Tracking Spillovers During the Taper Tantrum

May 2020

Evidence from Institutional Investor Transactions in Emerging Markets

Abstract

In this report, we study the mid-2013 taper tantrum—a market event comprised of a series of policy communications from the Federal Reserve that contributed to sharp volatility across global asset prices—as a case study to shed light on a widely-referenced monetary policy shock. Our research documents and analyzes the trading activity of institutional investors to provide policymakers and researchers with a picture of the interplay between market price movements and investor behavior. The work is motivated by the growing importance of unconventional monetary policy and the role of the market participants in transmitting such signals across markets. We use proprietary data that includes global financial markets transactions (FX and government bond trades) executed by all types of institutional investors, made available by the Markets Division of J.P. Morgan's Corporate & Investment Bank.

We find that flows of institutional investors have substantial explanatory power for EM currency performance. In particular, the extent of EM currency depreciation during the taper tantrum is correlated with the trading activity of a relatively small set of hedge funds and banks associated with momentum, as well as asset managers that do not typically exhibit systematic behavior. During the taper tantrum, asset manager net flows became increasingly correlated with changes in EM currencies and the net flows of certain banks and hedge funds, reflecting potential herding behavior that had a significant impact on prices. We also find evidence of a time-varying relationship between net flows and EM currency price action consistent with a larger impact of net flows amid the rise in market volatility over the period. Our findings illustrate how private investor trading activity can be an important, but difficult-to-predict, component in monetary policy transmission mechanism. Central banks should continue to advance their understanding of how policy measures designed to influence market prices also affect the behavior of market participants.

About the Institute

The JPMorgan Chase Institute is harnessing the scale and scope of one of the world's leading firms to explain the global economy as it truly exists. Drawing on JPMorgan Chase's unique proprietary data, expertise, and market access, the Institute develops analyses and insights on the inner workings of the economy, frames critical problems, and convenes stakeholders and leading thinkers.

The mission of the JPMorgan Chase Institute is to help decision makers—policymakers, businesses, and nonprofit leaders—appreciate the scale, granularity, diversity, and interconnectedness of the global economic system and use timely data and thoughtful analysis to make more informed decisions that advance prosperity for all.

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Executive Summary

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We leverage unique granular data on institutional investor transactions to shed light on emerging market volatility during the taper tantrum.

In this JPMorgan Chase Institute report on financial markets, we use the mid-2013 taper tantrum episode to elucidate interactions between market movements and institutional investor behavior around a major monetary policy shock, focusing on spillovers to emerging market (EM) currencies. We study the taper tantrum because it represents a key episode in the post-financial crisis use of large-scale asset purchases (LSAPs). Given the sustained low level of interest rates over the past decade, these measures have become an indispensable part of the modern central banking policy toolkit; however, policymakers' imperfect knowledge of market participant expectations and potential responses to policy adjustment has meant that these programs have been challenging to unwind smoothly.

Using the unique data available to the Institute, we document how investor behavior changed starkly around the onset of the taper tantrum, as flows from market participants that on-net were buying EM currencies began to reverse. In addition, we leverage the granular nature of the data to help answer the following three questions in the taper tantrum context:

1. Which market elements—news, liquidity, and net flows—best explain EM FX market performance?
2. Do particular groups of market participants drive the overall link between flows and market changes? If so, which groups?
3. Did herding activity play a role in price action and net flow changes?

Answers to these questions, grounded in new data (summarized in the graphic below), provide insight into how the taper tantrum period unfolded in EM currency markets and offers more general lessons on the potential role of investor behavior in contributing to large market swings. Accordingly, we organize our research around three findings described in the following pages.

The taper tantrum represents a key episode in the post-financial crisis use of large-scale asset purchases.

Data Asset

TRANSACTION DATA

395 MILLION
TRADES

44,000
INSTITUTIONAL INVESTORS

The data asset covers:

- Various types of institutional investors, including asset managers, banks, broker-dealers, corporates, hedge funds, pension funds, insurance companies, public sector investors, and others.
- All regions globally
- All asset classes: foreign exchange, equities, fixed income, and commodities
- Electronic and voice trades
- The post-financial crisis period (historical coverage varies by asset class)

ANALYTICAL SAMPLES

- Were spot or forward FX or government bond trades
- Occured during the 2012 to 2016 period
- Were not canceled
- Did not have missing trade date/execution time, zero/missing buy or sell amount, missing investor sector, outlier exchange rates,
- Were not primary market trades (for government bonds)

APPROXIMATE PER YEAR COUNTS

FX

EM - 1.2-1.5 MILLION TRADES • **8,000-13,000** INSTITUTIONAL INVESTORS

MAJORS - 7-12 MILLION TRADES • **27,000-43,000** INSTITUTIONAL INVESTORS

Gov't Bonds

EM - 17,000-25,000 TRADES • **700-900** INSTITUTIONAL INVESTORS

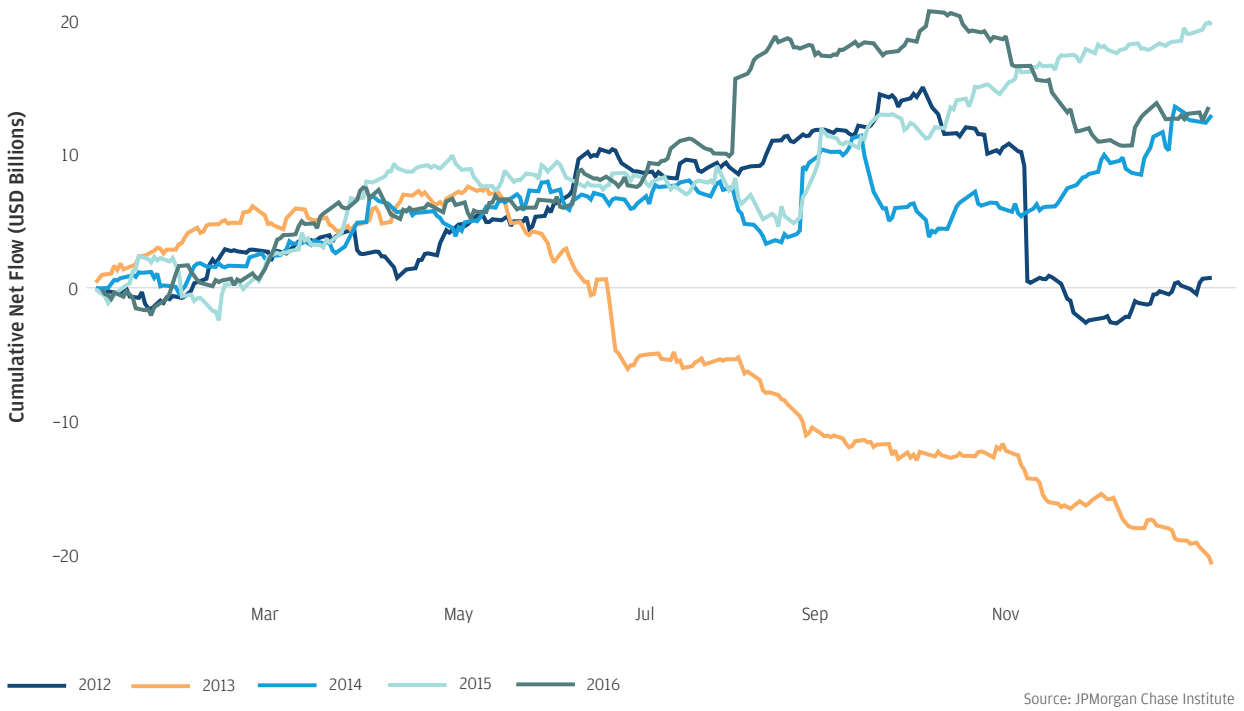
U.S. TREASURIES - 85,000-165,000 TRADES • **1,700-1,900** INSTITUTIONAL INVESTORS

Finding One

Net flows have substantial predictive power for EM FX and government bond market performance. The relationship between EM currency performance and flows is conditional on the degree of market liquidity, and depreciation during the taper tantrum was correlated with selling pressure from subsets of market participants.

Over the post-crisis period we study, our net flow data—disaggregated at the investor sector level—can explain substantial portions of the variation in EM FX and government bond markets. The boost to explanatory power (R-squared) from including net flows in regressions of these EM assets ranges from 25 to over 50 percent, depending on context, relative to the combined forecasting ability of U.S. equities and Treasury yields. Focusing on EM currencies, where our data are finer, we also find time variation in the relationship between net flows and EM currency index changes. In particular, asset manager sales of EM currencies are associated with a considerably larger depreciation than normal when liquidity is low. A sharp reversal in aggregate flows seen in our data in May 2013—coinciding closely with the onset of the taper tantrum—suggests a role for market participant transactions in contributing to the extent of depreciation during the episode.

Cumulative Net Flows in EM Currencies by Year

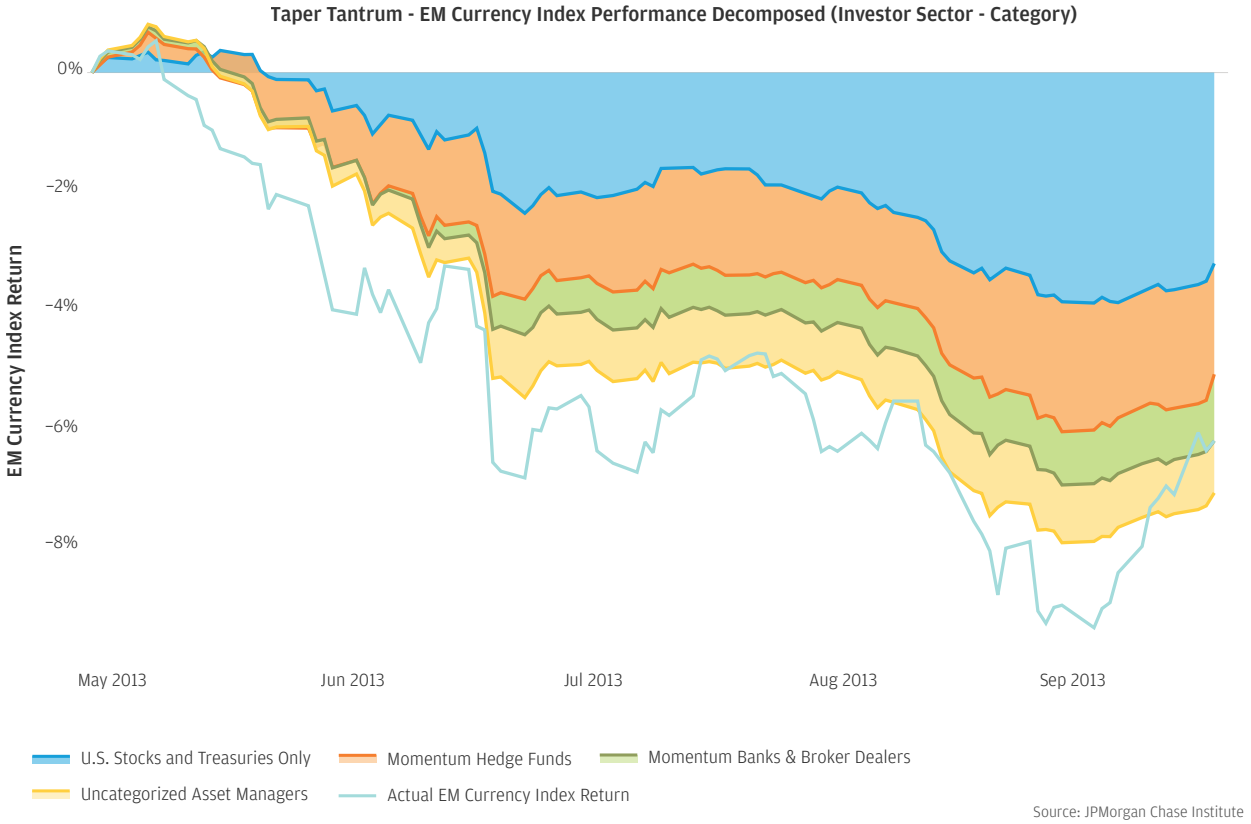


Source: JPMorgan Chase Institute

Finding Two

The explanatory power of flows during the taper tantrum can be accounted for by a relatively small subset of active market participants associated with momentum and a broad set of asset managers that typically do not exhibit strong systematic behavior.

To supplement our sector-level flows, we employ a parsing of market participants according to readily-observable systematic patterns in their transactions to understand the nature of the close connection evident between certain sectors' flows and market movements. In a key result, we identify relatively small pockets of the investor base—namely, hedge funds and banks associated with momentum trading—that appear to drive much of the explanatory power of net flows. Moreover, the transactions of asset managers that typically do not exhibit strong systematic patterns changed their behavior during the taper tantrum and became highly correlated with EM currency depreciation. To see how these three pockets of the investor base may have contributed to price action during the taper tantrum, we use our newly-derived investor archetypes (categorized using out-of-sample data) in a regression of EM currency performance over 2013. As depicted in the figure below, the predicted contributions to price action of flows from these market participants line up well with market dynamics and can account for much of the cumulative taper tantrum depreciation in excess of what would be predicted by U.S. market movements alone.



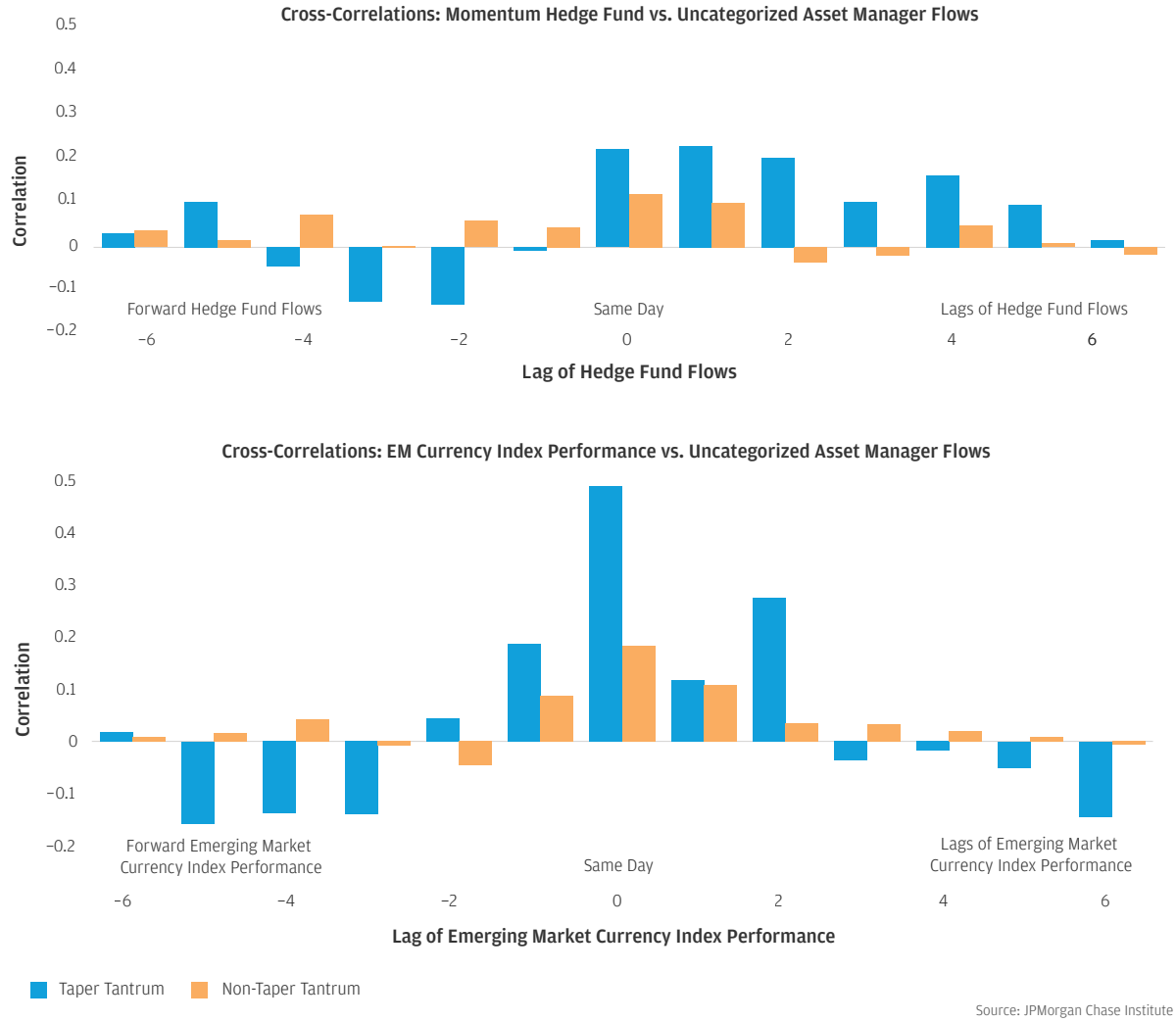
Source: JPMorgan Chase Institute

Finding Three

During the taper tantrum, linkages between certain market participants' flows and price action appeared to increase, reflecting potential herding behavior that had a significant impact on prices.

