

Evaporating Liquidity - Replication Report

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1 Background

Liquidity evaporated in many sectors of financial markets during the financial crisis 2007-09. There are at least two possible explanations for this disappearance of market liquidity. One is that the crisis amplified asymmetric information problems. An alternative and complementary theory is that the market turmoil strained the inventory-absorption capacity of the market-making sector, either because of a surge in liquidity demand from the public, or because market makers reduced liquidity supply in response to elevated levels of risk, tighter funding constraints, and reduced competition.

This paper studies this second channel using data from equity markets. The main objective is to estimate the extent by which the expected return from liquidity provision rises in times of financial market turmoil.

To construct a proxy for the returns from liquidity provision, Nagel examines reversal strategies that buy stocks that went down over the prior days, and sell stocks that went up during the prior days. The author shows that reversal strategy returns closely track the returns earned by liquidity providers. Moreover, the returns of the reversal strategy are highly predictable by the VIX index, which is a measure of the expected volatility of the S&P 500 index.

2 Methodology

This project replicates Table 1 and 2 in Evaporating Liquidity[?]. The author shows that the returns of short-term reversal strategies are generated by liquidity provision, and therefore are highly predictable by the VIX index. The author also found that reversal strategies on not only individual stocks but also industry portfolios produce high returns, especially during periods of high VIX.

The author constructs the reversal strategy by averaging the returns of five substrategies that weight stocks (or industries) proportional to the negative of market-adjusted returns on days $t - 1$ to $t - 5$.

$$w_{it}^R = - \left(\frac{1}{2} \sum_{i=1}^N |R_{it-1} - R_{mt-1}| \right)^{-1} (R_{it-1} - R_{mt-1}), \quad (1)$$

where $R_{mt-1} = \frac{1}{N} \sum_{i=1}^N R_{it-1}$ is the equal-weighted market return. Table 1 reports the summary statistics of the reversal strategies on individual stocks and industry portfolios. For individual stocks, the returns are calculated based on end-of-day transaction prices and quote midpoints.

Table 2 reports the results of the following predictive regression

$$L_t^R = a + bVIX_{t-5} + c'g_{t-5} + e_t, \quad (2)$$

where L_t^R is the return of the reversal strategy. VIX_{t-5} is the VIX index lagged by 5 days, divided by $\sqrt{250}$. g_{t-5} is a vector of control variables, including pre-decimalization dummy (takes a value of one prior to April 9, 2001 and a value of zero thereafter) and market return.

This project replicates these two tables using the same sample range as the original paper (from January 1998 to December 2010). We also provide the updated tables using data from January 1998 to December 2023.

3 Data Description

CRSP provides comprehensive historical data on stocks and indexes traded on U.S. exchanges, including NYSE, AMEX, and Nasdaq. In the project, CRSP daily stock data is pulled for constructing individual stock portfolios based on reversal strategy. Additionally, CRSP also provides daily index data, including indexes like CRSP value-weighted index, which is used to evaluate the performance of reversal strategy portfolios.

Fama/French Data Library database, created by Eugene Fama and Kenneth French, provides various financial data widely used in academic and investment research. The project pulls daily returns of 48 industry portfolios constructed based on Fama and French (1997) classification from Fama/French Data Library database. The data is used to construct industry portfolios based on reversal strategy.

FRED is a comprehensive source of economic data provided by the Federal Reserve Bank of St. Louis. The project pulls the CBOE Volatility Index (VIX) data from FRED, which is used as a predictor variable in the predictive regression.

4 Table Replication and Reproduction

Table 1 reports the summary statistics of the reversal strategies on individual stocks based on end-of-day transaction prices and quote midpoints, and industry portfolios. Below three tables represents the original table, the replicated table, and the updated table using data from January 1998 to December 2023. Although the replication table can not be exactly the same as the original table, the results are consistent.

Table 1: Summary Statistics of Reversal Strategy Returns

	Indiv. stock reversal Transact. prices	Indiv. stock reversal Quote-midpoints	Industry Portfolio reversal
Panel A: Raw Returns			
Mean return(% per day)	0.30	0.18	0.02
Std.dev.(% per day)	0.56	0.61	0.52
Skewness	3.02	2.74	1.06
Kurtosis	38.21	40.50	17.93
Worst day return(%)	-3.88	-4.76	-3.93
Worst 3-month return(%)	2.56	-2.13	-9.28
Beta	0.11	0.11	0.09
Annualized Sharpe Ratio	8.44	4.50	0.56
Panel B: Returns hedged for conditional market factor exposure			
Mean return(% per day)	0.29	0.17	0.01
Std.dev.(% per day)	0.48	0.54	0.47
Skewness	2.45	2.26	0.88
Kurtosis	31.26	34.51	15.97
Worst day return(%)	-2.26	-3.92	-3.12
Worst 3-month return(%)	2.27	-1.28	-7.97
Beta	0.00	0.00	0.00
Annualized Sharpe Ratio	9.58	4.91	0.44

