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Portfolio investment and U.S. monetary policy announcements: An event study analysis using high-frequency data from Mexico

Marco Hernandez-Vega ^{1*}

¹ Banco de Mexico, Mexico

* Correspondence: auhernandez@banxico.org.mx

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Abstract: We study how unconventional monetary policy announcements affected the entry of foreign investment in debt and equity in Mexico, placing special focus on announcements related to the third QE program and the taper tantrum episode. A novel dataset on daily debt and equity flows, that maps Balance of Payments data quite well, allows this paper to provide a better insight into movements of capital. The results suggest that both equity and debt flows reacted immediately to unexpected U.S. monetary policy announcements, particularly if these are considered as bad news by investors. In turn, results using weekly data support the idea that investors interested in fixed income instruments move more prudently than those interested in equity which react quickly.

Keywords: monetary policy announcements; unconventional monetary policies, capital flows; foreign portfolio investment; mexican equity and bond market

JEL codes: E4; E52; F21; F3; F62; G10

1. Introduction

The end of the financial crisis let the world economy sailing across uncharted territory characterized, mainly, by close to zero interest rates and weak economic growth in advanced economies. To encourage economic activity, their central banks were forced to draw upon unconventional monetary policy measures (UMP).

Such an environment motivated a “search for yield” behavior in international financial markets, leading to significant movements of capital towards emerging economies (EMEs). After the implementation of several UMP programs by the Federal Reserve (Fed)¹ and other major central banks (the European Central Bank and the Bank of Japan, for example) the world economy was left facing risks coming from the end of such programs and the normalization of monetary policy.

This posited significant challenges to emerging market economies, given the economic and financial implications of U.S. monetary policy events. For instance, there is the financial turmoil observed back in mid-2013 when the Chair of the Board of Governors of the Fed at the time, Ben Bernanke, hinted at the possibility of tapering the third quantitative easing program, which resulted in most emerging economies suffering from a significant retrenchment of foreign capital.² In addition,

¹ The first QE program, or QE1, started at the end of 2008 and ended in March 2010. QE2 in November 2010 and ended in June 2011. Operation Twist was announced in September 2011. Finally, QE3 lasted from September 2012 to October 2014.

² The taper was first mentioned on May 22 and a second time on June 19 of 2013.

EMEs were not only exposed to unexpected announcements of monetary policy but also the significant fall in commodities prices and the strong appreciation of the U.S. dollar since mid-2014.

In the particular case of Mexico, investors' search for yield behavior encouraged an important upturn of gross portfolio inflows. From the second half of 2009 and up to the second quarter of 2015, the average annual share of portfolio inflows became 60 percent of total gross capital inflows. Despite the taper tantrum episode in 2013 and the upsurge of risk aversion in international financial markets since the second half of 2014, gross portfolio inflows kept on registering positive values though they fell significantly in the first half of 2015.

As a result of the above, the literature on spillovers from U.S. monetary policy expanded. For example, Bowman et al. (2014) studied the transmission of unconventional monetary policy on exchange rates, sovereign yields, and stock prices for a set of 17 emerging economies and found that Federal Reserve announcements resulted in sudden upswings in volatility. In particular, the authors found that every time an announcement drove down U.S. sovereign yields, the same occurred in emerging economies. Their results also highlight that emerging economies with weaker fundamentals were more vulnerable to U.S. monetary policy shocks.

Other works focus on the impact of monetary policy in advanced economies on capital flows to emerging economies. Specifically, the effects on portfolio investment have recently drawn substantial attention given its high sensitivity to external shocks and the availability of high-frequency data.³ Among these works, Lo Duca (2012) studied the determinants of portfolio flows, estimating a time-varying parameters model. He shows that time variation is quite high and that local economic and financial developments are important for financial markets in periods of uncertainty, except for panic events where risk aversion dominates.

One result consistent with the relevant research is that strong macroeconomic fundamentals play an important role in minimizing the spillovers effects of monetary policy in emerging economies. For example, Fratzscher (2012) estimates a factor model with weekly data to account for country heterogeneity and finds that global shocks have had an important effect on portfolio flows to emerging economies, but that these differ across countries depending on individual characteristics such as quality of institutions and macroeconomic fundamentals.

Chen et al. (2014) introduced a new methodology based on the work of Gurkaynak et al. (2005, 2007b) to identify both, the portfolio rebalancing channel and the signaling channel of transmission of monetary policy announcements. Their work finds that macroeconomic fundamentals do play an important role in country vulnerability to monetary policy events in the U.S.

In a different approach, Dahlhaus and Vasishtha (2014) estimate a VAR with sign restrictions to identify the normalization of monetary policy. Their results point to small negative effects of a policy normalization shock on monthly capital flows to EMEs, but this still leads to higher financial volatility in such economies, i.e., exits of foreign capital, albeit small, were considered by financial markets as a sign of vulnerability.

Most of these studies cover the effects of monetary policy on emerging markets as a group and do not provide results for individual countries, which is also important given that the evidence points to a high degree of heterogeneity across countries in the response to portfolio flows. In this regard, Park and Um (2016) analyzed the effects of UMP measures adopted by the U.S. on Korea. Their results suggest that the Korean bond market was significantly affected by announcements related to "operation twist", taper, and forward guidance, while they also find that the effects of UMP on net foreign investment were significant only for short-term debt. Finally, their results also suggest that expectations of higher interest rates in the U.S. lead to retrenchments of net foreign investment.

³ One such dataset is Emerging Portfolio Fund Research (EPFR). This dataset provides daily, weekly, and monthly data on institutional and individual investor flows making it more viable to track changes in investors' demand and short-run developments (see Fratzscher (2012); Lo Duca (2012); Chen et al. (2014) and Park and Um (2016)). In addition, Fratzscher (2012) and Jotikasthira et al. (2012) argue EPFR data provides a good representation of the balance of payments data.

The objective of this work is to extend Park and Um (2016) analysis to portfolio investment in Mexico and study how UMP announcements affected the entry and exit of foreign capital and use the results as a benchmark for how one can expect portfolio inflows to respond to future unexpected announcements. A novel dataset with foreign investment in bonds (hereafter debt to follow Balance of Payments terminology) and equity at a daily frequency is used. The article differs from that of the mentioned authors; first, in that the dataset used here contains information for both debt and equity flows that maps Balance of Payments (BoP) data better than any other dataset available for Mexico. Second, we provide a more in-depth contrast of the results at different frequencies to account for possible delays in the reaction of investors after each monetary policy announcement. Third, we include additional variables to assess the robustness of the results and test if omitted variable bias is affecting the estimation. Fourth, we find serial correlation in the residuals when applying Park and Um (2016) specification, so we correct it.

The hypothesis is that after unexpected monetary policy announcements by the Fed, portfolio flows respond quickly and accordingly to as if such an announcement would ultimately drive down long-term yields. This implies that after QE3 announcements investors realized that the Fed would drive long-term yields down by restricting the net supply of bonds. Since the different assets within investor's portfolios are imperfect substitutes, they are forced to substitute those in low supply for other assets with similar characteristics such as Mexico's bond and equity instruments leading to an increase of foreign flows (the opposite took place with the taper announcements). In other words, the portfolio balance channel would have played a key role in the entry and exit of portfolio flows.

