Comments on Qianying Chen, Andrew Filardo, Dong He and Feng Zhu's paper "The impact of central bank balance sheet policies on the emerging economies"

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Introduction

The paper by Chen, Filardo, He and Zhou (2012)[3] provides a rich and interesting insight into international spillover, or cross-border effects, from changes in the structure of central bank (especially U.S.) balance sheets through quantitative easing (QE). As the authors note (page 1), "[the current literature] has focused on its domestic effects". We agree with the authors that understanding these effects is vital for better policy-making, especially since some policies – well-intentioned as they may well be – may lead to speculative flows to emerging nations, which in turn could lead to concerns later on if, for example, as occurred in the Asian crisis of 1997–1998, the flows were suddenly reversed.

CFHZ (2012) utilise an event study and global VAR methodology to determine the cross-border channels of transmission. VAR methodology is not without criticism, although as noted by Lutkepohl's (2007) survey, for integrated and cointegrated variables it provides convenient parameterization for model specification and economic analysis. CFHZ's conclusion that these impacts vary and appear linked to heterogeneity in the economic, financial and regulatory structures of each economy appears at odds with a broader literature that has observed increasing financial and economic integration in recent years, especially in regional economic blocs such as those in the Asia-Pacific region, owing to the effects of technology and communication systems as well as deliberate strategies aimed at facilitating trade and capital movement.[4]

Our contribution is to shed additional insights into the CFHZ (2012) findings by drawing upon key features and experiences of financial markets, both in the U.S. and elsewhere. This includes further analysis of key time series variables, especially the U.S. term structure. We argue that the CFHZ findings may be partly explained by three main factors: (a) complexity in the transmission process across the U.S. risk-free term structure, and the flow-on effects of monetary policy changes vis-à-vis risky debt; (b) the matching of the quantities of assets and liabilities in the international balance sheets of banks; and (c) risk aversion arising from the temporal nature of the correlation structure of foreign exchange rates, which affects international position-taking by banks. These three factors will be discussed each in turn. However, before doing so we will provide some preliminary comments on the broader context of the study – central bank policy when there is a near-zero lower band on interest rates – and why this may be ineffective in the short term.

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3 Henceforth simply CFHZ (2012).

4 For example, Bekaert and Harvey (1995), Gerard, Thanyalakpark and Batten (2003), and Bekaert, Harvey and Ng (2005).

1. The near zero interest rate policy dilemma

There are a number of papers which consider the policy alternatives faced by a central bank when confronting a zero lower band on nominal interest rates. These include well-known words by Bernanke and Gertler (1999), Bernanke and Reinhart (2004) and Bernanke, Reinhart and Sack (2004), amongst others. It is important to recognise that these authors were mindful of the quandary facing the Bank of Japan in the period from 1990–2000 in stimulating aggregate demand while nominal interest rates were near zero, and also the experience of the Kennedy Administration's 1961–1964 Operation Twist. These experiences are reflected in the policy options that these various papers considered – and of which CFHZ (2012) provides a recent assessment in terms of cross-border impacts, to wit: (a) the importance of shaping expectations of future interest rate directions; (b) quantitative easing via central bank purchases of securities; and (c) changing the composition and duration of the central bank balance sheet through risky asset purchases and the substitution of long for short bonds. More recently, Braun and Shioji (2006), Ito (2009) and Fukuda (2011) have also considered recent Japanese experience given the persistence of near zero short-term interest rates over the past decade.

Nonetheless, there are two main concerns with monetary intervention in the form of simple manipulation of the term structure of government securities. First, aside from capital adequacy and liquidity implications for banks in restricting supply, changing the government yield curve may prove insufficient in triggering new investment by financial intermediaries. In part, this implies a need to understand how changes in nominal risk-free yields flow through to the risky yields of corporate borrowers of equivalent maturity. For example, the theoretical prediction of structural credit spread models (e.g. Longstaff and Schwartz, 1995), where the difference in the risky and riskless yields is termed a credit spread, is that changes in riskless rates are negatively correlated with changes in credit spreads. Thus, lowering long rates through bond purchases may have the perverse effect of increasing the nominal yields on risky bonds.

In earlier work on Japanese bond markets, Pynnönen, Hogan and Batten (2002) and In, Batten and Kim (2003) also show that the interactions across and between risky and riskless yield curves of specific maturity and credit class are complex and temporal, and likely affected by liquidity and institutional factors such as the presence of futures contracts on specific bond maturities. Thus, the potential effects on economic growth via a financial markets channel, either from quantitative easing in its pure form through outright bond purchases or by changing expectations via the reshaping of the yield curve, may be compromised.

Second, while a yield curve twist may be sanitised in terms of overall market liquidity effects, outright quantitative easing via purchases of selected maturities is clearly not. Of potential concern is the risk-taking that this may encourage in investors with long-term liabilities (such as pension funds and insurance companies) who face supply-side restrictions on the availability of risk-free assets. Financial intermediaries may also have compromised their maturity gap positions as a result of the reshuffling of their securities portfolios. While new on-balance-sheet (gap) positions can be accommodated using interest rate derivatives, these off-balance-sheet transactions require an additional capital charge.

2. Some stylised facts on U.S. term structure behaviour

In their modelling of financial sector impacts, CFHZ utilise a term structure variable based on the difference between the 10-year and 3-month U.S. Treasury yield. One is mindful when reviewing their findings of the need for understanding the complex dynamics of the term structure relationship itself as well as the potential effects of interest rate effects on asset prices. To assist in forming better judgements of these relationships, this section provides three important insights into the behaviour of the U.S. Treasury term structure from 2000–2011: (a) the relationship between stock prices and changes in the shape of the yield curve; (b) the relationship between long- and short-term components of the yield curve; and (c) the relationship between changes in the shape of the curve and the business cycle. These issues are discussed in sequence.

A. The relation between stock prices and interest rates

The relation between the business cycle and changes in the interest rate term structure is a well-documented phenomenon, and in the case of the U.S. is clearly evident from Figure 1, which plots the nominal difference in yield between the 10-year and 5-year benchmark (U.S. Treasury) bonds. The two interest rate episodes when there are negative rates (10-year < 5-year yield) are associated with periods of recession. Thus, a positive gradient is typically associated with periods of economic growth, whereas a negative gradient is associated with an economic downturn (see also Ang, Piazzesi and Wei, 2006).

To highlight the link between expectations of changes in interest rates and asset prices, we begin by dividing U.S. Government bond yields (term structure) into two components: a short-term component (U.S. 5-year T-Bond yield minus the U.S. 13-week T-Bill yield) and a long-term component (U.S. 30-year T-Bond yield minus the 5-year T-Bond). A theoretical foundation for the relationship between changes in interest rates and stock prices may be found in structural models of corporate bond pricing, where rising asset prices relative to constant values of debt are linked to improved firm solvency and declining probabilities of default (Longstaff and Schwartz, 1995). Business cycle implications also need to be considered, since these episodes coincide with shifts in corporate default outcomes and investor preferences for riskless securities.

