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Abstract

Monetary policy loosening and the associated impact on credit availability may have played a role in the present financial crisis. If such liquidity risk exists and is undiversifiable, then loose monetary policy should be associated with a risk premium. This paper tests for the existence of such a premium in US and global equity markets, in an asset pricing framework which accounts for endogeneity from equity prices to credit availability.

JEL: E52, F31, G01, G15.

Keywords: Global excess liquidity, monetary policy, foreign exchange.

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Introduction

This paper asks whether equity market returns incorporate a risk premium for low interest rates, opposing the usual prediction that high interest rates constitute a risk factor. Low interest rates could constitute a risk factor if they lead to excess leverage, thus increasing crash risk. To limit the risk of endogeneity bias from equity prices to lending rates, common volatility in exchange rate markets is used as an indicator of the component of equity risk deriving from liquidity risk. Assuming that investors in equity and currency markets have access to the same global credit markets, the funding conditions faced by both investors are common across asset classes as well as assets. An increase in the shared component of volatility across assets could indicate the increased importance of liquidity conditions over fundamentals, signalling increased crash risk. In summary, this paper seeks to show that excessively low interest rates could increase leverage and crash risk, which in turn could increase excess equity returns, as investors demand compensation for this risk.

While there is a literature on incorporating liquidity risk in asset pricing models, to the best of the author's knowledge this will be the first paper to empirically test whether excessively loose global funding liquidity, rather than tight funding liquidity or low market liquidity, is a priced risk factor. This is akin to asking if investors know when interest rates are at a level which encourages excess leverage. If excess funding liquidity is a risk factor, then changes in common volatility may provide a means by which monetary policy or other financial oversight authorities can infer when low interest rates are causing or contributing to an asset price bubble.

The paper begins by establishing an empirical relationship between increased sensitivity of exchange rates to global shocks (increased common volatility) and changes in funding liquidity. This allows the liquidity-driven component of sensitivity to global shocks to be used as an indicator of the presence of global funding liquidity risk. Equity returns are then regressed on this factor. Commonality in variance is used because, unlike variance or covariance (commonality in returns), there is no clear mechanism whereby commonality in variance across assets in one market would influence global credit market conditions. Its use as an exogenous indicator of liquidity risk may therefore be less problematic than the use of commonality in returns. To further ensure the exogeneity of estimated liquidity risk to equity prices, predicted liquidity risk is used in the second stage. The procedure can be summed up as estimating a variable indicating excess liquidity and testing whether equity markets incorporate a risk premium when the excess liquidity indicator is high.

This paper relates most directly to Brunnermeier and Pedersen's (2009) contribution on Market and Funding Liquidity, where the authors derive an asset pricing equation which incorporates a cost of capital premium, part of which is asset specific and part of which is common across assets. Brunnermeier and Pedersen's model provides a theoretical justification for the contention that common variance across assets could depend on liquidity conditions. This paper also relates to the literature on volatility risk premia, but differs in that the volatility in question is not an asset's own volatility, but rather common volatility from the currency markets. Adrian and Shin (2008) note that changes in repo positions forecast the volatility risk premium, explaining that an expansion in balance sheets due to increased collateralized lending and borrowing releases new funding which chases yields, "selling the tails" and sending the risk premium higher. This provides some intuitive and empirical support for the contention that funding liquidity conditions can drive returns.

Finally, this paper also relates to the expansive literature on market liquidity premia, since market and funding liquidity are linked. Many studies have shown an asset-specific market liquidity premium. Ang et al (2006) have studied aggregate market liquidity, showing that this too is priced in equities. The present paper contributes to this literature in three ways:

it offers an economic argument for the significance of aggregate liquidity which differs from the usual market liquidity premium hypothesis, it empirically links returns back to aggregate funding liquidity, and it estimates a timely indicator of funding liquidity conditions.

I Previous Studies of Liquidity Premia

A number of recent studies have highlighted the link between the balance sheets of financial intermediaries and perceived market risk appetite. Adrian et al (2009) claim that "As balance sheets expand and leverage rises, the constraints faced by financial intermediaries loosen, thereby increasing their risk appetite". This expansion or contraction in balance sheets is found to forecast exchange rate returns, potentially providing some empirical basis for the use of exchange rate volatility as an indicator of the liquidity risk priced in equities. Likewise, Adrian and Shin (2008) show that changes in dealer repurchase agreements, which is the primary margin of adjustment for the aggregate balance sheets of intermediaries "forecast changes in financial market risk as measured by the innovations in the Chicago Board Options Exchange Volatility Index (VIX)". This is consistent with high funding liquidity causing increased financial risk, although in the present paper it is claimed that this occurs through greater leverage providing greater exposure of equity prices to liquidity conditions, rather than through increased risk appetite per se. The predictions from the two mechanisms potentially oppose each other. If increased funding availability decreases the price of risk, it will also decrease option-implied volatility (VIX), whereas if it provides greater exposure to liquidity risk, it will increase the common component of volatility and also the cross sectional average.

Brunnermeier and Pedersen (2009) present a model of market and funding liquidity spirals. Such spirals are also discusssed by Garleanu and Pedersen (2007), where, according to the authors, a fall in market liquidity may lead to tighter risk management due to the longer time required to sell a security. Tighter risk management in turn leads to lower market liquidity, since it takes longer to find a buyer with unused risk-bearing capacity. This liquidity spiral leads to a fall in prices. It seems plausible that the spiral would be steeper if investors are more highly leveraged, funding their positions partly via credit, unlike in Brunnermeier and Pedersen (2009) where speculators fund their positions from existing wealth. If investors are more highly leveraged, pressure to service debt and renew lines of credit provide additional sources of uncertainty, further tightening risk management. Following this logic, this paper tests whether tight ex ante credit conditions choke movement down the liquidity spiral, while loose credit conditions enable this movement.

