Effects of Quantitative Easing on Financial Market Integration and Hedging Efficacy

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ABSTRACT

Effects of Quantitative Easing on Financial Market Integration and Hedging Efficacy

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This thesis consists of three essays. The first essay (chapter 2) examines the correlations between bond markets, stock markets and currency forwards during the quantitative easing (QE) programs launched by the U.S. Federal Reserve. Using DCC-GARCH models, we document a spillover impact of QE on the international financial markets and find that these correlations differ by QE period across developed and emerging countries. Our findings provide new insights into the impact of unconventional monetary policy regimes on the relationships between various international financial asset markets.

The second essay (chapter 3) examines the effectiveness and performance (E&P) of hedging international portfolios of bonds from developed and emerging countries. The excess returns and the variances of these portfolios are significantly lower during the QE versus pre-QE period. During the QE period, excess return and variance sensitivities are positive and negative with the Fed's MBS holdings and become less positive and less negative with the Fed's holdings of Treasuries. Hedging E&P during the QEs depend on the chosen hedging strategy and level of economic development. Results are robust using other hedging E&P measures and excluding countries with their own QEs.

The third essay (chapter 4) finds that the integration of international bond and stock markets in 31 countries are affected significantly by U.S. quantitative easing (QE). After conceptually linking variations in the QE effects on bond and stock market integration to six transmission channels, we find that the actual effects depend upon the Fed holdings (MBS or Treasuries), channel considered, asset type (bond or stock), and the economic development categorization of the countries (developed or emerging). Cross-border banking flows as our proxy for the risk-taking channel significantly increase bond and stock market integration during each QE period for both developed and emerging countries.

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Table of Contents

List of Figures viii

List of Tables ix

List of Appendixes xi

CHAPTER ONE 1

1. INTRODUCTION 1

CHAPTER TWO 4

Cross-financial-market Correlations and Quantitative Easing 4

2.1. INTRODUCTION 4

2.2. HYPOTHESES AND DATA 5

2.3. EMPIRICAL TESTS 6

2.3.1. Methodology 6

2.3.2. Correlations between bond or stock markets and currency markets 8

2.3.3. Correlations between currency forward contracts 10

2.3.4. The differences in the correlations during the three QE periods 11

2.4. Conclusion 13

CHAPTER THREE 14

Currency Hedging of International Bond Portfolios: Effects of Unconventional Monetary Policy Regimes 14

3.1. INTRODUCTION 14

3.2. MEASURING HEDGING EFFECTIVENESS AND PERFORMANCE 18

3.3. SAMPLE AND HEDGING STRATEGIES 19

3.3.1. Sample Construction 19

3.3.2. Fully and unconditional variance-minimizing hedging strategies 20

3.3.3. Summary Statistics 22

3.3.4. Proxies for Various Dimensions of the Evolution of the Fed's Asset Holdings 23

3.3.5. Control Variables 24

3.4. HYPOTHESES DEVELOPMENT 25

3.5. COMPARISON OF RELATIVE HEDGING EFFECTIVENESS AND DIFFERENCED HEDGING PERFORMANCE BETWEEN THE QE AND PRE-QE PERIODS 27

3.6. RELATION BETWEEN HEDGING EFFECTIVENESS/PERFORMANCE AND THE FED'S ASSET HOLDINGS 29

3.6.1. Relative Hedging Effectiveness 29

3.6.2. Differenced Hedging Performance 33
3.7. ROBUSTNESS TESTS 36
3.7.1. Removal of Non-U.S. QE Implementers 36
3.7.2. Tests Using Other Hedging Effectiveness / Performance Measures 37
3.8 CONCLUSION 38
CHAPTER FOUR 39
DOES QUANTITATIVE EASING AFFECT FINANCIAL MARKET INTEGRATION? 39
4.1. INTRODUCTION 39
4.2. HYPOTHESES DEVELOPMENT 42
4.3. SAMPLE AND DATA 48
4.4. MEASURING INTEGRATION 49
4.4.1. Integration Time Trend 50
4.4.2. Formal Test of the Financial Market Integration Level During and Around the QEs 53
4.5. FINANCIAL MARKET INTEGRATION AND POTENTIAL QE TRANSMISSION CHANNELS 54
4.5.1. Methodology 54
4.5.2. Empirical Results 55
4.5.2.1. Results for financial market integration across All, DM, and EM countries using QE dummy variables 55
4.5.2.2. Effect of Fed's specific security holdings on financial market integration 61
4.5.2.3. Results for financial market integration for regional economies 62
4.6. TESTS OF ROBUSTNESS 63
4.6.1. Alternative Measure of Integration 63
4.6.2. Controlling for global financial crisis and the U.S. recession 65
4.7. CONCLUSION 66
CHAPTER FIVE 68
REFERENCES 70

List of Figures

Figure 3.1. The securities holdings by the Fed with respect to maturities for over five years or over ten years 88

Figure 3.2. Exchange rates around and during the QEs 89

Figure 3.3. Sharpe Ratios for fully-hedged and unhedged portfolios for the full time period 90

Figure 4.1. Weekly level of international market integration for country-level bond and stock indexes 105

List of Tables

Table 2.1. Summary statistics for the bond indexes, stock indexes and forward contracts.......... 78

Table 2.2. Average correlation coefficients between bond indexes, stock indexes and forward contracts 79

Table 2.3. Average correlation coefficients between the forward contracts................................ 80

Table 2.4. Regression results for various sets of correlations against the QE period dummy variables 81

Table 3.1. Summary statistics for various country indices 91

Table 3.2. Tests of the equality of the individual components of hedging effectiveness and performance between the QE and Pre-QE periods. 92

Table 3.3. Tests of the equality of hedging effectiveness and performance between the QE and Pre-QE periods.. 93

Table 3.4. Time-series regression results for effects of Fed's relative-to-$GDP and security-type holdings on relative hedging effectiveness 94

Table 3.5. Time-series regression results for effects of Fed's longer-maturity security-type holdings on relative hedging effectiveness 95

Table 3.6. Time-series regression results for the effects of Fed's security type holdings on the individual variances included in the relative hedging effectiveness measure 96

Table 3.7. Time-series regression results for effects of Fed's relative-to-$GDP and security-type holdings on differenced hedging performance 97

Table 3.8. Time-series regression results for effects of Fed's longer-maturity security-type holdings on differenced hedging performance 98

Table 3.9. Time-series regression results for the effects of security type holdings of the Fed on the individual Sharpe ratios included in the measure of differenced hedging performance......... 99

Table 3.10. Time-series regression results for the effects of security type holdings of the Fed on the excess return of the individual Sharpe ratios 100

Table 3.11. Time-series regression results for the effects of security types holdings by the Fed on relative hedging effectiveness (differential hedging performance) with non-U.S. QE implementers excluded 101

Table 4.1. Annual level of bond integration 106

Table 4.2. Annual level of stock integration.. 107

Table 4.3. Time trend and summary statistics for market integration 108

Table 4.4. Market integration during the three QE periods without/with controlling for bear markets... 109

Table 4.5. QE Channel Classifications and Other Control Variables.. 111

Table 4.6. Summary statistics for variables linked with the QE channels 113
Table 4.7. Financial market integration determinants based on QE time events for All, DM and EM countries 114
Table 4.8. The Effect of the U.S. Fed purchases on financial market integration 118
Table 4.9. Market integration during the three QE periods controlling for the global financial crisis 120
Table 4.10. Market integration during the three QE periods while controlling for the U.S. recession 122

List of Appendixes

Appendix 2.A. The parameter estimates based on the DCC-GARCH models for the bond market indexes 83

Appendix 2.B. The parameter estimates based on the DCC-GARCH models for the stock market indexes 84

Appendix 2.C. The parameter estimates based on the DCC-GARCH models for the currency forward contracts 85

Appendix 3.A. The Timeline and Main Events for the U.S. QEs........ 86

Appendix 3.B. Variable Definitions 87

Appendix 4.A. Country categories........ 102

Appendix 4.B. Variable descriptions........ 103

CHAPTER ONE

1. INTRODUCTION

In response to the recent financial crisis and to bring the U.S. economy out of the recent recession, the U.S. Fed implemented an unconventional monetary policy, Quantitative Easing or QE for short, in late November 2008. During this first QE round, the U.S. Fed completed the purchase of $1.25 trillion in mortgage-backed securities, $175 billion in agency debt and $300 billion in Treasury bonds in the open market to inject liquidity and credit into financial markets. During the second QE round (November 2010 to June 2011), the Fed bought about $600 billion of treasury securities to stimulate demand and to reduce the unemployment rate. A third QE round announced in September 2012 consisted of a new $40 billion per month, open-ended bond purchasing program of agency MBS (Mortgage Back Securities) designed to further bolster liquidity and economic prospects. This three-essay thesis examines the effect of these unconventional monetary policy implementations on the relationships between and among international bond and stock markets and currency forwards contracts, on the currency hedging effectiveness and performance of international bond portfolios; and on the financial market integration of international bond and stock markets.

In essay 1, we examine the cross-market correlations between bond, stock and currency forward markets during each QE period. We document a spillover impact of the QEs in the U.S. on international financial markets and find that the correlations across 31 countries differ for the various QE periods. Our findings have considerable implications for asset pricing models and for managers investing internationally.

In essay 2, we examine the effect of the Fed's holdings of MBS and Treasuries during the QEs on the effectiveness and performance of unhedged and hedged international bond portfolios from the perspective of U.S. investors. We measure the effectiveness and performance of currency hedging strategies by the percentage changes of their variances and the differences of their Sharpe ratios from those of an unhedged position, respectively, and their variance and excess return components for bond portfolios invested in developed and emerging countries.

We first run a univariate test to examine differences in hedging effectiveness, performance, and their excess return and variance components during the QE versus the pre-QE period. We find several pairs of significant differences for the fully hedged and unhedged portfolios. We then use time-series regressions to investigate how the variations in hedging effectiveness and performance during the QE and pre-QE periods are affected by the time-series evolution of specific assets held by the Fed. We find that the effects of two security-type holdings of the Fed on relative hedging effectiveness or differenced hedging performance depend on the implemented hedging strategy and/or the development level of financial markets (DM for developed market or EM for emerging market). In contrast, larger security type holdings significantly reduce the variances of international bond portfolios. The negative elasticities at the mean during the QE period are larger in magnitude for Treasuries than MBS, and are higher for the bond portfolios invested in EM than that in the DM countries for the same hedging strategy and security-type holding. These elasticities at the mean for the QE period also decrease monotonically from the unhedged to the fully hedged to the optimally hedged portfolios for the same independent variable and country category.

In essay 3, we examine the influence of QEs on international bond and stock market integration for 31 markets (emerging and developed) based on the measure of Pukthuanthong and Roll (2009). We find that average market integration significantly increases during QE1 and QE2 for the bond and stock markets of All, DM and EM countries, and significantly decreases during QE3 except for the significant increase for the bond markets of the EM countries. To explore the possible channels and mechanisms through which QEs affect financial market integration, we examine the following six potential channels: confidence, default risk, inflation, liquidity, portfolio balance and risk-taking. We find that the differential inflation rate, cross-border bank-to-bank liabilities, differential GDP growth potential, differential interest rate and cross-border banking capital flows as channel proxies significantly affect the relationship between QEs and financial market integration. This evidence supports the arguments that QE effects on market integration are transmitted via the inflation, liquidity, portfolio-balance and risk-taking channels. We also use the Fed's relative holdings of risk-free (Treasuries) and risky (MBS) securities to proxy for the effect on market integration from the decision of the Fed to target its purchases during a QE to a specific risk segment of the market (risky, risk-free or both). We find that the net purchase scale of the QEs significantly reinforces the impact of the QEs on market integration, and that the impact of the QEs on market integration depends upon the risk-appetite exhibited by Fed purchases, which lend more credence to our findings. Our findings also are robust to the use of an alternate measure of market integration; namely, the dynamic simple correlation (Billio, Donadelli, Paradiso, and Riedel, 2017).

CHAPTER TWO

Cross-financial-market Correlations and Quantitative Easing

2.1. INTRODUCTION

The U.S. Fed launched three periods of quantitative easing (hereafter, QE) from the end of 2008. Although the impacts of the QEs on various macroeconomic indicators such as economic growth, employment and inflation (e.g., Thornton, 2010; Bernanke, 2012) and financial indicators (e.g., D'Amico and King, 2013; Greenwood and Vayanos, 2014) have drawn considerable academic interest, little is known about if and how the cross-market correlations across developed and emerging countries changed under these unconventional monetary policy implementations. Since QE working through the international portfolio rebalancing channel changes the pattern of capital flows between countries by depreciating the domestic currency (US dollar), it seems reasonable to expect concurrent changes in asset and currency cross-correlations (Hau and Rey, 2006; Cho *et al.*, 2016). This can also be inferred from previous research which finds that the arrival of market information affects the cross-market correlations of currency futures (Darbar and Deb, 2002) and that the positive correlations of stocks with currency returns in emerging markets are sensitive to global market conditions (Cho *et al.*, 2016).

In this essay, we examine the cross-market correlations between bond, stock and currency forward markets during each QE period. To the best of our knowledge, this study is one of the first to examine the cross-market correlations in periods with unconventional monetary undertakings. Kenourgios *et al.* (2015a, b) examine the effects of QE announcements by the European Central Bank, the Bank of England and the Bank of Japan on the foreign exchange rate dynamics and intraday volatility transmissions among EUR, GBP and JPY. We document a spillover impact of

QE in the U.S. on the international financial markets and find that the correlations across 31 countries differ for the various QE periods. Our findings have considerable implications for asset pricing models and for managers investing internationally.

2.2. HYPOTHESES AND DATA

The investment effects of each QE worked primarily through the portfolio-rebalancing channel under somewhat different economic conditions. The portfolio-rebalancing effect channel argues that by reducing the supply of security type(s) to private investors, domestic-country large scaled asset purchases (hereafter, LSAPs) lead to an increase in demand for all substitute assets, including assets from non-domestic developed and emerging markets (Bernanke, 2012; Gagnon *et al.*, 2011; Joyce *et al*., 2011; Neely, 2015). As a result, LSAPs are expected to raise asset prices, lower the yields of those securities, promote employment and stabilize a low inflation rate (Bernanke, 2010b). If, as expected, domestic investors rebalance their portfolios towards more foreign assets, the resulting capital outflows from the domestic country to other developed and emerging markets are expected to result in the appreciation of their foreign currencies, increase their asset prices and change asset and currency cross-correlations. Thus, we expect that the correlations between bonds or stocks and currency forwards and between foreign currency forwards are different for and between the three QE periods.

Our stock and bond indices are collected from those included in the Morgan Stanley Capital International (MSCI) index, the J.P. Morgan (JPM) Global Bond Broad Indices (GBI Broad) and the JPM Government Bond Index - Emerging Markets Broad (GBI-EM Broad) Indices. After removing countries with missing observations, our sample covers 31 countries (All), including 19 developed markets (DM) and 12 emerging markets (EM) based on the MSCI equity index classifications, over the time period from September 2003 to November 2014.

The weekly total returns are denominated in local currencies for the stock and bond indices. The spot and forward currency prices on Friday are extracted from Datastream and Bloomberg. The WM Reuters Spot and one-month forward US dollar currency prices are computed by taking the arithmetic means of their closing bids and offers at 4 p.m. U.K. time. Missing forward rates are collected from Bloomberg. There are 20 different currency-denominated forward contracts since 11 of the countries use the European Euro.

Table 2.1 presents descriptive statistics for weekly returns (mean, median and standard deviation) for the bond, stock and forward contracts for the various countries over the full time period. Except for Greece, all of the other bond and equity indexes exhibit positive mean returns. Among the EM countries, the Brazilian bond index and the Colombian stock index have the highest mean returns of about 0.30% and 0.55%, respectively. The equal-weighted average of the bond and stock market standard deviations of returns for the DM countries of 1.48 and 3.46, respectively, are lower than their counterpart values of 2.05 and 4.27, respectively, for the EM countries. The last three columns report statistics for the long forward positions in the currency markets. The mean returns of forward positions are positive for the currencies of all DM countries and are positive for the EM countries other than the Indian Rupee, Mexican Peso, and South Africa Rand.

[Please place Table 2.1 about here.]

2.3. EMPIRICAL TESTS

2.3.1. Methodology

We obtain the correlations of interest using a model from the DCC-GARCH family with the largest negative Likelihood Ratio (LR) when the estimates of a plus b in equation (2.3) subsequently specified are less than 1. Since the most commonly chosen model is the DCC-GARCH(1,1), we confine our discussion to this model in this section of the essay.[1]

Engle and Sheppard (2001) and Engle (2002) propose the use of the DCC-GARCH(1,1) for estimating dynamic correlations while directly considering heteroscedasticity. Cho *et al.* (2016) and Yu *et al.* (2010) use this methodology to estimate stock-currency market correlations and co-movements of stock markets. The DCC-GARCH model is commonly used in the literature due to its many advantages. Compared to the Pearson Correlations and other correlation models such as CCC-GARCH, the DCC-GARCH model directly accounts for heteroscedasticity and has no volatility bias by estimating the correlation coefficients of the standardized residuals (Chiang *et al.*, 2007).[2]

Using a two-step procedure, we first estimate a univariate GARCH(1,1) model for each bond, stock, or forward returns series for each country. Then, we use the standardized residuals obtained from the first step to calculate the dynamic conditional correlations between the country-level bond or stock indexes and currency forwards. The univariate GARCH (1, 1) model estimated in the first step is defined as:[3]

$$r_t = \mu + u_t,\ u_t | I_{t-1} \sim N(0, H_t) \text{ and } H_t = \omega + \gamma \varepsilon_{t-1}^2 + \eta H_{t-1} \tag{2.1}$$

[1] The DCC-GARCH(1,1) is chosen for estimating at least 85% of the correlations between the indexes of bonds or stocks and currency forwards for each country. The other 15% of the pair-wise correlations are estimated based on the GJR/TARCH or EGARCH model in the first step and asymmetric DCC in the second step of the two-step estimation procedure detailed below. The pair-wise correlations are reported in detail in an appendix available from the authors. Unconditional correlations matrixes between bond or stock indexes and the currency forwards also are tabulated in a separate appendix which is available upon request.

[2] Among the many other estimation approaches, the DCC-GARCH (1, 1) is not model-free as is the case of a wavelet approach (Dajcman *et al.*, 2012) nor does it have the ability of the Double Smooth Transition Conditional Correlation (DSTCC–GARCH) model to allow correlations to transition smoothly or sharply between a set of extreme states when the transition path is governed by time and/or key indicators of financial market conditions (Silvennoinen and Thorp, 2013; Silvennoinen and Teräsvirta, 2015).

[3] We follow the notation of Cappiello *et al.* (2006).

In (2.1), r_t is the return of bonds, stocks, or forward contracts; H_t is the conditional covariance matrix and can be decomposed by $H_t = D_t R_t D_t$; D_t is a diagonal matrix of time-varying standard deviations from the univariate GARCH models with $\sqrt{h_{ii,t}}$ on the i-th diagonal; and R_t is the (possibly) time-varying correlation matrix of the standardized residuals $\varepsilon_{i,t} = u_{i,t} / \sqrt{h_{ii,t}}$. The model used in the second step, which maximizes the correlation component, Q_t, conditional on the standardized residuals from the first step is given by:

$$Q_t = (1-a-b)\overline{Q} + a\varepsilon_{t-1}\varepsilon_{t-1}^{'} + bQ_{t-1} \text{ and } R_t = Q_t^{*-1} Q_t Q_t^{*-1} \tag{2.2}$$

where $\overline{Q} = E[\varepsilon_t \varepsilon_t^{'}]$ is the unconditional covariance matrix of ε_t , and a and b are scalar parameters satisfying *(a+b) <1*. Q_t^{*-1} is the inverted diagonal matrix containing the square root of the diagonal elements of Q_t. The typical ith element of R_t has the form of $\rho_{ij,t} = \frac{q_{ij,t}}{\sqrt{q_{ii,t} q_{jj,t}}}$.

The correlations of bonds or stocks with forward contracts can be examined using the following bivariate model:

$$\begin{bmatrix} q_{11,t} & q_{12,t} \\ q_{12,t} & q_{22,t} \end{bmatrix} = (1-\text{a}-\text{b})\begin{bmatrix} 1 & \overline{q}_{12,t} \\ \overline{q}_{12,t} & 1 \end{bmatrix} + a\begin{bmatrix} \varepsilon_{1,t-1}^2 & \varepsilon_{1,t-1}\varepsilon_{2,t-1} \\ \varepsilon_{1,t-1}\varepsilon_{2,t-1} & \varepsilon_{2,t-1}^2 \end{bmatrix} + b\begin{bmatrix} q_{11,t-1} & q_{12,t-1} \\ q_{12,t-1} & q_{22,t-1} \end{bmatrix} \tag{2.3}$$

where $q_{11,t}$ and $q_{22,t}$ denote the variance of the standardized residuals obtained from the bond or stock returns based on the univariate GARCH(1,1).

2.3.2. Correlations between bond or stock markets and currency markets

Table 2.2 reports the average correlations between the bond or stock indexes and forward contracts based on the DCC model with the largest negative Likelihood Ratio (LR) when the estimates of *a* plus *b* in equation (2.3) are less than 1. This was generally a GARCH(1,1) but was also a GJR/TARCH or EGARCH model in the first step and asymmetric DCC in the second step of the estimation. The correlation for each country is the average correlation between the returns of the bond or stock market index for each home country with the returns of the other 19 currency forward contracts in the spirit of Cho et al. (2016). These results indicate that developed markets have higher correlations on average than the correlations in emerging markets. The correlations for the Eurozone countries are much higher than those for the other developed markets mainly because these countries uniformly adopted the Euro as their currency or because their currency is pegged to the Euro (e.g., Denmark). The correlations of bonds with forward contracts exceed those between stocks and forward contracts for all but the six countries of Japan, U.K., U.S., Chile, India, and South Africa. This indicates that hedging the currency risk for bond portfolios may yield different hedging performance than for stock portfolios. The U.S. bond market exhibits very low DCC correlations with the forward contracts of other countries. Consistent with the findings of Cho *et al.* (2016),[4] the correlations between the bond or stock indexes and currency forwards for the emerging markets are positive. The average correlation between the indexes of bonds or stocks and forward contracts for the DM sample is not lower than for the EM sample as in Cho *et al.* (2016).

[Please place Table 2.2 about here.]

The summary statistics of the parameters for the DCC correlations between bond indexes or stock indexes and forward contracts, or among forward contracts are reported in Appendix 2.A1-2.A3. Most parameters *a* and *b* are positive and significantly different from zero at the 10% level, indicating that the DCC model is superior to the constant conditional correlation model. The

[4] Cho *et al.* (2016) only examine correlations between exchange rates and stock returns.

estimates of the DCC parameter *b* typically reflect high persistence. For example, the mean (median) DCC parameter *b* for the Canadian bond market index is 0.805 (0.945). The last two columns report the minimum and maximum log likelihood ratio (LR) values. The LR values are used to determine whether the DCC-GARCH model should consider asymmetric effects in both steps of the DCC implementation.

2.3.3. Correlations between currency forward contracts

Based on the argument of Darbar and Deb (2002) that the arrival of market information affects the cross-market correlations of currency futures, we expect that the unconditional monetary policy may similarly affect cross-market correlations in the currency forward market. Table 2.3 reports the average correlations based on the DCC-GARCH(1,1) model (with one exception) between the returns of the currency forwards of each home country with the returns of the other 19 currency forwards.[5] We find that the mean correlations for the currency forwards for the developed or emerging countries in the European Union (EU) are usually higher than those for the countries in the other continents. For example, the mean DCC correlations of the currency forward contracts in the Eurozone and Sweden are 0.547 and 0.534, respectively. Similarly, the mean correlations of the currency forward contracts for the European emerging countries (such as Hungary and Poland) with the other 19 currency forward contracts are also higher. Since the British Pound is rather independent from the Euro, its mean correlation is lower than that for countries in the EU. The average correlation of the forward contracts for Japan with the other countries is the lowest at 0.113. Overall, the mean correlations of the currency forwards for the DM countries are higher than those for the EM countries.

[5] This is for the returns of the currency forward contract of Australia with that of Singapore where the chosen model is an asymmetric DCC-EGARCH model.

[Please place Table 2.3 about here.]

2.3.4. The differences in the correlations during the three QE periods

As QE1 and QE2 are implemented after the financial crisis when the U.S. financial market was still turbulent and QE3 took place in a more tranquil environment, we now examine whether the correlations between the bonds or stocks and forwards are different during the various QE periods using the follow regression:

$$corr_t = \beta_0 + \beta_1 QE1 + \beta_2 QE2 + \beta_3 QE3 + \beta_4 ControlVar_t + \varepsilon_t \tag{2.4}$$

The three time dummy variables, *QE1*, *QE2* and *QE3*, are equal to one during the corresponding QE period and zero otherwise. A wide range of control variables are used to control for the influence of other important variables that reflect the status of the U.S. economy. Specifically, we include the three Fama-French risk factors (Ex_Mkt, SMB and HML) and a liquidity risk factor (LIQ) to reflect the information from the stock market; the term and credit spread to reflect the information from the bond market; and inflation rate, M2, GDP and the policy uncertainty index as indicators of the state of the U.S. macro economy.[6]

Based on Panel A of Table 2.4, the means of the correlations of bonds and of stocks with forward contracts during the QE2 period compared to the non-QE period (i.e., all such periods together) are significantly higher for the All, DM, and EM country samples. In contrast, the means of the correlations of bonds with the forward contracts compared to the non-QE period are significantly lower during the QE1 and QE3 periods for the DM country sample and significantly higher during

[6] The detailed definition and sources of these control variables are provided in a separate appendix which is available if requested. Brief description is found in Table 2.4.

the QE3 period for the EM country sample. The means of the correlations of stock indexes with forward contracts compared to the non-QE period are significantly lower during the QE3 period across the All, DM, and EM country samples.

[Please place Table 2.4 about here.]

Panel B of Table 2.4 reports the differences of the mean correlations between bonds or stocks and forward contracts during each pair of QE periods. The means of the correlations of forward contracts with bond indexes or with stock indexes are significantly different between QE1 and QE2 and between QE2 and QE3 across the All, DM, and EM country samples. In particular, the differences of the means of the correlations of forward contracts with the stock indexes between the QE2 and QE3 periods is around 3.5 times than that for the bond indexes across the All, DM, and EM samples. The correlation patterns between bonds or stocks with the forward contracts suggest a number of important economic implications with respect to international portfolio management, especially for hedging currency risk for bond or stock portfolios across the DM and EM countries. These results also have implications for international asset pricing models.

The means of the correlations among forward contracts during the three QE periods for the All, DM and EM country samples and tests of the differences in means are also presented in Panels A and B of Table 2.4, respectively. Based on Panel A, the means of the correlations of forward contracts during the QE2 period compared to the non-QE period are significantly higher across the All and EM countries. In contrast, the means of the forward correlations are significantly lower during the QE1 and QE3 periods for the DM sample compared to those during the non-QE period. As shown in Panel B of Table 2.4, the means of the correlations between the forward contracts are significantly different between QE1 and QE2 and between QE2 and QE3 across the All, DM, and EM countries, and between QE1 and QE3 across the EM countries.

2.4. Conclusion

We investigate the cross-market correlations across 31 countries during the three QE periods in the U.S. We find that the means of the correlations between stocks (bonds) and forward contracts, and between forward contracts differ by QE period. These results suggest that cross-market correlations and their effects on international financial asset returns differ considerably between the conventional and unconventional monetary policy regimes and between various unconventional monetary policy regimes. Our findings have implications for portfolio managers making investment decisions overseas and regulators when considering the unintended consequences of their actions.

CHAPTER THREE

Currency Hedging of International Bond Portfolios: Effects of Unconventional Monetary Policy Regimes

3.1. INTRODUCTION

The U.S. Federal Reserve (Fed) initiated an unconventional monetary policy (UMP), so-called quantitative easing (hereafter, QE), starting from November 2008 by purchasing long-term government bonds, mortgage-backed securities (MBS) and agency debts. The objective was to stimulate the economy by injecting needed credit and liquidity into the financial markets to reduce short-term interest rates to nearly zero and to further stimulate the economy when short-term interest rates were about as low as they could get (Bernanke, 2010a). According to Rodnyansky and Darmouni (2017), the Fed had accumulated $1.75 trillion in MBS, or about 30% of the issued MBS by the end of the third QE round.[7] Figure 3.1 captures the net effect of long-term fixed-income transactions by the Fed on its holdings during the three QE rounds.[8]

[Please Insert Figure 3.1 about Here]

Such unprecedented large scale purchases of fixed-income securities (specifically mortgage-backed securities and Treasuries) by the Fed had a major impact on both domestic and international bond markets. Domestically, the QE significantly reduced U.S. long-term government bond yields (e.g., Gagnon, Raskin, Remache, and Sack, 2011; Glick and Leduc, 2012; Krishnamurthy and Vissing-Jorgensen, 2011; D'Amico and King, 2013), mortgage rates (Hancock and Passmore, 2011) and bond yields for U.S. non-financial firms (Gilchrist and Zakrajsek, 2015). With regard to global bond markets, large scaled purchases of MBS and Treasuries by the Fed significantly increased global corporate bond issuances across developed and emerging countries (Duca, Nicoletti, and Martinez, 2016), and significantly reduced long-term government bond yields in the developed countries (Neely, 2015). This differed from the negligible overall effect of the unconventional monetary policies of the European Central Bank on the international sovereign

[7] Appendix 3.A provides a summary of some aspects of the three U.S. QEs.
[8] We use the terms fixed-income and bonds interchangeably.

bond yields for advanced economies and emerging markets (Fratzscher, Lo Duca, and Straub, 2016).

According to Yellen (2011), "… central bank purchases of longer-term securities work through a portfolio balance channel to depress term premiums and longer-term interest rates" based on the premise that "long-term yields are associated with the outstanding quantity of longer-term assets in the hands of the public". The international portfolio balance channel argues that asset purchases can be transmitted to asset prices across market segments and countries (e.g., Bernanke, 2012; Fratzscher, Lo Duca, and Straub; 2016). Fratzscher, Lo Duca, and Straub (2016) aptly state this as follows: "As investors are crowded out from some market segments by central bank purchases, they move to close substitute assets, leading to portfolio rebalancing and to a chain of price effects. More broadly, unconventional monetary policy actions by affecting risk premiums and yields of key benchmark assets (in particular, government bonds) induce investors to rebalance their portfolios, ultimately having additional price effects on a broad range of assets."

Furthermore, according to the preferred-habitat model (e.g., Vayanos and Vila, 2009; Greenwood and Vayanos, 2010), investors have preferences for specific maturities. Since the interest rate for a given maturity is determined by the demand of investors with those preferences and the supply of bonds with that maturity, an increase in demand for long-term bonds raises long-term bond prices and reduces their yields. If the preferred habitat model works together with the international portfolio rebalancing channel, we may expect that the yields of long-term government bonds across countries are reduced. Since government treasury yields are one of the key determinants of the yields for various types of bonds (such as sovereign debts and corporate bonds), the large scale of purchases during a QE should inevitably affect the effectiveness and performance of the risk management strategies adopted by investors for their international bond portfolios.

Purchases of risky MBS are expected to push domestic investors into emerging markets through the risk-taking channel (Borio and Zhu, 2012) which is a variation of the risk-shifting channel. Ayala, Nedeljkovic, and Saborowski (2017) find that financial institutions in emerging countries created a more conducive environment for the growth of local markets during the post-crisis period. As foreign investors sought higher yielding assets, the bond markets became the main conduit for the flow of capital to emerging countries. Miyajima, Mohanty, and Chan (2015) find that from 2009 to 2013 foreign investors preferred local currency government bond markets in emerging economies, as cumulative net inflows to mutual funds dedicated to EM bonds in local currency debts increased by more than 75%. With improved macroeconomic fundamentals and greater depth of their local currency bond markets (e.g., GDP growth and fiscal balance), the diversification benefits of EM local currency bonds for foreign investors increased while yields decreased and global risk aversion increased (IMF, 2012).

The U.S. QE is not only associated with a depreciation of the U.S. dollar against various foreign currencies, such as the Euro, Australian dollar, Pound Sterling, Brazilian real, and the Indian rupee (see Figure 3.2) but it also is expected to have an impact on the currency risk exposure, expected returns and covariances of international bond portfolios through the portfolio rebalancing and risk-shifting (or risk-taking) channels, as discussed earlier. Thus, the objective of this essay is to empirically examine the spillover effects of the evolution of the holdings of the Fed prior to and during the QEs on the effectiveness and performance of unhedged and hedged international bond portfolios from the perspective of U.S. investors.[9]

[Please Insert Figure 3.2 about Here]

We measure the hedging effectiveness and hedging performance of currency hedging strategies by the percentage changes of their variances and the differences of their Sharpe ratios from those of an unhedged position, respectively, and their variance and excess return components for bond portfolios invested in developed and emerging countries. We employ currency forwards to hedge the currency risk by adopting two hedging strategies that are commonly used in the currency risk management of investment portfolios:[10] (1) a unitary hedge ratio (i.e., naïvely or fully hedged); and (2) a hedge ratio designed to minimize the portfolio variance based on historical information (i.e., optimally hedged).

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[9] Our choice to examine the effect of the U.S. QEs on the hedging effectiveness and performance of bond instead of equity portfolios is based on the size of international fixed-income markets, especially bond markets in emerging countries, and on the fact that the QEs are implemented by changes in the fixed income holdings of the Fed and by the observation that international equity and bond funds differ in their currency hedging policies (e.g., Lauricella, 2015). While international equity mutual funds tend not to hedge their FX risk based on the belief that the long-term effects of currency moves on returns are neutral and do not compensate for hedging costs, international bond mutual funds are more likely to hedge their FX risk based on the belief that bond returns are much more sensitive to currency swings than equity returns.

[10] Deli, Hanouna, Stahel, Tang, and Yost (2015) report differences in derivative usage by fund type with currency forwards being the most commonly used derivative for a random sample of N-SAR fund filings for 2014.

We first run a univariate test to examine differences in hedging effectiveness, performance, and their excess return and variance components during the QE versus the pre-QE period. We find several pairs of significant differences for the fully hedged and unhedged portfolios. We then use time-series regressions to investigate how the variations in hedging effectiveness and performance during the QE and pre-QE periods are affected by the time-series evolution of specific assets held by the Fed. We find that the effects of two security-type holdings (*MBSF* and *TREASF*)[11] by the Fed on relative hedging effectiveness or differenced hedging performance depend on the implemented hedging strategy and/or the development level of financial markets (DM for developed market or EM for emerging market). In contrast, larger security type holdings significantly reduce the variances of international bond portfolios. The negative elasticities at the mean during the QE period are larger in magnitude for TREASF than MBSF, and are higher for the bond portfolios invested in EM than that in DM countries for the same hedging strategy and security-type holding. These elasticities at the mean for the QE period also decrease monotonically from the unhedged to the fully hedged to the optimally hedged portfolios for the same independent variable and country category.

Since the return distributions deviate from normality with or without hedging (especially for the emerging market bond portfolios), we check the robustness of our findings using two measures that account for skewness and kurtosis; namely, abnormal value at risk (*AVaR*) for hedging effectiveness and the adjusted Sharpe ratio (*ASharpeR*) for hedging performance. We find that capturing the effects of any non-normality in returns does not materially affect our previous inferences for hedging performance and effectiveness that were based on the first two return moments.

Our study makes three contributions to the literature. First, this study provides the first empirical evidence about the spillover effect of QE on the unhedged and hedged international bond portfolios in the DM and EM countries. Closely related studies include Neely (2015) and Glick and Leduc (2012) who examine the spillover effects of central bank announcements on the international bond markets of developed countries. In contrast to our study that examines the excess returns and variances of unhedged and hedged international bond portfolios over a 10-year period covering the pre-QE and QE periods, they only examine the long-term government bond yields over short

[11] The suffix 'F' is added to indicate holdings by the Fed.

time periods. Our research is also related to Steeley and Matyushkin (2015) who only examine the volatility of single-issuer domestic bonds during the U.K. QE. In contrast, we focus on the spill-over effect of the U.S. QE for a sample consisting of the most prominent developed and emerging countries around the world.

Second, our study expands the understanding of the real (spill-over) impact of the security type holdings of the Fed during a QE on international fixed-income portfolios. This adds to the findings of previous studies which document the impact of the security type holdings on the behavior of market participants. Specifically, Rodnyansky and Darmouni (2017) find that the *MBSF* and *TREASF* holdings of the Fed significantly stimulate bank lending. Carpenter, Demiralp, Ihrig, and Klee (2015) examine from whom the Fed buys and how these investors rebalance their portfolios. Instead, we provide evidence about the impact of security type holdings on the return, risk and return-to-risk profiles of hedged and unhedged international bond portfolios.