During the taper tantrum, the transactions of a large subset of asset managers became more highly correlated with other investor categories and contemporaneous price action. Additionally, we find evidence that asset managers tracked the flows of hedge funds associated with momentum with a lag of a few days, suggesting a leader-follower dynamic that does not typically appear. To illustrate more closely the temporal dimension of these relationships, we plot (in the figure below) the correlation between asset managers and both hedge fund flows and price action with various leads and lags. A few observations stand out: first, the transactions of asset managers tracked lagged hedge fund flows but not the other way around; and second, the contemporaneous flow-flow and flow-price correlations were notably higher than usual during the taper tantrum (we test that this is not just a function of the change in volatility during the episode).

Finally, key flash points of EM currency depreciation during the taper tantrum were associated with sharp (negative) outliers in the number of buyers versus sellers of EM currencies in our data, which further points to herding activity that potentially affected market dynamics.



Source: JPMorgan Chase Institute

Introduction

Using the JPMorgan Chase Institute's unique data, we analyze the trading activity of institutional investors during the mid-2013 taper tantrum, a widely-referenced monetary policy shock. This market event comprised a series of policy communications from the Federal Reserve that contributed to sharp volatility across global asset prices and serves as a case study to provide policymakers and researchers with a better understanding of the interplay between market price movements and investor behavior. The work is motivated by the growing importance of large-scale asset purchases (LSAP) and other unconventional monetary policy measures and the role of market participants in transmitting such signals across markets. Indeed, the resumption of large scale asset purchase programs in the U.S. and elsewhere in response to the novel coronavirus (COVID-19) outbreak brings to light the continued relevance of lessons from past LSAPs.

In this report, we first lay out the U.S. and global monetary policy context for the taper tantrum, define the taper tantrum period, and address three key elements relevant for our analysis: price action, liquidity, and investor flows at an aggregated level. Next, we provide a description of the JPMorgan Chase Institute's granular institutional investor trading activity data. We analyze the data to answer three important questions about this key event:

1. Which market elements—news, liquidity, and net flows—best explain EM FX market performance?
2. Do particular groups of market participants drive the overall link between flows and market changes? If so, which groups?
3. Did herding activity play a role in price action and net flow changes?

Finally, we conclude with our view on the policy implications of these findings.

The Pre-Taper Tantrum Context

As 2013 began, monetary policy in most developed markets was highly accommodative. Benchmark rates in developed markets stood at or near their effective lower bounds: the Federal Reserve's target rate range stood at 0 to 0.25%, the European Central Bank's (ECB) deposit rate was set at 0%, the Bank of England's (BoE) bank rate was 0.5%, and the Bank of Japan's (BoJ) uncollateralized overnight call rate was set at 0%.

> The work is motivated by the role of market participants in transmitting unconventional monetary policy measures across markets.

In addition to low policy rates, central banks in developed markets had also engaged in LSAPs to boost growth and meet their objectives. As a result, the U.S. Federal Reserve entered January 2013 with over $2.9 trillion on its balance sheet (up over three times from its pre-crisis level) and had initiated its third phase of quantitative easing (QE-3) on September 13, 2012.[1] Unlike the previous two programs of QE, in announcing QE-3, the Fed committed to maintaining an $85 billion-a-month pace of purchases composed of $40 billion in Agency Mortgage Backed Securities (MBS) and $45 billion in U.S. Treasuries with no fixed end date. Because purchases remained opened-ended, QE-3 was colloquially dubbed "QE Infinity."

Other central banks had introduced similar asset purchase programs. For example, the ECB was conducting Outright Monetary Transactions (OMTs) in secondary sovereign bond markets of member states.[2] The ECB set no ex-ante quantitative limits on the size of its transactions, though member states had to meet certain criteria in order to participate.

As well, the BoE's asset purchase facility had begun its asset purchase program of UK government gilts in 2009. Beyond gilts, the BoE also purchased corporate bonds and commercial paper over two episodes of QE. In July 2012, the BoE expanded its second round of QE to 375 billion GBP.[3] And, in April of 2013 the Bank of Japan (BoJ) introduced Quantitative and Qualitative Monetary Easing, in which the bank committed to an open-ended asset purchase program.[4] To increase the BoJ's purchases of Japanese Government Bonds (JGBs), ETFs, and REITs, in the same month, the central bank indicated the monetary base would approximately double by the end of 2014.

Before the onset of the taper tantrum, the 10-year U.S. Treasury Note yield was only modestly above its prior all-time lows at 1.70, the Emerging Markets Currency Index (EMCI) had appreciated by 14 percent from its crisis lows in 2009, and EM sovereign debt yields were near their lowest levels in over a decade. Meanwhile, implied volatility in key markets sensitive to U.S. monetary policy was at or near post-crisis lows in April 2013, suggesting compressed risk premia and little anxiety by market participants about a near-term monetary policy shock.

The Taper Tantrum Period

Against this global monetary policy backdrop, we mark the taper tantrum period as beginning May 1, 2013 and ending September 18, 2013.

At the May 1, 2013 meeting of the Federal Open Market Committee (FOMC), the Federal Reserve first introduced the statement "the Committee is prepared to increase or reduce the pace of its purchases to maintain appropriate policy accommodation as the outlook for the labor market or inflation changes," which was a departure from prior statements and marks the beginning of the taper tantrum period.[5] While not universally interpreted as signaling a less accommodative stance, this was the first time the Federal Reserve suggested that they might be prepared to reduce the pace of their asset purchases, conditional on improvements in U.S. employment or increases in U.S. inflation.

Subsequent movements in financial markets were notable—by May 21, 2013, the 10-yr yield had increased by 28 basis points, taking it to the top end of its trading range over the prior twelve months. Over the next several weeks, the Federal Reserve reiterated the possibility of changing the pace of their asset purchases, and U.S. Treasury yields continued to rise as market expectations about the timing of reducing the pace of asset purchases began to focus on the September 18, 2013 FOMC meeting.[6]

For example, during his testimony to the congressional Joint Economic Committee on May 22, 2013, the Federal Reserve Chairman at the time, Ben Bernanke, responded to a question about the timing of adjusting asset purchases by saying "if we see continued improvement and we have confidence that that's going to be sustained then we could in the next few meetings … take a step down in our pace of purchases."[7] From May 22, 2013 to June 18, 2013, the 10-yr yield increased another 20 basis points.

At the press conference following the June 19, 2013 FOMC meeting, Chairman Bernanke in his opening statement said: "If the incoming data are broadly consistent with this forecast, the Committee currently anticipates that it would be appropriate to moderate the monthly pace of purchases later this year." The interpretation of the June FOMC communications overall was broadly viewed as less accommodative than expected. By the end of the trading day, the 10-yr yield had increased 13 basis points, U.S. equities had declined, and EM currencies had depreciated sharply. The price action continued the next day, with the combined rise in the 10-yr yield reaching 24 basis points; the two-day decline in U.S. equities was almost 4 percent, and the EMCI EM foreign exchange (FX) index fell by over 2 percent. Each of these moves represent multiple standard deviation events, measured using post-crisis data.

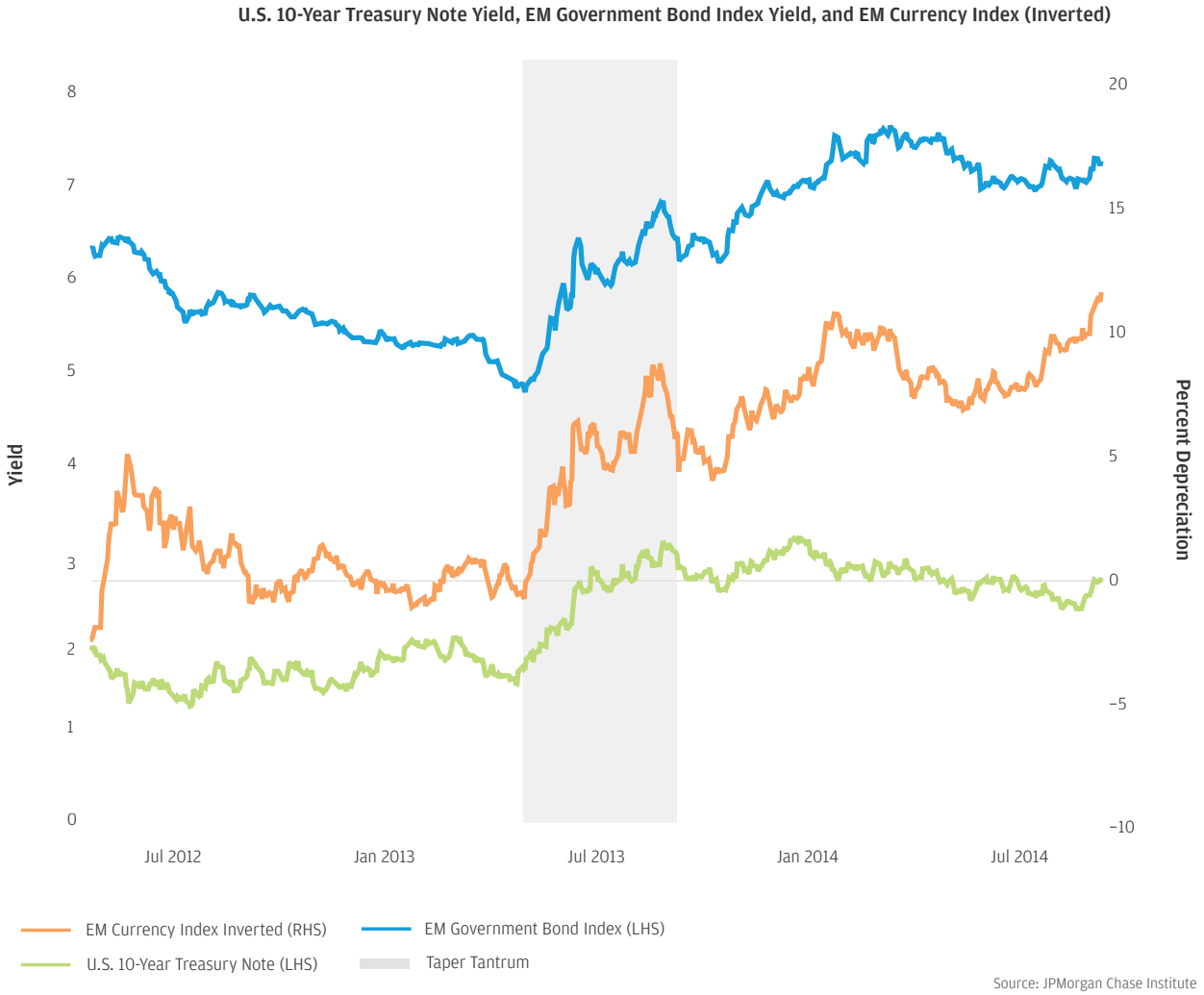
By September 17, 2013, the day before the FOMC's scheduled meeting, the price action across Treasuries and EM assets had extended and market expectations regarding tapering were centered on the September FOMC meeting.[8] The September 18, 2013 FOMC statement indicated otherwise, finding that while the Committee saw "growing underlying strength," in the economy it "decided to await more evidence that progress will be sustained before adjusting the pace of its purchases."[9] The yield on the The 10-yr yield fell 15 basis points, stocks rose, and EM currencies rallied. We use this date to mark the end of the taper tantrum.

Three Key Market Elements Considered: (1) Price action; (2) Liquidity; (3) Net flows

(1) Price action

From a historical perspective, the market reaction during the taper tantrum was noteworthy not just for U.S. markets, but also for emerging markets (EM). In Figure 1, we show the 10-yr yield, EM government bond yields (represented by the Emerging Markets Government Bond Index, or GBI-EM), and EM currencies (represented by the EMCI) around the taper tantrum window.

Figure 1. U.S. and EM yields rise as EM currencies depreciate

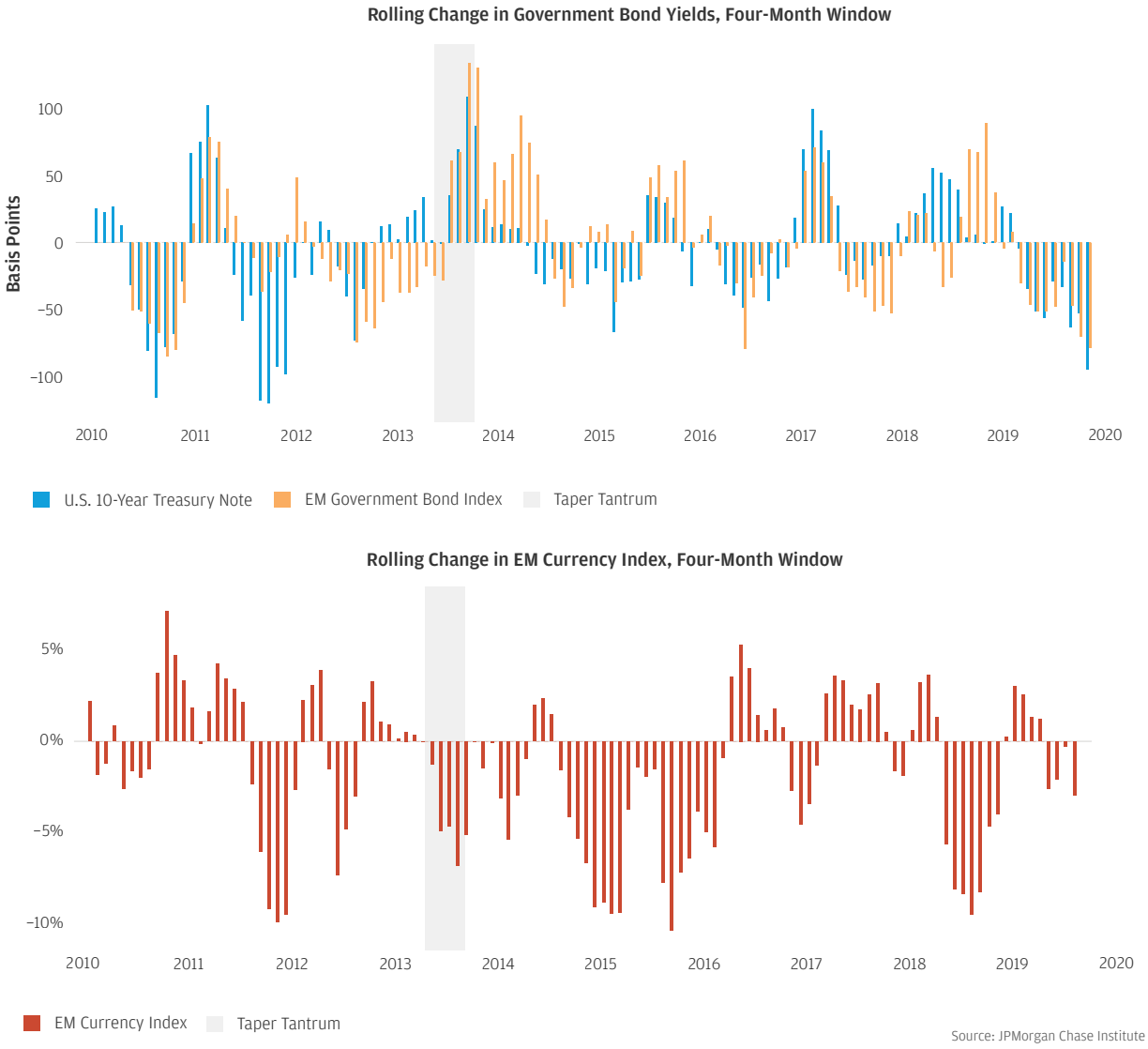


Source: JPMorgan Chase Institute

In Figure 2, we show the rolling change in each of the markets using 4-month windows chosen to approximately match the length of the taper tantrum. During the taper tantrum, the 10-yr yield increased over 130 basis points and the GBI-EM yield increased over 170 basis points, both of which were the largest rise in yields in any four-month period in the last ten years.[10]

The EMCI lost almost 10 percent of its value, exceeding the average four-month move (in absolute value) by nearly two standard deviations.[11]

Figure 2. Movements in Yields and EM Currencies were Large, but not Unprecedented



Source: JPMorgan Chase Institute

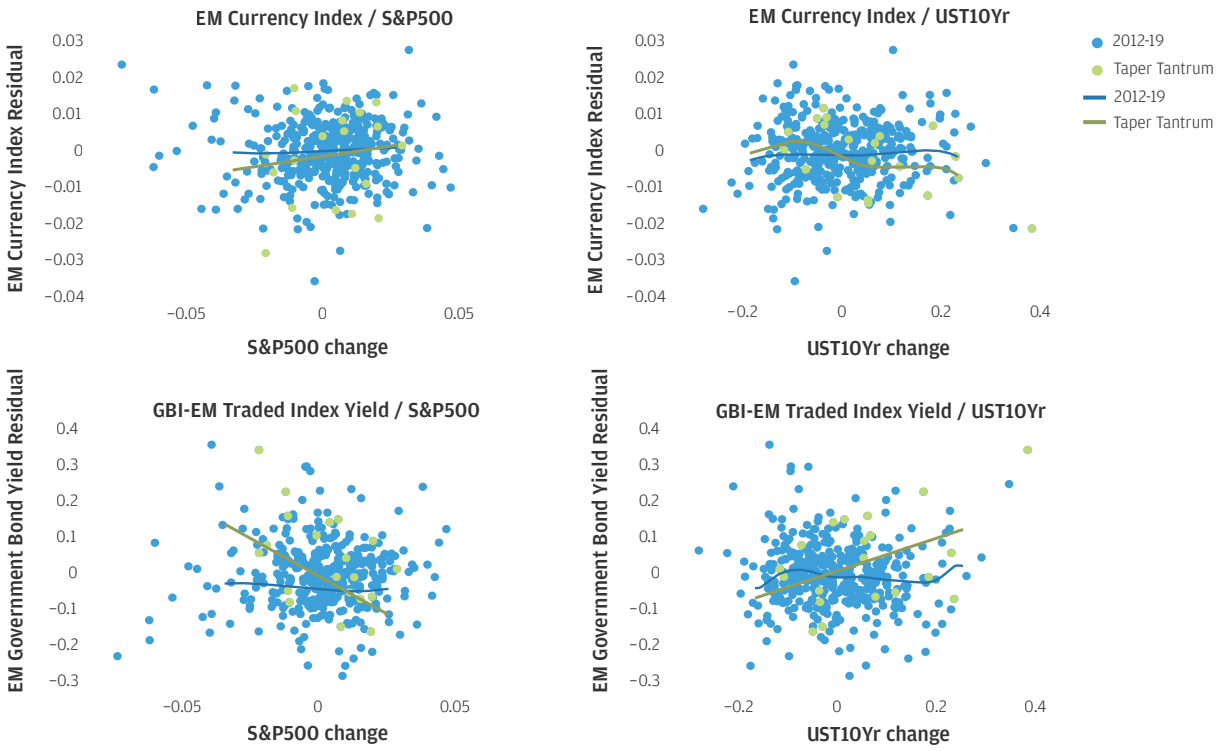
Relative to the typical relationship with U.S. market changes, the movements in EM currencies and government bond markets were considerably more pronounced. As we document through this report, market participant behavior and liquidity conditions provide a potential explanation for this apparent shift.