The results with daily data are mixed. The coefficients turn out with the expected sign only in some of the cases. The hint in September 2012 that the Fed may implement a new QE3 had a positive effect on debt flows the day after, while the taper announcement in June 2013 led to an important retrenchment. In the case of equity, both QE3 events as well as the unexpected taper announcement in May had a negative significant impact. These counterintuitive results may be the result of investors' delayed response or because of omitted variable bias which is a common issue in event study analysis. To account for a possible tardy reaction from investors, flows data are accumulated into a five-day window (weekly), to address the last one we include some additional financial variables.

Our results show the following: First, the estimations with daily flows are quite robust to the inclusion of additional variables suggesting that omitted variable bias is not a big concern, but still, some counterintuitive results are present. Second, using weekly data the signs of the estimated parameters are more in line with what the portfolio balancing channel implies driving inflows up after QE3 announcements and leading to retrenchment after the taper events. Third, including additional variables for weekly estimations does not lead to changes in the signs of the event dummy variables but some of the former become significant suggesting that omitted variable bias may be relevant, in contrast to what we observe for the model with daily data.

All in all, both equity and debt flows reacted immediately to unexpected U.S. monetary policy announcements, in particular, if these were considered as bad news. An additional result common in all our weekly estimations, and in the daily ones for debt flows, is that the effect of the unexpected taper announcement in May was relatively smaller than that in June, which may also support the idea expressed above about a more determined investors' response once they assessed the effects of such announcements in their portfolios.

One way to interpret these results is that investors interested in fixed income instruments moved more prudently compared to those interested in equity who reacted quickly, to what they considered bad news. Once the surprise of the initial announcement is assimilated, the probability of a similar announcement increased, leading investors to respond faster at the time such an event took place. That would explain the drastic change in signs, magnitude, and significance of the estimated parameters from daily to weekly data.

The paper is organized as follows: the next section provides some stylized facts about capital flows in Mexico. The third section describes the new high-frequency dataset and shows how it has a good match with the Balance of Payments data. The fourth section describes the methodology of the

event study analysis. Results are given in the fifth section. The sixth section shows some robustness tests. The seventh section concludes.

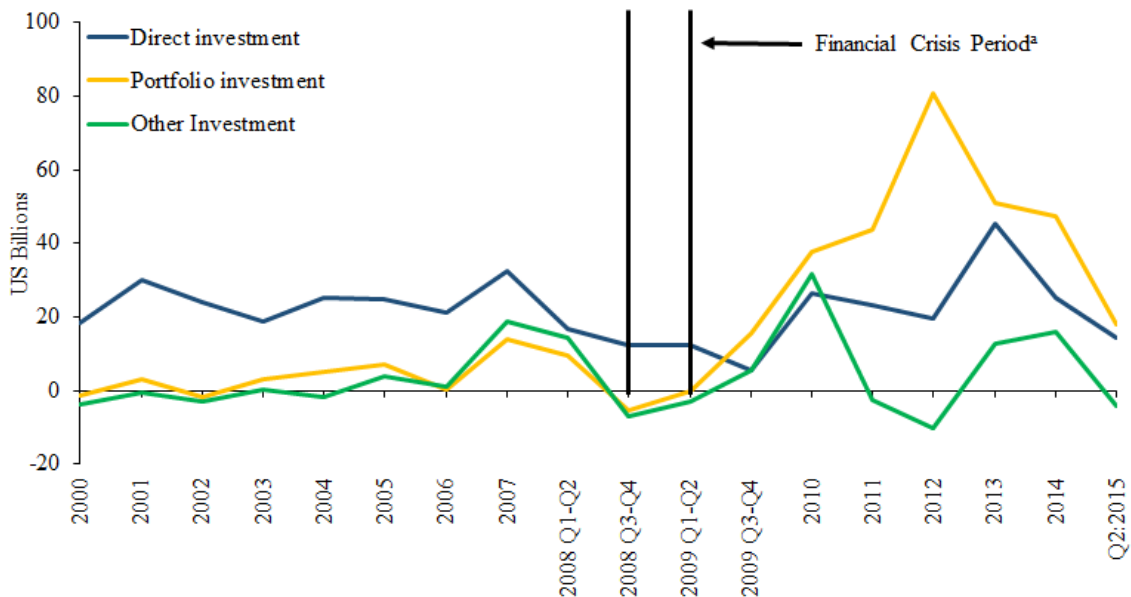
2. Stylized Facts About Capital Flows in Mexico During UMP

Up to the previous financial crisis, foreign direct investment (FDI) was the main component of capital flows to Mexico. From January 2000 up to the second quarter of 2008, FDI average annual share in total gross inflows was around 88 percent. Moreover, during such crisis (2008:Q3 to 2009:Q2 inclusive) FDI remained positive albeit the amount invested was smaller than in the previous years, see Figure 1.

Meanwhile, gross portfolio and other inflows average annual shares accounted for only 9 and 3 percent of total gross inflows respectively but increased rapidly in 2007 and in the first half of 2008 (in this period their participation in total gross inflows were 22 and 32 percent respectively). In contrast to FDI inflows, portfolio and other investment in Mexico suffered an important reversal during the crisis (the withdrawal in such flows was of 5.7 and 10 billion USD respectively).

After the financial crisis, investors' search for yield behavior encouraged an important upturn of gross portfolio inflows in Mexico (other investment flows also began to increase rapidly but at a slower pace, and such a rise lasted a shorter period than portfolio flows). From the second half of 2009 and up to the second quarter of 2015, the average annual share of portfolio inflows became 60 percent of total gross inflows, whereas FDI and other inflows shares were only 32.5 and 7.5 percent respectively. Despite the taper tantrum episode in 2013 and the recent upsurge of volatility and risk aversion in international financial markets since the second half of 2014, gross portfolio inflows kept on registering positive values. Although, they fell rapidly in the first half of 2015 because of the high degree of uncertainty on the global economy, and in EMEs. These significant changes in the composition of capital flows in Mexico have made the analysis of portfolio investment relevant.