Last, our research also highlights the heterogeneity of the QEs' impacts on international bond portfolios which differ by the chosen hedging strategies and the selection of bonds from DM or EM countries. We show that the QEs' effects on both hedging effectiveness and hedging performance are contingent on the hedging strategy implemented and the economic categories of countries upon which the bond portfolios are based. These findings have important implications for fixed-income portfolio managers when selecting hedging strategies in the face of unconventional monetary policy regimes.

The rest of the essay is organized as follows: Section 2 describes the measures of hedging effectiveness and performance. Section 3 presents the data and descriptive statistics. Section 4 develops the hypotheses. Section 5 reports and discusses the relative hedging effectiveness and differenced hedging performances between the QE and pre-QE periods. Section 6 analyzes the relation between hedging effectiveness/performance and the Fed's asset holdings. Section 7 presents tests of robustness. Section 8 concludes.

3.2. MEASURING HEDGING EFFECTIVENESS AND PERFORMANCE

We use various metrics to quantify hedging effectiveness and performance. Our first measure of differenced hedging excess-return performance is given by:

$$DifHdgExRtrn = (ExRtn_{hdg} - ExRtn_{unhdg}), \quad (3.1)$$

where *ExRtn* is the excess return or $\bar{R}_t - r_{ft}$ for either the hedged or unhedged portfolio of DM or EM countries; $\bar{R}_t$ is the mean of the realized weekly returns of each of these portfolios during the forward window [t+1: t+24]; and r_f is the risk-free rate.

We measure relative hedging effectiveness as the difference between the variances (Var) of the optimally (fully) hedged portfolio and its corresponding unhedged counterpart, scaled by the variance of its unhedged counterpart, which is given by (e.g., Caporin, Jimenez-Martin and Gonzalez-Serrano; 2014; Cotter and Hanly, 2006; Ederington 1979):

$$RelHdgEffect = (Var_{unhdg} - Var_{hdg})/Var_{unhdg}. \quad (3.2)$$

Consistent with the practice in the literature for comparing Sharpe ratios (e.g., Glen and Jorion, 1993; Campbell, Serfaty-de Medeiros and Viciera, 2010) and given that Sharpe ratios can have negative values, we measure differenced hedging performance by:

$$DifHdgPerf = (SR_{hdg} - SR_{unhdg}). \quad (3.3)$$

The Sharpe ratios are formed at time t based on weekly returns for the forward window [t+1: t+24]. A Sharpe ratio is given by $SR_t = (\bar{R}_t - r_{ft})/Var_t^{0.5}$ where $Var_t^{0.5}$ denotes the standard deviation of the realized weekly returns of each of these portfolios during the forward window [t+1: t+24]; and all the other terms are as previously defined.

3.3. SAMPLE AND HEDGING STRATEGIES

3.3.1. Sample Construction

The bond indices denominated in local currencies and T-bill rates are collected on every Friday from Datastream. [12] The indices are the J.P. Morgan (JPM) Global Bond Broad Indices (GBI Broad) and the JPM Government Bond Index - Emerging Markets Broad (GBI-EM Broad) Indices. After removing missing observations, our sample covers 31 countries, including 19 developed markets

[12] The choice of a weekly frequency is based on several factors, including the need to have a sufficient number of observations to adequately determine the optimal hedge ratio using more current data and to test both hedging effectiveness and performance.

(DM) and 12 emerging markets (EM),[13] over the time period from September 12, 2003 to April 17, 2015. Since 24 weeks are used to form and to evaluate the portfolios,[14] the first and last portfolios are formed on February 27, 2004 and October 31, 2014 (i.e., the end of QE3).

According to JPM (2013), the GBI Broad index includes bonds from 27 countries with maturities of 3 to 5 years, while the GBI-EM Broad index includes government bonds from 17 emerging countries with maturities of at least 13 months. There are four countries, Hungary, Poland, South Africa and Mexico, which are included in both bond indices. We use the JPM GBI Broad index for Hungary, Poland, and South Africa, and the JPM GBI-EM Broad index for Mexico to maximize the time spans of the data available for analysis.

The spot and forward currency prices on Friday are extracted from Datastream and Bloomberg.[15] The U.S. nominal T-bill rates at a weekly frequency on Friday are obtained from French's data library.[16] The WM Reuters Spot and one-month forward U.S. dollar currency prices are computed by taking the arithmetic means of their closing bids and offers at 4 p.m. U.K. time that are provided by the WM Company. Missing forward rates are collected from Bloomberg. Since our sample includes 11 countries using the euro, there are only 20 different currency-denominated forward contracts.

3.3.2. Fully and unconditional variance-minimizing hedging strategies

There are a number of hedging strategies, either simple minimum variance hedging (Ederington, 1979; Malliaris and Urrutia, 1991; Benet, 1992), hedging taking into account higher moments information (Brooks, Černý and Miffre, 2012), or hedging using time-series econometric models such as GARCH (Zanotti, Gabbi and Geranio, 2010; Caporin, Jimenez-Martin and Gonzalez-Serrano; 2014). A large strand of the literature suggests that simple minimum variance hedging outperforms the sophisticated econometric models. For example, Brooks, Černý and Miffre (2012) find that higher moments do not matter for hedging decisions and even traditional OLS hedging

[13] The classification of countries as being developed or emerging is based on the categorization used for the IMF country categories.
[14] To identify the *postQE1not* period, which is defined in appendix 3.B, we use a window width of 24 weeks. However, our results are robust to other window widths such as 36 weeks. These results are available upon request.
[15] We choose forwards contracts because they are not expensive and are more flexible than futures; for example, any desired size can be delivered. Forwards are the more popular choice for hedging in the literature. Examples include Glen and Jorion (1993) and De Roon, Nijman and Werker (2003).
[16] We thank Kenneth R. French for making the data available on his website.

outperforms hedging with higher moments. Other studies report that sophisticated econometric models provide negligible economic benefits for minimum-variance hedging and that the OLS hedge ratio is superior (Alexander and Barbosa, 2007; Lence, 1995). Since our main purpose is to examine and interpret the effects of UMP on the effectiveness and performance of currency hedging rather than discussing sophisticated hedging strategies based on different econometric models, we focus on the minimum-variance hedging and fully hedging, which are popular currency risk-management strategies for investment portfolios.[17]

We follow Gagnon, Lypny, and McCurdy (1998) and use the portfolio hedging approach with multiple currency forwards contracts so that the variance-minimizing hedge takes into account not only its own correlation with the underlying assets but also the correlations with the other forwards contracts. Otherwise, each hedge ratio would tend to end up being over-insuring. The assumption in the classic hedging model is that the investor holds one unit of each spot asset; that is, the weight of each underlying bond is one.[18] Then we use N currency forwards contracts to hedge an N-asset portfolio.

We denote $\sum$ as the partitioned variance-covariance matrix $\sum = \begin{bmatrix} \sigma_p^2 & \sum_{pf} \\ \sum_{pf}^{'} & \sum_{ff} \end{bmatrix}$, where σ_p^2 is the variance of the spot portfolio return, $\sum_{ff}$ is an n×n covariance matrix of changes in forwards returns, and $\sum_{pf}$ is an 1×n vector of covariances between the underlying portfolio return and the forwards returns. The unconditional optimal minimum-variance hedge ratio is measured as $\beta = \sum_{ff}^{-1} \sum_{pf}$.

We use a "rolling-sample", similar to DeMiguel, Garlappi and Uppal (2010) and Cotter and Hanly (2006). The estimated hedge ratio conditions on recent information and uses a rolling-window estimator of the variance-covariance matrix. As Cotter and Hanly (2006) point out, the

[17] Using the results of a worldwide survey of 563 institutional investors conducted by Mellon/Russell (Harris, 2004), Michenaud and Solnik (2008) report that 39% of the respondents do not hedge, 34% adopt a 50% hedging strategy, 14% adopt a 100% hedging strategy and 13% use another hedge ratio. Deli, Hanouna, Stahel, Tang, and Yost (2015) report that the most commonly used derivatives for a random sample of 10% of the funds with N-SAR filings for 2014 are currency forwards (13% of funds), followed by equity futures (12%) and interest rate futures (11%).

[18] The measurement of the minimum-variance hedge ratio is irrelevant to the weights of the underlying assets and in the classical hedging model it is assumed that the investor holds one unit of each spot asset; that is, the weight of each underlying bond is 1. This means, for example, one Canadian bond, one Brazilian bond, and so on.

rolling-window with updating information leads to more efficient estimates of the hedge ratio and also considers the time variation in the return distributions. We set the estimation window width *W* = 24 weeks without a loss of generality and move forward one week in every step by adding a new weekly observation and dropping the most distant week until the end of the third QE period is reached. We employ an optimally and fully hedging strategy, as described in the previous sections of this essay. To ensure that the examinations of the hedging performance and effectiveness of these portfolios are realistic, we use a rolling out-of-sample evaluation window with the same width (*W*) as that used for portfolio formation. We also find in untabulated results that our reported findings are robust to the choice of *W*.

3.3.3. Summary Statistics

We assume the perspective of an U.S. investor. The return on a security is expressed as $R_{i,t+1} = \frac{P_{i,t+1}S_{i,t+1}}{P_{i,t}S_{i,t}} - 1$, where $S_{i,t}$ denotes the spot price of foreign currency *i* at time *t*, denominated by the number of U.S. dollars per unit of foreign currency, and $P_{i,t}$represents the market value of the security denominated by the foreign currency. The return on forward contracts is denoted by $f_{i,t+1} = \left(F_{i,t+1} - F_{i,t}\right)/F_{i,t}$, where $F_{i,t+1}$ is the forward price of currency *i* at time *t+1,* denominated by the number of U.S. dollars per unit of foreign currency. Therefore, the return on a hedged portfolio consisting of the underlying assets and corresponding forward contracts is calculated by $R_{t+1}^{h} = R_{t+1} + h_t f_{i,t+1}$, where h is the weight of currency forwards or the *hedge ratio*. We set hedge ratios to 0 and 1 for the unhedged and fully (i.e., *naively*) hedged portfolios, respectively. In a portfolio containing multiple assets, R_{t+1} denotes the n-vector of random returns, each multiplied by its corresponding weight; and $h_t \cdot f_{t+1}$ represents the dot product of the *n*-vector of hedge ratios with the corresponding vector of forward currency payoffs.

Table 3.1 reports the summary statistics (means and standard deviations) for exchange rates, forwards rates, and unhedged, fully-hedged, and optimally-hedged portfolios of bonds across 31 countries during the period from September 2003 to October 2014. As shown in the first column, the average weekly percentage changes of the spot currency rates vary widely in both sign and magnitude. In particular, we note that, on average, the India rupee, Mexican peso, and South African rand depreciated, while the others appreciated from as little as 0.01 percent (British pound, Hungarian forint, and Japanese yen) to 0.07 percent (Australian dollar and New Zealand dollar).

The weekly volatilities of the spot exchange rates calculated at a weekly frequency also vary drastically across currencies from 0.71 percent for the Singapore dollar to 2.35 percent for the South Africa Rand. As the exchange rates of the currencies for the emerging markets are more volatile than those for the developed markets, it foreshadows the possible benefits for hedging when the international portfolio holdings of a U.S investor include securities from emerging countries. As expected, the volatilities of forward prices closely match their corresponding spot prices.

[Please place Table 3.1 about here]

We observe that the cross-sectional average of the mean weekly returns fall, sometimes dramatically, with a cross-sectional average decline of 0.82% and 0.21% for the fully- and optimally-hedged portfolios of international bonds compared to their corresponding unhedged counterparts. Similarly, the cross-sectional average of the standard deviations decline by 1.60% and 1.83% for the fully- and optimally-hedged portfolios of international bonds, respectively, compared to their unhedged counterparts. The substantially lower risks and returns for the fully-hedged portfolios of bonds are consistent with the findings of Glen and Jorion (1993).

Figure 3.3 provides a comparison of the Sharpe ratios of the unhedged and fully-hedged portfolios where plots above the line indicate Sharpe ratio superiority for the fully-hedged portfolio. Fully hedging improves the Sharpe ratios for the bond portfolios for all the countries except Japan, Greece and Singapore. Some examples of extreme improvements in the Sharpe ratios are more than four times for the Brazilian bond portfolio, and almost three times for the South African and Colombian bond portfolios.

[Please place Figure 3.3 about here]

3.3.4. Proxies for Various Dimensions of the Evolution of the Fed's Asset Holdings

We capture various dimensions of the Fed's asset holdings over time using various independent variables. Our first variable is designed to capture the total asset holdings of the Fed relative to the dollar value of domestic economic activity. As in Meaning and Zhu (2012), we use *TAF/GDP*, which measures the Fed's total asset (*TAF*) holdings relative to the level of domestic *GDP*, to examine its effect on hedging effectiveness and performance. Our next two variables are designed to capture the relative time-series evolution of two major domestic debt security holdings through which the Fed implemented its QE activities; namely, risk-free Treasury bonds (*TREASF*) and risky mortgage-backed securities (MBSF). As in Rodnyansky and Darmouni (2017), we use *TREASF/TAF* and *MBSF/TAF* where the Fed's Treasury bond holdings (*TREASF*) and mortgage-backed securities (*MBSF*) are scaled by the Fed's total assets (*TAF*) to examine their effect on hedging effectiveness and performance. Using these metrics, Rodnyansky and Darmouni (2017) find that bank lending is affected by the bank's exposure to unconventional monetary policy shocks caused by large-scale asset purchases. We would expect that this would have an impact on the international returns and covariances of country bond indices.

Our final set of variables is designed to capture the relative time-series evolution of the Fed's relative holdings of Treasury bonds and MBS with longer maturities, and their impact on hedging effectiveness and performance. This choice of variables is based on the observation that the U.S. Federal Reserve bought large amounts of long-term securities, including mortgage-backed securities, corporate bonds, and long-term Treasury bonds during the QE period to reduce long-term interest rates in order to stimulate economic activity (Bernanke, 2012). Based on the preferred habitat model, Carpenter, Demiralp, Ihrig, and Klee (2015) argue that buying longer-term securities can affect longer-term yields because investors are less willing to switch into other assets. Since what is long-term could be contentious, we use $TREASF_{matur}/TAF$ and $MBSF_{matur}/TAF$ with maturity (*matur*) equal to over five years and then to over ten years to ensure that our findings are robust to our choice of what maturities are deemed to be long term.

3.3.5. Control Variables

We expect that differences in hedging effectiveness and performance between optimally (fully) hedged and unhedged portfolios of bonds are affected by various financial market and macro variables. To control for these effects in the multivariate analyses, we use various control variables that are described in Appendix 3.B.

The control variables for the U.S. capture aspects of domestic economic policy and bond markets. The trade-weighted broad exchange rate index (*TWEXB*) is used to measure the change of the U.S. dollar exchange rate. The term spread (*Term*), which is the difference between the yields of a 10-year and a three-month Treasury-bill, and the credit spread (*Credit*), which is the difference between yields on Moody's Baa and Aaa corporate bond yields, capture the term structure and credit quality of the U.S. bond markets, respectively. Using security-level data to estimate the local flow and stock effects of the Federal Reserve's 2009 purchase of $300 billion of treasury bonds, D'Amico and King (2013) find that fluctuations in the supply of government debt affected Treasury yields. In turn, this led to a persistent downward shift in yields of about 30 basis points. In addition, the economic policy uncertainty index (*PUI*), which reflects newspaper coverage of policy-related economic uncertainty and disagreement among economic forecasts, is used as proxy for policy uncertainty.[19]

Following Aslanidis and Christiansen (2012), the quarterly or monthly data for some of these control variables are converted to a weekly frequency by using the values until updated.

3.4. HYPOTHESES DEVELOPMENT

The U.S. Fed launched three rounds of QE by purchasing long-term government securities and mortgage-backed securities to keep the short-term interest rate close to zero and stimulate the economy by adding needed liquidity. Various papers examine the effect of QE on the U.S. or international bond markets. One strand of research focuses on the impact of QE on government bond rates using event studies. Within a short time period, the U.S. QE reduced 10-year government bond yields by around 100 basis points (Gagnon, Raskin, Remache, and Sack, 2011; Glick and Leduc, 2012; Krishnamurthy and Vissing-Jorgensen, 2011) and about 80 and 85 basis points for 10- and 5-year bond yields, respectively (Meaning and Zhu, 2012). Other studies find that the QE led to smaller and more diverse reductions in the yields of government bonds, especially bonds with 10- to 15-year maturities. D'Amico and King (2013) find bigger and significant bond yield reductions for bonds with longer maturities. Szczerbowicz (2011) finds that the reduction of yields for maturities of ten years are slightly different for the purchases of government bonds, mortgage-backed securities (MBS) and agency backed securities.[20]

The QEs not only reduced government bond yields in the U.S. and U.K., but also affected bond yields in other countries. Neely (2015) finds that the U.S. QE reduced the 10-year government bond yield in the U.K., Australia, Canada, Germany, and Japan. Glick and Leduc (2012) report that the long-term government bond yield decreased in the DM markets. The findings of these

[19] We only use the *PUI* instead of the unemployment rate because an increase in the *PUI* forecasts a decline in economic growth and employment in the following months, and the PUI may capture the effect of changes in the unemployment rate given their correlation of at least 0.78.

[20] Martin and Milas (2012) conduct an extensive survey on the effect of a QE.

studies are consistent with the expectation based on the portfolio balancing channel (Tobin 1965, 1969; Bernanke, 2012; Gagnon, Raskin, Remache, and Sack, 2011; Joyce, Lasaosa, Stevens, and Tong, 2011; Hamilton and Wu, 2012; Neely, 2015). Specifically, the U.S. Fed's purchases of long-term treasury bonds and mortgage-backed securities from the open market reduced the supply of these securities to investors and consequently caused them to shift into riskier financial assets, including financial assets in other developed and emerging markets. Thus, we conjecture that:

H1: The unhedged and hedged international bond portfolios for the DM or EM countries exhibit lower excess returns during the QE versus pre-QE period.

The signaling channel argues that large scaled asset purchases by central banks may signal information about current or future economic conditions or monetary policy to investors (Bernanke, 2012; Bauer and Neely, 2014; Christensen and Rudebusch, 2012; Krishnamurthy and Vissing-Jorgensen, 2011). A QE can moderate market turbulence after its inception by sending a strong signal to all the countries and thereby reduce heterogeneous beliefs in bond markets (Steeley and Matyushkin, 2015). Consistent with this argument, Steeley and Matyushkin (2015) provide evidence that the U.K. QE dramatically reduced the volatility of long-term government bonds in the U.K. Thus, our second hypothesis is:

H2: The unhedged and hedged international bond portfolios for the DM or EM countries have a lower variance in the QE compared to the pre-QE period.

Rodnyansky and Darmouni (2017) argue that the type of assets purchased during an unconventional monetary policy (UMP) is central to its effect. Gilchrist and Zakrajšek (2013) find that the average reductions in longer-term yields and mortgage backed securities are about 20 and 25 basis points, respectively, and statistically significant at the 5% level. Lo Duca, Nicoletti, and Martinez (2016) find that the purchases and holdings of MBS and Treasuries by the Fed lead to stronger corporate bond issuance in developed and emerging countries and that the MBS holdings appear to be a main driver of QE effects through a portfolio balancing channel. The portfolio balancing channel is based on the notion that various types of assets are not perfect substitutes so that the Fed's purchases of long-term government bonds or MBS may motivate domestic investors to invest in non-domestic bond markets (Neely, 2015). Thus, our third hypothesis is:

H3: The change in the excess return (and variance) for an international bond portfolio from a change in the Fed's holdings of MBS and Treasuries will differ during the QE period and will differ from the pre-QE to QE period for the same security-type holding.

Other QE effects can only be determined empirically because no a priori expectations are possible. To illustrate, a QE's net effect can result in the Sharpe ratio increasing, decreasing or remaining unchanged since the expected effects of the QEs on excess returns (and variances) of the unhedged bond portfolios are in the same direction, and those for the hedged portfolios are further comingled with the efficacy of the chosen hedging strategy.

3.5. COMPARISON OF RELATIVE HEDGING EFFECTIVENESS AND DIFFERENCED HEDGING PERFORMANCE BETWEEN THE QE AND PRE-QE PERIODS

In this section, we identify significant differences in hedging effectiveness and performance and their individual components between the QE and pre-QE period using t-tests (Wilcoxon rank-sum tests) of the null hypotheses that their means (medians) are zero. We begin with a test of the individual means and medians of excess returns (*ExRtn*) used to compute the differenced hedging excess-return performances given by eq. (3.1) and *DifHdgExRtn* itself. Based on Panel A of Table 3.2, we observe significantly lower excess returns for the unhedged and fully hedged portfolios during the QE period, consistent with H1. In contrast, the excess returns are insignificantly lower and significantly higher for the optimally hedged portfolios of EM and DM countries, respectively. Based on Panel A of Table 3.3, we observe that the differenced hedging excess-return performances (*DifHdgExRtn*) of the QE versus pre-QE period are consistently positive and significant, consistent with H1. Thus, while the excess returns of the hedged portfolios when not benchmarked to an unhedged position are not consistently higher during the QE versus pre-QE period; the excess returns are higher during the QE versus pre-QE period for the hedged portfolios when they are benchmarked to an unhedged position.

[Please Insert Tables 3.2 and 3.3 about Here]

We then conduct a similar examination for the individual variance (*Var*) components of *DifHdgEffect* given by eq. (3.2) and *DifHdgEffect* itself. Based on Panel B of Table 3.2, our inferences for *Var* depend upon whether we examine the means or medians between the QE and pre-QE period. A comparison of the means indicates generally lower (two insignificant) *Var* during the QE period, while a comparison of the medians indicates that all comparisons of *Var* are significant but with four higher and two lower during the QE period. Concentrating on the tests of equality for the means and medians of individual *Var* that provide significant and consistent inferences, we find during the QE versus pre-QE period that both the mean and median individual *Var*: (i) are lower for the fully hedged and unhedged portfolios of DM countries, and (ii) are higher for the optimally hedged portfolios of EM countries. Based on Panel B of Table 3.3, we observe mixed results for *DifHdgEffect*. We observe that their means and medians are significantly different only for the fully hedged portfolios; higher for the portfolios of DM countries and lower for the portfolios of EM countries.

We conclude with a similar examination of the individual Sharpe ratio (*SharpeR*) components of *DifHdgPerf* given by eq. (3.3) and *DifHdgPerf* itself. Concentrating on the tests of equality for the means and medians that provide significant and consistent inferences reported in Panel C of Table 3.2, we find that both the means and medians of the individual Sharpe ratios: (i) are lower during the QE versus pre-QE period for the fully hedged and unhedged portfolios for both the DM and EM countries, and (ii) are higher for the optimally hedged portfolios for the DM countries. Based on Panel C of Table 3.3, we find that the tests of the equalities of both the means and medians of *DifHdgPerf* for the QE versus the pre-QE period are significant and indicate higher values for the QE period for the hedged portfolios of DM countries. Only the mean differences are significant (and positive) for the hedged portfolios of EM countries. Furthermore, all of the mean and median *DifHdgPerf* are positive during both the QE and pre-QE period, and are materially large in magnitude for the optimally hedged portfolios and particularly so during the QE period.

We also test and find that both hedging strategies improve the means and medians of out-of-sample Sharpe ratios for the bond portfolios for the DM and EM countries compared to their unhedged counterparts when assessed over the complete time period. These benefits are small in magnitude for the fully hedged and much larger for the optimally hedged bond portfolios. [21] These results are consistent with Ackermann, Pohl, and Schmedders (2017) who report a carry-trade Sharpe ratio of 0.91 for a mean-variance optimized portfolio of foreign currency versus 0.15 for a

[21] The untabulated results show that all the means of the differences of the Sharpe ratios for the optimally and fully hedged portfolios versus their unhedged counterparts are significant (p-value <0.001) for the DM and EM countries. These means are respectively 0.436 and 0.009 for the DM countries and 0.786 and 0.008 for the EM countries. Results are consistent for Wilcoxon rank-sum tests for median equality.

naïvely (equally weighted) diversified portfolio. The inference from these results differs from the conclusion of DeMiguel, Garlappi, and Uppal (2009) that a naively diversified portfolio is superior to one optimized using mean-variance analysis because of estimation error.

3.6. RELATION BETWEEN HEDGING EFFECTIVENESS/PERFORMANCE AND THE FED'S ASSET HOLDINGS

In this section, we continue with tests of the time-series relationship between either relative hedging effectiveness or differenced hedging performance as the dependent variable and various characteristics of the asset holdings of the U.S. Fed while controlling for various other economic and market characteristics that could influence these dependent variables. Definitions and data sources for all the variables in each of the regression formulations are provided in Appendix 3.B.

3.6.1. Relative Hedging Effectiveness

We begin by estimating the following regression to examine the effect over the studied period of changes in the Fed's total asset (*TAF*) holdings relative to the level of domestic *GDP* (also used in a different context by Meaning and Zhu, 2012):

$$RelHdgEffect_\tau \text{ or } DifHdgPerf_\tau = \gamma_0 + \gamma_1 QE + \gamma_2 PostQE1not + \gamma_3 TAF/\$GDP_\tau + \gamma_4 TAF/\$GDP_\tau * QE + \gamma_5 TAF/\$GDP_\tau * PostQE1not + \varphi Controls_t + \epsilon_\tau \quad (3.4)$$

where the period dummies (QE and postQE1not), which take a value of one for each date that falls into a week during their respective periods and zero otherwise, are used to identify two periods from the beginning of the first QE (QE1); and all other variables are as previously defined.

This regression specification considers the effects on relative hedging effectiveness ($RelHdgEffect_\tau$) or differenced hedging performance ($DifHdgPerf_\tau$) over an out-of-sample future evaluation period τ consisting of weeks τ = t+1 to t+24 of a portfolio formed at time t.[22] All the considered controls are known at portfolio formation (i.e., prior to the beginning of the evaluation period). As argued in previous studies (e.g. Carrieri, Chaieb, and Errunza, 2013), this lagged modeling specification should alleviate somewhat the concerns associated with endogeneity biases

[22] This is an out-of-sample evaluation period using a moving (rolling) window with a width equal to 24 weeks since we are interested in the effect of unconventional monetary policy on predicted hedging effectiveness and hedging performance.

given the difficulty if not impossibility of finding exogenous instruments to reduce endogeneity concerns.[23] Furthermore, we could not find any plausible argument for the why the asset holdings of the Fed would depend upon the hedging effectiveness or performance of international bond portfolios.

The specification models (1) - (4) in Table 3.4 report the results of regression (4). We observe that the coefficient estimates for *TAF/$GDP* are significant for specifications (1) - (3). We also observe numerous changes in the signs and/or significances of the relations between relative hedging effectiveness and *TAF/$GDP* from the pre-QE to the postQE1not period. For example, while the relation is significantly positive for the optimally hedged portfolios of DM countries in the pre-QE period, it becomes insignificantly negative during the QE period and significantly negative during the postQE1not period. Similarly, while this relation is significantly negative for the fully hedged portfolios of DM countries in the pre-QE and QE periods, it becomes significantly positive during the postQE1not period. This is to be expected since *TAF/$GDP* cannot capture all aspects of the Fed's asset transaction behavior and it is unlikely that our regression (3.4) contains all the determinants of relative hedging performance, particularly for international bond portfolios. We find that average relative hedging effectiveness after controlling for the independent variables in regression (3.4) is still significant (and positive) for the three sub-periods for all four specifications.

[Please Insert Table 3.4 about Here]

We continue with the estimation of the following regression model that examines the effect on relative hedging effectiveness (*RelHdgEffect*) of the time-series evolution of the Fed's relative holdings of two types of domestic debt securities:

$$RelHdgEffect_\tau \; or \; DifHdgPerf_\tau = \beta_0 + \beta_1 QE + \beta_2 PostQE1not + \beta_3 TREASF/TAF_\tau + \beta_4 TREASF/TAF_\tau * QE + \beta_5 TREASF/TAF_\tau * PostQE1not + \beta_6 MBSF/TAF_\tau * QE + \beta_7 MBSF/TAF_\tau * PostQE1not + \varphi' Controls_t + \varepsilon_\tau \quad (3.5)$$

[23] A similar argument is used in the corporate governance literature for the use of lagged independent variables to deal with endogeneity (e.g., Adams, Mansi and Nishikawa, 2009; Jiraporn, Singh and Lee, 2009; Kryzanowski and Mohebshahedin, 2016).

where *TREASF/TAF* and *MBSF/TAF* are the holdings of risk-free treasury bonds and risky mortgage-backed securities by the Fed scaled by the total asset holdings of the Fed;[24] and all the other variables are as previously defined. This regression provides for an examination of the effect of changes in the Fed's risk-preference purchases on relative hedging effectiveness.

The results for specifications (5) through (8) for regression (3.5) are reported in Table 3.4. The relation between relative hedging effectiveness and the Treasury bond holdings by the Fed for the pre-QE period reported in Table 3.4 is negative when significant. The relation between these two variables becomes more negative (generally significantly) for the hedged portfolios of DM countries during the QE period. In contrast, this relation does not change significantly for the hedged portfolios of EM countries during the QE period which nevertheless is negative. The relation between relative hedging effectiveness and MBS holdings by the Fed is only significant (negatively) for the optimally hedged portfolios during the QE period. Thus, with some exceptions, hedging effectiveness tends to be negatively but not always significantly related to the Fed's holdings of both of these domestic asset types during the three periods examined. As expected, we again find that average relative hedging effectiveness after controlling for the independent variables in regression (3.4) is still significant (and positive) for the three sub-periods for all four specifications.

We end with an examination of the effect on relative hedging effectiveness (*RelHdgEffect*) of the time-series evolution of the Fed's relative holdings of long-term Treasuries and MBS. As can be seen in Figure 3.1, the representation of these two security types in the Fed's asset holdings fluctuated considerably after the initiation of QE1. To more formally examine their effects, we estimate the following regression:

$$\begin{aligned} RelHdgEffect_\tau \text{ or } DifHdgPerf_\tau = {} & \delta_0 + \delta_1 QE + \delta_2 PostQE1not + \\ & \delta_3\, TREASF_{matur}/TAF_\tau + \delta_4\, TREASF_{matur}/TAF_\tau * QE + \\ & \delta_5\, TREASF_{matur}/TAF_\tau * PostQE1not + \delta_6\, MBSF_{matur}/TAF_\tau * QE + \\ & \delta_7\, MBSF_{matur}/TAF_\tau * PostQE1not + \varphi'' Controls_t + \vartheta_\tau; \end{aligned} \tag{3.6}$$

Where $TREASF_{matur}/TAF$ and $MBSF_{matur}/TAF$ are the Fed's proportional holdings of Treasury bonds and mortgage-backed securities with maturities of over five (*matur* = 5) and over ten (*matur*

[24] $MBSF/TAF_\tau$ is not included because it is equal to zero before the beginning of the first QE.

= 10) years; and $MBSF_{matur}/TAF_{\tau}$ is not included because it is equal to zero before the beginning of the first QE.

The summary results for regression (3.6) for the categories with maturities >5 years and >10 years are summarized in panels A and B of Table 3.5, respectively. Not only are the results relatively weak, but there are many cross-period changes in the sensitivities of relative hedging effectiveness and their significances to the Fed's relative holdings of each maturity category of Treasuries. To illustrate, the relation as reported in col. (6) is insignificantly negative in the pre-QE period, significantly positive in the QE period, and once again insignificantly negative in the postQE1not period. We find similar mixed results for the sensitivities of hedging effectiveness and their significances to the Fed's relative holding of each maturity category of MBS. Consistent with previous results, we find that average relative hedging effectiveness after controlling for the independent variables in regression (3.6) is significant (and positive) for the three sub-periods and four specifications, with the exception of specification (5) for the postQE1not period.

[Please Insert Table 3.5 about Here]

Since the effect of the Fed's QE holdings may have different effects on the two variances included in our measure of relative hedging effectiveness, we rerun regression equation (3.5) when the dependent variable is the optimally hedged *Var*, fully hedged *Var*, and unhedged *Var* for the portfolios of DM and EM countries. The results are reported in Table 3.6 for the six regressions for each dependent variable (i.e., for the three hedging strategies for each of the two categories of country portfolios). The six sensitivities of the individual variances to the Fed's Treasury bond holdings (*TREASF/TAF*) for the pre-QE period are significant and negative but substantially larger in magnitude for the portfolios of EM countries. The six estimated sensitivities become significantly less negative for the QE and postQE1not periods with the magnitudes of the reductions being substantially larger for the portfolios of EM countries with the exception of the optimally hedged portfolios. While the six estimated sensitivities remain significantly negative for the QE period, they become positive for the postQE1not period but only significantly so for the three regressions for the portfolios of DM countries. The preceding discussion also applies to the estimated sensitivities of the individual variances to the Fed's MBS holdings (*MBSF/TA*). We find that the negative effect on the individual variances of the unhedged and hedged portfolios based on elasticities at the mean during the QE period is different for the two types of Fed holdings, consistent with hypothesis H3.[25] These elasticities are with one exception higher for TREASF than MBSF and higher for the portfolios of EM countries than DM countries. To Illustrate, the elasticities at the mean for *TREASF* and *MBSF* for the unhedged portfolios of EM countries [see col. (8) in Table 3.6] are -1.135 and -0.376, which represent the percentage change in Var from a one percent change in each of these variables from their means. Similarly, the elasticities at the mean for TREASF and MBSF for the unhedged portfolios of DM countries [see col. (7) in Table 3.6] are -0.213 and -0.126. The elasticities from the mean also decrease monotonically from the unhedged to the fully hedged to the optimally hedged portfolios for the same independent variable and country category. The only control variable with a consistently significant (negative) effect on the individual variances is the credit spread. Consistent with previous results, we find that average individual variances after controlling for the independent variables in regression (3.6) are significant and positive for the pre-QE period, and become significantly less positive but remain significantly positive during the QE periods.

[Please Insert Table 3.6 about Here]

Thus, the findings reported in Table 3.6 help to explain our findings for the impact of the evolution of the Fed's asset holdings pre-to-post QE on relative hedging effectiveness. While the directional impacts of the Fed's holdings on the individual variances are the same during the QE period, their magnitudes differ substantially across the different hedging strategies for the same portfolios of countries and even more so for the same hedging strategy across the two portfolios of each of the two types of market development.

3.6.2. Differenced Hedging Performance

The results for equation (3.4) that investigates the effect on differenced hedging performance (*DifHdgPerf*) of the Fed's total asset (TAF) holdings relative to domestic *$GDP* are reported in Table 3.7. While hedging performance is positively but insignificantly related to *TAF/$GDP* during the pre-QE period, it is positively and significantly related to *TAF/GDP* during the QE period and with one exception [(specification (3)] in the postQE1not period. In contrast to the results presented earlier in Table 3.4 for hedging effectiveness, we find that the positive and

[25] The elasticity at the sample mean for a level variable is given by $(dy/y)/(dx/x) = \beta \times (\bar{x}/\bar{y})$, where $\bar{x}$ is the sample mean of the independent variable x, β is the estimated coefficient for x, and $\bar{y}$ is the sample mean of the dependent variable y.

generally significant average differenced hedging performance after controlling for the independent variables in regression (3.5) are significantly or in one case insignificantly positive during the QE and postQE1not periods.

[Please Insert Table 3.7 about Here]

The results from the estimations of equation (3.5) that examine the effect on differenced hedging performance (*DifHdgPerf*) of the time-series evolution of the Fed's relative holdings of the two domestic debt security types, risk-free Treasuries and risky *MBS*, also are reported in Table 3.7. The negative (and generally significant) sensitivities of differenced hedging performance to *TREASF/TAF* during the pre-QE period tends to become less (more) negative during the QE (postQE1not) period. While only one of these sensitivities is significant during the QE period, all are negative with three being significant during the postQE1not period. We observe that the sensitivities of differenced hedging performance to *MBSF/TAF* is negative and significant during the QE and postQE1not period, except for the insignificant negative estimate for specification (8) in the QE period. We find that the average differenced hedging performance is positive and generally significant after controlling for the independent variables in regression (5).

