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The Dynamic Impact of Macroeconomic Factors on Initial Public Offerings: Evidence from Time-Series Analysis

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Abstract

This paper examines the explanatory power and the dynamic impact of macroeconomic conditions on IPO activities in the U.S. during the period from 1970 to 2005. Applying time-series econometric techniques, we find the existence of long-run equilibrium relationships between IPO activities and selected macroeconomic variables. Stock market performance and volatility are shown to play the most important role in the timing of IPOs. The Fed funds rate and the 10-year U.S. Treasury bond yield play a comparable role in determining the amount of proceeds raised in the IPOs. There also exist different short-run dynamic adjustment mechanisms between IPOs and macroeconomic factors toward the long-run equilibrium path and they are mostly completed within the period of six months to one year. The results have some useful implications for forecasting IPO activities.

Keywords: Initial public offerings (IPO), cointegration, VAR, VEC

JEL classification: G32, G10, E44

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I. Introduction

Going public activities have varied greatly over time during the past three decades. During the period from 1973 to 1979, only 283 firms in the U.S. went public and raised less than \$3 billion in total. In comparison, the period from 1983 to 1989 witnessed 3,227 initial public offerings (IPOs) with a total amount of \$109 billion. Most active is the period between 1993 and 1999 when 4,500 IPOs raised a total proceed of \$312 billion (see Figure 1). Such variations in IPO activities have been observed to move together with changing economic conditions over time.

Macroeconomic conditions, to a certain extent, affect the industry-level and firm-level business performance, the optimal operation within each firm, and therefore the firm's decision to go public. Although fluctuation in the IPO volume is well known¹, the cause and mechanism of such fluctuation from the macroeconomic perspective have not been studied extensively. The issues of how macroeconomic conditions influence IPO activities, how long the effects last, and to what extent each condition affects new equity issuance are of interest to investors, investment banks, and IPO-planning firms alike.

The objectives of this paper are, first, to examine the dynamic impact of various macroeconomic determinants on IPO activities, including economic growth, stock market conditions, the Fed's changes in monetary policy, and long-term bond yields, and second, to investigate the causality and impulse-response mechanisms between the macroeconomic shocks and IPO activities. The paper also derives some implications of the selected macroeconomic determinants on forecasting IPO activities.

Most previous literature on IPOs has focused on certain corporate-level factors that explain why companies go public. Zingales (1995), for example, shows in his model that owners try to maximize the proceeds when selling their companies through IPOs by balancing their control and ownership. Chemmanur and Fulghieri (1999) propose a theory of going public in which the

¹ For example, see Ibbotson and Jaffe (1975), Ritter (1984), Lowry (2003), and Pastor and Veronesi (2005).

equilibrium timing of the going-public decision is determined by the firm's trade-off between lowering the information duplication produced by outsiders and avoiding the risk-premium demanded by venture capitalists. Lerner (1994) studies 350 privately held venture-backed biotechnology firms and concludes that these companies go public when equity valuations are high, while they employ private financing when values are lower. Seasoned venture capitalists appear to be particularly proficient at taking companies public near market peaks. Pagano, Panetta, and Zingales (1998) show that the most important determinants of IPOs are the company size and the industry market-to-book ratio. They conclude that going public lowers the borrowing cost and that entrepreneurs attempt to time their IPOs to take advantage of good market conditions.

Given the importance of market conditions for conducting IPOs, very few authors have examined in depth the macroeconomic determinants of IPOs. Loughran, Ritter, and Rydqvist (1994) review the timing of IPOs of 15 countries using stock price indexes and GNP growth rates. They show that the number of IPOs and the stock price level are positively correlated. Ljungqvist (1995) finds the same result for 11 European countries using data for the period from 1980 to 1989. Ritter and Welch (2002) review IPO activity, pricing, and allocations and suggest that market conditions are the most important factor in the decision to go public. In addition, Lowry (2003) shows that firms' capital demand and investor sentiment are the important determinants of the IPO volume. Recently, Gleason, Johnston, and Madura (2008) find that IPO aftermarket risk is higher for firms that go public during periods of high market volatility. Although it is a stylized fact that firms raise funds when market conditions are favorable, the question of which market indicators of macroeconomic conditions do matter in the short-run and long-run is still unanswered by most empiricists. This paper examines the effects of market liquidity, inflation, interest rates and the Fed's action on monetary policy, besides the common stock market indicators, on IPO activities to uncover the relative importance of different macroeconomic determinants of IPOs and the interaction between the macroeconomic environment and IPO activities.

This paper employs three different measures of IPO activities. Previous research mostly focuses on the number (or volume) of IPOs as a sole measure of IPO activities. The proceeds raised by IPOs are expected to appropriately reflect the extent to which the capital markets affect IPO activities. In addition, the average proceeds raised by all IPOs may also be a useful indicator of a relative performance of IPO activities as shown in Figure 1.

Applying time-series econometrics techniques to monthly IPO activities in the U.S. during the period from January 1970 to December 2005, we find the existence of long-run equilibrium relationships between IPO activities and selected macroeconomic variables. Our results show that stock market performance and volatility play the most important role in the timing of IPOs. The Fed funds rate and the 10-year U.S. Treasury bond (TB) yield play a significant role in determining the amount of proceeds raised in these IPOs. The effect of market liquidity, however, is only marginal for the timing of IPO. We also find that there exist different patterns of short-run dynamic adjustment mechanisms among the IPO activity and macroeconomic variables toward the long-run equilibrium path. The dynamic adjustment processes are shown to finish mostly within the period of six months to one year. The results are also shown to provide useful implications for forecasting IPO activities.

The rest of the paper is structured as follows. Section II describes the dataset and specifies the econometric methodology. Section III discusses the empirical results and implications for forecasting IPO activities. Section IV concludes.

II. Data and methodology

We collect firm-level IPO data from the Securities Data Company (SDC) during the period from January 1970 to December 2005. SDC's IPO database includes daily IPO data from 1970. We aggregate the number of IPOs and total proceeds raised in these IPOs from daily into monthly observations. Average proceeds are total proceeds raised per IPO in a month.

We use three measures of IPO activities in this analysis, which are (1) the number of IPOs as a measure of IPO activities, (2) total proceeds as a measure of the aggregate IPO value, and (3) average proceeds per IPO as a measure of the average size of IPO activities. Following Ritter's methods (1984), we exclude small-sized Regulation A offerings (raising less than \$1.5 million during the 1980s), real estate investment trusts (REITs), closed-end funds, and American Depositary Receipts (ADRs).² We match our aggregate number of IPOs with the updated monthly IPO data in Ibbotson, Sindelar, and Ritter (1994). Table 1 shows the summary statistics of the variables used in this paper. The maximum number of IPO per month is 108 in October 1996 but the maximum total proceed raised in a month is about \$14 billion in April 2000. However, the maximum average proceed per month is \$973 million in October 1998. These statistics show that the levels of the three IPO measures are somewhat different in time from each other and it is worth exploring individually.