Figure 2 plots the rolling 66-day regression betas of the relationship between stock index returns, proxied by changes in the Dow Jones Industrial Average (DJIA) stock index, and changes in the two components of the U.S. term structure, for the period from January 2000 to December 2012 (2,995 daily observations). The blue line represents the DJIA correlation with changes in the short end of the yield curve (5y–13w), while the red line represents changes in the long end of the yield curve (30y–5y). It is clear from this figure that these two yield curve components appear negatively correlated to one another, while the degree of correlation with the DJIA index is time dependent.

B. The relation between the long and short end of the term structure

The next Figure (3) shows the 66-day correlation between the short and long end of the U.S. yield curve over the same 2000–2011 period. As is evident in the figure, rarely over the past decade have the short and long ends of the U.S. term structure moved together (characteristic of a parallel shift in the U.S. yield curve). Historically, the relationship is negative, although the degree of correlation is time-variant. One interpretation of this finding is that an accommodative monetary policy in the short term may be perceived as encouraging inflation in the longer term (see Gürkaynak, Sack and Wright, 2010). Note that the positive spike in the correlation in late 2011 may be linked to the combined effects of QE2 and Operation Twist.

The negative correlation between the long and short end implies that the yield curve typically pivots in response to economic news that is deemed maturity-specific, or due to liquidity factors brought about by the issuance maturities of new bonds and the on-the-run auction premiums paid by investors. These observations are consistent with more complex explanations of yield curve behaviour than provided by expectations or segmentation theories (see Gürkaynak and Wright, 2010), which suggests that "term structure movements cannot always be understood in terms of changes in expected short term interest rates, inflation or other macroeconomic variables, but that shifts to clientele demand and bond supply are also an important driver" (Greenwood and Vayanos, 2010: 585).

C. Time-varying yield curve volatility

The volatility relationships between yields in the U.S. term structure are estimated using two approaches. While it is commonplace to measure asset volatility based on a regular time interval (such as a day), we first utilise a more complex measure, the Garman and Klass (1980) estimator (GKe)[5], which measures volatility based on differences between the open, close, high and low prices within a particular time interval, which in this instance is one day. This estimator assumes that prices follow geometric Brownian motion with zero drift.

Table 1

Intraday volatility (GKe) estimates of U.S. 5-year, 10-year and 30-year T-Bonds 2000–2011

Year	N	μ(5Y-UST) GKe	μ(10Y-UST) GKe	μ(30Y-UST) GKe	σ(5Y-UST)GKe	σ(10Y-UST)GKe	σ(30Y-UST)GKe
2000	249	0.000013	0.0000110	0.000010	0.000023	0.0002317	0.000016
2001	248	0.000033	0.0000729	0.000012	0.000051	0.0002322	0.000022
2002	250	0.000057	0.0000722	0.000013	0.000060	0.0001253	0.000013
2003	252	0.000095	0.0000645	0.000019	0.000087	0.000074	0.000016
2004	252	0.000048	0.0000278	0.000011	0.000086	0.0000478	0.000013
2005	250	0.000021	0.0000244	0.000014	0.000026	0.0000258	0.000015
2006	251	0.000010	0.0000126	0.000009	0.000010	0.0000092	0.000009
2007	251	0.000028	0.0000249	0.000012	0.000039	0.0000326	0.000014
2008	253	0.000212	0.0001246	0.000043	0.000325	0.0001711	0.000057
2009	252	0.000156	0.0001247	0.000053	0.000190	0.0001741	0.000102
2010	251	0.000148	0.0000748	0.000026	0.000219	0.0000773	0.000043
2011	235	0.000235	0.0001442	0.000037	0.000281	0.0002403	0.000044
F-Statistic		65.33	26.94	34.04			
p-value		0.000	0.000	0.000			
Adjusted R^2		19.12	8.70%	10.83			

Source: Thomson-Reuters Eikon and Yahoo Finance: U.S. 30-year, U.S. 10-year and U.S. 5-year benchmark bond yields, January 1, 2000 – December 7, 2011. The Garman-Klass estimator is based on the daily open, close and high and low prices (yields).

The GKe for the U.S. 5-year, 10-year and U.S. 30-year bonds are reported in Table 1 and plotted in Figure 4. A One-Way ANOVA of mean differences in intraday volatility estimated

5 The GKe is $s^2 = 0.511(H-L)^2 - 0.019(C-0)(H+L-2C)(l-C) - 0.383(C-O)^2$.

by the GKe (for the 12 years from 2000 to 2011) is significant, with the *F-statistic* improving in size as the maturity decreases. Thus, intraday volatility is higher for shorter-term bonds, with the 5-year bond having the highest intraday volatility in all years. The sudden increase in intraday volatility (evident in Figure 4) in the past 3-4 years is unexpected and is likely due to the destabilising effects of the GFC, as investors sought risk protection through purchases of U.S. Government securities.

The volatility relationship between the short (13-week to 5-year) and long (5-year to 30-year) end of the yield curve was also measured as the interday difference in yield, and reported in Table 2. Overall, the short end of the yield curve was also more volatile than the long end, measured both in levels and differences. The long end of the U.S. Treasury term structure steepened from 2000 to 2003, declined to 2005 and then steepened again from 2006 to 2011. The short end steepened from 2000 to 2002, declined from 2004 to 2006, steepened from 2006 to 2009 and declined thereafter.

Yield curve inversion also occurred, and this phenomenon can be linked to business cycle expansions and contractions. The negative average of –0.2073 and the average of 0.1355 for μ(30y–5y) in 2000 and 2006 signalled the onset of the U.S. recessions of April 2001 and January 2008 as determined by the NBER Business Cycle Dating Committee. Note that banks typically face declining interest margins during periods of yield curve inversion. Apart from the rising relative costs of funding sources such as deposits or securities issuance, capital constrained banks can typically resort to securitisation to regain liquidity (see Estrella, 2002; Altunbas, Gambacorta and Marques, 2007). However, during the global financial crisis period, securitisation prospects diminished as market conditions deteriorated.

3. The recent scale and scope of bank internationalisation

One key area of investigation of the CFHZ paper is bank credit. Their analysis extends other recent work on the role of lending during the GFC and on the importance of the bank lending channel in stimulating economic growth (e.g. Altunbas, Gambacorta and Marques-Ibanez, 2007; Disyatat, 2010; Gambacorta and Marques-Ibanez, 2011). One potential cross-border transmission channel is through bank internationalisation as perverse domestic economic circumstances force domestic banks to seek investment opportunities abroad. Note that since recent changes in monetary policy have occurred against a background of ongoing banking sector disintermediation, consolidation, heightened competition and extensive political pressure to improve financial sector regulation, it may be difficult to disentangle which of these factors dominates or has the most important impact on bank lending.

Investigation of the international positions of banks nonetheless provides additional insights into the broader question of whether banks responded to the domestic monetary conditions by expanding internationally. We follow the approach adopted by Batten and Szilagyi (2011a, 2011b), who investigate the internationalisation of banks using data sourced from the Bank for International Settlements (BIS). These data show that there was an increase in total international assets from US$9,495.3 billion in 1995 to US$35,279.3 billion in March 2011, and an increase in international liabilities from US$9,306.8 billion to US$33,451.5 billion over the same period. Note that apart from two earlier episodes in the late 1980s and 1995, the share of non-bank assets has continued to increase, with the GFC providing only a minor interruption to this trend. Internationalisation provides benefits to the lending institution in the form of credit diversification, despite the costs of monitoring and the potential information asymmetries present in foreign markets.

