Dynamics of Tobin's Q and US Stock Performance

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ABSTRACT

To study the dynamic effects of changes in Tobin'Q on stock prices of selected 249 US public companies of different industry categories. Panel unit roots tests and cointegration tests are implemented. Next, DOLS and GMM models are estimated. Annual data for the 2004-2012 period are used for the above selected US companies. Panel unit root tests provide somewhat mixed evidence of non-stationarity of both variables. There is clear evidence of cointegration between the above variables. The negative coefficient of the error-correction term shows convergence toward long-run equilibrium, though at slow pace. The estimates also reveal short-run net positive interactive feedback effects between the variables. Both DOLS and GMM estimates display similar picture of overvaluation of stocks in terms of upward movement in Tobin's Q beyond 0-to-1 range. For most parts of the sample period, the US stock market was in declining mode due to heightening of economic uncertainties during the Great Recession and several years beyond. Tobin's Q should be improved to boost stock prices. This is more of a long-run phenomenon. In the short run, both reinforce each other. The topic is unique and the existing literature on this topic is scant. Relatively new econometric techniques have been applied for estimation using panel data. The results are quite insightful, in our view.

Key Words: Tobin'Q, Stock Performance, Panel Cointegration, Panel ECM, GMM, DOLS

JEL Classifications: G20, G29

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I. Introduction

The objective of this study is to empirically investigate the dynamic influences of changes in Tobin's Q on stock prices of 249 US companies of different industry-categories over the period of 2004-2012. To this effect, sophisticated heterogeneous panel cointegration, heterogeneous panel dynamic OLS and dynamic GMM (Generalized Method of Moments) econometric procedures are applied. The relevant data are obtained from the Federal Reserve's "Flow of Funds Accounts of United States Z1".

Tobin (1969) contributes the Q ratio (known as Tobin's Q). For a company, Tobin's Q is calculated as a ratio of the market value of installed capital to the replacement cost of capital. A low Tobin's Q (between 0 and 1) means that the market value is less than the recorded value of the assets of the company. This suggests that the market undervalues the company with implication for undervaluation of its stock. Conversely, a high Tobin's Q (greater than 1) implies that a firm's stock is overvalued. High Tobin's Q encourages firms to invest more in capital because they are worth more than the price they paid for them. Such measure of stock valuation is the driving factor behind investment decisions in Tobin's Model. The ratio has considerable macroeconomic significance and usefulness as the nexus between financial markets and markets for goods and services. In other words, movements in stock prices largely reflect changes in consumption and investment.

Usually, stock prices are predicted by dividend yield and price-to-earnings ratio individually as a causal variable. Tobin's Q also significantly helps predict both the above causal variables. As a result, Tobin's Q should have better predictive power for stock returns (%

changes of stock prices). To add further, diversified companies have a lower Tobin's Q as compared to focused companies because the market penalizes the value of the firm assets (Lang and Stulz, 1994). For more details, please see the **Appendix.**

The remainder of the paper proceeds as follows. Section II briefly reviews the related literature. Section III outlines the empirical methodologies. Section IV reports empirical results. Finally, section V offers conclusions.

II. Brief Review of Related Literature

A growing interest among macroeconomists and financial economists is to better understand price behaviors in the asset markets by investigating the ability of various macroeconomic and financial variables in forecasting stock returns (e.g., Cochrane 1991b; Cooper and Priestley, 2005; Lamont, 2000; Lettau and Ludvigson, 2001a; Menzly, Santos and Veronesi, 2004). By recognizing how various macroeconomic variables influence stock returns, investors and portfolio managers alike can manage their investments and risks. Empirically, Tobin's Q has significant statistical power in predicting stock price-to–earnings ratio and dividend yield. Tobin's Q thus contains important information in predicting stock returns.