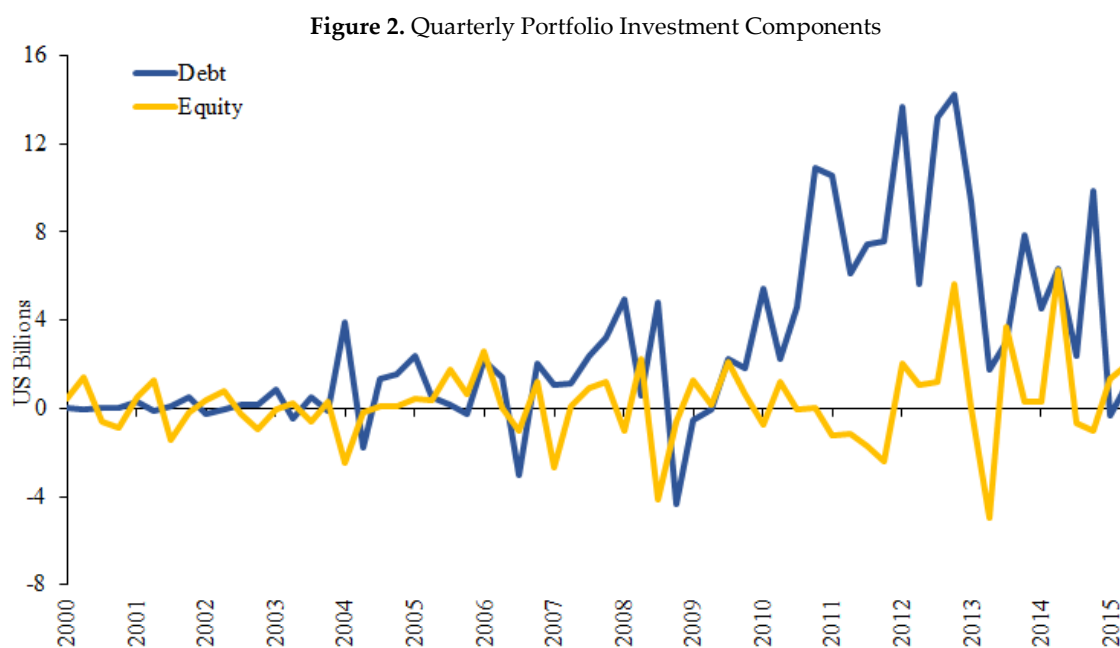
Figure 1. Capital Flows in Mexico



a. The data was divided into quarters in 2008 and 2009 and aggregated in periods of 6 months to show a clearer picture of capital flows dynamics during the financial crisis.

Source: Banco de Mexico, Balance of Payments Statistics.

Portfolio inflows are composed of investments in debt and equity. Looking at the information provided in the BoP, before the financial crisis portfolio inflows played a modest role in the financial account, being debt the one component that appeared more attractive to foreign investors: From 2000 and up to the first half of 2008 debt inflows averaged 0.74 billion USD, whilst equity inflows averaged only around 0.14 billion USD. After the crisis, investment in debt increased dramatically registering an average inflow of 6.3 billion USD from the third quarter of 2009 to the second quarter of 2015, while equity rose to 0.57 billion USD during the same period. The maximum amount of debt inflows occurred in the third quarter of 2012 reaching 14 billion USD and equity's peak was at 6.26 billion USD in the second quarter of 2014, see Figure 2.



Source: Banco de Mexico, Balance of Payments Statistics.

Note that during the taper tantrum episode, equity flows fell substantially. In particular, they registered a retrenchment of foreign capital of around 5 billion USD. On the other hand, even under such a scenario of high volatility in financial markets debt flows remain positive up to the first quarter of 2015.

Nevertheless, the balance of payments data has two disadvantages for policy implementation; first, the data is available with a significant delay; and second, the low frequency at which such data is produced makes it not adequate to analyze the immediate response of portfolio flows during periods of uncertainty. Particularly, when markets perceive a change in the monetary policy stance in advanced economies. An analysis with data at a higher frequency could shed more light on how markets behave during such periods.

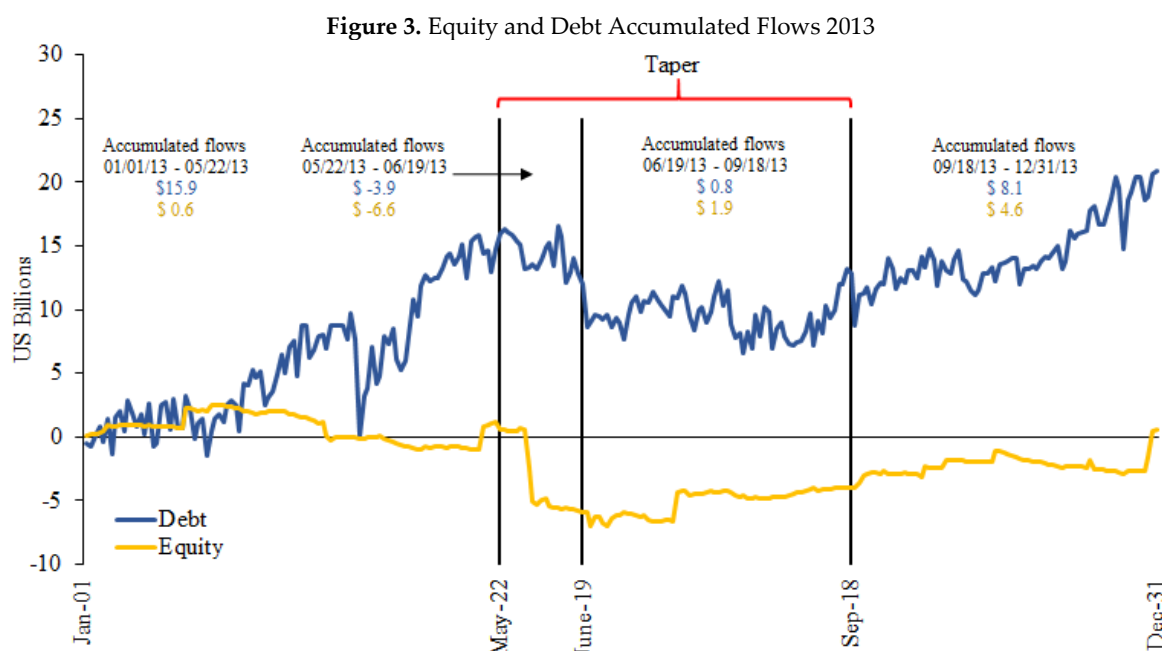
3. High-Frequency Portfolio Investment Data

In this work, we address the mentioned shortcomings of quarterly BoP data using a novel dataset that contains daily information on foreign net holdings of portfolio flows in Mexico (debt and equity). These data represent transactions of the most liquid instruments in the portfolio investment category in the Balance of Payments. The sources of the data are Banco de Mexico and INDEVAL (hereafter we refer to these new data as BN-IND).⁴

⁴ Quoting Abreu Goodger et al. (2014) INDEVAL is "... the securities deposit agency (the Mexican CSD) that also manages - the Securities Deposit and Settlement System (also known for its acronym in Spanish as DALÍ), a settlement system for government debt securities issued locally ..." for more details about INDEVAL go to www.indeval.com.mx or see the cited reference.

Specifically, BN-IND includes information about all debt issued by the Federal government, public institutions, state-owned companies, the deposit insurance institute (IPAB by its name in Spanish), and those issued by banks and corporations, and has data about all transactions in equity that take place in the Mexican stock market. The data is available from January 2012 up to January 2015. Following BoP definitions, we define debt as the aggregation of all public and private debt instruments.⁵

A particular period characterized by high financial volatility was 2013. On May 22 of such year, the president of the Federal Reserve (Ben Bernanke) hinted at the possibility of “tapering” the third quantitative easing program, making the second remark in the following Federal Open Market Committee (FOMC) meeting of June 19. As a result, markets reaction revealed an increased risk aversion toward EMEs leading to significant exits of portfolio flows. In Mexico's case, the retrenchment of equity was around 6.6 billion USD between May 22 and June 19. This amount is quite significant considering that since the beginning of 2013 and up to May 22, the accumulated amount invested in equity was only around 0.6 billion USD. In turn, debt suffered an outflow of 3.9 billion USD in the same period. However, since the first day of 2013 and up to the day before Bernanke's announcement, there was an accumulated inflow of around 15.9 billion USD, see Figure 3.