The results from the estimations of equation (3.6) that examine the effect on differenced hedging performance of the Fed's relative holdings of Treasuries and MBS for two long-term maturity categories are reported in Table 3.8. Concentrating on specifications (5) – (8) for Treasuries with maturities greater than 10 years, this variable's sensitivities are not significant during the pre-QE period and generally significant and positive during the QE and postQE1not periods. Similarly, the sensitivities for MBS with maturities greater than 10 years are generally not significant for the QE period and generally negative and significant during the postQE1not period. We find that the average differenced hedging performance after controlling for the independent variables in regression (3.6) are generally mixed in terms of sign and whether they are significant.

[Please Insert Table 3.8 about Here]

Since the effect of the Fed's QE holdings may have different effects on the two Sharpe ratios included in our measure of differenced hedging performance, we rerun regression equation (3.5) when the dependent variable is the optimally hedged Sharpe ratio, fully hedged Sharpe ratio, and unhedged Sharpe ratio for the portfolios of DM and EM countries. These summary results are reported in Table 3.9. The relation between the individual Sharpe ratios and the Treasury bond holdings by the Fed is significantly positive for the fully hedged and unhedged portfolios during the pre-QE period. These relations remain positive during the QE period but are only significant for the portfolios of EM countries. They become insignificantly negative during the postQE1not period. The significantly negative relation between the individual Sharpe ratios and the Treasury bond holdings by the Fed for the optimally hedged portfolios of DM countries during the pre-QE period becomes insignificantly negative during the QE period and significantly negative during the postQE1not period. The significantly positive sensitivities of *MBSF/TAF* during the QE period for the fully and unhedged portfolios are insignificant during the postQE1not period. We find that the individual Sharpe ratios after controlling for the independent variables in regression (3.6) that are generally significant in the pre-QE and QE periods become generally insignificant in the postQE1not period.

[Please Insert Table 3.9 about Here]

The results from estimating the effect of security type holdings of the Fed on the individual excess returns included in the Sharpe ratios used to compute the differenced hedging performances are reported in Table 3.10. The sensitivities of the excess returns to *TREASF/TAF* are significantly positive for the fully hedged and not hedged portfolios and significantly negative for the optimally hedged portfolios during the pre-QE period. These sensitivities change sign during the QE period in that they become significantly negative for the fully hedged and unhedged portfolios and significantly positive for the optimally hedged portfolios. The sensitivities of the excess returns to *MBSF/TAF* are also significantly positive for the fully hedged and unhedged portfolios and significantly negative for the optimally hedged portfolios during the QE period. While it remains significantly negative for the optimally hedged portfolios during the postQE1not period, the remaining sensitivities are not significant during the postQE1not period. We find that the individual excess returns after controlling for the independent variables in regression (3.6) are generally significant and positive in all three subperiods for the optimally hedged portfolios. In contrast for the fully hedged and unhedged portfolios, they are significant and negative in the pre-QE and QE periods and insignificant in the postQE1not period.

[Please Insert Table 3.10 about Here]

We deal with an important caveat before proceeding to our further tests of robustness. We caution the reader that our implementations of both hedging strategies do not reflect hedging costs due to data unavailability. Based on previous findings reported in the literature, we can only surmise about the effects of including hedging costs on these two strategies. We surmise that the performance benefits of the optimally hedged bond portfolios of DM countries could survive as Perold and Schulman (1988) report that hedging costs captured by quoted spreads for the major currencies are generally between 8 and 16 bps, averaging around 12 bps. All hedging costs reported by Ackermann, Pohl, and Schmedders (2017) for ten DM countries during 2009 are below 10 bps which highlights not only the decline in hedging costs over time but that they were low even during the financial crisis. However, while the cost of each hedging change is low, the use of rolling window hedging increases transaction costs (performance drag) due to its time-varying hedge ratio and frequent portfolio rebalancing (Cotter and Hanly, 2006). In contrast, we surmise that the positive but smaller in magnitude hedging performance benefits for the optimally hedged bond portfolios for the EM countries would most likely not survive given the substantially higher hedging costs for emerging countries (Atwill, 2015).[26] However, transaction costs can be minimized by carefully selecting from among the many well-developed derivatives with low transaction costs available in currency markets (Ackermann, Pohl, and Schmedders, 2017).

3.7. ROBUSTNESS TESTS

3.7.1. Removal of Non-U.S. QE Implementers

Our previous findings include confounding events caused by the Bank of Japan, Bank of England, and the European Central Bank implementing their own UMPs to stimulate their own economies during our sample period. After eliminating these three jurisdictions, we examine the determinants of relative hedging performance [eq. (3.4)] and differential hedging effectiveness [eq.

[26] Non-deliverable currency forwards (NDFs), which trade in relatively liquid OTC markets depending upon tenor, are used for currencies with no "regular" forward markets. NDFs are used for five of the twelve countries in our EM sample with one month pips (or equivalently one basis point for most currency pairs) in 2012 in parentheses: Brazil (5), Chile (20), Colombia (3), India (2), and S. Korea (50). Unlike forward contracts, NDF counterparties use a compensating payment to settle the difference between the contracted price or rate and the prevailing spot price or rate on an agreed notional amount. Most of the NDFs are traded against the U.S. dollar which adds another forward contract for non-U.S. investors. For greater details on hedging instruments, see: *HSBC's Emerging Markets Currency Guide 2012*, Global Research, December 2011.

(3.5)] for the remaining six DM and eleven EM countries.[27] By comparing the summary findings reported in Table 3.11 with those in Tables 3.4 and 3.7, we find that the estimated coefficients for *TREASF/TAF*QE* and for *MBSF/TAF*QE* become marginally more (less) consistent in sign and/or significance. To illustrate, all the estimated coefficients for *TREASF/TAF*QE* in regression formulations (1) to (4) in Table 3.11 are negative and three are significant at conventional levels. In contrast, only three of their counterparts in Table 3.4 are negative and only two are significant. Thus, we conclude that our previous inferences are not compromised by them being based on a sample that included non-U.S. QE implementers.

[Please place Table 3.11 about here]

3.7.2. Tests Using Other Hedging Effectiveness / Performance Measures

In this section, we use an alternative measure for hedging effectiveness and for hedging performance and conclude based on the results reported in Online Tables 3.A1, 3.A2 and 3.A3 that our previous inferences are not materially affected although there are some changes in the estimated coefficients. Both of the alternate measures attempt to capture the effect of non-normality in returns that prior studies, for example, find for emerging-market bond portfolios (Burger and Warnock, 2007). Thus, our inferences are robust to return normality although the null hypothesis of normality is rejected at conventional significance levels for all the return series examined herein using the Jarque-Bera (JB) normality test. We now briefly describe both of these alternative measures. While we previously measured risk as fluctuations around the mean (μ) using the standard deviation (σ), an alternate measure of risk, Value-at-Risk (*VaR*), is based on deviations below a critical value. Replacing VaR (i.e., Value-at-Risk) by $AVaR$ (i.e., Abnormal VaR) in the relative hedging effectiveness measure of Cotter and Hanly (2006) for normally distributed returns becomes: $HE = 1 - [AVaR_{99\%Hedged}/AVaR_{99\%NotHedged}]$. AVaR is given by Bali, Gokcan and Liang (2007) as:

$$AVaR = \mu + \Omega(\alpha)\sigma, \text{ and} \tag{3.7}$$

[27] After excluding 10 Eurozone countries, Japan, U.K. and U.S., the DM sample consists of Australia, Canada, Denmark, New Zealand, Singapore, and Sweden. After excluding Greece, the EM sample consists of Brazil, Chile, Colombia, Czech Republic, Hungary, India, Mexico, Poland, South Africa, South Korea, and Thailand.

$$\Omega(\alpha) = z(\alpha) + \frac{1}{6}(z(\alpha)^2 - 1)S + \frac{1}{24}(z(\alpha)^3 - 3z(\alpha))K - \frac{1}{36}(2z(\alpha)^3 - 5z(\alpha))S^2 \tag{3.8}$$

Where $\Omega(\alpha)$ is the critical value based on the loss probability level, *S* and *K* of the portfolios; *z(α)* is the critical value from the normal distribution for probability (*1-α*); and all the other terms are as previously defined.

To account for any skewness (*S*) and kurtosis (*K*) of returns at the expense of implicitly assuming constant absolute risk aversion, we use the following Adjusted-Sharpe ratio (*ASharpeR*) (Pézier and White, 2008; Ackermann, Pohl, and Schmedders, 2017):[28]

$$ASharpeR = SharpeR\left[1 + \left(\frac{S}{6}\right)SharpeR - \left(\frac{K-3}{24}\right)SharpeR^2\right] \tag{3.9}$$

3.8 CONCLUSION

To the best of our knowledge, this study is the first to examine the spillover effects on the international portfolios of bonds from the DM and EM countries from the perspective of U.S. investors or asset managers that includes a period of quantitative easing (QE) launched by the U.S. after the sub-prime financial crisis. We find that the excess returns and the variances of unhedged international bond portfolios are significantly reduced during the QE versus the pre-QE periods. The effect of the QE on the hedging effectiveness and hedging performance of international bond portfolios depends on the choice of hedging strategy and the development level of the country in which a financial market is situated.

Our findings have important implications for the currency-hedging decisions of U.S. investors who invest in foreign financial markets, especially during periods with unconventional monetary policy actions by the central monetary authority. Our study also highlights the signaling role of the security holdings of the Fed since changes in holdings by security type during the QE have a significant effect on the returns, risk and return-to-risk profiles of hedged and unhedged portfolios of bonds from developed and emerging markets.

[28] This formula is derived from a Taylor series approximation to exponential utility.

CHAPTER FOUR

DOES QUANTITATIVE EASING AFFECT FINANCIAL MARKET INTEGRATION?

4.1. INTRODUCTION

In response to the recent financial crisis and to bring the U.S. economy out of the most recent recession, the U.S. Federal Reserve (Fed) implemented an unconventional monetary policy, Q*uantitative Easing* (or QE for short hereafter), in late November 2008. During the first QE round, the U.S. Fed completed the purchase of $1.25 trillion in mortgage-backed securities (MBS), $175 billion in agency debt and $300 billion in Treasury bonds (Treasuries) in the open market to inject liquidity and credit into financial markets. Although these actions alleviated the impact of the subprime crisis on the banking sector, they did not boost economic growth because the banks did not re-inject this additional credit and liquidity into other economic sectors (Benmelech and Bergman, 2012). During the second QE round (November 2010 to June 2011), the Fed bought about $600 billion of treasury securities to stimulate demand and to reduce the unemployment rate. A third QE round announced in September 2012 consisted of a new $40 billion per month, open-ended bond purchasing program of agency MBS designed to further bolster liquidity and economic prospects in the U.S..[29]

While these purchases were confined to U.S. financial securities, recent studies show that the QEs also generated profound impacts on non-U.S. economies through a portfolio-balancing channel (Bernanke, 2012; Gagnon, Raskin, Remache, and Sack, 2011; Joyce, Lasaosa, Stevens, and Tong, 2011; Hamilton and Wu, 2012; Neely, 2015), signaling channel (Bernanke, 2012; Bauer

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[29] Respective sources for each QE round are:
http://www.federalreserve.gov/newsevents/press/monetary/20081125b.htm;
http://money.cnn.com/2010/11/03/news/economy/fed_decision/index.htm; and
http://www.federalreserve.gov/newsevents/press/monetary/20121024a.htm

and Neely, 2014; Krishnamurthy and Vissing-Jorgensen, 2011), liquidity premium channel (Gagnon, Raskin, Remache, and Sack, 2011; Joyce, Lasaosa, Stevens, and Tong, 2011; Krishnamurthy and Vissing-Jørgensen, 2011); and confidence channel (Joyce, Tong and Woods, 2011). The larger monetary base in the U.S. during the QE periods also significantly affected international capital flows (Fratzscher, Lo Duca and Straub, 2012; Lim and Mohapatra, 2016) and foreign exchange risk (Kryzanowski, Zhang and Zhong, 2017). An important question that remains unanswered is: What effect (if any) did these spillover effects of the U.S. QEs on international economies have on international financial market integration? Of similar importance is the identification of the channels through which the effects of the various QE implementations are transmitted to changes in financial market integration.

In this essay, we examine the influence of QEs on international market integration for 31 countries, including both emerging markets (henceforth, EM) and developed markets (henceforth, DM) during the 2003-2014 period. We use the approach of Pukthuanthong and Roll (2009) to measure market integration and three indicators (QE1, QE2 and QE3) to identify the QE periods. We find that average market integration significantly increases during QE1 and QE2 for the bond and stock markets of All, DM and EM countries, and significantly decreases during QE3 except for the significant increase for the bond markets of the EM countries.[30] The percentage changes based on the elasticities at the mean are considerably higher during QE1 and QE2 for the EM countries (about 12.81% and 16.84%) versus the DM countries (2.53% and 3.80%).[31]

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[30] This integration measure is also used by Berger, Pukthuanthong, and Yang (2011), Berger and Pukthuanthong (2012), Christiansen (2014), and Lehkonen (2015).

[31] The average of the integration levels in bond (stock) markets in DM and EM countries are 79% and 57% (74% and 62%), respectively, in Panel B of Table 4.3. The incremental percentage is equal to the estimated coefficient of a QE dummy divided by the corresponding mean of the integration level. For example, it is equal to 16.84% (i.e., 7.3%/57%) for the EM bond markets during QE1.

To explore the possible channels and mechanisms through which QEs affect financial market integration, we examine the following six potential channels for the transmission of QE effects on market integration: confidence, default risk, inflation, liquidity, portfolio balance and risk-taking. Following the closely related literature and economic intuition, we use the VIX index to proxy for the confidence channel; credit spreads to proxy for the default risk channel; differential inflation rate to proxy for the inflation channel; cross-border bank-to-bank liabilities, money supply (M2) and 3-month treasury bills to proxy for the liquidity channel; differential GDP growth potential, differential interest rates and portfolio flows to proxy for the portfolio balance channel; and cross-border banking and capital flows to proxy for the risk-taking channel. We find that the differential inflation rate, cross-border bank-to-bank liabilities, differential GDP growth potential, differential interest rate and cross-border banking capital flows significantly affect the relationship between QEs and financial market integration. This evidence supports the arguments that QE effects on market integration are transmitted via the inflation, liquidity, portfolio-balance and risk-taking channels. Further, we use the Fed's relative holdings of risk-free (Treasuries) and risky (MBS) securities to proxy for the effect on market integration from the decision of the Fed to target its purchases during a QE to a specific risk segment of the market (risky, risk-free or both). We find that the net purchase scale of the QEs significantly reinforces the impact of the QEs on market integration, and that the impact of the QEs on market integration depends upon the risk-appetite exhibited by Fed purchases, which lend more credence to our findings. Our findings also are robust to the use of an alternate measure of market integration.

To the best of our knowledge, this essay is the first one to examine the influence of an unconventional monetary policy on the evolution of international bond and stock market integration in both the developed and emerging markets. As such, it contributes to the literature on international market integration or its reversed measure, segmentation.[32] For example, Koutoulas and Kryzanowski (1994) derive pure (bi-) national determinants for explaining the level of integration (alternatively segmentation) between the U.S. and Canadian stock markets using various macro-variables and their inter-country differences. Bekaert, Harvey, Lundblad, and Siegel (2011) consider six categories of variables for the segmentation of the global equity market: de facto openness, political risk and institutions, financial development, risk appetite and business cycles, information variables, and growth determinants. Several papers investigate the impact of big economic events on stock market integration, such as Frijns, Tourani and RadIndriawan (2012).

We also contribute to the line of research dealing with bond market integration which only consists of a small number of papers primarily for sovereign bond markets. This includes Chaieb, Errunza and Gibson (2017) who report that credit quality, political stability, and inflation risk are important determinants of the time-varying integration of developed and emerging sovereign bond markets and that illiquidity becomes important during crisis periods.

The rest of this essay is organized as follows: Section 4.2 describes the related theory and develops testable hypotheses. Section 4.3 describes the data. Section 4.4 reports the empirical results. Section 4.5 investigates the possible channels and mechanisms. Section 4.6 examines the robustness of our results. Section 4.7 concludes.

4.2. HYPOTHESES DEVELOPMENT

International financial markets tend to be more correlated in bear than bull markets (Longin and Solnik, 2001) and to be highly integrated in volatile (especially down) markets (Pukthuanthong and Roll, 2009). The U.S. stock market is the center of the international volatility spillover network

[32] Please see the online appendix for a brief but more comprehensive review of this literature.

(Yang and Zhou, 2017). The U.S. QEs alone explain 40% to 55% of intensifying spillover from the U.S. and are the primary drivers of the intensifying volatility spillover from the U.S. to the rest of world from 2008 (Yang and Zhou, 2017). Rajan (2015) argues that unconventional monetary policies (UMPs) launched by central banks actually cause higher financial risks in the emerging markets as aggregate world demand weakens after a financial crisis.

Empirical research finds that the spillover effects of the U.S. QEs on various economic and market factors that have been found to be the determinants of market integration differ across the various QE periods.[33] Compared to the non-QE period, Kryzanowski, Zhang, and Zhong (2017) find that the means of the cross-financial-market correlations of bonds and of stocks with forwards contracts are significantly higher during QE2 and that the mean of the correlations of bonds with the forward contracts are significantly lower during QE1 and QE3 for the DM country sample and significantly higher during the QE3 period for the EM country sample. Furthermore, they find that the mean correlations of country stock indexes with forward contracts are significantly lower during the QE3 period compared to the non-QE period for the All, DM, and EM country samples. Rodnyansky and Darmouni (2017) find that QE1 has a significant but smaller impact on bank lending than QE3, while QE2 has no significant impact on bank lending. QE1 has a bigger impact on capital flows than QE2 and QE3 (Cho and Rhee, 2014; Park, Ramayandi, and Shin, 2014; Moore, Nam, Suh, and Tepper, 2013). Global portfolio flows differed across economic regions and QE rounds with capital inflows into the U.S. during QE1 and outflows from the U.S. during QE2 and QE3 (Fratzscher, Lo Duca, and Straub, 2016). The emerging countries experienced strong

[33] Various papers examine the domestic impact of U.S. QEs on various macro-variables, such as the long-term interest rate (e.g., Gagnon, Raskin, Remache, and Sack, 2011; Krishnamurthy and Vissing-Jorgensen, 2011), Treasury supply and bond yields (e.g., Hamilton and Wu, 2012; Wright, 2012; D'Amico and King, 2013; Greenwood and Vayanos, 2014), and market liquidity (Christensen and Gillan, 2014).

currency appreciations, generally higher inflation rates and quite mixed changes in their output growths during QE1 and QE2 (Chen, Filardo, He and Zhu, 2014). The asset purchases of the Fed differed in terms of riskiness for each of the three periods; a mixture of risky MBs and risk-free Treasuries in QE1, risk-free Treasuries in QE2, and risky MBS in QE3. Furthermore, only the QE1 period included a bear market, the global financial crisis and a U.S. recession. Given this diversity in the riskiness of the Fed's asset purchases during the QEs, the troubled state of the global financial markets and the U.S. economic performance, and the effects of the QEs on the various market and economic factors (essentially flow-through channels) that affect market integration for various individual countries and those grouped by level of development status, we can only determine their net effects on the changes in bond and stock market integration for and between the three QE periods compared to the non-QE period empirically. Thus, the alternative hypothesis to be tested in this essay is:

H_A^1: *The integration levels of international bond (stock) markets in the DM (EM) countries are significantly different for and between each QE period and compared to that during the non-QE period.*

We identify six channels through which the effects of unconventional monetary policy are likely to be transmitted to financial securities and markets. We present our second alternative hypothesis before discussing the expectations for each of these six channels:

H_A^2: *The QE effects on the integration levels of international bond (stock) markets for the DM (EM) countries transmitted through each channel are significantly different for and between each QE period and compared to that in the non-QE period.*

Confidence channel. Large-scaled asset purchases (LSAP) have broader confidence effects and are expected to lead to better economic prospects which may directly boost consumer confidence and the willingness of consumers to spend (Joyce, Tong and Woods, 2011). VIX has been widely used to capture the global market investment sentiment and global market uncertainty during non-QE and QE periods (Panchenko and Wu, 2009; Bekaert, Harvey, Lundlad, and Siegel, 2011; Carrieri, Chaieb, and Errunza, 2013; Lim and Mohapatra, 2016). Carrieri, Chaieb, and Errunza (2013) argue that VIX could act as a “push” factor and be related to integration at the market level if it is associated with a flight to quality. It follows from this line of thought that VIX would be expected to increase bond and stock market integration during a QE.

Default risk channel. QEs affect the magnitude of the default spread and the price of default risk. To the extent that the QEs may succeed in stimulating the U.S. economy, corporate default risk and the Baa rate may fall (Krishnamurthy and Vissing-Jorgensen, 2011). However, using an event-study with relatively narrow announcement windows, Krishnamurthy and Vissing-Jorgensen (2011) find that the default risk channel is only significant for QE1 but not for QE2. Yu (2016) argues that the use of short windows makes it difficult to establish long-term effects. Even when yields on long-term assets are very low, investors may allocate to high risk assets and market volatility may increase. Volatility spillovers increase with high default spreads during the QEs, indicating worse business conditions in the future (Yang and Zhou, 2017). As financial market volatility increases during the QEs, financial market integration tends to be more volatile. If such is the case, the default credit spread is expected to be associated with a high level of market integration.

Inflation channel. As an expansionary monetary policy, QEs can increase tail risk surrounding inflation. When investors are uncertain about the monetary policy effects on inflation, a policy action may lead to greater inflation uncertainty (Krishnamurthy and Vissing-Jorgensen, 2011). Yu (2016) states that QE is positively associated with GDP growth and inflation but the effects fluctuate widely. For instance, increases in U.S. GDP over the three QEs average 2% and range between 0.1% and 8%. To seek economic growth and greater certainty, investors may shift their investments to other developed or emerging countries. As with the default risk premium, greater financial market uncertainty caused by greater inflation rate uncertainty is expected to increase financial market integration.

Liquidity channel. A key transmission channel identified for QEs is the liquidity channel (Gagnon, Raskin, Remache, and Sack, 2011; Joyce, Lasaosa, Stevens, and Tong, 2011; Krishnamurthy and Vissing-Jørgensen, 2011). LSAPs by the Federal Reserve greatly increased liquidity and decreased the liquidity risk of holding the securities purchased under LSAP, which in turn increased the credibility of previously liquidity-constrained banks. Such purchases reduce borrowing costs for investors and increase overall bank lending, including direct and indirect lending to developing countries. Cross-border bank-to-bank liabilities and three-month Treasury bills are used in previous studies (Bruno and Shin, 2015; Lim and Mohapatra, 2016) to measure liquidity channel effects as they are closely related to borrowing costs. As a result, we expect that higher cross-border bank-to-bank liabilities and three-month Treasury bill rates are associated with financial market integration. In addition, money supply has been used to capture global liquidity (Bekaert, Harvey, Lundlad and Siegel; 2011; Lim and Mohapatra, 2016). Thus, a higher grow rate of the money supply during a QE period compared to the non-QE period is expected to be related to an increase in financial market integration.

Portfolio Balance Channel. The portfolio balance channel argues that by reducing the supply of security type(s) to private investors, the U.S. QEs lead to an increase in demand for all substitute assets, including assets from non-domestic developed and emerging markets (Bernanke, 2012; Gagnon et al., 2011; Joyce, Lasaosa, Stevens, and Tong, 2011; Hamilton and Wu, 2012; Neely, 2015). As a result, QEs are expected to raise asset prices, lower the yields of those securities, promote employment and stabilize a low inflation rate (Bernanke, 2010b). Differential growth potentials, differential interest rates, portfolio flows, and term structure spreads have been used in measuring the effects on market integration through the portfolio balance channel.[34] These variables, which act as push factors in driving capital flows (Bekaert, Harvey, Lundlad and Siegel, 2011), are expected to be associated with financial market integration.

Risk-taking channel. During the recent periods of U.S. monetary expansion, lower funding costs had spillover effects on global financial conditions because they increased cross-border liabilities and stimulated the economies of recipient countries by encouraging banks to make more loans. Therefore, regional banks in the U.S. could borrow more in U.S. dollars from global banks to lend to local corporate borrowers (Bruno and Shin, 2015). This risk-taking channel through the banking sector influences financial conditions and real economic decisions, which can lead to banking capital flows from the U.S. to other countries (particularly the emerging countries). Lee (2011) and Chan, Covrig, and Ng (2005) find that the countries with large cross-border portfolio holdings attract more global investors. As banking flows are one type of capital flow, greater banking flows working through the risk-taking channel during QEs are expected to be associated with greater financial market integration.

[34] Lim and Mohapatra, 2016; Frankel, 1992; Bekaert, Harvey, Lundlad and Siegel; 2011; Fratzscher, Lo Duca, and Straub, 2016; Panchenko and Wu, 2009; Frijns, Tourani and RadIndriawan, 2012; Bekaert and Harvey, 1995; Carrieri, Chaieb and Errunza, 2013; De Santis and Gerard, 1997; Frijns, Tourani, and RadIndriawan, 2012; Bekaert and Harvey, 1995; Carrieri, Chaieb and Errunza, 2013.

4.3. SAMPLE AND DATA

The bond and stock indices are collected from those included in the J.P. Morgan (JPM) Global Bond Broad Indices (GBI Broad), the JPM Government Bond Index - Emerging Markets Broad (GBI-EM Broad) Indices, and the Morgan Stanley Capital International (MSCI) index. We match all countries from the JPM GBI Broad and GBI-EM Broad Indices with those from the MSCI Equity Indices. After removing the countries with missing observations, our sample covers 19 developed markets (DM) and 12 emerging markets (EM) over the time period from September 2003 to December 2014.[35] The country or regional categories are defined in Appendix 4.A.

We use weekly total returns denominated in local currencies for all bond and stock indices.[36] The bond indices for the DM and EM countries are those included in the GBI Broad index and the GBI-EM Broad index, respectively.[37] For the countries included in both bond indices, we use the JPM GBI Broad index for Hungary, Poland, and South Africa, and the JPM GBI-EM Broad index for Mexico to maximize the time coverage available for analysis.

We obtain the spot currency prices on Friday from Datastream and Bloomberg. The WM Reuters spot currency prices are the arithmetic means of their closing bids and offers at 4 p.m. U.K. time provided by the WM Company. Three time dummies, QE1, QE2 and QE3, are used to identify each QE round. They are equal to one if the date falls into their respective time periods and zero

[35] In order to calculate integration at an annual frequency, the sample includes all of 2014.

[36] Pukthuanthong and Roll (2009) find that weekly observations show a very similar pattern of integration as daily observations and that the weekly data lead to the same general conclusions about integration. They also argue that in estimating integration the cautious approach is to rely on long-term trends over short-term variation. Christiansen (2014) also finds that the integration results are robust to the use of weekly returns. Billio, Donadelli, Paradiso, and Riedel (2017) argue that monthly data rather than daily data can avoid high-frequency data problems including the presence of zero returns, non-synchronicity and excess noise.

[37] The former includes bonds with maturities of 3-5 years (JPM, 2013) and the latter includes government bonds with maturities of at least 13 months.

otherwise. The definitions and data sources for all the other control variables are provided in Appendix 4.B.

4.4. MEASURING INTEGRATION

Following Pukthuanthong and Roll (2009) and Christiansen (2014) and using the latter's notation,[38] we measure integration as the adjusted R-square obtained from the following OLS regression:

$$r_{i,\tau,t} = \beta_{i,\tau,0} + \beta_{i,\tau,1,t} PF_{i,\tau,1,t} + \ldots + \beta_{i,\tau,K,t} PF_{i,\tau,K,t} + \varepsilon_{i,\tau,t} \qquad (4.1)$$

where $r_{i,\tau,t}$ is the bond or stock return for week *t* for country *i* in year τ and $PF_{i,\tau,k,t}$ is the return for a country-level bond or stock index *k* (k = 1…K) based on the K main principal components. $R_{i*,\tau-1}$ is defined as the weekly return matrix for all countries other than country *i* for year $\tau-1$, and its principal components have factor loadings of $\alpha_{i*,\tau-1}$. The bond or stock index returns excluding the country under estimation represented by *i** are given by $PF_{i,\tau,K,t} = R_{i*,\tau} * \alpha_{i*,k,\tau-1}$, where $R_{i*,\tau}$ are the returns in the current year and $\alpha_{i*,k,\tau-1}$ are the factor loadings from the previous year.

The local total return indexes for bonds and stocks in a country are converted into U.S. dollars to mitigate exchange rate noise (Pukthuanthong and Roll, 2009). To account for at least 80% of

[38] Pukthuanthong and Roll (2009) argue that simple correlations not only fail theoretically but they also provide an "imperfect and biased downward empirical depiction of actual market integration".

the cumulative eigenvalues, we extract the first six principal components for bond indexes and eight for stock indexes.[39]

4.4.1. Integration Time Trend

As in Pukthuanthong and Roll (2009) and Christiansen (2014), we report the level of integration (adjusted R-squares) on an annual basis based on equation (4.1) for the country-level bond and stock indexes (Tables 4.1 and 4.2, respectively). For example, the integration levels for 2005 are 0.75 and 0.40 for the Australian bond and stock markets, respectively. We find that most of the EU bond markets are highly integrated at the beginning and end of the years examined herein and are lower in 2010 and 2012. The integration values for the EU bond markets are similar to those reported by Christiansen (2014) and are much higher than those for the DM countries in Asia or North America. The emerging bond markets exhibit greater cross-sectional and time-series variations. The changes in integration levels are more similar for the EM versus the DM countries. On average, the integration levels increase and then decrease over the time period studied. Also the emerging bond markets in the EU show higher levels of integration than those in Asia, South Africa, and South America. Based on a comparison of Table 4.2 with Table 4.1, we observe that the average integration level of stock markets is lower than that of bond markets, especially for the European countries. In Table 4.2, the integration levels are higher for the EU stock markets compared to those for the other developed countries. The integration levels for the emerging stock markets are more dispersed than those for the developed stock markets.

[Please place Tables 4.1 and 4.2 about here.]

[39] Although the choice of 80% is arbitrary, Pukthuanthong and Roll (2009) use 90% and Christiansen (2014) uses 70%. The explanatory power of the principal components for the bond and stock market indexes are available upon request.

To rigorously examine the trends of the integration levels around and during the QE periods, we run rolling window regressions of equation (4.1) with a 52-week window. We extract the first matrix of principal components from an initial 52-week period and then extract the subsequent matrices of principal components by advancing the window by a week by adding the new week and dropping the most distant week until the end of the time-series observations is reached. We calculate the adjusted R-squares using the two matrices of principal components based on equation (4.1) to obtain a series of weekly integration estimates. This not only provides for a robustness test for the yearly integration results but also meets the requirement of a sufficiently large sample size for the principal component analysis.

Panel A of Table 4.3 reports the integration level estimates for the various country-level bond and stock markets based on the regressions of the adjusted R-square values on a constant and a time trend. Of the 31 country-level bond markets, 27 show a strong time trend. The integration levels have significantly decreased (increased) for most of the bond markets in the DM (EM) countries. Significant downward trends occur for the developed country-level bond markets in the EU countries (Italy and Portugal) and significant upward trends occur in North America (e.g., Canada and the U.S.).[40] Consistent with the findings of Christiansen (2014), the slope of the trend in integration levels for the emerging bond markets in the EU is mixed, significantly upward in the Czech Republic and Greece but significantly downward in Hungary and Poland. The emerging markets in Asia, South America and South Africa (with the exception of Thailand) show a significant increase in the integration level of their bond markets.

[Please place Table 4.3 about here.]

[40] The trend in the EU country bond markets may be due to increasing frictions embodied in legal or technical barriers, differential tax treatments, or different investment habits (Wessel, 2003).

The time trends of the integration levels differ for the stock markets. The integration levels for most of the DM countries significantly increase. For example, the stock markets in the EU countries become more integrated, consistent with the findings of Pukthuanthong and Roll (2009). The stock markets in the EM countries show mixed evidence with about an equal proportion of countries showing increases and decreases in the integration levels of their stock markets.

We also construct equally- and GDP-weighted integration indexes (Looi, Nicita, and Olarreaga, 2009; Wolf, 2000) using the integration estimates for each country in each sample (i.e., All, DM, and EM countries) for the bond and stock markets, respectively. Panels A and B of Figure 4.1 plot these indexes for the bond and stock markets for the All, DM, and EM countries, respectively. The weekly time trends for the DM and EM countries are similar to those reported in Berger, Pukthuanthong, and Yang (2011). We observe from Figure 4.1 that both the bond and the stock markets are highly integrated during the QE1 and QE2 periods and are less so during the QE3 period. Since QE1 and QE2 were launched after much of the financial turmoil and QE3 was implemented during a rather stable economic environment, this finding may indicate that market integration increased, on average, during volatile markets and decreased during stable markets, consistent with the findings of Pukthuanthong and Roll (2009).

[Please place Figure 4.1 about here.]

Panel B of Table 4.3 reports the summary statistics for All, DM, and EM countries. The mean (median) equal-weighted R^2 for the bond markets are in general greater than the corresponding values for their GDP-weighted counterparts. The equally- (GDP-) weighted integration index for the bond (stock) market in the DM countries is higher than its counterpart for the EM countries. Since the results for equally-weighed integration and GDP-weighted integration are similar, we focus on the equally-weighted integration in the following sections.

4.4.2. Formal Test of the Financial Market Integration Level During and Around the QEs

To investigate the level of bond and stock country-level market integration during the three rounds of QE, we run the following regressions where equation (4.3) tests previous findings that financial markets tend to be more highly integrated during bear than bull markets (e.g., Longin and Solnik, 2001):

$$Integr_{i,t} = \beta_0 + \beta_1 QE1 + \beta_2 QE2 + \beta_3 QE3 + \beta_4 Control_{i,t} + \epsilon_{i,t} \quad (4.2)$$

$$Integr_{i,t} = \beta_0 + \beta_1 QE1 + \beta_2 QE2 + \beta_3 QE3 + \beta_5 BearNonQE + \beta_6 BearQE1 + \beta_7 Control_{i,t} + \epsilon_t \quad (4.3)$$

where $Integr_{i,t}$ is the weekly integration level for each country based on the methodology of Pukthuanthong and Roll (2009); $QE1, QE2, and\ QE3$ are the dummy variables set to one in the weeks falling into each of the three rounds of QE and zero otherwise; $BearNonQE$ is equal to one if the market is bear during the non-QE period and zero otherwise; and $BearQE1$ is equal to one if the market is bear during QE1 and zero otherwise.[41] All the variables are defined in Appendix 4.B.

[Please place Table 4.4 about here.]

Based on Panel A of Table 4.4, we find that the integration level of the bond markets during QE2 are significantly higher for the All, DM and EM countries and the integration levels of the stock markets during QE1 (QE3) significantly increase (decrease) for the All, DM, and EM countries. Based on Panel B of Table 4.4, we find that after controlling for the effect of bear markets on market integration, the results for the integration of the bond and stock markets are consistent with those reported in Panel A during each QE round. Interestingly, the estimated

[41] For the period examined herein, bear market periods fall exclusively in the non-QE and QE1 periods.

coefficients for *bearNonQE* are significantly lower for the integration of stock markets but for *bearQE1* are significantly higher for the All, DM, and EM countries.

4.5. FINANCIAL MARKET INTEGRATION AND POTENTIAL QE TRANSMISSION CHANNELS

4.5.1. Methodology

Our panel regression specification is motivated by Bekaert, Harvey, Lundlad, and Siegel (2011), Frijns, Tourani-Rad, and Indriawan (2012), and Christiansen (2014). Specifically:

$$Integr_{i,t} = \alpha + \beta_{1i} QE_1 + \beta_{2i} QE_2 + \beta_{3i} QE_3 + \sum_k \gamma_{ik} X_{ikt} * QE_{1t} + \sum_k \eta_{ik} X_{ikt} * QE_{2t} + \sum_k \lambda_{ik} X_{ikt} * QE_{3t} + \psi_j Control_{jit} + e_{i,t} \quad (4.4)$$

where $Integr_{i,t}$ is the level of integration for country *i*; X_{ikt} are the various explanatory variables that provide channels for transmitting the QE effects to financial security market integration (six channels with their proxies are summarized in Table 4.5); and QE_{1t}, QE_{2t}, and QE_{3t} are the dummy variables that capture the dynamics of the three quantitative easing operations by the Fed, and $Control_{jit}$ are the control variables that are related to financial market openness and development and the political risk and institutional environment, categorized by Bekaert, Harvey, Lundlad and Siegel (2011) and defined in Appendix 4.B. The dynamics of the QE operations are captured by either using QE dummies or alternatively by the Fed's total assets holdings in U.S. Treasury securities, agency securities, and mortgage-backed securities or relative holdings of Treasuries or MBS (MacDonald, 2017; Yang and Zhou, 2017).