To fit the scope of this paper, we select macroeconomic variables, some of which have been identified as the most relevant in the literature, including (1) industrial production index (IP) as a proxy for real economic activity, (2) S&P500 index (SP) as a measure for stock market performance, (3) market volatility (VOL) as a proxy for investment risk, (4) market liquidity (LIQ) as a measure of investors' willingness to commit resources in the market, (5) inflation (CPI), (6) the effective Federal funds rate (FF) as an indicator of the Fed's monetary policy stance, and (7) the 10-year U.S. Treasury bond yield (TB) as a proxy for long-term financing costs in the debt market and information captured in the yield curve.³

The industrial production index is used in place of GDP since GDP data are not available on a monthly basis. We obtain the S&P500 index from the Center for Research in Security Prices

² According to Ritter (1984), these small offerings are excluded in his study due to limited data availability. Similar to many IPO studies, we focus only on initial public offerings of common stocks and exclude REITs, closed-end funds, and ADRs due to structural differences of these offerings.

³ See, for example, Fama (1990), Bernanke and Blinder (1992), Lee (1992), Loughran, Ritter, and Rydqvist (1994), Bernanke and Gertler (1999), Bernanke and Kuttner (2003), Pástor and Stambaugh (2003), Pástor and Veronesi (2005), and Gleason, Johnston, and Madura (2008) that use these macroeconomic measures in their studies of financial economics including IPO activities.

(CRSP). Market volatility is obtained as standard deviation of daily market returns during each month, as used, for example, in Pástor and Veronesi (2005). For the measurement of market liquidity (LIQ), we calculate the aggregate measure of market liquidity using the methodology proposed by Pástor and Stambaugh (2003).⁴ The daily stock return and volume data which are needed to compute market liquidity are obtained from CRSP. We use the consumer price index (CPI) as a proxy for inflation. We obtain data on industrial production index, CPI, the Fed funds rates, and bond yield rates from the *FRED* macroeconomic database provided by the Federal Reserve Bank in St. Louis.

To analyze the dynamic impact of macroeconomic factors on IPO activities, we first perform unit-root tests for each of the variables to ensure that our regressions are not spurious. When the variables follow unit-root processes and they are cointegrated, we estimate the vector error correction (VEC) model. Otherwise, we run contemporaneous ordinary least squares regressions on the log-differenced data. Second, if they pass unit-root tests, we check for a long-run cointegration relationship among the variables. Third, we apply relevant time-series econometrics tools, including the multivariate vector autoregressive model (VAR), the error correction model (VEC), and impulse response function analysis, to examine the effects of changes in macroeconomic environments on IPO activities and identify their adjustment mechanisms to various macroeconomic shocks. Finally, we check the VEC model's relative performance of forecasting IPO activities, compared to those from a naïve forecasting method.

III. Empirical results

Times-series properties and bench-mark regressions

⁴ Aggregate market liquidity in each month is constructed by averaging individual stock measures of liquidity for the month and then multiplying them by the ratio of the total dollar value of the stocks at the end of the previous month and the dollar value of the stocks in January 1970. The individual stock measure of liquidity for a given month is obtained as a regression slope coefficient, which is estimated using daily returns and volume data within that month. For more details, see Pástor and Stambaugh (2003).

To test for the presence of unit roots, we conduct the Augmented Dickey-Fuller (ADF) tests with trend and intercept as the most general unit roots test approach. The null hypothesis for ADF tests is that the variable has unit roots. We transform all variables into their natural logarithms and perform ADF tests for both the levels and also for their first differences when the variable has unit roots at the level. We use the Schwarz Information Criterion to select the number of lags in the regression for the ADF tests. The results reported in Table 2 show that the null hypothesis of unit roots for the level cannot be rejected at the 1%, 5%, and 10% significance levels for all variables except market volatility and market liquidity. On the other hand, for the variables that have unit roots at the level, the null hypothesis of unit roots at the first difference can be rejected at the 1% significance level. Therefore, these variables have unit roots at the level but do not have unit roots at the first difference. In other words, they are integrated of order 1. As a result, we use the log-differenced data for these variables in our estimation.

The preliminary correlation results reported in Table 3 show that IPO variables are positively correlated with stock market performance and market liquidity, but negatively correlated with market volatility, the Fed funds rate, and the 10-year Treasury bond yield rate. To examine the relationship between each of the three IPO performance variables and seven macroeconomic variables, we conduct OLS regressions, as bench-mark regressions, on the level data for market volatility and market liquidity and on the log-differenced data for all other variables as follows:

$$X_i = \alpha_i + \beta_{ij}M_j + \gamma_{ik}C_k + \varepsilon_i,$$

where X_i is a vector of IPO measures ($i=1, \dots, 3$), M_j is a vector of macroeconomic variables ($j=1, \dots, 7$), and C_k is a vector of control variables. Log-difference transformation of the variables represents growth rates and is found to be stationary based on the results of the above unit roots tests. Cross correlations across macroeconomic variables reported in Table 3 show that multicollinearity is not an issue among these variables. To simplify the variable names, we use the original name of each variable for the log-differenced one. Table 4 reports the estimation results.

The estimation results for the number of IPOs reported in Panel A of Table 4 shows that the number of IPOs is positively correlated with S&P500 stock price index and negatively correlated with market volatility. Stock market performance dominates other macroeconomic factors in explaining the timing to go public. Entrepreneurs try to take advantage of a better stock market performance to bring their company to public, attracting stock investors who pursue higher stock returns. When the market is risky, entrepreneurs prefer to remain private to avoid the chance of their newly listed stocks moving downward. Market liquidity plays a marginal role when we exclude S&P500 index and market volatility. Our R^2 , albeit low, is similar to the preliminary result reported in the literature, for example, by Pástor and Veronesi (2005).

Regressions of total proceeds and average proceeds reported in Panel B and Panel C of Table 4 show somewhat different significance levels on their coefficients from Panel A. While market volatility still affects the dollar amount raised through IPOs, stock market performance and liquidity no longer play a role as in the case of the number of IPOs, as shown in Panel A. The 10-year Treasury bond yield rate is negatively correlated with total proceeds and average proceeds of IPOs. When interest rates increase, investors find debt markets more attractive than equity markets, assuming that investing in loans is an alternative to investing in equity from public offerings. The dollar amount of proceeds raised in IPOs, therefore, becomes less in periods of high interest rates. The Fed funds rate, as an indicator for monetary policy stance taken by the Fed, plays a marginal role in the case of total proceeds when we exclude stock market performance and volatility as reported in regression (2) of Panel B. CPI is statistically significant as a control factor for inflation in both panels.