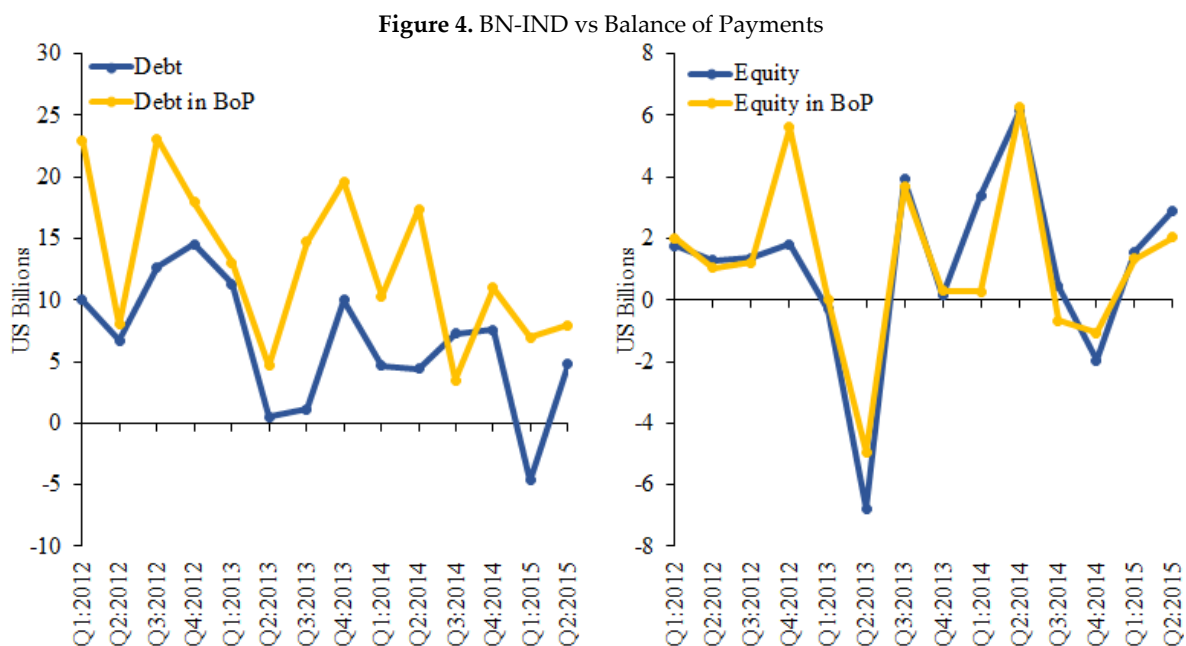


Source: Banco de Mexico and INDEVAL.

From the time of the second remark about tapering QE3 up to the day before the FOMC meeting of September 18, when the Federal Reserve took back the taper, the accumulated amount of inflows to both, debt and equity, registered positive values of 0.8 and 1.9 billion USD respectively. This suggests that investors may have already inferred the delay of the taper as the date of the FOMC meeting of September was approaching. After that and to the end of the year, foreign investment in debt securities increased by 8 billion USD and by 4.6 billion USD in equity.

One of the main issues with high-frequency data on portfolio investment is its matching with the Balance of Payments. Accumulating BN-IND into quarters, we observe that they are quite close, see Figure 4. Equity has the best match since it is practically identical in almost the whole period of analysis, but in the fourth quarter of 2012 and the first quarter of 2014, its correlation with equity in BoP is 86 percent. These mismatches respond to a reclassification of some equity transactions to the FDI category. Unfortunately, the information is not available to exclude them from the dataset.

⁵ However, it does not contain information on debt instruments issued abroad.



Source: Banco de Mexico and INDEVAL.

In the case of debt, though not as close as equity, it does move similarly to debt from the BoP. The differences between these two can be explained by the fact that BoP data includes information on debt issued abroad, which sometimes can be quite significant and even offset the dynamics of that emitted domestically. The correlation between BN-IND and debt in the BoP is 60 percent.⁶

The above suggests that indeed BN-IND is a very good representation of gross portfolio flows reported in the BoP. Specifically, when comparing it against Emerging Portfolio Fund Research (EPFR) which also provides high-frequency data for Mexico but whose coverage of funds represent only a subset of all portfolio inflows.

The greatest advantage of EPFR is that it provides high-frequency flows data for a vast number of countries allowing for cross-country comparison and analysis. However, EPFR weekly data on country flows to Mexico is not as good a representation of BoP data as BN-IND is. The differences are quite striking in some cases. For example, the opposite movements in debt from the third quarter of 2013 to the first quarter of 2014, and from the fourth quarter of 2014 to the second of 2015. Also, EPFR data correlation with BoP is weaker at 39 percent for debt and 29 percent for equity, see Figure 5.

4. Methodology

Given the importance of portfolio flows in Mexico after the crisis, the objective of this work is to assess how unexpected monetary policy announcements in the U.S. affected foreign inflows of debt and equity and use the results as a benchmark for how one can expect portfolio inflows to respond when facing future unexpected announcements.

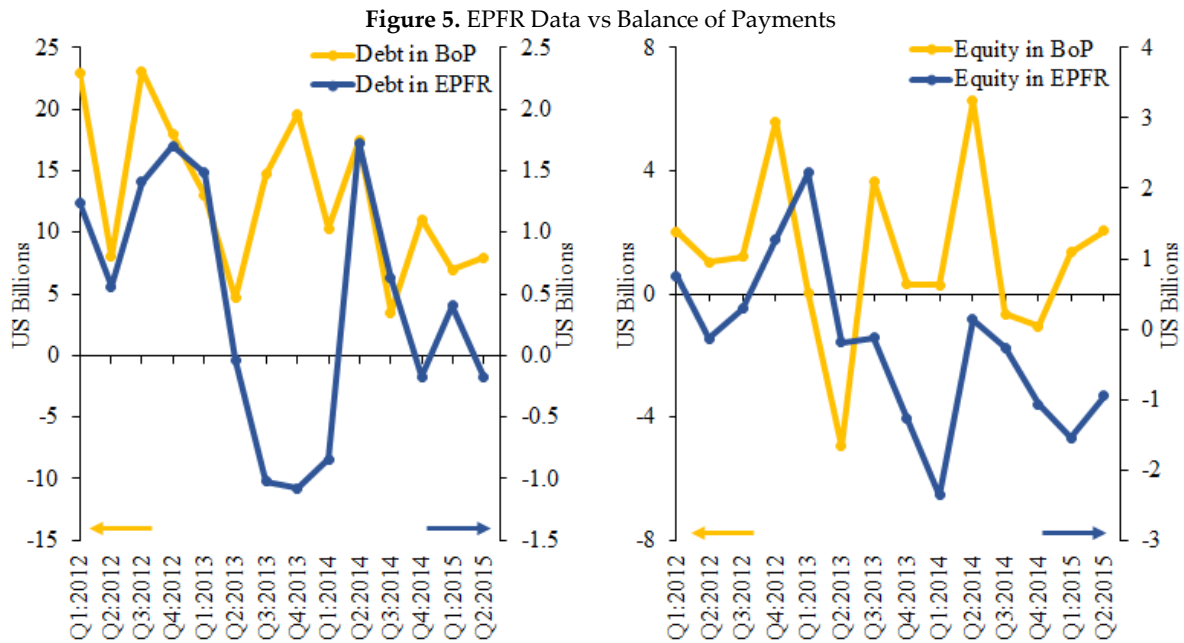
The analysis relies on an event study analysis following Park and Um (2016). These authors state that such methodology suffers from endogeneity and omitted variable bias problems.⁷ In the authors' work endogeneity could arise if the Federal Reserve's reaction function were to include Korean asset prices as a factor that could affect its monetary policy decision. However, the fact that the stance of monetary policy in the U.S. depends on domestic factors only, solves this problem.