Studying the US equity market, Ang et al (2006) find that stocks with high exposure to systematic volatility risk earn low returns, and that market-wide liquidity risk does not explain this effect. The present paper claims that liquidity should have a differential effect on equity returns over different horizons, whereby high liquidity enables a liquidity crisis, and a reduction in liquidity is the precipitative cause. This is the rationale for examining liquidity-induced uncertainty (volatility), which may be an indicator of potential liquidity crises which have yet to manifest in actual liquidity.

This paper will also contribute to the literature on common risk factors in exchange rates. Lustig and Verdelhan (2009) show how a single common factor, equal to the difference between the return to high and low interest rate currencies, can explain a significant portion of the returns to the carry trade. It is possible that this factor is related to global liquidity, a question which this paper will help to answer. Guo, Neely and Higbee (2008) have shown that realized foreign exchange volatility is priced in equity returns, possibly because an increase in exchange rate volatility makes the hedging of exchange rate level risk more difficult. Some portion of the foreign exchange volatility risk premium identified by these authors may be attributable to liquidity risk, with volatility proxying for crash risk. This paper suggests that this is the case.

II Empirical Model

Brunnermeier and Pedersen present a model of funding and market liquidity in which ϕ, the shadow cost of capital to a speculator, partly determines asset prices (indexed by j at time $0, 1$):

$$p_0^j = E_0[p_1^j] + Cov_0[\phi_1, p_1^j]/E_0[\phi_1]. \tag{1}$$

A high ϕ means that the level of funding available is low relative to the level needed by the market. Normally, some part of a speculator's position will be leveraged, and the speculator must return to the credit market at intervals to roll over her loans. If funding liquidity is relatively low in some period, the speculator may have to reduce her open portfolio positions. Thus, changes in the cost of capital can influence prices by forcing speculators to reduce (or allowing them to increase) the absolute value of their long or short positions. This is one way in which a liquidity spiral of the type studied by Brunnermeier and Pedersen can begin. In that paper larger margin requirements play the role of an increasing cost of capital, however it seems likely that if larger margin requirements force a sell-off of assets this would have to be accompanied by higher interbank lending rates, since the marginal investor would fund part of the additional margin through the credit market and part by reducing her position in the asset. Increasing margin requirements and increasing interbank lending rates both affect asset prices by reducing available funding.

In a model where liquidity plays a role in prices, the effect on prices of a unit change in the cost of capital will vary depending on the initial level of funding provision, which in turn depends on interest rates. Letting h and l indicate high and low interest rate regimes, P the principal and i the interest rate, the change in interest repayments is greater under the low regime:

$$(i^h + 1)P^h - i^h P^h < (i^l + 1)P^l - i^l P^l. \tag{2}$$

This condition is satisfied as long as $P^h < P^l$, in other words more is borrowed under the low interest rate regime. Ceteris paribus, the speculator will be forced to sell a greater proportion of her position under the low interest rate regime than under the high. If we suppose the net order flow from the speculator is a function of the change in interest repayments, which would occur if the speculator invests until her budget constraint binds (as is the case in Brunnermeier and Pedersen for speculators who take a non-zero position in some asset) then we expect order flow and asset prices to depend more on interest rate changes under a low interest rate regime. In this way, the interest rate level determines the extent to which funding liquidity drives asset price uncertainty. To establish this relationship empirically requires an estimate of liquidity-driven volatility, where volatility is used as an indicator of uncertainty.

Following from Equation 1, an asset's volatility can be decomposed into a fundamental-driven, idiosyncratic component and a common, liquidity-driven component:

$$Var(p^j) = a^j Var^j + b^j Var(\phi). \tag{3}$$

The cross-sectional average volatility

$$\overline{Var}(p^j) = 1/k\Sigma_j a^j Var^j + \bar{b^j} Var(\phi) \tag{4}$$

provides an estimate of the liquidity driven volatility factor which is unbiased under the assumption that idiosyncratic volatility is mean zero with zero covariance in the cross section, in which case the first term on the right hand side is zero for a sufficiently large sample size of assets, k. In the empirical analysis, volatility z-scores (whose construction is explained below) are used. These have zero mean but possibly non-zero cross-sectional correlation. The correlation, and thus the term $1/k\Sigma^j a^j Var^j$, may be non-zero if there is some factor other than liquidity conditions that determines the degree of common variation in exchange rates. Zero correlation of non-liquidity related volatility is not required, since estimated common volatility is used in the second stage. As long as non-liquidity related volatility is orthogonal to interest rates, this estimated volatility is an unbiased estimate of liquidity-induced volatility. This orthogonality is guaranteed by definition of the common volatility as the component of volatility that derives from the interest rate level.

As discussed above, the interest rate level (i_t) may determine the component of average asset price uncertainty that derives from uncertainty in liquidity ($\bar{b_t^j} Var(\phi_t)$). By definition of the common volatility component as the component of volatility deriving from liquidity risk, average fundamental volatility ($1/k\Sigma^j a^j Var^j$) is orthogonal to interest rates. Regressing average asset volatility on interest rates

$$\overline{Var}(p_t^j) \equiv 1/k\Sigma_t^j a_t^j Var_t^j + \bar{b_t^j} Var(\phi_t) = c + f(i_t) \tag{5}$$

thus produces an estimate of the liquidity driven component of asset price volatility, $\widehat{\overline{Var}}(p_t^j) = \bar{b_t^j}\widehat{Var(\phi_t)}$. To further strengthen the claim for the exogeneity of common exchange rate volatility to equity returns, predicted common volatility is used in the equity regressions instead of realized volatility. Predicted common volatility is interpreted as an indicator of crash risk arising from the level of liquidity and leverage. The final step in the procedure is to regress equity returns on predicted common volatility, to test whether liquidity risk is a priced risk factor. The twelve month lagged moving average of the three-month T-Bill rate is used to represent the interest rate level. This time horizon is consistent with the argument that excess liquidity could build up over a sustained period of excessively low rates.