Overall, the results of the OLS estimation reported in Table 4 show that stock market volatility and market liquidity are important factors in determining the number of IPOs, while long-term interest rates and inflation are shown to explain better the amount of proceeds raised in these IPOs. A tight monetary policy, indicated by a high Fed funds rate, seems to affect IPO activity adversely, but the coefficients are not quite statistically significant.

As robustness tests, we include two dummy variables, NBER and SOX, to control for different phases of the business cycle and a possible structural break due to regulatory changes brought by the Sarbanes-Oxley Act of 2002.⁵ The dummy variable, NBER, has the value of 1 for the non-recession period and the value of zero for the recession period, which are declared by the National Bureau of Economic Research (NBER). We also include the first lag of the dependent variable to capture partial adjustment mechanisms of IPO activities. As reported in the regression (3) of Table 4, adding these dummies for business cycle (NBER) and Sarbanes-Oxley (SOX) does not significantly change our main results discussed above.

Long-run equilibrium relations between IPO activities and macroeconomic conditions

After finding correlations between IPO activities and selected macroeconomic factors, we explore a possibility of long-run equilibrium relationships, or common stochastic trend, between IPO activities and the macroeconomic factors, by applying multivariate cointegration analyses. It is necessary to determine the appropriate number of lags for the cointegration tests. We perform lag length tests using five different criteria, including (1) the sequential modified likelihood ratio test statistic, (2) the final prediction error, (3) the Akaike information criterion, (4) the Schwarz information criterion, and (5) the Hannan-Quinn information criterion.⁶ The test results reported in Table 5 show that the appropriate number of lags should be three according to the likelihood ratio, final prediction error, and Akaike information criteria in all cases and other criteria in some cases. This number of lags is consistent through all different lag tests and applies for all three measures of IPO activity.

Using the method of Johansen and Juselius (1991), we check for cointegrations among IPO variables and macroeconomic variables using the multivariate cointegration on each of the IPO

⁵ Sarbanes-Oxley, effective on August 29, 2002 in response to several major corporate scandals, requires U.S. public companies to comply with specific rules about financial reporting and corporate governance. These requirements may make private firms reluctant to go public due to substantial costs of compliance.

⁶ See Akaike (1974, 1976), Hannan-Quinn (1979), and Schwarz (1978) for more information on model selection using these criteria.

variables and the seven macroeconomic variables. The unrestricted cointegration rank tests assume a linear deterministic trend.⁷ The Johansen trace test statistic of the null hypothesis that there are at most r cointegrating vectors and $n - r$ common stochastic trends is calculated as

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^n \ln(1 - \lambda_i)$$

and the maximum eigen value test the null hypothesis of r cointegrating vectors using

$$\lambda_{max}(r, r+1) = -T \ln(1 - \lambda_{r+1})$$

where λ_i is the $n - r$ least squared canonical correlations and T is the sample size.

The results from both trace and maximum eigen value tests reported in Table 6 show that there are four cointegration equations in the system, which indicates that common stochastic trends exist between IPO activities and macroeconomic factors. This finding implies that there exist long-run equilibrium relationships between each of the three measures of IPO activity and a group of the selected seven macroeconomic variables.

Fluctuation of IPO activities and the adjustment mechanism

We proceed to examine the dynamic relationships among IPO variables and macroeconomic factors using the cointegration results. To evaluate these dynamics, we use the vector error correction (VEC) model. When the variables are cointegrated, the VEC model provides more efficient parameter estimates in the short and long run than the vector autoregressive (VAR) model. Besides, the VAR model in differences is not well specified since it ignores important information on the long-run equilibrium relationship contained in the levels of the cointegrated series.

Following Johansen's methodology and Engle and Granger (1987), we estimate the multivariate VEC model to explore if there is any error correction mechanism when IPO activities

⁷ Using different deterministic trend assumptions yields four or five cointegration equations. The case of four cointegration equations dominates in linear and quadratic assumptions.

drift away from the long-run equilibrium path. Let $Y_{t,i} \equiv (X_i, M_j)$ where X_i is one of the three IPO measures ($i=1, 2, 3$), M_j is the vector of the seven macroeconomic variables ($j=1, \dots, 7$). If $Y_{t,i}$ is cointegrated, a VEC model can be specified as, according to the Granger Representation Theorem:

$$\Delta Y_{t,i} = \alpha_i + \gamma_i \beta_i Y_{t-1,i} + \sum_{j=1}^k \Gamma_{j,i} \Delta Y_{t-j,i} + \varepsilon_{t,i}$$

where α is a constant vector representing a linear trend, β represents the cointegration vector, and γ , which is called the error correction coefficient, provides information on the speed of adjustments to the long-run equilibrium path. The γ coefficient is expected to have a negative sign in a range of $-1 < \gamma < 0$. Table 7 reports the estimated error correction coefficient, γ , from the estimation results of the VEC model and the VEC model's fitness of data, which is shown to be reasonably good. All the error correction coefficients show a correct sign. The size of the coefficients is between 0.13 and 0.47 for the frequency of IPOs and between 0.23 and 0.52 for the total proceeds of IPOs. This finding implies that it would take approximately one to 6 months and one to less than 3 months to complete the half-way adjustments toward the long-run equilibrium path of the IPO frequency and IPO total proceeds, respectively.⁸

As the VAR/VEC models require the proper order of the variables in the system to perform the impulse-response analysis using orthogonal innovations, we conduct the Granger causality tests of the macroeconomic variables on the frequency, total proceeds and average proceeds of IPOs. The results of Granger causality tests, as reported in Table 8, indicate that the stock market, industrial production and inflation play a significant role in Granger-causing all three IPO variables. Market volatility and liquidity Granger-cause the number of IPOs but not the IPO proceeds, whereas the Fed funds rate Granger-causes the IPO proceeds. The number of IPOs and industrial production are found to Granger-cause in a bi-directional way. Stock market and the IPO proceeds are also shown to have a bi-directional Granger-cause relationship. These bi-directional

⁸ The time required for a half-way adjustment is obtained using $\ln(1-0.5)/\ln(1-\alpha)$, where α is the error correction coefficient in the VEC model estimation.

causal relationships between the selected macroeconomic variables and IPO measures justify our VAR/VEC models which treat all the variables in the system endogenous.