The omitted variable bias issue can be more difficult to deal with. The authors suggest that this problem can be minimized by narrowing the time window of analysis as much as possible so that only

⁶ If debt issued abroad is removed from BoP data, the correlation can go as high as 86 percent.

⁷ For a broader discussion about problems when using event study analysis, see Gurkaynak et al. (2005, 2013).

the innovations to U.S. monetary policy are captured, i.e., the smaller the time window around the time the announcement is made, the higher its variance would be relative to that from other shocks and the bias will converge to zero. Taking advantage of high-frequency data the authors estimate an OLS model for the one-day change in Korean bonds and net foreign investment using only dummy variables for the three quantitative easing programs, operation twist, the taper, and some forward guidance announcements.



Source: Banco de Mexico and EPFR.

Extending these assumptions for Mexico's case, portfolio flows the immediate response to unexpected announcements by the Fed is obtained from OLS estimation of the following model:

$$Y_t = \alpha + \beta_1 QE3_s + \beta_2 QE3_d + \beta_3 T_m + \beta_4 T_j + \varepsilon_t \tag{1}$$

Where Y_t stands for daily gross inflows in equity or debt in billions of USD.⁸ All dummies are set equal to one the next day after the announcement. The sample period used goes from January 3, 2012, up to July 9, 2015, as the data obtained from INDEVAL starts on that date.

In equation 1, U.S. monetary policy announcements are analyzed separately. The hypothesis is that, for example, markets were taken by surprise when the Federal Reserve first mentioned the taper on May 22 but were more alert by the announcement on June 19. If this is true, the market's immediate reaction was probably not as dramatic in May. By introducing two separate dummies, we could gauge if this happened. Then, the following set of dummy variables are defined: First, $QE3_s$ representing the initial hint of a possible asset purchase program on September 13, 2012, and $QE3_d$ for the announcement ratifying its implementation on December 12, 2012.⁹ Lastly, the dummies T_m and T_j represent the announcements of May 22 and June 19, 2013, respectively.

Initial results of equation 1 with daily data exhibit an important drawback in that the null hypothesis of no serial correlation in the residuals is strongly rejected, see Appendix C. To correct this problem, we initially used the Bayesian information criterion to include lags of the dependent variable as recommended by Enders (2004), see Appendix D. This works only for debt flows, but not for equity

⁸ All flows variables are stationary, see Appendix B

⁹ The Federal Reserve also mentioned QE3 on August 31, but the announcement was clearer in September. In addition, this announcement took place on a Friday and the following Monday, September 3, was Labor Day making it more difficult to identify the effect of this announcement on portfolio flows.

where such criterion pointed to zero lags.¹⁰ In this case, we estimate equation 1 using Newey-West standard errors.¹¹

As a result of the above, the model for daily debt flows becomes:

$$Y_t = \alpha + \sum_{i=0}^I \rho_i Y_{t-i} + \beta_1 QE3_s + \beta_2 QE3_d + \beta_3 T_m + \beta_4 T_j + \varepsilon_t$$

Where $I = 2$ according to the Bayesian information criterion.

4. Results and Discussion

This section discusses the effects of U.S. monetary policy announcements on portfolio investment in Mexico. First, we study the response of the daily flows in debt and equity to assess the immediate impact of such announcements. Second, we extend the analysis to weekly accumulated flows to account for the possible delayed response of investors.

Table 1. Effect of QE3 and Taper Announcements on Daily Debt and Equity Flows to Mexico

Variable	Equity	Debt
Y_{t-1}	-	-0.334***
	-	(0.000)
Y_{t-2}	-	-0.170***
	-	(0.000)
QE3 _s	-0.035***	0.884***
	(0.002)	(0.000)
QE3 _d	-0.025**	-0.955***
	(0.027)	(0.000)
T_m	-0.065***	0.967***
	(0.000)	(0.000)
T_j	-0.012	-4.034***
	(0.266)	(0.000)
Autocorrelation tests		
Alternative Durbin test	-	0.403
	-	(0.525)
Breusch-Godfrey	-	0.407
	-	(0.524)
N	853	851
R ² adjusted	-0.005	0.113
RMSE	0.301	1.182

P-values in parenthesis, + significant at 10% ** significant at 5% *** significant at 1%.

The results for daily equity flows suggest that the initial hint provided by the Federal Reserve, in September 2012, about a possible implementation of QE3, as well as its confirmation in December 2012, had a negative significant impact. The unexpected announcement made by the Federal Reserve on

¹⁰ We initially overlook such a result and estimated the model for equity using from 1 and up to 5 lags. The results were highly unstable with estimated parameters switching signs with each different specification or nothing being significant.

¹¹ It is also possible to use an ARCH type of model but the fact that the events considered occurred rarely, it will not be possible for the model to capture all the effects of these events. Additionally, all regressions include robust standard errors or Newey-West standard errors for daily data on equity.

May 22, 2013, about tapering QE3 led to a decrease in equity flows, but surprisingly, the second time the taper was mentioned had no effect, see column 2 in Table 1.

The effects on daily debt flows differ from those obtained for equity. The former increased the day after the initial hint of a new quantitative easing program then fell after the ratification of such measure in December 2012. Unexpectedly, after the taper was first mentioned debt flows increased; but they decreased following the June announcement, see Table 1 column 3.

These somewhat counterintuitive results may be originated by other factors still influencing the model, such as omitted variable bias or, as noted in recent literature, a slow response by investors to unanticipated events. Authors like Lo Duca (2012) and Hernandez (2014) state that investors will react once they have analyzed and interpreted all relevant information regarding the impact of the unexpected announcement on their portfolios. In this sense, we extend our analysis to weekly flows. Debt and equity data are accumulated over a five-business day window going from Thursday to Wednesday.¹² Because all these events occurred on a Wednesday, the dummy variables for each QE3 and taper announcement will then be equal to one the following week. This approach helps the estimation of the accumulated impact of U.S. monetary policy on debt and equity flows up to five business days (a week) after each announcement.

The estimations show some important differences concerning those obtained with daily data. In the case of equity, the hint of September had no significant effect, while the confirmation of QE3 in December 2012 has a significant positive impact. The taper announcement in June 2013 is now associated with a significant fall in equity and the unexpected mentioning of the taper in May 2013 became not relevant, see Table 2 column 2.

Table 2. Effect of QE3 and Taper Announcements on Weekly Debt and Equity Flows to Mexico

Variable	Equity	Debt
Y_{t-1}	-	-0.227***
	-	(0.000)
QE3 _s	-0.004	1.271***
	(0.934)	(0.000)
QE3 _d	0.847***	2.430***
	(0.000)	(0.000)
T _m	-0.058	-1.116***
	(0.283)	(0.000)
T _j	-0.897***	-4.226***
	(0.000)	(0.000)
Autocorrelation tests		
Alternative Durbin test	0.119	0.014
	(0.730)	(0.904)
Breusch-Godfrey	0.123	0.015
	(0.726)	(0.902)
N	185	184
R ² adjusted	-0.006	0.052
RMSE	0.716	1.827

P-values in parenthesis, + significant at 10% ** significant at 5% *** significant at 1%.