To explore this shift, we use standard linear regressions of EM assets on U.S. Treasuries and stocks, and then examine the taper tantrum residuals for systematic—and potentially non-linear—aspects to the cross-asset relationships that differed during the taper tantrum period.

Figure 3 shows the residuals of regressions of EM sovereign debt yields and EM FX on the 10-Yr yield and the S&P 500, plotted against the same U.S. assets, respectively. The residuals are from regressions estimated over the baseline period of 2012 to 2019, and we fit nonparametric regression lines on the residuals for the full period and the taper tantrum, respectively. If the relationships between the variables in question are stable and linear on average, then there should be nothing interesting to observe in the non-linear relationship between the 10-yr yield or the S&P 500 and the residuals (by construction, the regression pulls out the linear relationship and the residuals should have no meaningful relationship with the 10-yr yield and S&P 500). For the full 2012 to 2019 period, this linearity seems to basically hold on average—the nonparametric fitted curves for both EMCI and GBI-EM are fairly flat.

In contrast, during the taper tantrum, a change in EMCI and GBI-EM sensitivity to U.S. Treasuries and the S&P 500 is apparent. With respect to U.S. Treasuries, the negative (positive) slope of the green line for EMCI (GBI-EM) indicates that the slope estimated for the 2012 to 2019 baseline underestimates the magnitude of the relationship during the taper tantrum. Similarly, for the S&P 500 the positive (negative) slope of the green line for EMCI (GBI-EM) indicates underestimation of the sensitivity of EM assets to U.S. equities. Both point to higher than usual EM sensitivity to U.S. markets during the taper tantrum, a result that is not driven by outliers alone, as shown below.

Figure 3. Changing EM Sensitivity to U.S. Asset Prices



Source: JPMorgan Chase Institute

Changing volatility, or heteroscedasticity, across samples can lead to shifts in such measurements in other words, changing variances can cause changes in sample correlations, even if the 'structural' relationships are unchanged (Forbes and Rigobon, 2001).[12] However, if our results were driven by heteroscedasticity alone, during the taper tantrum period, the shift in the relationships we observe would be driven mainly by outliers in the distribution of the 10-yr yield changes or S&P 500 changes. This is not the case; a shift in the bivariate relationships is apparent even for relatively modest Treasury yield and S&P 500 changes. While this evidence is not definitive—in part due to the limited sample size during the taper tantrum—we view it as suggestive that heteroscedasticity is not the sole feature driving the apparent change in EM asset sensitivity to U.S. market movements.

(2) Liquidity

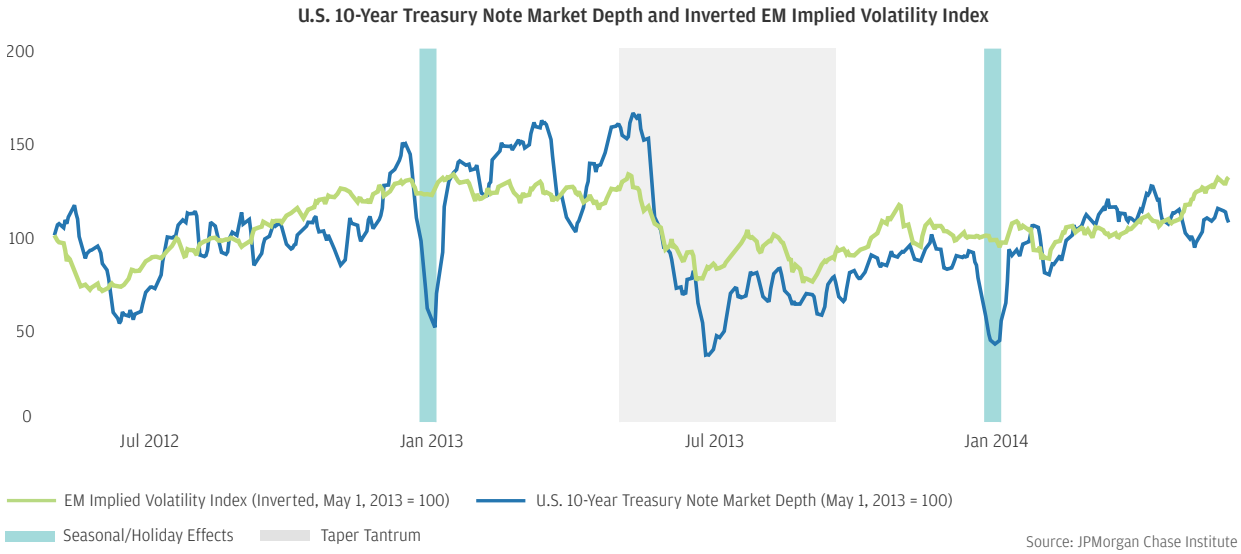
Coincident with declines in prices, indicators of market liquidity in U.S. Treasuries and EM currencies fell significantly during the taper tantrum period. The relationship between liquidity and market volatility is two-way: a drop in liquidity can cause an increase in market volatility and an increase in market volatility can cause a drop in liquidity. In later analysis, we attempt to parse the direction of the relationships that may be active at certain points of time.

Mirroring the decline in U.S. Treasury market depth, an analogous indicator for EM FX market liquidity deteriorated in the wake of the Fed communications in May and June. Constructing a measure of market depth for the range of emerging market currencies we are interested in analyzing would be difficult given the lack of consolidated liquidity-related data sources for every market, so we use an implied volatility index based on EM FX market options as a proxy for liquidity. The index captures the premium traders are willing to pay for protection against future market movements and is therefore closely related to uncertainty and liquidity.

Figure 4 indicates that liquidity was particularly robust in the months leading up to the taper tantrum and fell during the period. Liquidity was likely elevated in the first four months of 2013 because some market participants perceived that the open-ended quantitative easing program from the Fed would last indefinitely, as described in Stein (2014).[13] Meanwhile, a high level of complacency among the investor community was reflected in interest rate derivatives markets. On April 30, 2013, implied volatility on near-dated options on 10-year swap rates, a gauge of uncertainty on the direction of long-dated U.S. yields, had dropped to a post-Great Recession low.

To preview results presented in our main findings, we see regression-based evidence of a price impact of our net flow data that is conditional on market-implied volatility (a proxy for liquidity); the finding and flows are consistent with the view that a decline in liquidity exacerbated the moves in EM currencies and government bonds.

Figure 4. Indicators of Market Liquidity Deteriorated



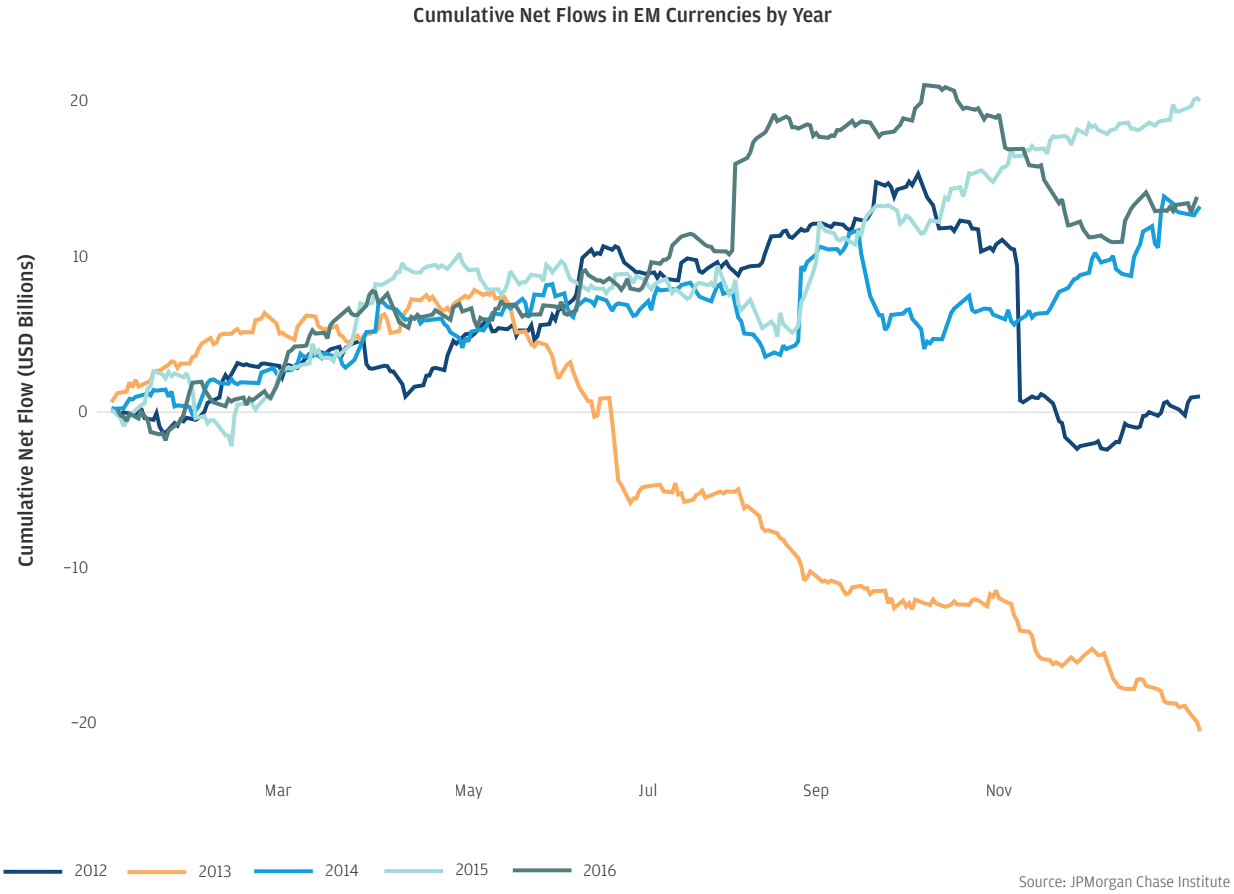
Source: JPMorgan Chase Institute

(3) Net flows

In aggregate, during the taper tantrum, institutional investors sold EM currencies and as they depreciated, a departure from their trading pattern in the surrounding years. Institutional investors were, on-net, buying EM currencies in every year between 2012 and 2016, except for 2013. Beginning in May 2013, net flows in EM FX turned decidedly negative and remained so over the course of the year. In this sense, 2013 stands out as an interruption in an environment generally characterized by the net accumulation of "carry trade"[14] positions as described in Brunnermeier, Nagel, and Pedersen (2009) and Mancini et al. (2013), among others, against a backdrop of sustained accommodative U.S. monetary policy and a low volatility market environment.

Figure 5 depicts the reversal in EM FX net flows from institutional investors around the onset of the taper tantrum. Cumulative net flows from January to the end of April in 2013 look similar to those of the surrounding years, as investors steadily accumulate EM currencies. However, May 2013 marks the onset of sustained selling of EM FX consistent with carry trades being unwound. Other potentially contributing factors include fund outflows (either realized or anticipated) and the reduction of leverage in the face of higher volatility.

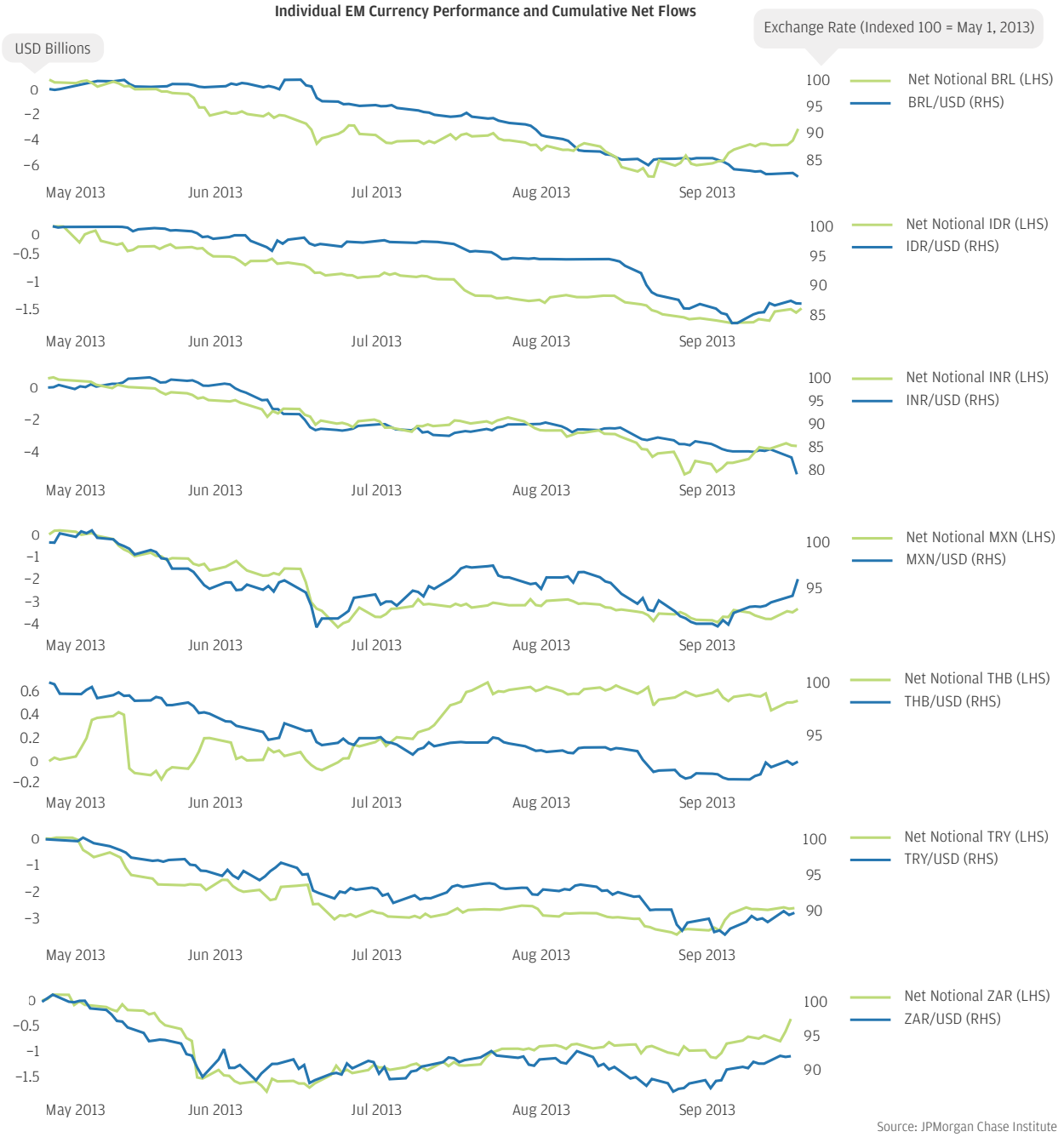
Figure 5. Reversal in EM Currency Inflows during Taper Tantrum



Source: JPMorgan Chase Institute

We find additional evidence of the relationship between net flows and changes in exchange rates during the taper tantrum by examining our data for seven EM exchange rates separately: BRL, MXN, IDR, INR, THB, TRY, and ZAR (shown in each panel of Figure 5). For six of the seven currencies, there appears to be a contemporaneous relationship between cumulative net flows and the exchange rate: in general, currency sales (marked by decreasing cumulative net flows) are frequently accompanied by currency depreciation, while currency purchases (marked by increasing cumulative net flows) are accompanied by currency appreciation. The THB remains the sole exception. In Finding 1, we present regression results validating the visual connection between our net flow data and EM currencies.