III Model Estimation and Data

A Model Estimation

The model is estimated in two stages.

Stage 1: Estimate the uncertainty due to liquidity conditions in exchange rate markets by regressing average exchange rate volatility on the lagged (by one month) twelve-month moving average of the three-month T-Bill return:

$$\overline{Var}(p_t^j) = \alpha + \beta i_{t-1} + \epsilon_t. \tag{6}$$

To allow a causal interpretation of the effect of the interest rate level on liquidity volatility, this regression is implemented within a Structural VAR, identified by the restriction that time-t exchange rate volatility cannot affect the lagged twelve month moving average of the T-Bill return.

Stage 2: Determine if liquidity volatility is priced in equity markets by regressing equity returns on predicted common exchange rate volatility

$$r_t = \gamma + \delta\widehat{\overline{Var}}(p_t^j) + \zeta F_t + u_t, \tag{7}$$

where F is a vector of other factors commonly used to explain equity returns. The factors used are the market return, the size and value factors of Fama and French (1993), the momentum factor of Jegadeesh and Titman (1993), changes in the VIX volatility index, Pastor and Stambaugh's (2001) market liquidity factor, the TED spread and realized exchange rate volatility.

A.1 Calculation of Global Currency Volatility

Country i's volatility in month t is $\omega_t^i = (\sigma_t^i - \bar{\sigma}_t^i)/\sigma_{\sigma_t^i}$ where σ_t^i is the standard deviation in month t of the daily exchange rate and $\sigma_{\sigma_t^i}$ is the standard deviation over all periods of the monthly standard deviations. This gives a scale-free measure of exchange rate volatility for a given month. For example, $\omega_t^i = 0$ if month t's volatility is equal to the long run average, and $\omega_t^i = 1$ if it exceeds by one standard deviation the long run average. Global volatility is then calculated as $\omega_t = \Sigma_i b_i \omega_t^i$, where b_i is country (or block of countries in the case of the euro) i's static weight, calculated as its share of total GDP of the six areas in 2000. The weights are given in Table I. The global currency volatility measure is based on the six major floating currencies against the dollar: yen, euro, pound, Swiss franc, Australian and Canadian dollars. Prior to the introduction of the euro, the Deutschmark is used in its place, with the weights adjusted accordingly.

B Data

Size, value and momentum factors, as well as the market return and the 25 size by value portfolios are all taken from Kenneth French's data library.[2] For countries other than the US, market return, book to market equity and earnings/price data are also taken from Kenneth French's data library. International returns are based on dollar prices. The countries for which these data are provided are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Italy, Japan, Malaysia, Netherlands, New Zealand, Norway, Singapore, Spain, Sweden, Switzerland, United Kingdom.

[2]http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

Exchange rate data, VIX (the Chicago Board Options Exchange implied volatility index), T-Bill returns and the TED spread are taken from Global Financial Data. The TED spread is the difference between 3-month LIBOR (an average of interest rates offered in the London interbank market for 3-month dollar-denominated loans) and the 3-month treasury bill rate. A rising TED spread may be an indication that liquidity is being withdrawn. LIBOR data are available from 1986, and this year is chosen as a starting point for the analysis.

GDP data for the purpose of weighting currencies in the average volatility calculation are taken from the Penn World Tables (Heston, Summers and Aten, 2009).

IV Empirical Results

The empirical results are consistent with the hypothesis advanced above, that low interest rates can increase equity risk by increasing investors' degree of leverage. Table I shows that the major exchange rates display a strong common volatility factor. Regressions of individual exchange rate volatilities on the estimated common factor have significant explanatory power in every case. Figure 1 shows the considerable variation in interest rates over the period 1986-2008, and also suggests that the choice of interest rate will not be a critical factor at monthly frequency. Figure 2 plots realized common exchange rate volatility against the three-month T-Bill rate. It is possible that contemporaneous exchange rate volatility is endogenous to the T-Bill rate, with both variables potentially responding to financial market distress, for example. This is consistent with the significant negative correlation shown in Table A. Of greater interest in this paper is any possible long run effect of the interest rate level on common exchange rate volatility, which is interpreted as an estimate of the common asset price volatility arising from risks to funding liquidity. In order to analyze this possible relationship, a structural vector auto-regression is estimated. It is interesting to note that both realized and predicted common exchange rate volatility are significantly positively correlated with the TED spread, which is sometimes used as an indicator of illiquidity. Rather than indicating actual illiquidity, the average volatility variable is intended to estimate uncertainty in funding liquidity, so that a perfect correlation with actual illiquidity would not be expected. Similarly, the correlation with Pastor and Stambaugh's liquidity factor (not shown) is significant and negative for both realized and estimated liquidity volatility, although the p-value in the case of estimated volatility is higher at 0.06.