Table 2

Levels and changes in the long end (5-year to 30-year) and short end (13 week to 5-year) of the U.S. term structure 2000–2011

Year	N	μ(30y-5y)	σ(30y-5y)	M(5y-13w)	σ(5y-13w)	μ(30y-5y)Δ	σ(30y-5y)Δ	μ(5y-13w)Δ	σ(5y-13w)Δ
2000	249	–0.2073	0.2733	0.3355	0.6100	0.00137	0.03821	–0.00779	0.08115
2001	248	0.9923	0.2958	1.1115	0.8280	0.0027	0.05446	0.01375	0.07250
2002	250	1.5301	0.3714	2.1572	0.5770	0.0036	0.03954	–0.00444	0.06916
2003	252	1.9910	0.1126	1.9352	0.3929	–0.00079	0.03612	0.00302	0.07188
2004	252	1.6162	0.2117	2.0490	0.4591	–0.00254	0.02932	–0.00349	0.06264
2005	250	0.5291	0.2203	0.9068	0.3317	–0.00408	0.02602	–0.00420	0.04658
2006	251	0.1355	0.0801	0.0288	0.2451	–0.00028	0.01995	–0.00227	0.08409
2007	251	0.4149	0.2967	0.0900	0.3627	0.00355	0.03191	0.00199	0.10365
2008	253	1.4830	0.2301	1.4596	0.5711	0.00051	0.06360	0.00443	0.12451
2009	252	1.8919	0.1881	2.0506	0.3658	0.00321	0.04903	0.00480	0.08143
2010	251	2.3357	0.2428	1.7855	0.4881	0.00155	0.03690	–0.00295	0.06170
2011	235	2.4226	0.2253	1.5042	0.4791	–0.00072	0.04673	–0.00409	0.05807

Source: Thomson-Reuters Eikon and Yahoo Finance: Daily U.S. 13-week T-bills, U.S. 30-year and U.S. 5-year benchmark bond yields, January 1, 2000–December 7, 2011. The long end of the U.S. yield curve is the difference in yield between the U.S. 30-year and U.S. 5-year bond, while the short-end is the difference in yield between the U.S. 5-year bond and the U.S. 13-week Treasury note.

The international positions may also be expressed as a ratio of international assets to international liabilities. This ratio ranges from 102.03 in December 1995 to 103.15 in March 2011 for total assets and liabilities, and a slightly higher ratio of 103.08 to 105.57 over the same period for external assets and liabilities. Figure 5 provides a quarterly plot of this ratio for the period from December 1977 to March 2011. Also plotted is a 2-year moving average to better show the trend in the ratio over time. Of particular significance in this graph is the sudden decline in the ratio following the GFC. This suggests a deliberate strategy by financial intermediaries to better match quantities of international assets and liabilities over the past decade.

Specific detail on the net positions of bank external assets, categorised by country and region, are reported in Table 3. The first key result is that external assets of BIS banks to all countries exceeded liabilities by about US$1.65 trillion in March 2011. Importantly, this amount is 18.09% less than in December 2007 and signals reduced on-balance-sheet risk. This outcome has come at the cost of reduced international lending and a preference for matching international assets and liabilities, which likely signals reduced risk-taking and bank profitability. The prospect of Basel III implementation also weighs on the banking system, and along with continued international economic uncertainty encourages risk aversion and more conservative lending and banking practices.

At a country level there is considerable heterogeneity in net positions amongst those developed nations shown in Table 3. For example, Germany reduced the size of its net deficit (meaning less lending). By comparison to these positions, Japan now has net borrowings of US$117 billion. Note that the major source for these funds is the offshore centres (US$564 billion) and the Africa-Middle East region (US$286 billion).

The second key result is the change in the positions of the U.K. and the U.S. The U.S. is especially relevant given the focus of QE by the U.S. monetary authorities in recent years. Historically, both the U.K. and the U.S. were net receivers of international bank funds (e.g. US$ 1.93 trillion in December 2007), with the U.S. being the larger of the two (US$ 1.42 trillion in December 2007). This situation has changed post-GFC: the U.S. remains a net receiver, albeit at a much lower level (US$729 billion in March 2011, which is a 48.8% reduction from 2007), whereas the U.K. is now a net international lender (US$ 29.8 billion in March 2011). The U.S. situation is therefore at odds with the view that U.S.-based banks internationalised to leverage cheap domestic funding, while there is limited evidence for the reverse applying to the U.K. Thus, despite similarities in the scale and scope of their international banking markets, they differ in that international banks lend significantly more to the US than is received, whereas the flows in and out of the UK tend to be more balanced.

Another point worthy of mention concerns the net flows through offshore centres, which have declined significantly since the GFC. For example, the preferred domicile location for U.S. SPVs, the Cayman Islands, has experienced a 754% reduction in the decline of net flows, to US$ 148 billion. Therefore, reduced domestic bank lending has also been associated with reductions in securitization and security issuance post-crisis. Table 3 also shows the net positions for developing countries and regions (lower panel). While the developing countries are historically net receivers of bank funds (US$788.1 billion in March 2011), the largest net inflow is emerging Europe, with US$473.9 billion in March 2010, while the region that provided the largest outflows was Africa-Middle East, with US$285.6 billion.

Overall, these tables show evidence of significant reductions – deleveraging – of international exposures after the onset of the GFC, though clear evidence of the reallocation of risky assets to other regions in order to diversify, or to reduce asset concentration, is not so apparent. This may in part be due to the role of financial centres in hiding the ultimate destination of lent (or borrowed) funds. Nonetheless, though significant, the flows through these centres were reduced as one consequence of the crisis.

Table 3

BIS Reporting Banks' Net Positions to Developed and Developing Countries and Offshore Centres (millions of US dollars)

Millions of US$	Dec. 2000	Dec. 2007	Dec. 2008	Dec. 2009	Sep. 2010	Dec. 2010	Mar. 2011	% Change 2000–2007	% Change 2007–2011
All countries	353,255	2,020,249	2,099,163	1,947,173	1,911,848	1,655,592	1,654,751	472	–18
Developed Countries	1,788,276	5,735,530	5,434,556	5,306,216	4,569,742	4,149,720	4,148,182	221	–28
(i) Euro area	1,250,946	3,671,326	3,628,012	3,716,696	3,307,020	2,979,959	2,866,627	193	–22
United Kingdom	43,675	510,287	458,559	254,686	–60	88,987	–29,854	1,068	–106
Germany	300,179	–287,150	–362,391	–253,370	–88,614	–42,632	–87,532	–196	–70
France	214,704	788,661	668,284	609,996	575,450	553,775	500,305	267	–37
ii) Other developed countries	642,016	1,789,936	1,436,229	1,288,022	1,236,160	1,051,771	1,296,473	179	–28
Japan	53,056	–97,737	–199,037	119,883	200,519	208,117	117,142	–284	–220
United States	462,038	1,424,537	1,230,716	708,332	618,699	411,299	729,047	208	–49
(iii) Offshore centres	–429,685	–1,119,908	–1,259,499	–979,139	–670,784	–604,340	–564,638	161	–50
Cayman Islands	–51,440	22,650	–296,692	–122,992	–37,709	–96,544	–148,230	–144	–754
Singapore	–56,748	–91,399	–38,074	–41,055	–11,824	14,859	43,994	61	–148
Hong Kong SAR	–153,595	–378,480	–293,604	–204,561	–117,494	–59,300	–13,412	146	–96
Developing countries	–126,231	–120,800	272,249	332,770	613,840	656,404	788,086	–4	–752
Africa & Middle East	–152,821	–413,675	–318,715	–275,006	–236,305	–240,533	–285,633	171	–31
Asia & Pacific	–65,751	–28,807	65,465	118,453	299,837	346,394	475,165	–56	–1,749
Europe	51,753	302,007	509,943	457,616	455,612	444,279	473,885	484	57
Latin America/Caribbean	40,588	19,675	15,556	31,707	94,696	106,264	124,669	–52	534