[Please place Table 4.5 about here.]

We choose the specific macro-variables in X_{ikt} in regression (4.4) that represent various channels for transmitting the first-order effects of (non)conventional monetary policy on the macro-variables to their effects on market integration including those identified in the literature.

Bond and stock integrations are estimated using rolling windows of 52 weeks, and the variables linked with QE channels and the control variables, whose definitions and data sources are provided in Appendix 4.B, are estimated at the beginning of each 52-week rolling window. The use of lagged variables helps in reducing any endogeneity problems due to omitted variables or unobserved effects (Carrieri, Chaieb, and Errunza, 2013). Following Aslanidis and Christiansen (2012), the quarterly or monthly data are converted to a weekly frequency by using the values unchanged until updated. As most of the variables are measured at a quarterly frequency, we also provide a robustness test reflecting this in section 4.6.

4.5.2. Empirical Results

In this section, we discuss the effects of the QEs on international bond and stock market integration. We use pooled ordinary least squares (OLS) to estimate regression (4.4), as in Bekaert, Harvey, Lundlad and Siegel (2011) and Carrieri, Chaieb, and Errunza (2013). The standard errors are robust to clustering by two-dimensional country and time effects (Petersen, 2009). To investigate the role of UMP launched by the U.S. Fed on international bond or stock market integration for various economic regions, we estimate regression (4.4) for the samples of All, DM, and EM countries, as well as for the regions of Asia-Pacific, Europe, Latin America, and NAFTA countries.

4.5.2.1. Results for financial market integration across All, DM, and EM countries using QE dummy variables

We begin by examining the summary statistics reported in Table 4.6 for all the independent variables linked with the QE channels. The means for all the variables during the non-QE period are positive except for portfolio (bond or equity) flows. When we compare the mean for each variable in a QE period to its value in the non-QE period, we find significantly positive differences for *BankLiabGDP*, *TermSpread*, and *BankingFlow* for all three QEs, for *CreditSpread* and *difINFL* for QE1, for *difGDP* for QE1 and QE2 but not QE3 where the difference is significantly negative, and for *difINT* during QE2 and QE3 but not QE1 where the difference is significantly negative. In contrast, we find significantly negative differences for *US3MTbill* for all three QEs, for *CreditSpread* during QE3, for *BondFlow* during QE1 and QE2, for *EquityFlow* during QE2 but not QE1 where the difference is significant and positive. We find no significant differences for *M2*. Thus, we observe significant differences for all but one independent variable linked with a QE channel in a QE versus non-QE period.

[Please place Table 4.6 about here.]

Table 4.7 reports the results for the determinants of bond or stock market integration considering the channels which potentially transmit the effects associated with the QEs.[42] As expected in comparison to the non-QE period, the average level of integration for the bond market is significantly higher during *QE1* and *QE2* for All and DM countries. It is also significantly higher during *QE3* for All, DM and EM countries. The level of stock market integration compared to the non-QE period exhibits significantly higher average integration for the DM countries during *QE1* and *QE2*, and for the All countries during *QE2*. In contrast, the level of stock market integration is significantly lower for the EM countries during *QE1* and *QE2* and for the All countries during *QE1* and *QE3*.

[Please place Table 4.7 about here.]

[42] The independent variables include bond or equity flows. Since the bond flow data are not available for Singapore and India and the equity flow data are not available for Singapore, Colombia, and Mexico, we run the regressions excluding bond or equity flows and the results are qualitatively similar when these countries are included. The variance inflation factors (VIF) for assessing multicollinearity between the independent variables for the All-country sample are all below 10.

We now discuss the estimated coefficients for the channel proxies starting with the confidence channel. While all but one of the estimated coefficients for *VIX* are significantly positive during the non-QE period, they are not significantly different for any of the QE periods compared to the non-QE period as was the case for the mean *VIX* itself. Nevertheless, the total effect of *VIX* (e.g., *VIX* + *VIX*QE1*) on the level of market integration during each of the three QEs is no longer significant. Thus, the expected positive effect of *VIX* on market integration due to *VIX's* effect on global and local risk aversion and co-variance risk (Carrieri, Chaieb, and Errunza, 2013) was neutralized during each QE period.

Stock market integration changes significantly (decreases) only in the EM countries with an increase in credit spreads during the non-QE period. The total effect of *CreditSpread* on market integration is significantly negative during QE1 for the All, DM, and EM countries for the bond and stock portfolios and significant (positive) only during QE3 for the bond portfolios of the EM countries. Thus, credit spreads play a vital role in explaining bond and stock market integration primarily during the first QE period.

We observe a significantly positive relation between the differential inflation rate (our proxy for the inflation channel) and equity market integration during the non-QE period in the All, DM and EM countries. Even with many significant changes in the estimated coefficients for differential inflation during the QE versus non-QE periods, the estimated coefficients remain significantly positive for equity market integration with the exception of the significantly negative and insignificant positive estimates during QE1 and QE2 for the DM countries. In contrast, the relation between differential inflation and bond market integration is insignificant for all countries since it is significantly positive for the DM countries and significantly negative for the EM countries. The corresponding estimated coefficients become significantly negative for the DM countries during all three QEs and only remain significantly negative for the EM countries during QE2.

Our proxies for the liquidity channel are the ratio of cross-border bank-to-bank liabilities to GDP, broad money supply, and US 3-month T-bill rate. The estimated coefficients for the ratios of cross-border bank-to-bank liabilities to GDP are significantly positive for the EM countries during the non-QE period, and only remain significantly positive during QE2 and QE3. The estimated coefficients for this ratio are significantly negative for the All countries and the DM countries (for equity market integration only) during the non-QE period. While they remain significantly negative for the All and DM countries during the QEs for equity market integration, they generally become insignificant for bond market integration during the QEs. While average bank-to-bank liabilities to GDP are significantly higher during each QE period compared to the non-QE period for the All sample (Table 4.6), untabulated results reveal a different behavior for the EM countries where the average ratio compared to the non-QE period did not change significantly in QE1, significantly decreased in QE2 and significantly increased in QE3.

Our second proxy for the liquidity channel, the US 3-month T-bill rate, is significantly and negatively related to bond and stock market integration during the non-QE period. A significantly negative coefficient for this variable only remains during QE3 for bond market integration for the EM countries. This is expected as this rate was near zero during the QEs. Our third proxy for the liquidity channel, the broad money supply M2, has no effect on the bond and stock market integration during any of the examined periods. This is not unexpected during the QEs since the broad money supply did not change significantly and the QEs were implemented to increase the asset holdings of the U.S. Fed due to the failure of conventional monetary policy to stimulate the U.S. economy.

We now examine four proxies for the portfolio balance channel: differential growth potential (GDP), differential interest rate, portfolio flows, and term structure spread. We find that differential GDP has a significantly positive (negative) effect on the bond (stock) market integration only for the EM countries during the non-QE period. There is a significant difference in the estimated coefficient between each QE period and the non-QE period for all but one of the bond portfolios, and for all of the stock portfolios for the EM countries. As a result, the total effect of differential GDP for the All, DM, and EM countries is significantly negative on bond market integration during QE2 and significantly positive on stock market integration during QE3.

Our second proxy for the portfolio balance channel, differential interest rate, has a negative (generally significant) effect on bond and stock market integration during the non-QE period, which for the EM countries becomes significantly positive during QE1 for both bond and stock market integration and during QE3 for stock market integration.

Our third proxy for the portfolio balance channel, portfolio flows, has a significantly negative (positive) effect on bond (stock) market integration during the non-QE period for the DM countries and a significantly positive (negative) effect on the bond (stock) market integration during the non-QE period for the EM countries. The total effect of portfolio flows on bond market integration is only significant (negatively) during QE1 for the EM countries while the total effect of portfolio flows on stock market integration becomes insignificant during QE1, becomes significantly negative during QE2, and remains significantly positive during QE3 for the DM countries.

Our fourth and final proxy for the portfolio balance channel, term spread, has a significantly negative effect on bond and stock market integration during the non-QE period. The estimated coefficients for this variable compared to the non-QE period are significantly higher in QE2 and significantly lower during QE3 with the exception of stock market integration for the All and DM countries. The total effect of the term spread is significantly negative with bond and stock market integration during QE3 and with equity market integration during QE1.

Our proxy for the risk-taking channel, cross-border banking flows, has a significant effect on bond and stock market integration during all four periods examined herein. Consistent with our expectation for the risk-taking channel, this finding indicates that greater borrowing capacity provided by global banks to regional banks, as shown in Table 4.6 for cross-border banking flows, significantly increases bond (and stock) market integration. It is evident that the banking sectors are important determinants of financial market integration in both DM and EM countries, although most of the previous literature pays little or no attention to the role of cross-border banking flows on financial market integration. An exception is Lucey and Zhang (2011) who examine the borrowing ability at the firm level during the financial integration process.

Overall, bond and stock market integration depend on different channels for the transmission of QE effects and on the economic development categories of countries (DM or EM). Cross-border banking flows significantly increase the bond and stock market integration during each of the three QEs for the DM and EM countries. Given that the U.S. Fed did not significantly increase the broad money supply as conventionally measured during the QE versus non-QE periods, market integration was not significantly impacted by changes in the broad money supply during the QE periods. Instead, unconventional monetary actions taken by the U.S. Fed during the QE periods that significantly changed the Fed's asset holdings but not magnitude of the conventionally measured money supply had significant impacts on market integration.

Consistent with the existing evidence that financial market openness and development is related to stock market integration (Bekaert, Harvey, Lundlad and Siegel; 2011; Bakert and Harvey, 1995), its proxies, market capitalization to GDP, market openness, total value of stock traded to GDP, and trade openness, have significantly positive effects on bond market integration for the All, DM, and EM countries. In contrast, the proxies for financial market openness and development have mixed effects on stock market integration, as in Carrieri, Chaieb and Errunza (2013). The coefficient of market capitalization to GDP is significantly positive but market openness is significantly negative for the DM and EM countries. The total value of stock traded to GDP has a significantly negative (positive) effect on the DM (EM) countries and trade openness has a significantly positive (negative) effect on the DM (EM) countries.

Our proxies for political risk and institutions show that higher economic freedom and private credit indicate lower integration levels for the All and DM countries. Higher legal rights are associated with higher integration levels for the bond portfolios of the All and DM countries but lower integration levels for the stock portfolios. The estimated coefficient for our last control variable, business cycle variation, is negative and significant, indicating that countries with more volatile business cycles are less integrated with the world market (Bekaert, 1995).

We observe that the adjusted R-squares for the regressions for bond market integration are 79.3%, 82.3% and 76.5% for the All, DM, and EM countries, respectively. These values are consistently higher than their stock market counterparts of 0.745, 0.771, and 0.733. Nevertheless, all the estimations fit the data well.

4.5.2.2. Effect of Fed's specific security holdings on financial market integration

We now investigate whether the U.S. Fed purchases of two types of securities affected bond and stock market integration using the following regression specification:

$$Integr_{i,t} = \beta_0 + \beta_1 QE_1 + \beta_2 QE_2 + \beta_3 QE_3 + \beta_4 TREASF/TAF_{i,t} + \beta_5 \sum_{i=1}^{3} TREASF/TAF_{i,t} * QE_i + \beta_6 MBSF/TAF_{i,t} + \beta_7 \sum_{i=1}^{3} MBSF/TAF_{i,t} * QE_i + \beta_8 Control_{i,t} + \epsilon_{i,t} \quad (4.5)$$

where *TREASF*, *MBSF*, and *TAF* are the U.S. Fed's treasury bond holdings, mortgage-backed securities, and total asset holdings, respectively. The QE dummies and control variables are defined in Appendix 4.B. Based on the results of Table 4.8, we find that the estimated coefficients for treasury bond holdings (*TREASF/TA*) become significantly positive for bond and stock market integration during QE1 (i.e., *TREASF/TAF+TREASF/TAF*QE1*), insignificant during QE2, and significant during QE3 (positive for bond market integration and negative for stock market integration). The estimated coefficients for the mortgage-backed securities holdings (*MBSF/TA*) become significantly negative for the bond and stock market integration during QE1, insignificant for QE2, and significant during QE3 (positive for bond market integration and negative for stock market integration). In summary, the Fed holdings of Treasury bond securities and mortgage-backed securities significantly affect the integrations of bond and of stock markets during QE1 and QE3 (periods of Fed's MBS purchases and some Treasuries in QE1) but not during QE2 (period of Fed's Treasury purchases), and their directional effects during QE1 differ.

[Please place Table 4.8 about here.]

4.5.2.3. Results for financial market integration for regional economies

To investigate financial market integration for regional economies, we classify the 31 countries into four regions: Asia-Pacific, Euro, Latin American, and North American Free Trade Agreement (NAFTA).[43] Untabulated results show that compared to the non-QE period,[44] the average level of integration for the bond market measured by the U.S. QE dummy variables or the scale of QE purchases by the U.S. Fed is significantly higher for the European region during the three QEs, for the European and Latin regions during QE1, and for the Asian, European, and Latin regions during

[43] The regional categories, which are based on the IMF and World Bank, are reported in Appendix 4.A.
[44] Please see the Online Appendix Tables 4.A3 and 4.A4.

QE3. In general, the estimated coefficients for the variables linked with the QEs for the Asian, European, and Latin American regions are consistent with those reported in Table 4.7.

We further examine how the integration results change when we examine integration for each region differentiated by its DM and EM countries. In general, average bond and stock market integration compared to the non-QE period is significantly higher during QE1 and QE2 for the European DM countries and during QE1 for the European EM countries. Average bond market integration compared to the non-QE period is significantly higher during QE3 for the Asian DM and EM countries and average stock market integration is higher during QE3 for the Asian DM and EM countries. Overall, the results for the Asian and European DM and EM countries are generally consistent with their results non-differentiated by the security-type holdings of the Fed.

4.6. TESTS OF ROBUSTNESS

4.6.1. Alternative Measure of Integration

Among the alternative measures of financial market integration, the simple correlation is the most widely used measure (Billio, Donadelli, Paradiso, and Riedel, 2017; Kearney and Lucey, 2004). Billio, Donadelli, Paradiso, and Riedel (2017) find that all the measures of integration yield a very similar integration pattern but that the dynamic simple correlation explains diversification benefits as well as or better than more sophisticated measures of integration. Thus, we choose the dynamic simple correlation metric to test the robustness of our previously reported results for bond and stock market integration. The dynamic simple correlation is computed between one country and all the other countries and is estimated using a rolling window of 52 weeks to be consistent with our implementation of the measure of Pukthuanthong and Roll (2009). We find that bond or stock market integration based on the cross-country average dynamic simple correlations displays a trend very similar to the measure of Pukthuanthong and Roll (2009) and that, on average, the market integration levels (especially for stock market integration) are higher during QE1 compared to the non-QE period, and that the stock market integration, on average, is lower during QE3 compared to the non-QE period.[45] Consistent with the findings of Panels A and B in Table 4.4, the integration of the bond markets during QE2 are significantly higher for the All, DM and EM countries and the integration levels of the stock markets during QE1 (QE3) significantly increase (decrease) for the All, DM, and EM countries with or without controls for the effect of bear markets on market integration.[46]

We use the dynamic simple correlation as a measure of financial market integration when re-estimating regressions (4.4) and (4.5). Online Table 4.A6 shows that the determinants of financial market integration using dynamic simple correlations are consistent with those using the integration measure of Pukthuanthong and Roll (2009) reported earlier in Table 4.7. The average level of integration for the bond market in comparison to the non-QE period is significantly higher during QE1 and QE2 for All and DM countries. It is also significantly higher during QE3 for All, DM and EM countries. The level of stock market integration compared to the non-QE period exhibits significantly higher average integration for the DM countries during QE1 and QE2, and for the All countries during QE2. In contrast, the level of stock market integration is significantly lower for the EM countries during QE1 and QE2 and for the All countries during QE1 and QE3.

The estimated coefficients of the variables linked with the QE channels for these new estimations are generally consistent with those based on the integration measure of Pukthuanthong and Roll (2009) reported earlier in the essay. The results reported in Online Table 4.A7 is in line with the findings of Table 4.8 that the Fed holdings of Treasury bond securities and mortgage-

[45] The trend of bond or stock market integration during the three rounds of QE is plotted in the online appendix Figure 4.1 for this essay.
[46] Please see online appendix Table 4.A5 for this essay.

backed securities significantly affect the integration of bond and stock markets during QE1 and QE3 (periods of Fed's MBS purchases) but not during QE2 (period of Fed's Treasury purchases), and that their directional effects during QE1 differ.

4.6.2. Controlling for global financial crisis and the U.S. recession

Bekaert, Harvey, Lundblad, and Siegel (2011) and Lehkonen (2015) find that during the global financial crisis equity market integration tends to decrease. We formulate the following regression to control for the financial crisis effect on bond and stock market integration:

$$Integr_{i,t} = \beta_0 + \beta_1 QE1 + \beta_2 QE2 + \beta_3 QE3 + \beta_5 CrisisGlobalNonQE + \beta_6 CrisisGlobalQE1 + \beta_7 Control_{i,t} + \epsilon_t \quad (4.6)$$

where $Integr_{i,t}$ is the weekly integration level for each country based on the methodology of Pukthuanthong and Roll (2009); $QE1, QE2, and\ QE3$ are the dummy variables set to one in the period falling into each of three QE rounds and zero otherwise; $CrisisGlobalNonQE$ is equal to one for each global financial crisis week during the non-QE period and zero otherwise; and $CrisisGlobalQE1$ is equal to one for each global financial crisis week during QE1 and zero otherwise. Since the global financial crisis began on August 7, 2007 or September 15, 2008 (Bekaert, Ehrmann, Fratzscher, and Mehl, 2014; Lehkonen, 2015) and finished in June 2009, we run the regression using the two different time periods.

Based on the results reported in Panels A and B of Table 4.9, we observe that the results for the integration of bond and stock market integration are consistent with the results when controlling for bear markets reported in Table 4.4, which is consistent with our first hypothesis. We also find that bond and stock market integration is significantly lower during the *CrisisGlobalNonQE* period of 8/2007-6/2009 (panel A) and significantly higher during the *crisisQE1* period. This may be consistent with the finding of Bekaert, Harvey, Lundblad, and Siegel (2011) that "segmentation (integration) increased (decreased) towards the end of 2008 but then returned to its pre-crisis levels in 2009", which is summarized by Lehkonen (2015).

[Please place Table 4.9 about here.]

Since the U.S. recession may affect bond and stock market integration, we also run regression (4.4) by adding dummy variables, $RecessionUSNonQE$ and $RecessionUSQE1$. The U.S. recession is defined by NBER as being for the period of 12/2007-6/2009. The results reported in Table 4.10 are consistent with those obtained controlling for bear markets and the global financial crisis. In summary, bond market integration significantly decreases during QE2 (period of Fed's Treasury purchases) while stock market integration significantly increases during QE1 but decreases during QE3 (periods of Fed's MBS purchases with only QE1 containing a U.S. recession).

[Please place Table 4.10 about here.]

4.7. CONCLUSION

In this essay, we investigate the effect of the three rounds of quantitative easing (QE) launched by the U.S. Federal Reserve on international financial market integration and investigate the possible channels for transmitting the effects of the QEs holdings of risk-free (Treasuries) and risky (MBS) assets on financial market integration in 31 countries (developed and emerging). We find that the average financial market integration in 31 countries changes significantly during the three U.S. QE periods, and that the QEs affect international financial market integration mainly through the inflation, liquidity, portfolio balance, and risk-taking channels. Additionally, the impact of QEs on financial market integration is intensified by the scale of securities purchased by the U.S. Fed during each QE period, and by whether the holdings of the Fed reflected purchases of risk-free Treasuries (QE2) or risky MBS securities (QE3) or a mixture of both (QE1).

Our essay to the best of our knowledge is the first empirical analysis providing evidence on the (especially channel) impacts of unconventional monetary policy on international market integration for both bond and stock markets in developed and emerging countries. Our findings complement previous studies on the determinants of international market integration on various economic and financial indicators and enrich the emerging literature on the impacts of quantitative easing on international economies. Our findings also shed light on the importance of the spillover impact of a domestic unconventional monetary policy on international market integration, and provide immediate implications for policy makers when evaluating the consequences of unconventional monetary policies on global financial markets given their growing importance in economic activity.

CHAPTER FIVE

In the first essay, we investigate the cross-market correlations across 31 countries during the three QE periods in the U.S. We find that the means of the correlations between stocks (bonds) and forward contracts, and between forward contracts differ by QE period. These results suggest that cross-market correlations and their effects on international financial asset returns differ considerably between the conventional and unconventional monetary policy regimes and between various unconventional monetary policy regimes. Our findings have implications for portfolio managers making investment decisions overseas and regulators when considering the unintended consequences of the actions of the monetary authorities.

In the second essay, we examine the spillover effects on the international portfolios of bonds from the DM and EM countries from the perspective of U.S. investors or asset managers that includes a period of quantitative easing (QE) launched by the U.S. after the sub-prime financial crisis. We find that the excess returns and the variances of unhedged international bond portfolios are significantly reduced during the QE versus the pre-QE periods. The effect of the QEs on the hedging effectiveness and hedging performance of international bond portfolios depends on the choice of hedging strategy and the development level of the country in which a financial market is situated.

These findings have important implications for the currency-hedging decisions of U.S. asset managers who invest in foreign financial markets, especially during periods with unconventional monetary policy actions by the central monetary authorities. These findings also highlights the signaling role of the security holdings of the Fed since changes in holdings by security type during the QE have a significant effect on the returns, risk and return-to-risk profiles of hedged and unhedged portfolios of bonds from developed and emerging markets.

In the third essay, we investigate the effect of the three rounds of quantitative easing (QE) launched by the U.S. Federal Reserve on international financial market integration and investigate the possible channels for transmitting the effects of the Fed's holdings of risk-free (Treasuries) and risky (MBS) assets during the QEs on financial market integration in 31 countries (developed and emerging). We find that the average financial market integration in 31 countries changes significantly during the three U.S. QE periods, and that the QEs affect international financial market integration mainly through the inflation, liquidity, portfolio balance, and risk-taking channels. Additionally, the impacts of the QEs on financial market integration are intensified by the scale of securities purchased by the U.S. Fed during each QE period, and by whether the holdings of the Fed reflected purchases of risk-free Treasuries (QE2) or risky MBS securities (QE3) or a mixture of both (QE1). Our findings complement previous studies on the determinants of international market integration on various economic and financial indicators and enrich the emerging literature on the impacts of quantitative easing on international economies. Our findings also shed light on the importance of the spillover impact of a domestic unconventional monetary policy on international market integration, and provide immediate implications for policy makers when evaluating the consequences of unconventional monetary policies on global financial markets given their growing importance in economic activity.

In future work, we plan to examine the effect of the U.S. unconventional monetary policy on the firm-level exchange rate exposure in emerging markets through capital flow channel. This would extend the findings of Fratzscher, Lo Duca, and Straub (2018) that the effects of the QE on global portfolios flows differed across capital flow receiving countries, types of flows, and QE rounds.

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Table 2.1. Summary statistics for the bond indexes, stock indexes and forward contracts

This table reports summary statistics for the weekly returns in percentage of 31 bond and stock market indexes and for 20 currency forward contracts. The sample period is from September 2003 to November 2014. The 20 currency forward contracts are for: Australia, Canada, Denmark, Japan, New Zealand, Singapore, Sweden, United Kingdom, Brazil, Chile, Colombia, Czech Republic, Hungary, India, Mexico, Poland, South Africa, South Korea, and Thailand. The total number of observations is 583.

		Bond			Stock			Forward	
Country	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
DM									
Australia	0.18	0.26	1.79	0.30	0.65	3.63	0.07	0.17	1.90
Eurozone									
Austria	0.11	0.14	1.41	0.16	0.52	4.42	0.03	0.08	1.37
Belgium	0.12	0.17	1.49	0.20	0.47	3.39	0.03	0.08	1.37
Finland	0.15	0.13	1.68	0.18	0.48	4.00	0.03	0.08	1.37
France	0.11	0.13	1.38	0.19	0.48	3.43	0.03	0.08	1.37
Germany	0.11	0.09	1.35	0.25	0.66	3.57	0.03	0.08	1.37
Ireland	0.16	0.24	1.88	0.07	0.42	4.22	0.03	0.08	1.37
Italy	0.13	0.17	1.58	0.13	0.38	3.81	0.03	0.08	1.37
Netherlands	0.11	0.12	1.37	0.21	0.41	3.27	0.03	0.08	1.37
Portugal	0.15	0.22	2.17	0.09	0.36	3.34	0.03	0.08	1.37
Spain	0.13	0.18	1.63	0.24	0.44	3.92	0.03	0.08	1.37
Canada	0.12	0.20	1.33	0.25	0.49	3.34	0.04	0.13	1.37
Denmark	0.10	0.07	1.37	0.32	0.66	3.34	0.03	0.08	1.36
Japan	0.04	-0.04	1.48	0.12	0.13	2.60	0.01	-0.06	1.45
New Zealand	0.17	0.33	1.92	0.23	0.50	3.03	0.07	0.28	1.96
Singapore	0.11	0.12	0.82	0.27	0.41	3.00	0.05	0.07	0.72
Sweden	0.11	0.14	1.65	0.31	0.58	3.92	0.03	0.08	1.72
UK	0.10	0.08	1.33	0.19	0.50	3.04	0.01	0.06	1.37
US	0.07	0.07	0.45	0.19	0.25	2.44			
EM									
Brazil	0.30	0.40	2.28	0.41	0.56	5.06	0.04	0.14	2.04
Chile	0.09	0.17	1.74	0.27	0.38	3.46	0.04	0.13	1.68
Colombia	0.27	0.42	1.99	0.55	0.61	3.81	0.06	0.14	1.64
Czech Republic	0.15	0.29	1.81	0.33	0.43	3.94	0.06	0.20	1.77
Greece	-0.11	0.04	2.91	-0.04	0.14	5.08	0.03	0.08	1.37
Hungary	0.19	0.26	2.88	0.22	0.55	5.36	0.01	0.10	2.18
India	0.07	0.14	1.29	0.35	0.58	3.92	-0.05	0.01	0.99
Mexico	0.15	0.29	2.12	0.36	0.61	3.97	-0.03	0.10	1.56
Poland	0.18	0.36	2.32	0.28	0.50	4.60	0.05	0.25	2.10
South Africa	0.09	0.24	2.54	0.33	0.55	4.11	-0.04	0.08	2.35
South Korea	0.12	0.19	1.54	0.28	0.50	4.21	0.02	0.09	1.45
Thailand	0.13	0.11	1.12	0.35	0.45	3.71	0.04	0.01	0.84

Table 2.2. Average correlation coefficients between bond indexes, stock indexes and forward contracts

This table reports the average correlations (Corr.) between the indexes of bonds or stocks with forward contracts based on the DCC model with the largest negative Likelihood Ratio (LR) when the estimates of *a* plus *b* in equation (2.3) are less than 1. This was generally a GARCH(1,1) but was also a GJR/TARCH or EGARCH model in the first step and asymmetric DCC in the second step of the estimation. The correlations for each individual country are based on the weekly returns on its bond or stock market index with the corresponding returns on forward contracts with a maturity of one month for the 19 other markets. The sample period ranges from September 2003 to November 2014. The 20 currency forward contracts are for the following countries: Australia, Canada, Denmark, Japan, New Zealand, Singapore, Sweden, United Kingdom, Brazil, Chile, Colombia, Czech Republic, Hungary, India, Mexico, Poland, South Africa, South Korea, and Thailand. The mean correlation for bonds (stocks) with forward contracts for All the countries is 0.459 (0.419). The total number of observations is 583.

DM Country	Bond & Forward Corr.	Stock & Forward Corr.	EM Country	Bond & Forward Corr.	Stock & Forward Corr.
Australia	0.539	0.469	Brazil	0.526	0.446
Eurozone			Chile	0.371	0.444
Austria	0.577	0.472	Colombia	0.323	0.332
Belgium	0.567	0.453	Czech Republic	0.790	0.437
Finland	0.508	0.287	Greece	0.493	0.372
France	0.566	0.475	Hungary	0.506	0.465
Germany	0.520	0.472	India	0.267	0.448
Ireland	0.514	0.363	Mexico	0.306	0.415
Italy	0.526	0.485	Poland	0.551	0.476
Netherlands	0.524	0.440	South Africa	0.453	0.519
Portugal	0.508	0.462	South Korea	0.367	0.351
Spain	0.520	0.457	Thailand	0.249	0.207
Canada	0.450	0.431			
Denmark	0.551	0.479			
Japan	0.180	0.309			
New Zealand	0.491	0.372			
Singapore	0.492	0.423			
Sweden	0.524	0.465			
UK	0.447	0.462			
US	0.036	0.313			
Mean	0.476	0.426	Mean	0.434	0.409

Table 2.3. Average correlation coefficients between the forward contracts

This table reports the average correlations (Corr.) between the 20 currency forward contracts with a maturity of one month. The DCC-GARCH correlation for each country is measured as the average correlations between the currency forward returns for a home country with the currency forward returns for each of the 19 other currencies at a weekly frequency. The sample period ranges from September 2003 to November 2014. The 20 currency forward contracts are for the following countries/zones: Australia, Canada, Denmark, Eurozone, Japan, New Zealand, Singapore, Sweden, United Kingdom, Brazil, Chile, Colombia, Czech Republic, Hungary, India, Mexico, Poland, South Africa, South Korea, and Thailand. The means for the DM, EM and All countries are 0.448, 0.467 and 0.432, respectively. The total number of observations is 583.

DM Country	DCC Corr.	EM Country	DCC Corr.
Australia	0.540	Brazil	0.416
Canada	0.436	Chile	0.377
Denmark	0.547	Colombia	0.291
Eurozone	0.547	Czech Republic	0.525
Japan	0.113	Hungary	0.547
New Zealand	0.468	India	0.364
Singapore	0.555	Mexico	0.372
Sweden	0.534	Poland	0.562
UK	0.464	South Africa	0.558
		South Korea	0.401
		Thailand	0.335
Mean	0.467	Mean	0.432

Table 2.4. Regression results for various sets of correlations against the QE period dummy variables

This table reports results for regressions of the correlations (Corr.) between bond or stock indexes or forward contracts with forward contracts against the QE dummies and various control variables in Panel A across All, DM, and EM countries over the period from September 2003 to November 2014. The time dummies (QE1, QE2, and QE3) represent the QEs launched by the U.S. Federal Reserve during QE1 (November 2008 to March 2010), QE2 (November 2010 to June 2011), and QE3 (September 2012 to October 2014), respectively. The term spread and credit spread reflect information from the U.S. bond market. The Ex_Mkt, SMB, and HML are the Fama and French (1993) three factors and reflect the information in the U.S. stock market. The liquidity factor (LIQ) measures the level of aggregate liquidity of the U.S. stock market. The residual VIX represents the U.S. commodity market obtained by regressing the VIXrate on the Ex_Mkt. Macro variables are inflation rate, M2, real GDP growth rate, and policy uncertainty index (PUI). Robust *t*-statistics are reported in the parentheses based on Newey-West (1987) standard errors with six lags. Results for tests of the null hypothesis of no differences in correlations between two periods is reported in Panel B. Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively. The total number of observations is 583.

Panel A: Correlations between portfolios of bonds or stocks or forward contracts with forward contracts

	Bond & Forward Corr.			Stock & Forward Corr.			Forward & Forward Corr.		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	All	DM	EM	All	DM	EM	All	DM	EM
QE1	-0.013	-0.013*	-0.014	-0.003	-0.003	-0.003	-0.025**	-0.026**	-0.023
	(-1.50)	(-1.79)	(-0.76)	(-0.22)	(-0.23)	(-0.20)	(-2.11)	(-2.55)	(-1.44)
QE2	0.037***	0.025**	0.056***	0.038***	0.036***	0.042***	0.035***	0.019	0.049***
	(3.32)	(2.29)	(3.77)	(2.68)	(2.60)	(2.73)	(2.89)	(1.42)	(3.27)
QE3	0.000	-0.014*	0.024**	-0.041***	-0.052***	-0.023**	-0.008	-0.023**	0.003
	(0.05)	(-1.69)	(2.10)	(-3.67)	(-4.14)	(-2.33)	(-0.89)	(-2.50)	(0.31)
Term	0.280	0.140	0.501	0.489	0.408	0.617	0.691**	0.607**	0.761**
	(1.08)	(0.54)	(1.22)	(1.26)	(1.04)	(1.50)	(2.34)	(2.03)	(1.98)
Credit	1.252*	0.133	3.025***	3.580***	3.282***	4.051***	1.798**	-0.080	3.334***
	(1.93)	(0.21)	(2.64)	(3.60)	(3.37)	(3.73)	(2.19)	(-0.10)	(3.07)
Ex_Mkt	0.019	-0.057	0.139	0.087	0.064	0.124	0.046	-0.058	0.131
	(0.32)	(-0.92)	(1.43)	(0.89)	(0.64)	(1.26)	(0.60)	(-0.75)	(1.36)
SMB	0.028	0.159*	-0.180	-0.168	-0.110	-0.261**	-0.022	0.166	-0.176
	(0.33)	(1.67)	(-1.44)	(-1.34)	(-0.82)	(-2.12)	(-0.21)	(1.41)	(-1.40)
HML	0.052	0.192*	-0.169	-0.069	-0.012	-0.160	0.008	0.239*	-0.181
	(0.52)	(1.70)	(-1.14)	(-0.43)	(-0.07)	(-1.01)	(0.07)	(1.76)	(-1.23)
LIQ	0.013	0.008	0.022	0.032	0.040	0.019	0.022	0.028	0.017
	(0.46)	(0.22)	(0.45)	(0.65)	(0.84)	(0.36)	(0.60)	(0.70)	(0.34)
VIXrate	-0.011	-0.015	-0.006	-0.012	-0.013	-0.010	-0.009	-0.011	-0.007
	(-1.26)	(-1.60)	(-0.43)	(-0.86)	(-0.93)	(-0.69)	(-0.83)	(-1.01)	(-0.53)
INF	-0.298	-0.027	-0.726	-0.801	-0.673	-1.003	-0.312	0.123	-0.668
	(-0.46)	(-0.05)	(-0.71)	(-0.81)	(-0.69)	(-0.96)	(-0.35)	(0.15)	(-0.62)
M2	-0.323	-0.727	0.315	-0.002	-0.143	0.221	-0.274	-0.983*	0.307
	(-0.69)	(-1.42)	(0.43)	(-0.00)	(-0.21)	(0.32)	(-0.52)	(-1.75)	(0.46)
GDP	0.823*	0.714	0.996	1.751**	2.021*	1.325	1.216**	0.899*	1.476*
	(1.73)	(1.57)	(1.24)	(2.11)	(2.55)	(1.43)	(2.00)	(1.69)	(1.71)
PUI	0.000	0.001	-0.001	-0.021	-0.022	-0.018	-0.001	0.002	-0.003
	(0.00)	(0.05)	(-0.06)	(-1.41)	(-1.45)	(-1.23)	(-0.08)	(0.12)	(-0.20)
Constant	0.443***	0.476***	0.392***	0.382***	0.393***	0.365***	0.428***	0.473***	0.391***
	(54.15)	(55.38)	(27.61)	(29.19)	(30.15)	(26.17)	(44.94)	(47.00)	(28.87)
adj. R^2	0.127	0.101	0.196	0.347	0.366	0.313	0.167	0.140	0.207

Panel B: Hypothesis Tests

		Bond & Forward Corr.			Stock & Forward Corr.			Forward & Forward Corr.		
H_0	Statistic	All	DM	EM	All	DM	EM	All	DM	EM
QE1 vs. QE2	F(1, 533)	18.19***	9.42***	18.06***	7.67***	7.16***	7.76***	21.29***	9.21***	20.22***
	Prob > F	0.000	0.002	0.000	0.006	0.008	0.006	0.000	0.003	0.000
QE1 vs. QE3	F(1, 533)	1.66	0.01	5.82**	7.44***	10.77***	2.21	1.87	0.08	3.48*
	Prob > F	0.198	0.919	0.016	0.007	0.001	0.138	0.173	0.783	0.063
QE2 vs. QE3	F(1, 533)	8.18***	8.88**	5.72**	28.39***	30.56***	21.44***	10.92***	7.75***	10.3***
	Prob > F	0.004	0.003	0.017	0.000	0.000	0.000	0.001	0.006	0.001

Appendix 2.A.[a] The parameter estimates based on the DCC-GARCH models for the bond market indexes

This table reports summary statistics for parameter estimates based on the chosen DCC-GARCH models for the correlations between the returns of the bond market index for each home country with the returns of the other 19 currency forward contracts. Australia and Brazil are the first DM and EM countries, respectively. Sign - and Sign + are the number of estimates out of 19 that are significant at the 10% level.