¹² As is common in other datasets that report weekly financial data such as EPFR.

In the same fashion, estimations for debt flows also changed drastically. Although all estimated parameters are still significant, a couple of them switched signs. First, the QE3 event in December has now a positive impact on debt, while the effect of the taper announcement in May has a significant negative impact, see column 3 in Table 2.

The new results have points in favor and against the hypothesis of a delayed response from investors. On one hand, it is not clear that this assumption holds because the effect of the QE3 hint in September remains practically unchanged, whether one takes daily or weekly cumulated data. In addition, in the case of debt flows the estimated coefficient for the dummy T_j changed only slightly.

On the other hand, it appears to be a delayed response in equity and debt during the confirmation of QE3, given that in both cases the estimated parameter went from negative and significant, in the daily results, to positive and significant in the five-day estimations. Also, the same can be said for the unexpected taper event of May, which changes from not significant with daily data to negative and significant for five-day accumulated debt flows.

5. Robustness Tests

Up to now, we have ignored if the omitted variable bias problem is still an important issue in our estimations. In particular, since portfolio flows may also respond to other financial variables that also move at a higher frequency, we augment Equation 2 to assess, in a simple manner, if omitted variable bias is affecting our estimations.

As is common in the capital flows literature, additional variables must represent domestic and foreign factors (also known as pull and push factors). Domestic variables included are the nominal exchange rate vs U.S. dollar and the 3-month interbank equilibrium rate as a proxy for the short-term domestic interest rate. Foreign variables are the VIX index as a proxy for global risk and oil prices represented by the WTI.¹³ The sources of these variables are Banco de Mexico, Bloomberg, and the Federal Reserve Bank of St. Louis FRED.

Before proceeding with the estimation, it is important to note that differences in holidays between Mexico and the U.S. led to several mismatches in the dataset. For example, December 12 is a holiday in Mexico so that there are no data for Mexican variables while there are in the case of U.S. variables. As a first step, the data is adjusted to account for holidays in both countries by dropping such observations from the dataset. The few remaining gaps in the data are filled averaging the previous and the next observation. Hence, the model becomes:

$$Y_t = \alpha + \sum_{i=0}^l \rho_i Y_{t-i} + \beta' UMP_t + \gamma' X_{t-1} + \varepsilon_t$$

Where UMP_t is a matrix containing the four dummy variables described in Equation 2, X_{t-1} is a matrix of additional variables containing the first difference in the domestic short-term interest rate, the growth rate of the nominal exchange rate, the VIX index, and the growth rate of oil prices, all introduced with a lag to account for the kind of information that investors have at the time they decide their portfolio allocation; β and γ are vectors of estimated parameters.¹⁴ As before, the number of lags included in the estimation was selected according to the Bayesian information criterion.

The results for daily data are shown in Table 3 columns 2 and 3. When contrasting them against those in Table 1, we can conclude that these are robust to the inclusion of additional variables with minor differences among the estimated parameters of the variables representing monetary policy announcements.

One simple way to identify the effects of omitted variable bias is to test for equality of parameters using the generalized Hausman test proposed by Wessie (1999), who modifies the estimation of the

¹³ Other variables considered were CDS for Mexico, FX swaps, EMBI, S&P500 index and the certificate of deposits for Mexico, none of them having a significant effect.

¹⁴ Domestic interest rates were first averaged over the five-day window and then the first difference was obtained. Averaged weekly growth rates were obtained for the others, but the VIX which is already stationary, see Appendix B.

variance of the difference between coefficients to account for their covariance. The results are in Table 4 columns 2 and 3.

Table 3. Effect of QE3 and Taper Announcements on Debt and Equity Flows to Mexico Including Other Variables

Variable	Daily data		Weekly data	
	Equity	Debt	Equity	Debt
Y_{t-1}	-	-0.336***	-	-0.235***
	-	(0.000)	-	(0.001)
Y_{t-2}	-	-0.171***	-	-
	-	(0.000)	-	-
QE3 _s	-0.053**	0.871***	-0.092	1.167***
	(0.039)	(0.000)	(0.157)	(0.000)
QE3 _d	-0.027**	-0.948***	0.750***	1.961***
	(0.035)	(0.000)	(0.000)	(0.000)
T_m	-0.066***	1.006***	0.065	-0.680***
	(0.001)	(0.000)	(0.638)	(0.007)
T_j	0.009	-4.094***	-0.738***	-3.765***
	(0.875)	(0.000)	(0.000)	(0.000)
Δi_{t-1}	-0.064	-0.027	-1.033	-1.943
	(0.669)	(0.988)	(0.647)	(0.385)
E_{t-1}	-0.005	0.024	-0.376	-0.929**
	(0.799)	(0.724)	(0.151)	(0.048)
VIX _{t-1}	-0.005	-0.003	-0.001	0.053
	(0.103)	(0.838)	(0.965)	(0.282)
Oil _{t-1}	0.002	0.029	0.099**	-0.121
	(0.505)	(0.228)	(0.024)	(0.577)
Autocorrelation tests				
Alternative Durbin test	-	0.791	0.282	0.183
	-	(0.374)	(0.596)	(0.669)
Breusch-Godfrey	-	0.802	0.298	0.194
	-	(0.371)	(0.585)	(0.660)
N	851	851	183	183
R ² adjusted	-0.006	0.111	0.022	0.056
RMSE	0.302	1.184	0.709	1.824

P-values in parenthesis, + significant at 10% ** significant at 5% *** significant at 1%.

At daily frequency, the parameters of the quantitative easing program and the taper are not statistically different with and without financial variables. This is in favor of Park and Um (2016) statement that the smaller the window of the event study analysis, the lower the chance of the omitted variable bias to be a major issue. Nevertheless, such a problem may be of some relevance once the analysis goes from daily to weekly data, as other variables may be influencing investors' decisions.

The generalized Hausman test fails to reject the null of equality of parameters for weekly equity flows, see Table 4 column 4. However, when including additional variables, we see that the change in

oil prices has a significant positive relation with weekly equity flows. This means that prior developments in the oil market also are a significant factor for this type of investment.

The same test finds that the estimated coefficients for the quantitative easing announcement of September are not significantly different in the case of debt data, but it strongly rejects the null for all other coefficients (Table 4 column 5). Moreover, the exchange rate has a significant negative impact on debt flows, so that a depreciation of the peso makes investors lose their appetite for Mexican debt.

These results suggest that omitted variable bias is less of a problem for the model with daily data but it is affecting the weekly results. Therefore, one must be careful when specifying an event study analysis for equity and debt flows. In particular, it is important to take into account the frequency of the data as well as the inclusion of lags and additional variables.

