Liquidity and asset prices: a VECM approach

Attila Ács

The recent financial and economic crisis highlighted the importance to better understand the relationship between liquidity developments and asset price movements. Central banks with focus on inflation targeting allowed asset price inflation, following burst, with its devastating consequences for the financial system and real economy. Equilibrium price should emanate from fundamentals. However liquidity conditions are part of fundamental variables and should be taken into consideration as explanatory variables in the process of asset pricing. Furthermore in many cases assets serve as collateral in refinancing which means that refinancing conditions influence values of pledged assets.

Keywords: liquidity, asset pricing, broker dealer, repo, error correction

1. Introduction

Low and stable inflation supports financial stability, it also add to the probability that excess demand show up first in credit aggregates and asset prices, sooner than in the prices of goods and services. By anchoring expectations and hence inducing greater stickiness in prices and wages can lessen the inflationary pressures emanating from increased demand. Consequently, in certain situations, a response by the monetary authorities to credit and asset markets can be motivated to safeguard both financial and monetary stability (Borio and Lowe, 2002).

2. Relevant literature, liquidity variables

At the eruption of the financial crisis the notion of funding liquidity frequently was pointed out in relation to asset prices. The funding or balance sheet liquidity is the ability of a financial institution to settle obligations with immediacy (Drehmann and Nikolaou, 2009). This inherently supposes that funding conditions should be an intrinsic part of asset and financial stability valuation process. In the midst of rapidly evolving financial theory not surprisingly there are difficulties with the identification of liquidity and as a consequence with its measurement. To find relationship between asset prices and monetary or credit aggregates seems appealing but only after the recent financial crisis arrived satisfactory answer.

The non-interest-bearing fiat money is simply the outcome of a liquidity shortage, not a logical requirement. In the future money may ultimately disappear owing to ultra-liquid, privately-issued securities that earn interest. In this view, Monetary Economics should be displaced by Liquidity Economics. Money has no intrinsic value and people are willing to hold because they find it difficult to barter. Money is accepted because it's been believed that would be accepted it in the future. That is mutually-sustaining beliefs are indispensable to its acceptance and existence (Kiyotaki and Moore, 2001). As fiat money is not interest bearing everybody who holds it faces opportunity cost. A kind of hot potato affect is a characteristic of fiat money - that is nobody desires to hold for a sustained period – which urge economic agents to exchange it for interest bearing assets. Ceteris paribus more money leads to increased demand for assets.

Continuous rapid credit growth together with huge increases in asset prices seems to increase the possibility of an occurrence of financial instability. However rapid credit growth, on its own, creates modest risk to the stability of the financial system. The same is true for quick growths in asset prices or investments. It is the combination of events, particularly the synchronized happening of fast credit growth and rapid increases in asset prices and that increases the likelihood of financial risk, rather than any one of these events alone (Borio and Lowe, 2002).

Studies ahead of the recent financial crisis predominantly used money and credit aggregates to explain asset price developments, e.g. Detken and Smets (2004), Wyplosz (2005). Baks and Kramer (1999) computed growth rate in broad and narrow money to generate global liquidity indictors for the G-7 countries. Borio et al. (1994) examined the link between credit and asset prices, trying to identify an indicator of future movements in output and inflation and to determine the demand for money. Borio and Lowe (2002) highlighted the importance of cumulative effects of credit growth. This approach is understandable as before the monetary policy shifted to inflation targeting during 80's and 90's central banks pursued monetary targeting regime.

Main feature of the development of financial systems since the 1970s has been the rapid expansion of financial markets. The importance of liquidity has been acknowledged by central banks in respect to both monetary and financial stability. This is reflected in market-oriented operating procedures and the intense use of asset prices as a guide for monetary policy. For example, yield curves are commonly used to extract information about market participants' expectations concerning inflation. This process depends crucially on the liquidity of the underlying market, namely the treasury and bond market. In case of financial stability central banks use asset prices in the monitoring of vulnerabilities in the financial system, as they include information about market participants' assessment and risk pricing (Borio, 2000).

Classical monetary and credit aggregates do not fully cover market participants' aggregated ability to buy assets. The studies mentioned above measured liquidity in monetary aggregates but liquidity is something more. Monetary aggregates measure the liabilities of deposit-taking banks, and so may have been useful before the advent of the so called market-based financial system. Market-based institutions (broker-dealers, investment banks) overtook the dominant role in the supply of credit from commercial banks. These market-based financial institutions were deeply involved in securitisation and actively used capital and financial markets to satisfy their funding needs. This way market-based liabilities such as repos and commercial paper are better indicators of credit conditions that influence the economy. As a result there is a case for restore a role for balance sheet quantities in the conduct of monetary policy. From the point of view of financial stability measures of collateralized borrowing, such as the weekly series of primary dealer repos can prove very useful. This changing nature of finance is reflected by the aggregate balance sheet of market-based financial intermediaries which in 2007 reached 17.000 trillion of dollars compared to commercial banks 13.000 trillion (Adrian and Shin, 2008).