	DCC Parameter *a*						DCC Parameter *b*						LR	
Country	Min	Mean	Median	Max	Sign -	Sign +	Min	Mean	Median	Max	Sign -	Sign +	Min	Max
Australia	-0.028	0.036	0.031	0.143	1	12	-0.441	0.666	0.863	0.975	0	14	-2242.1	-1464.2
Eurozone														
Austria	-0.014	0.032	0.030	0.097	0	9	0.649	0.856	0.895	0.979	0	18	-2218.2	-1206.3
Belgium	-0.031	0.029	0.029	0.097	1	9	0.677	0.844	0.864	0.985	0	19	-2240.2	-1265.6
Finland	-0.005	0.071	0.052	0.175	1	17	-0.153	0.820	0.922	0.982	1	17	-2356.8	-1611.5
France	-0.011	0.034	0.030	0.100	0	9	0.692	0.869	0.916	0.980	0	19	-2209.1	-1189.7
Germany	-0.018	0.029	0.025	0.108	0	9	0.697	0.876	0.939	0.985	0	18	-2202.0	-1172.5
Ireland	-0.040	0.037	0.035	0.107	2	11	0.408	0.835	0.877	0.979	0	18	-2300.1	-1407.5
Italy	-0.033	0.027	0.020	0.144	1	10	0.421	0.800	0.845	0.984	0	18	-2279.3	-1388.8
Netherlands	-0.012	0.029	0.030	0.093	0	9	0.650	0.859	0.899	0.986	0	18	-2204.2	-1179.3
Portugal	-0.014	0.030	0.025	0.100	0	11	0.503	0.866	0.936	0.972	0	16	-2388.1	-1617.5
Spain	-0.023	0.028	0.029	0.098	0	9	0.494	0.822	0.838	0.983	0	17	-2293.0	-1434.7
Canada	-0.015	0.033	0.028	0.125	0	12	-0.955	0.805	0.945	0.978	1	18	-2113.6	-1386.7
Denmark	-0.028	0.024	0.028	0.102	1	10	0.619	0.858	0.910	0.979	0	19	-2205.1	-1171.3
Japan	0.029	0.095	0.093	0.183	0	17	0.584	0.833	0.853	0.940	0	18	-2317.6	-1556.4
New Zealand	-0.043	0.046	0.040	0.108	1	15	-0.190	0.786	0.911	0.988	0	16	-2347.1	-1590.7
Singapore	0.008	0.042	0.032	0.113	0	15	0.131	0.865	0.932	0.984	0	17	-1871.0	-1253.2
Sweden	-0.010	0.038	0.027	0.165	0	14	0.551	0.884	0.931	0.979	0	18	-2289.2	-1525.7
UK	0.012	0.043	0.035	0.093	0	7	-0.792	0.670	0.828	0.929	1	16	-2163.5	-1396.4
US	0.009	0.063	0.041	0.136	0	15	0.581	0.832	0.832	0.968	0	19	-1611.4	-903.0
Brazil	0.012	0.033	0.022	0.078	0	15	0.730	0.926	0.963	0.978	0	19	-2400.0	-1714.4
Chile	0.011	0.042	0.039	0.100	0	9	-0.977	0.563	0.820	0.979	2	13	-2303.1	-1595.8
Colombia	0.010	0.044	0.030	0.127	0	12	-0.621	0.790	0.852	0.988	1	18	-2421.0	-1582.2
Czech Republic	-0.031	0.009	0.013	0.057	3	6	0.147	0.760	0.911	0.981	0	13	-2344.1	-1576.0
Greece	-0.008	0.045	0.038	0.146	0	12	0.739	0.895	0.916	0.981	0	18	-2398.1	-1451.4
Hungary	-0.019	0.035	0.019	0.105	1	9	0.245	0.826	0.882	0.991	0	18	-2564.1	-1850.7
India	-0.013	0.043	0.040	0.088	0	18	0.664	0.908	0.939	0.955	0	18	-2151.9	-1440.1
Mexico	-0.015	0.039	0.030	0.096	1	12	-0.027	0.807	0.839	1.000	0	18	-2349.2	.-1655.1
Poland	-0.030	0.032	0.029	0.142	2	11	-0.198	0.740	0.846	0.984	0	15	-2443.1	-1703.2
South Africa	-0.048	0.023	0.018	0.062	1	14	0.158	0.848	0.913	0.980	0	16	-2448.7	-1817.0
South Korea	0.009	0.034	0.029	0.088	0	11	0.795	0.909	0.927	0.987	0	19	-2156.7	-1399.7
Thailand	-0.023	0.071	0.072	0.146	1	14	0.617	0.804	0.809	0.951	0	19	-2120.0	-1382.2

[a]We chose the DCC model with the largest negative Likelihood Ratio (LR) when the estimates of *a* plus *b* in equation (2.3) are less than 1. For each country at least 85% of the correlations between the indexes of bonds or stocks and the currency forwards are measured using the DCC-GARCH (1, 1) model and the remainder is measured using the GJR/TARCH or EGARCH model in the first step and asymmetric DCC in the second step of the procedure discussed in section 3.

Appendix 2.B. The parameter estimates based on the DCC-GARCH models for the stock market indexes

This table reports summary statistics for parameter estimates based on the chosen DCC-GARCH models for the correlations between the returns of the stock market index for each home country with the returns of the other 19 currency forward contracts. Australia and Brazil are the first DM and EM countries, respectively. Sign - and Sign + are the number of estimates out of 19 that are significant at the 10% level.

	DCC Parameter *a*						DCC Parameter *b*						LR	
Country	Min	Mean	Median	Max	Sign -	Sign +	Min	Mean	Median	Max	Sign -	Sign +	Min	Max
Australia	-0.033	0.029	0.031	0.089	1	11	0.573	0.870	0.899	0.976	0	18	-2649.4	-1938.6
Eurozone														
Austria	0.016	0.036	0.029	0.089	0	14	0.547	0.914	0.939	0.969	0	18	-2796.7	-2062.7
Belgium	-0.033	0.024	0.036	0.059	3	11	-0.206	0.791	0.919	0.964	0	16	-2643.7	-1929.4
Finland	-0.032	0.019	0.018	0.063	1	9	0.190	0.876	0.956	0.981	0	16	-2802.2	-2103.7
France	-0.034	0.038	0.038	0.084	1	15	0.100	0.822	0.932	0.968	0	16	-2642.9	-1943.1
Germany	-0.035	0.034	0.029	0.072	1	13	0.026	0.838	0.932	0.973	0	17	-2680.1	-1968.7
Ireland	-0.032	0.021	0.028	0.051	3	10	0.363	0.857	0.927	0.980	0	18	-2809.0	-2100.3
Italy	-0.037	0.031	0.028	0.101	2	15	0.019	0.845	0.940	0.979	0	17	-2705.9	-1995.4
Netherlands	0.016	0.040	0.033	0.107	0	18	0.721	0.914	0.942	0.969	0	19	-2655.1	-1946.3
Portugal	0.014	0.045	0.038	0.090	0	17	0.829	0.912	0.927	0.967	0	19	-2675.1	-1948.5
Spain	-0.023	0.028	0.028	0.078	2	10	0.296	0.830	0.942	0.964	0	17	-2750.7	-2042.3
Canada	-0.017	0.027	0.028	0.065	0	10	-0.554	0.737	0.932	0.978	0	15	-2590.2	-1904.0
Denmark	-0.031	0.027	0.028	0.091	2	9	0.117	0.802	0.842	0.976	0	16	-2658.6	-1944.6
Japan	-0.018	0.027	0.028	0.061	1	11	0.063	0.865	0.921	1.001	0	17	-2628.2	-1898.5
New Zealand	-0.017	0.024	0.019	0.072	3	11	0.393	0.884	0.931	0.979	0	18	-2638.4	-1922.1
Singapore	0.010	0.038	0.035	0.088	0	11	0.181	0.833	0.907	0.972	0	17	-2555.2	-1972.4
Sweden	-0.027	0.026	0.026	0.069	2	11	0.684	0.881	0.906	0.973	0	18	-2729.7	-1789.3
UK	-0.030	0.033	0.033	0.085	1	13	-0.096	0.844	0.945	0.973	0	17	-2540.7	-1846.4
US	-0.033	0.030	0.031	0.064	1	11	0.004	0.851	0.929	0.987	0	18	-2463.7	-1777.2
Brazil	0.015	0.046	0.044	0.094	0	14	0.235	0.786	0.896	0.981	0	16	-2851.7	-2186.6
Chile	-0.060	0.013	0.017	0.052	2	5	0.386	0.889	0.917	1.009	0	18	-2683.3	-1981.8
Colombia	0.016	0.047	0.048	0.097	0	16	0.650	0.883	0.905	0.978	0	19	-2788.6	-2099.2
Czech Republic	0.007	0.028	0.024	0.052	0	14	0.820	0.927	0.927	0.982	0	19	-2764.6	-2052.4
Greece	-0.003	0.027	0.026	0.049	0	12	0.461	0.892	0.938	0.971	0	17	-2926.4	-2228.3
Hungary	-0.018	0.025	0.022	0.082	2	12	-0.609	0.769	0.934	0.977	0	17	-2940.0	-2231.9
India	0.012	0.031	0.025	0.090	0	9	0.778	0.914	0.944	0.978	0	19	-2790.4	-2103.3
Mexico	-0.041	0.034	0.035	0.067	1	12	0.531	0.884	0.903	0.973	0	19	-2736.9	-1611.2
Poland	-0.038	0.029	0.026	0.104	1	12	0.298	0.881	0.898	0.981	0	17	-2844.2	-2142.2
South Africa	-0.048	0.026	0.026	0.116	2	15	0.086	0.851	0.927	0.982	0	18	-2692.8	-2047.9
South Korea	-0.007	0.045	0.042	0.115	1	15	0.750	0.878	0.893	1.001	0	19	-2783.3	-2079.7
Thailand	0.006	0.068	0.041	0.202	0	13	0.310	0.795	0.888	0.978	0	18	-2790.0	-2098.3

Appendix 2.C. The parameter estimates based on the DCC-GARCH models for the currency forward contracts

This table reports summary statistics for parameter estimates based on the chosen DCC-GARCH models for the correlations between the returns of the currency forward contracts for each home country with the returns of the other 19 currency forward contracts. Australia and Brazil are the first DM and EM countries, respectively. Sign - and Sign + are the number of estimates out of 19 that are significant at the 10% level.

	DCC Parameter *a*						DCC Parameter *b*						LR	
Country	Min	Mean	Median	Max	Sign -	Sign +	Min	Mean	Median	Max	Sign -	Sign +	Min	Max
Australia	-0.032	0.026	0.023	0.102	2	10	-0.209	0.783	0.862	0.988	0	15	-2281.6	-1525.3
Canada	0.005	0.032	0.023	0.112	0	11	0.678	0.906	0.953	0.980	0	19	-2135.8	-1420.3
Denmark	-0.033	0.018	0.014	0.083	3	7	-0.243	0.757	0.903	0.980	0	14	-2196.3	-1401.3
Euro	-0.034	0.018	0.014	0.084	3	7	-0.222	0.760	0.895	0.980	0	14	-2197.6	-1402.4
Japan	0.034	0.089	0.083	0.186	0	18	0.729	0.847	0.872	0.943	0	19	-2306.8	-1543.9
New Zealand	-0.045	0.045	0.039	0.102	0	15	-0.101	0.764	0.873	0.966	0	15	-2304.4	-1630.6
Singapore	-0.019	0.033	0.022	0.186	1	11	0.514	0.906	0.941	0.992	0	18	-1764.2	-1159.2
Sweden	-0.010	0.038	0.026	0.165	0	14	0.527	0.882	0.929	0.981	0	18	-2302.8	-1539.9
UK	-0.019	0.040	0.023	0.102	1	8	-0.209	0.759	0.845	0.992	0	16	-2165.1	-1403.2
Brazil	0.011	0.034	0.023	0.089	0	17	0.739	0.924	0.959	0.980	0	19	-2332.9	-1643.6
Chile	0.011	0.043	0.041	0.100	0	9	-0.101	0.761	0.786	0.981	0	15	-2277.6	-1572.0
Colombia	0.010	0.044	0.030	0.127	0	12	-0.621	0.790	0.852	0.988	1	18	-2421.0	-1582.2
Czech Republic	-0.028	0.021	0.018	0.091	1	11	0.514	0.899	0.961	0.979	0	18	-2333.8	-1561.7
Greece	-0.034	0.018	0.014	0.084	3	7	-0.222	0.760	0.895	0.980	0	14	-2197.6	-1402.4
Hungary	0.008	0.034	0.020	0.097	0	8	0.390	0.847	0.897	0.986	0	17	-2397.8	-1665.9
India	0.009	0.036	0.033	0.079	0	15	0.848	0.938	0.951	0.968	0	19	-1966.6	-1240.9
Mexico	-0.017	0.025	0.018	0.082	2	12	-0.243	0.797	0.923	0.988	0	17	-2172.0	-1483.7
Poland	-0.032	0.032	0.028	0.135	3	8	0.223	0.715	0.785	0.979	0	14	-2379.2	-1624.9
South Africa	-0.034	0.027	0.022	0.071	2	13	0.413	0.871	0.920	0.984	0	16	-2397.8	-1764.2
South Korea	0.009	0.034	0.026	0.086	0	14	0.825	0.920	0.943	0.982	0	19	-2105.3	-1342.1
Thailand	0.017	0.061	0.057	0.091	0	14	0.683	0.851	0.862	0.953	0	19	-1924.8	-1159.2

Appendix 3.A. The Timeline and Main Events for the U.S. QEs

Before QE: Sept. 5, 2003 – Nov. 19, 2008.
2008 Financial Crisis. On Sept. 15, 2008, Lehman Brothers announced that it had filed for bankruptcy (Mamudi, 2008). On Oct 29, 2008, the Fed reduced the interest rate to 1 percent.

QE1: Nov. 25, 2008 - Mar. 31, 2010.
The Federal Reserve and the Treasury announced $800 billion of new lending programs on Nov. 25, 2008, indicating that they would print as much money as required to stimulate the banking system (Andrews, 2008). On Dec. 16, 2008, the Fed cut the interest rate to near zero. The Fed completed the purchases of $1.25 trillion in mortgage-backed securities, $175 billion in agency debt and $300 billion in Treasury bonds (Rodnyansky and Darmouni, 2017)

QE2: Nov. 3, 2010 - June 30, 2011.[47]
After QE1, the U.S. economy recovered slowly, so on Nov. 3, 2010, the Federal Reserve, announced a second round of large purchases of Treasury bonds to stimulate economic growth (Chan and Sanger, 2010). The Fed initiated the purchase of $600 billion of long-term Treasury securities by the end of the second quarter of 2011 (Bernanke, 2010b; Fawley and Neely, 2013).

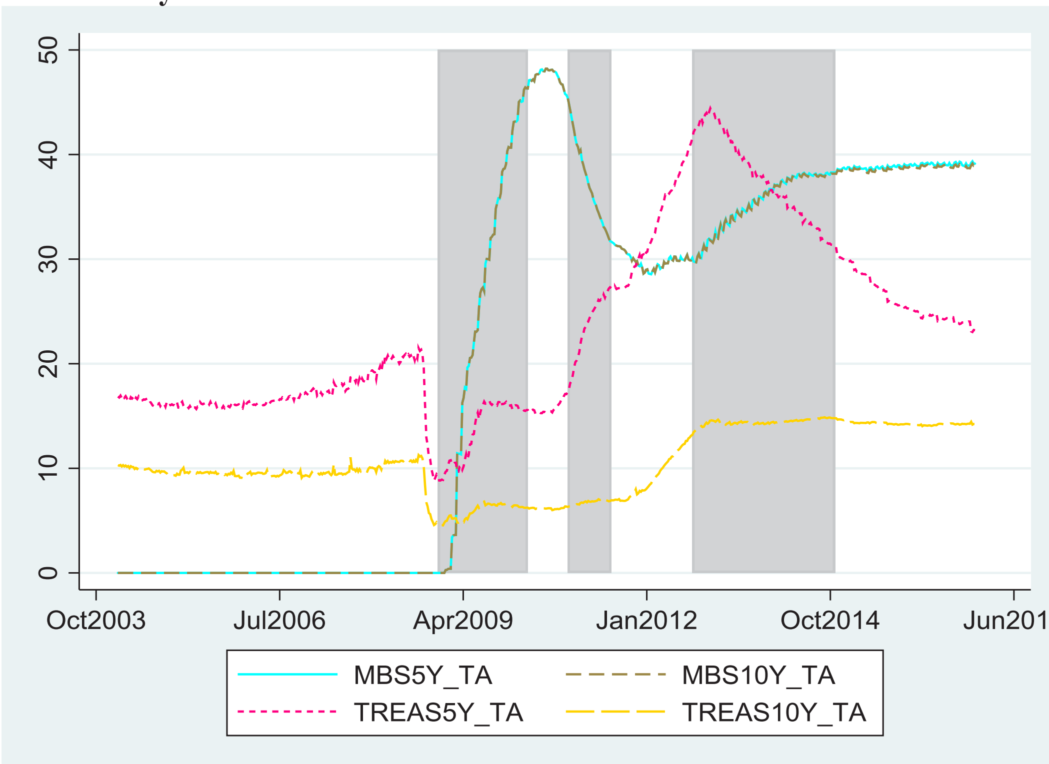
QE3: Sept. 13, 2012 to Oct. 29, 2014.
The central bank announced its intentions to buy an additional $40 billion in mortgage-backed securities monthly until the economy recovered.[48] The Fed announced on Oct. 29, 2014 that it ended the bond-buying program, but would continue to keep short-term interest rates close to zero.[49]

[47] http://www.federalreserve.gov/newsevents/press/monetary/20101103a.htm.
[48] https://www.federalreserve.gov/newsevents/press/monetary/20120913a.htm
[49] https://www.federalreserve.gov/newsevents/press/monetary/20141029a.htm

Appendix 3.B. Variable Definitions

Variable	Definition and Sources
Portfolio Performance Measures	
RelHdgEffect	Difference in the variances *(*Var) for the optimally (fully) hedged portfolio and its unhedged counterpart, scaled by the variance of its unhedged counterpart. Data source: authors' calculation.
DifHdgPerf	Difference in the Sharpe ratios for the optimally (fully) hedged portfolio and its unhedged counterpart. Data source: authors' calculation.
Quantitative Easing Dummies	
QE and	The time dummy equal to one for periods during which the U.S. Fed implemented a QE (including the three QE rounds); zero otherwise.
PostQE1not	The time dummy equal to one for periods after the QE1 period but not during any of the three QE rounds; zero otherwise.
The Fed's Security Type Holdings (Data source: FRED)	
TREASF/TAF	The Treasury securities holdings of the Fed scaled by the Fed's total asset holdings. Suffix 'F' indicates holdings by the Fed. Data source: FRED.
MBSF/TAF	The mortgage-backed securities holdings of the Fed scaled by the Fed's total asset holdings. Suffix 'F' indicates holdings by the Fed.
TAF/$GDP	The Fed's total asset (TAF) holdings relative to the level of domestic dollar GDP. Suffix 'F' indicates holdings by the Fed.
$TREASF_{matur}/TAF$	The Fed holdings of Treasury bonds with maturities of over five (*matur* = 5) or over ten (*matur* = 10) years.
$MBSF_{matur}/TAF$	The Fed holdings of mortgage-backed securities with maturities of over five (*matur* = 5) or over ten (*matur* = 10) years.
The Control Variables for the U.S. Markets	
ΔTWEXB	Percentage change of the trade-weighted broad exchange rate index, which is a weighted average of the foreign exchange value of the U.S. dollar against the currencies of a broad group of major U.S. trading partners which include 26 countries or regions. Data source: Board of Governors of the Federal Reserve System (U.S.).
TERM	Term spread. Difference between the yield of a 10-year and a three-month Treasury-bill. Data source: Datastream.
CREDIT	Credit spread. Difference between Moody's Baa corporate bond yield and Aaa corporate bond yield. Data source: Datastream.
PUI	An index of economic policy uncertainty constructed from: 1) newspaper coverage of policy-related economic uncertainty; 2) the number of federal tax code provisions; and 3) disagreement among economic forecasts. Scaled by 0.01. Data source available at: http://www.policyuncertainty.com/us_historical.html

Figure 3.1. The securities holdings by the Fed with respect to maturities for over five years or over ten years

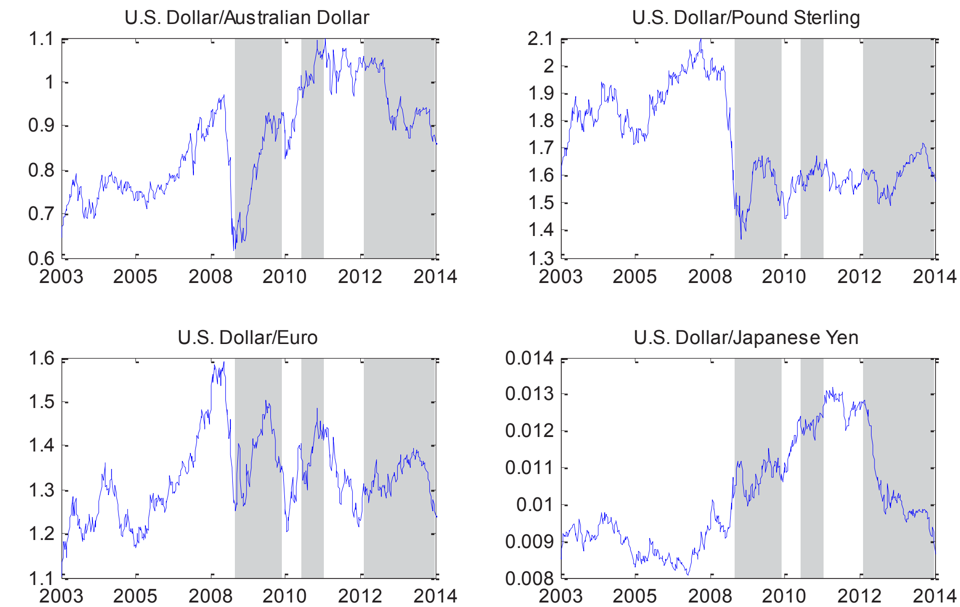


Note: The numbers of MBS5Y and MBS10Y are very close to each other, so the two lines are almost overlapping.

Figure 3.2. Exchange rates around and during the QEs

This figure depicts the exchange rates of U.S. dollars to the currencies in some major developed (Panel A) and emerging countries (Panel B) for the period from September 2003 to October 2014 at a weekly frequency. The shaded areas indicate the QE periods designated by the Federal Reserve in the U.S.

Panel A: Developed Countries



Panel B: Emerging Countries

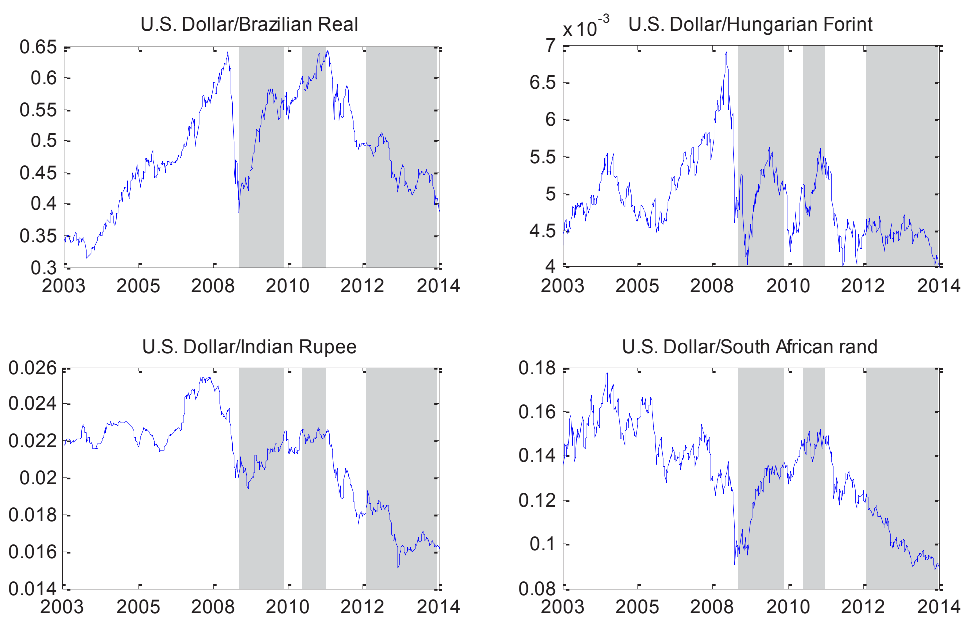


Figure 3.3. Sharpe Ratios for fully-hedged and unhedged portfolios for the full time period

The Sharpe ratios of fully-hedged portfolios are plotted against the Sharpe ratios of unhedged portfolios from September 2003 to October 2014. The dashed line at a 45-degree angle through the origin indicates where the Sharpe ratios of the hedged and unhedged portfolios are equal. The 31 countries are the developed countries of Australia (AU), 11 developed markets from the Eurozone [Austria (AT), Belgium (BE), Finland (FI), France (FR), Germany (DE), Ireland (IE), Italy (IT), Netherlands (NL), Portugal (PT), and Spain (ES)], Canada (CA), Denmark (DK), Japan (JP), New Zealand (NZ), Singapore (SG), Sweden (SE), United Kingdom (UK), and the United States (US), and the developing countries of Brazil (BR), Chile (CL), Colombia (CO), Czech Republic (CZ), Greece (GR), Hungary (HU), India (IN), Mexico (MX), Poland (PL), South Africa (ZA), South Korea (SR), and Thailand (TH).

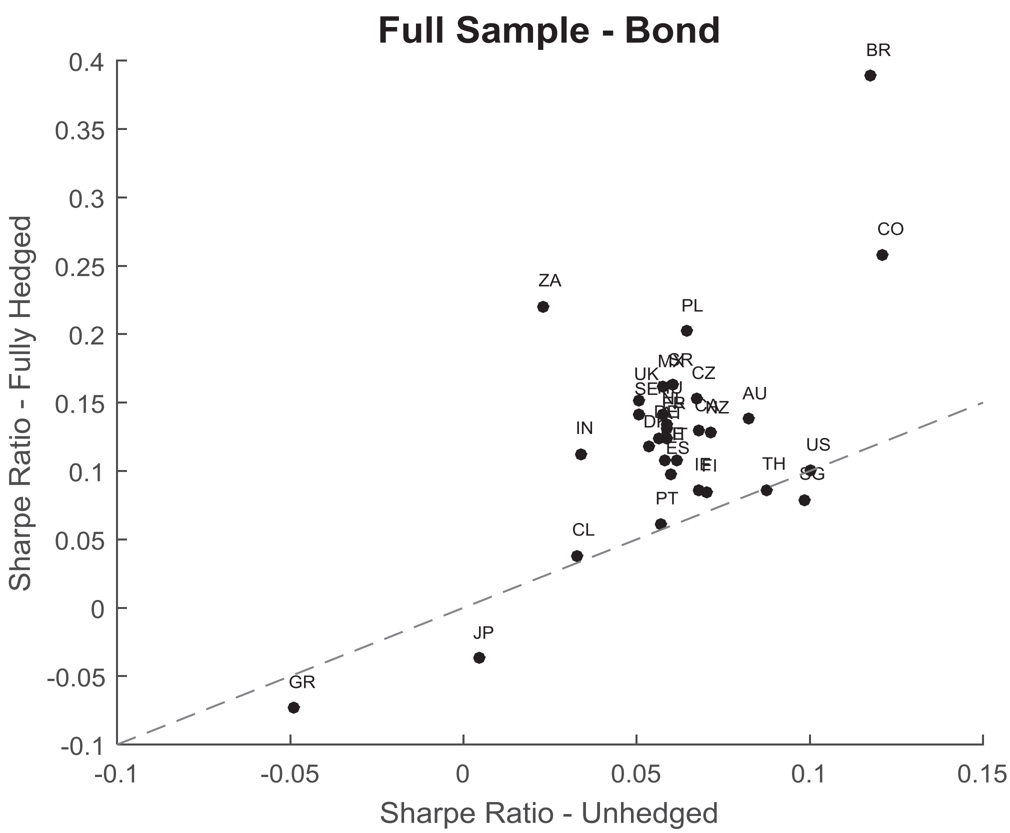


Table 3.1. Summary statistics for various country indices

This table reports the summary statistics (means and standard deviations) for the forward rates, foreign exchange rates and out-of-sample total returns for the unhedged, fully hedged, and optimally hedged portfolios of bonds for the various country indices. The sample period is September 2003 to October 2014. The weekly data are obtained on Friday from Datastream and Bloomberg. The forward contracts relative to the U.S. currency have a maturity of one month. All the results are in percentages. All 19 developed and 12 emerging countries are included.

	FX changes		Forward Payoffs		Hedging Strategy for Bonds: Not		Fully		Optimally	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
DM										
Australia	0.07	1.94	0.07	1.90	0.18	1.79	0.08	0.58	0.12	0.48
Eurozone										
Austria	0.03	1.37	0.03	1.37	0.11	1.41	0.05	0.43	0.09	0.40
Belgium	0.03	1.37	0.03	1.37	0.12	1.49	0.06	0.53	0.09	0.50
Finland	0.03	1.37	0.03	1.37	0.15	1.68	0.09	1.04	0.13	1.02
France	0.03	1.37	0.03	1.37	0.11	1.38	0.05	0.40	0.09	0.36
Germany	0.03	1.37	0.03	1.37	0.11	1.35	0.05	0.38	0.08	0.33
Ireland	0.03	1.37	0.03	1.37	0.16	1.88	0.10	1.15	0.14	1.11
Italy	0.03	1.37	0.03	1.37	0.13	1.58	0.07	0.63	0.10	0.60
Netherlands	0.03	1.37	0.03	1.37	0.11	1.37	0.05	0.38	0.09	0.34
Portugal	0.03	1.37	0.03	1.37	0.15	2.17	0.09	1.54	0.13	1.51
Spain	0.03	1.37	0.03	1.37	0.13	1.63	0.07	0.70	0.10	0.66
Canada	0.04	1.37	0.04	1.37	0.12	1.33	0.05	0.37	0.08	0.32
Denmark	0.03	1.36	0.03	1.36	0.10	1.37	0.04	0.38	0.08	0.34
Japan	0.01	1.45	0.01	1.45	0.04	1.48	-0.01	0.18	0.02	0.17
New Zealand	0.07	2.00	0.07	1.96	0.17	1.92	0.07	0.52	0.10	0.47
Singapore	0.06	0.71	0.05	0.72	0.11	0.82	0.03	0.32	0.05	0.30
Sweden	0.03	1.71	0.03	1.72	0.11	1.65	0.05	0.36	0.09	0.31
U.K.	0.01	1.37	0.01	1.37	0.10	1.33	0.06	0.38	0.09	0.33
U.S.	-	-	-	-	0.07	0.45	-	-	-	-
EM										
Brazil	0.04	2.04	0.04	2.04	0.30	2.28	0.22	0.58	0.26	0.52
Chile	0.04	1.67	0.04	1.68	0.09	1.74	0.02	0.46	0.05	0.45
Colombia	0.06	1.64	0.06	1.64	0.27	1.99	0.18	0.69	0.21	0.60
Czech Republic	0.06	1.76	0.06	1.77	0.15	1.81	0.06	0.38	0.09	0.36
Greece	0.03	1.37	0.03	1.37	-0.11	2.91	-0.17	2.35	-0.14	2.24
Hungary	0.01	2.17	0.01	2.18	0.19	2.88	0.15	1.08	0.19	0.83
India	-0.05	1.00	-0.05	0.99	0.07	1.29	0.09	0.80	0.12	0.73
Mexico	-0.03	1.55	-0.03	1.56	0.15	2.12	0.15	0.91	0.18	0.77
Poland	0.05	2.10	0.05	2.10	0.18	2.32	0.10	0.49	0.14	0.42
S.Africa	-0.04	2.35	-0.04	2.35	0.09	2.54	0.10	0.47	0.13	0.42
S.Korea	0.02	1.46	0.02	1.45	0.12	1.54	0.07	0.44	0.10	0.42
Thailand	0.04	0.84	0.04	0.84	0.13	1.12	0.06	0.68	0.09	0.65

Table 3.2. Tests of the equality of the individual components of hedging effectiveness and performance between the QE and Pre-QE periods.

This table reports initial tests of the mean (t-test) and median (Wilcoxon rank-sum or Wil. test) equalities between the QE and Pre-QE periods reported in the same column for an individual component of hedging effectiveness or performance for international bond portfolios of developed market (DM) and emerging market (EM) countries from the perspective of a U.S. investor. The individual components are excess returns or *ExRtn* in Panel A, variances or *Var.* in Panel B, and Sharpe ratios in Panel C. [a], [b], and [c] indicate statistical significance at the 1%, 5% and 10% level, respectively. All the mean and median variances reported in panel B are scaled by 100 in order to facilitate comparisons.

	Optimally		Fully		Not	
	DM	EM	DM	EM	DM	EM
Panel A: Differences in component excess returns during QE period compared to Pre-QE period						
Mean for QE period	0.0080	0.0171	0.0057	0.0095	0.0056	0.0092
Mean for Pre-QE period	0.0067	0.0189	0.0091	0.0186	0.0093	0.0188
Mean for dif. of above two periods	0.0013 [a]	-0.0018	-0.0035 [c]	-0.0091 [a]	-0.0036 [c]	-0.0096 [a]
T-test of above mean, p-value	0.0054	0.1056	0.0708	0.0064	0.0923	0.0081
Median for QE period	0.0083 [a]	0.0164	0.0046 [b]	0.0125 [a]	0.0049 [b]	0.0119 [a]
Median for Pre-QE period	0.0068	0.0167	0.0126	0.0254	0.0139	0.0265
Wil. test of above medians, p-value	0.0002	0.7978	0.0114	0.0000	0.0112	0.0000
Panel B: Differences in component Variances during QE period compared to Pre-QE period						
Mean for QE period	0.0182	0.0625	0.6258	2.3985	0.7855	2.7495
Mean for Pre-QE period	0.0288	0.0405	0.9053	2.6337	1.1312	3.0529
Mean for dif. of above two periods	-0.0107 [a]	0.0221 [a]	-0.2795 [a]	-0.2352	-0.3457 [a]	-0.3034
T-test of above mean, p-value	0.0000	0.0001	0.0000	0.4065	0.0000	0.3531
Median for QE period	0.0164 [b]	0.0299 [b]	0.5239 [a]	1.8182 [a]	0.6649 [a]	2.0831 [a]
Median for Pre-QE period	0.0161	0.0241	0.6694	1.2842	0.8384	1.4895
Wil. test of above medians, p-value	0.0411	0.0112	0.0000	0.0004	0.0000	0.0003
Panel C: Differences in component Sharpe ratios during QE period compared to Pre-QE period						
Mean for QE period	0.7219	1.0383	0.0563	0.0783	0.0457	0.0690
Mean for Pre-QE period	0.4344	1.0158	0.1394	0.2260	0.1320	0.2181
Mean for dif. of above two periods	0.2875 [a]	0.0225	-0.0830 [a]	-0.1477 [a]	-0.0863 [a]	-0.1491 [a]
T-test of above mean, p-value	0.0000	0.7376	0.0007	0.0000	0.0004	0.0000
Median for QE period	0.6338 [a]	0.8319	0.0658 [a]	0.0837 [a]	0.0632 [a]	0.0767 [a]
Median for Pre-QE period	0.4659	1.0866	0.1430	0.2203	0.1373	0.2150
Wil. test of above medians, p-value	0.0000	0.7957	0.0031	0.0000	0.0022	0.0000

Table 3.3. Tests of the equality of hedging effectiveness and performance between the QE and Pre-QE periods. This table reports initial tests of the mean (t-test) and median (Wilcoxon rank-sum or Wil. test) equalities between the QE and Pre-QE periods reported in the same column for each metric of hedging effectiveness or performance for international bond portfolios of developed market (DM) and emerging market (EM) countries from the perspective of a U.S. investor. Each reported metric measures the effectiveness or performance of the hedged portfolio versus its corresponding unhedged portfolio. The metrics are differenced excess returns or *DifHdgExRtn* in Panel A, relative hedging effectiveness or *RelHdgEffect* [eq. (3.1)] in Panel B, and differenced hedging performance or *DifHdgPerf* [(eq. (3.2)] in Panel C. [a], [b], and [c] indicate statistical significance at the 1%, 5% and 10% level, respectively.