Table 4. Generalized Hausman Test of Equality of Parameters

Test	Daily data		Weekly data	
	Equity	Debt	Equity	Debt
$QE3s^1 = QE3s^2$	0.140 (0.712)	0.020 (0.890)	0.220 (0.641)	0.370 (0.541)
$QE3d^1 = QE3d^2$	0.050 (0.828)	0.040 (0.836)	0.740 (0.389)	4.710** (0.030)
$T_m^1 = T_m^2$	0.010 (0.914)	0.320 (0.571)	1.560 (0.212)	5.920** (0.015)
$T_j^1 = T_j^2$	0.180 (0.671)	0.130 (0.719)	1.410 (0.236)	3.090* (0.079)

P-values in parenthesis, + significant at 10% ** significant at 5% *** significant at 1%.

Retaking the hypothesis of delayed response by investors for the case of equity, it is not clear that there exists a delayed response. Nevertheless, consider the following: by the time the implementation of QE3 was confirmed, the Fed had already given hints in the previous FOMC meeting of September, so markets were not surprised by the December confirmation and kept using their original investment strategies. Then, in the following days after studying the available information, investors saw that this event implied that a very relaxed monetary policy stance was going to be maintained for a while and one place where to gain higher returns at the time was Mexico.

Something similar occurs if we analyze the coefficients of the taper. When the Fed surprised markets at the end of May, investors saw it as very bad news and acted immediately leading to a fall in equity. Then by the time the taper was mentioned a second time they did not react as fast, see Table 2 column 1 and Table 3 columns 2 and 4.

In the case of debt flows, investors' delayed response may be playing a more relevant role. Mainly because some of the coefficients show drastic changes in signs and even significance, see Table 3 columns 3 and 5. An explanation for this phenomenon could be that investors interested in debt pay more attention to domestic macroeconomic fundamentals, which in the case of Mexico were quite solid at that time, and it wasn't until investors realized that the taper could affect them that they decided to respond.

An additional result common in all our weekly estimations, and in the daily ones for debt flows, is that the coefficient of the dummy T_m is smaller than that of T_j , which may also support the idea expressed above about a more determined investors' response after they assessed the effects of such announcements in their portfolios.

In general, our results show that debt reaction to U.S. monetary policy is stronger relative to that of equity, which agrees with the findings in previous literature such as Fratzscher et al. (2012, 2018), Lim et al. (2014), and {Dahlhaus and Vasishtha (2014). In particular, Lim et al. (2014) state that the portfolio balance channel is the main factor affecting investment in debt, but that it is not significant

for equity and that could explain why debt flows are more sensitive to monetary policy announcements.

In this regard, Chen et al. (2014) used a modification of Gurkaynak et al. (2005, 2007b) methodology to isolate both, the portfolio rebalancing and the signaling channels from monetary policy in the U.S. This methodology can be used as well to see how these channels affect debt and equity in Mexico. Unfortunately, the results do not provide any insight about the effects that each type of channel had on either equity or debt flows as no significant estimated parameter was found (see Appendix D for details about the methodology and the results).

At the end of the day, considering the possible delayed response of investors, the frequency at which the data are analyzed, and the omitted variable bias problem can help policymakers to assess how these flows would respond to future unexpected monetary policy announcements from the U.S.

5. Conclusion

After the financial crisis, the implementation of UMPs and close to zero interest rates in advanced economies led to a significant upsurge in portfolio flows to Mexico. In an economic context characterized by the end of such programs and the normalization process of monetary policy in the U.S. led to a marked fall of such flows which increased the risks of reversals that could have destabilized the economy.

In this work, we follow Park and Um (2016) approach of an event study analysis to assess how portfolio flows to Mexico responded to unexpected monetary policy announcements from the U.S. using a novel dataset on foreign investment in fixed income and equity at a daily frequency. The analysis focus on announcements related to the third QE program and the taper tantrum episode. The results can be used as a benchmark scenario for how these flows could react to future unexpected announcements.

The results show that the model with daily data is quite robust to the inclusion of additional variables so that omitted variable bias is not a major problem, but there are still some counterintuitive results. These are corrected when we accumulate the data into a five-day window. Here the results show a rise of foreign capital after QE3 announcements and a retrenchment after taper events, in particular for bonds. Our results also suggest that omitted variable bias may be an important issue when using weekly inflows given that when we include additional variables in the model, some turn out significant.

One way to interpret these results is that investors interested in fixed income instruments moved more prudently than those interested in equity who reacted quickly to what they considered as bad news. Then, once the surprise of the initial announcement is assimilated, the probability of a second related announcement increases, leading investors to respond faster. That would explain the drastic change in signs and significance of the estimated parameters from daily to weekly debt flows.

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Appendix A**Table A.** Summary Statistics

Variable	Units	Daily data		Weekly data	
		Mean	Std. Dev.	Mean	Std. Dev.
FLOW VARIABLES1/					
Equity	US billions	0.017	0.300	0.080	0.714
Debt Securities	US billions	0.109	1.261	0.502	1.892
DOMESTIC VARIABLES					
E	MXN/USD	13.384	0.861	13.399	0.873
i	Percentage	4.071	0.621	4.069	0.624
FOREIGN VARIABLES					
VIX	Index	15.369	2.825	15.430	2.720
Oil	USD per barrel	89.014	17.335	88.724	17.558
N		853		185	

Source: Banco de Mexico, Bloomberg, Federal Reserve Bank of Saint Louis FRED.

Appendix B

Table B. Unit Root Tests

	Daily		Weekly	
	Aug Dickey-Fuller	Phillips-Perron	Aug Dickey-Fuller	Phillips-Perron
DEPENDENT VARIABLES				
Equity	-26.92*** (0.00)	-26.92*** (0.00)	-13.20*** (0.00)	-13.20*** (0.00)
Debt Securities	-39.06*** (0.00)	-42.12*** (0.00)	-16.56*** (0.00)	-16.37*** (0.00)
DOMESTIC VARIABLES				
E	-31.66*** (0.00)	-31.64*** (0.00)	-13.88*** (0.00)	-13.89*** (0.00)
D.i	-29.49*** (0.00)	-29.50*** (0.00)	-10.28*** (0.00)	-10.17*** (0.00)
FOREIGN VARIABLES				
VIX	-33.37*** (0.00)	-34.02*** (0.00)	-16.39*** (0.00)	-16.86*** (0.00)
OIL	-32.86*** (0.00)	-32.73*** (0.00)	-13.03*** (0.00)	-13.15*** (0.00)

Under the null hypothesis, there is a unit root

Source: EPRF.

Appendix C

Table C1. OLS Estimation of Equation 1 on Daily Debt and Equity Flows to Mexico

Variable	Equity	Debt
QE3 _s	-0.035 (0.908)	1.420 (0.259)
QE3 _d	-0.025 (0.935)	-1.087 (0.387)
T _m	-0.065 (0.829)	0.309 (0.806)
T _j	-0.012 (0.967)	-3.512*** (0.005)
N	853	853
R ²	0.000	0.012
R ² adjusted	-0.005	0.007
RMSE	0.301	1.257
Autocorrelation tests ^a		
Durbin-Watson	5.296** (0.021)	73.511*** (0.000)
Breusch-Godfrey	5.300** (0.021)	68.119*** (0.000)

a. The null in both tests is that of no serial correlation

P-values in parenthesis, + significant at 10% ** significant at 5% *** significant at 1%.