Table 1: Summary Statistics of Reversal Strategy Returns (Replicated)

	Indiv. stock reversal Transact. prices	Indiv. stock reversal Quote-midpoints	Industry Portfolio reversal
Panel A: Raw Returns			
Mean return(% per day)	0.31	0.19	0.02
Std.dev.(% per day)	0.56	0.67	0.56
Skewness	3.01	3.58	0.77
Kurtosis	38.46	50.26	14.60
Worst day return(%)	-3.84	-4.54	-3.70
Worst 3-month return(%)	2.51	-2.72	-12.17
Beta	0.11	0.09	0.10
Annualized Sharpe Ratio	8.61	4.54	0.45
Panel B: Returns hedged for conditional market factor exposure			
Mean return(% per day)	0.30	0.19	0.01
Std.dev.(% per day)	0.54	0.65	0.54
Skewness	3.02	3.84	0.65
Kurtosis	39.00	55.98	12.20
Worst day return(%)	-3.05	-3.96	-3.31
Worst 3-month return(%)	2.07	-2.02	-9.18
Beta	0.00	0.00	0.00
Annualized Sharpe Ratio	8.87	4.58	0.38

Table 1: Summary Statistics of Reversal Strategy Returns (Updated)

	Indiv. stock reversal Transact. prices	Indiv. stock reversal Quote-midpoints	Industry Portfolio reversal
Panel A: Raw Returns			
Mean return(% per day)	0.23	0.16	0.01
Std.dev.(% per day)	0.67	0.77	0.52
Skewness	-0.51	4.97	0.70
Kurtosis	48.95	136.49	14.54
Worst day return(%)	-12.44	-7.50	-3.70
Worst 3-month return(%)	-7.53	-9.62	-12.17
Beta	0.12	0.10	0.09
Annualized Sharpe Ratio	5.39	3.29	0.32
Panel B: Returns hedged for conditional market factor exposure			
Mean return(% per day)	0.22	0.16	0.01
Std.dev.(% per day)	0.65	0.76	0.50
Skewness	-0.72	5.39	0.64
Kurtosis	52.57	151.89	12.62
Worst day return(%)	-12.47	-7.49	-3.30
Worst 3-month return(%)	-5.39	-9.79	-10.05
Beta	-0.00	-0.00	-0.00
Annualized Sharpe Ratio	5.44	3.27	0.22

Table 2 reports the results of the predictive regression of reversal strategy returns on the VIX index, as well as other control variables. Below three tables represents the original table, the replicated table, and the updated table. The replicated table has been verified that coefficients of relicated result are within the 99.7% confidence interval of the original result.

Table 2: Predicting Reversal Strategy Returns with VIX

Original Table 2 from the paper.

	Individual stocks Transaction-price returns				Individual stocks Quote-midpoint returns				Industry portfolios			
	Daily		Monthly		Daily		Monthly		Daily		Monthly	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Intercept	-0.03 (0.03)	-0.05 (0.02)	-0.02 (0.02)	0.02 (0.02)	-0.06 (0.03)	-0.07 (0.03)	-0.04 (0.03)	-0.01 (0.02)	-0.08 (0.02)	-0.09 (0.02)	-0.06 (0.02)	-0.05 (0.01)
VIX	0.22 (0.02)	0.20 (0.02)	0.18 (0.02)	0.15 (0.01)	0.16 (0.02)	0.16 (0.02)	0.13 (0.02)	0.10 (0.02)	0.07 (0.02)	0.07 (0.02)	0.05 (0.02)	0.04 (0.01)
Pre-decim.		0.22 (0.03)	0.22 (0.03)	0.23 (0.03)		0.08 (0.03)	0.09 (0.03)	0.09 (0.03)		0.00 (0.02)	0.01 (0.02)	0.01 (0.02)
R_M			-0.60 (0.19)	-0.03 (0.26)			-0.59 (0.21)	-0.16 (0.28)			-0.42 (0.17)	-0.05 (0.16)
Adj. R^2	0.07	0.11	0.11	0.56	0.03	0.03	0.04	0.25	0.01	0.01	0.01	0.07

Table 2: Predicting Reversal Strategy Returns with VIX (Replicated)

Replicated Table 2, which uses the same sample range as the original (from January 1998 to December 2010). It has been verified that coefficients of predictor variables in the replicated result have the same sign with the original result. The coefficients of replicated result are within the 99.7% confidence interval of the original result.