	Optimally		Fully	
	DM	EM	DM	EM
Panel A: Differences in *DifHdgExRtn* during QE period compared to Pre-QE period				
Mean for QE period	0.0024	0.0079	0.0001	0.0003
Mean for Pre-QE period	-0.0025	0.0001	-0.0001	-0.0002
Mean for dif. of above two periods	0.0049	0.0078	0.0002	0.0005
T-test of above mean, p-value	0.0006 [a]	0.0000 [a]	0.0071 [a]	0.0000 [a]
Median for QE period	0.00148	0.00584	0.00015	0.00027
Median for Pre-QE period	-0.0080	-0.0144	-0.0010	-0.0012
Wil. test of above medians, p-value	0.0006 [a]	0.0000 [a]	0.0071 [a]	0.0000 [a]
Panel B: Differences in *RelHdgEffect* during QE period compared to Pre-QE period				
Mean for QE period	0.9749	0.9793	0.2003	0.1305
Mean for Pre-QE period	0.9753	0.9809	0.1973	0.1379
Mean for dif. of above two periods	-0.0004	-0.0017	0.0030 [b]	-0.0073 [a]
T-test of above mean, p-value	0.7160	0.1235	0.0176	0.0000
Median for QE period	0.9777	0.9815 [b]	0.2020 [b]	0.1243 [a]
Median for Pre-QE period	0.9789	0.9848	0.1990	0.1371
Wil. test of above medians, p-value	0.1556	0.0295	0.0209	0.0000
Panel C: Differences in *DifHdgPerf* during QE period compared to Pre-QE period				
Mean for QE period	0.6762	0.9693	0.0106	0.0093
Mean for Pre-QE period	0.3024	0.7977	0.0074	0.0079
Mean for dif. of above two periods	0.3738 [a]	0.1716 [b]	0.0033 [a]	0.0015 [b]
T-test of above mean, p-value	0.0000	0.0116	0.0000	0.0179
Median for QE period	0.5284 [a]	0.7866	0.0113 [a]	0.0076
Median for Pre-QE period	0.2763	0.8256	0.0071	0.0070
Wil. test of above medians, p-value	0.0000	0.2388	0.0000	0.1554

Table 3.4. Time-series regression results for effects of Fed's relative-to-$GDP and security-type holdings on relative hedging effectiveness

This table reports summary statistics for the relations between the relative hedging effectiveness of international bond portfolios from the perspective of a U.S. investor and the total asset holdings relative to $GDP (i.e.,*TAF/$GDP*) of the U.S. Fed based on eq. (3.4) and the security-type holdings based on eq. (3.5). The time dummies (QE and PostQE1not) represent the period of QE and the post QE1 period where the latter period excludes the QE period launched by the U.S. Fed. Information about each variable is provided in Appendix 3.B. The total number of observations is 558. Robust *t*-statistics are reported in the parentheses based on Newey-West (1987) standard errors with six lags. ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

	Eq. (3.4) for hedging effectiveness				Eq. (3.5) for hedging effectiveness			
	Optimally Hedged		Fully Hedged		Optimally Hedged		Fully Hedged	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	DM	EM	DM	EM	DM	EM	DM	EM
QE	0.024**	-0.023***	0.010	0.009	0.043**	0.006	0.037***	0.007
	(2.05)	(-2.93)	(1.22)	(1.05)	(2.35)	(0.61)	(3.20)	(0.53)
PostQE1not	0.065***	-0.021	-0.079***	-0.025	0.320***	-0.322***	0.162	0.331*
	(4.14)	(-0.90)	(-4.14)	(-0.98)	(4.34)	(-2.84)	(1.37)	(1.68)
TREASF/TAF					-0.033*	-0.075***	-0.058***	0.024
					(-1.65)	(-4.66)	(-3.61)	(1.44)
TREASF/TAF *QE					-0.060***	0.023	-0.073***	-0.033
					(-3.00)	(1.40)	(-3.42)	(-1.33)
TREASF/TAF *PostQE1not					-0.328***	0.348***	-0.108	-0.319
					(-4.44)	(2.94)	(-0.90)	(-1.54)
MBSF/TAF *QE					-0.071*	-0.101***	-0.047	0.021
					(-1.95)	(-3.54)	(-1.49)	(0.61)
MBSF/TAF *PostQE1not					-0.442***	0.374**	-0.293*	-0.464*
					(-4.24)	(2.45)	(-1.78)	(-1.73)
TAF/$GDP	0.500**	-0.414*	-0.802***	0.109				
	(2.03)	(-1.90)	(-4.37)	(0.49)				
TAF/$GDP*QE	-0.517**	0.449**	0.500***	-0.185				
	(-2.23)	(2.37)	(2.99)	(-0.92)				
TAF/$GDP*PostQE1not	-0.757***	0.438*	1.194***	0.108				
	(-2.99)	(1.78)	(6.07)	(0.38)				
VIX	0.003	0.001	0.003	-0.001	0.000	-0.002	0.001	0.000
	(1.35)	(0.41)	(1.05)	(-0.40)	(0.10)	(-0.86)	(0.57)	(0.19)
ΔTWEXB	0.147*	-0.006	0.006	-0.210***	0.157**	-0.047	-0.041	-0.194**
	(1.78)	(-0.08)	(0.08)	(-2.68)	(1.99)	(-0.64)	(-0.61)	(-2.51)
Term	0.226**	-0.379***	-0.013	-0.061	-0.012	-0.582***	-0.189	0.018
	(2.36)	(-3.11)	(-0.10)	(-0.51)	(-0.08)	(-3.99)	(-1.36)	(0.16)
Credit	-0.301	0.623*	-1.232***	0.649	-2.171***	-1.428**	-1.508**	1.253*
	(-1.15)	(1.75)	(-4.04)	(1.58)	(-2.62)	(-2.55)	(-2.18)	(1.76)
PUI	-0.002	0.001	0.005	-0.002	-0.004	-0.001	0.006	-0.001
	(-0.59)	(0.17)	(1.41)	(-0.66)	(-1.16)	(-0.20)	(1.61)	(-0.43)
Constant	0.955***	0.992***	0.250***	0.125***	1.024***	1.051***	0.258***	0.106***
	(68.38)	(77.52)	(25.07)	(9.07)	(47.30)	(61.42)	(13.79)	(5.30)
adj. R^2	0.1153	0.1235	0.4585	0.3123	0.198	0.202	0.364	0.336
Computed from above estimates:								
Constant + QE	0.980***	0.969***	0.261***	0.134***	1.067***	1.057***	0.295***	0.113***
	(113.11)	(75.65)	(24.38)	(11.00)	(30.02)	(42.43)	(10.44)	(3.76)
Constant + PostQE1not	1.020***	0.970***	0.172***	0.100***	1.344***	0.729***	0.420***	0.437**
	(92.85)	(42.51)	(8.74)	(4.20)	(16.86)	(6.26)	(3.42)	(2.18)
TAF/$GDP +TAF/$GDP *QE	-0.017	0.035	-0.303***	-0.076				
	(-0.40)	(0.68)	(-6.46)	(-1.63)				
TAF/$GDP + TAF/$GDP*PostQE1not	-0.257***	0.024	0.391***	0.217				
	(-3.24)	(0.16)	(3.06)	(1.21)				
TREASF/TAF +TREASF/TAF *QE					-0.093***	-0.052**	-0.131***	-0.009
					(-2.92)	(-2.00)	(-4.31)	(-0.27)
TREASF/TAF + TREASF/TAF *PostQE1not					-0.475***	0.300*	-0.351**	-0.440
					(-4.30)	(1.92)	(-2.07)	(-1.62)

Table 3.5. Time-series regression results for effects of Fed's longer-maturity security-type holdings on relative hedging effectiveness

This table reports the effects of the security type holdings of the Fed with longer maturities on the relative hedging effectiveness of international bond portfolios from the perspective of a U.S. investor. The time dummies (QE and PostQE1not) represent the period of QE and the post QE1 period where the latter period does not include the QE period launched by the U.S. Federal Reserve. Information about each variable is provided in Appendix 3.B. The total number of observations is 558. Robust *t*-statistics are reported in the parentheses based on Newey-West (1987) standard errors with six lags. ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

	Panel A: Eq. (3.6) (matur = 5 years)				Panel B: Eq. (3.6) (*matur* = 10 years)			
	Optimally Hedged		Fully Hedged		Optimally Hedged		Fully Hedged	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	DM	EM	DM	EM	DM	EM	DM	EM
QE	-0.023*	-0.009	0.004	0.023**	-0.018	-0.014	0.014	0.024***
	(-1.89)	(-0.76)	(0.34)	(2.37)	(-1.57)	(-1.33)	(1.23)	(3.21)
PostQE1not	-0.047	0.011	-0.016	-0.151***	-0.052*	0.009	-0.008	-0.052**
	(-1.16)	(0.37)	(-0.51)	(-4.82)	(-1.95)	(0.38)	(-0.32)	(-2.55)
$TREASF_{matur}$/TAF	-0.003***	-0.000	-0.001	0.001	-0.005**	-0.001	-0.003	0.002*
	(-2.94)	(-0.54)	(-1.20)	(1.61)	(-2.33)	(-0.36)	(-1.33)	(1.76)
$TREASF_{matur}$/TAF * QE	0.002**	0.001	0.000	-0.001**	0.004**	0.002	-0.000	-0.003***
	(2.52)	(0.88)	(0.37)	(-2.16)	(2.01)	(1.24)	(-0.19)	(-2.61)
$TREASF_{matur}$ /TAF *	0.003**	0.000	0.002	0.002***	0.005*	-0.000	0.005*	0.005***
PostQE1not	(2.26)	(0.21)	(1.61)	(3.11)	(1.76)	(-0.08)	(1.84)	(2.93)
MBS_{matur}/TAF * QE	-0.000**	-0.000	0.000	-0.000	-0.001**	-0.000	-0.000	-0.000
	(-2.14)	(-0.59)	(0.39)	(-0.82)	(-2.24)	(-0.49)	(-0.34)	(-0.53)
MBS_{matur}/TAF *	0.000	-0.000	-0.000	0.002***	0.000	-0.000	-0.000*	0.000*
PostQE1not	(0.43)	(-0.60)	(-0.28)	(4.82)	(1.40)	(-0.58)	(-1.71)	(1.89)
VIXrate	0.001	0.002	0.004	-0.000	0.000	0.002	0.003	-0.000
	(0.33)	(0.55)	(1.63)	(-0.27)	(0.02)	(0.53)	(1.37)	(-0.13)
ΔTWEXB	0.116*	0.010	0.004	-0.193***	0.102	-0.019	0.051	-0.189***
	(1.75)	(0.14)	(0.07)	(-2.86)	(1.42)	(-0.27)	(0.82)	(-2.82)
Term	0.041	-0.282**	-0.047	-0.006	0.155	-0.257*	-0.022	-0.007
	(0.43)	(-1.98)	(-0.34)	(-0.06)	(1.52)	(-1.86)	(-0.17)	(-0.06)
Credit	-1.087***	0.588	0.016	0.410	-1.300***	0.708	-0.430	0.565
	(-3.64)	(1.61)	(0.04)	(1.18)	(-2.96)	(1.63)	(-0.89)	(1.40)
PUI	0.000	0.003	0.008*	-0.006*	-0.001	0.003	0.008**	-0.006*
	(0.03)	(0.68)	(1.93)	(-1.84)	(-0.33)	(0.69)	(2.01)	(-1.72)
Constant	1.038***	0.979***	0.218***	0.119***	1.037***	0.977***	0.229***	0.113***
	(56.39)	(62.21)	(11.19)	(9.72)	(45.26)	(52.89)	(9.51)	(7.66)
adj. R^2	0.267	0.102	0.387	0.447	0.157	0.141	0.484	0.445
Computed from above estimates:								
Constant + QE	1.015***	0.971***	0.222***	0.142***	1.018***	0.963***	0.243***	0.137***
	(92.44)	(78.49)	(16.34)	(11.75)	(65.22)	(63.37)	(14.50)	(9.84)
Constant + PostQE1not	0.991***	0.991***	0.202***	-0.032	0.985***	0.985***	0.221***	0.062***
	(27.46)	(39.14)	(8.07)	(-1.13)	(52.31)	(63.88)	(15.83)	(3.78)
$TREASF_{matur}$/TAF+	-0.001***	0.000	-0.001***	-0.000	-0.001**	0.001**	-0.003***	-0.001*
$TREASF_{matur}$/TAF*QE	(-3.43)	(1.43)	(-4.51)	(-1.51)	(-2.06)	(2.43)	(-6.78)	(-1.69)
$TREASF_{matur}$/TAF+	-0.000	-0.000	0.001	0.003***	-0.000	-0.001	0.002*	0.007***
$TREASF_{matur}$/TAF* PostQE1not	(-0.41)	(-0.63)	(1.43)	(7.06)	(-0.22)	(-0.89)	(1.95)	(6.97)

Table 3.6. Time-series regression results for the effects of Fed's security type holdings on the individual variances included in the relative hedging effectiveness measure

This table reports the effects of the security type holdings of the U.S. Fed Reserve on the individual variances included in measuring relative hedging effectiveness of international bond portfolios from the perspective of a U.S. investor. The dependent variables are the individual variances (*Var*) for the optimally hedged, fully hedged, and not hedged portfolios. The time dummies (QE and PostQE1not) represent the period of QE and the post QE1 period where the latter period excludes the QE period launched by the U.S. Fed. Information about each variable is provided in Appendix 3.B. Note that MBST/TA is not included since there are no pre-QE values for this variable. The elasticity at the mean is reported for TREASF and MBSF for the QE period. The total number of observations is 558. Robust *t*-statistics are reported in the parentheses based on Newey-West (1987) standard errors with six lags. ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

	Optimally Hedged		Fully Hedged		Not hedged	
	(1)	(2)	(3)	(4)	(5)	(6)
	DM	EM	DM	EM	DM	EM
QE	-0.001***	-0.001	-0.027***	-0.105***	-0.034***	-0.122***
	(-3.25)	(-1.29)	(-4.07)	(-3.37)	(-4.03)	(-3.39)
PostQE1not	-0.007***	-0.002	-0.161***	-0.843**	-0.203***	-0.954**
	(-3.60)	(-0.24)	(-3.16)	(-2.43)	(-3.14)	(-2.43)
TREASF/TAF	-0.002***	-0.003***	-0.062***	-0.386***	-0.079***	-0.446***
	(-6.44)	(-4.11)	(-8.73)	(-10.26)	(-8.80)	(-10.29)
TREASF/TAF * QE	0.002***	0.000	0.038***	0.145***	0.048***	0.168***
	(4.62)	(0.02)	(4.93)	(3.52)	(4.87)	(3.58)
TREASF/TAF * PostQE1not	0.007***	0.003	0.167***	0.947***	0.210***	1.073***
	(3.69)	(0.30)	(3.17)	(2.61)	(3.16)	(2.62)
MBSF/TAF * QE	-0.001	-0.001	-0.049***	-0.273***	-0.063***	-0.316***
	(-1.58)	(-0.56)	(-3.76)	(-4.34)	(-3.86)	(-4.38)
MBSF/TAF * PostQE1not	0.007***	-0.000	0.158**	0.736	0.197**	0.822
	(2.71)	(-0.03)	(2.26)	(1.57)	(2.23)	(1.55)
VIX	-0.000	0.000	-0.000	0.000	-0.000	0.000
	(-0.25)	(0.86)	(-0.21)	(0.06)	(-0.22)	(0.04)
ΔTWEXB	-0.000	0.003	0.016	0.064	0.020	0.069
	(-0.35)	(1.01)	(0.61)	(0.49)	(0.60)	(0.45)
Term	0.000	0.011***	0.041	-0.383***	0.048	-0.439***
	(0.22)	(2.73)	(1.15)	(-2.77)	(1.08)	(-2.76)
Credit	-0.010	-0.053	-0.700***	-6.019***	-0.916***	-6.901***
	(-0.76)	(-1.62)	(-3.16)	(-5.08)	(-3.31)	(-5.08)
PUI	0.000**	0.000	0.003*	0.019**	0.004*	0.022**
	(2.14)	(1.19)	(1.78)	(2.47)	(1.82)	(2.48)
Constant	0.002***	0.004***	0.068***	0.404***	0.087***	0.465***
	(6.14)	(3.89)	(9.10)	(9.90)	(9.17)	(9.95)
adj. R^2	0.665	0.333	0.774	0.734	0.776	0.740
<u>**Computed from above estimates:**</u>						
Constant + QE	0.001	0.003**	0.041***	0.298***	0.053***	0.343***
	-1.35	(2.19)	(4.05)	(5.66)	(4.20)	(5.68)
Constant + PostQE1not	-0.005**	0.002	-0.093*	-0.439	-0.116*	-0.488
	(-2.54)	(0.19)	(-1.82)	(-1.28)	(-1.79)	(-1.26)
TREASF/TAF + TREASF/TAF * QE	-0.000	-0.003*	-0.023***	-0.242***	-0.031***	-0.278***
	(-0.65)	(-1.93)	(-2.61)	(-4.75)	(-2.79)	(-4.80)
TREASF/TAF + TREASF/TAF * PostQE1not	0.005***	-0.000	0.105**	0.561	0.131**	0.628
	(2.73)	(-0.04)	(2.00)	(1.56)	(1.98)	(1.55)
<u>**Elasticities at the mean:**</u>						
MBSF/TAF *QE	-0.013	-0.009	-0.110	-0.349	-0.126	-0.376
TREASF/TAF +TREASF/TAF *QE	0.000	-0.093	-0.177	-1.062	-0.213	-1.135

Table 3.7. Time-series regression results for effects of Fed's relative-to-$GDP and security-type holdings on differenced hedging performance

This table reports the effects of the relative-to-$GDP and security-type holdings of the U.S. Federal Reserve on the differenced hedging performance of international bond portfolios from the perspective of a U.S. investor. The time dummies (QE and PostQE1not) represent the period of the QE and the post QE1 period where the latter period excludes the QE period launched by the U.S. Fed. Information about each variable is provided in Appendix 3.B. The total number of observations is 558. Robust *t*-statistics are reported in the parentheses based on Newey-West (1987) standard errors with six lags. ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

	Eq (3.4) for differenced hedging performance				Eq (3.5) for differenced hedging performance			
	Optimally Hedged		Fully Hedged		Optimally Hedged		Fully Hedged	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	DM	EM	DM	EM	DM	EM	DM	EM
QE	-1.526**	-2.586***	-0.005	-0.020**	-0.307	-1.387***	-0.002	-0.004
	(-2.44)	(-3.77)	(-0.56)	(-2.43)	(-0.94)	(-3.09)	(-0.55)	(-0.69)
PostQE1not	-4.905***	-6.954***	-0.078***	-0.052**	12.759***	17.093	0.275***	0.295**
	(-4.51)	(-4.46)	(-3.93)	(-2.45)	(3.01)	(1.54)	(4.76)	(2.43)
TREASF/TAF					-2.855***	-3.299***	-0.041***	-0.006
					(-4.24)	(-3.53)	(-4.50)	(-0.56)
TREASF/TAF *QE					1.965***	4.469***	-0.001	0.021**
					(2.74)	(4.92)	(-0.08)	(2.05)
TREASF/TAF *PostQE1not					-10.920**	-14.632	-0.252***	-0.277**
					(-2.55)	(-1.28)	(-4.22)	(-2.20)
MBSF/TA *QE					-3.598***	-4.652***	-0.028*	-0.022
					(-3.35)	(-2.75)	(-1.78)	(-1.17)
MBSF/TAF *PostQE1not					-22.879***	-31.220**	-0.455***	-0.444***
					(-3.84)	(-2.04)	(-5.69)	(-2.67)
TAF/$GDP	1.075	4.704	0.029	0.008				
	(0.39)	(0.97)	(0.63)	(0.16)				
TAF/$GDP*QE	8.479*	11.466*	0.001	0.108				
	(1.84)	(1.86)	(0.02)	(1.64)				
TAF/$GDP*PostQE1not	26.825***	34.643***	0.420***	0.295**				
	(3.87)	(3.20)	(3.36)	(2.07)				
VIX	0.004	-0.040	0.002	-0.001	-0.130	-0.183	0.000	-0.001
	(0.05)	(-0.25)	(1.31)	(-0.91)	(-1.53)	(-1.18)	(0.23)	(-1.10)
ΔTWEXB	-2.292	-2.819	-0.075*	-0.028	-2.754	-3.687	-0.077*	-0.006
	(-1.03)	(-0.56)	(-1.77)	(-0.63)	(-1.21)	(-0.78)	(-1.89)	(-0.15)
Term	13.339***	1.015	0.304***	0.0 29	5.423	-3.450	0.138*	0.061
	(3.12)	(0.17)	(3.72)	(0.36)	(1.26)	(-0.55)	(1.71)	(0.73)
Credit	-18.277***	17.145	-0.460***	0.092	-105.661***	-81.472**	-1.453***	-0.352
	(-2.88)	(1.34)	(-3.59)	(0.74)	(-4.20)	(-2.19)	(-5.17)	(-0.88)
PUI	0.078	0.032	0.005**	0.000	0.011	-0.058	0.004**	0.001
	(0.53)	(0.13)	(2.40)	(0.18)	(0.08)	(-0.28)	(2.03)	(0.30)
Constant	0.565**	0.344	0.013***	0.007*	3.791***	4.320***	0.058***	0.017
	(2.52)	(1.08)	(3.35)	(1.79)	(4.94)	(3.90)	(6.00)	(1.44)
adj. R^2	0.443	0.349	0.281	0.179	0.417	0.308	0.374	0.159
Computed from above estimates:								
Constant + QE	-0.961*	-2.241***	0.009	-0.013**	3.484***	2.933**	0.056***	0.013
	(-1.86)	(-4.35)	(1.25)	(-2.17)	(3.58)	(2.20)	(5.01)	(0.84)
Constant + PostQE1not	-4.340***	-6.610***	-0.065***	-0.045**	16.550***	21.414*	0.333***	0.311**
	(-4.29)	(-4.54)	(-3.46)	(-2.29)	(3.77)	(1.91)	(5.58)	(2.55)
TREASF/TAF +					-0.890	1.170	-0.042***	0.015
TREASF/TAF *QE					(-0.94)	(1.02)	(-3.70)	(1.09)
TREASF/TAF +					-13.775***	-17.931	-0.293***	-0.283**
TREASF/TAF *PostQE1not					(-3.16)	(-1.56)	(-4.83)	(-2.24)
TAF/$GDP + TAF/$GDP	9.554***	16.171***	0.030	0.116***				
*QE	(3.53)	(7.10)	(1.01)	(4.06)				
TAF/$GDP +	27.900***	39.348***	0.449***	0.303**				
TAF/$GDP*PostQE1not	(4.81)	(4.40)	(4.17)	(2.42)				

Table 3.8. Time-series regression results for effects of Fed's longer-maturity security-type holdings on differenced hedging performance

This table reports the effects of security type holdings of the Fed with longer maturities on the differenced hedging performance of international bond portfolios from the perspective of a U.S. investor. The time dummies (QE and PostQE1not) represent the QE period and the post QE1 period where the latter period does not include the QE period launched by the U.S. Federal Reserve. Information about each variable is provided in Appendix 3.B. The total number of observations is 558. Robust *t*-statistics are reported in the parentheses based on Newey-West (1987) standard errors with six lags. ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

	Panel A: Eq. (3.6) (matur = 5 years)				Panel B: Eq. (3.6) (matur = 10 years)			
	Optimally Hedged		Fully Hedged		Optimally Hedged		Fully Hedged	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	DM	EM	DM	EM	DM	EM	DM	EM
QE	0.132	-1.436***	0.015	-0.010**	-0.588	-1.894***	-0.001	-0.013**
	(0.24)	(-2.66)	(1.15)	(-2.07)	(-1.62)	(-3.39)	(-0.12)	(-2.40)
PostQE1not	0.879	-6.381***	0.062***	-0.101***	0.897	-2.469*	0.034**	-0.046***
	(0.90)	(-3.24)	(3.12)	(-5.22)	(1.20)	(-1.82)	(2.45)	(-3.56)
$TREASF_{matur}$/TAF	0.009	-0.046	0.001*	-0.001*	-0.010	-0.074	0.000	-0.001
	(0.27)	(-1.04)	(1.88)	(-1.95)	(-0.17)	(-0.81)	(0.38)	(-1.37)
$TREASF_{matur}$/TAF *QE	0.000	0.079*	-0.001**	0.001**	0.071	0.209**	-0.001	0.002**
	(0.01)	(1.87)	(-2.09)	(2.43)	(1.19)	(2.47)	(-0.73)	(2.54)
$TREASF_{matur}$ /TAF *	0.002	0.171***	-0.001**	0.003***	0.037	0.342***	-0.001	0.005***
PostQE1not	(0.06)	(3.17)	(-2.42)	(5.49)	(0.55)	(2.96)	(-1.06)	(4.96)
$MBSF_{matur}$/TAF *QE	-0.002	-0.009	0.000	-0.000*	-0.000	-0.009	0.000	-0.000**
	(-0.20)	(-0.75)	(1.25)	(-1.86)	(-0.05)	(-0.74)	(1.53)	(-2.06)
$MBSF_{matur}$/TAF *	-0.034**	0.044	-0.001***	0.001***	-0.041***	-0.031**	-0.001***	0.000
PostQE1not	(-2.38)	(1.54)	(-3.34)	(3.57)	(-4.34)	(-2.13)	(-3.88)	(0.10)
VIXrate	0.026	-0.002	0.003*	-0.001	0.017	-0.021	0.003	-0.001
	(0.29)	(-0.02)	(1.69)	(-0.92)	(0.19)	(-0.15)	(1.60)	(-1.14)
ΔTWEXB	0.019	-1.103	-0.025	-0.012	-2.079	-3.772	-0.044	-0.035
	(0.01)	(-0.24)	(-0.63)	(-0.30)	(-0.91)	(-0.86)	(-1.11)	(-0.91)
Term	15.839***	12.403*	0.258***	0.121*	17.530***	14.345**	0.265***	0.154**
	(3.75)	(1.75)	(3.19)	(1.68)	(4.08)	(2.16)	(3.33)	(2.14)
Credit	-38.886**	-15.389	-0.420	-0.389**	-29.470**	-7.885	-0.334	-0.351*
	(-2.48)	(-0.78)	(-1.56)	(-2.01)	(-2.10)	(-0.36)	(-1.44)	(-1.71)
PUI	0.071	0.061	0.004*	0.001	0.101	0.059	0.005**	0.001
	(0.44)	(0.24)	(1.74)	(0.36)	(0.64)	(0.24)	(2.31)	(0.27)
Constant	0.713	1.885**	-0.003	0.026***	0.886	1.750*	0.010	0.024***
	(1.22)	(2.22)	(-0.33)	(3.53)	(1.32)	(1.71)	(0.92)	(2.60)
adj. R^2	0.322	0.294	0.333	0.266	0.372	0.375	0.292	0.319
Computed from above estimates:								
Constant + QE	0.845*	0.449	0.013	0.015**	0.298	-0.144	0.009	0.011*
	(1.67)	(0.70)	(1.37)	(2.57)	(0.64)	(-0.20)	(1.14)	(1.68)
Constant + PostQE1not	1.592**	-4.497**	0.059***	-0.076***	1.783***	-0.719	0.044***	-0.022**
	(2.01)	(-2.56)	(3.37)	(-4.22)	(3.93)	(-0.74)	(4.39)	(-2.23)
$TREASF_{matur}$/TAF+	0.009	0.033***	-0.000*	0.000	0.061**	0.135***	-0.000	0.001***
$TREASF_{matur}$/TAF*QE	(1.14)	(3.18)	(-1.69)	(1.39)	(2.52)	(4.87)	(-0.97)	(3.05)
$TREASF_{matur}$/TAF +$TREASF_{matur}$/TAF *	0.011	0.125***	-0.000	0.002***	0.027	0.268***	-0.001	0.004***
PostQE1not	(0.90)	(4.48)	(-1.52)	(6.75)	(1.14)	(4.41)	(-1.42)	(6.99)

Table 3.9. Time-series regression results for the effects of security type holdings of the Fed on the individual Sharpe ratios included in the measure of differenced hedging performance

This table reports the effects using regression (3.4) of the security type holdings of the Fed on the individual Sharpe ratios included in computing the differenced hedging performance of international bond portfolios from the perspective of a U.S. investor. These are the Sharpe ratios for the optimally hedged, fully hedged, and unhedged portfolios. The time dummies (QE and PostQE1not) represent the QE period and the post QE1 period where the latter period excludes the QE period launched by the U.S. Federal Reserve. Information about each variable is provided in Appendix 3.B. The total number of observations is 558. Robust *t*-statistics are reported in the parentheses based on Newey-West (1987) standard errors with six lags. ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

	Optimally Hedged		Fully Hedged		Not Hedged	
	(1)	(2)	(3)	(4)	(5)	(6)
	DM	EM	DM	EM	DM	EM
QE	0.366	-0.728	0.671***	0.656***	0.673***	0.659***
	(1.10)	(-1.30)	(2.90)	(2.75)	(2.91)	(2.81)
PostQE1not	14.312***	18.871	1.827	2.072	1.552	1.777
	(2.80)	(1.41)	(0.95)	(0.70)	(0.83)	(0.62)
TREASF/TAF	-1.017*	-0.989	1.797***	2.304***	1.838***	2.309***
	(-1.73)	(-0.97)	(5.50)	(6.40)	(5.59)	(6.48)
TREASF/TAF *QE	0.234	2.890***	-1.731***	-1.558***	-1.730***	-1.579***
	(0.37)	(2.84)	(-4.94)	(-5.00)	(-4.93)	(-5.13)
TREASF/TAF *PostQE1not	-13.322**	-17.304	-2.653	-2.949	-2.402	-2.672
	(-2.57)	(-1.26)	(-1.36)	(-0.97)	(-1.26)	(-0.91)
MBSF/TAF *QE	-1.794*	-2.833	1.776***	1.798***	1.804***	1.819***
	(-1.91)	(-1.58)	(3.31)	(3.63)	(3.35)	(3.70)
MBSF/TAF *PostQE1not	-22.547***	-31.047*	-0.123	-0.271	0.332	0.173
	(-3.17)	(-1.68)	(-0.05)	(-0.07)	(0.13)	(0.04)
VIX	-0.004	-0.081	0.127***	0.101**	0.126***	0.102**
	(-0.05)	(-0.49)	(2.60)	(2.05)	(2.61)	(2.10)
ΔTWEXB	-0.766	-1.055	1.911	2.626*	1.988	2.632*
	(-0.36)	(-0.21)	(1.26)	(1.80)	(1.31)	(1.83)
Term	7.970*	1.017	2.685	4.529	2.547	4.468
	(1.65)	(0.13)	(1.06)	(1.29)	(1.00)	(1.29)
Credit	-59.422***	-28.017	44.786***	53.102***	46.239***	53.455***
	(-2.75)	(-0.72)	(4.48)	(5.85)	(4.62)	(5.98)
PUI	0.048	-0.101	0.042	-0.043	0.038	-0.043
	(0.40)	(-0.45)	(0.64)	(-0.73)	(0.58)	(-0.75)
Constant	1.958***	2.134*	-1.775***	-2.170***	-1.832***	-2.187***
	(3.08)	(1.82)	(-5.25)	(-6.33)	(-5.39)	(-6.44)
adj. R^2	0.281	0.192	0.352	0.419	0.363	0.429
<u>Computed from above estimates:</u>						
Constant + QE	2.324***	1.405	-1.104**	-1.514***	-1.159***	-1.527***
	(2.71)	(0.98)	(-2.49)	(-3.55)	(-2.61)	(-3.63)
Constant + PostQE1not	16.270***	21.004	0.053	-0.098	-0.280	-0.409
	(3.11)	(1.56)	(0.03)	(-0.03)	(-0.14)	(-0.14)
TREASF/TAF +TREASF/TAF *QE	-0.782	1.900	0.066	0.746*	0.108	0.730*
	(-0.94)	(1.46)	(0.14)	(1.70)	(0.23)	(1.69)
TREASF/TAF + TREASF/TAF *PostQE1not	-14.339***	-18.294	-0.857	-0.646	-0.564	-0.363
	(-2.73)	(-1.32)	(-0.43)	(-0.21)	(-0.29)	(-0.12)

Table 3.10. Time-series regression results for the effects of security type holdings of the Fed on the excess return of the individual Sharpe ratios

This table reports the effects of the security type holdings of the Fed on the excess returns of international bond portfolios from the perspective of a U.S. investor. The excess returns are for the optimally hedged, fully hedged, and not hedged portfolios. The time dummies (QE and PostQE1not) represent the QE period and the post QE1 period where the latter period excludes the QE period launched by the U.S. Federal Reserve. Information about each variable is provided in Appendix 3.B. The total number of observations is 558. Robust *t*-statistics are reported in the parentheses based on Newey-West (1987) standard errors with six lags. ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

	Optimally Hedged		Fully Hedged		Not hedged	
	(1)	(2)	(3)	(4)	(5)	(6)
	DM	EM	DM	EM	DM	EM
QE	-0.006*	-0.053***	0.065***	0.120**	0.075***	0.133**
	(-1.65)	(-5.33)	(2.68)	(2.41)	(2.73)	(2.46)
PostQE1not	0.076	0.422*	0.181	0.775*	0.190	0.777*
	(1.42)	(1.94)	(1.34)	(1.81)	(1.27)	(1.73)
TREASF/TAF	-0.039***	-0.072***	0.181***	0.385***	0.211***	0.423***
	(-4.93)	(-3.20)	(5.92)	(6.53)	(6.07)	(6.65)
TREASF/TAF *QE	0.013**	0.081***	-0.139***	-0.245***	-0.157***	-0.269***
	(2.11)	(5.55)	(-4.64)	(-4.50)	(-4.65)	(-4.55)
TREASF/TAF *PostQE1not	-0.059	-0.389*	-0.263*	-0.940**	-0.286*	-0.957**
	(-1.10)	(-1.73)	(-1.91)	(-2.14)	(-1.87)	(-2.07)
MBSF/TAF *QE	-0.040***	-0.050*	0.142***	0.280***	0.163***	0.307***
	(-3.87)	(-1.76)	(3.13)	(3.16)	(3.19)	(3.21)
MBSF/TAF *PostQE1not	-0.170**	-0.743**	-0.008	-0.605	0.019	-0.559
	(-2.28)	(-2.48)	(-0.05)	(-1.04)	(0.09)	(-0.92)
VIX	-0.000	-0.000	0.012***	0.019***	0.013***	0.021***
	(-0.16)	(-0.14)	(2.87)	(2.61)	(2.88)	(2.65)
ΔTWEXB	-0.024	0.007	0.218*	0.583***	0.252*	0.625***
	(-0.86)	(0.08)	(1.78)	(2.90)	(1.84)	(2.88)
Term	0.071	0.244*	0.484**	1.032***	0.531**	1.106***
	(1.44)	(1.80)	(2.40)	(2.85)	(2.36)	(2.87)
Credit	-0.967***	-0.700	4.157***	8.716***	4.834***	9.528***
	(-3.95)	(-1.14)	(4.99)	(5.17)	(5.13)	(5.27)
PUI	0.002*	0.002	0.001	-0.015	0.001	-0.016
	(1.77)	(0.67)	(0.23)	(-1.54)	(0.12)	(-1.59)
Constant	0.050***	0.089***	-0.178***	-0.377***	-0.209***	-0.415***
	(5.93)	(3.78)	(-5.82)	(-6.31)	(-6.01)	(-6.45)
adj. R^2	0.401	0.473	0.463	0.554	0.478	0.563
<u>Computed from above estimates:</u>						
Constant + QE	0.044***	0.036	-0.113***	-0.257***	-0.133***	-0.283***
	(4.45)	(1.46)	(-2.98)	(-3.46)	(-3.11)	(-3.53)
Constant + PostQE1not	0.125**	0.510**	0.003	0.399	-0.018	0.362
	(2.28)	(2.33)	-0.02	-0.94	(-0.12)	(0.82)
TREASF/TAF +TREASF/TAF *QE	-0.027***	0.009	0.043	0.140**	0.054	0.154**
	(-2.84)	(0.39)	-1.18	-2.23	(1.31)	(2.29)
TREASF/TAF + TREASF/TAF *PostQE1not	-0.098*	-0.462**	-0.082	-0.555	-0.075	-0.534
	(-1.79)	(-2.05)	(-0.59)	(-1.28)	(-0.49)	(-1.17)