Source: BIS Quarterly Review: September 2011: Table 6A. Loans comprise those financial assets which are created through the lending of funds by a creditor (lender) to a debtor (borrower) and which are not represented by negotiable securities. Deposits comprise all claims reflecting evidence of deposit – including non-negotiable certificates of deposit (CDs) – which are not represented by negotiable securities. Thus, loans and deposits include interbank borrowings and loans and inter-office balances (BIS 2008, "Guidelines to the International Locational Banking Statistics", Monetary and Economic Department, November 2006 and update December 2008).

4. Time variation in the foreign exchange correlation structure

The final factor that helps to explain the CFHZ findings involves the identification of the degree of time variation in the correlation, or covariance, structure of foreign exchange rates. This variation will affect the propensity for risk taking by banks. For example, if the covariance structure remains stable over time then financial intermediaries can be more confident about their ability to diversify market risks. If a region becomes more integrated, in an economic or political sense, then the quandary for intermediaries is that idiosyncratic risks then become harder to diversify.

These observations lead to two related questions, which share aspects which are difficult to disentangle. First, to what extent has the GFC contributed to further economic integration of the Asia-Pacific region and second, did improved integration assist in the transmission of central bank balance sheet policies during the GFC episode?

While CFHZ also consider these questions in some detail, a simple measure of the scale and scope of the problem is to determine the degree of convergence, in the form of higher correlations, of exchange rate returns. This exercise should provide further insights into the problem faced by financial intermediaries in their efforts to diversify their assets across the Asia-Pacific region.

To assess these impacts, we form equally weighted currency portfolios comprising major Asia-Pacific and European currencies, with all currency pairs priced against the US dollar. Some basic statistics of these currencies are reported in Table 4A, while the correlation structure between the currency pairs is reported in Table 4B. Over the sample period the USD/NZD was the most volatile pair, while the USD/CNY was the least. A number of currency pairs displayed negative skewness (especially the USD/KRW and the USD/HKD) and positive kurtosis (USD/HKD, USD/KRW, and the USD/CNY). These higher moments add to the difficulty of diversifying currency portfolios based on a standard mean-variance framework.

The correlation matrix shows that the highest pairwise correlation was between USD/AUD and USD/NZD (0.852), followed by the correlation between USD/EUR and USD/SWF (0.809). The currency pair most highly correlated to other currency pairs was USD/SGD, whereas the least was USD/CNY. Interestingly USD/AUD and USD/NZD had no significant correlation to USD/JPY, despite evidence of carry-trade related capital flows.

These currencies were then used to form four portfolios comprising equally weighted component currencies: (a) European currencies: euro, Swiss franc and U.K. pound; (b) other Western currencies: Australian, Canadian and New Zealand dollars; (c) Northern Asia-Pacific currencies: China, Japan, Korea and Taiwan; and (d) Southern Asia-Pacific currencies: Hong Kong, Malaysia, Singapore and Indonesia. The descriptive statistics of these portfolios are reported in Table 4C, which shows that the least-risk portfolio was (d), while the most risky was (b). Portfolio (d) also had the highest kurtosis, while (c) had negative skewness. The correlation pairs reported in Table 4D show that the highest pairwise correlation (0.640) was between portfolios (a) and (b), whereas the least (0.385) was between portfolios (a) and (d). Importantly, the size of these correlations provides a simple measure of the extent of regional currency integration, and also highlights the difficulty of adequately diversifying currency portfolios, although selectively targeting individual currencies may offer more promise. Rolling 22-day correlations between these portfolios, plotted in Figure 6, do however highlight the time-dependent nature of the covariance structure.

Table 4A

Descriptive Statistics of Major Spot Currencies, January 1, 2000 to December 7, 2011

Variable	Mean	SE Mean	Standard Deviation	Minimum	Median	Maximum	Skewness	Kurtosis
USD/AUD	–0.00015	0.00016	0.00880	–0.07156	–0.00053	0.08	0.36	7.21
USD/EUR	–0.00009	0.00013	0.00701	–0.04102	–0.00013	0.04	0.08	1.92
USD/JPY	–0.00009	0.00012	0.00646	–0.03370	–0.00003	0.04	–0.06	2.71
USD/GBP	0.00002	0.00011	0.00623	–0.03387	–0.00008	0.05	0.49	4.89
USD/CHF	–0.00018	0.00014	0.00746	–0.03883	–0.00014	0.09	0.50	7.90
USD/NZD	–0.00013	0.00017	0.00911	–0.04747	–0.00069	0.05	0.38	2.33
USD/CAD	–0.00012	0.00011	0.00608	–0.06851	–0.00019	0.04	–0.26	7.50
USD/HKD	0.00000	0.00001	0.00030	–0.00375	0.00000	0.00	–1.21	23.86
USD/SGD	–0.00009	0.00006	0.00328	–0.02461	–0.00014	0.02	0.08	3.76
USD/MYR	–0.00006	0.00005	0.00292	–0.02295	0.00000	0.02	–0.12	7.71
USD/TWD	–0.00001	0.00005	0.00273	–0.03097	0.00005	0.03	–0.07	14.45
USD/KRW	0.00000	0.00013	0.00734	–0.12186	–0.00015	0.09	–0.98	45.04
USD/IDR	0.00008	0.00014	0.00788	–0.09660	0.00002	0.13	0.54	45.49
USD/CNY	–0.00009	0.00004	0.00230	–0.05947	0.00000	0.06	–0.15	599.21
USD/SDR	–0.00004	0.00006	0.00342	–0.03768	–0.00004	0.04	0.01	13.25