Although Black and Scholes (1974) and Miller and Scholes (1982) suggest that the relationship between stock returns and dividend yield does not seem to exist, numerous studies have produced empirical evidence to the contrary. Blume (1980) indicates a significantly positive association between yields and stock returns. Litzenberger and Ramaswamy (1982), and Morgan (1982) support Blume's findings that a positive (yet nonlinear) link between equity returns and dividend yields exists. Kiem (1985) also finds positive relationship between stock returns and dividend yield. Furthermore, Fama and French (1988) show that stock returns can be forecasted by dividend yields. Hodrick (1992) finds that changes in dividend yields can forecast expected stock returns. The empirical documentation of the positive relationship between stock returns and dividend yields is, furthermore, evidenced in Naranjo, Nimalendran and Ryngaert (1998). Other studies have established an inverse relationship between stock returns and price-to-earnings ratio. For instance, Basu (1977) reports that portfolios of stocks whose price-to-earnings ratios are low, exhibit higher risk-adjusted returns than the portfolios of stocks whose price-to-earnings ratios are high. Similar findings are documented in Peavy and Goodman (1983). Campbell and Shiller (1988) show an increase in price-to-earnings ratio induces lower growth in equity price. In another paper, Harney and Tower (2003) show that Tobin's Q is better than price-to-earnings ratio in forecasting stock returns.

To add further, Jiang and Lee (2007) find that excess equity risk premiums can be explained by a linear combination of dividends and book-to-market ratio in 1095. Sum (2013a) shows that dividend yield and price-to-earnings ratio Granger-cause the movement in stock market returns. In addition, Sum (2013b) shows that Tobin's Q ratio changes forecasts about 67.53% to 67.78% of price-to-earnings ratio at the two-quarter to eight-quarter horizons. Another study by Sum (2013c) finds that changes in aggregate Tobin's Q forecasts about 6.43% of the S&P 500 dividend yield at the 3-quarter horizon and 11.22% at the 8-quarter horizon. Other studies have used Tobin's Q as a proxy for corporate value or firm's performance [e.g., Cho (1998), Lang and Stulz 91994), McConnell and Servaes (1990), Morck et al. (1998)].

III.Empirical Methodologies

Panel data as a combination of cross-sectional and time series observations are used in this study. This provides a convenient way to study phenomenon where a statistically adequate number of cross-sectional and time series observations are not available. The pooled data argument both quality and quantity. Otherwise, it would be impossible to use only one of these two dimensions for meaningful analyses (Gujarati, 2003). This study provides an example of such situation where incorporating observations on the variables over successive time periods allows to expand the informational content of the data. Furthermore, since the length of the time series is small compared to the number of cross-sections, the effects of autocorrelation are small, if not negligible. Panel data estimation models include the constant coefficient (pooled), the fixed effects and the random effects regression models.

In order to test for the existence of a long-run equilibrium relationship among variables in a heterogeneous panel, the following model is specified:

$y_{it} = \alpha_i + \beta_i x_{it} + \gamma_t D_{it} + e_{it}$ ……………………………………(1)

Where, y = log of stock price (STR) and x = log of Tobin's Q (TBQ)

i=1,…., N and t= 1, …., T. The panel data set thus has altogether N*T observations.

In model (1), α_i shows the possibility of company-specific fixed effects and β_i allows for heterogeneous cointegrating vectors. γ_t represents time-dependent common shocks, captured by common-time dummies (D_{it}), that might simultaneously affect all the 249 US companies included in this study. Model (1) estimates by following Pedroni (2000, 2001) panel Fully-Modified Ordinary Least Squares (FMOLS) cointegration technique, which adjusts for the presence of endogeneity and serial correlation in the data. This method is an appropriate technique, especially if there are endogenous macroeconomic factors that can cause co-movements in the above variables.

Before estimating model (1), it is required that the order of integration of the variables be determined by using four panel unit root tests. If all variables are found to be I (1), then by using the Pedroni panel cointegration tests (1999, 2000, 2001) are applied to investigate whether they are co-integrated. The above mentioned tests and techniques are preferred to make sure that no spurious regression phenomenon exists in the estimation of β_i. In order to test for the presence of a unit root in the panel data under study, panel unit root tests as proposed in Im, Peseran and Shin (2003); Hadri (1999); Levin, Lin and Chu (2002) and Breitung (2000) are employed. For all these tests, the null hypothesis is non-stationarity in the data exists, except Hadri test relating to null hypothesis of stationarity of variables. The rejection of the null hypothesis of nonstationarity or stationary requires that the computed values of the coefficients exceed the respective critical values at 1% and /or at 5% levels of significance.

