Journal of Banking & Finance 67 (2016) 1–11

Contents lists available at ScienceDirect

Journal of Banking & Finance

journal homepage: www.elsevier.com/locate/jbf

Currency momentum, carry trade, and market illiquidity ☆

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ARTICLE INFO

Article history:
Received 29 May 2015
Accepted 23 February 2016
Available online 2 March 2016

JEL classification:
F31
G15

Keywords:
Currency momentum
Carry trades
Market illiquidity

ABSTRACT

This study empirically examines the effect of equity market illiquidity on the excess returns of currency momentum and carry trade strategies. Results show that equity market illiquidity explains the evolution of currency momentum strategy payoffs, but not carry trade. Returns on currency momentum are low following months of high equity market illiquidity. However, in the recent decade, illiquidity positively predicts the associated payoffs. The findings withstand various robustness checks and are economically significant, approximating in value to one-third of average monthly profits.

1. Introduction

International finance literature has devoted considerable attention to currency market anomalies over the last three decades. However, only recently advances have been made on the issue of liquidity in the foreign exchange market. At the same time, equity market liquidity, along with its relationship with various anomalies in the equity and other financial markets has been extensively studied.[1] However, despite its importance, there is little evidence available on the cross-market links between currency anomalies on the one hand and stock market conditions on the other.[2] This paper aims for contributing towards filling this gap.

Accordingly, the current research investigates the role of equity market illiquidity and other equity market states in explaining the inter-temporal variations in returns of currency momentum and carry trade strategies. Currency momentum and carry trade strategies have long been known to yield significant excess returns, owing to exploitable disparities in macroeconomic conditions. Recent research reports the time-series dependence of carry trade payoffs on business cycles, stock market volatility, and on liquidity of the foreign exchange market (see Ranaldo and Soderlind, 2010; Christiansen et al., 2011; Menkhoff et al., 2012a; Mancini et al., 2013; Daniel et al., 2015). Other studies suggest that equity market conditions and equity-based funding risk measures may explain a proportion of currency carry trade returns (see Gromb and Vayanos, 2002; Hattori and Shin, 2009; Brunnermeier and Pedersen, 2009; Filipe and Suominen, 2014; Banti and Phylaktis, 2015). At the same time, Menkhoff et al. (2012b) find that currency momentum returns do not exhibit any interactions with standard proxies for currency market illiquidity (further FX illiquidity),

☆ Author is grateful for the comments and suggestions of the two anonymous referees, Lars Lochstoer, Doron Avramov, Mikko Leppämäki, Daniel Buncic (discussant), Tai David Yi (discussant), Sean Yoo (discussant), Janne Äijö, Sami Vähämaa and thanks seminar participants at Aalto School of Economics, Columbia Business School, the NHH EAP December 2014 workshop, the 2014 Australian Finance and Banking Conference, the 2015 Midwest Finance Association Annual Meeting, the 2015 Eastern Finance Association Annual Meeting for providing valuable comments. The paper was partially written while V. Orlov was a Visiting Scholar at the Columbia Business School. Author gratefully acknowledges financial support from the OP-Pohjola Group Research Foundation (grant 201500087).

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[1] Equity market illiquidity is found to explain payoff realizations of various pricing anomalies in stock market (see, e.g., Pastor and Stambaugh, 2003; Acharya and Pedersen, 2005; Avramov et al., 2015), government and corporate bond market (see, e.g., Fleming and Remolona, 1999; Bongaerts et al., 2012), and empirically helps to explain returns on commodities and on hedge funds (see Amihud et al., 2005).

[2] A number of studies provide evidence on cross-market linkages between equity and foreign exchange markets. Brandt et al. (2006) empirically combine stock markets, risk-free assets and exchange rates in their international risk sharing calculations. Pavlova and Rigobon (2007) highlight the examples of independence across stock, bond, and foreign exchange markets. Kamara et al. (2008) suggest that equity market conditions affect institutional investors' trading patterns, which in turn results in commonality across markets.

http://dx.doi.org/10.1016/j.jbankfin.2016.02.010
0378-4266/

currency market volatility, or business cycles. Pastor and Stambaugh (2003) find that equity illiquidity explains payoff realizations of stock momentum and guide future research to explore how the equity illiquidity affects other markets and various pricing anomalies therein. This study takes a step on that path and provides new evidence for the predictive role of equity market illiquidity in explaining the variations in currency momentum payoffs.

The empirical findings of this paper support the notion that equity market conditions affect speculative strategies in the foreign exchange market. We find that dollar-based currency momentum profitability depends on the level of aggregate equity market illiquidity. The full-sample investigation reveals that returns on the momentum long-short strategy are lower following months of high equity market illiquidity, and vice versa, strategy records high profits when the market is liquid. Moreover, the economic impact of the illiquidity effect is substantial, as one standard deviation increase in equity market illiquidity reduces profit by 0.303% per month, which approximates in value to one-third of average monthly profits. In addition, the dominant predictive role of equity market illiquidity stands out after controlling for other dimensions of market conditions.[3] Further, we find that the equity market illiquidity-carry trade relation is not robust, as it is dominated by FX market illiquidity and is attenuated by the introduction of alternative measure of illiquidity and other robustness checks.

The analysis is then extended to high and low illiquidity periods. Findings suggest the substantive ability of equity market illiquidity to predict returns on a currency momentum strategy, but the predictive effect is reversed in the two sample periods. In the period of high illiquidity (1976–2001), months of high (low) equity market illiquidity are followed by low (high) profits on the momentum strategy. Conversely, we find that in the recent decade of low illiquidity (2001–2012) equity market illiquidity positively predicts payoffs of currency momentum, in that returns on the strategies are high (low) following months of high (low) equity market illiquidity. We suggest that the observed divergence in predictability patterns is due to structural and technological changes in the most recent decade, which resulted in lower trading costs, increased market liquidity, a decreased role for funding liquidity, along with an overall increase in the salience of the currency anomalies (see French, 2008; Chordia et al., 2014). These results are only partially confirmed for the carry trade anomaly; that is, the sign of the effect for the carry trade strategy is analogous to its momentum counterpart, but the coefficient estimates only occasionally verge on significance, reflecting the differences between the anomalies.

Additionally, we expand our analysis in a number of directions. First, we show that the equity illiquidity effect on the currency momentum strategy is not subsumed by FX market illiquidity. Second, the main results of the paper hold true when we consider an alternative measure of equity market illiquidity as measured by Corwin and Schultz (2012) and perform sample split tests. Third, we show that results withstand several robustness checks. Specifically, the equity market illiquidity-momentum relationship is evident in portfolio returns with various formation periods and on the level of individual currencies, persists in different sample periods, endures after adjusting for traditional and currency-specific risk factors, transaction cost, currency tradability, and also sustains other robustness checks.