Table 4B

Spot currency correlation matrix January 1, 2000 to December 7, 2011

	USD / AUD	USD / EUR	USD / JPY	USD / GBP	USD / CHF	USD / NZD	USD / CAD	USD / HKD	USD / SGD	USD / MYR	USD / TWD	USD / KRW	USD / IDR	USD / CNY
USD / EUR	0.6290													
	0.0000													
USD / JPY	–0.0250	0.2110												
	0.1770	0.0000												
USD / GBP	0.5810	0.6640	0.1160											
	0.0000	0.0000	0.0000											
USD / CHF	0.4340	0.8090	0.3680	0.5290										
	0.0000	0.0000	0.0000	0.0000										
USD / NZD	0.8520	0.6000	0.0060	0.5600	0.4290									
	0.0000	0.0000	0.7630	0.0000	0.0000									
USD / CAD	0.6480	0.4930	–0.0350	0.4760	0.3370	0.5640								
	0.0000	0.0000	0.0540	0.0000	0.0000	0.0000								
USD / HKD	0.1230	0.1640	0.1110	0.1250	0.1450	0.1250	0.1140							
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000							
USD / SGD	0.6230	0.5930	0.2350	0.4940	0.4720	0.5780	0.5160	0.2060						
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000						

Table 4B (cont)

Spot currency correlation matrix January 1, 2000 to December 7, 2011

	USD / AUD	**USD / EUR**	**USD / JPY**	**USD / GBP**	**USD / CHF**	**USD / NZD**	**USD / CAD**	**USD / HKD**	**USD / SGD**	**USD / MYR**	**USD / TWD**	**USD / KRW**	**USD / IDR**	**USD / CNY**
USD / MYR	0.4880	0.3820	–0.0730	0.3280	0.2470	0.4510	0.4420	0.1890	0.6240					
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					
USD / TWD	0.4030	0.3570	0.1500	0.3140	0.2770	0.3820	0.3470	0.1440	0.5540	0.4330				
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
USD / KRW	0.5040	0.3360	–0.0160	0.3080	0.2180	0.4230	0.4280	0.0860	0.5680	0.4600	0.5070			
	0.0000	0.0000	0.3770	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
USD / IDR	0.2710	0.1650	0.0110	0.1620	0.0970	0.2400	0.2310	0.0520	0.3320	0.2440	0.2240	0.2570		
	0.0000	0.0000	0.5450	0.0000	0.0000	0.0000	0.0000	0.0040	0.0000	0.0000	0.0000	0.0000		
USD / CNY	0.0570	0.0800	0.0470	0.0810	0.0760	0.0410	0.0350	0.0470	0.1000	0.0930	0.0650	0.0340	0.0130	
	0.0020	0.0000	0.0110	0.0000	0.0000	0.0250	0.0560	0.0110	0.0000	0.0000	0.0000	0.0600	0.4740	
USD / SDR	0.1400	0.2660	0.1340	0.2200	0.2460	0.1590	0.0660	0.1190	0.1840	0.1250	0.1750	0.0940	0.0410	0.0500
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0260	0.0100

Table 4C

Descriptive statistics of currency portfolios

Variable	Mean	SE Mean	Standard Deviation	Minimum	Median	Maximum	Skewness	Kurtosis
PRT(E-C-G)	–0.000251	0.000335	0.018312	–0.100676	–0.000239	0.103563	0.01	1.77
PRT(A-NZ-C)	–0.000396	0.000395	0.021582	–0.180694	–0.001224	0.142099	0.21	5.10
PRT(C-J-K-T)	–0.000184	0.000213	0.011651	–0.116242	–0.000230	0.069746	–0.38	7.13
PRT(H-S-M-I)	–0.0000668	0.000203	0.011077	–0.094778	–0.000167	0.128233	0.25	13.03

Table 4D

Correlation matrix of currency portfolios

	PRT(E-C-G)	PRT(A-NZ-C)	PRT(C-J-K-T)
PRT(A-NZ-C)	0.6400		
	0.0000		
PRT(C-J-K-T)	0.4540	0.4170	
	0.0000	0.0000	
PRT(H-S-M-I)	0.3850	0.5270	0.4500
	0.0000	0.0000	0.0000

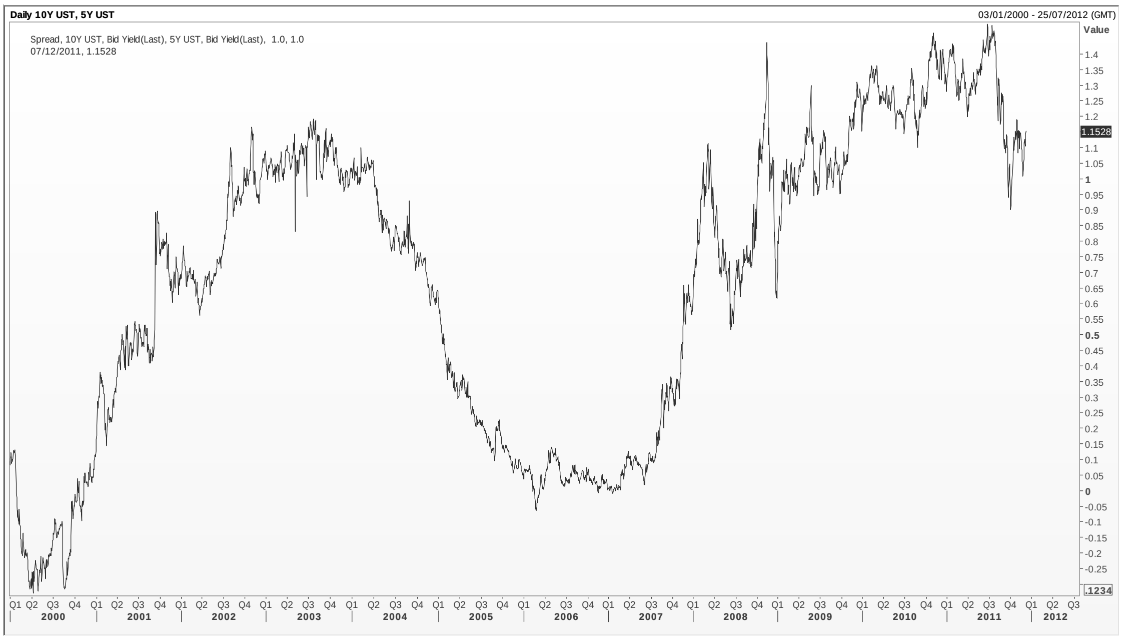
5. Discussion and concluding remarks

This discussion provides additional support for the cross-border impact of QE as evidenced by CFHZ (2012), in that the impacts varied and appear linked to heterogeneity in the economic, financial and regulatory structures of emerging economies in the Asia-Pacific and South American regions. We attribute this to three factors: First, time-dependent volatility and correlations along the US yield curve introduce complexity (and uncertainty) in the transmission mechanism between the U.S. term structure and others. Introducing the time-dependent covariance structure of exchange rates adds to market risk and so may limit the potential desire by domestic banks to internationalise their balance sheets. Second, bank net international positions highlight the dynamic nature of international asset/liability management and provide further evidence of more risk-averse lending strategies. Collectively these findings help explain the limited cross-border impact of quantitative easing. In addition, the segmented nature of Asian economies, evidenced by their exchange rate correlation structures, may also explain the heterogeneity in cross-border impacts of QE1 and QE2.

In sum, the CFHZ paper offers important insights into the cross-border effects of QE 1 and 2 and represents a first step in understanding the complexity of the international transmission process. The need for better understanding of these relationships cannot be understated, since despite multiple attempts at stimulus using a variety of conventional and unconventional monetary and fiscal means (despite obvious budgetary constraints), the international economy remains in a precarious state.