Subsequently, the following panel vector error- correction model in the spirit of (Engle and Granger, 1987) is estimated on the evidence of cointegrating relationship among variables of interest:

$$\Delta y_{it} = \alpha + \sum_{q=1}^{k} \beta i \Delta\, y_{it-q} + \sum_{q=1}^{l} \phi i \Delta\, x_{it-q} + \pi \hat{e}_{it-1} + \mu_{it} \quad \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

To restate, y = log of stock price (STR) and x = log of Tobin's Q (TBQ)

For long-run convergence and causal relationship, the estimated coefficient ($\hat{\pi}$) of the error-correction term ($\hat{e}_{it-1}$) is expected to be negative. The associated t-value indicates its statistical significance. The estimated β_i, and ϕ_i reveal short-run interactive feedback relationships. The appropriate lag-lengths are determined by the Akaike (1969) information criterion.

Next, Stock and Watson (1993) show that DOLS(Dynamic Ordinary Least Squares) is more favorable, particularly in small samples, compared to a number of alternative estimators of long-run parameters, including those proposed in Engle and Granger (1987), and Phillips and Hansen (1990). Furthermore, Short-run elasticity counterparts are also derived via robust dynamic error-correction models (ECMs).

For panel data, the estimating base equation is specified as follows:

$Y_{it} = \alpha_0 + \alpha_1 X_{it} + e_{it}$ ……(3)

Prior to testing for panel cointegration, four panel unit root tests LLC (Levin, Lin and Chu, 2002),Breitung (2000), IPS (Im, Pesaran and Shin, 2003) and Hadri (1999) are implemented.

Following Pedroni (2000), the following model for cointegration between the variables is estimated by DOLS;

$Y_{it} = \alpha_i + \beta_i X_{it} + \gamma_t D_{it} + \mu_{it}$ ……..(4)

Y_{it} is dependent variable with pooled data and X_{it} is explanatory variable with the same.

α_i captures possible company-specific fixed effects and β_i allows for heterogeneous cointegrating vector. γ_t captures time-dependent common shocks of common time dummies (D_{it}).

The DOLS procedure basically involves regressing any I(1) variables on the other I(1) variables, any I(0) variables and leads or lags of the first differences of any I(1) variables. However, since an investigation of the short-run dynamics are also of interest in the analysis, the panel bi-variate ECM formulation is described as follows in drawing inferences on the long-run and the short-run dynamics:

$$\Delta Y_{it} = \sum_{j=1}^{k} \emptyset_{ij}\, \Delta y_{t-j} + \sum_{j=0}^{m} n_j\, \Delta x_{i-j} + EC_{it-1} + \epsilon_t \ldots\ldots (5)$$

Intuitively, when the variables are cointegrated, then in the short term, deviations from this long-term equilibrium will feed back on the changes in the dependent variable in order to force the movement revert towards the long-term equilibrium. If the dependent variable is driven directly by this long-term equilibrium error, then it is responding to this feedback. If not, it is responding only to short-term shocks to the stochastic environment. The significance tests of the 'differenced' explanatory variables give an indication of the 'short-term' effects, whereas the 'long-term' causal relationship is implied through the significance or otherwise of the't' test of the lagged error-correction term, which contains the long-term information since it is derived from the long-term cointegrating relationship(s). The coefficient of the lagged error-correction term, however, is a short term adjustment coefficient and represents the proportion by which the long-term disequilibrium (or imbalance) in the dependent variable is being corrected in each short period. Non-significance or elimination of any of the 'lagged error-correction terms' affects the implied long-term relationship and may be a violation of the underlying theory.

Finally, this study also invokes Generalized Method of Moments (GMM), as developed in Hansen (1982), for robust and efficient estimates. GMM is one of the most widely used econometric tools in finance. A set of moment conditions is used to estimate model parameters by GMM. In general, the number of moment conditions is larger than the number of model parameters. A model misspecification for over-indentifying restrictions can be tested by GMM J-statistic. GMM does not require strong distributional assumptions for applications in finance.

Since this paper employs panel data, GMM dynamic panel estimation is more appropriate than the original GMM estimation. On differencing of the regression equation, unobserved company-specific effects and the use of differenced lagged regressors eliminate parameter inconsistency arising from simultaneity bias (Arellano and Bond, 1991). Monte Carlo simulations of the model offer discernible improvements in both efficiency and consistency (Blundell and Bond, 1997).