The SVAR regressions show a significant causal effect from shocks in the lagged twelve-month moving average interest rate to common exchange rate volatility. This is consistent with the hypothesis that holding interest rates low for too long can increase the risk of a funding liquidity crash, via increasing leverage, and vice versa: high interest rates reduce leverage, reduce the crash risk arising from possible changes in funding liquidity, and reduce common asset price volatility. Figure 3 shows that a shock to the moving average of the interest rate has a significant effect on exchange rate volatility after about a year. The forecast error variance decomposition is show in Figure 4. The component of the exchange rate volatility forecast error attributable to shocks in the moving average t-bill rate is not significant at standard significance levels. This may be a consequence of high persistence rendering the moving average representation on which the error decomposition is based less accurate. Explicitly detrending the series using Elliott, Rothenberg and Stock's (1996) generalized least squares Dickey Fuller procedure, instead of relying on the lag structure used in the SVAR, produces immediately significant forecast error component (shown in the right panel of Figure 4). The SVAR lag structure is preferred since it is more readily interpretable and because forecasting is not the primary aim of this research.

Table III shows that the exchange rate volatility prediction based on the estimated SVAR explains part of the cross sectional return dispersion of twenty-five size-by-value Fama French portfolios (Fama and French, 1993). This suggests that a prolonged period of excessively low interest rates increases liquidity crash risk, and that investors demand higher returns to compensate for such risk. Equally, a sustained period of high interest rates eventually reduces leverage and funding-related crash risk, leading to lower equity returns.

The recessions of the early 1990's and late 2000's coincided with significant financial market turmoil. To test if this fact influences the results, the model is re-estimated over the sub-period 1993-2006 (inclusive). The relationship between common exchange rate volatility and interest rate levels is still clearly seen over this period, although it is notable that the delay between an interest rate shock and the resulting common volatility is somewhat longer (Figure 5). This may be influenced by the response to the recession of the early 2000's. The results appear to suggest that the initial drop in interest rates in response to this recession did not adversely affect liquidity risk, but the sustained low interest rates over several years eventually had an affect. The second stage results also remain significant, although the level of significance falls. The p-value for the test of joint significance of the predicted exchange rate volatility betas over the 1993-2006 period rises to 0.06 (Table IV).

An alternative line of robustness checks investigates other measures of volatility. The first is range-based volatility, where the daily range of an exchange rate is calculated as the absolute difference between the daily high and low values. Standardized monthly averages of this value are then calculated, in line with the calculations detailed in Section III. The second alternative measure controls for shifts in the exchange rate by subtracting the absolute value of the difference between the open and close prices from the range. This variable is examined in first differences, due to high persistence in the levels. Structural VAR's based on both of these variables satisfy the stability conditions, despite the high persistence (Figure 6). Estimated betas based on the range measure are presented in Table V. These betas are jointly significant at the 1% level.

Finally, Table VI shows the estimated market betas for a number of countries, controlling for the international Fama French factors. Predicted volatility betas are not significant in the four portfolio cross section formed on the book-to-market equity and earnings/price ratio available from Kenneth French's website, but they are significant for a number of countries when tested on the market returns. Many of the countries for which the volatility beta is significant are countries which often witness funding liquidity-related changes in capital flows, most notably Japan, due to its involvement in the carry trade.

V Conclusion

Responding to the late 2000's financial crisis, many commentators have suggested that excessively low interest rates may have contributed to the build-up of leverage in the financial system, and that such high levels of leverage increased crash risk. If such liquidity crash risk is undiversifiable, then investors may have demanded a risk premium for exposure to it. This paper tests whether this occurred. A decomposition of asset return variance into the liquidity (common) and the idiosyncratic component produces an estimate of liquidity volatility. Since this source of volatility is common across assets and asset classes, it is possible to estimate funding liquidity volatility on one asset class and test its significance on another. Exchange rates are chosen as the asset class on which volatility is estimated, with the second stage testing performed on equities. The results support a long run (one year and above) causation from the interest rate level to funding liquidity uncertainty. This uncertainty is found to be priced in equity markets.

This paper provides a measure which may be useful as one indicator of whether asset prices are supported by excess leverage. When estimated liquidity volatility is high, monetary policy or financial oversight authorities should consider taking steps to reduce the overheating in credit markets, and thus reduce the risk of a liquidity crash. The common component of exchange rate volatility is a noisy indicator of liquidity volatility. It is possible that less noisy measures could be developed using the methodology outlined here, perhaps by utilizing an array of asset classes instead of exchange rates alone to estimate liquidity risk.

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A Data

COUNTRY	GDP WEIGHT		R-Squared
	Pre-Euro	*Post-Euro*	
Euro	-	0.54	87
Japan	0.38	0.23	44
Germany	0.26	-	67
United Kingdom	0.18	0.11	45
Canada	0.1	0.06	24
Australia	0.06	0.04	29
Switzerland	0.03	0.02	60

Table I: The table shows weights for the exchange rates used to calculate global exchange rate volatility, and the R-squared from a regression of estimated global exchange rate volatility on the volatility of a given country or area (monthly regressions using the average daily volatility for a given month, based on the bilateral dollar exchange rate). All R-squared values are significant, including for those rates with a small weight in the calculation. This supports the existence of a common factor in exchange rate volatility.