In addition, as reported in Panel B of Table 8, the causal relationships among the macroeconomic variables are multidirectional. Market liquidity seems to be the most exogenous variable, while industrial production seems to be the most endogenous variable among the macroeconomic variables. S&P500 stock price index significantly Granger-causes market volatility and industrial production, which has been widely accepted in the literature.⁹ The 10-year Treasury bond rate Granger-causes the Fed funds rate, which seems to be counter-intuitive and needs further examination for the direction of causality. To decide the final order of macroeconomic variables for the following variance decomposition and impulse-response function analysis, we also incorporate a conventional wisdom that the Fed's monetary policy actions will affect interest rates, bond yields and stock market variables. We perform a sensitivity analysis using different orders of the variables as a robustness check.

Table 9 reports the results of variance decomposition based on our multivariate VEC model estimates for each of the three IPO measures on the seven macroeconomic variables. These estimation specifications include a linear deterministic trend and up to three lag intervals (in first differences) as evidenced from the previous lag tests reported in Table 5. From panel A of Table 9, S&P500 stock price index and the Fed funds rate are shown to play the most powerful role in explaining the variance in the forecast error of the number of IPOs. Volatility is persistent from the beginning and its effect remains similar over time. The effect of market liquidity is marginal within the first few months but they become large and stable after six months.

While the S&P500 index plays an important role in explaining the forecast error variance of the number of IPOs, it does not do so for the case of total and average proceeds (in Panel B and C). Stock market performance affects the entrepreneur's desire to go public, but the dollar amount of proceeds raised depends more likely on capital structure and financing cost consideration by

⁹ See, for example, Lee (1992)

both entrepreneurs and investment banks underwriting the IPO. The Fed funds rate and the 10-year Treasury bond rate are shown to play a significant role in determining the total and average proceeds. We also perform diagnostic tests for the disturbance term using the Ljung-Box portmanteau and Lagrange Multiplier tests. Untabulated results indicate the absence of serial correlation and heteroskedasticity. We confirm that our findings are robust to the different ordering of the variables for the variance decomposition analysis.

We then proceed to conduct the impulse-response function (IRF) analysis to examine how each variable in the system responds to various shocks and what the patterns of the dynamic adjustments to the long run equilibrium are. We perform the IRF analysis for each of the three IPO variables to investigate how they respond to one standard deviation innovations of each of the seven macroeconomic variables. The results are reported in Figure 2. The response mechanism in the case of the number of IPOs seems to be faster toward the equilibrium than that of the proceeds. The variables do not show any explosive behavior and all effects are wiped out within a year or sooner. The response of the number of IPOs to macroeconomic shocks takes place mostly during the first three months after the shocks arrives, while the response of total and average proceeds to macroeconomic shocks takes place mostly during the first six months. The graphs also show that the S&P500 index plays an important role in all three cases of the number of IPOs, total proceeds, and average proceeds, while the Fed funds rate does so only in the cases of total and average proceeds. Changing the order of the variables does not change the main findings reported in this section significantly.

Implications for forecasting IPO activities

To determine whether the model has a proper power of predictability or not, we use the historical data from 1970 to 2002 to re-estimate the coefficients of the VEC model and generate forecast for three years from 2003 to 2005. The statistics of the model forecast are then used to compare to those of a naïve forecast which is based on the VAR model without the error correction

term. Table 10 shows that the VEC model which incorporates information on based on the long-run equilibrium cointegration relations improves the forecasting performance significantly, evidenced by smaller root mean square error, mean absolute error, and bias proportion. Besides, our adjusted R^2 from the VEC model significantly increases to more than 0.70. This is close to the R^2 of the rational IPO wave model proposed by Pástor and Veronesi (2005). Figure 3 shows that the VEC model captures the dynamic changes in IPO activities with lower forecast errors, while the naïve approach produces larger forecast errors. Our findings indicate that the VEC model on changes in the macroeconomic environment performs reasonably well in predicting IPO activities.

Our results provide useful policy implications for not only investors, investment banks, and IPO-planning firms, but also for macroeconomic policy planners. By anticipating future surge or drop in IPO activities based on the expected changes in the macroeconomic environment, policy makers can adopt adjustment mechanisms that complement or counteract with future IPO-induced consequences in the economy.

IV. Conclusion

This paper examines the explanatory power and the dynamic impact that selected macroeconomic factors have on IPO activities in the US during the period from 1970 to 2005. Using time-series econometrics techniques, we provide consistent evidence that selected macroeconomic factors, such as stock market performance, monetary policy stance and Treasury bond yield rates play an important role in providing with a favorable environment for a firm to go public. Our paper provides a closer look at these market conditions by examining their relative importance in determining IPO activities and interactive adjustment mechanisms.¹⁰

We find evidence that there exists a long-run equilibrium relationship between IPO activities and selected macroeconomic conditions. Specifically, stock market performance and

¹⁰ This is consistent with the viewpoint presented in Ritter and Welch (2002). They mention in their review of IPO activity, pricing, and allocations that market conditions are the most important factor in the decision to go public.

volatility play the most important role in the timing of IPOs. The effect of market liquidity and real economic activity proxied by industrial production are overshadowed by that of the stock market. While stock market performance plays an important role in explaining the number of IPOs, the Fed funds rate and the 10-year U.S. Treasury bond yield play a significant role in determining the amount of proceeds raised in these IPOs.

There also exist different short-run dynamic adjustment mechanisms between the macroeconomic factors and IPOs toward the long-run equilibrium path. We find that the short-run adjustment processes are completed for the most part within a period of six months to one year. Our findings also indicate that the VEC model, which incorporates an error correction mechanism between IPOs and selected macroeconomic variables, predicts IPO activities reasonably well. The exploration of the relative importance of other factors, such as firm-specific and industry-level determinants, in determining and predicting IPO activities is left to our future research agenda.

