DYNAMIC RELATIONSHIPS AND TECHNOLOGICAL INNOVATION IN HOT AND COLD ISSUE MARKETS

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Abstract

Dynamic Relationships and Technological Innovation in Hot and Cold Issue Markets

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The puzzle of hot and cold issue markets has attracted substantial interest in the academic community. The behavior of IPO volume and initial returns over time is well documented respectively (see, Ibbotson and Jaffe (1975), Ritter (1984), Rock (1986), McGuinness (1992), Lee, Taylor, and Walter (1999) and Lowry (2003)). Few studies, however, investigate the dynamic interrelationship between IPO volume and initial returns. This paper uses a simultaneous equations approach to study the endogenous interrelationship between IPO volume and initial return. We find that higher IPO volume causes higher initial returns, but not vice versa. Furthermore, lagged IPO volume is significantly negatively related to initial returns. In other words, the underpricing of a new issue is affected by not only the concurrent number of new issues at the mean time but also by the numbers of new issues in prior periods.

Another purpose of our study is to test the hypothesis that technological innovation is the main driver behind hot issue markets. Welch (1989) and Hoffmann-Burchardi (2001) suggest that the clustering of new issues is caused by IPO volume spikes in industries that have recently experienced technological innovations or favorable productivity shocks. Through analysis of the industry correlation matrix of new issue activity and a fixed-effects model based on industry level data, we find evidence against the technological innovation hypothesis.

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1. Introduction

Both the volume and average initial returns of initial public offerings (IPOs) fluctuate over time. Cycles in the IPO market have attracted the interest of numerous academics. Extremes in the cycles are often referred to as hot and cold issue markets. A hot issue market is generally associated with a period in which the average initial return of new equity issues is abnormally high while cold issue markets are associated with low underpricing. What factors cause these cycles in the IPO market is still largely unknown.

There are both demand-side and supply-side explanations for the hot and cold issue market puzzle. Ibbotson and Jaffe (1975) advance the argument that if issue markets are demand driven, entrepreneurs may be better off by going public in a cold issue period to raise more money for the firm and get a higher price for their stakes in the firm. In contrast, Loughran and Ritter (1995) find that the long-term performance of hot issue market issues is lower than the post-issue performance of cold market issues. They argue that hot markets provide a window of opportunity for even those firms to go public that would otherwise spark little investor interest.

Ritter (1984) examines the hot issue market of 1980 by studying the risk characteristics of issuing firms, and finds that the changing risk composition cannot explain the unusually high average initial returns during this hot issue period. Rock (1986) argues that riskier firms should have higher average initial returns compared to firms that are easier to evaluate. He argues that a hot issue market takes place when a large proportion of the new issues have high risk; and that a cold issue market takes place when a large proportion of new issues have low risk. This is consistent with Beatty and Ritter (1986), who find that the greater the degree of uncertainty, the more an issue is underpriced. Similarly, Choe et al. (1993) find that capital can be raised with lower cost when certain periods offer a window of opportunity.

Consistent with Choe et al.'s findings, Bayless and Chaplinsky (1996) examine volume trends in seasoned equity issuance. They find that the price reaction to seasoned equity issue announcements, measured as the cumulative announcement date prediction errors from day -1 to day 0, in periods with high issue volume is approximately 200 basis points lower than during periods with low equity issue volume. In a nutshell, a typical hot market issuer foregoes about two percent in additional equity value compared to a cold market issue. Similarly, Ljungqvist (1997) documents that a positive macroeconomic climate raises the average amount of underpricing.

In addition to the variations in IPO underpricing over time, we can also observe significant variations in IPO volume. Lee et al. (1991) argue that the large fluctuations in IPO volume are the result of market irrationality, i.e. firms time their IPOs by taking advantage of investor over-optimism. Similarly, Rajan and Servaes (1997) argue that IPO volume is influenced by the level of over-optimism in securities markets. Consistent with the over-optimism hypothesis, Pagona et al. (1998) suggest that fluctuations in IPO volume are primarily driven by owners' attempts to exploit sectoral mispricing. Lerner (1994), Loughran and Ritter (1995) and Pagano et al. (1998) provide empirical results that are consistent with this hypothesis. Lerner et al. (2003) interpret that during low IPO volume periods private firms can not access the stock markets under favorable conditions, thus they have to seek less favorable financing methods.

From a conventional academic point of view, the underpricing and IPO volume cycles are not perfectly synchronized. Ibbotson et al. (1994) find that initial returns lead

IPO volume by six to twelve months in the U.S. market. Lee et al. (1994) and Ljungqvist (1995) document a similar lead-lag relationship in Australia as well as in Germany and Sweden, respectively. Hoffmann-Burchardi (2001) claims that the IPO price of one firm serves as a feedback mechanism to other issuing firms since it can reveal information about the common value factor and therefore change the value of other firms. Similarly, Lowry and Schwert (2002) suggest that high initial returns lead to higher IPO volume in following periods and that both the cycles in initial returns and the lead-lag relationship between initial returns and IPO volume are mostly caused by information learned during the registration period. Their findings reveal that the relationship is caused by a positive information feedback which causes more companies to file their IPOs after periods of high initial returns. Ibbotson and Jaffe (1975) employ simple OLS regressions to try to reveal the relation between initial returns and IPO volume but observe no significant relationship between the two variables. Using firm-specific data, Cliff and Denis (2004) indicate a negative relationship between underpricing and IPO volume, i.e. underpricing is lower when the IPO volume is high. Lin et al. (2003) test the relation between IPO volume and initial returns in a simultaneous equations framework but find no significant relationship between IPO volume and initial returns.