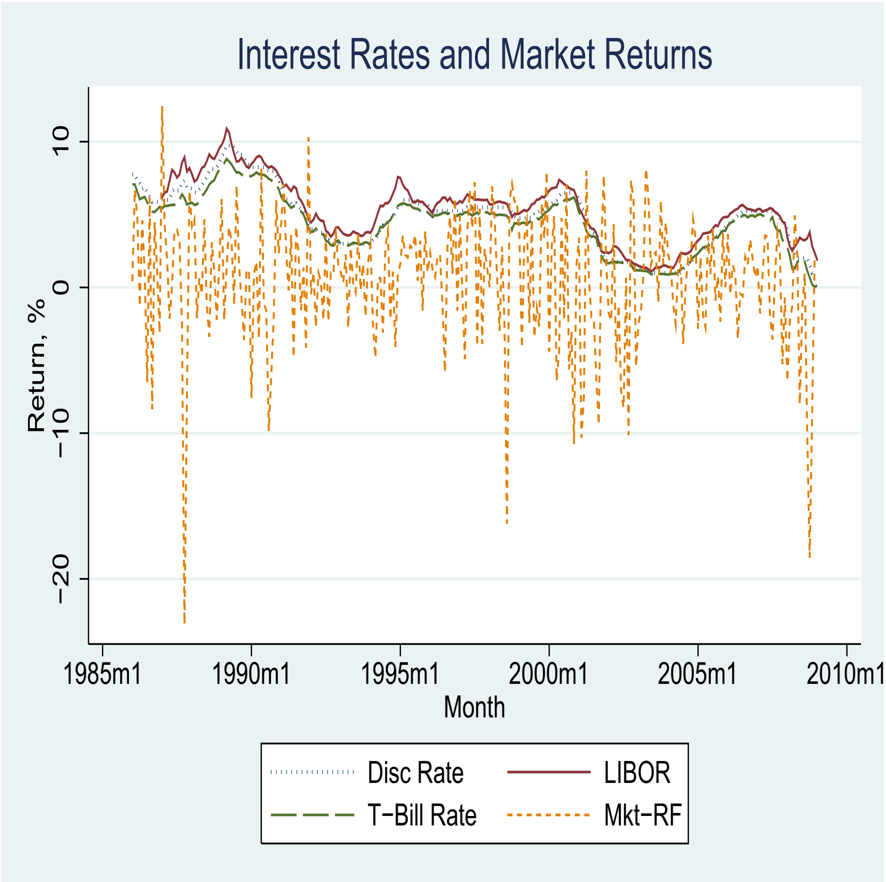

Figure 1: “Disc Rate” refers to the target discount rate for the Federal Reserve Bank of New York City (the Federal Funds Rate). LIBOR refers to the United States three-month LIBOR rate. The T-Bill rate is, likewise, for three month T-Bills. The three interest rates are seen to comove closely at monthly frequency. Falling interest rates tend to coincide with notable negative excess returns to the S&P 500, consistent with interest rates falling in response to weak economic conditions. This suggests there may be a negative contemporaneous correlation between interest rates and market turmoil. Lagged, longer term effects are tested via Structural VARs reported in Appendix B.

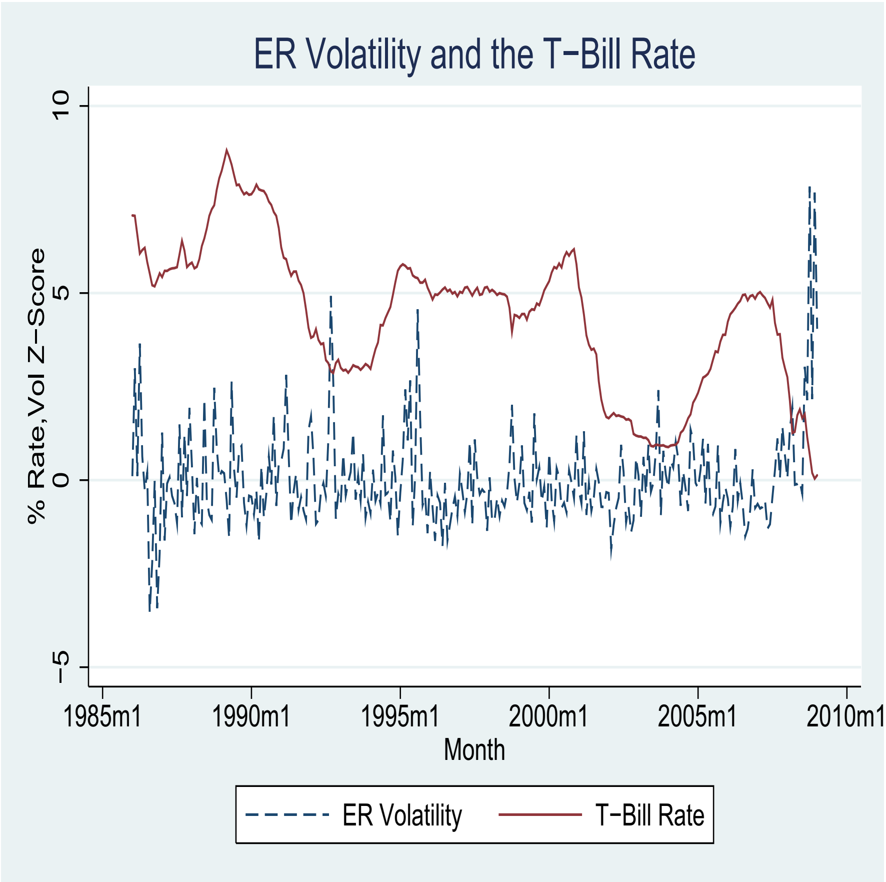

Figure 2: Average exchange rate volatility and the U.S. T-Bill return. The volatility unit is the (rescaled) weighted cross-sectional average z-score, as described in Section B. The spike in late 1992 is caused by the Exchange Rate Mechanism crisis, which saw high volatility in many major exchange rates. Exchange rate volatility clearly displays high variance and a large number of positive spikes.