Figure 6. Outflows Tend to Align with Depreciation for Most Currencies



Source: JPMorgan Chase Institute

Our Data

The core source of information for this report is a data set of transactions executed by institutional investors with J.P. Morgan's market-making trading desks. The role of a market maker is to provide liquidity to investors by offering (1) a firm price at which they will buy or sell a financial instrument and (2) immediacy, standing ready to buy or sell despite near-term imbalances in supply and demand.[15] Our transaction data has comprehensive coverage across investor types and asset classes.

The data set constructed for this report centers on FX and government bond trades collected at a daily level. The trades were executed through both voice and electronic trading channels and do not include any trades executed by J.P. Morgan in the interdealer market. We include trades in the major currencies (USD, GBP, EUR, and JPY) and in emerging market currencies (BRL, ZAR, MXN, TBH, TRY, INR, and IDR). These emerging market currencies were chosen because they represent a significant amount of trading activity by investors and showed a significant depreciation relative to USD over the taper tantrum period, with at least a 10 percent increase at some point between May 1, 2013 and September 18, 2013. This selection allows us to restrict the analysis to those currencies in which we reasonably would think investor flows in our data may have contributed to volatility.

FX trading activity is measured in two ways. First is gross trading volume, which is calculated by summing the total amount of currency traded by investors on a given day and indicates a level of total activity agnostic to the direction of the flow of risk. Second is net trading flows, which is calculated by summing the total amount of currency bought less the total amount of currency sold on a given day. The measured net flow is signed positively in the direction of the investor buying currency from the market maker and negatively in the direction of the selling currency to the market maker, thus it can be a measure of transferred risk. We convert all currency flow amounts into USD using the end of day exchange rates to make the trading volumes and net flows comparable.

A secondary data set for this analysis includes a new fixed income sample consisting of secondary market government bond trades also collected at a daily level. We include U.S. Treasuries, and, for emerging markets bonds, restrict our analysis to those on which we observe a significant amount of institutional investor trading activity and a significant increase in yields over the May to September 2013 period as above. The final sample includes bonds from Turkey, South Africa, Indonesia, Thailand, and Mexico. We focus on a calculation of dollar-value of a basis point, or dv01, as our measure of activity in government bonds. The dv01 measure captures the interest rate risk of a bond by estimating the price change, in dollar terms, in response to a parallel shift in the yield curve of a single base point. We utilize gross total dv01 as a measurement of total activity, and net dv01 flows as a signed measurement of the amount of risk transacted by institutional investors with market makers at J.P. Morgan on a given day. Positive net dv01 denotes institutional investors buying bonds, while negative net dv01 denotes investors selling bonds. As with net flows in FX, gross dv01 volume and net dv01 flows are converted into USD for ease of comparison.

It is important to note that our data only includes transactions and does not contain any position information. As such, we could not discern whether an investor is long or short a particular currency or bond. Furthermore, we could not see the currency or interest rate exposure generated by other assets or enterprise-related risks. In this report, we limited our analysis to spot and forward FX transactions and government bond transactions, and did not include other types of financial instruments (e.g., FX options, interest rate swaps, or bond futures) that might create currency or interest rate exposure for investors.

Broadly speaking, we believe that J.P. Morgan's overall market share is large enough that our transaction data was generally representative of the market activity of all types of institutional investors in the relevant markets we studied. However, there is natural variation in J.P. Morgan's market share across different asset classes, investor sectors, regions, and time zones, and this is an important factor to consider when interpreting the results of our analysis.

At times, we calculated cumulative trading volume or cumulative net flows over a period. When interpreting those results, it is important to note that while we believe our market share to be material and representative, the true cumulative change in position for an investor would include both their starting position and their trades with market makers other than J.P. Morgan. As such, charts showing cumulative net flows should be taken as illustrative of the generalized flow of risk reflecting investor sentiment rather than a true representation of positions.

As with previous research, we rely on six broad categorizations of investor sectors: hedge funds, asset managers, banks, corporates, pension fund/ insurance companies, and public / other.[16] These sectors are helpful to understand broadly the different incentives underpinning each type of investor and their behaviors. However, as we have noted in previous research (FX Markets Move on Surprise News), there was significant heterogeneity of investor behavior within each sector as captured by the timing, volume, and direction of trading around significant market events. Motivated by this, we sought to utilize systematic tendencies in observed FX flows to classify investors into archetypes of trading behavior, which is implemented as an additional categorization within each sector.

We utilized systematic tendencies in observed FX flows to classify investors into archetypes.

Finding

One

Net flows have substantial predictive power for EM FX and government bond market performance. The relationship between EM currency performance and flows is conditional on the degree of market liquidity, and depreciation during the taper tantrum was correlated with selling pressure from subsets of market participants.

Post-Crisis Baseline

In the context of EM FX and sovereign debt markets, we find that flows contribute meaningful explanatory power beyond what can be attributed solely to price action in key U.S. markets. Linear regressions that exclude flows indicate that U.S. equities and Treasury yields can explain about 20 percent of variation in EM FX and sovereign debt yields in post-crisis data, excluding the taper tantrum (see Box: 1 Background on our Methodology p. 24 for details). When adding net flow data across six market participant groupings (asset managers, hedge funds, banks/brokers, corporates, pension/insurance and public/other), both hedge funds and asset managers have an intuitive correlation with contemporaneous price action in EM FX and sovereign debt, and the measure of fit quality rises by around 10 percentage points. Statistical significance is strongest in FX among hedge funds, while asset managers have the closest relationship in government bonds.

Next, we explore whether we are able to detect variation in the relationship between flows and price action that corresponds to changing market liquidity conditions. Here, we focus on the FX market context, where our data allow for a finer parsing of relationships. The results imply that a $1 billion USD asset manager flow is associated with a move in EM FX that is approximately twice as large when volatility is one standard deviation above its average. To explore the relationship, we add to a linear regression interactions between flows and a proxy for market liquidity—an index tracking 3-month at-the-money implied volatility of options on EM currencies, VXY EM. The interpretation of a positive coefficient implies a larger price movement in the direction of the flow when volatility is higher, i.e. when liquidity is depressed. For most sectors, these interaction terms yield little in terms of statistical significance, although the R-squared for this regression is 3 percentage points higher. However, asset manager flows stand out with a statistically significant and positive coefficient. Heightened relevance of asset manager flows in periods of high volatility is explored further in the next section focused on the taper tantrum period. Results for each of the three specifications are shown in Table 1 on the following page, using data from our baseline period, which includes 2012 through 2016 but excludes 2013. Note, interpretation of the coefficients comes with caveats, which we describe in the Appendix section: Interpreting our Regression Results.

Table 1. EMCI Regressions in Baseline Post-Crisis Period

Sample: 2012-2016, Excluding 2013	EM Currency Index = News	EM Currency Index = News + Flows	EM Currency Index = News + Flows + Liquidity
Asset Managers		0.001*	0.003***
		(0.001)	(0.001)
Asset Managers x Implied Volatility			0.003***
			(0.001)
Hedge Funds		0.005***	0.006***
		(0.001)	(0.001)
Hedge Funds x Implied Volatility			0.002*
			(0.001)
S&P 500	0.251***	0.191***	0.181***
	(0.023)	(0.021)	(0.021)
Treasury 10-Year Yield	-0.007	-0.002	-0.003
	(0.005)	(0.005)	(0.005)
Constant	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)
Other Sector Flows Included	No	Yes	Yes
Other Interactions Included	No	No	Yes
N	999	999	999
R-squared	0.190	0.302	0.338

Note: Standard errors in parentheses are heteroscedasticity and autocorrelation (HAC) robust. Observations are rolling two-day intervals. Dependent variable is in percent changes, that is, a 1% move in EMCI is 0.01. Net flows are in USD billions. Implied volatility is in z-score units.

* p<.1, **p<.05, ***p<.01

Source: JPMorgan Chase Institute

We also study how informative our EM government bond transaction information could be for overall performance of the asset class. In analogous regression specifications, we find that asset manager flows have a statistically significant relationship with EM sovereign yields, but no other sector had a discernible relationship (see Table 2 below). We standardize bond transactions by scaling them according to their exposure to yield changes—dv01, as described in the Our Data section. In our baseline sample, the results imply that asset manager bond sales of $10 million in dv01 (roughly $1 billion in 10-year equivalents) are on-average associated with an approximate 1 basis point decline in yields for the EM index, all else equal. The U.S. asset prices enter with strong statistical significance and have the expected signs: increases in Treasury yields are associated with higher EM debt yields, although by a smaller magnitude, and positive U.S. equity performance is associated with EM debt rallies.

The addition of flows adds a noticeable improvement in explanatory power. However, the number of transactions and market participants in this context is significantly smaller than in FX. Due to these limitations, we omit the regression extensions and taper tantrum-specific analysis in the EM government bond context to focus on EM FX, where our data allow for more granular and systematic analysis.

Table 2. EM Government Bond Yield Regressions in Baseline Post-Crisis Period

Sample: 2012-2016, Excluding 2013	EM Government Bond Index = News	EM Government Bond Index = News + Net DV01 Flows
Asset Managers		-1.075***
		(0.21)
Hedge Funds		-1.214
		(1.57)
S&P 500	-2.737***	-2.446***
	(0.49)	(0.49)
Treasury 10-Year Yield	0.523***	0.486***
	(0.08)	(0.07)
Constant	0.004	0.017**
	(0.01)	(0.01)
Other Sector Flows Included	No	Yes
N	209	209
R-squared	0.239	0.308

Note: Standard errors in parentheses are heteroscedasticity consistent. Observations are weekly.

* p<.1, **p<.05, ***p<.01

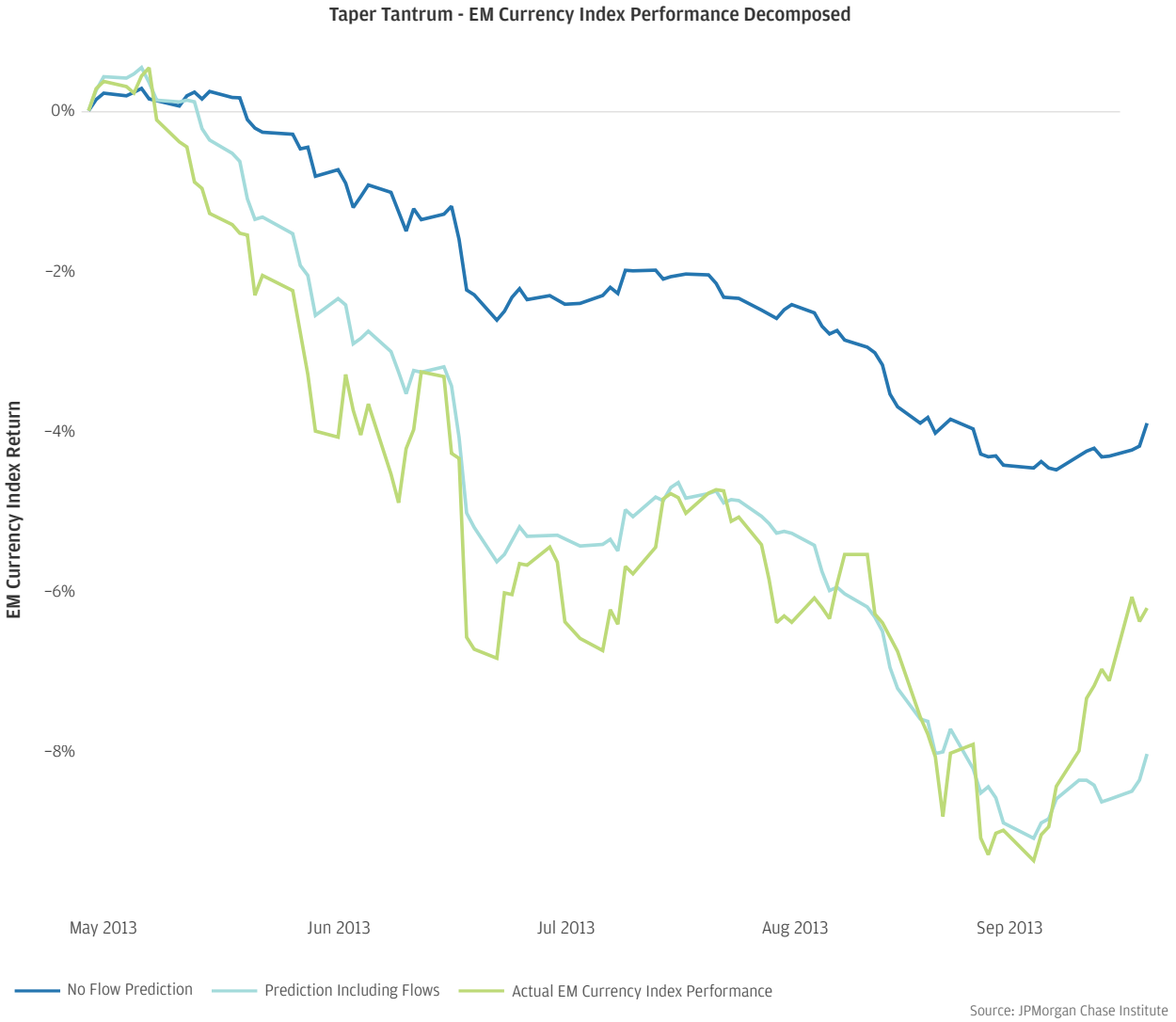
EM Government Bond Index is change in index yield in basis points.
Flow units are $10 million net dv01, such that positive values reflect net bond buying.

Source: JPMorgan Chase Institute

Taper Tantrum Sample

Similar to the baseline period, the addition of net flows adds considerable explanatory power to our main regression specifications during the taper tantrum. U.S. assets alone—using coefficients measured over 2013[17]—would predict less than half of the observed depreciation in EM currencies through the most volatile stages of the taper tantrum. Predicted performance augmented with flows does much better through most of the taper tantrum, capturing the vast majority of EMCI declines from May through August, although the empirical model underestimates the magnitude of the recovery in the first half of September (see Figure 7).

Figure 7. Net Flows Help Explain EM Currency Index Depreciation



Source: JPMorgan Chase Institute

Turning back to the regression framework to analyze 2013 data, our specification using U.S. asset prices alone results in an R-squared of 28 percent, a notable boost from the analogous regression over the baseline period. The results are presented in Table 3. Moreover, the coefficient for changes in U.S. Treasury yields becomes more negative and statistically significant in the 2013 sample, reflecting a different dynamic between EMCI and U.S. Treasury yields—a rise in yields in response to a monetary shock is, intuitively, associated with a depreciation in EM currencies. Another factor potentially causing differences across the regression results—in particular the R-squared—is differing volatility regimes across periods.[20]

Our specification including news and flows explains 43 percent of the variation in EMCI during 2013, up 10 percentage points from the baseline period. We observe two additional differences between 2013 and the baseline. First, in addition to hedge funds and asset managers, the net flows of banks also now exhibit a positive and statistically significant relationship with changes in EMCI. Second, the coefficient for asset managers is markedly higher than in the baseline period, which reinforces the finding in non-2013 data on a higher sensitivity of EMCI changes to asset manager flows when liquidity is lower than average (which it was during the taper tantrum).

Table 3. EMCI Regressions over 2013

	2013 Sample EMCI = News	2013 Sample EMCI = News + Net Flows
Asset Managers		0.003***
		(0.001)***
Banks & Broker Dealers		0.003***
		(0.001)
Corporates		-0.004
		(0.003)
Hedge Funds		0.003***
		(0.001)
Pension & Insurance		0.005
		(0.004)
Public Sector & Other		-0.001
		(0.003)
S&P 500	0.231***	0.160***
	(0.038)	(0.032)
Treasury 10-Year Yield	-0.031***	-0.019***
	(0.005)	(0.004)
Constant	-0.001**	-0.000
	(0.000)	(0.000)
N	249	249
R-squared	0.279	0.432

Note: Standard errors in parentheses are heteroscedasticity and autocorrelation consistent. Observations are rolling two-day intervals.