This study contributes to the literature in several important ways. First, we extend the strand of the literature on return predictability of currency anomalies. We provide new evidence on return predictability and add to the findings of studies, such as those of Bacchetta and van Wincoop (2010), Ranaldo and Soderlind (2010), Christiansen et al. (2011) and Menkhoff et al. (2012a), by exposing the predictive role of equity market illiquidity in explaining the inter-temporal variations in currency momentum returns. Further, our findings address Burnside's (2008) critique that literature on predictability is segmented across markets, as Amihud's (2002) illiquidity is also found to explain payoff realizations of equity pricing anomalies. Second, the finding indicating that equity market illiquidity negatively predicts profitability during the high-illiquidity period provides additional support for the theoretical work of Brunnermeier and Pedersen (2009) and Filipe and Suominen (2014) that links market liquidity and funding liquidity. Third, we add to the studies on recent trends in market anomalies (see Chordia et al., 2011; Brogaart et al., 2014; Chordia et al., 2014) by providing evidence on currency market anomalies payoff realizations and interaction with equity market conditions over the most recent decade. Finally, this study provides additional support to the prior literature that documents the linkage between equity and foreign exchange markets (e.g., Hau and Rey, 2006; Korajczyk and Viallet, 1992; Filipe and Suominen, 2014).

The remainder of the paper is organized as follows. In Section 2, we describe the dataset, predictive variables, the portfolio formation process, and provide descriptive statistics. In Section 3, we turn to the relation at the center of the current study and examine the predictive role of equity market illiquidity in portfolio returns. Several robustness checks are reported in Section 4, and Section 5 concludes the paper. This paper is accompanied with the Internet Appendix that provides results of additional robustness checks.

2. Data

2.1. Data sample

The sample consists of end-of-month observations of spot exchange rates, one-month forward exchange rates, and corresponding bid-ask spreads for the period from January 1976 to January 2014. The dataset was obtained from Barclays and Reuters via Datastream and comprises the currencies of the following 48 territories: Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Croatia, Cyprus, Czech Republic, Denmark, Egypt, the Euro area, Finland, France, Germany, Greece, Hong Kong, Hungary, India, Indonesia, Ireland, Israel, Italy, Iceland, Japan, Kuwait, Malaysia, Mexico, Netherlands, New Zealand, Norway, Philippines, Poland, Portugal, Russia, Saudi Arabia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Thailand, Ukraine, and United Kingdom. Throughout the studied period, the effective sample size varies greatly due to the availability of data quotes. The total number of end-of-month (not averaged over month) observations is 13,163.

Following recent studies (e.g., Burnside et al., 2011; Menkhoff et al., 2012b), we extend the dataset back to 1976 by complementing Barclays data quoted against the U.S. dollar (data become available from October 1983) with Reuters data quoted against the British Pound (available from January 1976), subsequently converting these additional quotes against the U.S. dollar. Doing this allows us to obtain the larger cross-section of currencies and longer time series essential for further analysis. In addition, in the Internet Appendix, we consider a smaller sample by excluding particular observations when trading was not possible and, even, completely exclude currencies with non-deliverable forward trading in offshore markets.

[3] Alongside the aggregate illiquidity measure, we also consider an aggregate market volatility measure (Wang and Xu, 2010) and a negative market returns measure (Cooper et al., 2004).

2.2. Currency excess returns

In this study we construct currency excess returns in a classic way, adopting the perspective of a U.S. investor, so that the monthly excess return for holding foreign currency i is defined as:

$$r^i_{t+1} = i^i_t - i_t - \Delta s^i_{t+1} \approx f^i_t - s^i_{t+1} \quad (1)$$

where i^i_t and i_t stand for the foreign and domestic (U.S.) interest rates in month t, respectively, and the interest rate differential is approximately equal to the log forward discount under a covered interest parity condition. f^i_t denotes the log one-month forward rate in units of foreign currency i per U.S. dollar in month t and s^i is the log spot exchange rate.

In order to account for transactions costs, we compute the log currency excess returns net of bid-ask spreads. For this purpose we employ bid-ask quotes from Reuters. Lyons (2001) shows that these quotes are of a magnitude almost double inter-dealer spreads, but, fortunately, they do not exhibit any lag effects on monthly frequency. Hence, our bid-ask spreads can be viewed as realistic, if perhaps overly vigilant. Log net excess returns are further applied in portfolio construction (momentum and carry trade). The log monthly net excess return to an investor who takes the long position in foreign currency is therefore:

$$r^{long}_{t+1} = f^b_t - s^a_{t+1} \quad (2)$$

where the letters b and a indicate bid and ask quotes, respectively. In this case the investor buys the foreign currency in the forward market at the bid price and, subsequently, sells the foreign currency at the ask price in the spot market. In a similar vein, the log monthly net excess return if an investor goes short on foreign currency is:

$$r^{short}_{t+1} = -f^a_t + s^b_{t+1} \quad (3)$$

2.3. Portfolios

Our portfolio formation approach is similar to Lustig et al. (2011) and Menkhoff et al. (2012b). To form momentum and carry trade portfolios at the end of each month t, we allocate currencies to one of six groups based on their lagged excess returns and lagged forward discount, respectively. Currency excess returns over the previous one, six, and twelve-months periods are used to sort currencies into momentum sextiles, while one-month lagged forward discounts are used to construct carry trade portfolios. In both cases, portfolios are held for one month and rebalanced on a monthly basis. The top (bottom) sextile of currencies constitutes the "High" ("Low") portfolios. Thus, one-sixth of all currencies with the highest lagged excess returns (forward discounts) are placed into the sixth portfolio ("High") in case of momentum (carry trade). In a similar manner, the first portfolio comprises one-sixth of all currencies with the lowest lagged excess returns (forward discount). Finally, the portfolio holding period return in month t is the equally-weighted sum of currency excess returns in each sextile.

Overall, six portfolios are used in evaluating the momentum and carry trade strategies. To build the time series of momentum and carry trade payoffs, we go long in the winner portfolio (sixth portfolio) and go short in the loser (first portfolio). In order to account for transaction costs, we assume that currency speculators short all foreign currencies in the first portfolio, while taking the long position in the remainder. These portfolios are referred to as "high-minus-low", "long-short" or "winner-minus-loser" portfolios. It is noteworthy that the number of currencies in the portfolios varies greatly over the period. We start with 16 currencies available at the beginning of 1976 and finish with 43 currencies by the end of 2013. The minimum number of currencies is nine at the end of 1983.

2.4. Momentum and carry trade returns

First, we provide an overview of the currency portfolios without transaction costs. Table 1 (Panels A and B) presents descriptive statistics of average monthly profits of the momentum and the carry trade portfolios over the full sample period. We also report maximum and minimum values, standard deviation of returns, skewness, kurtosis, and the Sharpe ratio, in addition to alphas (as a percentage) adjusted with various traditional and unconventional risk factor models.

Panel A of Table 1 presents the characteristics of six momentum portfolios formed on the basis of a one-month formation period and a one-month holding period. We find that the high portfolio outperforms the low portfolio to yield a substantial full-sample average monthly high-minus-low (H-L) portfolio return of 1.09 percent. Consistent with the existing literature, these momentum profits are not due to exposure to traditional or currency-specific risk factors. Specifically, the CAPM-adjusted H-L portfolio return increases to 1.16 percent per month. Similarly, the Fama–French three-factor-adjusted high-minus-low return is also significant at 1.16 percent per month. Turning to currency-based risk factor models, we report the 0.10 percent per month decrease in return after adjusting for the dollar risk factor (the average excess returns to all of the portfolios) and the HML_{fx} (the long-short carry trade return) risk factor derived from Lustig et al. (2011). The returns are further adjusted with the Menkhoff et al. (2012a) model, which results in a slight decrease in returns. Overall, currency-based risk factors also fell short in explaining currency momentum profits.[4]

Panel B of Table 1 shows descriptive statistics for six carry trade portfolios. We find that the average raw return for the high-minus-low carry trade portfolio is highly significant at 1.04 percent per month. Similar to the currency momentum profits, adjustments for common risk factors do not significantly change carry trade payoffs. In this panel, we consider only traditional risk based models as currency-specific factors to a large extent constructed to explain the returns on carry trade.