Table 3.11. Time-series regression results for the effects of security types holdings by the Fed on relative hedging effectiveness (differential hedging performance) with non-U.S. QE implementers excluded

This table reports the effects of the security type holdings by the Fed on the relative hedging effectiveness or differential hedging performance of international bond portfolios from the perspective of a U.S. investor. The regressions using forwards contracts and portfolio formation and evaluation rolling windows each consisting of 24 weeks are for a sample that excludes the non-U.S. QE implementers of Japan, U.K. and 11 euro zone members. The time dummies (QE and PostQE1not) represent the period of QE and the post QE1 period where the latter period excludes the QE period launched by the U.S. Federal Reserve. Information about each variable is provided in Appendix 3.B. The total number of observations is 558. Robust *t*-statistics are reported in the parentheses based on Newey-West (1987) standard errors with six lags. ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

	Hedging Effectiveness [eq. (3.4)]				Hedging Performance [eq. (3.5)]			
	Optimal Hedged		Fully Hedged		Optimal Hedged		Fully Hedged	
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	DM	EM	DM	EM	DM	EM	DM	EM
QE	0.045	0.018***	0.081***	0.021**	-0.267	-0.603	-0.002	-0.003
	(1.39)	(2.82)	(3.26)	(1.97)	(-1.29)	(-1.50)	(-0.30)	(-0.55)
PostQE1not	-0.284	-0.283**	-0.101	0.098	6.554**	2.067	0.418***	0.249**
	(-1.37)	(-2.53)	(-0.45)	(0.78)	(2.21)	(0.47)	(3.41)	(2.06)
TREASF/TA	-0.109**	-0.095***	-0.085***	-0.041**	-3.404***	-3.404***	-0.064***	-0.006
	(-2.46)	(-4.65)	(-2.75)	(-2.49)	(-6.45)	(-4.44)	(-3.85)	(-0.54)
TREASF/TA *QE	-0.054	-0.055***	-0.169***	-0.075***	1.364***	0.411	-0.008	0.012
	(-1.25)	(-4.31)	(-3.56)	(-3.90)	(2.75)	(0.40)	(-0.46)	(1.01)
TREASF/TA *PostQE1not	0.278	0.300***	0.212	-0.044	-5.417*	1.042	-0.387***	-0.222*
	(1.29)	(2.61)	(0.93)	(-0.34)	(-1.75)	(0.23)	(-3.08)	(-1.79)
MBSF/TA *QE	-0.169**	-0.012	-0.039	0.017	-3.621***	-0.203	-0.031	-0.003
	(-2.09)	(-0.54)	(-0.63)	(0.60)	(-4.33)	(-0.14)	(-1.03)	(-0.13)
MBSF/TA *PostQE1not	0.362	0.356**	0.036	-0.198	-13.541***	-9.210	-0.685***	-0.384**
	(1.26)	(2.30)	(0.12)	(-1.13)	(-3.30)	(-1.48)	(-4.06)	(-2.30)
VIX	0.003	-0.000	0.005	-0.000	-0.097	-0.089	0.001	-0.001
	(0.47)	(-0.05)	(1.11)	(-0.20)	(-1.25)	(-0.61)	(0.40)	(-0.93)
ΔTWEXB	0.487***	0.012	-0.147	-0.186***	-1.430	-1.732	-0.121	-0.013
	(2.87)	(0.18)	(-1.11)	(-2.69)	(-0.71)	(-0.47)	(-1.48)	(-0.26)
Term	-0.351	-0.832***	-0.408	-0.165	1.055	-3.712	0.185	0.060
	(-0.90)	(-3.13)	(-1.64)	(-1.20)	(0.32)	(-0.55)	(1.26)	(0.57)
Credit	-4.005**	-1.839***	-1.740	-0.260	-106.683***	-87.714***	-2.315***	-0.283
	(-2.35)	(-4.41)	(-1.24)	(-0.44)	(-6.17)	(-3.29)	(-4.47)	(-0.64)
PUI	0.002	0.002	0.015**	0.001	0.125	-0.030	0.009**	0.001
	(0.27)	(0.48)	(1.98)	(0.37)	(1.23)	(-0.17)	(2.03)	(0.25)
Constant	1.076***	1.066***	0.365***	0.193***	4.078***	4.330***	0.091***	0.018
	(22.98)	(64.16)	(9.68)	(10.68)	(6.98)	(5.11)	(5.26)	(1.34)
adj. R^2	0.129	0.3829	0.434	0.467	0.444	0.363	0.316	0.168
<u>Computed from above estimates:</u>								
Constant + QE	1.121***	1.084***	0.446***	0.214***	3.811***	3.726***	0.089***	0.014
	(15.74)	(52.31)	(7.62)	(8.82)	(5.89)	(3.42)	(4.24)	(0.85)
Constant + PostQE1not	0.792***	0.783***	0.264	0.291**	10.631***	6.397	0.509***	0.267**
	(3.68)	(6.95)	(1.13)	(2.25)	(3.44)	(1.39)	(4.05)	(2.18)
TREASF/TA +TREASF/TA *QE	-0.163**	-0.150***	-0.255***	-0.116***	-2.040***	-2.992**	-0.072***	0.005
	(-2.45)	(-6.11)	(-3.83)	(-4.31)	(-3.50)	(-2.36)	(-3.26)	(0.34)
TREASF/TA + TREASF/TA *PostQE1not	0.169	0.205*	0.127	-0.085	-8.821***	-2.362	-0.451***	-0.229*
	(0.78)	(1.78)	(0.54)	(-0.65)	(-2.79)	(-0.51)	(-3.53)	(-1.83)

Appendix 4.A. Country categories

The countries or regions categories are based on the IMF or World Bank. [50]

	Asia-Pacific region	Euro region	Latin area	North America Free Trade Agreement Countries (NAFTA)
DM	Australia, Japan, New Zealand, Singapore	Austria, Belgium, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal, Spain, Denmark, Sweden, United Kingdom		Canada, United States
EM	India, South Korea, Thailand	Czech Republic, Greece, Hungary, Poland	Brazil, Chile, Colombia, Mexico	Mexico

[50] https://www.imf.org/external/pubs/ft/weo/2017/01/weodata/groups.htm
http://www.worldbank.org/en/about/annual-report/regions

Appendix 4.B. Variable descriptions

This appendix provides the definitions and the data sources for the time dummy variables, various macro-variables, and control variables. The differential value for a macro-variable is equal to it value for the US minus its value for a non-U.S. country or weighted-average for a group of countries.

Time Dummies

QE1, QE2, and QE3 – Correspond to the three rounds of U.S. QEs to control for the different effects of the three QEs. Each dummy variable takes the value of one for the time period during which the Fed undertook QE1 (or QE2 or QE3) and zero otherwise The QE1, QE2, and QE3 are from Nov. 25, 2008 - Mar. 31, 2010, Nov. 3, 2010 - June 30, 2011, and Sept. 13, 2012 to Oct. 29, 2014, respectively.

$\boldsymbol{BearNonQE}$ – Equal to 1 for each bear market week during the non-QE period and 0 otherwise. The time periods for bear markets is based on Gold-Eagle. http://www.gold-eagle.com/article/history-us-bear-bull-markets-1929. The U.S. bear markets are Oct. 9, 2007 to Nov 20, 2008 and Jan. 6, 2009 to Mar. 9, 2009 in our sample period. Alternative bear market period based on NBC News is from Oct. 2007 to Mar. 2009.

$\boldsymbol{BearQE1}$ – Equal to 1 for each bear market week during QE1 and 0 otherwise.

$\boldsymbol{CrisisGlobalNonQE}$ – Equal to 1 for a global financial crisis week during the non-QE period and 0 otherwise based on Lehkonen (2015). Since the starting date of the global financial crisis may differ, we have two global financial crisis periods of 8/2007-6/2009 and 9/2008-6/2009.

$\boldsymbol{CrisisGlobalQE1}$ – Equal to 1 for a global financial crisis week during QE1 and 0 otherwise

$\boldsymbol{RecessionUSNonQE}$ – Equal to 1 for a U.S. recession week during the non-QE period and 0 otherwise. The U.S. recession period is based on NBER of 12/2007-6/2009.

$\boldsymbol{RecessionUSQE1}$– Equal to 1 for a U.S. recession week during QE1 and 0 otherwise.

Macro-variables

Credit or default spread – Difference between the average bond yield on Moody's Baa and the average bond yield on Moody's Aaa. Data source: Datastream.

Cross-border bank-to-bank liabilities – Cross-border bank-to-bank debt liabilities as percentage of GDP of the recipient economy. Data source: BIS locational banking statistics. Frequency: Quarter

Cross-border banking flows – The log difference of cross-border loans of BIS-reporting banks on banking sector counterparties, as measured by the difference between total borrowers and non-bank borrowers from the BIS Locational Banking Statistics. Data source: BIS Locational banking statistics. Frequency: Quarter

Cumulative net purchase of securities – Cumulative net purchase of securities through permanent open market operations or the size of U.S. Treasury securities, agency securities, and mortgage-backed securities holdings on the Fed's balance sheet. Data source: FRED

Differential inflation rate – Absolute difference in inflation rates between local and U.S. changes in consumer prices. Data source: IFS. Frequency: quarterly.

Differential growth potential – Absolute difference in local and U.S. real GDP growth rate. Data source: IFS. Frequency: Quarterly.

Differential interest rate – Absolute difference in local and U.S. real interest rates. Data source: IFS. Frequency: Quarterly.

Fluctuations in expectations of the world business cycle - World market dividend yield in excess of the 30-day Eurodollar rate. Data source: Datastream and FRED.

Money supply – The U.S. broad money supply (M2) growth rate. Data source: FRED.

Portfolio flows (bond or equity) – Cross-border bond or equity flows (%GDP). Data source: IFS. Frequency: Quarterly.

Term structure spread – Average yield of 10-year government bonds minus average yield of 3-month government T-bills. Data source: FRED.

Three-month treasury bill – Rate of the 3-month U.S. Treasury bill. Data source: FRED.

VIX index – VIX option volatility index. Available from: Chicago Board Option Exchange, www.cboe.com or Datastream.

Control variables

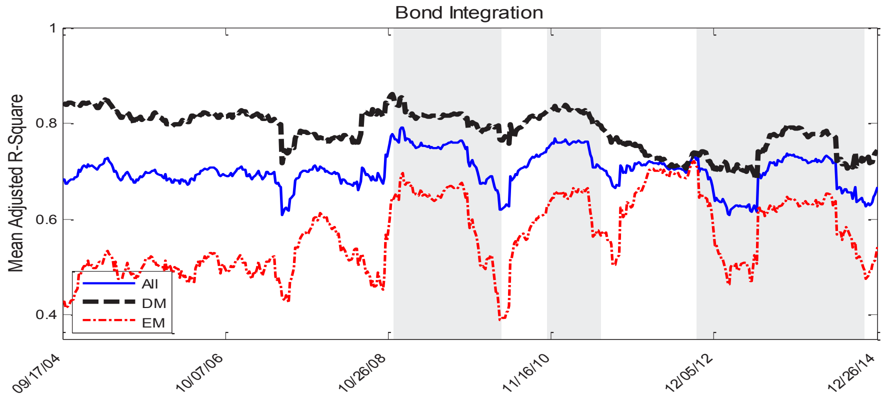
Market capitalization of listed companies to GDP – Equity market capitalization divided by gross domestic product. Annual frequency from: World Bank Development Indicators and FRED.

Market openness – Country's foreign equity assets & liabilities and foreign direct investment assets &liabilities as a share of GDP. Data available in: External Wealth of Nations Mark II database.
http://www.imf.org/external/pubs/cat/longres.aspx?sk=18942.0
Total value of stock traded to GDP – Equity market value traded divided by gross domestic product. Data source: World Bank Development Indicators. Available at:
http://data.worldbank.org/indicator/CM.MKT.TRAD.GD.ZS Frequency: Annual.
Trade openness – Exports plus imports over GDP for each country. Data source: World Bank Development.
Index of Economic Freedom – measures the impact of liberty and free markets around the globe. Available at: http://www.heritage.org/index/explore
Legal rights – the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending. The old index ranges from 0 to 10 but the new index ranges from 0 to 12 with higher scores indicating that collateral and bankruptcy laws are better designed to expand access to credit. Data for 2003-2009 are available at
https://www.arcgis.com/home/item.html?id=8abb6dc44b924c66a077db2823ec3ac3
Data for 2010-2012 are available at http://www.doingbusiness.org/Custom-Query or
http://www.doingbusiness.org/data/data%20revisions
Data for 2013-2014 are available at http://data.worldbank.org/indicator/IC.LGL.CRED.XQ
Private credit to GDP – This variable is not only a well-documented measure of financial development (King & Levine, 1993; Beck, Demirgüç-Kunt & Levine, 2010; Claessens & Laeven, 2003; Djankov, McLiesh, & Shleifer, 2007) but it also increases with the power of creditors (Djankov, McLiesh, & Shleifer, 2007). Data source: World bank. Available at: http://data.worldbank.org/indicator/FS.AST.PRVT.GD.ZS Frequency: Annual.
Business cycle variation – World market dividend yield in excess of the 30-day Eurodollar rate. Data source: Datastream and FRED.

Figure 4.1. Weekly level of international market integration for country-level bond and stock indexes

Panels A and B depict the weekly level of market integration before QE1 (September 2003 to October 2008), QE1 (November 2008 to March 2010), QE2 (November 2010 to June 2011), and QE3 (September 2012 to October 2014) for the 31 countries (and the 19 DM and 12 EM countries) for bond indexes in the upper panel and stock indexes in the lower panel. The adjusted R-square is obtained from equation (4.1), which measures market integration.

Panel A: Bond integration levels



Panel B: Stock integration levels

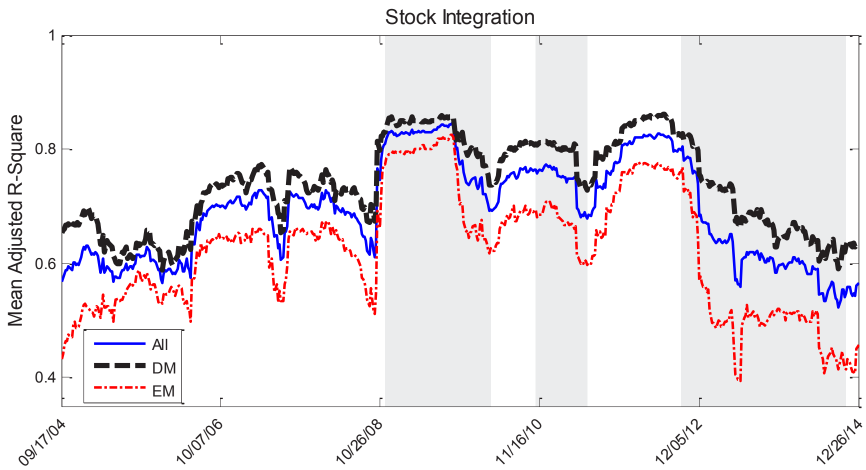


Table 4.1. Annual level of bond integration

This table presents the adjusted R-square values for the international bond country-level indexes annually for each country. The 31 countries are the developed countries of Australia (AU), 11 developed markets from Eurozone [Austria (AT), Belgium (BE), Finland (FI), France (FR), Germany (DE), Ireland (IE), Italy (IT), Netherlands (NL), Portugal (PT), and Spain (ES)], Canada (CA), Denmark (DK), Japan (JP), New Zealand (NZ), Singapore (SG), Sweden (SE), United Kingdom (UK), and the United States (US), and the developing countries of Brazil (BR), Chile (CL), Colombia (CO), Czech Republic (CZ), Greece (GR), Hungary (HU), India (IN), Mexico (MX), Poland (PL), South Africa (ZA), South Korea (SR), and Thailand (TH).

Year	Australia	Austria	Belgium	Finland	France	Germany	Ireland	Italy	Netherlands	Portugal	Spain	Canada	Denmark	Japan	New Zealand	Singapore
2005	0.75	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.34	0.99	0.43	0.57	0.57
2006	0.63	0.99	0.99	0.99	0.99	0.99	0.97	0.99	0.99	0.99	0.99	0.39	0.99	0.73	0.18	0.63
2007	0.76	0.93	0.93	0.15	0.93	0.93	0.89	0.93	0.93	0.93	0.93	0.17	0.93	0.69	0.54	0.24
2008	0.85	0.99	0.99	0.97	0.99	0.99	0.96	0.99	0.99	0.99	0.98	0.71	0.98	0.63	0.83	0.60
2009	0.68	0.98	0.98	0.98	0.98	0.97	0.92	0.96	0.98	0.97	0.98	0.45	0.96	0.22	0.66	0.60
2010	0.80	0.89	0.91	0.87	0.88	0.86	0.82	0.94	0.86	0.79	0.96	0.67	0.86	0.40	0.56	0.79
2011	0.77	0.95	0.87	0.95	0.97	0.92	0.61	0.88	0.96	0.62	0.86	0.70	0.89	0.20	0.56	0.80
2012	0.59	0.93	0.88	0.94	0.94	0.92	0.79	0.84	0.94	0.25	0.80	0.44	0.92	0.13	0.52	0.72
2013	0.67	0.98	0.97	0.98	0.98	0.97	0.93	0.83	0.98	0.47	0.86	0.59	0.96	0.32	0.60	0.54
2014	0.60	0.95	0.95	0.95	0.94	0.94	0.95	0.89	0.95	0.56	0.89	0.44	0.94	0.39	0.55	0.75

Year	Sweden	United Kingdom	United States	Brazil	Chile	Colombia	Czech Republic	Greece	Hungary	India	Mexico	Poland	South Africa	South Korea	Thailand
2005	0.86	0.63	0.06	0.36	0.44	0.25	0.83	0.99	0.65	0.13	0.29	0.54	0.55	0.37	0.43
2006	0.86	0.83	0.28	0.28	0.15	0.47	0.83	0.99	0.68	0.16	0.37	0.82	0.39	0.35	0.21
2007	0.77	0.47	0.54	0.63	0.37	0.67	0.65	0.93	0.82	0.42	0.52	0.78	0.48	0.46	-0.04
2008	0.73	0.62	0.14	0.76	0.62	0.41	0.77	0.96	0.80	0.16	0.82	0.84	0.63	0.53	0.00
2009	0.68	0.33	0.24	0.56	0.01	0.26	0.78	0.90	0.69	0.21	0.33	0.62	0.42	0.29	0.49
2010	0.80	0.41	0.42	0.60	0.31	0.54	0.82	0.44	0.84	0.71	0.59	0.93	0.77	0.56	0.15
2011	0.70	0.43	0.34	0.77	0.64	0.30	0.76	0.48	0.72	0.60	0.74	0.80	0.69	0.69	0.46
2012	0.53	0.53	0.30	0.26	0.63	0.32	0.84	0.42	0.70	0.22	0.55	0.89	0.41	0.32	0.40
2013	0.73	0.61	0.38	0.69	0.53	0.77	0.70	0.94	0.67	0.33	0.77	0.81	0.58	0.22	0.35
2014	0.57	0.51	0.48	0.44	0.30	0.38	0.85	0.94	0.52	0.12	0.56	0.70	0.57	0.10	0.13

Table 4.2. Annual level of stock integration

This table presents the adjusted R-square values for the international stock country-level indexes annually for each country. The 31 countries are the developed countries of Australia (AU), 11 developed markets from Eurozone [Austria (AT), Belgium (BE), Finland (FI), France (FR), Germany (DE), Ireland (IE), Italy (IT), Netherlands (NL), Portugal (PT), and Spain (ES)], Canada (CA), Denmark (DK), Japan (JP), New Zealand (NZ), Singapore (SG), Sweden (SE), United Kingdom (UK), and the United States (US), and the developing countries of Brazil (BR), Chile (CL), Colombia (CO), Czech Republic (CZ), Greece (GR), Hungary (HU), India (IN), Mexico (MX), Poland (PL), South Africa (ZA), South Korea (SR), and Thailand (TH).

Year	Australia	Austria	Belgium	Finland	France	Germany	Ireland	Italy	Netherlands	Portugal	Spain	Canada	Denmark	Japan	New Zealand	Singapore
2005	0.40	0.66	0.72	0.45	0.86	0.70	0.34	0.76	0.70	0.51	0.69	0.57	0.49	0.23	0.32	0.10
2006	0.56	0.84	0.86	0.61	0.86	0.86	0.73	0.85	0.78	0.57	0.80	0.53	0.74	0.60	0.06	0.63
2007	0.80	0.78	0.79	0.64	0.91	0.88	0.59	0.80	0.81	0.54	0.58	0.64	0.76	0.45	0.64	0.66
2008	0.88	0.82	0.69	0.69	0.92	0.95	0.52	0.89	0.88	0.75	0.87	0.84	0.90	0.62	0.79	0.82
2009	0.79	0.80	0.84	0.76	0.95	0.91	0.48	0.92	0.92	0.79	0.91	0.85	0.75	0.40	0.60	0.64
2010	0.84	0.79	0.88	0.73	0.95	0.92	0.60	0.90	0.92	0.81	0.83	0.84	0.80	0.49	0.69	0.72
2011	0.87	0.88	0.83	0.86	0.97	0.89	0.88	0.95	0.93	0.84	0.89	0.86	0.74	0.40	0.49	0.84
2012	0.61	0.87	0.74	0.75	0.95	0.90	0.61	0.92	0.86	0.53	0.77	0.77	0.49	0.46	0.46	0.69
2013	0.58	0.71	0.67	0.53	0.91	0.79	0.52	0.79	0.86	0.65	0.76	0.59	0.46	0.18	0.34	0.61
2014	0.30	0.67	0.71	0.77	0.87	0.77	0.59	0.80	0.75	0.61	0.76	0.70	0.56	0.20	0.10	0.27

Year	Sweden	United Kingdom	United States	Brazil	Chile	Colombia	Czech Republic	Greece	Hungary	India	Mexico	Poland	South Africa	South Korea	Thailand
2005	0.77	0.73	0.66	0.60	0.32	0.11	0.51	0.60	0.50	0.30	0.66	0.58	0.68	0.46	-0.01
2006	0.80	0.84	0.66	0.74	0.70	0.47	0.69	0.51	0.76	0.29	0.69	0.79	0.58	0.49	0.38
2007	0.75	0.91	0.65	0.84	0.49	0.48	0.63	0.68	0.64	0.44	0.73	0.61	0.75	0.76	0.26
2008	0.87	0.92	0.76	0.88	0.52	0.63	0.87	0.74	0.78	0.50	0.87	0.82	0.81	0.62	0.45
2009	0.80	0.87	0.82	0.70	0.49	0.49	0.62	0.68	0.74	0.55	0.74	0.61	0.85	0.53	0.48
2010	0.84	0.86	0.84	0.81	0.51	0.51	0.73	0.60	0.81	0.77	0.81	0.82	0.75	0.82	0.18
2011	0.92	0.91	0.75	0.90	0.73	0.49	0.70	0.55	0.72	0.70	0.86	0.87	0.79	0.77	0.65
2012	0.82	0.89	0.81	0.69	0.66	0.26	0.58	0.30	0.64	0.37	0.63	0.83	0.44	0.51	0.44
2013	0.76	0.80	0.53	0.64	0.46	0.43	0.37	0.30	0.18	0.37	0.50	0.41	0.64	0.22	0.49
2014	0.56	0.74	0.60	0.34	0.53	0.61	0.09	0.60	0.18	0.45	0.48	0.40	0.62	0.42	0.21

Table 4.3. Time trend and summary statistics for market integration

This table reports the coefficient of the time trend in a regression of the adjusted R-square values on a constant and a time trend (Panel A) assuming no structural breaks and summary statistics for the equal- and GDP-weighted averages of the country-level integration estimates for bond and stock markets across All, DM and EM countries (Panel B). The sample consists of 537 observations. The coefficients (*Coeff*) are multiplied by 10,000 in Panel A.

Panel A: Time trend of market integration

DM	Bond Markets		Stock Markets			Bond Markets		Stock Markets	
Countries	*Coeff*	*t-stat*	*Coeff*	*t-stat*	**EM Countries**	*Coeff*	*t-stat*	*Coeff*	*t-stat*
Australia	-0.57	-2.16	-0.54	-1.43	Brazil	4.61	10.30	0.17	0.57
Eurozone					Chile	4.53	10.40	0.86	2.55
Austria	-0.89	-27.32	0.98	4.22	Colombia	5.12	12.98	0.92	2.21
Belgium	-1.59	-17.85	-1.88	-8.88	Czech Republic	-0.30	-1.82	-3.02	-6.92
Finland	1.79	3.19	4.58	16.74	Greece	-5.18	-13.51	0.22	0.66
France	-0.86	-33.67	1.22	11.71	Hungary	2.72	10.41	-3.55	-8.48
Germany	-1.32	-25.83	0.15	0.96	India	6.66	15.01	3.41	8.65
Ireland	-3.52	-18.00	2.07	5.39	Mexico	6.73	16.64	-2.13	-5.85
Italy	-3.45	-41.55	1.26	6.10	Poland	2.88	13.39	-1.39	-3.94
Netherlands	-0.94	-30.26	1.72	10.60	South Africa	2.10	7.42	-0.43	-1.18
Portugal	-11.30	-37.53	3.16	9.81	South Korea	0.91	1.97	-1.40	-3.38
Spain	-3.76	-35.50	0.28	1.33	Thailand	-0.04	-0.08	1.09	2.78
Canada	4.88	10.60	2.08	5.94					
Denmark	-1.37	-21.58	-1.26	-3.73					
Japan	-7.99	-20.56	-4.00	-10.90					
New Zealand	-0.24	-0.65	2.27	4.19					
Singapore	3.55	10.11	3.13	9.01					
Sweden	-5.66	-26.08	0.74	3.21					
UK	-3.99	-11.68	1.10	5.78					
US	2.87	6.09	-0.05	-0.18					

Panel B: Summary statistics for market integration

	Equal-weighted						GDP-weighted					
	Bond Markets			Stock Markets			Bond Markets			Stock Markets		
Summary Statistics	All	DM	EM	All	DM	EM	All	DM	EM	All	DM	EM
Mean	0.70	0.79	0.57	0.69	0.74	0.62	0.57	0.48	0.08	0.72	0.61	0.10
Median	0.70	0.80	0.56	0.70	0.74	0.64	0.56	0.49	0.09	0.73	0.62	0.10
Std. dev.	0.04	0.04	0.08	0.09	0.08	0.11	0.07	0.07	0.02	0.08	0.06	0.02
25^{th} Pctl.	0.68	0.76	0.50	0.61	0.67	0.52	0.52	0.43	0.06	0.65	0.57	0.09
75^{th} Pctl.	0.72	0.82	0.64	0.76	0.81	0.69	0.62	0.53	0.10	0.79	0.66	0.12

Table 4.4. Market integration during the three QE periods without/with controlling for bear markets

This table reports the relationship between the bond or stock market integration level and the three rounds of QE periods without/with controlling for the U.S. bear market. The bear market is defined to be from Oct. 9, 2007 to Nov 20, 2008, and Jan. 6, 2009 to Mar. 9, 2009. Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

Panel A: Integration without controls for U.S. bear and bull markets

	Bond Markets			Stock Markets		
	(1)	(2)	(3)	(4)	(5)	(6)
	All	DM	EM	All	DM	EM
QE1	0.013**	0.015**	0.004	0.047***	0.042***	0.056***
	(2.08)	(2.21)	(0.40)	(10.85)	(8.17)	(7.13)
QE2	0.057***	0.049***	0.077***	0.001	0.004	-0.003
	(11.20)	(8.68)	(9.05)	(0.36)	(1.05)	(-0.46)
QE3	0.006	0.011*	0.004	-0.025***	-0.024***	-0.030***
	(1.05)	(1.77)	(0.42)	(-6.51)	(-5.24)	(-4.25)
MktCap_GDP	0.001***	-0.001***	0.001***	0.000***	0.000***	0.000*
	(12.79)	(-7.58)	(10.20)	(3.73)	(3.67)	(1.92)
MktOpen	-0.005**	0.011***	0.038***	0.005***	0.000	-0.023***
	(-2.56)	(5.91)	(7.00)	(4.12)	(0.25)	(-5.39)
TotalValueGDP	0.000***	0.000	0.001***	-0.000***	-0.000***	0.001***
	(6.56)	(0.03)	(8.41)	(-4.03)	(-4.56)	(4.05)
TradeOpenGDP	-0.001***	-0.004***	-0.000	-0.001***	-0.000***	-0.001***
	(-8.40)	(-24.43)	(-0.76)	(-10.21)	(-3.71)	(-5.09)
EconFree	0.001	0.000	-0.006***	-0.007***	-0.007***	-0.003***
	(0.97)	(0.51)	(-5.33)	(-14.44)	(-10.75)	(-2.97)
LegalRights	0.013***	0.007***	0.038***	-0.003**	-0.005***	0.001
	(8.34)	(4.15)	(12.36)	(-2.26)	(-4.26)	(0.49)
PrivateCredit	-0.001***	-0.002***	-0.004***	-0.000	-0.000	0.001***
	(-8.33)	(-17.22)	(-13.86)	(-0.93)	(-0.63)	(4.86)
BusinessCycleVariation	-0.012***	-0.003	-0.025***	-0.027***	-0.021***	-0.036***
	(-5.54)	(-1.11)	(-7.17)	(-17.77)	(-11.83)	(-13.07)
Constant	0.607***	1.109***	0.813***	1.281***	1.315***	0.728***
	(10.45)	(14.40)	(8.34)	(31.03)	(22.76)	(9.62)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes
N	16213	9937	5753	16213	9937	5753
Adj. R^2	0.755	0.778	0.719	0.725	0.733	0.646

Panel B: Integration with controls for U.S. bear markets

	Bond Markets			Stock Markets		
	(1)	(2)	(3)	(4)	(5)	(6)
	All	DM	EM	All	DM	EM
QE1	-0.003	0.000	-0.016	0.030***	0.026***	0.036***
	(-0.51)	(0.00)	(-1.43)	(6.09)	(4.45)	(4.05)
QE2	0.056***	0.048***	0.075***	-0.001	0.003	-0.005
	(10.92)	(8.39)	(8.89)	(-0.16)	(0.61)	(-0.80)
QE3	0.005	0.010*	0.002	-0.026***	-0.024***	-0.031***
	(0.84)	(1.69)	(0.19)	(-6.62)	(-5.30)	(-4.33)
bearNonQE	-0.000	-0.022***	0.025**	-0.030***	-0.032***	-0.034***
	(-0.05)	(-2.95)	(2.24)	(-6.27)	(-5.76)	(-3.91)
bearQE1	0.039***	0.018**	0.070***	0.017***	0.012**	0.021**
	(5.24)	(2.19)	(5.68)	(3.22)	(1.96)	(2.17)
MktCap_GDP	0.001***	-0.001***	0.001***	0.000***	0.000***	0.000*
	(12.80)	(-7.59)	(10.23)	(3.74)	(3.67)	(1.92)
MktOpen	-0.005**	0.011***	0.038***	0.005***	0.000	-0.023***
	(-2.56)	(5.92)	(7.02)	(4.13)	(0.26)	(-5.40)
TotalValueGDP	0.000***	0.000	0.001***	-0.000***	-0.000***	0.001***
	(6.56)	(0.03)	(8.43)	(-4.04)	(-4.57)	(4.07)
TradeOpenGDP	-0.001***	-0.004***	-0.000	-0.001***	-0.000***	-0.001***
	(-8.41)	(-24.46)	(-0.76)	(-10.23)	(-3.72)	(-5.10)
EconFree	0.001	0.000	-0.006***	-0.007***	-0.007***	-0.003***
	(0.97)	(0.52)	(-5.35)	(-14.46)	(-10.77)	(-2.97)
LegalRights	0.013***	0.007***	0.038***	-0.003**	-0.005***	0.001
	(8.35)	(4.15)	(12.40)	(-2.27)	(-4.27)	(0.49)
PrivateCredit	-0.001***	-0.002***	-0.004***	-0.000	-0.000	0.001***
	(-8.34)	(-17.24)	(-13.89)	(-0.93)	(-0.63)	(4.87)
BusinessCycleVariation	-0.008***	-0.001	-0.017***	-0.025***	-0.020***	-0.034***
	(-3.34)	(-0.37)	(-4.64)	(-15.69)	(-10.57)	(-11.59)
Constant	0.603***	1.107***	0.806***	1.279***	1.314***	0.727***
	(10.39)	(14.39)	(8.29)	(31.06)	(22.79)	(9.62)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes
N	16213	9937	5753	16213	9937	5753
Adj. R^2	0.756	0.778	0.721	0.726	0.735	0.647

Table 4.5. QE Channel Classifications and Other Control Variables

This table lists the macro-variables along with their QE channel classifications and control variables that affect market integration. The macro-variables linked with the QE channels are arranged alphabetically within the alphabetically arranged QE channels. They have been used in the literature as channels though with variables (such as the effects of unconventional monetary policy) may be transmitted to financial securities and markets. QE channel classifications are generally from the cited sources. The control variables are classified based on Bekaert, Harvey, Lundlad and Siegel (2011).

Panel A: QE Channel Classifications

Macro-variable	QE Channel Classification and Usage
VIX index	Confidence channel (Panchenko & Wu, 2009; Lim & Mohapatra, 2016; Carrieri, Chaieb, & Errunza, 2013).
Credit or default spread	Default risk channel (Krishnamurthy & Vissing-Jorgensen, 2011; Bekaert, Harvey, & Lundblad, 2011; Bekaert & Harvey, 1995; Carrieri, Chaieb & Errunza, 2013; Frijns, Tourani, & RadIndriawan, 2012; Panchenko & Wu, 2009).
Differential inflation rate	Inflation channel (Krishnamurthy & Vissing-Jorgensen, 2011; Alotaibi & Mishra, 2017; Panchenko & Wu, 2009; Volosovych, 2011, 2013).
Cross-border bank-to-bank liabilities	Liquidity channel (Bruno & Shin, 2015).
Money supply (M2)	Liquidity channel (Lim & Mohapatra, 2016; Bekaert, Harvey, Lundlad & Siegel, 2011).
Three-month treasury bill	Liquidity channel (Lim & Mohapatra, 2016; Panchenko & Wu, 2009).
Differential growth potential	Portfolio balance channel (Lim & Mohapatra, 2016).
Differential interest rate	Portfolio balance channel (Lim & Mohapatra, 2016; Frankel, 1992; Bekaert, Harvey, Lundlad & Siegel; 2011).
Portfolio flows	Portfolio balance channel (Fratzscher, Lo Duca, & Straub, 2016; Panchenko & Wu, 2009).
Term structure spread	Portfolio balance channel (Lim & Mohapatra, 2016; Frijns, Tourani, & RadIndriawan, 2012; Bekaert & Harvey, 1995; Carrieri, Chaieb & Errunza, 2013).
Cross-border banking capital flows	Risk-taking channel (Bruno & Shin, 2015).

Panel B: Other Control Variables

Control Variable	Description
Market capitalization to GDP	Financial market openness and development (Panchenko & Wu, 2009; Carrieri, Chaieb & Errunza, 2013).
Market openness	Financial market openness and development (Lane & Milesi-Ferretti, 2007; Umutlu, Akdeniz & Altay-Salih, 2010).
Total value of stock traded to GDP	Financial market openness and development (Panchenko & Wu, 2009; Carrieri, Chaieb & Errunza, 2013; Alotaibi & Mishra, 2017).
Trade openness	Financial market openness and development (Panchenko & Wu, 2009; Volosovych, 2011; Carrieri, Chaieb, & Errunza, 2013; Alotaibi & Mishra, 2017).
Index of Economic Freedom	Political risk and institutions (Lucey & Zhang, 2011; Panchenko & Wu, 2009).
Legal rights	Political risk and institutions (Lerner & Schoar, 2005; Djankov, McLiesh & Shleifer, 2007; Qi, Roth & Wald, 2016).
Private credit to GDP	Political risk and institutions (Bekaert, Harvey & Lundblad, 2011; Bekaert, Harvey, Lundlad & Siegel; 2011; Carrieri, Chaieb & Errunza, 2013).

Business cycle variation	Business Cycles (Bekaert, 1995; Bekaert & Harvey, 1995; Carrieri, Chaieb & Errunza, 2013; De Santis & Gerard, 1997; Frijns, Tourani & RadIndriawan, 2012).

