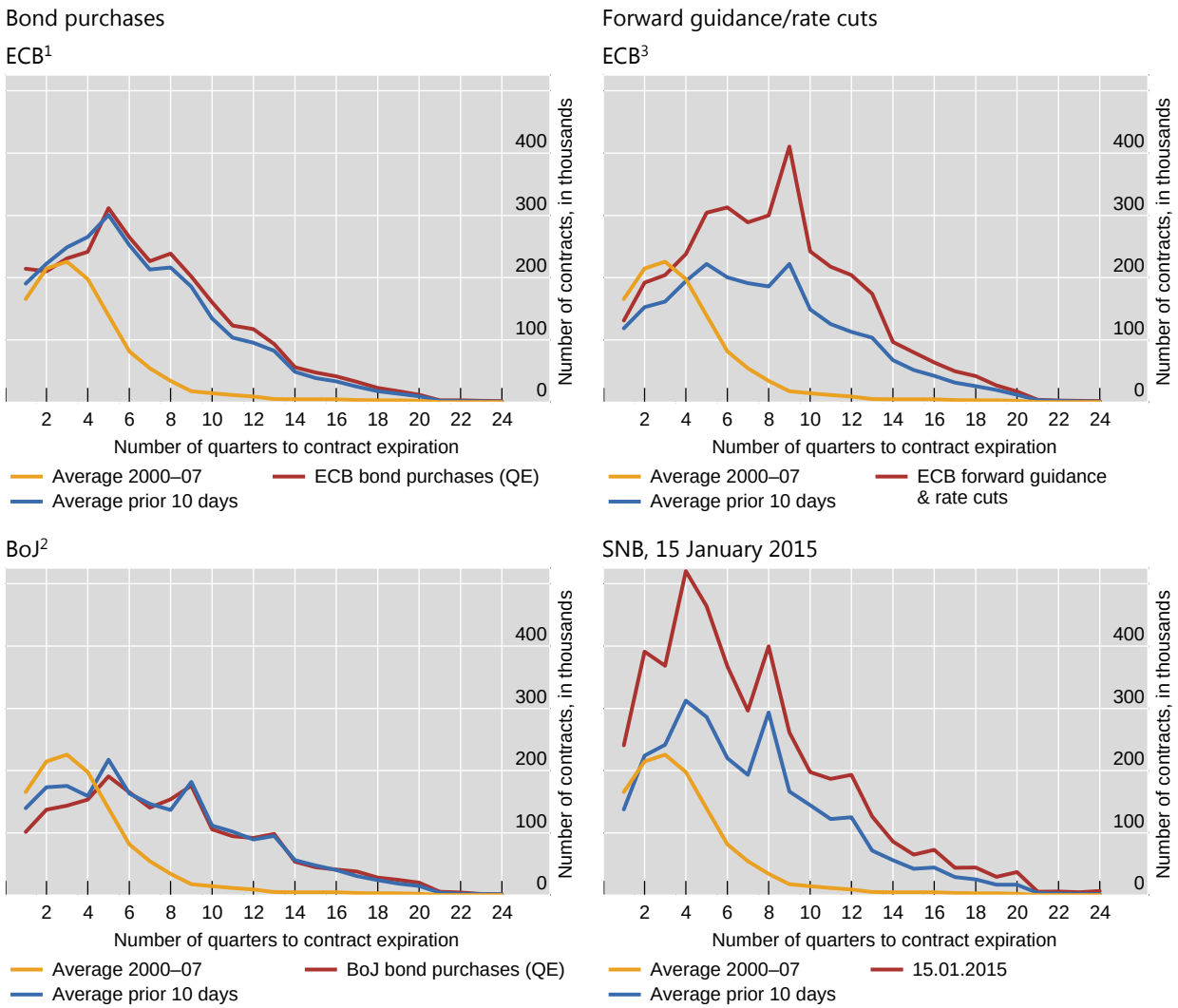
Many observers read the evidence in late 2014 and early 2015 as pointing to the influence of the euro area bond market on the US bond market. While the nominal yield gap between German and US bonds has not been so wide in recent memory, the negative term premia in the euro area bond market seemed to have led their US dollar counterparts down (BIS (2015, Graph V.5)). There is at least a plausible conjecture that 2014 saw "reverse causation" in transatlantic bond markets, ie the euro area bond market leading and the US bond market following. What does the evidence afforded by eurodollar futures turnover have to say on this question of reverse causation?