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Table 1. Summary statistics of IPO and selected macroeconomic variables

Level	Mean	Median	Max	Min	Std dev	Skewness	Kurtosis
The number of IPOs	28.39	23	108	0	23.87	0.89	3.13
Total proceeds (\$ mil)	1,924.62	1,189.65	13,989.30	0	2,271.36	1.65	6.72
Average proceeds (\$ mil)	73.54	36.73	973.32	0	126.53	3.71	20.49
Industrial production	70.07	67.16	110.45	40.70	20.01	0.52	1.98
S&P500	456.33	273.60	1517.68	63.54	425.53	0.98	2.51
Market volatility	0.82	0.70	4.93	0.28	0.42	3.20	24.29
Market liquidity	-0.02	-0.01	0.52	-0.89	0.13	-1.05	11.31
CPI	115.74	115.55	199.20	37.80	48.48	-0.10	1.74
Federal funds rate	6.66	5.91	19.10	0.98	3.49	1.00	4.49
10-year Treasury bond yield	7.66	7.34	15.32	3.33	2.48	0.88	3.47

Notes: Data include monthly observations during the period from January 1970 to December 2005 on three IPO variables and seven macroeconomic variables. The number of IPO is the number of firms going public in a month as in Ritter's specification. Total proceed is the total dollar raised in these IPOs in each month from the Securities Data Company (SDC). Average proceed is total proceed raised per one IPO in a month. Industrial production index is used in place of GDP since GDP data are not available on a monthly basis. S&P500 and data used to calculate the aggregate market liquidity from the Center for Research in Security Prices (CRSP). Market volatility is computed each month as standard deviation of daily market return within the month as in Pástor and Veronesi (2005). Market liquidity in each month is constructed by averaging individual stock measures for the month and then multiplying with the ratio of the dollar value at the end of the previous month of the stocks included in the average in current month and the dollar value in January 1970; and an individual stock's measure for a given month is a regression slope coefficient estimated using daily returns and volume data within that month as in Pástor and Stambaugh (2003). Data on industrial production index, CPI, the Fed funds rate, and Treasury bond yield are obtained from the Federal Reserve in St. Louis.

Table 2. Unit roots tests

	Log levels		Log differences	
	DF	ADF	DF	ADF
Number of IPOs	-2.03 [3]	-3.07 [3]	-3.68*** [6]	-17.09*** [2]
Total proceeds	-2.23 [3]	-2.26 [3]	-23.65*** [2]	-23.66*** [2]
Average proceeds	-2.21 [3]	-2.56 [3]	-8.44*** [6]	-9.14*** [6]
Industrial production	-2.51 [3]	-2.13 [1]	-7.55*** [2]	-9.71*** [1]
S&P500	-1.53 [0]	-2.23 [0]	-6.13*** [4]	-20.35*** [0]
Market volatility	-4.47*** [5]	-4.49*** [5]		
Market liquidity	-19.93*** [0]	-20.10*** [0]		
CPI	-1.03 [11]	-0.25 [1]	-5.03*** [4]	-11.94*** [0]
Federal funds rate	-2.49 [6]	-2.47 [1]	-11.86*** [0]	-11.86*** [0]
10-year Treasury bond yield	-1.49 [2]	-1.89 [2]	-3.69*** [6]	-15.61*** [1]

Notes: All variables are transformed into natural logarithms except market volatility and market liquidity. Both Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) tests are conducted with trend and intercept. The reported numbers are the t-statistics. The number of lags selected by the Schwarz Info Criterion is in brackets. The null hypothesis is that the variable has unit roots. ***, **, and * denote statistical significance at the 1%, 5% and 10% level, respectively. Critical values for DF with trend and intercept are -2.57, -2.89, and -3.48 at the 10%, 5%, and 1% level, respectively. Critical values for ADF with trend and intercept are -3.13, -3.42, and -3.98 at the 10%, 5%, and 1% level, respectively.

Table 3. Correlations among IPO and macroeconomic variables

	IP	SP	VOL	LIQ	CPI	FF	TB
NUM	-0.03	0.20	-0.17	0.08	-0.02	-0.07	-0.08
TOT	0.01	0.10	-0.07	0.02	0.09	-0.07	-0.10
AVG	0.02	0.07	-0.05	0.00	0.11	-0.07	-0.09
IP	1.00	-0.06	-0.12	-0.02	-0.12	0.31	0.16
SP		1.00	-0.29	0.19	-0.17	-0.20	-0.17
VOL			1.00	-0.29	0.01	-0.11	-0.04
LIQ				1.00	0.01	0.01	-0.03
CPI					1.00	0.11	0.18
FF						1.00	0.25
TB							1.00

Notes: The number of IPOs (NUM), total proceeds (TOT), average proceeds (AVG), industrial production (IP), S&P500 (SP), consumer price index (CPI), the Federal funds rate (FF), and 10-year Treasury bond yield (TB) are in the log-difference. Market volatility (VOL) and market liquidity (LIQ) are in the level.

Table 4. OLS bench-mark regressions

	Panel A: NUM			Panel B: TOT			Panel C: AVG		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
C	0.12 (1.69)	0.00 (0.07)	0.13 (1.29)	-0.25 (-0.61)	-0.52 (-2.14)	-0.56 (-0.93)	-0.38 (-0.99)	-0.54 (-2.37)	-0.73 (-1.28)
IP	-0.84 (-0.23)	0.06 (0.02)	-2.61 (-0.68)	28.35 (1.27)	30.25 (1.36)	12.43 (0.54)	29.77 (1.43)	30.78 (1.48)	15.77 (0.74)
SP	1.73*** (2.82)		1.72*** (2.91)	5.54 (1.50)		4.95 (1.40)	3.59 (1.04)		3.00 (0.91)
VOL	-0.17*** (-2.73)		-0.20*** (-3.19)	-0.41 (-1.10)		-0.45 (-1.19)	-0.24 (-0.68)		-0.24 (-0.67)
LIQ		0.33* (1.71)	0.00 (-0.01)		0.33 (0.29)	-0.38 (-0.34)		-0.03 (-0.03)	-0.37 (-0.35)
CPI	3.56 (0.48)	0.01 (0.00)	0.77 (0.10)	127.79*** (2.84)	117.03*** (2.61)	120.49*** (2.76)	127.41*** (3.02)	120.62*** (2.88)	123.25*** (3.02)
FF	-0.31 (-0.76)	-0.40 (-0.99)	-0.33 (-0.84)	-3.40 (-1.41)	-3.74 (-1.57)	-3.29 (-1.39)	-3.12 (-1.38)	-3.34 (-1.50)	-2.95 (-1.33)
TB	-0.70 (-1.07)	-0.86 (-1.30)	-0.56 (-0.89)	-8.13** (-2.08)	-8.73** (-2.23)	-8.46** (-2.28)	-7.47** (-2.04)	-7.89** (-2.16)	-8.03** (-2.31)
D(-1)			-0.30*** (-6.56)			-0.33*** (-7.43)			-0.34*** (-7.62)
NBER			0.03 (0.35)			0.46 (0.99)			0.45 (1.02)
SOX			0.07 (0.68)			0.70 (1.08)			0.63 (1.06)
R ² adj	0.04	0.01	0.13	0.03	0.02	0.14	0.02	0.02	0.14

Notes: The number of IPOs (NUM), total proceeds (TOT) and average proceeds (AVG) are regressed on macroeconomic variables. D(-1) is the first lag of the dependent variable. The NBER dummy variable equals one for the economic expansion period and zero for the recession period. The SOX dummy variable equals one for the period after Sarbanes-Oxley, which became effective on August 29, 2002. All other variables are defined as in Table 1 and Table 3. *t*-statistics are reported in parentheses. ***, **, and * denote the statistical significance at the 1%, 5% and 10% level, respectively.