Figure 1

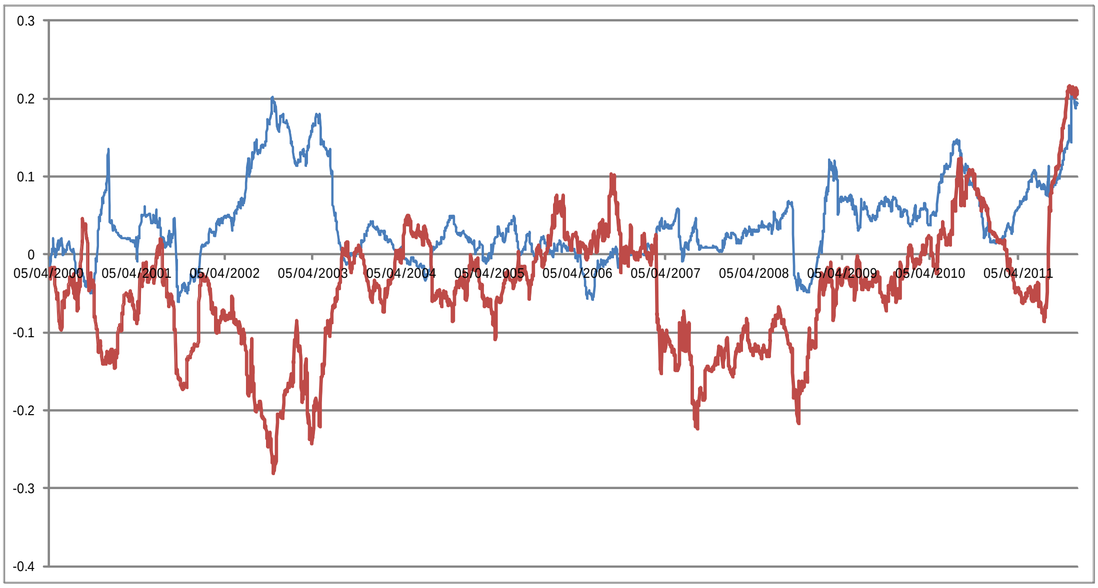
The business cycle and the U.S. term structure: The difference between 10-year and 5-year U.S. Treasury Bonds



Source: Thomson-Reuters Eikon. U.S. 10-year – U.S. 5-year benchmark bond yields, January 1, 2000 – December 7, 2011.

Figure 2

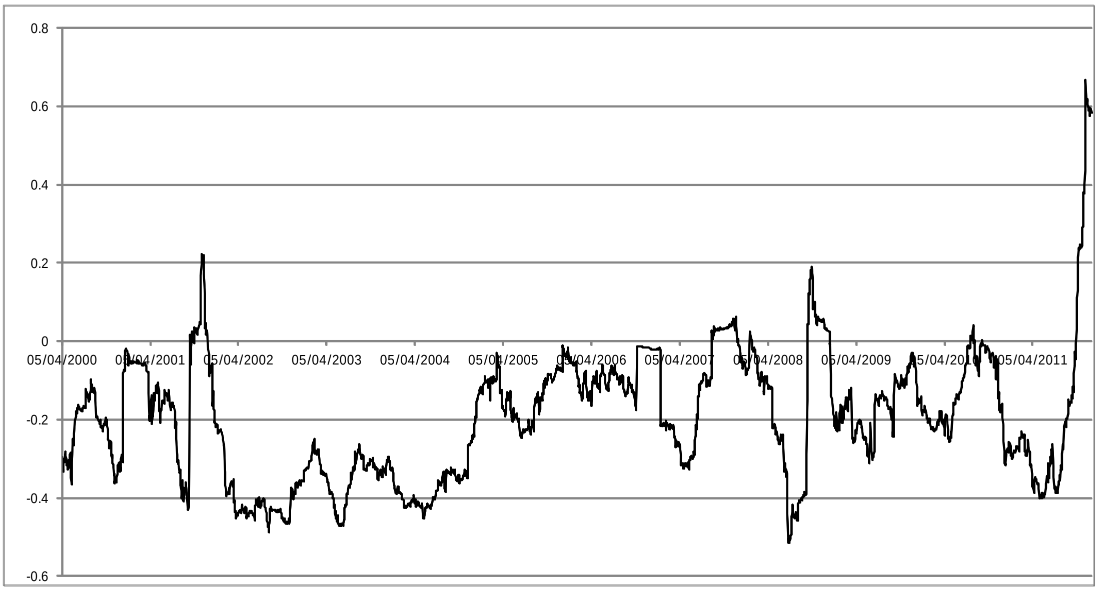
The relationship between changes in U.S. stock prices (DJIA) and changes in the long and short ends of the U.S. term structure



Source: Thomson-Reuters Eikon and Yahoo Finance: Daily U.S. 13-week T-bills, U.S. 30-year and U.S. 5-year benchmark bond yields, January 1, 2000 – December 7, 2011. The long end of the U.S. yield curve is the difference in yield between the U.S. 30-year and U.S. 5-year bonds, while the short end is the difference in yield between the U.S. 5-year bond and the U.S. 13-week Treasury note. The red line represents the DJIA correlation with changes in the long end of the yield curve, while the blue line represents changes in the short end of the yield curve.

Figure 3

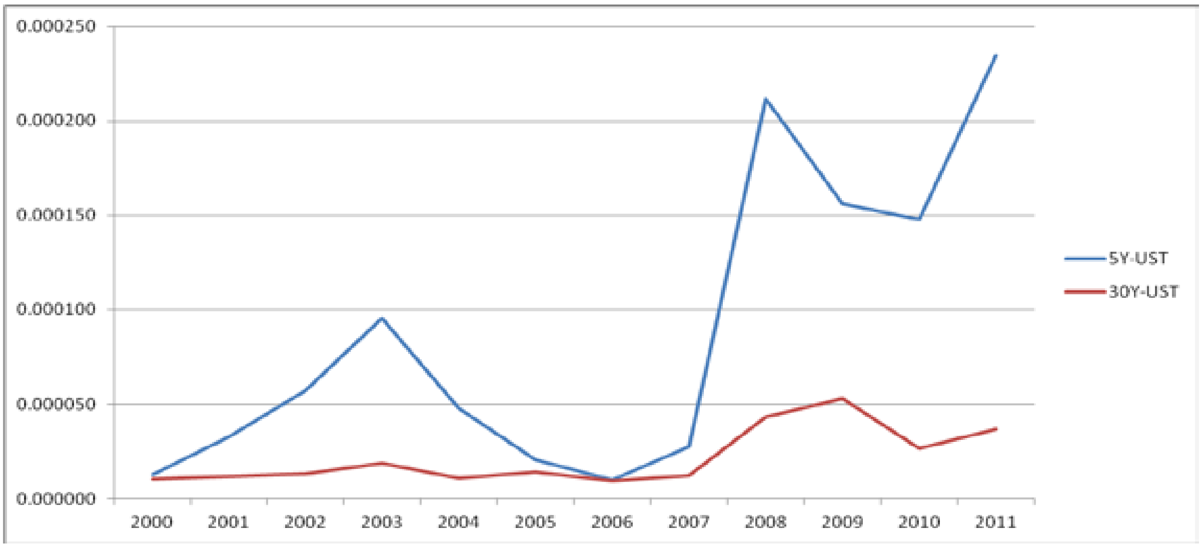
Correlation between long-end and short-end changes in the U.S. Term Structure



Source: Thomson-Reuters Eikon and Yahoo Finance: Daily U.S. 13-week T-bills, U.S. 30-year and U.S. 5-year benchmark bond yields, January 1, 2000 – December 7, 2011. The long end of the U.S. yield curve is the difference in yield between the U.S. 30-year and U.S. 5-year bonds, while the short end is the difference in yield between the U.S. 5-year bond and the U.S. 13-week Treasury note.