Table 1 also presents other characteristics of the portfolios, including standard deviation, skewness, kurtosis, and the Sharpe ratio. These descriptive statistics are intended to address the concern that momentum and carry trade, being the two most prominent currency speculative strategies, capture the same information. As can be seen above, both strategies demonstrate similar patterns in portfolio returns. However, the distribution of these returns is in fact very different. For instance, the momentum payoff is positively skewed (0.70), while the carry trade profit exhibits negative skewness (−0.68), suggesting that carry trade strategy comes with occasional crashes.[5]

2.5. Aggregate market state variables

The following empirical part of this paper mainly focuses on the role played by aggregate market liquidity in explaining the time variation in currency momentum and carry trade payoffs. We utilize Amihud's illiquidity as our main measure of aggregate market liquidity. Although, our analysis focuses on the role of aggregate liquidity, it is important to consider other dimensions of market states. We therefore compute a dummy for a negative cumulative

[4] We are grateful to Kenneth French for making common risk factors publicly available.

[5] For a more comprehensive comparison of currency momentum and carry trade returns see Menkhoff et al. (2012b). For more evidence on carry trade crashes see Brunnermeier et al. (2008).

Table 1
Descriptive statistics for momentum and carry trade returns.

	Low	2	3	4	5	High	Average	H-L
Panel A: momentum (1,1)								
Raw returns	−0.371**	0.004	0.186	0.200	0.214*	0.716***	0.158	1.088***
	(−2.38)	(0.07)	(1.29)	(1.43)	(1.75)	(4.01)	(1.14)	(6.54)
CAPM alpha	−0.467***	−0.058	0.152	0.156	0.178	0.695***	0.109	1.162***
	(−2.71)	(−0.39)	(1.35)	(0.97)	(1.32)	(3.66)	(0.69)	(6.46)
3-FM alpha	−0.486***	−0.056	0.152	0.153	0.161	0.676***	0.100	1.162***
	(−2.67)	(−0.36)	(0.95)	(0.90)	(1.13)	(3.64)	(0.60)	(6.24)
Lustig's alpha	−0.592***	−0.088	0.100	0.109*	0.126**	0.475***	0.022	1.067***
	(−5.23)	(−1.21)	(1.58)	(1.72)	(2.29)	(4.30)	(0.81)	(5.42)
Menkhoff's alpha	−0.290	−0.202	−0.386**	0.215	0.049	0.817***	0.051**	1.107**
	(−1.05)	(−0.84)	(−2.38)	(1.28)	(0.27)	(2.80)	(2.15)	(2.19)
Max (in %)	13.02	7.87	10.25	8.07	11.34	8.98	6.80	21.25
Min (in %)	−17.59	−10.92	−10.07	−9.54	−9.10	−9.95	−8.37	−11.98
Std. Dev.	3.084	2.589	2.661	2.619	2.483	2.783	2.287	3.319
Skewness	−0.688	−0.381	−0.186	−0.167	0.025	−0.080	−0.368	0.811
Kurtosis	7.361	5.034	4.347	3.796	4.552	4.167	3.914	7.771
Sharpe ratio	−0.120	0.001	0.070	0.076	0.086	0.257	0.069	0.328
Panel B: carry trade								
Raw returns	−0.310**	−0.048	0.096	0.167	0.268**	0.733***	0.151	1.043***
	(−1.98)	(−0.38)	(0.76)	(1.21)	(2.00)	(3.14)	(1.09)	(5.26)
CAPM alpha	−0.344**	−0.089	0.056	0.152	0.255*	0.735***	0.137	0.997***
	(−2.02)	(−0.64)	(0.40)	(1.03)	(1.71)	(3.18)	(0.67)	(5.05)
3-FM alpha	−0.362**	−0.094	0.074	0.114	0.193	0.657***	0.097	1.019***
	(−2.05)	(−0.67)	(0.51)	(0.72)	(1.25)	(2.79)	(0.58)	(4.87)
Max (in %)	8.93	8.28	8.84	10.75	7.28	10.62	7.38	12.06
Min (in %)	−12.72	−9.52	−8.73	−10.19	−9.59	−17.59	−8.26	−12.55
Std. Dev.	2.777	2.549	2.432	2.526	2.533	3.320	2.307	3.287
Skewness	−0.140	−0.077	−0.067	−0.144	−0.527	−0.751	−0.323	−0.676
Kurtosis	4.702	3.968	4.201	5.285	4.467	5.912	3.959	5.259
Sharpe ratio	−0.122	−0.019	0.039	0.066	0.106	0.221	0.065	0.317

	H-L	Amihud's illiquidity	Market volatility	Down market	Crisis
Panel C: Correlation among market states (Momentum profit with f = 1 is used)					
H-L	1.000				
Amihud's illiquidity	−0.110	1.000			
Market volatility	0.123	−0.216	1.000		
Down market state	0.031	−0.226	0.442	1.000	
Crisis	0.090	−0.112	0.183	0.155	1.000
Panel D: Correlation among market states (Carry trade profit)					
H-L	1.000				
Amihud's illiquidity	−0.113	1.000			
Market volatility	0.170	−0.216	1.000		
Down market state	0.084	−0.226	0.442	1.000	
Crisis	−0.091	−0.112	0.183	0.155	1.000

This table presents descriptive statistics of average monthly profits of the momentum and the carry trade portfolios. The data period spans January 1976 to January 2014. The currency momentum and the carry trade payoffs are formed with one-month formation period and one-month holding period. In Panel A (Panel B) we report average equally-weighted holding period returns of each sextile portfolio, as well as the average and the momentum (the carry trade) profits (H-L portfolio). H-L denotes the currency momentum (the carry trade) trading strategy profits, where the equally-weighted bottom sextile portfolio (Low) is subtracted from equally-weighted top sextile portfolio (High). Further, we report alphas (in %) by adjusting returns with CAPM, Fama–French three-factor, Lustig et al. (2011) and Menkhoff et al. (2012a) models. We also report maximum and minimum values, standard deviation of returns, skewness, kurtosis, and the Sharpe ratio, computed as average monthly excess portfolio return divided by its standard deviation. Panel C (Panel D) shows the pairwise correlation between the momentum (1,1) strategy (the carry trade strategy) and market state variables, such as Amihud's illiquidity, down market state, market volatility and crisis control. Newey and West (1987) HAC based *t*-statistics are presented in parenthesis. Numbers annotated with asterisks *, ** and *** are significant at the 10%, 5% and 1% level, respectively.

two-year stock market return and the measure of aggregate stock market volatility. All of these variables have been found to predict the evolution of stock market momentum payoffs.[6]