Repurchase agreement (repo) is a form of money (private/inside money), like demand deposits but for institutional investors and nonfinancial firms. These companies require ready access to cash should the need arise, a way to safely storage and some interest. In a repo deal a "depositor" (e.g. money market funds) deposits money at a financial institution (e.g. investment bank, broker-dealer) and receives collateral, valued at market prices. The contract is short term (typically overnight), which means the depositor can withdraw the money at any time by not renewing or rolling the repo. The deposits supported by assets (e.g. bonds, ABS) as collateral obtained from the institution where the fund is deposited. In banking crises available money from repo markets disappear, liquidity dries up because of a loss of confidence (Gorton and Metrick, 2010).

To protect against losses in case of default of borrower lenders apply a so called haircut on pledged assets, which is the difference between the current market price of the security and the price at which it is sold. The system of repurchase agreement is built on trust of the value of the underlying asset. If case of questioning the value of collateralised assets, the trust evaporates from the markets resulting in higher haircuts. A haircut addresses the risk that if the holder of the bond in repo, the depositor, has to sell a bond in the market to get the cash bank, he may face a better informed trader resulting in a loss (relative to the true value of the security). This risk is endogenous to the trading practice, which is not the danger of loss due to default. As a result, the price cannot adjust to address this risk. One way to protect against this endogenous adverse selection risk is to require overcollateralization (Gorton and Metrick, 2010).

Principal determinant of available funding to leveraged institutions is the variation of the haircut size, since the haircut determines the maximum possible leverage (ratio of assets to equity) for investors (Adrian and Shin, 2009; Brunnermeier and Pedersen, 2008).

Higher haircuts may come from increased market volatility which means uncertainty about the collateral value. Decreasing assets values mean lower amount of money available from repo which circumstance adds additional pressure to asset prices. To put it differently there is procyclicality between liquidity and asset prices.

It is true that risk emanating from repo is limited by collateral but repo is not free of counterparty risk. Collateral pricing in case of default can be uncertain, and illiquidity and volatility in the secondary markets for this collateral can induce large transactions costs. In this case, measures of bank-counterparty risk may be relevant to lenders, set as the spread between the 3-month LIBOR and the 3-month OIS (Gorton and Metrick, 2009).

Haircuts, volatility, counterparty risk, and short term refinancing creates funding liquidity risk. Information about aggregate funding liquidity risk can be learned by observing the bidding behaviour of banks during open market operations. The method observes the sum of the premium banks are willing to pay above the expected marginal rate (i.e. the expected interest rate which will clear the auction) times the bidding volume, and normalised by the expected amount of money supplied by the central bank. The obtained tool named liquidity risk insurance premia (LRP) which shows strong negative interrelationship with market liquidity. In this sense higher funding liquidity risk implies lower market liquidity (Drehmann and Nikolaou, 2010).

About the repo market it is important to mention that simply there is not enough AAA, highest rated debt in the world to satisfy demand (Fitch, 2011), so the banking system is under pressure to create supply. The prime reason is the rapid growth of money under management by institutional investors, pension funds, mutual funds. These entities need large amount of cash at hand, which earns interest, a safe investment, while offering the flexibility to use cash, in short, a demand deposit-like product. As a consequence the range of assets eligible for repo widened and haircuts got extremely low (Gorton and Metrick, 2010). As a response to the demand, the financial industry created new structures and produced new instruments that seemed to offer higher risk-adjusted yields. In this background, market discipline failed as optimism triumphed, due diligence was outsourced to third party credit rating agencies Low interest rates amid high price growth and low volatility urged investors around the world to look for yield further down the credit quality curve resulting in overoptimistic risk evaluation (IMF, 2009).