* p<.1, **p<.05, ***p<.01

Source: JPMorgan Chase Institute

Box 1: Background on Methodology

A central theme of our findings is the interplay between institutional investor net flows and the changes in EM exchange rates and EM government bond yields. To explore these relationships, we expand on a model of market dynamics presented in earlier research (FX Markets Move on Surprise News). In this narrative, price changes are a function of three interrelated factors: (1) news, (2) net flows, and (3) market liquidity. First, when information arrives, market makers and other institutional investors update their beliefs for appropriate prices on impact. Net flows faced by market makers then provide a basis for ongoing price action as changing information about investor demand is revealed and disseminated across market participants.[18] Additionally, market liquidity plays an important role conditioning the magnitude of market price changes given imbalances in net flows over a time interval.

We apply this framework to EM FX and government debt markets in a sequence of regressions (see specifications below). In the baseline, EM performance can be explained in part by market-relevant news. Key U.S. market indicators, the S&P 500 Index and Treasury 10-yr yield, serve as proxies that summarize shocks to growth expectations, monetary policy, and risk premia. Next, we add our flow data—disaggregated at the sector level or other categorizations—to pick up the relationship between price action and contemporaneous flows. Below, these investor groupings are indexed by g. Finally, we interact flows with indicators of liquidity—a z-score of implied volatility—to pick up conditionality between flows and price action based on the market environment.

Our rationale for using changes in Treasury yields and the S&P 500 equity index as a proxy for news in the context of understanding EM asset performance follows logic appearing in academic and policy analysis studying the relationship between EM performance and U.S. growth and monetary policy.[19] Growth news and policy surprises drive a substantial proportion of global market fluctuations and can be summarized using two examples:

1. Unexpected news about expectations for economic growth tends to be associated with positive co-movement of Treasury yields and the S&P 500; when growth expectations increase (decrease) one would expect Treasury yields to increase (decrease) and stocks to rise (fall). In the EM context, the negative effect on EM asset prices from the rise in Treasury yields tends to be offset by improvement in risk sentiment or positive growth spillovers.
2. If Treasury yields and the S&P 500 move in opposite directions, it suggests unexpected news about monetary policy. By extension, assumptions around the reaction function of the Federal Reserve imply that responses to economic information—and inflation data in particular—can manifest in markets like a monetary policy shock. These shocks tend to be associated with declines in EM currencies, as the direction of both risk sentiment and Treasury yields create depreciation pressure.

In the findings that follow, we will use these specifications to build a picture of the connections between flows and prices prevailing during the taper tantrum, and compare the relationship to baseline post-crisis periods. Importantly, we recognize that endogeneity between flows and price action complicates the interpretation of some of the results; we aim to offer insights into empirical relationships that help elucidate key facts of the taper tantrum episode in EM assets notwithstanding the dominant direction of causality.

Baseline (i.e "News"): $EM_{i,t} = \alpha_i + \beta_{i,s} SPX_t + \beta_{i,t} UST_t + \varepsilon_{i,t} +$

+ Net Flows: $\Sigma_g \beta_{i,g} F_{g,t} +$

+ Liquidity-Flow Interactions: $\Sigma_g \beta_{i,gl} F_{g,t} * L_{i,t}$

Note: Subscript i denotes the EM market indicator in question: that is, currency or government bond yield index. All market indicators are in changes (either percent for prices or basis points for yields).

Finding

Two

The explanatory power of flows during the taper tantrum can be accounted for by a relatively small subset of active market participants associated with momentum and a broad set of asset managers that typically do not exhibit strong systematic behavior.

The explanatory power of flows during the taper tantrum varied considerably by market participants across six traditionally-labeled investor sectors and across groupings based on empirical trading patterns.

We find that the net flows of a small subset of hedge funds and banks are responsible for the bulk of the additional predictive power of flows for EM currencies during the taper tantrum. Furthermore, a grouping of asset managers that did not typically trade in a systematic manner, in this case, changed their trading activity during the taper tantrum, resulting in an increase in the correlation between their net flows and EM currency performance. The balance of institutional investor net flows either had no statistically significant relationship with EM currency movements or were immaterial, and we find no evidence of institutional investors who systematically "leaned against the wind," buying EM currencies as they depreciated during the taper tantrum.[21]

While the six traditionally-labeled investor sectors have intuitive appeal in that we can use them to make more informed assumptions regarding their motivations, we have also shown in previous research (FX Markets Move on Surprise News) that there is considerable heterogeneity in trading behavior within each investor sector. Furthermore, many institutional investors trade EM FX: between 2012 and 2016, we observe over 10,000 institutional investors on average each year trading at least one of the EM currencies.

For these reasons, we develop a more sophisticated grouping of investors by employing a machine learning-based classification technique on our data. This grouping is based on readily-observable relationships between institutional investors trading activity and three variables: (1) contemporaneous price changes, (2) lagged net flows, and (3) lagged price changes. (Investor classification is further described in the Box 2 of this report, found on page 29.) Our goal is to identify market participants that feature systematic trading based in these dimensions to see whether we can gain additional insight on the set of market participants that play a role in transmitting news to prices and influence markets.

Using this new classification scheme, we assign institutional investors into four categories—momentum, contrarian, position builders, and reversals—based on their trading activity from 2014 to 2016, as described in Box 2. We then apply this more granular segmentation in our model of market dynamics to isolate those market participants who played a particularly prominent role during the taper tantrum period. We find that only a small subset of institutional investors exhibited a statistically significant relationship between their net flows and changes in the EM currencies.

Of the four categories, those who fall in the momentum category are the relevant potential influencers of market direction, given the category is partially defined by the positive relationship between their net flows and contemporaneous price movements. In the analysis that follows, we group institutional investors according to their sector and whether or not they were in the momentum category, then re-run the model described in the Methodology section for trading during 2013 using a two-day rolling window.[22] We also include uncategorized asset managers; this sector makes up about two-thirds of all uncategorized market participants in our data (see Appendix II: Categorizing Institutional Investors According to Their Trading Activity for more details). The results are shown in Table 4.

Table 4. Isolated Categories and Sectors Drive Connection between Flows and Price Action

Regression of EM Currency Index Performance on "News" and Flows, Sample: 2013		
Momentum	Asset Managers	0.003 (0.003)
	Banks & Broker Dealers	0.004** (0.001)
	Corporates	-0.000 (0.007)
	Hedge Funds	0.007*** (0.002)
	Pension & Insurance	-0.004 (0.007)
	Public Sector & Other	-0.011** (0.005)
Aggregated Non-Momentum Categories	Asset Managers	-0.001 (0.003)
	Banks & Broker Dealers	0.002 (0.001)
	Corporates	-0.004 (0.004)
	Hedge Funds	0.000 (0.001)
	Pension & Insurance	0.008* (0.004)
	Public Sector & Other	-0.002 (0.003)
Selected Uncategorized	Asset Managers	0.003*** (0.001)
U.S. Assets	S&P 500	0.169*** (0.035)
	Treasury 10-Year Yield	-0.019*** (0.004)
	N	249
	R-squared	0.482

Note: Standard errors in parentheses are adjusted for autocorrelation and heteroscedasticity

* p<.1, **p<.05, ***p<.01

Source: JPMorgan Chase Institute

In the momentum category, we find that only banks and hedge funds had a positive and statistically significant coefficient between their net flows and contemporaneous changes in EMCI. Surprisingly, uncategorized asset managers, whose net flows either did not show sufficiently systematic behavior or did not meet the activity filter during the baseline period, also had a positive and statistically significant coefficient between their net flows and contemporaneous changes in EMCI during the taper tantrum. Note that while pension and insurance companies outside of the momentum category and the public/other sector in the momentum category also had modestly statistically significant coefficients (only at the 10 percent level) between their net flows and contemporaneous changes in EMCI; their net flows during the taper tantrum were immaterial.

We draw four conclusions from these results. First, we are able to attribute the connection between net flows and price action that appears in more aggregated data to a relatively small subset of institutional investors. Out of greater-than one thousand hedge funds and banks actively trading EM FX during our period of analysis, a subset made up of only one-in-five hedge funds and one-in-eight banks dominates the contribution of flows to model R-squared. The net flows of the remaining hedge funds and banks did not demonstrate a systematic relationship with EM exchange rates.

Second, uncategorized asset managers—whose individual trading activity was not consistently systematic in the 2014 to 2016 period used for categorization—appear in the regression with a significant relationship with EMCI performance during the taper tantrum. In Finding 3, we use additional analysis to show that this group of uncategorized asset managers seemed to change their trading behavior and followed the lead of hedge funds in the momentum category.

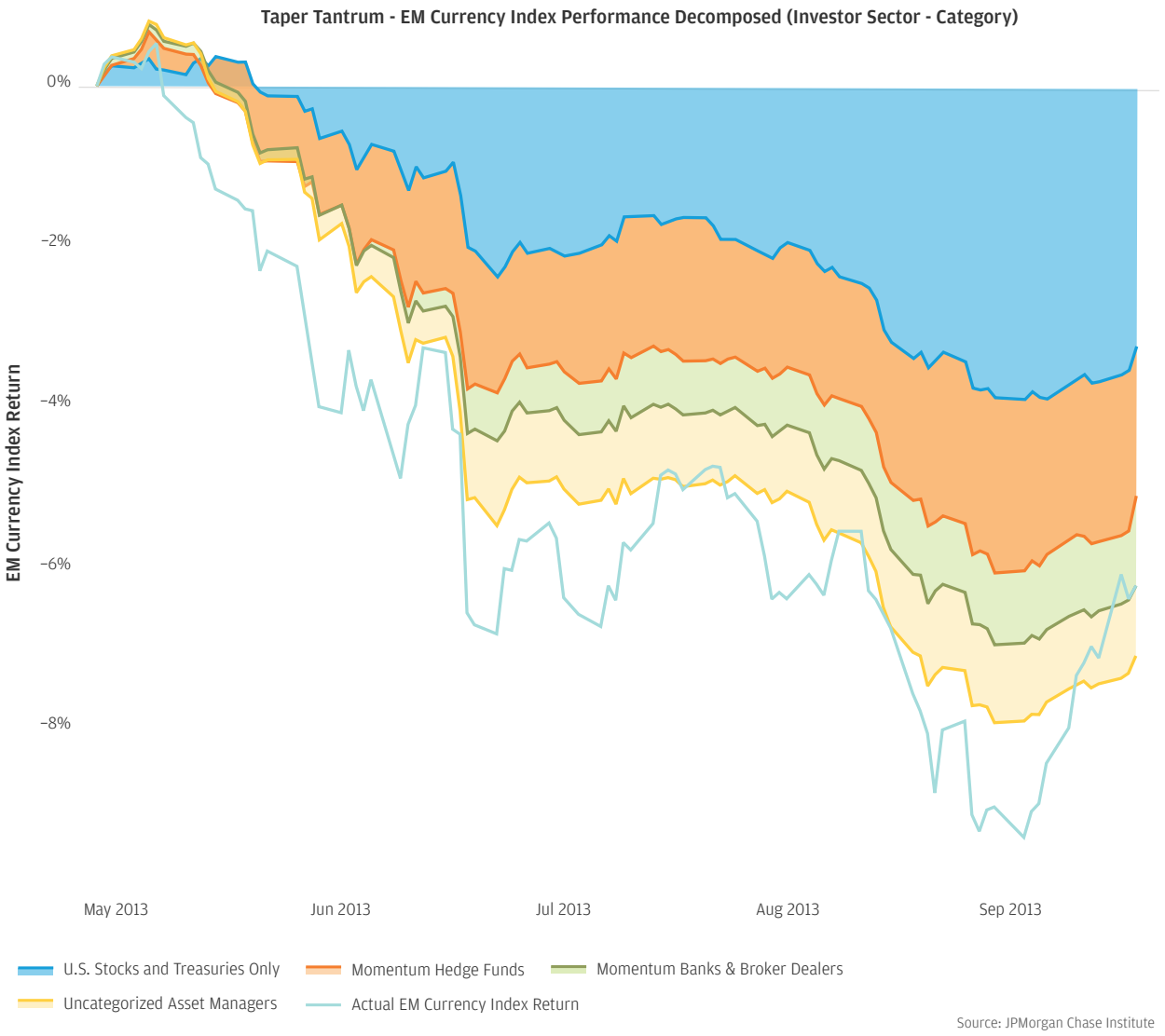
Third, the coefficient for net flows of hedge funds in the momentum category is about twice the size of the coefficients for banks in the momentum category and uncategorized asset managers. The regression results incorporate only our net flow data, which is naturally limited by the market share of J.P. Morgan's FX market-making operation, and so we are careful not to interpret the coefficients in an absolute sense.[23] In particular, the uncategorized asset manager grouping is very large in terms of the number of market participants and magnitude of flows; despite its lower coefficient, the contribution to predicted EM depreciation during the taper tantrum of this investor set is substantial (as depicted later in Figure 13).

Fourth, the negative and statistically significant coefficient for the public/other investors in the momentum category suggests that they traded against the prevailing market direction, buying EM currencies as they depreciated and therefore stabilizing the market. This is a surprising result. By design, institutional investors in the momentum category usually move with the market. However, the flows from this subset of investors were small during the taper tantrum, making it hard to draw a conclusion on whether they provided any material support to EM currencies.

A subset made up of only one-in-five hedge funds and one-in-eight banks dominates the contribution of flows to model R-squared.

To get a sense for the relative economic magnitudes of the flow categories with respect to potentially explaining price action during the taper tantrum, we apply the above regression coefficients to the taper tantrum data in Figure 8. There, we include the net flows for the three investor sector-category combinations that showed positive and statistically significant coefficients alongside the combined influence of changes in Treasury yields and equities. The plot is suggestive of spillovers spread through portfolio rebalancing from mid-May 2013 through the June 19, 2013 FOMC announcement, as flows help explain a substantial portion of EM FX price action in excess of the contribution from U.S. assets. Hedge funds in the momentum category and uncategorized asset managers were selling EM currencies as they depreciated, beginning in mid-May, and banks in the momentum category began selling around the end of May. The selling and depreciation continued into June and was punctuated by large sales by uncategorized asset managers just after the June 19, 2013 FOMC announcement.

Figure 8. Selected Categories' Flows Help Explain Taper Tantrum Depreciation



Source: JPMorgan Chase Institute

Box 2: Categorizing Institutional Investors According to Their Trading Behavior

In past work, we have analyzed the transactions of institutional investors disaggregated across six sectors: hedge funds, banks, asset managers, corporates, pension funds and insurance companies, and public sector/other. While these sectors have intuitive appeal in that we can use them to make more informed assumptions regarding their motivations, we have also shown in previous research that there is considerable heterogeneity in trading behavior within each investor sector. Indeed, the set of institutional investors that trade EM FX is broad: between 2012 and 2016, we observe over 10,000 institutional investors on average trading at least one of the EM currencies every year.

With that motivation, we implement a supplemental categorization of institutional investors based on readily-observable relationships between their trading activity and three variables: (1) contemporaneous price changes, (2) lagged net flows, and (3) lagged price changes. Our goal is to identify market participants that feature systematic trading in these dimensions to glean additional insights about which market participants may play a palpable role in market fluctuations. The archetypes resulting from this exercise are synthesized below.

	Contemporaneous Prices	Lagged Flows	Lagged Prices
Momentum	Positive	Small	Positive
Contrarian	Negative	Small	Negative
Position Builders	Small	Positive	Small
Reversal	Small	Negative	Small

1. Momentum

- Trade in the prevailing market direction and with recent past price action
- The majority of categorized hedge funds fall in this category, and asset managers feature prominently

2. Contrarian

- Trade against the market, opposite of momentum
- Banks have an outsized presence

3. Position Builders

- Build positions over time irrespective of near-term price action
- Public sector institutions appear here more than any other category

4. Reversals

- Quickly reverse their own flows
- Hedge funds and asset managers in this category could be trading based on short-term market signals

These investor groupings represent stable categories of institutional investors, in the sense that both of the following hold: (1) the clustering algorithm identifies approximately the same archetypes across calendar year samples; and (2) market participants show a tendency to exhibit the same behavior through time (i.e. categorization in one period depends on prior categorization). Investors may be left uncategorized because they did not meet our activity filter, which requires a substantial amount of trading in both dollar value and frequency of trades. Additionally, active market participants that do not demonstrate systematically repeated trading patterns are not categorized. The Methodology section of this report contains further details.

Finding

Three

During the taper tantrum, linkages between certain market participants' flows and price action appeared to increase, reflecting potential herding behavior that had a significant impact on prices.

We document indications of herding, focusing on asset manager behavior (in part "a" of this finding) and more broadly (in part "b").

Finding 3a: Asset manager net flows became increasingly correlated with changes in EM currencies and the net flows of certain banks and hedge funds during the taper tantrum.