Table 5. Lag length tests

Panel A: Lag test on number of IPOs and macroeconomic variables						Panel B: Lag test on total proceeds and macroeconomic variables					Panel C: Lag test on average proceeds and macroeconomic variables				
Lag	LR	FPE	AIC	SC	HQ	LR	FPE	AIC	SC	HQ	LR	FPE	AIC	SC	HQ
0	NA	0.00	-15.09	-15.05	-15.07	NA	0.00	-12.10	-12.05	-12.08	NA	0.00	-12.27	-12.23	-12.25
1	307.47	0.00	-15.71	-15.42*	-15.60	310.02	0.00	-12.72	-12.44	-12.61	310.83	0.00	-12.90	-12.61	-12.78
2	96.31	0.00	-15.82	-15.30	-15.61*	159.94	0.00	-12.99	-12.47*	-12.78	162.63	0.00	-13.17	-12.65*	-12.97
3	54.45*	0.00	-15.84*	-15.08	-15.54	110.67*	0.00	-13.14*	-12.38	-12.84*	110.76*	0.00	-13.33*	-12.56	-13.02*
4	31.98	0.00	-15.80	-14.80	-15.41	33.57	0.00	-13.11	-12.11	-12.71	34.24	0.00	-13.29	-12.29	-12.90
5	26.97	0.00	-15.75	-14.51	-15.26	33.34	0.00	-13.07	-11.84	-12.59	32.70	0.00	-13.26	-12.02	-12.77
6	21.57	0.00	-15.69	-14.21	-15.10	26.14	0.00	-13.02	-11.55	-12.44	26.59	0.00	-13.21	-11.73	-12.62

Notes: The tests of the lag length of IPO variables on macroeconomic variables use five different criteria: LR (sequential modified likelihood ratio test statistic), FPE (Final prediction error), AIC (Akaike information criterion), SC (Schwarz information criterion), and HQ (Hannan-Quinn information criterion). * indicates the lag order selected by each criterion (at the 5% significance level).

Table 6. Multivariate cointegration tests on IPO activity and macroeconomic variables

Trace criterion					Maximum Eigen value criterion				
Hypothesized No. of CE(s)	Eigen value	Stat	5% CV	p-value	Hypothesized No. of CE(s)	Eigen value	Stat	5% CV	p-value
Panel A: Number of IPOs and macroeconomic variables									
None ***	0.237	366.518	187.470	0.000	None ***	0.237	115.843	56.705	0.000
At most 1 ***	0.178	250.675	150.559	0.000	r = 1 ***	0.178	83.972	50.600	0.000
At most 2 ***	0.131	166.703	117.708	0.000	r = 2 ***	0.131	60.073	44.497	0.001
At most 3 ***	0.102	106.630	88.804	0.002	r = 3 ***	0.102	46.268	38.331	0.005
At most 4	0.054	60.362	63.876	0.095	r = 4	0.054	23.546	32.118	0.380
At most 5	0.038	36.816	42.915	0.178	r = 5	0.038	16.544	25.823	0.497
At most 6	0.031	20.272	25.872	0.212	r = 6	0.031	13.437	19.387	0.294
At most 7	0.016	6.836	12.518	0.362	r = 7	0.016	6.836	12.518	0.362
Panel B: Total proceeds and macroeconomic variables									
None ***	0.235	360.195	187.470	0.000	None ***	0.235	114.781	56.705	0.000
At most 1 ***	0.178	245.414	150.559	0.000	r = 1 ***	0.178	83.824	50.600	0.000
At most 2 ***	0.137	161.591	117.708	0.000	r = 2 ***	0.137	62.963	44.497	0.000
At most 3 ***	0.092	98.628	88.804	0.008	r = 3 **	0.092	41.151	38.331	0.023
At most 4	0.047	57.477	63.876	0.154	r = 4	0.047	20.783	32.118	0.590
At most 5	0.041	36.694	42.915	0.182	r = 5	0.041	17.822	25.823	0.391
At most 6	0.027	18.872	25.872	0.288	r = 6	0.027	11.854	19.387	0.429
At most 7	0.016	7.019	12.518	0.343	r = 7	0.016	7.019	12.518	0.343
Panel C: Average proceeds and macroeconomic variables									
None ***	0.233	354.097	187.470	0.000	None ***	0.233	113.721	56.705	0.000
At most 1 ***	0.177	240.376	150.559	0.000	r = 1 ***	0.177	83.563	50.600	0.000
At most 2 ***	0.137	156.814	117.708	0.000	r = 2 ***	0.137	62.816	44.497	0.000
At most 3 **	0.082	93.997	88.804	0.020	r = 3 *	0.082	36.844	38.331	0.073
At most 4	0.050	57.153	63.876	0.162	r = 4	0.050	22.129	32.118	0.483
At most 5	0.040	35.024	42.915	0.244	r = 5	0.040	17.378	25.823	0.426
At most 6	0.025	17.647	25.872	0.368	r = 6	0.025	10.848	19.387	0.529
At most 7	0.016	6.798	12.518	0.366	r = 7	0.016	6.798	12.518	0.366

Notes: The Unrestricted Cointegration Rank Tests assume a linear deterministic trend. These tests are performed on the level of each of the three IPO performance variables and the seven macroeconomic variables, all of which follow unit-root processes. The number of lags (in first differences) in the VAR specifications is one to three. CE(s) indicates Cointegration equation(s). CVs are the sample-size adjusted critical values provided in Cheung and Lai (1993). 'None' means one cointegrating relationship binding all variables. r denotes the number of cointegrating vectors. ***, **, and * denote rejection of the hypothesis at the 1%, 5% and 10% significance level, respectively.

Table 7. The estimation results of the error-correction model for IPO activities

	Error corrections				Regression F-statistics	Adjusted R ²
	(1)	(2)	(3)	(4)		
Number of IPOs	-0.13*** (3.90)	-0.47*** (3.65)	-0.23** (1.85)	-0.01 (0.12)	6.16***	0.25
Total proceeds	-0.23*** (5.55)	-0.28*** (4.40)	-0.52*** (3.90)	-0.17 (0.37)	13.15***	0.44
Average proceeds	-0.18*** (5.18)	-0.22*** (3.80)	-0.23*** (3.70)	-0.20 (0.49)	13.29***	0.43

Notes: *t*-statistics are in parentheses. ***, **, and * denote the statistical significance at the 1%, 5% and 10% level, respectively.