Figure 1/a: broker-dealers' balance sheet, M2

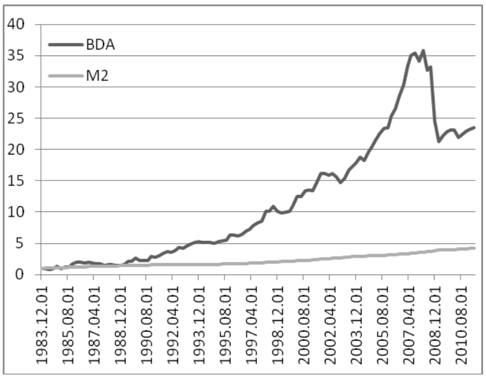
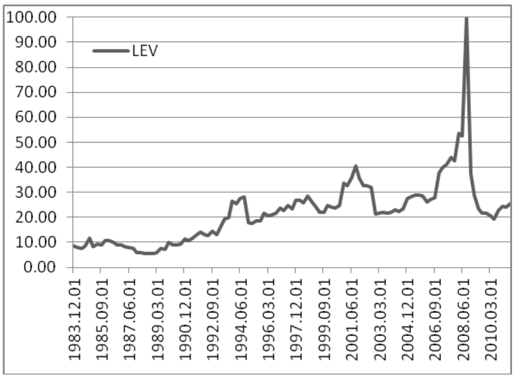


Figure 1/b: broker-dealer leverage



Source: Federal Reserve

3. Considerations

These paragraphs are built around relevant concept like refinancing conditions (collateral, repo, and haircut), maturity transformation and yield curve. Market participants' aggregated asset purchasing capacity and liquidity conditions are determined by the interaction between these factors. It is the combination of events which really matters rather than any factor independently and broker-dealers' aggregated balance sheet gives a good synthesis of liquidity conditions in general. But obviously factors can be investigated one by one more profoundly. This section offers reflections which can be used as starting points of a more profound research of the independent variables.

Development of broker-dealer leverage[1] is displayed in Figure 1/b which demonstrates that large decreases in broker-dealer leverage are associated with times of macroeconomic and financial sector turmoil (see the peeks at 2001Q3 and 2008Q3). In Figure 1/a the development of M2 monetary aggregate and broker-dealers' aggregated balance sheet is presented, both normalised to 1984Q1. The growing importance of broker dealers can be understood if the enormous size of their balance sheet is taken in consideration (17.000 trillion of dollars).

Refinancing by the use of repo is a universally used practice among investment companies. But repo usually is short term which exposes investors to refinancing risk frequently (daily, weekly, monthly). This also means that investors' reaction functions are similar and are not independent from each other. Similarity creates forces which move into the same direction at the same time exposing the financial system to stress events. The use of repo among US broker dealers gained popularity from the beginning on 90s and was the main driver of balance sheet for 3 years from 2004Q2 till 2007Q3.

If certain type of assets serve as collateral in refinancing it means that refinancing conditions influence values of pledged asset. Haircuts are different for different asset classes so ceteris paribus assets with lower haircut and higher revenue are more valuable as they afford higher leverage and potential profit. The availability of borrowable funds makes possible for investors to buy assets in addition to their capital exploiting the potential in leverage.

The notion of "collateral bubble" illuminates clearly one of the major sources of the recent financial crisis. Overly optimistic (imprudent) valuations cause not only asset bubble but as a consequence inflate collateral values too, emphasising the twofold role of assets as investments and collaterals. In

[1] Accounting leverage is calculated as the difference between total assets and total liabilities divided by total assets.

case of crisis (or illumination) not only investors or speculators lose money but also creditors as collaterals with decreased value do not offer enough counter-value in case of the borrowers' default.

The collateral bubble phenomenon causes procyclicality in the economy. The importance of the collateral issue in lending practices was highlighted by Borio et al. in 2001. The aggregate value of collateral to GDP can be an important issue to measure procyclicality. If in bank lending process the risks emanating from collateral are incorrectly assessed than the possibility of large credit cycles is increased (Borio et al., 2001).

Investors buy discounted future cash-flows represented by assets like bonds, commercial papers, stocks[2]. The trigger of the recent financial crisis was the loss of confidence in asset cash-flows (namely asset backed securities). The confidence in assets and collateral values and counterparties' solvency plunged very quickly from extreme highs resulting in increasing haircuts and narrowing circle of assets eligible for repurchase agreement. The consequence can be involuntary leverage as precipitating asset values wipe out leveraged borrowers' capital faster than they can reduce leveraged positions. This is precisely what happened in 2008 when broker dealers' accounting leverage reached nearly value of 100. [3]

By means maturity transformation and carry trade leverage can become more intense. In this sense a distinction can be made on two basic strategies: carry trade and maturity transformation. Carry trade attempts to capitalise on the difference of two interest rate environment; typically borrows money in a low-interest rate currency and buys higher-yielding assets in a different currency. This strategy is characteristic of investment banks.[4]

Maturity transformation takes advantage of the yield curve. The core of maturity transformation is the positively sloped (normal) yield curve, which means that shorter term investments (deposits, treasuries) earn lower interest rate than longer term ones (loans, mortgages, bonds). Steeper yield curve means higher profits from maturity transformation and flattening yield curve ceteris paribus decreasing the earning capacity of the financial industry. [5]

Though, distinction between two types of maturity transformation has to be made: liquidity transformation and interest rate risk transformation. Both build on the different market liquidity of long and short term assets. Longer terms assets are less liquid and are traded with interest rate premium. While the former one used typically by broker-dealers and assumes liquidity risk, the latter transformation involves the classical commercial banks which assume interest rate risk.