IV. Empirical Results

The panel unit root tests results for Tobin's Q and stock prices are reported as follows:

Table1: Panel Unit Root Tests

METHOD				
Variable (level)	**LLC**	**Breitung**	**IPS**	**Hadri**
TBQ	72.8444 (0.0000)	-42.0320 (0.0000)	56.1335 (0.0000)	4.41853 (0.0000)
STR	4.85344 (0.0000)	-0.76434 (0.2223)	18.8687 (0.000)	0.9793 (0.0000)
VARIABLE (DIFFERENCES)	LLC	Breitung	IPS	Hadri
Δ (TBQ)	38.1543 (1.0000)	-12.8539* (0.0000)	36.3133 (0.0000)*	0.57732* (0.2819)
Δ (STR)	37.9687 (1.0000)	-3.60093* (0.0002)	34.9772* (0.0000)	2.01616* (0.0219)

Where, TBQ = log of Tobin's Q; STR = log of stock price, and total number of observations (NT) 249X9 = 2241 Note: LLC = Levin, Lin, Chu (2002) IPS = Im, Pesaran and Shin (2003). The statistics are asymptotically distributed as standard normal with a left hand side rejection area, except on the Hadri test, which is right sided. *, indicates the rejection of the null hypothesis of nonstationarity (LLC, Breitung, IPS) or staitonarity (Hadri) at the 1 and 5 percent level of significance.

As observed above in Table 1, LLC, Breitung and IPS tests show that log of Tobin's Q (TBQ) and log of stock prices (STR) are nonstationary at 1 percent level of significance. Their counterpart (Hardi) test leads to a contrasting inference at 1 percent level of significance. Furthermore, Brietung test provides evidence of stationary in log of stock prices. In short, the evidence is somewhat mixed for nonstationarity of both variables. Subsequently, tests are performed for panel cointegration between TBQ and STR.A battery of seven panel cointegration tests results are reported as follows:

TABLE 2: Pedroni Panel Co-integration Tests

Test	Constant trend	Constant + Trend
Panel v-Statistic	-0.95430 (0.1700)	-1. 36881 (+ 0.9145)
Panel rho-Statistic	-136.8948 (0.0000)*	-112.3302 (0.0000)*
Panel PP-Statistic	-46.42832 (0.0000)*	-51.53257 (0.0000)*
Panel ADF-Statistic	-29.93782 (0.0000)*	-33..5417 (0.0000)*
Group rho-Statistic	-125.967 (0.0000)*	-97.17934 (0.0000)*
Group PP-Statistic	-54.0987 (0.0000)*	-54.90720 (0.0000)*
Group ADF-Statistic	-34.4988 (0.0000) *	-35.37046 (0.0000)*

*indicates significance at 1 % level.

The above panel for cointegration tests are applied on the null hypothesis of no-cointegration. Six tests confirm cointegrating relationship between TBQ and STR at 1 percent level of significance with constant trend and constant + trend except panel v- statistic. Thus, the evidence in favor of cointegration between the above variables is overwhelming revealing tendency toward long-run convergence.

DOLS results are provided below:

Table 3: Panel Dynamic Least Squares (DOLS) Estimates

Dependent Variable: STR

Variable	Coefficient	Std. Error	t-Statistic	Prob.
STR(-1)	1.000000	1.50E-17	6.68E+16	0.0000
TBQ(-1)	- 2.68E-17	9.75E-18	- 2.751418	0.0060
R-squared	1.000000	Adjusted R-squared		1.000000

The DOLS estimates, as reported in Table 3, show short-run negative effects of changes in TBQ and STR with one-year lag on current stock prices. The results show that higher values of TBQ above 1 indicate overvaluation of stocks since for most parts of the sample period, the US stock market slid. This would depress investment further pushing stock prices downward.

GMM estimates are as follows:

Table 4: Panel Generalized Method of Moments (GMM) Estimates

Dependent Variable: STR

Variable	Coefficient	Std. Error	t-Statistic	Prob.
STR	- 0.538783	0.018453	- 29.19736	0.0000
TBQ	0.137443	0.012535	10.96475	0.0000
TBQ(-1)	0.084778	0.012914	6.565022	0.0000
J-statistic	36.44975	Prob (J-statistic)		0.000000

The above GMM estimates disclose that current and preceding TBQ in conjunction with preceding STR exert short-run dynamic effects on current STR. Such net effects are negative implying overvaluation of stocks TBQ being above 1. Moreover, the GMM J-statistics at 36.44975 confirms no misspecification of the model. Both DOLS and GMM estimates portray similar pictures with regard to overvaluation of a majority of 249 US company stocks since 2008 during the sample period for the above reason. However, there are some magnitudinal differences in the coefficients and the associate t-values.