To further examine channels of potential spillovers during the taper tantrum, we explore time variation in relationships across flow categories in addition to changing linkages between flows and prices around the taper tantrum. Given the results described in Finding 2, we focus on banks and hedge funds in the momentum category and uncategorized asset managers. Uncategorized asset managers—hereafter referred to as 'asset managers'—represent a large group of institutional investment managers that do not typically exhibit systematic behavior in our data; the majority of the asset management sector is uncategorized in terms of investor count. Their transactions during the taper tantrum increasingly tracked those of the other influential market participant groupings. Coincident with the change in flow-flow relationships, the bilateral correlation of asset manager flows with EM currency movements increased sharply. This represents a pattern of herding that potentially contributed to the size of the moves in EM currencies.

Indeed, asset manager flows were more correlated with both banks and hedge funds in the momentum category during the taper tantrum than during a baseline period from 2014 to 2016. Additionally, these asset managers also appeared to be "chasing" hedge fund flows, as their flows tracked hedge fund flows with a roughly two-day lag during the taper tantrum. This dynamic was not evident during the surrounding periods. Overall, the explanatory power of contemporaneous and lagged hedge fund and banks flows for those of asset managers rises from between 0 to 2 percent during the baseline period to 3 to 16 percent during the taper tantrum (relationships are given in Table 5).

Table 5 reports regression results that estimate the dollar-for-dollar relationships between the flow categories. The much higher coefficients on the contemporaneous and lagged flow variables for the taper tantrum indicate that asset manager flows were substantially more sensitive to the momentum categories than in the baseline period (there was almost no relationship outside the taper tantrum, with the exception of momentum hedge funds).[24,25] Statistical significance, however, is fairly weak, with only lagged hedge fund flows significant at the 5 percent level. As is true in academic literature studying periods of crisis, low sample sizes inherently contribute to higher standard errors around estimates.

Meanwhile, EM FX price action responded much more forcefully to coincident asset manager flows during the taper tantrum, as indicated by the coefficient rising from 0.36 to 0.81—indicating a more than doubling in predicted depreciation per one billion in asset manager net sales—and the R-squared rising from 7 to 32 percent. The statistical power of the relationship also rose notably, despite the much lower number of observations during the taper tantrum.

Since periods of high volatility can lead to a mechanical changes in coefficients even if underlying structural relationships are constant, we explore methods to verify the extent to which changing variance may be driving the results described above in the Appendix section: Addressing Heteroscedasticity. The results of that analysis imply that changing volatility does not seem to be the sole factor driving these findings. Given the close connection between momentum hedge fund flows and price action, as a robustness check we ran a regression of the form above but extended to also include lagged EM performance to parse any influence of the market movements themselves from "flow chasing":

$$f_{i,t} = \alpha_i + \beta_{hf} f_{hf,t-1} + \beta_{px} EMCI_{t-1} + \varepsilon_{i,t}$$

Table 5. Uncategorized Asset Manager EM Flow Regressions Point to Increased Linkages

		Bilateral Regressions					
		Taper Tantrum Period			2014 to 2016 Baseline		
	RHS Variable	Coefficient	t-Stat*	R-squared	Coefficient	t-Stat*	R-squared
LHS: Uncat Asset Mgrs	Momentum Hedge Funds	0.65	1.77	0.07	0.27	3.56	0.03
	Lag (Momentum Hedge Funds)	0.74	2.61	0.08	0.01	0.19	0.00
	Momentum Banks	0.72	1.73	0.16	0.05	0.53	0.00
	Lag (Momentum Banks)	0.30	0.94	0.02	0.00	-0.02	0.00
EMCI**	**EM Currency Index Regression****						
	Uncat Asset Mgrs	0.81	7.22	0.32	0.36	2.76	0.07
	N	102			751		

Note: *Standard errors are heteroscedasticity and autocorrelation robust (HAC) using 2 lags.

**Coefficient is interpretable as percentage point change in EM Currency Index per $1 billion USD equivalent EM FX flow.

Source: JPMorgan Chase Institute

As presented in Table 6, the connection between lagged hedge fund flows and asset manager flows is unique to the taper tantrum period and is not subsumed by the tendency for asset managers to follow recent price action during the episode. The forecasting ability of the lagged variables during the taper tantrum is sharply higher than in the baseline, at 36 and 7 percent, respectively. As noted in the Appendix section Addressing Heteroscedasticity, asset manager flows were not noticeably more volatile than during the baseline period, suggesting that the change in volatility itself is not a likely explanation for the shift. However, statistical significance is relatively modest, which is to be expected with a relatively small number of observations during the taper tantrum.

Table 6. Asset Manager Flows Increasingly Track Lagged Hedge Fund Flows and Price Action

Dependent Variable: Uncategorized Asset Manager EM FX Flows (USD Billions)		
	Taper Tantrum	**2014 to 2016 Baseline**
Lag (Hedge Funds Flows)	0.52***	-0.02
	(0.17)	(0.06)
Lag (EM Currency Index)	37.54***	18.23***
	(9.64)	(3.02)
R-squared	36%	7%

Note: Standard errors in parentheses are heteroscedasticity and autocorrelation robust (HAC) using 2 lags.

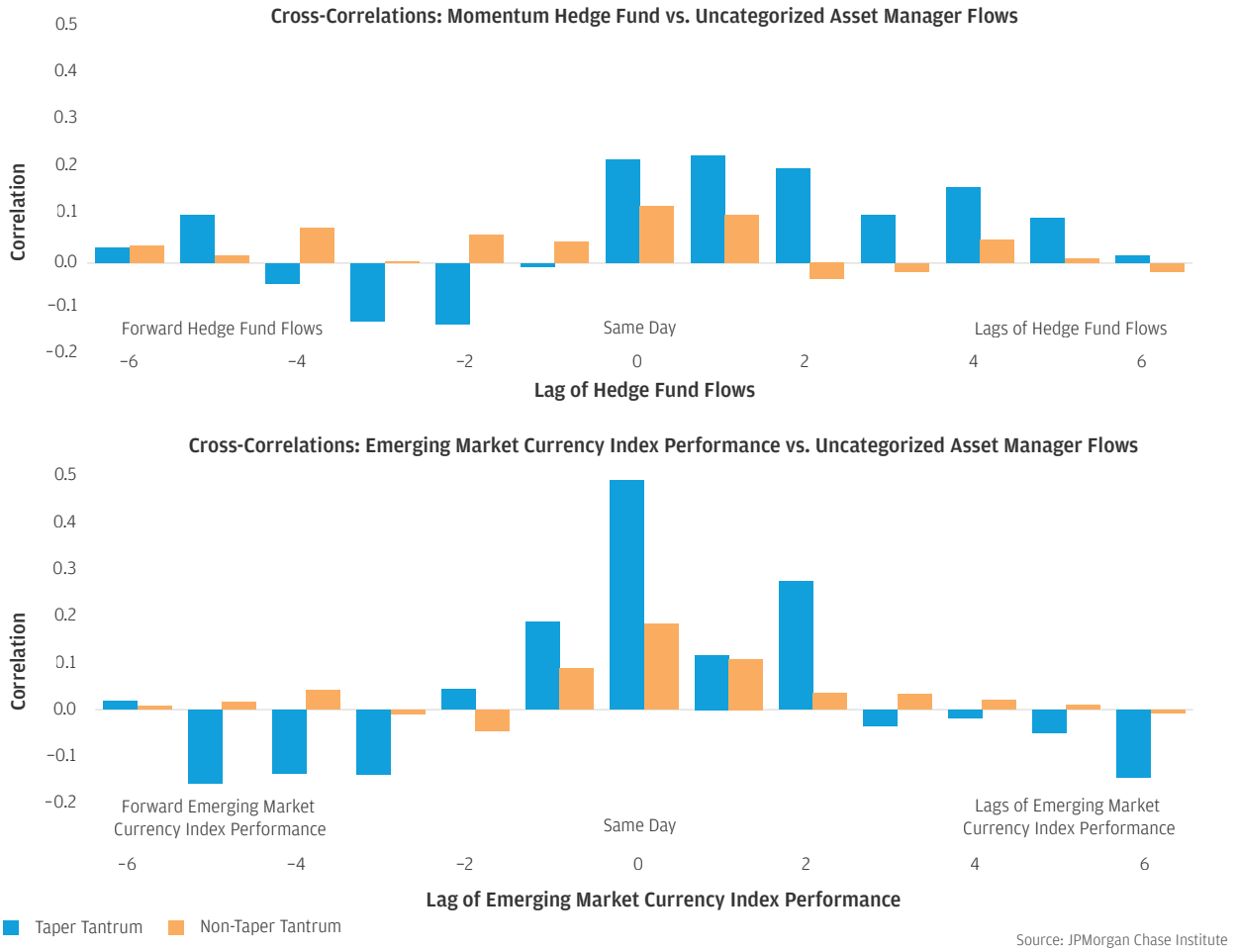
* p<.1, **p<.05, ***p<.01

Source: JPMorgan Chase Institute

As indicated by the regression output in Table 6, the connection between lagged momentum hedge fund flows and asset managers increases during the taper tantrum. Interestingly, the relationship appears to be strictly one-way; that is, lagged asset manager flows do not predict hedge fund flows. This is depicted in Figure 9, which displays correlations between flows between the two categories with varying lags of hedge fund flows. Contemporaneous and lagged hedge fund flows are correlated with asset managers more during the taper tantrum than in the baseline sample, and the correlations show no ability for asset manager flows to predict future hedge fund flows. A similar result is apparent, but not statistically significant, for banks in the momentum category.

Additionally, Figure 9 details the temporal connection between asset manager flows and EM FX and how the linkages evidently increased during the taper tantrum. The strongest connection between asset manager flows and price action is with no lag, which is consistent with either a price impact of trading or that asset managers respond to price action within the same day (or a little of both). Meanwhile, the positive correlations on one or two days of lagged price action point to asset managers chasing recent price action, for example selling EM FX in the wake of recent depreciation, perhaps in anticipation of fund outflows.[26]

Figure 9. Increasing Flow-Flow and Flow-Price Linkages for Asset Managers during the Taper Tantrum



Source: JPMorgan Chase Institute

Note: The cross-correlation functions (CCF) displayed above offer a visualization of the relationship between the selected flow variables at various leads and lags. The top plot highlights that the leader-follower link between hedge fund flows and asset managers seems to be one-way during the taper tantrum: positive blue bars (denoting the taper tantrum observations) tend to be at offsets of 0 and positive lag values. That is, the lags of hedge fund flows predict contemporaneous asset manager trades but not the other way around. The relationship is weaker in the post-taper tantrum years.

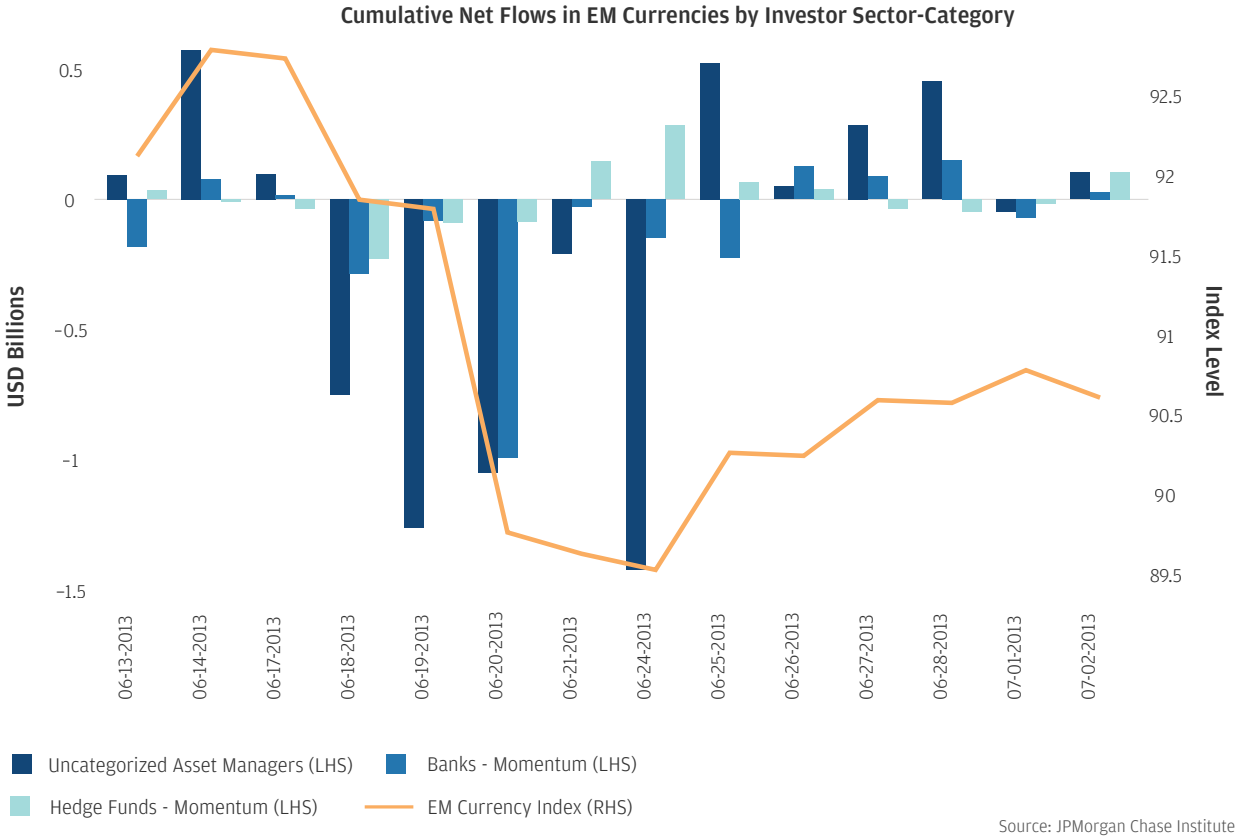
Additionally, (in the second CCF) there are multiple potential interpretations: (1) the strong contemporaneous correlation during the taper tantrum could suggest a higher price impact of trades, or a tighter intraday response of asset managers to price action; (2) the positive correlations with lags of EM performance suggest asset managers "chasing" recent price action, potentially to prepare for real or expected fund outflows; and (3) the small positive correlation between flows and next day EM performance suggests a potential delayed impact of flows or remnants of the contemporaneous relationship spilling over due to time zone cutoffs in the EM Currency Index.

Event Study: June 2013 FOMC Meeting

To illustrate the relationship between net flows and EMCI at a more granular level, we include an event study of the June 19, 2013 FOMC meeting and the immediate aftermath. The reaction to the post-meeting communications represents the largest swing in EMCI during the taper tantrum price action. Relevant flow variables are presented in Figure 10. In this important episode, EM currency depreciation coincided with sizeable net sales, in particular coming from banks in the momentum category and uncategorized asset managers. Hedge funds in the momentum category had unloaded significant risk ahead of the event (as shown earlier in Figure 8).

This case study can be interpreted as consistent with the findings in Feroli et al. (2014), in which the authors study mutual fund flows and returns, and note that "monetary shocks can drive flows, and flows can drive prices … in contrast to textbook long-term investors who step into a falling market to cushion price falls, the evidence from bond fund flows shows the potential for amplifying interactions of price and quantity changes."

Figure 10. Strong Net Outflows in EM Currencies around the June 2013 FOMC Meeting



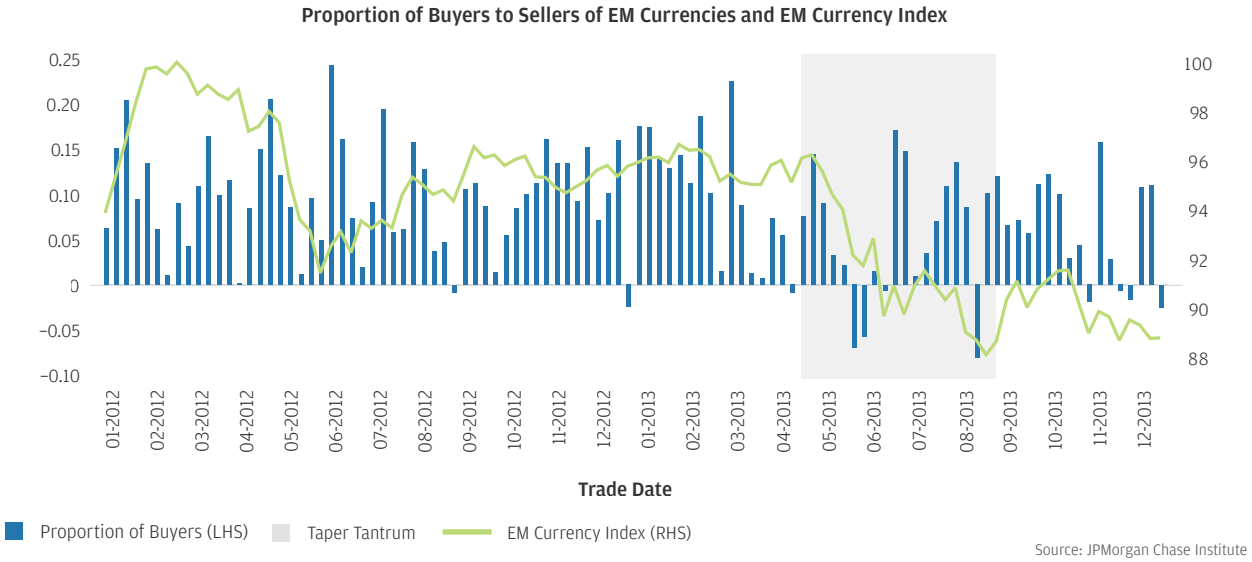
Source: JPMorgan Chase Institute

Finding 3b: During isolated pockets of the taper tantrum, the balance between the number of market participants buying EM currencies on net and selling flipped to extreme levels, suggesting potential herding activity.