Financial institutions taking part in maturity transformation take on interest rate risk, including changes in rates of greater magnitude (e.g., up and down 300 and 400 basis points) across different tenors to reflect changing slopes and twists of the yield curve (FDIC, 2010). This risk affects investment and commercial banks which creates similarities in reaction functions.

These days excessively low long term interest rates creates risk factors as they are so small that it isn't worthwhile to invest. This situation firstly creates impetus to accept lower quality debt as collateral in

[2] I would call this funding liquidity, namely raise cash against collateral.

[3] Economic leverage would be more informative about the real risk size however it depends on model assumptions regarding correlations (and volatilities) which in stressful times usually breaks down. Furthermore it would require information about the size and direction (short or long) of positions.

[4] Carry trade usually entails high risk due to open exchange rate positions or involves exchange rate hedge by us of expensive derivatives.

[5] Not by chance an inverted yield curve always portended the stagnation of the US economy as between these conditions the profitability of banking activity got under serious pressure.

repo transactions. Secondary it creates liquidity overhang urging the acquisition of riskier, less liquid, worse quality assets and present impetus for carry trade. This situation seems alarming in the midst of quantity easing an fragile economic and financial developments.

4. Empirical Research

In relation to factors influencing liquidity conditions different asset prices like stock, bonds can be investigated. Research direction is not straightforward. To begin with, money originating from a repo transaction can be used to buy different type of assets like bonds, stock, treasuries or asset-backed securities as well. The source of liquidity does not tell anything about the destination of the fund received. Secondly, money obtained in one county can be invested in a different country exploiting the potential in carry trade (liquidity spill-over effect). Of course there may be other patterns.

4.1. The dataset

The time span of investigation based on the change in the course of US monetary policy regime. In the Volker era happened the passing from monetary targeting regime to inflation targeting) which period was highlighted by great volatilities. Thus the time series start in 1984 Q1 and end in 2011 Q2 and are based on quarterly observations.

This research investigates the effect of the newly discovered measure of liquidity, namely broker-dealers' aggregated balance sheet (BDA), on assets. The explaining variables of liquidity apart from broker-dealers' or investment banks' aggregated balance sheet is broader M2 monetary aggregate[6] and gross national product (GDP). The variables under investigation are: S&P500 index (SX) representing price of the US stocks, treasury bond rate (10 year treasury bonds) and 3 months treasury rate standing for bond (B10) and treasury prices (T3) respectively – though the interpretation of these rates can be manifold. The data source for M2, BDA, T3 and B10 is the Federal Reserve Bank of the United States, for SX the Yahoo Finance and for GDP the Bureau of Economic Analysis. M2, BDA, GDP and SX time series were transformed logarithmically.

4.2. Methodology

A Vector Error Correction Model (VECM) been identified[7] for the economy of the United States as variables in case of US economy are easily available. VEC model has been chosen as it allows identification of long and short term relationships between variables. The core of VECM is cointegration which tested by the Johansen maximum likelihood procedure. In estimating the cointegration first has to be checked whether each of the series is integrated of the same order. Integration of a time series can be confirmed by the standard Augmented Dickey-Fuller test and Phillips-Perrons unit root tests. The number of cointegration ranks (r) is tested with the maximum eigenvalue and trace test. The maximum eigenvalue statistics test the null hypothesis that there are r cointegrating vectors against the alternative of r+1 cointegrating vectors. The trace statistics tests the null hypothesis of no cointegrating vector against the alternative of at least one cointegrating vector. The asymptotic critical values are given in Johansen (1991) and MacKinnonet al. (1999).

[6] The Fed stopped reporting values for M3 at the end of 2005.
[7] Jmulti and Eviews programs were used.

4.3. Descriptive Statistics

A summary of descriptive statistics of the variable can be found in Table 1. Sample mean, standard deviation, skewness and kurtosis, and the Jacque-Bera statistic and p-value have been reported. The relatively high standard deviation of B10 and T3 with respect to the mean is an indication of high price volatility of the traded items. According to the Jarque-Bera test the null hypothesis that the variables are normally distributed is acceptable only in case of T3.