Finally, the estimates of the VECM are reported as follows:

$$\Delta \mathrm{STR}_{it} = \underset{(-0.5600)}{-0.0074} + \underset{(14.3745)}{0.4925}\Delta STR_{\mathrm{it-1}} + \underset{(8.9978)}{0.2805}\Delta \mathrm{STR}_{\mathrm{it-2}} - \underset{(-8.8978)}{0.19742}\Delta \mathrm{STR}_{\mathrm{it-3}}$$

$$- \underset{(-9.7408)}{0.1974}\Delta \mathrm{TBQ}_{\mathrm{it-1}} - \underset{(-9.7573)}{0.2446}\Delta \mathrm{TBQ}_{\mathrm{it-2}} + \underset{(6.\ 1393)}{0.0825}\Delta \mathrm{TBQ}_{\mathrm{it-3}}$$

$$- \underset{(-10.6637)}{0.3938}\mathrm{EC}_{\mathrm{it-1}} \ldots \ldots \quad (5)'$$

$$\bar{R}^2 = 0.4435,\ F = 251.9438$$

Estimated equation (5)' corresponds to equation (5) in section III. Clearly, the error- correction term (EC_{it-1}) has expected negative sign for long-run convergence with high statistical significance in terms of the associated t-value (-10.6637). The short-run interactive net feedback effect of lagged changes in TBQ is negative showing that stock prices decline with TBQ being above one implying overvaluation of stocks. Presumably, most of the stocks included in this study seemed overvalued for the sample period since 2008 due to global economic and financial turmoils.

V. Conclusions

To sum up, the log of Tobin's Q and that of stock prices have somewhat mixed evidence on nonstationarity of both variables. However, both variables are clearly cointegrated. The DOLS estimates reveal overvaluation and consequent slide in stock prices due to rising TBQ above unity. The GMM estimates also provide a similar picture in the short run. However, there are some differences in the computed coefficients and their associated t-values.The estimates of the vector error-correction model show statistically significant convergence toward long-run equilibrium at slow pace and net negative effect implies overvaluation of stocks relating to TBQ.

In closing, changes in Tobin's Q have significant effects on stock overvaluation and hence decline in stock prices as an aftermath. Investors should closely monitor changes in TBQ to set and revise investment strategies in light of the aforementioned.

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Appendix: The q Theory of Investment in Brief

Tobin's q is defined as the ratio of the market value of installed capital to its replacement cost. To define,q= market value of installed capital/replacement cost of installed capital. The market value of installed capital is priced in the stock market and is the number of shares outstanding times their market price. The replacement cost of installed capital depends on the situation in the capital goods sectors. If the demand for capital goods is strong, the price of capital goods will rise.

If q<1, the firms have an incentive to increase their capital stock because capital once installed and producing goods and services is priced more highly than its cost. If q>1then firms should scrap capital, close plants, etc.However, as the Dixit and Pindyck analysis suggests, firms may delay expansion or contraction for some time and may only do so if q remains significantly above or below unity.

The Efficient Markets Hypothesis (EHM) suggests that share prices and thus the market valuation /capitalization of businesses reflect all available information regarding the business, its environment and its prospects. Thus, observed share prices impound information about business fundamentals such as earnings(profits), dividends, managerial performance, market conditions and the market's expectation of the future trends in such variables.

In theory, the share price and market capitalization should be driven by arbitrage to accurately reflect the intrinsic value of companies. If a share price rises above the consensus view of the intrinsic value of the stock, agents will sell driving the price back to it's fundamental value.

Thus, the numerator of the q equation provides a correct indication of the current worth and likely prospects for the business. If a firm faces a q>1, then this is a signal that it should buy additional capital because the present value of the future earnings from such capital will be greater than its cost. Clearly, when a firm expands its capital stock it will face diminishing returns, i.e. the marginal product of capital will fall as the capital stock grows. This will tend to cause q to revert back towards unity. However, if the EHM is correct, share prices will provide firms and agents with correct signals regarding how to allocate capital. If a firm is well regarded by the markets, then q will rise and the firm should increase its capital stock. This can be achieved by either purchasing capital equipment or by taking over the assets of other firms.

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http://www.slideshare.net/RafikAlqeria/a-brief-summary-of-q-theory