Table 8. Granger causality tests

Panel A:

Granger causality tests of macroeconomic variables on the number of IPOs, total proceeds, and average proceeds.

Macro factor	NUM	TOT	AVG	The macro factor does not Granger cause		
	does not Granger cause the macro factor			NUM	TOT	AVG
IP	2.599***	3.236***	2.594***	2.481***	3.535***	3.027***
SP	1.184	1.834**	1.986**	4.270***	3.787***	2.181**
VOL	0.885	0.578	0.514	2.003**	0.949	0.478
LIQ	0.812	0.145	0.135	2.220**	0.258	0.152
CPI	1.349	1.795**	1.934**	1.588*	1.944**	1.957**
FF	1.024	0.875	0.798	1.462	2.221**	1.868**
TB	1.473	0.663	0.531	1.199	0.510	0.421

Notes: F -statistics are from the F -test for the null hypothesis that IPO variables do not Granger-cause the macroeconomic variables in the left panel and vice versa for the right panel. All variables are defined as in Table 1 and Table 3. ***, **, * denotes rejection of the null hypothesis at the 1%, 5% and 10% significance level, respectively.

Panel B:

Granger causality tests among macroeconomic variables.

Macro	IP	SP	VOL	LIQ	CPI	FF	TB
IP		1.082	0.897	0.245	0.614	6.677***	3.009**
SP	6.365***		8.237***	1.598	0.536	6.309***	2.945**
VOL	5.376***	2.015		1.579	1.683	6.022***	1.669
LIQ	2.994**	0.992	0.968		0.193	0.237	3.154**
CPI	4.175***	2.182	1.404	0.389		0.554	3.730**
FF	2.093	1.771	2.854**	0.609	3.833***		0.516
TB	2.397*	3.352**	0.308	1.702	2.152*	8.146***	

Notes: F -statistics are from the F -test for the null hypothesis that the variable in the vertical column on the left does not Granger-cause the variable in the horizontal bar at the top. All variables are defined as in Table 1 and Table 3. ***, **, * denote rejection of the hypothesis at the 1%, 5% and 10% significance level, respectively.

Table 9. Multivariate VAR/VEC: Variance decomposition

Panel A: Number of IPOs (NUM)								
Month	NUM _t	IP _t	SP _t	VOL _t	LIQ _t	CPI _t	FF _t	TB _t
1	92.00	0.12	3.46	2.41	0.01	0.31	1.15	0.55
3	89.86	0.24	4.74	1.91	0.30	1.03	1.12	0.80
6	84.03	0.61	5.39	2.45	2.29	1.32	2.97	0.94
9	82.88	0.92	5.62	2.41	2.35	1.59	3.20	1.02
12	82.21	1.09	5.62	2.46	2.33	1.78	3.46	1.05
18	80.79	1.53	5.54	2.47	2.33	2.15	4.08	1.12
24	79.48	1.93	5.46	2.49	2.31	2.50	4.63	1.20
Panel B: Total proceeds (TOT)								
Month	TOT _t	IP _t	SP _t	VOL _t	LIQ _t	CPI _t	FF _t	TB _t
1	93.37	0.51	0.35	0.71	0.04	1.41	1.35	2.25
3	93.24	0.32	1.19	0.51	0.12	1.68	1.10	1.83
6	89.75	0.68	1.32	0.49	0.19	2.65	2.93	1.98
9	89.05	0.87	1.31	0.50	0.20	2.73	3.30	2.05
12	88.89	0.93	1.31	0.50	0.22	2.78	3.32	2.05
18	88.52	1.15	1.32	0.51	0.24	2.78	3.43	2.06
24	88.24	1.34	1.34	0.51	0.26	2.77	3.49	2.06
Panel C: Average proceeds (AVG)								
Month	AVG _t	IP _t	SP _t	VOL _t	LIQ _t	CPI _t	FF _t	TB _t
1	93.54	0.40	0.06	0.33	0.09	2.69	1.10	1.80
3	92.90	0.26	0.65	0.31	0.15	3.19	1.01	1.52
6	89.57	0.62	0.70	0.32	0.17	4.46	2.25	1.91
9	88.91	0.72	0.69	0.33	0.21	4.53	2.59	2.02
12	88.75	0.75	0.70	0.35	0.22	4.59	2.61	2.03
18	88.50	0.87	0.72	0.36	0.24	4.61	2.65	2.04
24	88.32	0.98	0.74	0.38	0.25	4.62	2.66	2.05

Notes: Multivariate VEC estimates of three IPO measures and seven macroeconomic variables. For the definition of the variables, refer to Table 1 and Table 3. These estimations assume a linear deterministic trend. The number of lags (in first differences) in the VAR specifications are 1 to 3. Variance decomposition is the percentage of forecast error, in the number of IPOs, total proceeds and average proceeds, that can be explained by macroeconomics variables (Cholesky one standard deviation).

Table 10. Forecast statistics

	Root mean squared error	Mean absolute error	Bias proportion	Adjusted R ²
<i>The number of IPOs</i>				
- Naïve forecast	0.556	0.429	0.003	0.044
- Model forecast	0.082	0.066	0.001	0.705
<i>Total proceeds</i>				
- Naïve forecast	0.811	0.655	0.202	0.027
- Model forecast	0.660	0.527	0.078	0.779
<i>Average proceeds</i>				
- Naïve forecast	0.841	0.662	0.161	0.023
- Model forecast	0.650	0.525	0.128	0.782

Notes: Forecast statistics of the change in number of IPOs, total proceeds, and average proceeds for the period from 2003 to 2005 using historical data from 1970 to 2002. The naïve forecast provides estimates using the VAR model which does not include the error correction term. The model forecast provides estimates using the VEC model.