We define the level of aggregate market illiquidity as *Amihud's illiquidity* or, simply, *illiquidity* in the rest of the paper. The measure is constructed in a similar way to that presented by Amihud (2002) and normalized. Specifically, it is the value-weighted average of a monthly Amihud's (2002) illiquidity measure of each NYSE and AMEX firm for the period from January 1976 to December 2011. The monthly illiquidity measure for a single firm is computed as the absolute value of the daily stock return divided by the daily trading volume of that stock, subsequently aggregated over the number of trading days in the month. The next market state variable is a dummy for a negative cumulative two-year stock market return (henceforth, "*the down market*"). The dummy variable takes the value of one if the past twenty-four months' return on the value-weighted CRSP market index is negative and zero otherwise. The volatility measure is calculated as the standard deviation of the value-weighted CRSP market index. Time spans for all three market state variables are matched. Additionally, in most of our analyses we control for potentially systemic macroeconomic events, introducing a dummy variable taking the value of one if a relevant macroeconomic event occurs. Specifically, the list of

[6] There is extensive literature on equity momentum and market state conditions. Avramov et al. (2015) show that a market illiquidity state is able to explain some variation in stock market momentum payoffs. Cooper et al. (2004) show that past performance of the market index also predicts equity momentum payoffs. Finally, Wang and Xu (2010) point out that equity momentum returns are lower following high market volatility periods.

relevant events includes: the devaluation of the Thai baht (1997:07), the Russian default (1998:08), the Icelandic currency crisis (2006:03), the Lehman Brothers collapse (2008:09) and many others.[7]

Panels C and D of Table 1 show the time-series correlation of market state variables with the high-minus-low momentum and carry trade returns, respectively. Correlation coefficients for both momentum and carry trade payoffs with market level variables are low, ranging from −0.11 to 0.12. In turn, aggregate market state variables are fairly well correlated. It is notable that Amihud's illiquidity proves to have a negative correlation with other predictors. This fact is counter-intuitive and arises owing to the limited period for which data is available, as when the data period was extended back to 1928, the correlations became positive. Additionally, we checked that the autocorrelation is far from 1.0 and that Stambaugh's (1999) small sample bias is clearly not an issue.

3. Currency momentum, carry trade in portfolio returns, and illiquidity

3.1. Equity market illiquidity and currency anomalies

This section presents empirical findings on the predictive power of equity market illiquidity to explain the evolution of currency momentum and carry trade payoffs, while investigating the full sample period. The analysis is based on eight time-series regression specifications, starting from the *iid* model (intercept only) and concluding with a comprehensive specification, where we control for other dimensions of equity market conditions. In these models, the dependent variable is either currency momentum or carry trade high-minus-low portfolio return, formed on the basis of a one-month formation period and one-month holding period. As the predictive variables, we consider three one-month lagged aggregate equity market state measures, namely, Amihud's illiquidity, a bear market return state, and market volatility. Additionally, we control for potentially disturbing macroeconomic events by introducing a crisis control variable.

Table 2 reports the coefficient estimates of all regression designs with adjustments for Fama–French common risk factors. All of the models in Panel A include a winner-minus-loser momentum return as the dependent variable, while Panel B reports results of analogous models with a high-minus-low carry trade payoff. The data period spans 1976:1 to 2011:12. Estimates of such regressions consistently support the notion that equity market illiquidity explains the inter-temporal variation of currency momentum and, possibly, carry trade payoffs. The slope coefficients of Amihud's illiquidity measure are −0.349 and −0.431 for momentum and carry trade, respectively, and are significant in the specification with the single predictor (Model 2 in Panels A and B). Further, inclusion of the down market and market volatility variables results in a drop in the coefficients for illiquidity for the two strategies and their significance. Noteworthy, the coefficient of Amihud's illiquidity exhibits only a slight decrease in significance and magnitude in the all-inclusive model (Model 8 in both panels), while in the carry trade regression the coefficient value is around 30 percent smaller relative to the *iid* model and significant only at a 10 percent level. Moreover, the illiquidity effect has a considerable economic impact, as one standard deviation increase in equity market illiquidity leads to a 0.303% per month decline in profit for momentum and, if coefficient considered significant, a 0.297% drop in the monthly return for a carry trade strategy. Such an effect can be considered economically significant as it approximates in value to one-third of average monthly profits.

The effect of aggregate market illiquidity dominates the other two measures of equity market conditions.[8] Their regression estimates are rather inconsistent throughout the analysis, occasionally verging on significance, but are usually statistically and economically insignificant. This is especially evident in the models with momentum payoffs as the dependent variable. The same patterns are found in our additional results, where we consider the same eight model specifications, while adjusting for currency-specific risk factor models or testing momentum strategies with various formation periods. These additional estimations confirm the dominant role of market illiquidity over other market states in both single-predictor and in joint models.

The results reported in this section moderately suggest a possible predictive role in explaining the two anomalies returns for the equity market illiquidity, suggesting a common intuition behind the intertemporal variations in currency momentum and carry trade payoffs. This is a puzzling finding, given that the two anomalies exhibit different patterns in returns and have been found to be largely unrelated to one another (see, e.g., Burnside et al., 2011; Menkhoff et al., 2012b). In the following sections, we perform a more systematic analysis and present evidence that the predictive role of equity market illiquidity is robust only for currency momentum, but not for carry trade strategy.

3.2. The illiquidity effect and the period of improved liquidity

In this section, we continue to explore the predictive effect of equity market illiquidity on currency momentum and carry trade strategies by investigating a period associated with unprecedented reduction in the overall cost of trading due to technological improvements and structural changes. French (2008) documents how institutional commission has palpably declined over time, while Chordia et al. (2014) show that the most recent decade is associated with low values of standard illiquidity proxies (e.g., bid-ask spread). Indeed, the time series of Amihud's illiquidity (Fig. 1) depict the improvements in aggregate market liquidity in recent years. Hendershott et al. (2011) connect the overall increase in market liquidity with the improvements in trading technology and the rise of algorithmic trading. Other studies have also documented changes in liquidity, trading volume, funding liquidity and trading technology in the post-decimalization period (see Roll et al., 2007; Chordia et al., 2011; Brogaart et al., 2014). In this regard, the recent regime of increased market-wide liquidity comprises a unique setting to test the effect of aggregate market illiquidity on currency anomalies.

Evidence on stock market anomalies indicates that some anomalies tend to attenuate over the previous decade (Chordia et al., 2014). Conversely, we find that currency market anomalies exhibit higher mean returns in the post-decimalization period (2001–2012) than in the prior sample period. Findings also indicate that the returns to the two currency strategies are positively correlated in the period of improved liquidity and reflect the increase in currency anomalies' payoffs relative to the former period. Next, we investigate the role of aggregate market illiquidity in predicting currency momentum and carry trade returns while splitting the sample into two periods, reflecting those before and after technological and structural changes occurred. Results are reported in Table 3.

The decision to implement the division into two sub-periods is motivated by the abundance of evidence on reduced trading costs, changes in market liquidity, funding liquidity and trading volume, and facilitation of algorithmic trading by institutions over the

[7] See the Internet Appendix for the detailed list of events.

[8] Additionally, in unreported results we document that results persist after controlling for an alternative proxy for equity market volatility, the CBOE VIX index.