Figure 4

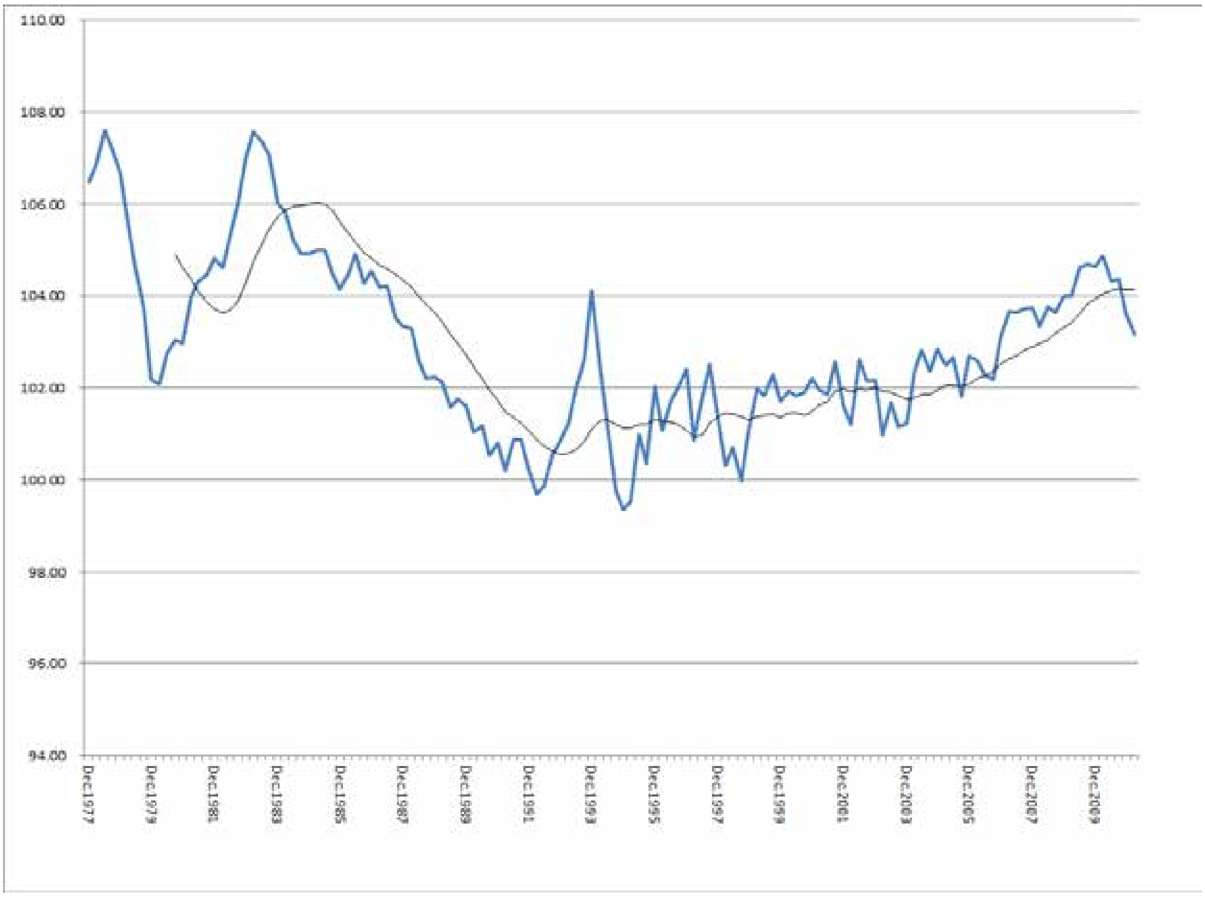
Plot of Garman-Klass intraday volatility estimates for the 5-Year and 30-Year U.S. T-Bonds



Source: Thomson-Reuters Eikon and Yahoo Finance: Daily U.S. 30-year and U.S. 5-year benchmark bond yields, January 1, 2000 – December 7, 2011. The Garman-Klass estimator is based on the daily open, close and high and low prices (yields).

Figure 5

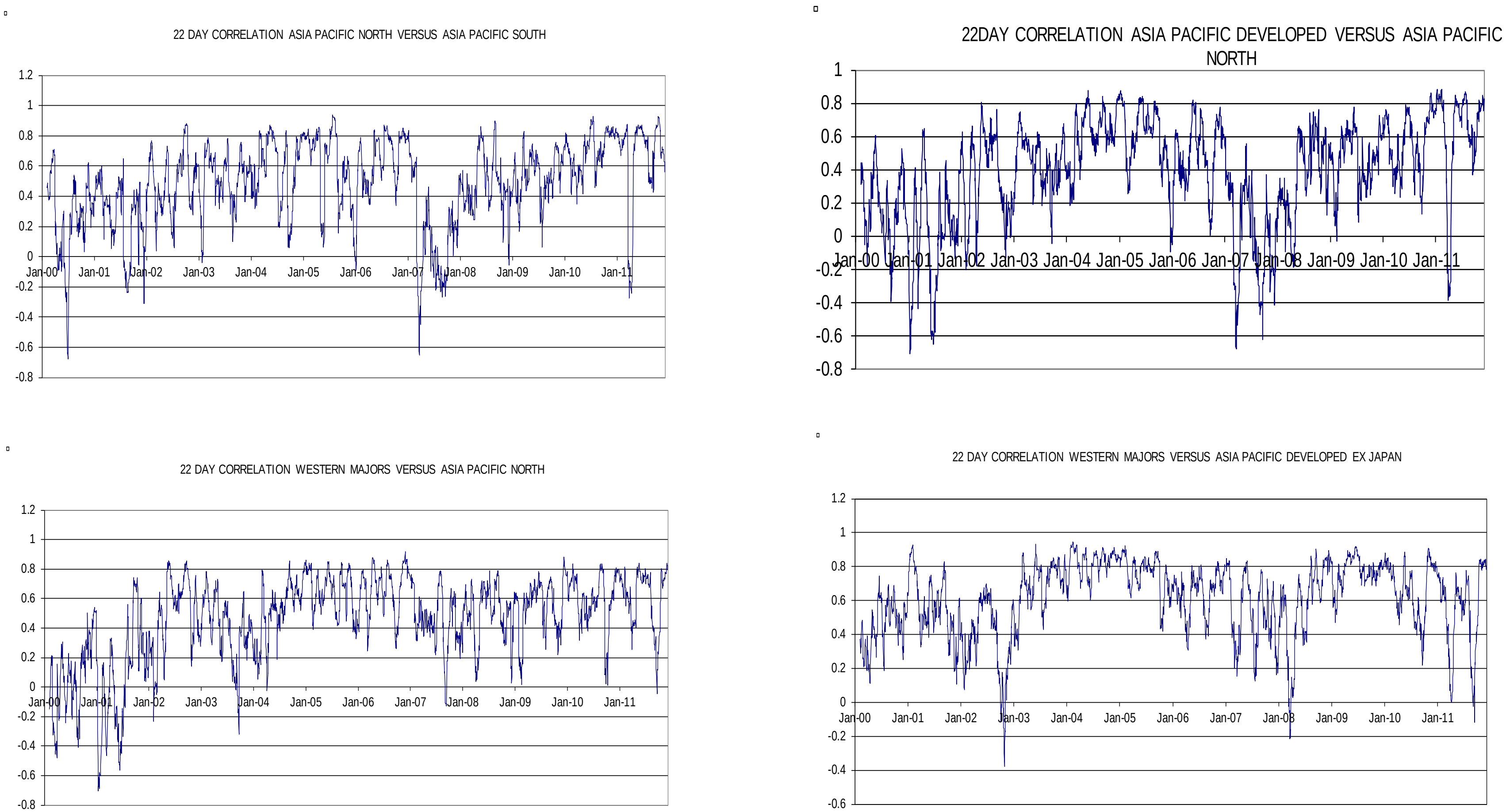
The Ratio of BIS Reporting Banks'International Assets to Liabilities 1977–2011