Table 4.6. Summary statistics for variables linked with the QE channels

This table presents summary statistics for key variables linked with the QE channels. The sample consists of 31-country observations from September 2003 until October 2014. The mean, median and standard deviation are provided for the non-QE, QE1, QE2, and QE3 periods. Summary statistics for the differences in the independent variables during QE1, QE2, and QE3 compared to the values in their corresponding non-QE periods are reported. Mean differences are denoted by ***, **, and * if significant at the 1%, 5%, and 10% level, respectively. M2 is multiplied by 1000 and PortfolioFlow is multiplied by 10 for presentation purposes.

	non-QE			QE1			QE2			QE3		
	mean	median	std. dev	mean	median	std. dev	mean	median	std. dev	mean	median	std. dev
VIX	0.013*	0.000	0.141	-0.025	-0.023	0.118	-0.008	-0.002	0.134	-0.008	0.001	0.114
CreditSpread	1.050***	0.940	0.336	0.873***	1.590	0.903	-0.118	0.910	0.116	-0.129**	0.910	0.138
difINFL	1.345***	0.939	1.373	1.143***	1.666	2.532	0.002	1.084	1.390	-0.042	0.750	1.814
BankLiabGDP	0.015***	0.002	0.033	0.012***	0.007	0.047	0.014***	0.004	0.051	0.017***	0.008	0.058
M2	1.112***	0.001	0.002	-0.217	0.001	0.002	0.433	0.001	0.002	0.084	0.001	0.002
US3MTbill	2.228***	1.825	1.810	-2.095***	0.135	0.069	-2.127***	0.120	0.047	-2.162***	0.070	0.028
difGDP	2.130***	1.658	1.982	0.463***	1.958	2.547	0.138**	1.573	2.542	-0.191***	1.484	1.919
difINT	1.878***	0.930	2.664	-0.166***	1.073	1.828	0.270***	0.993	2.618	0.135**	1.195	2.398
BondFlow	-0.055*	-0.233	3.430	-0.624***	-0.548	2.821	-0.726***	-0.560	3.863	0.067	-0.377	2.710
EquityFlow	-0.100***	0.051	2.296	0.097*	-0.064	1.253	-0.273***	-0.033	2.675	0.052	0.054	1.573
TermSpread	1.626***	1.810	1.188	1.533***	3.310	0.458	1.509***	3.220	0.280	0.504***	1.935	0.469
BankingFlow	11.455***	11.541	1.716	0.224***	11.761	1.670	0.347***	11.816	1.493	0.162***	11.691	1.503

Table 4.7. Financial market integration determinants based on QE time events for All, DM and EM countries

This table reports the coefficients for regression (4.2) which reflect the effects of the potential channels for the transmission of the effects of unconventional monetary policy based on weekly data. The dependent variables are the level of integration for international bond or equity markets. The independent variables are the proxies for the potential channels for transmitting the effects of unconventional monetary policy defined in Table 4.5. Data are not available for Singapore and India for bond flows and for Singapore, Colombia, and Mexico for equity flows. The coefficients of the regressions are consistent with those for the regressions including the countries without the flows (bond or equity). ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively. The variable definitions and data sources are reported in Appendix 4.A. The estimated coefficients of M2 and PortfolioFlow are multiplied by 1000 and 10, respectively.

	Bond Integration			Equity Integration		
	(1)	(2)	(3)	(4)	(5)	(6)
	All	DM	EM	All	DM	EM
QE1	0.153***	0.387***	0.085	-0.142***	0.390***	-0.322***
	(2.67)	(5.63)	(0.92)	(-3.24)	(7.35)	(-3.92)
QE2	0.527***	0.554***	-0.558***	0.177***	0.361***	-0.208*
	(6.44)	(5.73)	(-3.83)	(2.82)	(4.85)	(-1.68)
QE3	0.438***	0.398***	0.314***	-0.271***	0.027	0.020
	(8.76)	(6.64)	(3.48)	(-7.12)	(0.59)	(0.28)
VIXrate	0.020**	0.011	0.038***	0.024***	0.022***	0.027***
	(2.40)	(1.18)	(2.95)	(3.74)	(3.16)	(2.66)
VIXrate*QE1	-0.003	0.002	-0.013	0.000	-0.004	-0.001
	(-0.12)	(0.08)	(-0.35)	(0.01)	(-0.17)	(-0.02)
VIXrate*QE2	-0.024	-0.015	-0.035	-0.028	-0.021	-0.034
	(-0.79)	(-0.44)	(-0.75)	(-1.20)	(-0.83)	(-0.93)
VIXrate*QE3	-0.018	-0.022	-0.007	0.001	0.002	0.004
	(-0.71)	(-0.77)	(-0.18)	(0.05)	(0.07)	(0.15)
CreditSpread	-0.004	-0.001	-0.003	-0.004	0.003	-0.016**
	(-0.71)	(-0.08)	(-0.30)	(-0.84)	(0.66)	(-2.17)
CreditSpread*QE1	-0.038***	-0.027***	-0.065***	-0.033***	-0.030***	-0.037***
	(-4.48)	(-2.93)	(-4.79)	(-5.18)	(-4.19)	(-3.57)
CreditSpread*QE2	-0.032	-0.043	-0.101	0.007	-0.019	0.013
	(-0.44)	(-0.53)	(-0.88)	(0.13)	(-0.31)	(0.15)
CreditSpread*QE3	0.019	-0.012	0.112**	0.027	-0.004	0.071*
	(0.64)	(-0.36)	(2.37)	(1.22)	(-0.16)	(1.95)
difINFL	0.000	0.033***	-0.016***	0.008***	0.020***	0.006***
	(0.35)	(16.81)	(-10.55)	(9.29)	(13.28)	(5.98)
difINFL*QE1	-0.021***	-0.053***	0.001	0.000	-0.027***	0.006***
	(-9.48)	(-14.74)	(0.38)	(0.30)	(-9.67)	(3.27)
difINFL*QE2	-0.011**	-0.073***	0.037***	0.010***	-0.020***	0.017***
	(-2.43)	(-13.52)	(4.73)	(3.99)	(-4.80)	(5.37)
difINFL*QE3	-0.007**	-0.077***	0.010**	0.006***	-0.006	0.025***
	(-2.15)	(-12.20)	(2.32)	(3.99)	(-1.30)	(13.85)
BankLiabGDP	-0.417***	0.039	16.760***	-0.247***	-0.647***	5.438***
	(-6.72)	(0.62)	(12.75)	(-5.41)	(-13.53)	(5.61)
BankLiabGDP*QE1	0.304***	-0.042	-15.785***	-0.134**	0.301***	-6.971***
	(3.94)	(-0.54)	(-4.85)	(-2.32)	(4.94)	(-2.98)
BankLiabGDP*QE2	-0.426***	-0.001	65.770***	0.109	0.320***	17.431***
	(-4.78)	(-0.02)	(10.71)	(1.43)	(4.42)	(3.59)
BankLiabGDP*QE3	0.451***	0.163**	-1.864	0.396***	0.444***	21.714***
	(6.55)	(2.52)	(-0.82)	(7.77)	(8.92)	(11.82)
M2	-0.000	-0.297	0.394	0.000	0.390	-0.199
	(-0.20)	(-0.48)	(0.45)	(0.56)	(0.81)	(-0.29)
M2*QE1	0.001	0.938	0.081	-0.000	0.752	-1.417
	(0.48)	(0.52)	(0.03)	(-0.28)	(0.55)	(-0.72)
M2*QE2	0.001	1.640	-0.946	-0.000	0.080	-1.026
	(0.28)	(0.73)	(-0.30)	(-0.31)	(0.05)	(-0.41)
M2*QE3	0.000	0.166	0.218	-0.001	-2.143*	0.407

	(0.14)	(0.10)	(0.10)	(-1.24)	(-1.72)	(0.23)
US3MTbill	-0.028***	-0.017***	-0.051***	-0.025***	-0.025***	-0.028***
	(-5.83)	(-3.15)	(-6.85)	(-6.85)	(-6.21)	(-4.85)
US3MTbill*QE1	0.113**	0.057	0.110	0.084**	0.060	0.123**
	(2.47)	(1.14)	(1.55)	(2.46)	(1.55)	(2.23)
US3MTbill*QE2	0.123	0.144	0.134	-0.175	-0.100	-0.211
	(0.71)	(0.76)	(0.49)	(-1.36)	(-0.69)	(-1.00)
US3MTbill*QE3	-0.093	0.080	-0.417**	0.278***	0.396***	-0.203
	(-0.71)	(0.55)	(-2.06)	(2.85)	(3.57)	(-1.29)
difGDP	0.008***	0.002	0.007***	-0.001	-0.001	-0.002**
	(8.41)	(1.60)	(5.58)	(-1.15)	(-0.98)	(-2.42)
difGDP*QE1	-0.008***	-0.008***	-0.005**	0.002	-0.010***	0.006***
	(-4.55)	(-3.06)	(-2.23)	(1.50)	(-5.06)	(3.43)
difGDP*QE2	-0.020***	-0.013***	-0.035***	0.001	0.003	-0.005**
	(-9.25)	(-3.30)	(-10.55)	(0.37)	(0.89)	(-2.38)
difGDP*QE3	-0.011***	0.004	-0.004*	0.022***	0.029***	0.011***
	(-5.98)	(1.15)	(-1.74)	(17.26)	(11.10)	(6.52)
difINT	-0.012***	-0.013***	-0.014***	-0.000	0.013***	-0.001**
	(-16.01)	(-9.37)	(-14.33)	(-0.05)	(12.57)	(-2.18)
difINT*QE1	0.013***	0.014***	0.020***	0.004**	-0.012***	0.012***
	(6.10)	(2.71)	(7.11)	(2.24)	(-2.88)	(5.57)
difINT*QE2	-0.002	-0.028***	0.009***	-0.008***	-0.012***	-0.002
	(-0.81)	(-9.54)	(2.63)	(-5.13)	(-4.45)	(-0.88)
difINT*QE3	0.008***	-0.052***	0.017***	-0.004***	-0.022***	0.007***
	(4.56)	(-14.85)	(6.30)	(-3.27)	(-8.24)	(4.83)
PortfolioFlow	-0.001***	-0.002***	0.007***	0.001	0.002***	-0.010***
	(-2.98)	(-6.00)	(5.35)	(1.38)	(3.96)	(-4.30)
PortfolioFlow*QE1	0.000	0.001	-0.016***	-0.007***	-0.004**	-0.000
	(0.32)	(0.85)	(-4.08)	(-4.15)	(-2.21)	(-0.04)
PortfolioFlow*QE2	-0.000	0.002*	-0.006	-0.013***	-0.009***	0.017*
	(-0.16)	(1.76)	(-0.89)	(-8.97)	(-5.89)	(1.66)
PortfolioFlow*QE3	0.000	0.004***	-0.007**	0.010***	0.006***	0.022***
	(0.23)	(3.17)	(-2.19)	(7.15)	(4.54)	(2.63)
Term	-0.012***	-0.001	-0.038***	-0.021***	-0.015***	-0.031***
	(-2.71)	(-0.29)	(-5.49)	(-6.14)	(-3.92)	(-5.74)
Term*QE1	0.001	-0.016	0.037*	-0.003	-0.008	0.003
	(0.05)	(-1.19)	(1.90)	(-0.34)	(-0.77)	(0.18)
Term*QE2	0.036**	0.031*	0.074***	0.037***	0.035**	0.052***
	(2.23)	(1.76)	(2.89)	(3.03)	(2.54)	(2.66)
Term*QE3	-0.080***	-0.071***	-0.085***	-0.003	0.019**	-0.056***
	(-8.52)	(-6.77)	(-5.76)	(-0.37)	(2.38)	(-4.88)
BankingFlow	0.115***	0.101***	0.043***	0.029***	0.040***	0.049***
	(28.89)	(18.01)	(6.90)	(9.34)	(9.18)	(9.18)
BankingFlow*QE1	-0.005**	-0.017***	-0.011**	0.018***	-0.020***	0.029***
	(-2.02)	(-5.64)	(-2.12)	(9.78)	(-8.70)	(5.37)
BankingFlow*QE2	-0.047***	-0.042***	0.042***	-0.019***	-0.030***	0.010
	(-16.51)	(-10.83)	(4.68)	(-8.24)	(-10.06)	(1.22)
BankingFlow*QE3	-0.021***	-0.008***	-0.026***	0.010***	-0.014***	-0.017***
	(-9.30)	(-2.71)	(-4.47)	(5.70)	(-6.19)	(-3.48)
MktCap_GDP	0.001***	-0.000	0.001***	0.000***	0.000***	0.000***
	(8.92)	(-0.74)	(6.15)	(4.11)	(4.22)	(3.23)
MktOpen	-0.001	0.006**	0.022***	0.004***	-0.007***	-0.035***
	(-0.38)	(2.24)	(4.34)	(2.76)	(-3.74)	(-9.02)
TotalValueGDP	0.001***	0.000***	0.001***	-0.000***	-0.000***	0.000**
	(8.62)	(3.42)	(8.65)	(-4.75)	(-7.45)	(2.47)
TradeOpenGDP	0.001***	-0.001**	0.001**	-0.002***	0.001***	-0.000*
	(5.13)	(-2.52)	(2.07)	(-9.21)	(3.36)	(-1.73)
EconFree	-0.007***	-0.001	-0.007***	-0.007***	-0.007***	0.003***
	(-10.68)	(-1.33)	(-5.87)	(-12.69)	(-10.76)	(2.59)
LegalRights	0.009***	0.001	0.024***	-0.001	-0.004***	-0.009***
	(5.83)	(0.60)	(7.51)	(-0.47)	(-3.15)	(-3.27)
PrivateCredit	-0.002***	-0.002***	-0.003***	-0.000***	-0.000***	-0.000

	(-15.41)	(-18.44)	(-10.25)	(-5.01)	(-4.75)	(-0.45)
BusinessCycleVariation	-0.008***	-0.004	-0.011**	-0.018***	-0.017***	-0.020***
	(-2.68)	(-1.24)	(-2.55)	(-8.31)	(-6.83)	(-5.80)
Constant	0.093	0.024	0.727***	1.087***	0.904***	0.175**
	(1.31)	(0.23)	(8.42)	(19.24)	(11.58)	(2.31)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes
N	15061	9308	5753	14485	9308	5177
Adj. R^2	0.793	0.823	0.765	0.745	0.771	0.733
Computed from above estimates:						
VIX + VIX*QE1	0.017	0.013	0.025	0.024	0.019	0.026
	(0.78)	(0.53)	(0.74)	(1.41)	(1.00)	(0.98)
VIX + VIX*QE2	-0.004	-0.004	0.003	-0.004	0.001	-0.008
	(-0.13)	(-0.12)	(0.06)	(-0.18)	(0.04)	(-0.21)
VIX + VIX*QE3	0.002	-0.011	0.031	0.024	0.024	0.031
	(0.09)	(-0.41)	(0.84)	(1.36)	(1.18)	(1.09)
CreditSpread + CreditSpread*QE1	-0.042***	-0.028***	-0.067***	-0.036***	-0.027***	-0.052***
	(-6.32)	(-3.78)	(-6.31)	(-7.34)	(-4.72)	(-6.48)
CreditSpread + CreditSpread*QE2	-0.036	-0.043	-0.104	0.004	-0.016	-0.002
	(-0.50)	(-0.54)	(-0.91)	(0.06)	(-0.26)	(-0.03)
CreditSpread + CreditSpread*QE3	0.015	-0.012	0.109**	0.024	-0.001	0.055
	(0.51)	(-0.39)	(2.36)	(1.08)	(-0.03)	(1.55)
difINFL + difINFL*QE1	-0.021***	-0.020***	-0.015***	0.008***	-0.007***	0.012***
	(-10.73)	(-6.63)	(-5.73)	(6.78)	(-2.95)	(7.48)
difINFL + difINFL*QE2	-0.010**	-0.040***	0.021***	0.017***	0.000	0.023***
	(-2.39)	(-7.70)	(2.70)	(7.25)	(0.00)	(7.21)
difINFL + difINFL*QE3	-0.007**	-0.044***	-0.006	0.014***	0.014***	0.031***
	(-2.11)	(-7.04)	(-1.44)	(9.61)	(2.92)	(17.91)
BankLiabGDP + BankLiabGDP*QE1	-0.113	-0.003	0.975	-0.381***	-0.346***	-1.533
	(-1.40)	(-0.04)	(0.30)	(-6.36)	(-5.32)	(-0.65)
BankLiabGDP + BankLiabGDP*QE2	-0.843***	0.038	82.531***	-0.138*	-0.327***	22.869***
	(-9.15)	(0.41)	(13.33)	(-1.78)	(-4.30)	(4.65)
BankLiabGDP + BankLiabGDP*QE3	0.034	0.202***	14.897***	0.148***	-0.203***	27.153***
	(0.47)	(2.91)	(6.78)	(2.76)	(-3.75)	(14.60)
M2 + M2*QE1	0.001	0.641	0.475	-0.000	1.143	-1.616
	(0.44)	(0.38)	(0.20)	(-0.09)	(0.88)	(-0.88)
M2 + M2*QE2	0.000	1.344	-0.552	-0.000	0.470	-1.226
	(0.23)	(0.62)	(-0.18)	(-0.16)	(0.28)	(-0.51)
M2 + M2*QE3	0.000	-0.131	0.612	-0.001	-1.753	0.207
	(0.07)	(-0.09)	(0.29)	(-1.11)	(-1.52)	(0.13)
US3MTbill + US3MTbill*QE1	0.085*	0.040	0.059	0.059*	0.035	0.095*
	(1.90)	(0.82)	(0.85)	(1.77)	(0.92)	(1.76)
US3MTbill + US3MTbill*QE2	0.095	0.127	0.083	-0.200	-0.126	-0.239
	(0.55)	(0.67)	(0.30)	(-1.55)	(-0.86)	(-1.14)
US3MTbill + US3MTbill*QE3	-0.121	0.063	-0.468**	0.253***	0.370***	-0.231
	(-0.93)	(0.44)	(-2.31)	(2.60)	(3.34)	(-1.47)
difGDP + difGDP*QE1	-0.001	-0.005***	0.001	0.001	-0.011***	0.003**
	(-0.39)	(-2.58)	(0.67)	(0.99)	(-6.52)	(2.37)
difGDP + difGDP*QE2	-0.012***	-0.011***	-0.028***	-0.000	0.002	-0.007***
	(-6.11)	(-2.88)	(-8.96)	(-0.12)	(0.59)	(-3.58)
difGDP + difGDP*QE3	-0.003*	0.006*	0.003	0.022***	0.028***	0.009***
	(-1.93)	(1.89)	(1.59)	(18.31)	(11.29)	(6.00)
difINT + difINT*QE1	0.001	0.001	0.006**	0.004**	0.002	0.010***
	(0.65)	(0.21)	(2.01)	(2.16)	(0.44)	(4.74)
difINT + difINT*QE2	-0.013***	-0.041***	-0.005	-0.008***	0.002	-0.004
	(-7.17)	(-14.94)	(-1.58)	(-5.13)	(0.77)	(-1.47)
difINT + difINT*QE3	-0.003**	-0.065***	0.002	-0.004***	-0.009***	0.006***
	(-1.98)	(-18.67)	(0.84)	(-3.33)	(-3.26)	(3.89)
PortfolioFlow + PortfolioFlow*QE1	-0.001	-0.001	-0.008**	-0.007***	-0.003	-0.010***
	(-0.87)	(-1.51)	(-2.37)	(-3.89)	(-1.39)	(-2.90)
PortfolioFlow + PortfolioFlow*QE2	-0.001	-0.000	0.001	-0.012***	-0.007***	0.007

	(-1.34)	(-0.49)	(0.18)	(-8.70)	(-4.81)	(0.72)
PortfolioFlow + PortfolioFlow*QE3	-0.001	0.002	0.000	0.011***	0.008***	0.012
	(-0.71)	(1.48)	(0.09)	(7.77)	(5.95)	(1.49)
TermSpread + TermSpread*QE1	-0.011	-0.018	-0.001	-0.024***	-0.023**	-0.028**
	(-0.97)	(-1.37)	(-0.04)	(-2.69)	(-2.30)	(-1.98)
TermSpread + TermSpread*QE2	0.024	0.030*	0.036	0.016	0.020	0.021
	(1.63)	(1.85)	(1.53)	(1.47)	(1.60)	(1.19)
TermSpread + TermSpread*QE3	-0.092***	-0.072***	-0.122***	-0.023***	0.004	-0.087***
	(-11.11)	(-7.82)	(-9.45)	(-3.71)	(0.60)	(-8.54)
BankingFlow + BankingFlow*QE1	0.110***	0.084***	0.032***	0.047***	0.019***	0.078***
	(25.46)	(13.18)	(4.64)	(13.22)	(3.91)	(12.47)
BankingFlow + BankingFlow*QE2	0.068***	0.059***	0.084***	0.010**	0.010*	0.059***
	(13.66)	(8.53)	(8.05)	(2.57)	(1.82)	(6.14)
BankingFlow + BankingFlow*QE3	0.094***	0.093***	0.016**	0.039***	0.025***	0.032***
	(20.73)	(15.03)	(2.13)	(11.22)	(5.34)	(5.24)

Table 4.8. The Effect of the U.S. Fed purchases on financial market integration

This table reports the effects of the security type holdings of the U.S. Federal Reserve on financial market integration. The dependent variables are the level of integration for international bond or equity markets. The independent variables which proxy for the Fed security type holdings are *TREASF/TAF* and *MBSF/TAF*. ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

	Bond Markets			Stock Markets		
	(1)	(2)	(3)	(4)	(5)	(6)
	All	DM	EM	All	DM	EM
QE1	0.039*	-0.002	0.125***	-0.002	0.020	-0.028
	(1.82)	(-0.06)	(3.54)	(-0.12)	(1.10)	(-1.02)
QE2	-0.368	-0.370	-0.273	-0.154	-0.219	-0.165
	(-0.43)	(-0.38)	(-0.19)	(-0.25)	(-0.31)	(-0.15)
QE3	-1.397***	-1.080***	-1.149***	1.047***	1.358***	0.536
	(-5.44)	(-3.75)	(-2.71)	(5.77)	(6.33)	(1.63)
TREASF/TAF	0.027	-0.024	0.136***	-0.097***	-0.082***	-0.119***
	(0.87)	(-0.69)	(2.70)	(-4.49)	(-3.20)	(-3.04)
TREASF/TAF*QE1	0.042	0.063**	-0.021	0.140***	0.097***	0.206***
	(1.54)	(2.06)	(-0.47)	(7.28)	(4.27)	(5.87)
TREASF/TAF*QE2	0.980	0.797	0.995	0.969	1.005	1.156
	(0.51)	(0.37)	(0.31)	(0.71)	(0.62)	(0.47)
TREASF/TAF*QE3	1.752***	1.546***	1.198**	-1.456***	-1.717***	-1.008**
	(4.89)	(3.85)	(2.03)	(-5.76)	(-5.74)	(-2.20)
MBSF/TAF	0.203***	0.087*	0.446***	0.044	0.069*	0.031
	(4.54)	(1.74)	(6.06)	(1.39)	(1.86)	(0.55)
MBSF/TAF*QE1	-0.707***	-0.168	-1.650***	-0.604***	-0.674***	-0.552***
	(-4.85)	(-1.03)	(-6.87)	(-5.86)	(-5.53)	(-2.96)
MBSF/TAF*QE2	0.175	0.322	-0.042	-0.428	-0.298	-0.563
	(0.38)	(0.62)	(-0.06)	(-1.31)	(-0.77)	(-0.95)
MBSF/TAF*QE3	1.270***	0.653***	1.497***	-0.733***	-1.236***	0.053
	(5.74)	(2.63)	(4.10)	(-4.69)	(-6.68)	(0.19)
MktCap_GDP	0.001***	-0.001***	0.001***	0.000***	0.000***	0.000*
	(12.83)	(-7.60)	(10.32)	(3.75)	(3.68)	(1.93)
MktOpen	-0.005**	0.011***	0.038***	0.005***	0.000	-0.022***
	(-2.56)	(5.93)	(7.13)	(4.18)	(0.27)	(-5.45)
TotalValueGDP	0.000***	0.000	0.001***	-0.000***	-0.000***	0.001***
	(6.59)	(0.04)	(8.57)	(-4.07)	(-4.61)	(4.12)
TradeOpenGDP	-0.001***	-0.004***	-0.000	-0.001***	-0.000***	-0.001***
	(-8.47)	(-24.48)	(-0.84)	(-10.35)	(-3.78)	(-5.18)
EconFree	0.001	0.000	-0.006***	-0.007***	-0.007***	-0.003***
	(0.98)	(0.52)	(-5.44)	(-14.58)	(-10.85)	(-3.02)
LegalRights	0.013***	0.007***	0.038***	-0.003**	-0.005***	0.001
	(8.38)	(4.15)	(12.54)	(-2.29)	(-4.30)	(0.49)
PrivateCredit	-0.001***	-0.002***	-0.004***	-0.000	-0.000	0.001***
	(-8.37)	(-17.25)	(-14.10)	(-0.94)	(-0.63)	(4.91)
BusinessCycleVariation	-0.005**	0.001	-0.013***	-0.021***	-0.018***	-0.027***
	(-2.11)	(0.31)	(-3.33)	(-12.63)	(-8.85)	(-8.81)
Constant	0.578***	1.126***	0.688***	1.360***	1.383***	0.825***
	(9.05)	(13.63)	(6.51)	(30.15)	(22.48)	(10.03)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes
N	16213	9937	5753	16213	9937	5753
Adj. R^2	0.757	0.778	0.727	0.730	0.739	0.655

Computed from above estimates:						
TREASF/TAF+TREASF/TAF*QE1	0.069***	0.039**	0.115***	0.043***	0.016	0.086***
	(4.02)	(2.04)	(4.07)	(3.58)	(1.09)	(3.93)
TREASF/TAF+TREASF/TAF*QE2	1.007	0.773	1.131	0.872	0.923	1.037
	(0.52)	(0.36)	(0.35)	(0.64)	(0.57)	(0.42)
TREASF/TAF+TREASF/TAF*QE3	1.779***	1.523***	1.334**	-1.553***	-1.799***	-1.128**
	(5.01)	(3.82)	(2.28)	(-6.19)	(-6.06)	(-2.48)
MBSF/TAF+MBSF/TAF*QE1	-0.504***	-0.081	-1.204***	-0.560***	-0.605***	-0.521***
	(-3.57)	(-0.51)	(-5.17)	(-5.60)	(-5.12)	(-2.87)
MBSF/TAF+MBSF/TAF*QE2	0.378	0.409	0.404	-0.384	-0.229	-0.531
	(0.80)	(0.77)	(0.52)	(-1.15)	(-0.58)	(-0.88)
MBSF/TAF+MBSF/TAF*QE3	1.473***	0.740***	1.943***	-0.690***	-1.167***	0.085
	(6.74)	(3.02)	(5.40)	(-4.47)	(-6.40)	(0.30)

Table 4.9. Market integration during the three QE periods controlling for the global financial crisis

This table reports the relationship between the bond or stock market integration level and the three rounds of U.S. QE periods while controlling for the global financial crisis. The global financial crisis is defined to be from Oct. 9, 2007 to Nov 20, 2008, and Jan. 6, 2009 to Mar. 9, 2009. Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

Panel A: The time period of the global financial crisis is August 7, 2007- June, 2009

	Bond Markets			Stock Markets		
	(1)	(2)	(3)	(4)	(5)	(6)
	All	DM	EM	All	DM	EM
QE1	-0.002	-0.000	-0.012	0.029***	0.027***	0.032***
	(-0.27)	(-0.04)	(-1.07)	(6.18)	(4.79)	(3.71)
QE2	0.056***	0.048***	0.076***	-0.001	0.003	-0.006
	(10.94)	(8.36)	(8.92)	(-0.15)	(0.66)	(-0.84)
QE3	0.005	0.011*	0.002	-0.026***	-0.025***	-0.031***
	(0.89)	(1.74)	(0.24)	(-6.66)	(-5.31)	(-4.38)
CrisisGlobalNonQE	-0.008	-0.031***	0.013	-0.024***	-0.025***	-0.031***
	(-1.39)	(-4.63)	(1.31)	(-5.81)	(-5.06)	(-4.08)
CrisisGlobalQE1	0.028***	0.012*	0.048***	0.022***	0.015***	0.032***
	(4.42)	(1.70)	(4.64)	(4.92)	(2.83)	(3.93)
MktCap_GDP	0.001***	-0.001***	0.001***	0.000***	0.000***	0.000*
	(12.80)	(-7.59)	(10.22)	(3.74)	(3.67)	(1.93)
MktOpen	-0.005**	0.011***	0.038***	0.005***	0.000	-0.023***
	(-2.56)	(5.92)	(7.01)	(4.13)	(0.26)	(-5.41)
TotalValueGDP	0.000***	0.000	0.001***	-0.000***	-0.000***	0.001***
	(6.56)	(0.04)	(8.42)	(-4.04)	(-4.57)	(4.07)
TradeOpenGDP	-0.001***	-0.004***	-0.000	-0.001***	-0.000***	-0.001***
	(-8.41)	(-24.47)	(-0.76)	(-10.24)	(-3.72)	(-5.11)
EconFree	0.001	0.000	-0.006***	-0.007***	-0.007***	-0.003***
	(0.97)	(0.52)	(-5.34)	(-14.47)	(-10.77)	(-2.98)
LegalRights	0.013***	0.007***	0.038***	-0.003**	-0.005***	0.001
	(8.35)	(4.15)	(12.38)	(-2.27)	(-4.27)	(0.49)
PrivateCredit	-0.001***	-0.002***	-0.004***	-0.000	-0.000	0.001***
	(-8.34)	(-17.25)	(-13.88)	(-0.93)	(-0.63)	(4.88)
BusinessCycleVariation	-0.008***	-0.002	-0.019***	-0.025***	-0.020***	-0.032***
	(-3.77)	(-0.76)	(-5.06)	(-15.33)	(-10.44)	(-11.17)
Constant	0.604***	1.108***	0.807***	1.279***	1.314***	0.726***
	(10.41)	(14.41)	(8.30)	(31.05)	(22.78)	(9.62)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes
N	16213	9937	5753	16213	9937	5753
Adj. R^2	0.756	0.778	0.720	0.726	0.735	0.648

Panel B: The time period of the global financial crisis is September 15, 2008 – June 2009

	Bond Markets			Stock Markets		
	(1)	(2)	(3)	(4)	(5)	(6)
	All	DM	EM	All	DM	EM
QE1	0.002	0.010	-0.016	0.035***	0.034***	0.038***
	(0.29)	(1.40)	(-1.47)	(7.49)	(6.09)	(4.48)
QE2	0.056***	0.049***	0.075***	0.000	0.004	-0.004
	(11.04)	(8.63)	(8.86)	(0.11)	(0.90)	(-0.68)
QE3	0.005	0.010*	0.002	-0.026***	-0.025***	-0.032***
	(0.89)	(1.70)	(0.25)	(-6.75)	(-5.38)	(-4.45)
CrisisGlobalNonQE	0.022***	0.046***	-0.016	0.003	0.014**	-0.012
	(2.83)	(5.20)	(-1.20)	(0.52)	(2.15)	(-1.16)
CrisisGlobalQE1	0.030***	0.021***	0.044***	0.028***	0.022***	0.039***
	(5.05)	(3.17)	(4.39)	(6.57)	(4.30)	(5.04)
MktCap_GDP	0.001***	-0.001***	0.001***	0.000***	0.000***	0.000*
	(12.80)	(-7.59)	(10.22)	(3.74)	(3.67)	(1.92)
MktOpen	-0.005**	0.011***	0.038***	0.005***	0.000	-0.023***
	(-2.56)	(5.92)	(7.01)	(4.13)	(0.26)	(-5.40)
TotalValueGDP	0.000***	0.000	0.001***	-0.000***	-0.000***	0.001***
	(6.56)	(0.03)	(8.42)	(-4.04)	(-4.57)	(4.06)
TradeOpenGDP	-0.001***	-0.004***	-0.000	-0.001***	-0.000***	-0.001***
	(-8.41)	(-24.47)	(-0.76)	(-10.22)	(-3.71)	(-5.10)
EconFree	0.001	0.000	-0.006***	-0.007***	-0.007***	-0.003***
	(0.97)	(0.52)	(-5.34)	(-14.45)	(-10.76)	(-2.97)
LegalRights	0.013***	0.007***	0.038***	-0.003**	-0.005***	0.001
	(8.35)	(4.15)	(12.38)	(-2.27)	(-4.26)	(0.49)
PrivateCredit	-0.001***	-0.002***	-0.004***	-0.000	-0.000	0.001***
	(-8.34)	(-17.25)	(-13.88)	(-0.93)	(-0.63)	(4.87)
BusinessCycleVariation	-0.008***	-0.001	-0.019***	-0.023***	-0.019***	-0.031***
	(-3.77)	(-0.39)	(-5.22)	(-14.63)	(-9.90)	(-10.59)
Constant	0.604***	1.107***	0.808***	1.278***	1.313***	0.724***
	(10.41)	(14.40)	(8.30)	(30.99)	(22.74)	(9.58)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes
N	16213	9937	5753	16213	9937	5753
Adj. R^2	0.756	0.778	0.720	0.725	0.734	0.647

Table 4.10. Market integration during the three QE periods while controlling for the U.S. recession

This table reports the relationship between the bond or stock market integration level and the three rounds of QE periods when controlling for the U.S. recession. The U.S. recession is defined to be from 12/2007-6/2009. Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

	Bond Markets			Stock Markets		
	(1)	(2)	(3)	(4)	(5)	(6)
	All	DM	EM	All	DM	EM
QE1	-0.008	-0.001	-0.024**	0.018***	0.017***	0.020**
	(-1.14)	(-0.19)	(-2.08)	(3.73)	(2.91)	(2.18)
QE2	0.055***	0.048***	0.074***	-0.002	0.002	-0.007
	(10.77)	(8.35)	(8.71)	(-0.53)	(0.37)	(-1.08)
QE3	0.005	0.010*	0.003	-0.026***	-0.025***	-0.031***
	(0.90)	(1.69)	(0.28)	(-6.68)	(-5.33)	(-4.39)
RecessionUSNonQE	-0.031***	-0.032***	-0.037**	-0.065***	-0.061***	-0.077***
	(-3.42)	(-3.10)	(-2.41)	(-9.96)	(-8.00)	(-6.50)
RecessionUSQE1	0.022***	0.013*	0.036***	0.013***	0.007	0.022***
	(3.52)	(1.75)	(3.41)	(2.93)	(1.36)	(2.69)
MktCap_GDP	0.001***	-0.001***	0.001***	0.000***	0.000***	0.000*
	(12.80)	(-7.59)	(10.22)	(3.75)	(3.68)	(1.93)
MktOpen	-0.005**	0.011***	0.038***	0.005***	0.000	-0.023***
	(-2.56)	(5.92)	(7.02)	(4.14)	(0.26)	(-5.42)
TotalValueGDP	0.000***	0.000	0.001***	-0.000***	-0.000***	0.001***
	(6.56)	(0.03)	(8.43)	(-4.05)	(-4.58)	(4.08)
TradeOpenGDP	-0.001***	-0.004***	-0.000	-0.001***	-0.000***	-0.001***
	(-8.41)	(-24.46)	(-0.77)	(-10.26)	(-3.73)	(-5.12)
EconFree	0.001	0.000	-0.006***	-0.007***	-0.007***	-0.003***
	(0.97)	(0.52)	(-5.34)	(-14.50)	(-10.79)	(-2.99)
LegalRights	0.013***	0.007***	0.038***	-0.003**	-0.005***	0.001
	(8.35)	(4.15)	(12.39)	(-2.27)	(-4.27)	(0.49)
PrivateCredit	-0.001***	-0.002***	-0.004***	-0.000	-0.000	0.001***
	(-8.34)	(-17.24)	(-13.89)	(-0.93)	(-0.63)	(4.89)
BusinessCycleVariation	-0.009***	-0.001	-0.020***	-0.025***	-0.020***	-0.032***
	(-3.89)	(-0.35)	(-5.50)	(-15.49)	(-10.49)	(-11.25)
Constant	0.604***	1.107***	0.809***	1.279***	1.314***	0.726***
	(10.41)	(14.39)	(8.32)	(31.12)	(22.82)	(9.64)
Country Effect	Yes	Yes	Yes	Yes	Yes	Yes
Time Effect	Yes	Yes	Yes	Yes	Yes	Yes
N	16213	9937	5753	16213	9937	5753
Adj. R^2	0.756	0.778	0.721	0.727	0.736	0.650