While definitions of herding behavior in financial markets vary, for the purposes of this analysis we consider herding as defined by a change in the general direction of flows across a range of market participants, especially when the behavior shift is connected with a corresponding change in price action. To examine potential herding behavior in EM currencies, we calculate on a weekly basis the proportion of buyers versus sellers, loosely based on the herding analysis described in Cai et al. (2018). Specifically, we count the number of institutional investors registering net EM FX purchases in a given week, subtract the number executing net sales, and divide by the total number of market participants with positive transactions. Unsurprisingly, the general relationship between this buyer-seller imbalance measure and price action and EM currency performance is moderately positive; the correlation over the 2012 to 2016 period is 0.25 in weekly data.

Consistent with net accumulation of EM currencies among clients in our data in the run-up to the taper tantrum, we find that, typically, the number of buyers exceeds the numbers of sellers (see Figure 11). However, during three weeks within the taper tantrum, the number of sellers relative to the number of buyers exceeded any other week outside this particular episode in the two-year period between 2012 and 2013.

Figure 11. Buyers-to-Sellers Imbalance Declines around Amid Volatile Pockets of Depreciation



Source: JPMorgan Chase Institute

It is important to note that this comparison of client counts inherently ignores their size. As a caveat, consider a scenario in which imbalances in this metric may be distorted by the presence of a large trader: lopsided demand on one side of the market from a small number of large investors could lead a market maker to seek out clients willing to take offsetting positions. If the offsetting positions are sourced across a large number of small clients, the buyer-seller imbalance metric discussed here would point in the opposite direction of the initial net flow from the larger clients, potentially leading to a false indication of herding as typically interpreted.

Notwithstanding the drawbacks from such this metric, sharp EMCI depreciation in the run-up to the volatile June FOMC meeting coincides closely with two net seller dominated weeks. Additionally, the most negative value in the buyer-seller imbalance in the 2012 to 2013 period occurred in late August 2013, closely preceding the nadir in EMCI in the taper tantrum. So, while only suggestive, we view this indicator as highlighting a potentially important role for price action-flow interactions that may—at acute periods in time—jointly affect a broad swath of market participants.

Conclusions and Implications

Spillovers and Monetary Transmission Mechanisms

During the summer of 2013, the trading behavior of hedge funds and banks associated with momentum acted as a monetary transmission mechanism, propagating signals of future adjustment in the Federal Reserve's Large-Scale Asset Purchase program to EM currencies. Furthermore, signs of changing asset manager trading patterns are indicative of herding that potentially impacted market prices; these investors increasingly tracked the trajectory of lagged momentum hedge fund flows and had a higher correlation with contemporaneous price action.

Our findings illustrate how the behavior of market participants can serve as an extension of the more traditional levers of monetary policy; institutional investors—while influenced with a margin of error—can determine the magnitude and speed with which monetary policy signals are transmitted across markets. As global central banks increasingly rely on influencing assets that they do not directly control in order to affect financial conditions and macroeconomic targets, a detailed understanding of how market participants respond to monetary policy signals has gained importance.

Relevance for Unconventional Monetary Policy

Central banks should continue to advance their understanding of how policy measures designed to influence market prices also influence the behavior of market participants, both as new policies are enacted and, perhaps more importantly, as those new policy measures are removed. While unconventional monetary policy tools were an important part of the recovery after events of 2008 and early 2009, central banks in developed markets have only limited experience contending with the consequences of reversing unconventional monetary policy measures—and in certain instances, the removal has led to market instability.

Unconventional policy measures are often undertaken as a response to a sharp economic downturn and, therefore, the ability of the central bank to make specific statements about the near-term trajectory of its policy actions can be a powerful and effective part of the policy toolkit. However, the smooth removal of unconventional policy accommodation has proven difficult due to imperfect knowledge of how market participant behavior is conditioned on the degree of policy certainty, with associated consequences for asset prices. In this sense, an increase in market volatility may be an unavoidable side effect of achieving the desired policy and economic outcome.

Indeed, both the taper tantrum episode and the Swiss National Bank's (SNB) removal of the Minimum Exchange Rate policy (documented in previous Institute research: Does the Timing of Central Bank Announcements Matter?) provide two prominent examples of central bank policy changes significantly affecting investor behavior, coincident with a high degree of market volatility. Our findings regarding trading behavior during the taper tantrum covered herein and regarding hedge fund trading during the Minimum Exchange Rate policy and its removal underscore that when policymakers want to unwind unconventional policy measures and return pricing power to the market the behavior induced by the distorted incentives can become a complicating factor.

Feroli et al. (2014) summarize this point succinctly, suggesting that "the tradeoff for monetary policy is not the contemporaneous one between more versus less policy stimulus today, but is better understood as an intertemporal tradeoff between more stimulus today at the expense of a more challenging and disruptive policy exit in the future." They go on to say that their analysis does suggest that unconventional monetary policies (including QE and forward guidance) can build future hazards by encouraging certain types of risk-taking that are not easily reversed in a controlled manner."

Financial Market Stability

Policymakers interested in monitoring financial market stability should continue to build a better understanding of institutional investor behavior, including the momentum trading and crowded trades, as described in Stein (2009). Since the Global Financial Crisis, the public sector has undertaken efforts to fill information gaps, in part, by capturing more transaction data than ever before. For example, Financial Industry Regulatory Authority (FINRA) member firms since 2017 have been reporting transactions in U.S. Treasury Securities to U.S. regulators via the Trade Reporting and Compliance Engine (TRACE).[27] While transactions data do not directly reveal some sources of financial stability risks, like crowded positions, such granular information can be used to make inferences about risk factors and the potential market impact.

Crowded positions arise when a broad set of investors concurrently take the same position in a financial instrument or related financial instruments. Because each individual market participant has only partial information of how many other market participants are taking the same position and the collective market's capacity, capital, or liquidity, an adverse change in price can rapidly escalate and create market dislocations. Increasing communication with key institutional investors would help central bankers identify crowded positions and understand how they might be unwound, and both the Federal Reserve, through the FRBNY Survey of Market Participants[28] and the ECB through their Survey of Monetary Analysts[29] have taken steps in this direction.

Policymakers should also be attuned to the idea that when changes in policy lead to an increase in uncertainty, liquidity is likely to drop and can lead to financial market instability. As we show in this report, liquidity seems to drop on unexpected news, which can lead to amplified market movements. This is consistent with empirical work from De Pooter et al. (2018), which notes that when uncertainty is low, market participants take more risk and therefore have to trade more if they are surprised, which leads to a larger impact on yields.

Finally, our findings add to the body of evidence that refutes the popularly-held narrative that long-only investors with long-term investment horizons tend to act as a stabilizing force amid market volatility. Such behavior did not occur in EM currencies during the taper tantrum—none of the investor sectors or investor sector-category combinations registered substantial purchases of EM currencies as they depreciated during the taper tantrum—findings that are consistent with our previous research (FX Markets Move on Surprise News) and the empirical results of Feroli et al. (2014).

Data Asset

In this report, the JPMorgan Chase Institute utilizes a novel data asset to inform our understanding of institutional investor behavior in financial markets. We have constructed a unique, de-identified trade-level data asset that includes certain institutional investor transactions where the Markets Division of J.P. Morgan's Corporate & Investment Bank (CIB) acted as the market maker.

This data asset is a unique resource being used for publicly available, policy-oriented research that allows for a highly granular and detailed look at the behavior of institutional investors across all regions and in all asset classes. This data asset includes nearly 395 million trades and over 44,000 unique institutional investors.

Our data asset covers:

1. Various types of institutional investors, including asset managers, banks, broker-dealers, corporates, hedge funds, pension funds, insurance companies, public sector investors, and others.[30]
2. Institutional investors from all regions globally that, for this report, we broadly categorize into three regions: Americas, Asia/Pacific (APAC), and Europe/Middle East/Africa/Other (EMEA).
3. Trades in financial instruments in all asset classes: FX, equities, fixed income, and commodities.
4. Both electronic and voice trades.

Our data cover the post-financial crisis period, though historical coverage varies by asset class. For this report, we analyzed activity occurring between 2012 and 2016.

Our data is de-identified and excludes the name of the institutional investor and other information that would allow us to identify the institutional investor associated with any particular trade. Each institutional investor is assigned a random identifier before we ingest the data and this identifier allows us to allocate trades to a given institutional investor and track their transactions over time.

We can also observe the institutional investor's sector and country. We are able to identify transaction details such as the exact instrument traded, whether it was bought or sold by the institutional investor, the amount of each instrument transacted, and the price at which it was executed. Given these details, we can calculate a first-order measure of risk associated with each transaction. This is a critical distinction and advantage of our data, and allows us to comment not only on transaction volumes but also on the amounts of risk being transferred. Most publicly available data do not include or facilitate the calculation of a measure of risk. As the first financial institution to use this type of data for the benefit of the public good, JPMorgan Chase puts strong guardrails, filters, and strict data sharing protocols in place throughout the data asset building and analysis process to preserve the confidentiality requirements of the institutional investors who transact with the Corporate Investment Bank.

Box 3: JPMC Institute—Public Data Privacy Notice

The JPMorgan Chase Institute has adopted rigorous security protocols and checks and balances to ensure all customer data are kept confidential and secure. Our strict protocols are informed by statistical standards employed by government agencies and our work with technology, data privacy, and security experts who are helping us maintain industry-leading standards.

There are several key steps the Institute takes to ensure customer data are safe, secure, and anonymous:

- The Institute's policies and procedures require that data it receives and processes for research purposes do not identify specific individuals.
- The Institute has put in place privacy protocols for its researchers, including requiring them to undergo rigorous background checks, and enter into strict confidentiality agreements. Researchers are contractually obligated to use the data solely for approved research, and are contractually obligated not to re-identify any individual represented in the data.
- The Institute does not allow the publication of any information about an individual consumer or business. Any data point included in any publication based on the Institute's data may only reflect aggregate information or information that is otherwise not reasonably attributable to a unique, identifiable consumer or business.
- The data are stored on a secure server and only can be accessed under strict security procedures. The data cannot be exported outside of JPMorgan Chase's systems. The data are stored on systems that prevent them from being exported to other drives or sent to outside email addresses. These systems comply with all JPMorgan Chase Information Technology Risk Management requirements for the monitoring and security of data.

The Institute prides itself on providing valuable insights to policymakers, businesses, and nonprofit leaders. But these insights cannot come at the expense of consumer privacy. We take all reasonable precautions to ensure the confidence and security of our account holders' private information.

Constructing our Samples

For this analysis, we constructed a data set of institutional investors who transacted in the FX or government bond markets between 2012 and 2016.

We include transactions in FX that met the following criteria:

1. Occurred in major currencies: GBP, JPY, EUR; or emerging market currencies: MXN, BRL, ZAR, THB, TRY, IDR, INR, against any other currency, including USD
2. Were spot or forward trades

We include transactions in government bonds that met the following criteria:

1. Occurred in U.S. Treasuries or emerging market government bonds in Mexico, South Africa, Indonesia, Thailand, and Turkey that were denominated in local currency
2. Were conducted in the secondary market

For bonds, we eliminated trades that appear to be primary market auction trades by removing client transactions in any security that match the date and price of its bond auctions. This includes primary issuance and any re-openings.

Further, we clean the data to eliminate any trades that were cancelled, had a missing trade date, a buy or sell amount of zero or missing, a missing investor sector, or were associated with an exchange rate that was very different than the prevailing market exchange rate.

In all, we have a large number of trades over the years covered.

Table 7. Approximate Number of Trades Per Year

Year	FX		Bonds	
	Majors	Emerging Markets	U.S. Treasury	Emerging Markets
2012	7,740,000	1,233,000	124,000	20,000
2013	11,010,000	1,436,000	104,000	22,000
2014	17,699,000	1,284,000	85,000	25,000
2015	16,121,000	1,215,000	94,000	23,000
2016	20,236,000	1,502,000	165,000	17,000

Source: JPMorgan Chase Institute

Broadly speaking, we believe that J.P. Morgan's overall share of institutional investor trading is large enough for our data asset to be representative of market activity by all institutional investors in the relevant markets. For the analysis in this report, we believe our share of the total FX market to be among the largest of all market makers and large enough overall to be directionally representative of the entire market. However, given the natural variation in J.P. Morgan's market share across different currencies, investor sectors, regions, and time zones, the degree to which the sample we are analyzing is representative of the broader market will vary. Also, it is likely that our data would be most representative for investors in the Americas and least representative for investors in Asia/Pacific. This is an important factor to keep in mind when interpreting the results of our analysis. However, as shown in Table 8 below, we believe that our institutional investor coverage in all currencies, sectors, and regions to be large enough for our analysis across these dimensions to be informative and meaningful.

Table 8. Approximate Number of Institutional Investors Per Year

Year	FX		Bonds	
	Majors	Emerging Markets	U.S. Treasury	Emerging Markets
2012	27,700	8,500	1,700	800
2013	29,300	9,300	1,800	900
2014	33,000	10,200	1,600	700
2015	36,400	10,900	1,600	800
2016	42,600	12,700	1,900	700

Source: JPMorgan Chase Institute

Appendix

Appendix I: Interpreting our Regression Results

Interpretation of the results of our regressions of price action on flows (and other variables) is not straightforward. Causal channels that would generate correlations between certain investors' flows and price action likely run in multiple directions. Selling pressure can cause depreciation (consistent with models of dealer inventories and liquidity provision), or price depreciation could influence investors to sell (in order to raise funds for anticipated fund outflows, for example).

There are good reasons to believe mechanisms that work in both directions may be active simultaneously, especially considering heterogeneity across institutional investors in these markets. Additionally, since our transaction data only contain those that traders execute against J.P. Morgan, interpretation of their magnitude is further nuanced.[31] In future work, we will seek to disentangle the various channels at play here, in part through making greater use of more granular transaction time stamps.

Appendix II: Categorizing Institutional Investors According to Their Trading Activity

We investigate an additional categorization of institutional investors (beyond their sector) based on readily observable relationships between their trading activity and three variables: (1) contemporaneous price changes, (2) lagged net flows, and (3) lagged price changes. Our goal is to identify market participants that feature systematic trading based in these dimensions to see whether we are able to glean additional insights about which market participants may play a role in transmitting news to prices and influence markets.

We use the following:

$$f_{i,t} = c_i + \beta_{px} px_t + \beta_{lf} f_{i,t-1} + \beta_{lpx} px_{t-1} + \varepsilon_{i,t}$$

1. $f_{i,t}$: ***Net Flows:*** represents market participants *i*'s net flows in time *t*
2. β_{px}: ***Price Pressure***[32]***:*** the contemporaneous relationship between flows and price action
3. β_{lf}: ***Autocorrelation:*** correlation between recent and current flows
4. β_{lpx}: ***Momentum:*** lagged price action's correlation with current flows

We begin with a universe of over 10,000 institutional investors who ever traded FX from 2012 to 2016. Next, we filter out inactive investors (for whom there is insufficient data for meaningful categorization) by ranking all investors by gross volume for each currency and keeping the largest investors who make up 90 percent of the volume but dropping those who have fewer than 20 transactions in the currency over the period of interest. The activity filter leaves us with over 4,000 institutional investors that were classified as active by this definition in any calendar year and any currency. Approximately 2,000 institutional investors were active in any single year in our data.

We then run the regression specification above at the market participant level using rolling five-day trading day windows from a training sample covering each year between 2014 and 2016. These regressions yield currency-market participant coefficients for the relationship between net flows and contemporaneous prices, lagged prices, and lagged net flows for each year in the sample.

The resulting set of estimates is a relatively high dimensional object, making it a candidate for statistical tools aimed at dimensionality reduction to help us find meaningful and intuitive ways to group market participants. To systematically make sense of the results, we leverage a machine learning method known as k-means to cluster market participants that seem most alike in terms of their trading footprint, as described by the t-stats associated with their regression coefficients.[33]

In our benchmark setting, we use four groups and employ the k-means algorithm to find groups of institutional investors whose trading behavior is similar to one another by "clustering" investors with similar coefficients. We found that this number of groups provides an intuitive parsing of differentiated trading patterns, which we describe in the table below.