We have a negative finding and a positive finding to report regarding the ECB, SNB and BoJ events. Announcements regarding bond purchases, whether securities market programmes, "whatever it takes", outright monetary transactions, targeted long-term repo operations, ABS/covered bond purchases, or government bond purchases, did not make big waves in the eurodollar futures market (Graph B, upper-left hand panel). Similarly, the surprising moves of the BoJ on April 2013 ("Quantitative and Qualitative Monetary Easing") or the unexpected acceleration of government bond purchases on 31 October 2014, had limited impact (Graph A, lower left-hand panel). Turnover in US Treasury bond futures may have responded to these events, but turnover in eurodollars did not.

ECB cuts in short-term rates towards and through the so-called zero lower bound, however, did roil eurodollar futures turnover. Graph A, upper right-hand panel shows reverse causation at least in activity terms in eurodollar futures on the days of the rate cuts by the ECB on 7 November 2013 and 4 September 2014. Similarly, the 50 basis points cut by the SNB of its rate paid on marginal sight deposits to –0.75% and of its targeted 3-month Swiss franc Libor to –0.25% to –1.25% stirred trading in eurodollars. (Of course, the SNB move was a joint event with the unpegging of the Swiss franc against the euro, so that an alternative interpretation would focus on cross-asset volatility spillover from the foreign exchange market.)

Term structure of eurodollar futures turnover: ECB, BoJ and SNB events

In thousands of contracts — Graph B



[1] Aggregates observations for 10 May 2010 (SMP), 26 July 2012 ("whatever it takes"), 6 September 2012 (OMT details), 5 June 2014 (targeted long-term repo operations), 2 October 2014 (ABS/covered bond purchases), 22 January 2015 (government bond purchases). [2] Aggregates observations for 4 April 2013 and 31 October 2014. [3] Aggregates observations for 5 July 2013 (4 July 2013 "extended period"), 7 November 2013 (MRO cut to 25 basis points), 4 November 2014 (MRO to 5 basis points, deposit rate to -20 basis points).

Sources: ECB; BoJ; SNB; Chicago Mercantile Exchange; Bloomberg; authors' calculations.

On this evidence, one can at least advance the hypothesis that European central bank moves to and through the zero interest rates have spilled over into US money markets. With the Federal Reserve paying 25 basis points on excess reserves, banks with operations in the US may set in train broad adjustments in response to the reality or even the prospect of paying 25 basis points (ECB) or 75 basis points (SNB). (The forward rate on the euro/dollar has once again swung into a skewed reading with the implied dollar yield in excess of dollar Libor, indicating the pressure for dollar borrowing by efforts to hold dollars hedged back into euros.)

4. Conclusions

The dramatic liquidation of a long eurodollar futures position by AMs in the autumn of 2014 motivated our examination of the role played by large, institutional AMs in this key derivatives market, a market that allows positions to be taken on the future path of dollar interest rates. We find that AMs generally hold the largest eurodollar positions among buy-side participants but play a much less important role in day-to-day trading. AMs' dominance in positioning establishes them as gatekeepers for the Fed's forward guidance. In 2013-14, AMs stood athwart that guidance with a large long position that was premised on sustained lower rates. Beginning in 2015, however, we discover that AMs for the first time took on a large net short position in eurodollar futures that pulled the market in the direction of the Federal Reserve's own projections about short–term rates. AMs play an important role in facilitating—or hindering—the transmission of monetary policy to market rates.

We analyse turnover in the eurodollar futures market to see how unconventional monetary policy has affected trading in the US dollar money market. We define *turnover duration* and find that forward guidance doubled the average maturity of eurodollar contracts traded through 2014. Since then turnover duration has fallen, indicating that the market has been normalising in anticipation of the Fed's tightening arc that got underway in December 2015.

Looking back we find large responses of eurodollar futures turnover to forward guidance news through 2013. We also find an increasing response in 2014-15 to the FOMC dots that show the policy rates anticipated by Committee members. Similar to the finding of Filardo and Hofmann (2014) for one-year forward eurodollar rates, we find that forward guidance led to money market turnover not responding to news as it had done previously. In particular, we find that eurodollar turnover did not rise with the scale of US payroll surprises in 2012–15. The response to forward guidance was accompanied by less responsiveness to the macroeconomy.

The Federal Reserve Bank of New York is now regularly surveying AMs in order to better understand what scenarios lie behind observed money market prices (Potter (2016)). In 2014, the Bank's Open Market Desk initiated a Survey of Market Participants (SMP), which extends the long-standing Survey of Primary Dealers (Correia-Golay et al (2013)) to AMs, including mutual and pension funds, as well as to hedge fund managers and corporate treasurers. The finding that AMs' views on the course of monetary policy differ from those of the Federal Reserve's immediate counterparties, the primary dealers, is fully consistent with our findings on AMs' activity and positioning in eurodollar futures.

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