All of the six time-series are integrated of order one as the Augmented Dickey-Fuller test display evidence of nonstationarity at levels but first differences are stationary at 5% significance level. Consistent with Figure 2, we conclude that all the variables are I (1).

4.4. VAR analysis, residual test

The selection of the optimal lag length was based on an auxiliary Vector Autoregression (VAR) model. The Likelihood Ratio (LR) and Final Prediction Error (FPE) statistics propose a lag length of order 6, Akaike Information Criterion (AIC) statistics propose a lag length of order 8, while Schwarz Criterion (SC) and Hannan–Quinn (HQ) criterion offer to use lag order one and two respectively.

The Lagrange multiplier (LM) test revealed presence of residual autocorrelation with all of the proposed leg length. To ensure normality, dummies were created based on the economic calendar and the graphs of the standardized residuals, which have revealed a couple of large outliers. Three blip dummy variables were created with values 1 at 87Q4, 01Q3 and 08Q4 and zeros otherwise. The 3 dummy represent 3 extreme events: the black Friday on the stock exchange, the aftermath of September 11, 2001 (and aftermath of the Enron scandal) and the recent financial crisis. By the use of these dummies with length of 4 the hypothesis of no residual autocorrelation can be accepted with fairly high confidence level (Table 2). The SC has tendency to underestimate the lag order, while adding more lags increases the penalty for the loss of degrees of freedom. AIC, SC, HQ is based on the maximal value of the likelihood function with an additional penalizing factor related to the number of estimated parameters (Juselius, 2003, p. 78). Thus the use of 4 lags is rationalised.

The normality tests are based on skewness and kurtosis. The tests show that the null of the tests, normally distributed errors, is not accepted in the multivariate case and for all individual time series aside from the treasury rate. Normality test of residuals is rejected due to kurtosis but normality of skewness is accepted at 72% confidence level. These test results are acceptable because it has shown that kurtosis is less serious than skewness (Juselius, 2003, p. 76).

Additionally, test of heteroscedasticity, signs for ARCH effects (the hypothesis of no ARCH effect can be accepted only at 1.3% confidence level). However, cointegration tests are robust against moderate residual ARCH effects (Juselius, 2003, p. 51). Since most test statistics are accepted, the model seems to describe the data well.

4.5. Cointegration test

Consider a VAR system of order p where y represents a vector of variables with $k = n$,

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_k y_{t-k} + u_t \tag{1}$$

where y_t is a vector of non-stationary I(1) variables and the A_i's are $(n \times n)$ coefficient matrices and $u_t = (u_{1t}, u_{2t}, \ldots, u_{nt})$ is an unobservable i.i.d. zero mean error term or innovations. It can be reparameterized by adding and subtracting $A_k y_{t-k+1}$ from the right hand side:

$$\Delta y_t = -\Pi y_{t-1} + \sum_{i=1}^{n-1} \Phi_i \Delta y_{t-1} + u_t \qquad (2)$$

where,

$$\Pi = (I - \sum_{i=1}^{n} A_i) \text{ and } \Phi_i = -\left(\sum_{j=i+1}^{n} A_j\right) = -A*(L) \qquad (3)$$

Using exogenous dummy or exogenous variables D, Δy_t can be expressed with the following form:

$$\Delta y_t = \Pi y_{t-1} + \Gamma_1 \Delta y_{t-1} + \Phi D_t + u_t \qquad (4)$$

If the characteristic polynomial in Δy_t

$\Pi(\lambda) = I_p - \lambda\Pi_1 - \lambda^2\Pi_2 = (1-\lambda)I_p - \Pi\lambda - \Gamma_1\lambda(1-\lambda)$ (or the companion matrix) has unit root, then $|\Pi(\lambda)| = 0$ fpr $\lambda = 1$ and $\Pi(1)$=$-\Pi = -\alpha\beta'$. And the ECM model becomes:

$$\Delta y_t = \alpha\beta' y_{t-1} + \Gamma_1 \Delta y_{t-1} + \Phi D_t + u_t \qquad (5)$$

Granger's representation theorem asserts that if the coefficient matrix Π has reduced rank $r < k$, then there exist a k x r matrices α and β each with rank r such that $\Pi = \alpha\beta'$ and $\beta' yt$ is $I(0)$. r is the number of cointegrating relations (the cointegrating rank) and each column of β is the cointegrating vector. As explained below, the elements of α are known as the adjustment parameters in the VEC model. Johansen's method is to estimate the Π matrix from an unrestricted VAR and to test whether we can reject the restrictions implied by the reduced rank of Π.