Table C2. OLS Estimation of Equation 1 on Weekly Debt and Equity Flows to Mexico

Variable	Equity	Debt
QE3 _s	-0.004 (0.995)	1.193 (0.529)
QE3 _d	0.847 (0.240)	2.101 (0.268)
T _m	-0.058 (0.936)	-1.032 (0.586)
T _j	-0.897 (0.213)	-3.278* (0.085)
N	185	185
R ²	0.016	0.027
R ² adjusted	-0.006	0.005
RMSE	0.716	1.888
Autocorrelation tests ^a		
Durbin-Watson	0.118 (0.732)	11.009*** (0.001)
Breusch-Godfrey	0.121 (0.728)	10.719*** (0.001)

a. The null in both tests is that of no serial correlation

P-values in parenthesis, + significant at 10% ** significant at 5% *** significant at 1%.

Appendix D

Table D. Lag Selection Criteria

Lags	Daily data				Weekly data			
	Equity		Debt		Equity		Debt	
	AIC ^a	SIC ^b	AIC	SIC	AIC	SIC	AIC	SIC
0	-2.404	-2.399*	0.465	0.470	-0.669*	-0.652*	1.281	1.299
1	-2.407*	-2.396	0.375	0.386	-0.653	-0.618	1.237*	1.272*
2	-2.405	-2.388	0.350	0.366*	-0.642	-0.590	1.243	1.296
3	-2.401	-2.379	0.351	0.373	-0.628	-0.558	1.259	1.329
4	-2.399	-2.371	0.347*	0.374	-0.620	-0.532	1.267	1.355
5	-2.396	-2.363	0.349	0.383	-0.605	-0.499	1.275	1.381
6	-2.393	-2.354	0.350	0.389	-0.589	-0.464	1.291	1.416

a. Akaike information criterion.

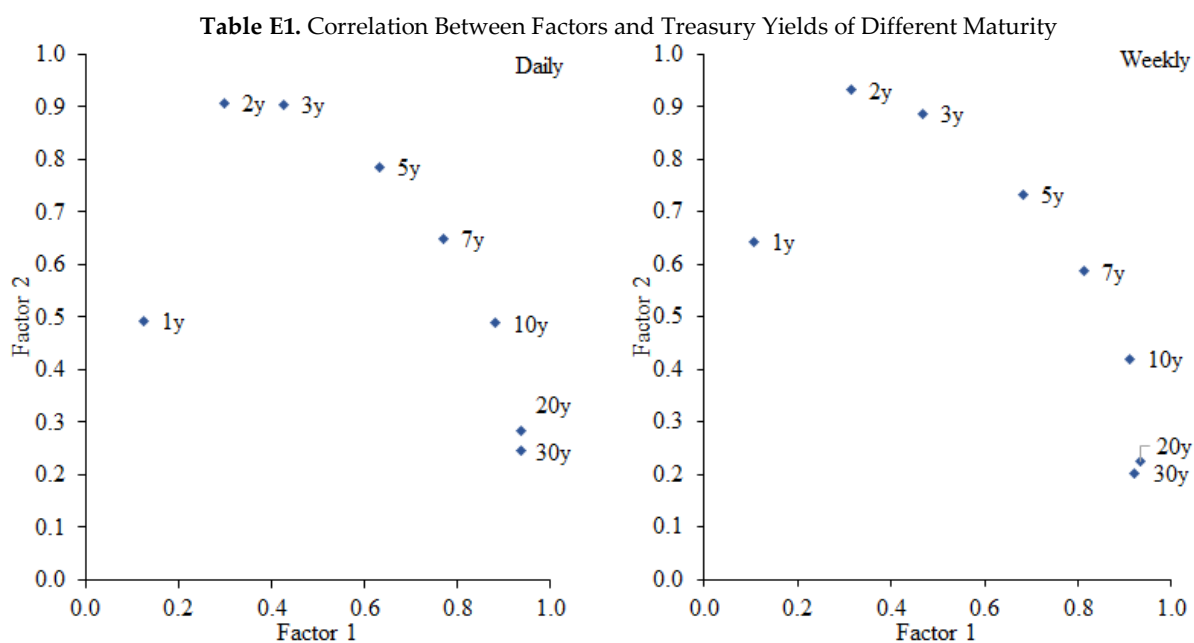
b. Bayesian information criterion.

* indicates the number of lags recommended by each criteria.

Appendix E

The second method used by Park and Um (2016) based on Chen et al. (2014), consists of identifying monetary policy events by subtracting information from U.S. Treasury yields with maturities from 1 and up to 30 years. Their method is a modification of Gurkaynak et al. (2005, 2007b) consisting of subtracting two factors, one correlated to long-run expectations of monetary policy representing the portfolio rebalancing channel (called the market factor) and the other with a high correlation to short-run developments (called the signal factor).

These factors are the rotated first two principal components of the U.S. Treasury yield obtained from the Gurkaynak et al. (2007a).¹⁵ The first component is the market factor given its high correlation with yields of 5 or more years of maturity, and the second rotated principal component represents the signal factor due to its high correlation with yields of 5 or fewer years of maturity, see Figure E1.



Factor 1 corresponds to the market factor (or portfolio balancing channel). Factor 2 to the signal factor.
 Source: Federal Reserve Bank.

Once the rotated components are obtained, they are used as regressors in an OLS model of portfolio flows, which may or may not include other explicative variables as in Chen et al. (2014). Park and Um (2016) estimate this model including only the two rotated components and using a rolling window of half a year to identify which factor affects more net foreign investment but do not say anything about how these factors may affect debt and equity.

Here we follow Chen et al. (2014) and regress debt and equity on the rotated factors plus the macroeconomic variables used in Equation 2. The results, unfortunately, do not provide any insight about factor one having a more important effect on either daily or weekly debt, or factor two being most important for equity, see Table E2 below.

This does not mean that it is not true that the portfolio rebalancing channel is not the main reason explaining debt dynamics, but a different methodology may be necessary to confirm it.

¹⁵ Data can be downloaded from <http://www.federalreserve.gov/pubs/feds/2006/200628/200628abs.html>.

Table E2. Market and Signal Effects on Debt and Equity Flows to Mexico Including Other Variables

Variable	Daily data		Weekly data	
	Equity	Debt	Equity	Debt
Y _{t-1}	-	-0.333*** (0.000)	-	-0.195*** (0.005)
Y _{t-2}	-	-0.163*** (0.000)	-	-
RPC ₁	-0.006 (0.432)	-0.005 (0.894)	-0.033 (0.465)	0.172 (0.188)
RPC ₂	0.002 (0.762)	-0.033 (0.408)	0.000 (0.995)	-0.102 (0.430)
Δi _{t-1}	-0.060 (0.685)	-0.082 (0.963)	-1.035 (0.645)	-1.942 (0.405)
E _{t-1}	-0.005 (0.792)	-0.009 (0.906)	-0.430* (0.086)	-0.998** (0.037)
VIX _{t-1}	-0.005 (0.106)	-0.004 (0.795)	-0.001 (0.939)	0.048 (0.326)
Oil _{t-1}	0.003 (0.473)	0.026 (0.289)	0.100** (0.030)	-0.223 (0.303)
N	851	851	183	183
R ²	0.004	0.108	0.056	0.084
R ² adjusted	-0.004	0.099	0.023	0.047
RMSE	0.301	1.192	0.709	1.833

P-values in parenthesis, + significant at 10% ** significant at 5% *** significant at 1%.

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