	Individual stocks Transaction-price returns				Individual stocks Quote-midpoint returns				Industry portfolios			
	Daily		Monthly		Daily		Monthly		Daily		Monthly	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Intercept	-0.06 (0.03)	-0.09 (0.02)	-0.06 (0.03)	-0.01 (0.02)	-0.06 (0.03)	-0.07 (0.03)	-0.03 (0.04)	0.00 (0.03)	-0.10 (0.03)	-0.10 (0.03)	-0.07 (0.03)	-0.04 (0.02)
VIX	0.25 (0.02)	0.23 (0.02)	0.21 (0.02)	0.18 (0.01)	0.18 (0.03)	0.17 (0.03)	0.14 (0.03)	0.11 (0.02)	0.08 (0.02)	0.08 (0.02)	0.06 (0.02)	0.04 (0.01)
Pre-decim.		0.23 (0.03)	0.24 (0.03)	0.25 (0.03)		0.11 (0.03)	0.11 (0.03)	0.12 (0.03)		0.01 (0.02)	0.01 (0.02)	0.02 (0.02)
R_M			-0.45 (0.19)	0.10 (0.23)			-0.78 (0.23)	-0.28 (0.26)			-0.57 (0.21)	-0.21 (0.16)
Adj. R^2	0.07	0.10	0.10	0.65	0.02	0.03	0.03	0.27	0.01	0.01	0.01	0.07

Table 2: Predicting Reversal Strategy Returns with VIX (Updated)

Updated Table 2, using data from January 1998 to December 2023. The results are consistent.

	Individual stocks Transaction-price returns				Individual stocks Quote-midpoint returns				Industry portfolios			
	Daily		Monthly		Daily		Monthly		Daily		Monthly	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Intercept	-0.08 (0.02)	-0.08 (0.03)	-0.05 (0.02)	-0.01 (0.02)	-0.09 (0.03)	-0.09 (0.03)	-0.06 (0.03)	-0.02 (0.03)	-0.09 (0.02)	-0.09 (0.02)	-0.07 (0.02)	-0.06 (0.02)
VIX	0.24 (0.02)	0.21 (0.02)	0.19 (0.02)	0.15 (0.02)	0.19 (0.02)	0.18 (0.03)	0.17 (0.02)	0.12 (0.03)	0.08 (0.02)	0.08 (0.02)	0.07 (0.02)	0.05 (0.01)
Pre-decim.		0.26 (0.03)	0.27 (0.03)	0.28 (0.03)		0.09 (0.03)	0.10 (0.03)	0.12 (0.03)		0.00 (0.02)	0.00 (0.02)	0.01 (0.02)
R_M			-0.39 (0.17)	0.03 (0.18)			-0.47 (0.23)	-0.04 (0.26)			-0.24 (0.16)	-0.03 (0.13)
Adj. R^2	0.04	0.05	0.05	0.53	0.02	0.02	0.02	0.19	0.01	0.01	0.01	0.08

5 Additional Analysis

Apart from the original statistical analysis of reversal strategy provided by the paper, we create a new version of performance matrix which includes VaR(0.05), CVaR(0.05), max drawdown, and other drawdown-based strategy performance, and we also add CRSP value weighted index as the benchmark to evaluate the performance of reversal strategies. The metrics are shown in Table 3.

Compared to the CRSP value weighted index, the reversal strategy based on individual stocks tends to have much higher annualized mean return and lower annualized volatility, which cause a way higher annualized sharpe ratio. The mean return of industry reversal strategy is a little bit lower than the banchmark, but it has lower volatility with higher sharpe ratio.

With regard to max drawdown, the transact price based individual reversal strategy is the best(-4.38%) among all the reversal strategies(quote-midpoints: -7.70%, industry: -13.90%) and the CRSP index(-57.18%). That strategy dropped form the peak on 2009-10-22 after the period of financial crisis. And it only used 7 days to recover the lose since the peak, while the industry reversal strategy took 433 days to recover and CRSP value weighted index didn't recover to the peak.