Table 2
Momentum and carry trade profits and market states.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Panel A: Momentum profits regressed on lagged market state variables								
Intercept	1.165***	1.169***	1.027***	1.164***	1.062***	1.169***	1.013***	1.034***
	(6.24)	(6.32)	(5.79)	(6.22)	(5.92)	(6.30)	(5.50)	(5.65)
Illiquidity		−0.349***			−0.281**	−0.357***		−0.303**
		(−2.61)			(−2.26)	(−2.69)		(−2.42)
Down market			1.111		0.923		1.297*	1.148
			(1.61)		(1.32)		(1.83)	(1.61)
Volatility				0.038		−0.038	−0.149	−0.192
				(0.23)		(−0.23)	(−0.93)	(−1.22)
MKT-RF	−0.038	−0.039	−0.037	−0.037	−0.038	−0.040	−0.040	−0.041
	(−0.77)	(−0.80)	(−0.77)	(−0.76)	(−0.79)	(−0.82)	(−0.84)	(−0.88)
SMB	0.032	0.041	0.021	0.031	0.031	0.042	0.021	0.032
	(0.63)	(0.84)	(0.42)	(0.61)	(0.63)	(0.84)	(0.43)	(0.64)
HML	−0.005	−0.005	−0.004	−0.004	−0.004	−0.007	−0.010	−0.012
	(−0.11)	(−0.10)	(−0.07)	(−0.07)	(−0.08)	(−0.14)	(−0.21)	(−0.25)
Crisis control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj-Rsq	0.002	0.010	0.011	0.011	0.016	0.008	0.010	0.016
Obs	430	430	430	430	430	430	430	430
Panel B: Carry trade profits regressed on lagged market state variables								
Intercept	1.110***	1.116***	0.895***	1.114***	0.923***	1.119***	0.916***	0.936***
	(5.20)	(5.32)	(4.33)	(5.39)	(4.45)	(5.44)	(4.42)	(4.49)
Illiquidity		−0.431**			−0.308*	−0.370**		−0.297*
		(−2.39)			(−1.75)	(−2.07)		(−1.69)
Down market			1.874***		1.668**		1.708**	1.561**
			(2.78)		(2.42)		(2.35)	(2.11)
Volatility				0.378*		0.299	0.133	0.090
				(1.89)		(−1.57)	(0.65)	(0.46)
MKT-RF	0.114***	0.113***	0.116***	0.122***	0.115***	0.120***	0.119***	0.117***
	(3.27)	(3.25)	(3.24)	(3.40)	(3.23)	(3.37)	(3.25)	(3.25)
SMB	0.022	0.035	0.004	0.017	0.015	0.029	0.004	0.014
	(0.41)	(0.64)	(0.08)	(0.31)	(0.29)	(0.53)	(0.07)	(0.28)
HML	0.017	0.017	0.020	0.035	0.020	0.032	0.026	0.024
	(0.31)	(0.32)	(0.35)	(0.52)	(0.35)	(0.57)	(0.46)	(0.42)
Crisis control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj-Rsq	0.022	0.037	0.055	0.033	0.061	0.042	0.054	0.059
Obs	430	430	430	430	430	430	430	430

This table presents the results of the following monthly time-series regressions:

$$H\_L_t = a_t + B_1 \text{illiquidity}_{t-1} + B_2 down_{t-1} + B_3 \text{volatility}_{t-1} + B_4 crisis_t + B_5 mkt\_rf_t + B_6 smb_t + B_7 hml_t + e_t$$

where *H-L* is the currency momentum (the carry trade in Panel B) trading strategy payoff, where the equally-weighted loser portfolio is subtracted from the equally-weighted winner portfolio in month t; *illiquidity* stands for the normalized market illiquidity measure adopted from Amihud (2002) in month $t-1$, in particular, it is the value-weighted stock-level Amihud's (2002) illiquidity measure of all NYSE and AMEX firms for the period from 1976:1 to 2011:12; *down* is the dummy variable that takes the value of one if the past twenty-four months return on the value-weighted CRSP market index is negative and zero otherwise; *volatility* is the standard deviation of the value-weighted CRSP market index in month $t-1$; *crisis* stands for the dummy variable that takes value of one if potentially systemic macroeconomic events occur in month t; *mkt_rf*, *smb*, and *hml* are FF factors, including the market factor, the size factor and the book-to-market factor, respectively. Newey-West HAC based t-statistics are presented in parenthesis. Numbers annotated with asterisks *, ** and *** are significant at the 10%, 5% and 1% level, respectively.

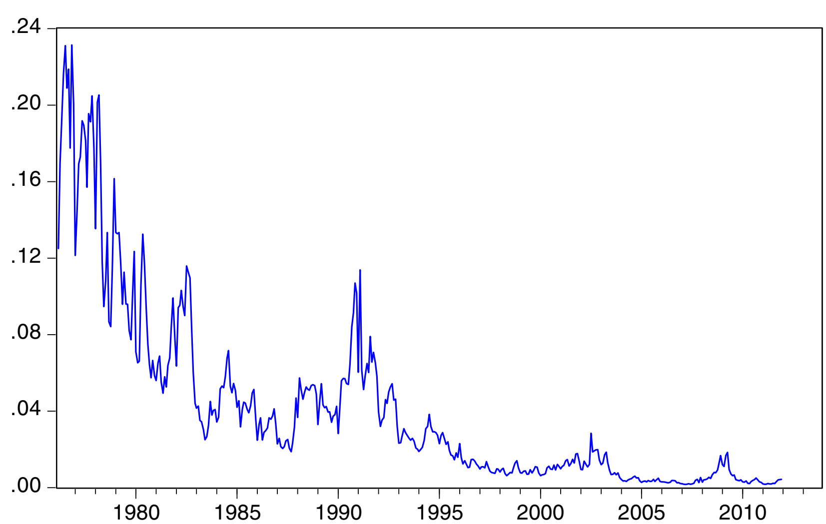

Fig. 1. Time-series of Amihud's (2002) illiquidity. Figure shows the time-series of the market illiquidity measure constructed from Amihud (2002) in month $t-1$, in particular, it is the value-weighted average of stock-level Amihud's (2002) illiquidity measure of all NYSE and AMEX firms for the period from 1976:1 to 2011:12.

Table 3
Illiquidity effect in different sample periods.

	Momentum				Carry trade	
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2
Panel A: Profits regressed on lagged market state variables (1976–2001)						
Intercept	1.044***	1.062***	1.070***	1.219**	0.768***	0.707***
	(5.25)	(4.95)	(4.82)	(2.04)	(3.34)	(3.10)
Illiquidity	−0.384**	−0.429***	−0.416***	−0.422***	−0.190*	−0.126*
	(−2.35)	(−2.74)	(−2.75)	(−2.67)	(−1.85)	(−1.72)
Down market		2.611	2.392	2.400		0.446
		(3.58)	(1.05)	(1.07)		(0.23)
Volatility		−0.171	−0.125	−0.140		0.475**
		(−1.01)	(−0.79)	(−0.82)		(2.25)
FF factors		Yes				Yes
Lustig et al. factors			Yes			
Menkhoff et al. factors				Yes		
Crisis Control		Yes	Yes	Yes	Yes	Yes
Adj-Rsq	0.008	0.017	0.021	0.018	0.002	0.041
Obs	298	298	298	298	298	298
Panel B: Profits regressed on lagged market state variables (2001–2012)						
Intercept	1.580***	1.332***	1.108**	1.234	1.991***	2.092***
	(5.38)	(3.71)	(2.48)	(1.04)	(9.02)	(6.82)
Illiquidity	0.882***	0.919***	0.718*	0.926**	0.859***	1.416***
	(2.82)	(2.81)	(1.86)	(2.45)	(3.88)	(5.13)
Down market		0.291	0.529	0.577		0.159
		(0.46)	(0.72)	(0.77)		(0.30)
Volatility		−0.407	−0.552*	−0.764*		−1.011***
		(−1.42)	(−1.75)	(−1.80)		(−4.18)
FF factors		Yes				Yes
Lustig et al. factors			Yes			
Menkhoff et al. factors				Yes		
Crisis Control		Yes	Yes	Yes	Yes	Yes
Adj-Rsq	0.091	0.141	0.125	0.102	0.097	0.321
Obs	132	132	132	132	132	132