	ER Vol	$\widehat{ERVol}$	TED	HML	SMB	ΔVIX	MOM	TB MA	TB_t	Market
ER Vol	1									
$\widehat{ERVol}$	0.44*	1								
TED	0.32*	0.27*	1							
HML	-0.04	-0.08	0	1						
SMB	0.02	0.06	-0.1*	-0.3*	1					
ΔVIX	0.20*	-0.03	0.46*	0.1	-0.2*	1				
MOM	0.04	0	0.04	-0.11	0.09	0.1	1			
TB MA	-0.09	-0.2*	-0.03	-0.05	-0.11	0	0.04	1		
TB_t	-0.1*	-0.3*	-0.02	-0.04	-0.1*	0	0.03	0.90*	1	
Market	-0.1*	0.02	-0.2*	-0.4*	0.20*	-0.6*	-0.11	0.04	0.07	1

Table II: Correlation coefficients for explanatory variables. A star indicates significance at the 5% level. "TB MA" refers to the twelve month lagged moving average of the T-Bill rate. Exchange rate volatility is negatively correlated with both the T-Bill and market excess return, although the T-Bill and market excess return are not themselves correlated. This may be consistent with the use of volatility as an indicator of liquidity related risk, if such risk is priced. Predicted exchange rate volatility is not unconditionally correlated with the market return, in contrast to the traditional risk factors. The positive and significant correlation of TED and both predicted and realized exchange rate volatility may support the interpretation of this variable as signifying liquidity risk.

B Structural VAR and Equity Pricing Results

A Structural VAR

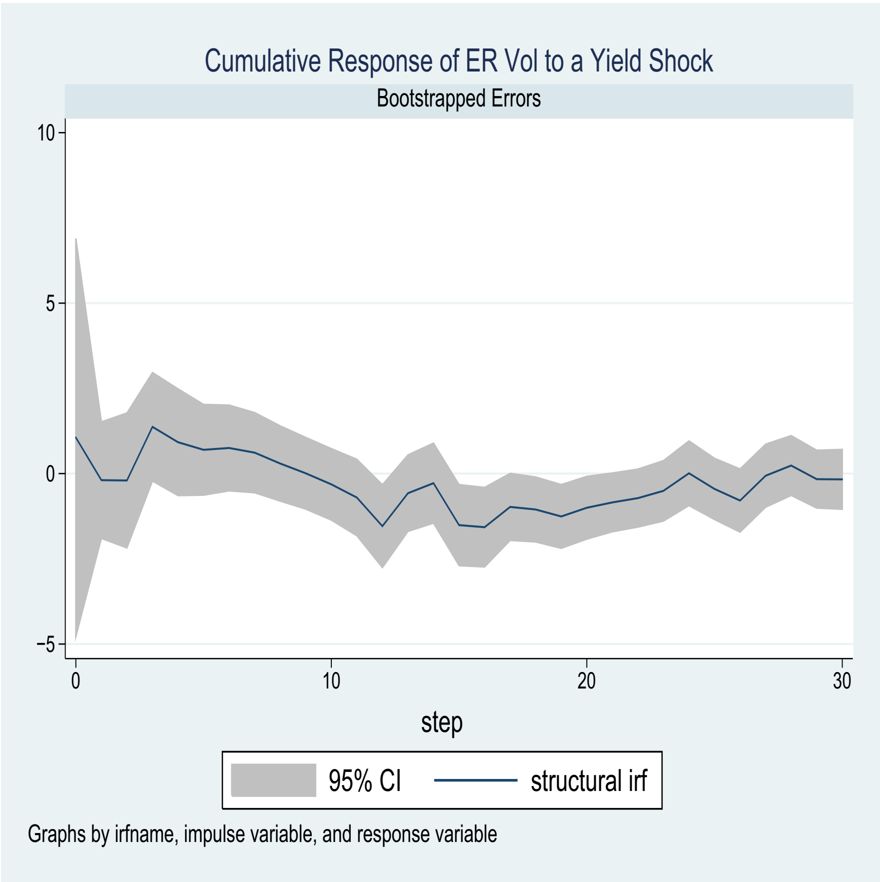

Figure 3: Structural Impulse Response Function, 1986-2008, monthly frequency. The identifying restriction is that the time-t exchange rate volatility cannot influence the lagged twelve-month moving average of the T-Bill rate. A shock to the lagged moving average of the interest rate has a significant negative effect on exchange rate volatility after approximately a year, which persists for several months. The predicted exchange rate volatility based on this relation is used in the second stage, below. The highest order lag included in the SVAR is 16. The lag selection process used started with 24 lags and individually eliminated insignificant lags according to the Wald Lag exclusion criteria. The confidence interval is based on bootstrapped standard errors.