Table 3: Additional Summary Statistics of Reversal Strategy Returns

	Transact. prices	Quote-midpoints	Industry portfolio	CRSP Value Weighted Index
Annualized Mean Return(%)	76.97	48.23	4.02	7.86
Annualized Volatility(%)	8.94	10.60	8.85	19.65
Annualized Sharpe Ratio	8.61	4.55	0.45	0.40
Skewness	3.01	3.55	0.77	-0.27
Kurtosis	38.46	49.69	14.60	12.01
VaR (0.05)(%)	-0.33	-0.61	-0.74	-1.92
CVaR (0.05)(%)	-0.67	-1.02	-1.22	-2.96
Max Drawdown(%)	-4.38	-7.70	-13.90	-57.18
Peak	2000-04-11	2001-07-13	1998-04-09	2007-10-09
Bottom	2000-04-14	2001-09-21	1998-10-08	2009-03-09
Recovery Date	2000-04-18	2001-10-24	1999-06-16	2013-03-08
Duration (days)	7	103	433	1977

Figure 1 shows the three-month moving average return of the reversal strategy and VIX index across 1998 to 2010. The blue curve(VIX index) has a pre-trend of the red curve(3-month MA return of reversal strategy), which presents a key finding of the paper that the VIX index has a power to predict the reversal strategy return.

During the LTCM crisis in 1998 and Nasdaq decline in 2000, the reversal strategy return increased with VIX increasing. From then until 2007, returns declined steadily to less than 0.2% per day, but during the financial crisis, they surged, surpassing levels seen during the LTCM crisis. The figure illustrates a strong correlation between the time variation in the reversal strategy's return and the VIX index. Since the financial crisis began in 2007, the returns of the reversal strategy and the VIX have closely tracked each other.

6 Success and Challenges

The main challenge of the project is the data collection and processing. The original paper uses CRSP daily stock data and Fama/French Data Library database to construct individual stock and industry portfolios based on reversal strategy. The project needs to pull the data from these two databases and process the data to construct the portfolios. The project also needs to

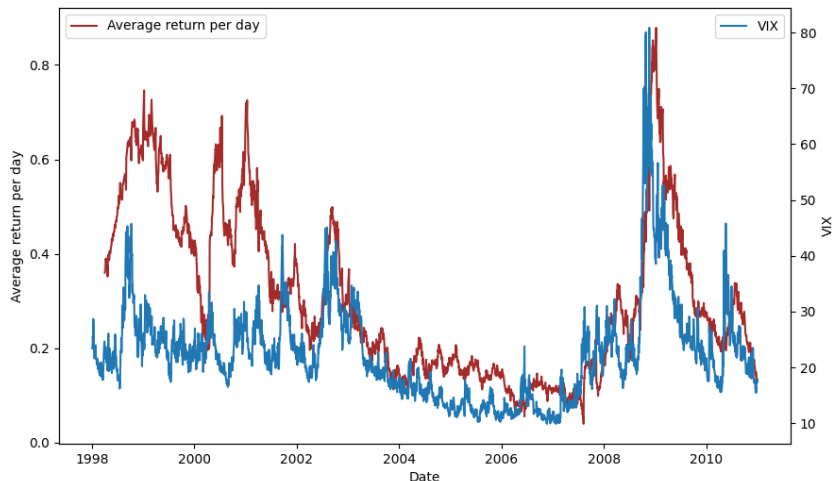


Figure 1: Reversal Strategy and VIX

pull the VIX data from FRED to use as a predictor variable in the predictive regression. The data collection and processing are time consuming and require careful attention to details.

While using GitHub to manage the project, the challenges are that the team members need to be pay attention to version control and the project needs to be well-organized to avoid conflicts. The project also needs to be well-documented and well-tested to ensure the robustness of the results.

Since the team members can easily track the changes and collaborate well on the project, the project is well-organized and the team members are able to work efficiently. The project successfully overcomes the challenges and completes the replication. The results are consistent with the original paper, which further verifies the robustness of the original paper. The project also provides the updated tables using data from January 1998 to December 2023, which provides more recent evidence on the predictability of reversal strategy returns by the VIX index.

7 Conclusion

In summary, our endeavor to duplicate Tables 1 and 2 from "Evaporating Liquidity" encountered a mix of triumphs and hurdles, offering priceless insights. Our efforts to replicate yielded results that closely aligned with the originals, validating Stefan Nagel's rigorous approaches. Although we faced some difficulties, our project illustrates that through careful methodology and dedicated work, essential scholarly conclusions can be confirmed.

References

- [Nagel(2012)] Nagel, Stefan. 2012. “Evaporating Liquidity.” *The Review of Financial Studies* 25 (7):2005–2039. URL <https://doi.org/10.1093/rfs/hhs066>.