This table presents the results of the following monthly time-series regressions for the samples from 1976:1 to 2000:12 (Panel A) and from 2001:1 to 2011:12 (Panel B):

$$H\_L_t = a_t + B_1 \text{illiquidity}_{t-1} + B_2 down_{t-1} + B_3 \text{volatility}_{t-1} + B_4 crisis_t + B_5' F_t + e_t$$

where *H-L* is the currency momentum or the carry trade trading strategy payoff; *illiquidity* stands for the normalized market illiquidity measure constructed from Amihud (2002) in month $t-1$, in particular, it is the value-weighted stock-level Amihud's (2002) illiquidity measure of all NYSE and AMEX firms; *down* is the dummy variable that takes the value of one if the past twenty-four months return on the value-weighted CRSP market index is negative and zero otherwise; *volatility* is the standard deviation of the value-weighted CRSP market index in month $t-1$; *crisis* stands for the dummy variable that takes value of one if potentially systemic macroeconomic events occur in month *t*; *mkt_rf*, *smb*, and *hml* are FF factors; *dol* and *hml_fx* are Lustig et al. (2011) factors; *dol* and *vol_fx* are Menkhoff et al. (2012a) factors. Newey-West HAC based *t*-statistics are presented in parenthesis. Numbers annotated with asterisks *, ** and *** are significant at the 10%, 5% and 1% level, respectively.

recent years. Further, we refer to the pre- and post-structural change sub-periods as high and low illiquidity sub-samples, respectively. The effect of equity market illiquidity is conspicuous. In Table 3 (both Panels), the *t*-statistics for all illiquidity coefficient estimates reject the null hypothesis of there being no predictive effect of aggregate equity market illiquidity on currency speculative strategies in favor of the alternative. However, the predictive effect varies in times of high and low illiquidity, being negative in the high illiquidity period and positive in the low illiquidity period.

The results of Panel A of Table 3 indicate that equity illiquidity negatively predicts profitability of the anomalies during the period associated with the high levels of illiquidity. This is consistent with the theoretical liquidity framework of Brunnermeier and Pedersen (2009) that links market liquidity and funding liquidity. In particular, during a period marked by an illiquid market, leveraged investors face margin calls, which subsequently triggers position unwinding and fire sales that drives prices away from their fundamental basis, causing losses. In addition, the theoretical model suggests that market liquidity and funding liquidity are mutually reinforcing concepts. Therefore, when market illiquidity is high and/or fluctuates traders are more exposed to the funding liquidity risk than during the liquid and stable market condition.

Conversely, equity illiquidity positively predicts profitability of the anomalies in the latter sub-period (Panel B). This sample period is associated with increased liquidity, high trading volume, highly integrated markets, excessive funding liquidity, and advances in trading technology. In the later period both currency anomalies become negatively correlated with the stock market and with some prominent equity anomalies (e.g., stock momentum), suggesting hedging opportunities. Thus, in conjunction with the evidence on the negative stock momentum returns following the months of high market illiquidity (Avramov et al., 2015), investors may switch to currency strategies in search of higher returns and diversification benefits. Finally, the later period is associated with the improved tradability of the currencies, as noted in Menkhoff et al. (2012b), which, alongside the improvements in trading technology and reductions in trading costs, results in increased currency market accessibility. Overall, we suggest that the evidence of high returns on currency anomalies following months of high equity market illiquidity originates from the observed structural changes, decreased role of funding liquidity, increased salience of the currency anomalies and changes in the diversification properties of currency strategies.

3.3. Equity market illiquidity or FOREX illiquidity?

The results thus far indicate a possible predictive role for aggregate equity market illiquidity in explaining the two anomalies returns. The evidence also suggests that the sign of the effect changes in a period of low illiquidity. At the same time, recent studies of Mancini et al. (2013) and Karnaukh et al. (2015) argue

Table 4
Equity market liquidity and FX liquidity.

	Momentum		Carry trade	
	Model 1	Model 2	Model 1	Model 2
Panel A: FX liquidity (full sample)				
Intercept	1.581***		1.513***	
	(6.65)		(5.27)	
FX illiquidity	0.294		−1.348***	
	(0.60)		(−3.29)	
Adj-Rsq	0.003		0.069	
Obs	252		252	
Panel B: Profits regressed on lagged illiquidity variables (1991–2001)				
Intercept	1.531***	1.415***	0.961***	0.221
	(5.41)	(5.38)	(2.23)	(0.68)
FX illiquidity	1.663	1.595	−1.683*	−2.060***
	(1.57)	(1.53)	(−1.91)	(−2.77)
Equity market illiquidity		−0.321***		−0.936**
		(−2.63)		(−2.23)
Adj-Rsq	0.004	0.043	0.046	0.097
Obs	120	120	120	120
Panel C: Profits regressed on lagged illiquidity variables (2001–2012)				
Intercept	1.585***	1.635***	2.024***	2.084***
	(4.56)	(6.08)	(5.62)	(7.30)
FX illiquidity	−0.173	−0.552	−1.218***	−1.675***
	(−0.27)	(−0.77)	(−3.18)	(−5.28)
Equity market illiquidity		0.966***		1.166***
		(3.32)		(4.23)
Adj-Rsq	0.002	0.116	0.111	0.297
Obs	132	132	132	132

This table presents the results of the monthly time-series regressions with FX illiquidity as a single explanatory variable (Model 1) as well as jointly specified with equity illiquidity (Model 2) for the full sample (Panel A), and samples from 1976:1 to 2000:12 (Panel B) and from 2001:1 to 2011:12 (Panel C). *FX illiquidity* is the Karnaukh, Ranaldo and Söderlind (2015) aggregate Corwin-Schultz estimator based illiquidity measure in month $t-1$. *Equity market illiquidity* the normalized market illiquidity measure constructed from Amihud (2002) in month $t-1$, in particular, it is the value-weighted stock-level Amihud's (2002) illiquidity measure of all NYSE and AMEX firms. Newey-West HAC based t-statistics are presented in parenthesis. Numbers annotated with asterisks *, ** and *** are significant at the 10%, 5% and 1% level, respectively.

that FX illiquidity can explain a substantial proportion of the variations in carry trade returns. The natural question arising is whether it is the currency market illiquidity, but not the equity market illiquidity, that is responsible for the observed relation.[9] Illiquidity can indeed be correlated across markets. In this subsection we address this concern and guard against the possibility that equity market illiquidity confers no marginal effect on currency anomalies. Specifically, we examine whether the predictive effects of equity market illiquidity on momentum and carry trade returns are subsumed by a variation in FX market illiquidity.