By the use of VECM model several effects can be examined. The β_{ij} coefficients show the long run equilibrium relationships between levels of variables. The α_{ij} coefficients show the amount of changes in the variables that bring the system back to equilibrium. Γ_{ij} coefficients show the short run changes occurring due to previous changes in the variables and Φ_{ij} coefficients show the effect on the dynamics of external events.

4.6. Empirical results

Johansen Cointegration test indicates mixed results about the number of cointegration. The number of cointegration ranks (r) is tested with the maximum eigenvalue and trace test. The maximum eigenvalue statistics test the null hypothesis that there are r cointegrating vectors against the alternative of r+1 cointegrating vectors. The trace statistics tests the null hypothesis of no cointegrating vector against the alternative of at least one cointegrating vector. The asymptotic critical values are given in Johansen (1991) and MacKinnon et al. (1999).

The level data sets have clear linear trends but about the intercepts of cointegrating equation(s) (CE) nothing can be told. Accordingly the Johansen test performed with the optimal lag length of 4 and with and without the intercepts of cointegrating equation(s). In both cases one or two CEs at the 0.05 level is signalled by trace test and maximum eigenvalue test, however in case of trend assumption in the CE the presence of 2 CEs is accepted by the maximum eigenvalue and only borderline declined by Trace Test. Thus the use VECM is motivated.

The graphs of the cointegrating relations of the unrestricted model can be seen on Figure 3. The two graphs show persistent behaviour and strongly suggest mean-reversion behaviour and look fairly stationary (Figure 3). As a result, this indicator points to a rank of 2. Figure 4 depicts the recursively calculated log-likelihood which provides further information on parameter constancy and confirms a constant parameter regime. As a result, the assumption of constant parameters, which is important for valid identification of the long-run structure, is fulfilled.

The t statistics of the parameters (Table 4) are significant (value close to1.9) at least in one of the two cointegarting equation which gives evidence of considerable evidence of long term relationship between money variables and asset prices.

5. Conclusion

The objective of this paper to prove evidence of remarkable relationship between asset prices and monetary developments, with special focus on broker dealer balance sheet, is reached by the identification of the cointegrating equations. Coefficient restrictions and detailed interpretation of the results is not intended by this paper.

Cointegration between non-stationary data series represents the statistical expression of the economic notion of a long-run economic relation. Co-integration analysis makes possible to check for various long-run relations in the data that can help to improve the understanding of the relationship between money and asset prices (Wiedmann, 2011, p. 55, 56). Parameters with significant t statistics of the (Table 4) proves the connection and especially the relevant information content of broker dealers' balance sheet

In a future research coefficient restrictions, identification of the long-run structures, short-run dynamics and the long-run impact of the common trends can be the next step forward. Relevant input data connected to this tread of study can be other monetary aggregates (M1, M3), volatility indices (VIX), repurchase agreement statistics (collateral value, haircut), measure of counterparty risk (LIBOR-OIS spread, Gorton and Metrick, 2009), or measure of funding liquidity risk (LRP, Drehmann and Nikolaou, 2010).

Additional variables under investigation can be assets like real estate, stock or derivatives. Further explanatory variables can be inflation, productivity or unemployment data, interbank money market conditions, market liquidity indexes (bid-offer spread, market depth, resilience, immediacy) financial innovation, accounting rules, regulatory capital rules.

Acknowledgement

Acknowledgement to Balázs Kotosz for the useful comments and time devoted to VAR analysis.

References

1. Adrian, T. – Shin, H. S. (2008): Liquidity and financial cycles. *BIS Working Paper*.
2. Adrian, T. – Shin, H. S. (2009): Money, Liquidity, and Monetary Policy. *Federal Reserve Bank of New York Staff Report*.
3. Baks, K. – Kramer, C. (1999): Global Liquidity and Asset Prices: Measurement, Implications, and Spillovers. *IMF Working Paper*, WP/99/168.
4. Borio, C. (2000): Market liquidity and stress: selected issues and policy implications. *BIS Quarterly Review*, III. Special feature.