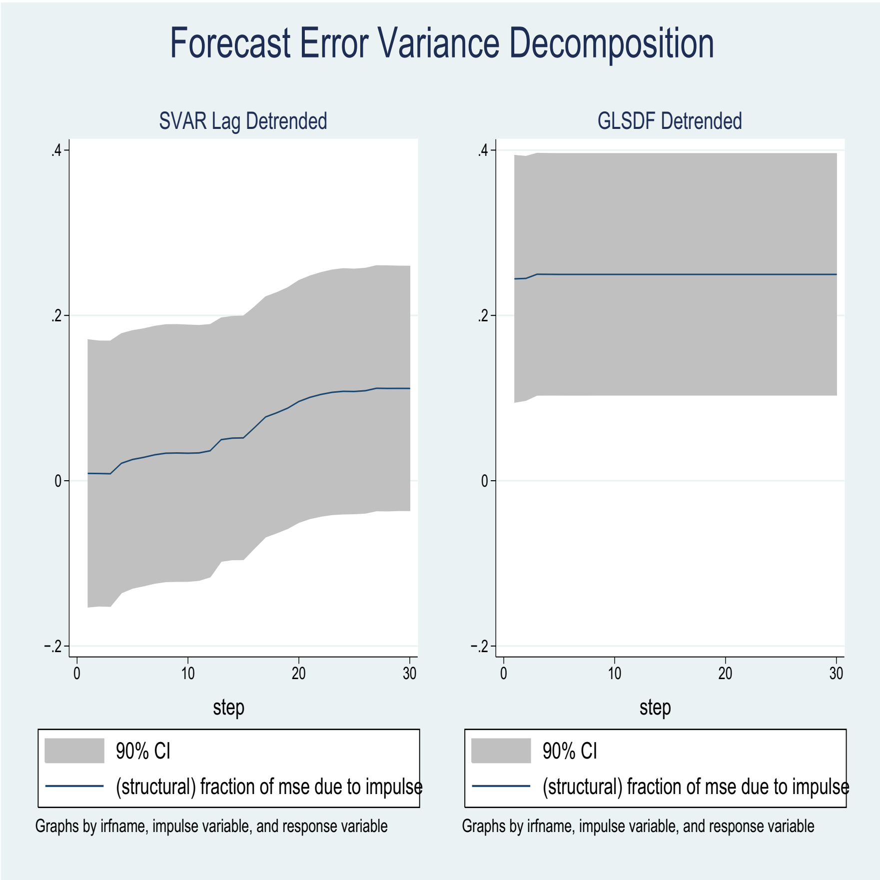

Figure 4: The graphs show the structural forecast error variance decomposition for the SVAR of the interest rate and exchange rate volatility, with 90% confidence intervals. The impulse variable is the lagged twelve-month moving average of the T-Bill rate and the response variable is the average exchange rate volatility. The high variance of the estimated variance decomposition may be due to persistence in the variables rendering the moving average representation on which the decomposition is based less accurate. The right hand graph shows the decomposition when both variables are subjected to explicit detrending (using a Generalized Least Squares Dickey Fuller procedure) before estimating the SVAR.

B Equity Pricing

	Value				
	Low	2	3	4	High
Small	-4.32	-4.08*	-2.74*	-3.59**	-3.79**
2	1.43	-0.95	2.1	-1.32	1.11
3	0.24	1.39	1.4	0.74	6.95***
4	-1.44	0.14	0.47	-1.79	-0.85
Big	-2.47**	0.6	-1.55	-3.46**	4.30*

Table III: Predicted ER Vol Betas for 25 Fama French Factors, 1986-2008. Market returns, the HML, SMB factors and momentum factors, changes in VIX and realized exchange rate volatility are all controlled for. The significance levels of the predicted exchange rate volatility factor are not as great as those of the traditional factors, however they are jointly significant according to a Seemingly Unrelated Regression χ^2 test (Zellner, 1962). When conditioned on these other factors, it is difficult to discern a pattern in the betas, although there may be a pattern of increasing coefficients towards Large and High Value companies. The betas for a four factor model (including Market Return, HML and SMB) are almost identical to those shown here. Inclusion of two estimates of actual (il)liquidity, the TED spread and Pastor and Stambaugh's (2001) aggregate market liquidity factor, does not significantly affect the results. This is consistent with the interpretation of predicted volatility as reflecting actual, unobserved liquidity volatility.

C Robustness

A Estimation over the Period 1993-2006

A.1 Structural VAR

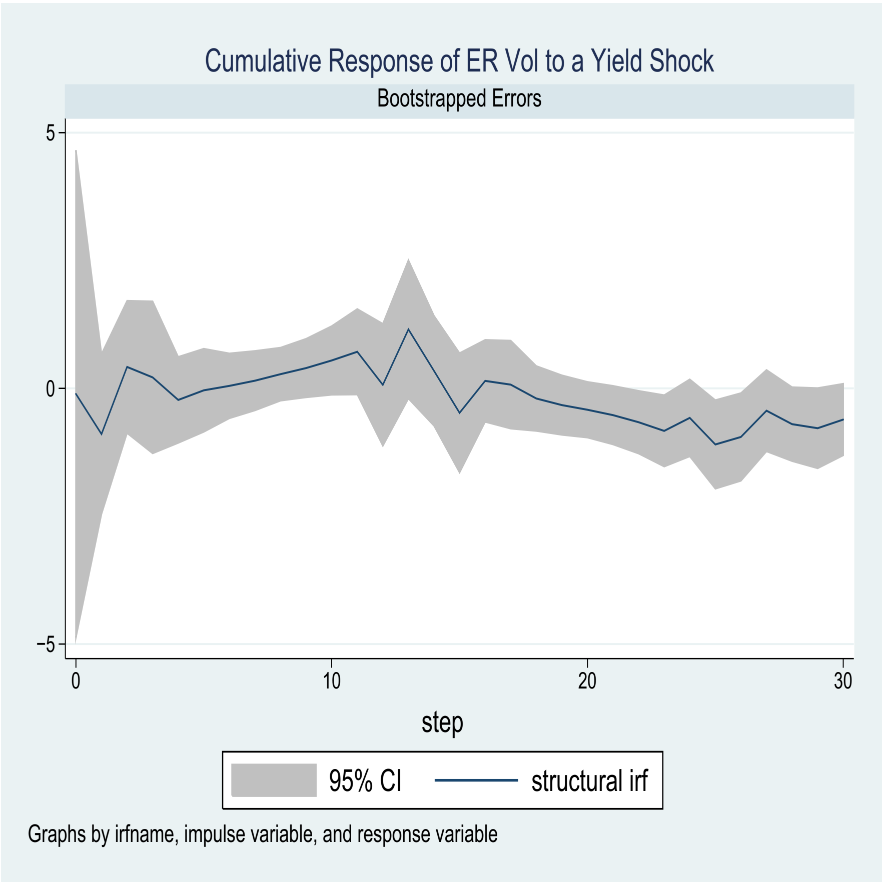

Figure 5: The response of exchange rate volatility is slower in this subsample, but remains negative and significant. The delay may be due to the rate drop around 2001 being initially justified, in the sense that it did not cause excess liquidity, but the continued regime of low interest rates eventually increased liquidity volatility.