The measure of FX illiquidity is based on Karnaukh et al. (2015).[10] Specifically, the monthly FX illiquidity measure for each currency pair is computed based on the Corwin-Schultz spread estimator with adjustments for overnight returns as a simple average across positive two-day estimates. The simple average across individual currency pair's monthly estimators is the aggregate FX illiquidity measure in our paper. This measure is positively correlated with Amihud's (2002) equity illiquidity measure with the correlation coefficient of 0.03 in the sample from 1991:01 till 2011:12.

First, we consider the role of the state of FX illiquidity in the time-variation of currency anomalies returns in a model with a single predictor (Panel A of Table 4). Similar to the evidence in the prior literature, the FX illiquidity posts a negative and statistically significant coefficient estimate in the case of carry trade returns (right panel), however, the results for currency momentum (left panel) are statistically indistinguishable from zero. Next, we investigate the predictive role of the equity market illiquidity in addition to FX illiquidity in jointly specified models. These results are presented for the samples from 1991:1 to 2000:12 (Panel B) and from 2001:1 to 2011:12 (Panel C). The correlation coefficients between the two illiquidity measures are −0.24 and 0.37 for Panels B and C, respectively. The results on currency momentum strategy confirm the strong influence of equity market illiquidity states on momentum returns in both sub-samples, while revealing no evidence of an FX illiquidity-momentum relationship. Conversely, in the case of carry trade, the FX illiquidity dominates equity market illiquidity in terms of both magnitudes and statistical significance, albeit, the latter is not entirely subsumed by the variation in FX market illiquidity.

To conclude, the results of Section 3 indicate the dominant predictive role of the equity market illiquidity measure over other equity market state variables in explaining the variations in portfolio returns of currency market anomalies. Further, the structural change in equity market illiquidity results in the negative-to-positive sign reversal in the illiquidity-anomalies relationship. Furthermore, we document that the equity illiquidity-momentum effect is sustained upon the introduction of FX illiquidity into the analysis, while FX illiquidity overshadows equity market illiquidity in explaining carry trade returns. Overall, results of this section suggest the moderately possible predictive role of the aggregate equity illiquidity for both anomalies. However, in the following sections, we show that the predictive effect of equity market illiquidity is robust only for currency momentum, but not for carry trade.

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[9] We thank an anonymous referee for the suggested analysis.

[10] We thank Angelo Ranaldo for making the time series of their FX illiquidity measure and instruction on its construction publicly available.

Table 5
Alternative measures of aggregate market illiquidity.

	1976–2001				2001–2012			
	Momentum		Carry trade		Momentum		Carry trade	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Panel A: Profits regressed on lagged equity market state variables								
Intercept	1.107***	2.664***	0.948***	0.630	1.456***	1.946**	2.099***	2.558***
	(4.46)	(4.26)	(4.45)	(0.88)	(5.69)	(2.10)	(8.66)	(2.82)
Illiquidity	−0.296*	−0.167**	−0.857***	−0.721	0.262*	0.496*	0.228	0.113
	(−1.93)	(−2.11)	(−2.73)	(−1.16)	(1.72)	(1.91)	(1.40)	(0.23)
Down market		1.943		0.325		1.153*		1.633**
		(0.97)		(0.17)		(1.67)		(2.05)
Volatility		−1.714***		0.305		−1.045		−1.00
		(−3.06)		(0.46)		(−1.14)		(−1.20)
FF factors		Yes		Yes		Yes		Yes
Crisis control		Yes		Yes		Yes		Yes
Adj-Rsq	0.030	0.041	0.024	0.046	0.017	0.142	0.014	0.212
Obs	298	298	298	298	132	132	132	132

	1991–2001		2001–2012	
	Momentum	Carry trade	Momentum	Carry trade
	Model 3	Model 3	Model 3	Model 3
Panel B: Profits regressed on lagged equity and currency market illiquidity variables				
Intercept	1.529***	0.953**	1.234***	1.753***
	(5.47)	(2.44)	(3.64)	(5.15)
Illiquidity	−0.328**	−1.335**	0.809**	0.624*
	(−2.37)	(−2.21)	(2.52)	(1.67)
FX illiquidity	1.547	−2.154***	−1.378	−2.148***
	(0.78)	(−3.46)	(−1.49)	(−4.91)
Adj-Rsq	0.047	0.139	0.069	0.156
Obs	120	120	132	132

This table presents the results of the following monthly time-series regressions for the samples from 1976:1 to 2000:12 (left panel) and from 2001:1 to 2011:12 (right panel):
Panel A:

$$H\_L_t = a_t + B_1 CSilliquidity_{t-1} + B_2 down_{t-1} + B_3 volatility_{t-1} + B_4 crisis_t + B_5' F_t + e_t$$

Panel B:

$$H\_L_t = a_t + B_1 CSilliquidity_{t-1} + B_2 FXilliquidity_{t-1} + e_t$$

where in Panel A *H-L* is the currency momentum or the carry trade trading strategy payoff; *CSilliquidity* (denoted as Illiquidity below) stands for the normalized market illiquidity measure that is alternatively specified as in Corwin and Schultz (2012) in month $t-1$, specifically, it is the value-weighted average of the stock-level Corwin-Schultz illiquidity estimator of all NYSE and AMEX firms; *down* is the dummy variable that takes the value of one if the past twenty-four months return on the value-weighted CRSP market index is negative and zero otherwise; *volatility* is the standard deviation of the value-weighted CRSP market index in month $t-1$; *crisis* stands for the dummy variable that takes value of one if potentially systemic macroeconomic events occur in month *t*; *mkt_rf*, *smb*, and *hml* are FF factors. In Panel B *H-L* represents the strategy payoffs; *CSilliquidity*, as above, stands for the aggregate Corwin and Schultz (2012) illiquidity measure in month $t-1$; and *FXilliquidity* (denoted as FX illiquidity below) is the Karnaukh et al. (2015) aggregate FX market illiquidity measure. Newey-West HAC based *t*-statistics are presented in parenthesis. Numbers annotated with asterisks *, ** and *** are significant at the 10%, 5% and 1% level, respectively.

4. Robustness and additional tests

In this section we explore the robustness of our analysis and present supplementary empirical findings on the presence of the illiquidity-momentum effect under various restrictions.[11] In particular, we investigate the predictive power of equity market illiquidity on currency momentum and carry trade using an alternative measure of illiquidity. Furthermore, we report the results of a sample split test and check that the effect is not period-specific and not unduly stirred by outliers. Finally, we perform a battery of other supplementary robustness checks conducted to validate our findings.[12]

4.1. Alternative measure of equity market illiquidity

First, we consider an alternative measure of equity market illiquidity, that is, the Corwin and Schultz (2012) bid-ask spread estimator constructed from daily high and low stock prices. To obtain a monthly bid-ask spread estimator for a single stock, we follow the procedures outlined by Corwin and Schultz (2012). Accordingly, we compute the two-day high-to-low price measure, set negative two-day spreads to zero, and take a simple average across the observations. We do this for all NYSE and AMEX firms over the studied period. Finally, the value-weighted average of constructed Corwin-Schultz measure across all firms is the alternative measure equity market illiquidity. Corwin and Schultz (2012) argue that such a measure of aggregate illiquidity has similar power to the Amihud (2002) measure and outperforms other conventional estimators. The alternative measure is positively, but not perfectly, correlated with Amihud illiquidity and FX illiquidity with correlation coefficients of 0.25 (for the 1976–2012 sample) and 0.61 (for the 1991–2012 sample). The empirical estimation procedures are similar to those reported in Section 3, the only exception being the alternative illiquidity measure specified. Results are presented in Table 5.