Figure 1. Monthly IPO activities from 1970 to 2005

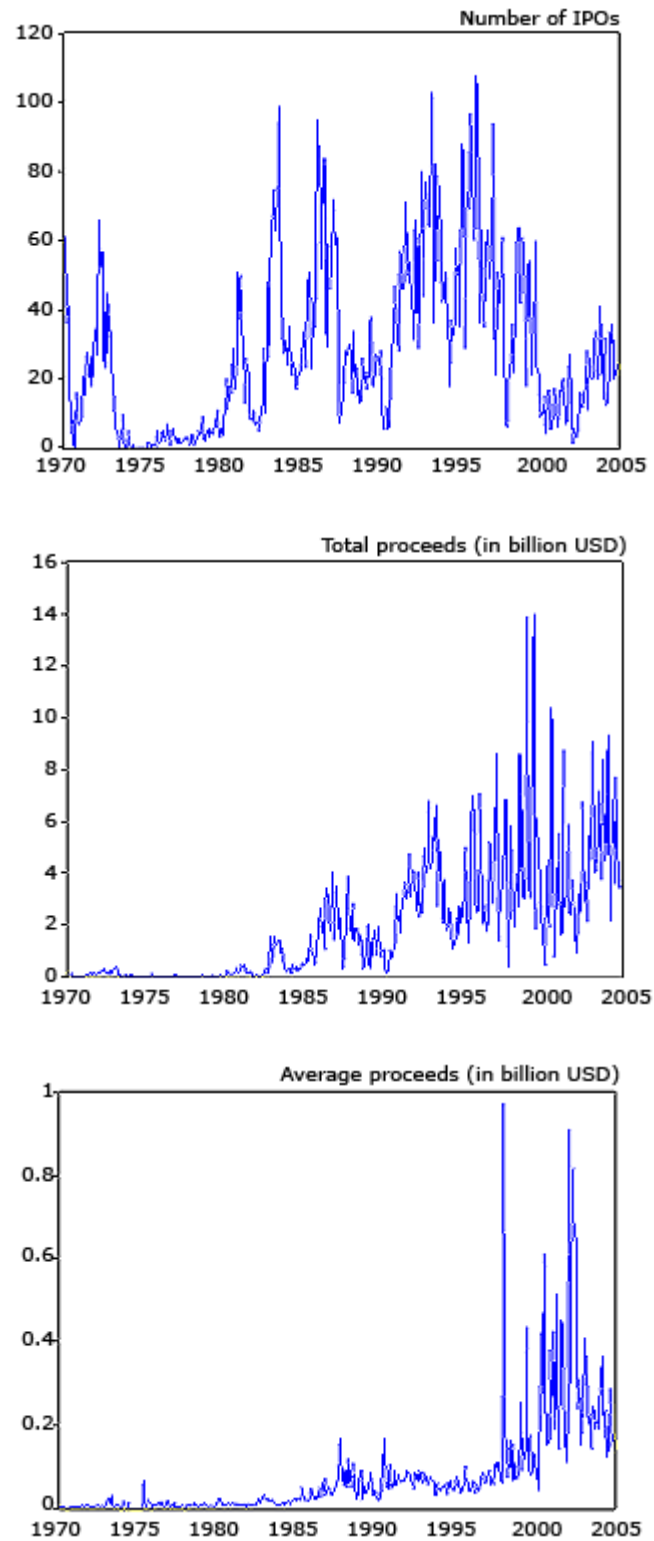
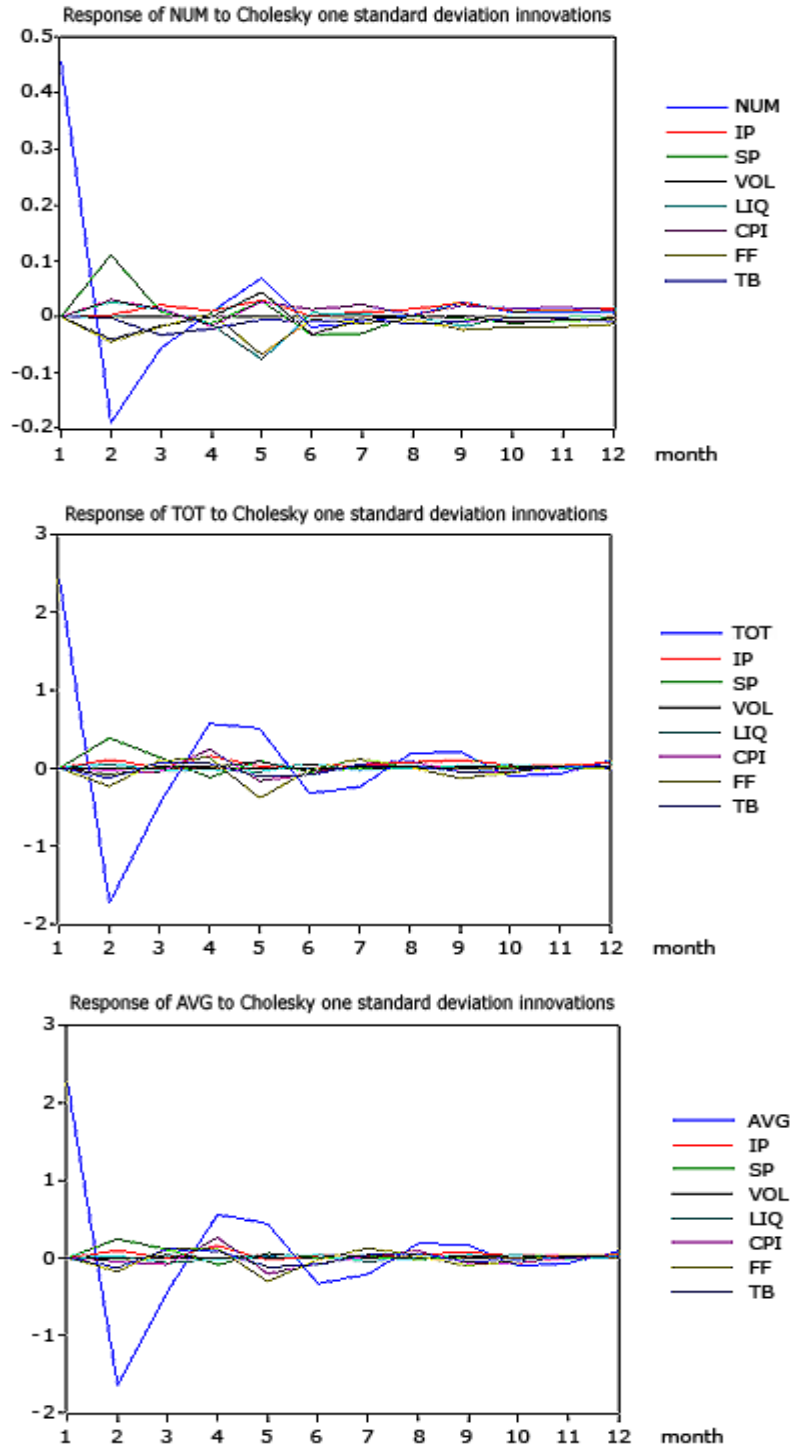


Figure 2. Impulse response function analysis on the impact of macroeconomic factors on IPO activities



Notes: Variable names: Number of IPOs (NUM), Total proceeds (TOT), Average proceeds (AVG), Industrial production (IP), S&P500 (SP), Market volatility (VOL), Market liquidity (LIQ), Consumer price index (CPI), Fed funds rate (FF), 10-year U.S. Treasury bond yield (TB)

Figure 3. IPO activities forecasting