5. Borio, C. – Furfine, C. – Lowe, P. (2001): Procyclicality of the financial system and financial stability: issues and policy options. *BIS Papers*.
6. Borio, C. – Kennedy, N. – Prowse, S. (1994): Exploring aggregate asset price fluctuations across countries: measurement, determinants and monetary policy implications. *BIS Economic Papers*.
7. Borio, C. – Lowe, P. (2002): Asset prices, financial and monetary stability: exploring the nexus. *BIS Working Paper*, No 114.
8. Brunnermeier, M. K. – Pedersen, L. H. (2008): „Market Liquidity and Funding Liquidity", RFS Advance Access.
9. Detken, C. – Smets, F. (2004): Asset Price Booms and Monetary Policy. *ECB Working Papers*.
10. Drehmann, M. – Nikolaou, K. (2010): Funding liquidity risk: definition and measurement. *BIS Working Paper*.
11. Issues. Federal Reserve Bank of New York, *Current Issues in Economics and Finance*, 12, 5..
12. Federal Deposit Insurance Corporation, FDIC (2010): *Advisory on Interest Rate Risk Management*.
13. Fitch Ratings (2011, August 4.): *Money Market Survey*.
14. Gorton, G. – Metrick, A. (2009): Securitized Banking and the Run on Repo. *Yale ICF Working Paper,* No. 09-14.
15. Gorton, G. – Metrick, A. (2010): Haircuts. *Yale ICF Working Paper* No. 09-15.
16. IMF (2009): *Initial Lessons of the Crisis*. International Monetary Fund, Research, Monetary and Capital Markets, and Strategy, Policy, and Review Departments.
17. Juselius, K. (2003): *The Cointegrated VAR Model: Econometric Methodology and Macroeconomic Applications*. Oxford University Press, Oxford.
18. Kiyotaki, N. – Moore, J. (2001): Evil is the root of all money. *Clarendon Lectures*, London School of Economics and Edinburgh University and London School of Economics.
19. Wiedmann, M. (2011): *Money, Stock Prices and Central Banks: A Cointegrated VAR Analysis*. Springer-Verlag Berlin Heidelberg.
20. Wyplosz, C. (2005): Excess of liquidity in the Euro Area. *Briefing notes to the Committee for economic and monetary affairs of the European Parliament*.