The results of the analyses based on the alternative equity illiquidity measure are similar to their counterparts in Tables 3 and 4, thereby further reinforcing the evidence of the predictive role of equity market illiquidity in explaining the variations in currency

[11] We thank an anonymous referee for the suggested additional robustness checks.

[12] Additionally, in unreported results, we check that illiquidity effect is sustained when the market-wide sentiment (Baker and Wurgler, 2006) is introduced into the analysis. We find that the effect of equity market illiquidity is not subsumed by the investor sentiment. Results are available upon request.

momentum returns. Once again, the results of both panels consistently indicate that in a period of high illiquidity, momentum payoffs are low when the equity market is illiquid, while the effect is reversed in the latter period (see the right-hand panel of Table 5). The Corwin-Schultz illiquidity estimator dominates other market state variables as well as FX market illiquidity, and is significant (at least at a ten-percent level) throughout all of the model specifications in the upper panel. Hence, the predictive role of the aggregate equity market illiquidity for momentum returns remains robust against our alternate measures of illiquidity. However, results are the opposite for carry trade, that is, the Corwin-Schultz illiquidity only occasionally verges on significance, and is insignificant in most of the analysis. Importantly, the signs of the equity illiquidity variable are identical to their counterparts in previous tables.

4.2. Split sample tests

To further assess robustness, we perform a sample split test. Specifically, we split the full sample into four parts such that each part covers the period associated with the corresponding decade. The left-hand panel of Table 6 shows the results for momentum and the right-hand panel presents the results for the carry trade strategy.

The outcomes of the sample splitting procedure validate a previous finding of momentum-illiquidity relationship and indicate that results are not unduly affected by outliers. Regardless of the subsample, the coefficients on illiquidity are uniformly statistically significant in the case of momentum, albeit not as strongly as the corresponding estimates in Table 3. In contrast, the results for the carry trade strategy are not as convincing, reaching significant levels only in the latter decade. Nevertheless, the sign of the illiquidity coefficient aligns with the evidence from Section 3.2 indicating that the sign of the effect changes in the post-decimalization period. Additionally, to reassure readers of the robustness of this evidence, we show that the signs of illiquidity estimates remain unchanged when the samples are partitioned into twelve subsamples, each of three-years' length. We report results of three-year sample splits in the Internet Appendix.

4.3. Other robustness tests

Next, we perform a number of supplementary robustness checks. First, to guard against the possibility that currency-specific information may be lost while aggregating to portfolios, we follow Lo and MacKinlay (1990) suggestion and perform test at an individual currency level. The results of two-stage regressions (as in Avramov and Chordia, 2006) suggest that individual currency level momentum is weaker following illiquid months. Next, to ensure that our results do not originate from extreme observations, we repeat the decade-based split of Table 6, while winsorizing the illiquidity measure at 99%, 95% and 90% levels. Next, we check if the negative-to-positive change of the illiquidity coefficient occurs only once around the beginning of the post-decimalization period. To do this, we perform additional sample partitioning on the basis of the three-year-long sub-sample. Further, we repeat the empirical analysis of Table 2 and can report that the predictive role of market illiquidity in explaining the variation in momentum returns persists when adjusting for currency-specific risk factors. Moreover, the illiquidity effect exists for momentum portfolios constructed with various formation periods. In the next step, we introduce transaction costs to the data, report the descriptive statistics and re-estimate the models from Section 3.1 accounting for transaction costs. Finally, we check that the results of this paper are not affected by issues of currency tradability, by repeating the analysis of the paper with tradability-adjusted datasets, where we gradually correct the dataset for currencies that were untradeable in certain periods and eliminate currencies with the largest values of NDF trading.

Although ultimately the results of a few tests deviate from the central findings of the paper, principally, the robustness checks confirm the predictive role of the equity market illiquidity in explaining the variation in currency momentum returns. Additional results reinforce the findings on the negative-to-positive change in the illiquidity effect before and after structural changes. In sum, the predictive effect on the currency momentum strategy holds through the robustness procedures, while the effect on carry trade is not robust, and becomes attenuated in most of the additional robustness checks. In most of the tests the illiquidity variable delivers similar estimates to the counterpart's values in the benchmark specifications of the previous sections. Additionally, we report supplementary descriptive statistics on individual currencies and control variables, as well as time-series correlations between anomalies of interest. In the interest of conciseness space, the detailed discussion on the aforementioned robustness procedures appears alongside the corresponding empirical results in the supplementary Internet Appendix.

Table 6
Decade based time splits.

	Momentum			Carry trade		
	Intercept	Illiquidity	Adj-Rsq	Intercept	Illiquidity	Adj-Rsq
Panel A: splitting on decades						
70s	2.223***	−0.597**	0.056	0.980	−0.151	0.002
	(2.76)	(−2.00)		(0.85)	(−0.35)	
80s	0.688***	−0.391*	0.012	0.719*	−0.206	0.001
	(2.72)	(−1.68)		(1.96)	(−0.43)	
90s	1.504***	−0.502*	0.019	0.871**	−0.407	0.014
	(4.72)	(−1.85)		(2.07)	(−1.10)	
00s	1.564***	0.823***	0.082	1.925***	0.749**	0.080
	(5.72)	(2.85)		(5.78)	(2.55)	

This table presents the results of the decade based time sample splits. For each decade we estimate the model with the independent variable being either currency momentum trading or carry trade strategy returns, where the equally-weighted loser portfolio is subtracted from the equally-weighted winner portfolio in month t; and the explanatory variable is the normalized market illiquidity measure constructed from Amihud (2002) in month $t-1$, specifically, it is the value-weighted stock-level Amihud's (2002) illiquidity measure of all NYSE and AMEX firms. Newey-West HAC based t-statistics are presented in parenthesis. Numbers annotated with asterisks *, ** and *** are significant at the 10%, 5% and 1% level, respectively.

5. Conclusions

The results of this paper indicate that aggregate equity market illiquidity explains the evolution of currency momentum payoffs, but the equity illiquidity effect is fairly inconspicuous in currency carry trade returns. Returns on currency momentum are low (high) following months of high (low) equity market illiquidity. The effect of equity market illiquidity dominates other measures of equity market conditions. The predictive effect of equity market illiquidity on currency momentum returns is robust to the alternative equity illiquidity specification and persists after controlling for aggregate FX liquidity, and also sustains a number of robustness checks. Finally, separate investigation of the role of equity market illiquidity in the most recent decade and prior periods reveals that the predictive effect is reversed in the latter period.

This study does not aim to present complete explanations of currency excess returns or to identify a new profitable trading strategy, but it does explore how equity market conditions contribute to the observed returns of the most prominent currency anomalies. In light of our findings, this paper significantly expands the existing literature by revealing novel evidence on the effect of equity market illiquidity on the currency market.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jbankfin.2016.02.010.

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