Source: Authors' calculations based on BIS (2011, September). In December 1977, the ratio of international assets to international liabilities was 106.46. This ratio has subsequently dropped to 103.15 as of March 2011. The blue (bold) line plots the quarterly ratio over this time period, while the grey (thin) line plots the 2-year (8 quarters) average. The y-axis shows the ratio of international assets to international liabilities.

Figure 6

22-day rolling correlation between various currency portfolios
(Asia North, Asia South, Western Majors, Asia-Pacific Developed)



References

Altunbas, Yener, Gambacorta, Leonardo and David Marques-Ibanez (2007), "Securitisation and the Bank Lending Channel" (November 2007). *Bank of Italy Temi di Discussione (Working Paper) no. 653; ECB Working Paper no. 838*. Available at SSRN: http://ssrn.com/abstract=1032833.

Ang, A., Piazzesi, M. and M. Wei (2006), "What does the Yield Curve tell us about GDP growth?" *Journal of Econometrics* 131, pp. 359–403.

Batten, Jonathan A. and Peter G. Szilagyi (2011a), "The Recent Internationalisation of Japanese Banks". The Japanese Economy 38(1), spring: 81–120.

Batten, Jonathan A., and Peter G. Szilagyi (2011b), "Bank Internationalisation during the Global Financial Crisis: An Asia Pacific Perspective". Journal of the Asia Pacific Economy, 16(3), August, pp. 372–392.

Bekaert, G. and C. Harvey (1995), "Time Varying World Market Integration". Journal of Finance, 50(2), pp. 403–44.

Bekaert, G., Harvey, C. and A. Ng (2005), "Market Integration and Contagion". Journal of Business, vol. 78, pp. 39–69.

Bernanke, B. S. and M. Gertler (1999), "Inside the Black Box: The Credit Channel of Monetary Policy Transmission". Journal of Economic Perspectives, 9 (4), pp. 27–48.

Bernanke, B. S. and V. R. Reinhart (2004), "Conducting Monetary Policy at very low Short-term Interest Rates". American Economic Review, 94(2), pp. 85–90.

Bernanke, B. S. Reinhart, V. R. and B. P. Sack (2004), "Monetary Policy Alternative at the Zero Bound: An Empirical Assessment". Brookings Papers on Economic Activity, 2, pp. 1–78.

Braun, A.R. and E. Shioji (2006), "Monetary Policy and Term Structure of Interest Rates in Japan". Journal of Money, Credit and Banking, 38 (1), pp. 141–162.

Chen, Qianying, Filardo, Andrew, He, Dong and Feng Zhu (2012), "The Impact of Central Bank Balance Sheet Policies on the Emerging Economies". this volume.

Disyatat, Piti (2010), "The bank lending channel revisited", BIS Working Papers, no. 297: http://www.bis.org/publ/work297.htm.

Estrella, A. (2002), "Securitization and the Efficacy of Monetary Policy". *FRBNY Economic Policy Review*, May, pp. 243–255.

Fukuda, S. (2011), "Nontraditional Financial Policies: Zero Interest Rates and Quantitative Easing". The Japanese Economy, 38(2), pp. 45–78.

Gambacorta, L. and D. Marques-Ibanez (2011), "The bank lending channel: Lessons from the crisis", BIS Working Paper no. 345. Monetary and Economic Department, May. Bank for International Settlements, Basel, Switzerland.

Garman, M. and M. Klass (1980), "On the Estimation of Security Price Volatilities from Historical Data". *Journal of Business*, 53:67–78.

Gerard, Bruno, Thanyalakpark, Kessara and Jonathan Batten (2003), "Are the East Asian Markets Integrated: Evidence from the ICAPM". Journal of Economics and Business. 55: 585–607.

Greenwood, Robin and Dimitri Vayanos (2010), "Price Pressure in the Government Bond Market". *American Economic Review*, 100(2): 585–90. DOI:10.1257/aer.100.2.585.

Gürkaynak, Refet S., Sack, Brian P. and Jonathan H. Wright (2007), "The U.S. Treasury Yield Curve: 1961 to the Present". *Journal of Monetary Economics*, 54, pp. 2291–2304.

Gürkaynak, Refet S., Sack, Brian P. and Jonathan H. Wright (2010), "The TIPS Yield Curve and Inflation Compensation". *American Economic Journal: Macroeconomics*, 2, pp.70–92.

In, Francis, Batten, Jonathan and Sangbae Kim (2003), "What Drives the Japanese Yen Eurobond Term Structure". *Quarterly Review of Economics and Finance*, 43(3): 518–541.

Ito, T. (2009), "Zero Interest Rate Policies and Quantitative Easing", in Macroeconomic Stability and Financial Regulation: Key issues for G20, editors M. Dewatripont, X. Freixas, R. Portes, pp. 67–79. London: Centre for Economic Policy and Research.

Longstaff, Francis A. and Eduardo S. Schwartz (1995), "A Simple Approach to Valuing Risky Fixed and Floating Rate Debt". *Journal of Finance*, vol. 50, no. 3, (July), pp. 789–819.

Lutkepohl, Helmut (2007), "Econometric Analysis with Vector Autoregressive Models", EUI Working Papers, ECO 2007/11: ISSN 1725–6704. European University Institute, Badia Fiesolana, Italy.

Pynnönen, Seppo, Hogan, Warren and Jonathan Batten (2002), "Expectations and Liquidity in High Grade Yen Bond Markets". *Journal of the Asia-Pacific Economy*, 7(3): 335–354.