The k-means algorithm requires a complete matrix as an input, and so for a given market participant we impute values for any currencies in which they were not active as the average of observed values for that investor. We further filter the results by leaving as uncategorized investors those who were not in the same category for at least two of the three years in our training sample, to help target repeated systematic trading footprints. This leaves us with about 1,200 categorized institutional investors in our sample, covering approximately 60 percent of transactions and gross volume.

As described in the Box 2 (page 29), the clustering algorithm results in stable categories of institutional investors based on the relationships between their net flows and contemporaneous market prices, lagged market prices, and lagged net flows. The categories can be described as follows:

1. Market participants associated with **momentum** trade in the prevailing direction of contemporaneous and lagged prices. More than half of the categorized hedge funds fall in this category, and a number of asset managers and pension and insurance companies also feature prominently.
2. **Contrarians**, a category dominated by banks, tend to trade against the prevailing market movement. One reason for trading in this way would be risk management practices that prescribe a specific weighting for exposures, so when a currency appreciates, that currency takes a larger weight and must be sold.
3. **Reversal** traders appear to have a short-term rationale for trading and tend to quickly unwind flows irrespective of price action. The hedge funds and asset managers in this category could be trading based on short-term market signals.
4. **Builders** accumulate (or unwind) positions over time in a way that is not closely linked with near-term price action. Public sector institutions are more likely to be in this category than any other, and asset managers and banks make up the majority of the category.
5. Finally, **uncategorized** institutional investors failed to meet our activity filter or did not demonstrate systematic trading patterns as defined by our categorization method. The majority of these market participants are asset managers.

Table 9. Market Participant Counts across Categories and Sectors

Category	Sector	Percent of Category	Percent of Sector*
Momentum	Asset Managers	34%	43%
	Banks & Broker Dealers	27%	29%
	Corporates	9%	31%
	Hedge Funds	21%	55%
	Pension Funds & Insurance	6%	51%
	Public Sector & Other	3%	31%
Contrarian	Asset Managers	16%	17%
	Banks & Broker Dealers	56%	50%
	Corporates	12%	35%
	Hedge Funds	10%	23%
	Pension Funds & Insurance	3%	19%
	Public Sector & Other	2%	22%
Reversals	Asset Managers	43%	9%
	Banks & Broker Dealers	17%	3%
	Corporates	23%	13%
	Hedge Funds	13%	6%
	Pension Funds & Insurance	2%	2%
	Public Sector & Other	2%	3%
Builders	Asset Managers	41%	31%
	Banks & Broker Dealers	26%	17%
	Corporates	10%	21%
	Hedge Funds	10%	16%
	Pension Funds & Insurance	6%	28%
	Public Sector & Other	6%	44%

Percent of Uncategorized Market Participants		
Uncategorized Sectors	Asset Managers	67%
	Banks & Broker Dealers	6%
	Corporates	19%
	Hedge Funds	5%
	Pension Funds & Insurance	2%
	Public Sector & Other	1%

Note: *percent of categorized market participants

Source: JPMorgan Chase Institute

Table 10. Market Participant Category Transitions

		Time t + 1			
		Momentum	**Contrarian**	**Reversal**	**Builder**
Time t	**Momentum**	45%	28%	9%	17%
	Contrarian	30%	43%	8%	20%
	Reversal	27%	24%	38%	10%
	Builder	29%	26%	3%	41%

Source: JPMorgan Chase Institute

Category Stability

The clusters resulting from our process are stable over time in the sense that when run on consecutive calendar years, the algorithm generally finds it optimal to place cluster centers in such a way that we are able to maintain consistent interpretations of the categories year-after-year. Further, the mix of cluster centers are consistent across currencies. That is, the cluster centers associated with momentum reflect positive contemporaneous and lagged relationships with price action across all currencies included in the analysis.

Similarly, investors tend to remain in the same category over time, as compared with a null hypothesis of random categorization changes. The dynamics of market participant categorization can be summarized by a transition matrix denoting the empirical probability of transitioning from one category to another from year-to-year. We summarize these dynamics in Table 10.

The interpretation of Table 10 is as follows. The rows can be thought of as the categorization in the base year (say time t) and the columns are the category in which an institutional investor lands in the following year (t+1). Values in any row A and column B in the table reflect the probability of experiencing the transition from category A to category B. With four categories, independent categorization through time would imply a table with values of 25 percent everywhere. On the contrary—and consistent with stability relative to random categorization—numbers on the diagonal are higher than the off-diagonal elements, meaning market participants are most likely to remain in the same category than make any other switch.

Appendix III: Trading volumes were only modestly higher during the taper tantrum relative to surrounding periods despite significant price changes.

To account for seasonality in trading volumes, we benchmark trading during the taper tantrum period against the same months in the surrounding years. We find that the monthly trading volumes of institutional investors in U.S. Treasuries, EM currencies, and EM government bonds increased during the taper tantrum but were not materially or consistently larger than in the same month in the surrounding years. We hypothesize that the modest increases in trading volume were unlikely to be the sole cause of the increased market volatility in U.S. Treasuries, EM FX, and EM government bonds during the taper tantrum.

Figure 12 shows a month-by-month comparison of trading volumes in U.S. Treasuries, EM currencies, and EM government bonds from 2012 to 2016. We focus on a month-by-month comparison to account for seasonality in trading volumes. In U.S. Treasuries, trading volumes in May, June, July, and August of 2013 were a modest 22 percent higher than trading volumes in the same months of 2012 and 2014, but lower than trading volumes in 2016. Monthly trading volumes in EM FX during the taper tantrum months of 2013 were higher than in the corresponding months of 2012 but similar to the trading volumes in the corresponding months of 2014 through 2016. In EM government bonds, monthly trading volumes were elevated in May and June of 2013 relative to the same months in 2012 and 2014 but similar to volumes in the same months of 2016. In addition, monthly trading volumes in EM government bonds were lower in July, August, and September of 2013 compared to the same months in surrounding years.[34]

Figure 12. Volumes were Relatively Stable through the Taper Tantrum Compared to Surrounding Years

Source: JPMorgan Chase Institute

Appendix IV: Addressing Heteroscedasticity

Academic literature has described how changing volatility can mechanically affect correlation coefficients. Since times of crisis almost by definition implies higher volatility, we attempt to check our measures of herding activity during the taper tantrum, presented in Finding 3a, with metrics adjusted for heteroscedasticity. The procedure we use is described in Forbes and Rigobon (2002). The correction, under certain assumptions,[35] effectively puts estimates from periods of different volatilities on a level playing field.

To carry out the test of changing correlations, we compute the contemporaneous correlations among the net flows of the institutional investors in Finding 3a (uncategorized asset managers and hedge funds and banks from the momentum category). We also examine the change in the correlation between asset manager net flows and changes in EMCI on a rolling two-day basis. The short multi-day tenor was chosen to reduce the effect of time zone differences across global markets but avoid unduly reducing the number of observations.

Table 11 below shows the relevant correlations along with test statistics, both unadjusted and adjusted for the changes in volatilities observed over the taper tantrum. The increasing correlations—and the adjusted t-stats—suggest changing relationships that are not due solely to higher volatility during the taper tantrum. Statistical significance is somewhat unimpressive in part due to the small taper tantrum sample; t-statistics in the table are all close to 2, implying rejection of a null hypothesis of constant correlation at about the 5 percent level.

The correlation estimates adjusted for changing volatility do not tell a substantially different story than the unadjusted figures; both show palpable changes in linkages in the flow-flow and flow-price action relationships, suggesting that the rise in explanatory power was not a relic solely of the change in volatility. Indeed, flows during the taper tantrum were not substantially more volatile relative to the general post-crisis baseline. The largest rise in net flow volatility comes from banks in the momentum category, with an increase of 22 percent, while uncategorized asset manager and momentum hedge fund flow standard deviations were approximately flat and lower, respectively, relative to the baseline 2014 to 2016 period.

Table 11. Changing Flow-Flow and Flow-Price Linkages

	Taper Tantrum Period Correlation	Taper Tantrum Period Adjusted Correlation	2014 to 2016 Baseline	Unadjusted* T-Stat on Change	Adjusted* T-Stat on Change
Uncategorized Asset Managers, Momentum Hedge Funds	0.39	0.43	0.16	1.61	1.95
Uncategorized Asset Managers, Momentum Banks	0.36	0.33	0.03	2.30	2.08
EM Currency Index, Uncategorized Asset Managers	0.49	0.50	0.25	1.84	1.86

Note: *Sample estimates and test statistics computed using two-day non-overlapping observations.

	Volatility Ratio: Taper Tantrum Standard Deviation Relative to Baseline**
Momentum Hedge Funds	0.78
Momentum Banks	1.22
Uncategorized Asset Managers	0.99
EM Currency Index	1.12

Note: ** Taper tantrum net flow standard deviation divided by the same measure over the 2014 to 2016 baseline period.

Source: JPMorgan Chase Institute

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Endnotes

1 See https://www.federalreserve.gov/newsevents/pressreleases/monetary20120913a.htm

2 September 2013 speech by ECB Executive Board member Benoît Cœuré: https://www.ecb.europa.eu/press/key/date/2013/html/sp130902.en.html

3 The March 2013 Bank of England Asset Purchase Facility Report: https://www.bankofengland.co.uk/-/media/boe/files/asset-purchase-facility/2013/2013-q1

4 Bank of Japan monetary policy statement "Introduction of the 'Quantitative and Qualitative Monetary Easing' dated April 4, 2013: https://www.boj.or.jp/en/announcements/release_2013/k130404a.pdf.

5 May 1, 2013 FOMC statement: https://www.federalreserve.gov/newsevents/pressreleases/monetary20130501a.htm

6 We use the results of the FRBNY Primary Dealer Survey as a proxy for market expectations. It shows that on April 22, 2013, half of the primary dealers did not expect tapering to begin until 2014. By July 22, 2013, half of the primary dealers expected tapering to begin at the September 18, 2013 FOMC meeting.

7 See https://www.reuters.com/article/us-usa-fed-bernanke-highlights/bernankes-qa-testimony-to-congressional-panel-idUSBRE94L00720130522

8 On September 9, 2013, 75 percent of primary dealers expected tapering to be announced at the September 18, 2013 FOMC meeting, according to the New York Fed's Survey of Primary Dealers.

9 September 2013 FOMC statement: https://www.federalreserve.gov/monetarypolicy/fomchistorical2013.htm

10 We analyze EM government bond yields rather than the spread (difference) between EM government bond yields and U.S. Treasury yields because what matters for economic activity is bond yields and not spreads. Furthermore, while they may hedge their portfolios using financial instruments of their choice, most institutional investors typically buy or sell EM government bonds outright rather than against a U.S. Treasury security of a similar maturity. Finally, because we are examining EM government bonds denominated in local currency, we would need to take into account the cross-currency basis to convert each EM government bond yield into a spread to Treasuries.

11 The average four-month change in EMCI over the period was -1.48%, with a standard deviation of 4.3%. EMCI depreciated 9.3% between the beginning of May and the start of September 2013, which is about 1.8 standard deviations larger than the average four-month move, measured over 2010 through 2019.

12 Other factors that can drive such changes in reduced-form relationships include omitted variables and endogeneity between EM assets and U.S. assets. To address the former, we emphasize the role for investor portfolio rebalancing as an important additional variable driving EM assets, which we document in the main findings of this report.

13 In a 2014 speech by then-Fed Governor Jeremy Stein, he hypothesizes that a number of "QE-infinity" optimists may have contributed to the volatility, even when policy statement merely "clarify" a path of policy that is close to a central expectation, e.g. a survey median. In terms of the knock-on effects of these traders, he states, "... crucially, in asset markets, it is often the beliefs of the most optimistic investors--rather than those of the moderates--that drive prices, as they are the ones most willing to take large positions based on their beliefs. Moreover, this same optimism can motivate them to leverage their positions aggressively. In this setting, a piece of monetary policy communication that merely 'clarifies' things—that is, one that delivers the median market expectation but truncates some of the more extreme possibilities—can have powerful effects."

14 In FX, a carry trade is traditionally implemented by buying a high-yielding currency while selling a low-yielding currency, with the view that the positive interest rate differential will more than offset any deprecation of the high-yielding currency relative to the low-yielding currency.

15 To illustrate the role of a market maker, suppose an investor wanted

to buy EUR100 million and sell CHF and asked J.P. Morgan (among other market makers) to price such a transaction. J.P. Morgan would propose the exchange rate for the transaction, for example at 1.205 CHF per EUR. If the exchange rate shown by J.P. Morgan was best among the market makers and accepted by the investor, then J.P. Morgan would sell the investor EUR100 million and buy from the investor CHF120.5 million. By executing this transaction, the investor has transferred risk to the market maker: J.P. Morgan is now shorter EUR100 million and longer CHF120.5 million relative to their positions prior to this trade, while having provided liquidity to the investor and put capital at risk. Examples of market makers in FX include banks, broker-dealers, and high-frequency trading firms. Institutional investors choose which market makers to transact with based on many factors, including price and relationship. For a more complete description of the role of market makers in setting prices, see Weill (2007).

16 The bank category includes the Chief Investment Office and Treasury departments of banks, which might execute FX transactions to hedge their assets or liabilities and might purchase (or sell) government bonds as investments. The bank category also includes broker dealers and the FX market-making operations of smaller banks that transact with J.P. Morgan for liquidity. The inclusion of the latter category likely accounts for much of the two-way net flows (both buying and selling) we see from this sector in the same or adjacent time intervals.

17 This narrower sample more closely represents the relationships prevailing around a monetary policy shock. In particular, the coefficient on the 10-yr Treasury yield becomes statistically significant in regressions of both EMCI and GBI-EM yields, and the magnitude of the estimate is larger.

18 Academic work—including by Evans and Lyons (1999 and 2012)—describe the role of order flow as a determinate of FX rate fluctuations in a similar context.

19 Recent examples include Hoeck, Kamin, and Yoldas (2020), Cieslak and Pang (2019), and Jarocinski and Karadi (2018).

20 As described in Forbes and Rigobon (2001), volatility changes can change statistical measurements, like correlations and regression estimates, even when the underlying structural relationships between variables is unchanged.

21 To be sure, a number of market participants were net purchasers of EM currencies during the taper tantrum. However, neither sector-level flows nor our trading pattern-based categorization methods clearly identified a group of investors that provided systematic market support through the episode.

22 We use all of 2013 in this context, given the relatively short length of the taper tantrum measured in two-day rolling increments.

23 Our assumption is that our net flows are representative of total market net flows over time and across a broad set of currencies but we acknowledge that this representativeness likely varies from currency to currency and over time. Given this assumption, if we scaled our net flows up by 1/our market share, the coefficients in our regression would fall proportionately.

24 In these regressions, net flows for both leader and follower are aggregated over two days and lags are set to two days to fully distinguish contemporaneous relationships from those occurring on different days. That is, when the lag is equal to 1, we would be testing for the relationship between the leader's net flows on Monday and Tuesday and the follower's net flows on Wednesday or Thursday.

25 We also examined these relationships in vector autoregression (VAR) settings. The results did not identify interesting time series dynamics other than the ones implied in the simple regression results presented in this section.

26 The positive correlation during the taper tantrum (and, to a lesser

degree, during the baseline) between flows and one-day-forward price action could be due to misalignment of flows and prices due to time zone differences and EMCI index computation methodology. Alternatively, the estimate could capture a lagged influence of flows on price action.

27 Further information can be found in this New York Fed blogpost: https://libertystreeteconomics.newyorkfed.org/2018/09/unlocking-the-treasury-market-through-trace.html

28 Accessible at: https://www.newyorkfed.org/markets/survey_market_participants

29 Accessible at: https://www.ecb.europa.eu/stats/ecb_surveys/sma/html/index.en.html

30 The public sector includes entities such as central banks, sovereign wealth funds, regional governments, and supranationals. The other category includes private equity investors and special purpose vehicles. Designations of investment style are outputs of JPMC Institute algorithms after de-identification occurs.

31 Our assumption is that our net flows are representative of total market net flows over time and across a broad set of currencies, but we acknowledge that this representativeness likely varies from currency to currency and over time. Given this assumption, if we scaled our net flows up by 1/our market share, the coefficients in our regression would fall proportionately and we would still fully explain the price action in EMCI as shown in the figure.

32 We use the term "price pressure" to reflect the influence of demand-driven flows into or out of an asset on its price. See Greenwood and Vayanos (2009) and Hendershott and Menkveld (2014) for analogous uses of the term.

33 We found that using t-stats—corrected for heteroscedasticity and autocorrelation—instead of raw coefficients was a more robust way to categorize investors because they summarize the statistical strength of a relationship and help standardize market participants that trade widely varying gross volumes of currencies.

34 The modest increase in trading volumes during the taper tantrum stands in marked contrast to our findings regarding the spike in trading volumes surrounding other market events, as described in previous Institute research: FX Markets Move.

35 As described in Forbes and Rigobon (2002), these assumptions are no omitted variables and no endogeneity. While we do not necessarily think these are realistic assumptions, the authors note the difficulty of making comparisons without them.

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