A.2 Equity Pricing

	Value				
	Low	2	3	4	High
Small	0.46	-5.77	-3.13	-6.52**	-2.72
2	2.3	-0.65	0.36	-5.74**	-2.17
3	2.98	0.92	-2.22	-0.44	0.18
4	-0.94	-4.84	-1.63	-1.78	-1.5
Big	-4.22**	-1.44	-3.12	-4.81	5.05

Table IV: Predicted ER Vol Betas for 25 Fama French Factors, 1993-2006. Betas retain joint significance with a p-value of .06. Market returns, the size and value factors are included as control variables.

B Estimation using Alternative Volatility Estimators

B.1 Structural VAR

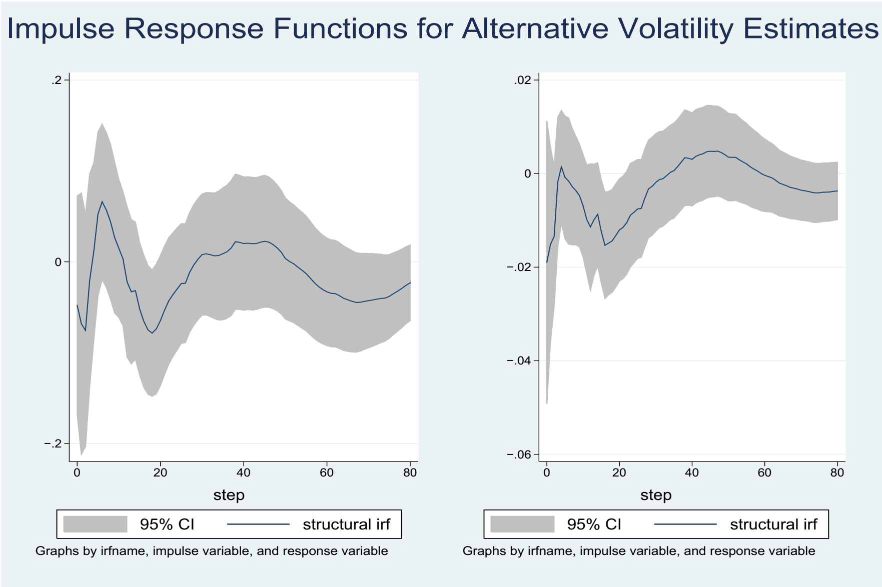

Figure 6: The left panel shows the structural IRF for range based volatility, estimated over 1986-2008. Range refers to the absolute difference between the daily high and low exchange rates. The right panel shows the effect of a shock to the lagged moving average T-Bill rate on first-differenced average intradaily volatility, controlling for level changes in the exchange rate. To control for level changes, the absolute value of the difference between the daily close and open rates is subtracted from the range. Persistence in both cases is clearly considerable, however the eigenvalue stability conditions are satisfied.

B.2 Equity Pricing

	Value				
	Low	2	3	4	High
Small	-1.6	-1.29	-1.86	-0.55	-2.64*
2	1.87	0.64	1.55	0.09	2
3	-0.29	1	3.54**	1.2	7.40***
4	-0.03	0.45	0.76	-1.07	-2.45
Big	-1.54	1.69	-0.39	-1.14	5.38**

Table V: Range Based Volatility Betas. These betas are jointly significant at the 1% level.

D International Results

COUNTRY	$\widehat{ERVOL}$	BEME	EP
Australia	0.09	-0.17	-0.29***
Austria	0.05	0.04	-0.07
Belgium	0	0.09	0.13
Canada	0.09	-0.04	-0.29***
Switzerland	0.06	0.28***	-0.14*
Germany	0	-0.01	-0.29***
Denmark	-0.05	-0.05	-0.11
Spain	0.08	-0.21**	-0.17*
Finland	0.19*	-0.43***	-0.09
France	0.05	-0.01	0.1
United Kingdom	0.08	0.21**	0.06
Hong Kong	0.17*	0.63***	-0.15
Ireland	0.01	-0.06	0
Italy	0.07	0.28***	-0.19**
Japan	0.17**	0.31***	-0.76***
Malaysia	0.46*	0.61***	-0.17
Netherlands	0	0.12**	0.15**
Norway	0.1	0.12**	0.03
New Zealand	0.13	-0.04	0.23***
Singapore	0.21**	0.36***	-0.29***
Sweden	0.17*	0.07	-0.30***

Table VI: Factor betas for market returns for various countries, 1986-2008 (data taken from Kenneth French's website). The (scaled) predicted exchange rate volatility variable ($\widehat{ERVOL}$) is not significant in the cross section based on four portfolios formed on book-to-market equity and the earnings/price ratio, however it is significant for some countries when tested on the market return. The countries which show a significant beta may correspond with those countries which are often implicated on either side of the carry trade, such as Japan, Malaysia and Hong Kong. The volatility of carry trade flows may enable the global funding liquidity risk factor to be detected in these countries' equity markets.

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