Appendix

Figure 2: The graph of the variables

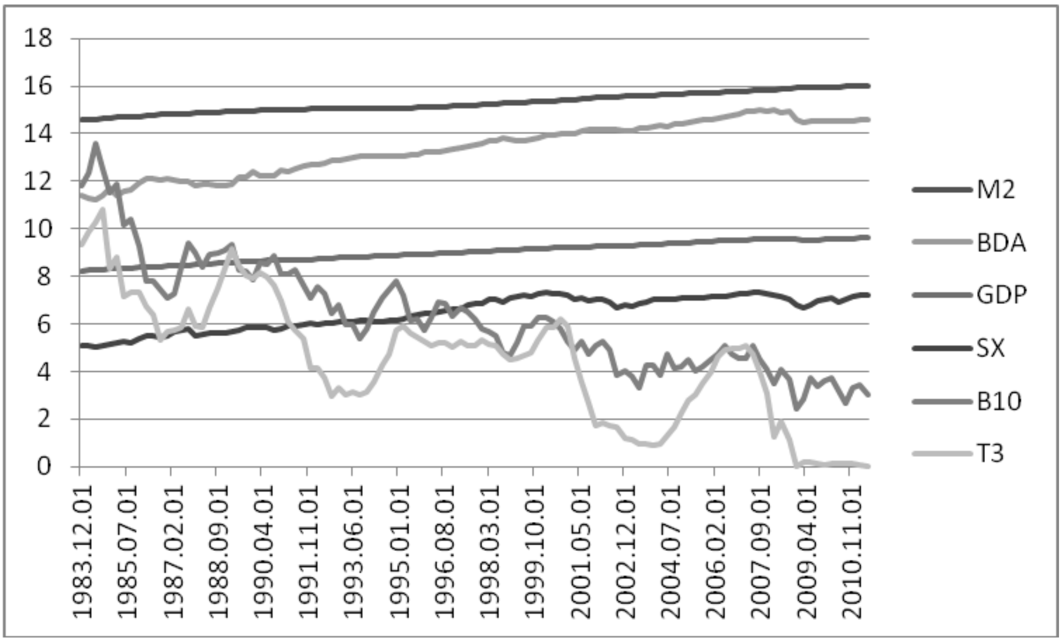


Figure 3: the cointegating relations

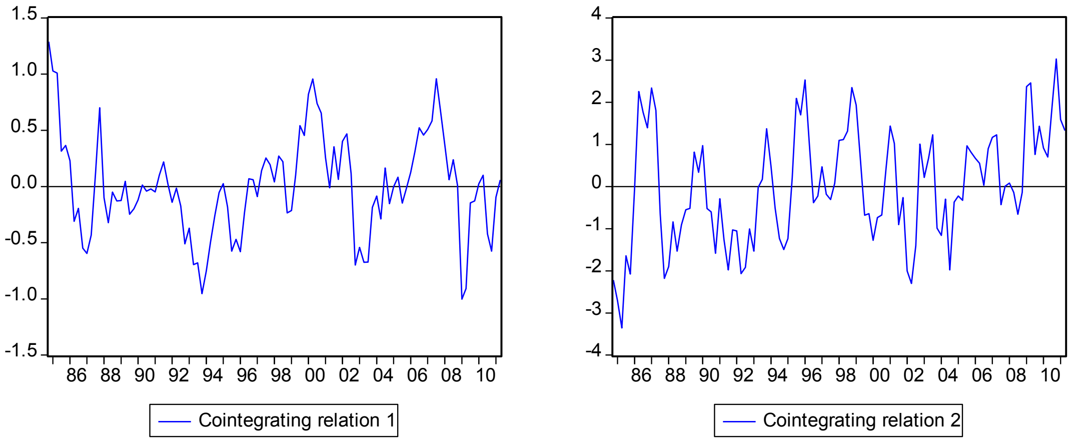


Table 1: Summary Statistics of variables

	B10	T3	LM2	LSX	LBDA	LGDP
Mean	6.284955	4.475405	15.29066	6.461711	13.38164	9.009552
Median	5.96	4.92	15.19418	6.703532	13.52624	9.037165
Maximum	13.56	10.8	16.02344	7.330897	14.99239	9.616658
Minimum	2.42	0.03	14.56961	5.031614	11.22244	8.212867
Std. Dev.	2.347868	2.618038	0.407104	0.693861	1.091384	0.41734
Skewness	0.805798	0.027878	0.206121	-0.471398	-0.288999	-0.185444
Kurtosis	3.381779	2.425087	1.874666	1.850847	1.801361	1.798972
Jarque-Bera	12.68637	1.543054	6.642975	10.21855	8.19002	7.307623
Probability	0.001759	0.462307	0.036099	0.00604	0.016656	0.025892
Sum	697.63	496.77	1697.263	717.25	1485.362	1000.06
Sum Sq. Dev.	606.3734	753.9538	18.23074	52.95878	131.0231	19.15902
Observations	111	111	111	111	111	111

Table 3. VAR Residual Serial Correlation LM Tests

VAR Residual Serial Correlation LM Tests
H0: no serial correlation at lag order h
Date: 02/01/12 Time: 14:18
Sample: 1984Q1 2011Q2
Included observations: 107

Lags	LM-Stat	Prob
1	44.21763	0.1634
2	45.24496	0.1389
3	40.72389	0.2703
4	42.50861	0.2111
5	44.3219	0.1608
6	32.48261	0.6367
7	28.19775	0.8201
8	27.14324	0.8563
9	19.73547	0.9873

Probs from chi-square with 36 df.

Table 4. Vector Error Correction Estimates

Vector Error Correction Estimates
Date: 02/01/12 Time: 12:55
Sample (adjusted): 1984Q4 2011Q2
Included observations: 107 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	CointEq2				
LBDA(-1)	1	0				
T3(-1)	0	1				
B10(-1)	0.54124	-2.08814				
	-0.07577	-0.17273				
	[7.14273]	[-12.0893]				
LM2(-1)	2.277849	-5.65699				
	-1.29969	-2.9626				
	[1.75261]	[-1.90946]				
LSX(-1)	1.16397	-1.2826				
	-0.42176	-0.9614				
	[2.75977]	[-1.33410]				
LGDP(-1)	-6.51801	-24.4881				
	-2.72467	-6.21081				
	[-2.39222]	[-3.94282]				
@TREND(83Q4)	0.033754	0.358443				
	-0.03466	-0.079				
	[0.97390]	[4.53701]				
C	-2.26557	303.9369				
Error Correction:	D(LBDA)	D(T3)	D(B10)	D(LM2)	D(LSX)	D(LGDP)
CointEq1	0.031322	-0.75322	-0.59437	0.005895	-0.06171	-0.00392
	-0.02803	-0.177	-0.15596	-0.00165	-0.02476	-0.00159
	[1.11761]	[-4.25556]	[-3.81104]	[3.57253]	[-2.49173]	[-2.47459]
CointEq2	-0.01856	-0.11203	0.161822	0.001875	0.001162	-0.00106
	-0.00983	-0.06208	-0.0547	-0.00058	-0.00869	-0.00056
	[-1.88860]	[-1.80467]	[2.95843]	[3.24078]	[0.13380]	[-1.91198]

Figure 4. Recursivelly clculated eigenvalues