The above theories partially explain the fluctuations of IPO volume and underpricing over time, but few of them have explored the dynamic interrelationship between the two variables. We fill this gap by examining the endogeneity of IPO volume and initial returns in a simultaneous equations framework. By using two-stage and three-stage least squares estimation, we uncover dynamic interrelationships between IPO volume and initial returns that the existing literature did not yet capture. In addition, we add to the existing literature by examining whether hot issue markets are driven by technological innovations in certain industries. Chemmanur and Fulghieri (1999) and Hoffmann-Burchardi (2001) suggest that hot issue markets are the result of positive productivity shocks and positive surprises about industry prospects in a small number of related industries. Our paper is the first to use a fixed effects model to examine the cross-sectional effects in IPO issuing activity. Our findings indicate that hot issue markets are not driven by increased issuing activity in a small number of industries, but that they occur across a broad range of industries at the same time. The remainder of this paper is organized as follows. In Section 2, we review the literature relating to IPO underpricing, IPO volume and the technological innovations hypothesis. In Section 3, we describe our data and provide summary statistics for our sample. In Section 4, we model IPO volume and initial returns in a simultaneous equations framework. Section 5 tests the technological innovations hypothesis. Section 6 provides concluding remarks.

2. Literature review

2.1. Underpricing

The persistent and systematic underpricing of new equity issues is puzzling. Research on the underpricing puzzle can be categorized along two lines: theories based on asymmetric information and theories based on symmetric information.

2.1.1 Asymmetric information and underpricing

Theories based on asymmetric information argue that the unbalanced information set between issuers, underwriters, and investors causes initial returns to be positive.

2.1.1.a The winner's curse hypothesis

Rock (1986) proposes the winner's curse hypothesis. This hypothesis assumes that some investors are better informed than others. Faced with an adverse selection problem, less informed investors will only submit purchase orders if, on average, IPOs are underpriced sufficiently enough to compensate them for the bias in the allocation of new issues. Koh and Walter (1989), Levis (1990) and Keloharju (1993) find empirical support for this theory. Similarly, Ritter (1984) suggests that hot issue periods are characterized by a higher level of ex-ante uncertainty which cause higher underpricing. McGuinness (1992) examines the standard deviation of daily returns during first 15 trading days after an IPO as a proxy for ex ante uncertainty. His results are supportive of Ritter's hypothesis, i.e. he observes that stocks with higher initial returns have a higher standard deviation of returns in the early IPO aftermarket.

2.1.1.b The signaling hypothesis

The signaling hypothesis was first suggested by Ibbotson (1975). Ibbotson argues that issuers underprice their issues in order to leave "a good taste in the mouth" of investors, allowing the firm to place secondary equity offerings (SEOs) at a higher price than would otherwise be the case. Similarly, Welch (1989) argues that high quality firms will underprice their IPOs in order to get better prices for seasoned offerings. Empirical evidence on this theory is mixed. Michaely and Shaw (1994) apply a simultaneous equations model and find no support for the signaling hypothesis. On the other hand, using a sample of IPOs and subsequent SEOs in the 1990s, Fohlin (2000) finds support for the hypothesis.

2.1.1.c The monopsony power hypothesis

Baron (1982) argues that an issuer has less information about the demand for his issue than his underwriter. Based on Baron's model, Ritter (1984) suggests that investment bankers underprice the new issues on purpose and reap their profits by allocating IPOs only to their favored customers. Cliff and Denis (2004) examine links among IPO underpricing, post-IPO analyst coverage and the likelihood of switching underwriters. Their results indicate a significant positive relationship between underpricing and analyst coverage by the lead underwriter. Consistent with this result, Bradley et al. (2003) find that abnormal returns, concentrated in a five day window around the end of the quiet period, are positively related to the number of analysts that initiate coverage. The cumulative average abnormal return for firms receiving coverage is 4.1 percent compared to 0.1 percent for those without coverage.

2.1.1.d The market feedback hypothesis

Benveniste and Spindt (1989) propose a market feedback hypothesis which assumes that investors have more information about the demand and appropriate price for an IPO than the issuer. When bookbuilding is used, investment bankers need the help of regular investors to reveal information during the pre-issue information-gathering period, which can then be used to assist in pricing the issue. In return to the truthful revelation of information by regular investors, investment bankers compensate investors by an increase in both underpricing and share allocation. Empirical support for this hypothesis is offered by Weiss-Hanley (1993), Lee and Henderson (1999), and Cornelli and Goldreich (2001).

2.1.2 Symmetric information and underpricing

In contrast to asymmetric information models, some theories assume symmetric information. The two main theories in this area are the lawsuit avoidance hypothesis and the ownership dispersion hypothesis.

2.1.2.a The lawsuit avoidance hypothesis

The lawsuit avoidance hypothesis argues that issuers and their underwriters underprice IPOs to protect themselves from future lawsuits. Tiniç (1988) and Hughes and Thakor (1992) find support for the lawsuit avoidance hypothesis. On the other hand, Alexander (1993) argues that the degree of underpricing is too much when compared with the average lawsuit settlement costs and the low historical lawsuit frequency. Thus, the lawsuit avoidance hypothesis is questionable. Lowry and Shu (2002) apply a simultaneous equations framework and find evidence in support of the hypothesis, i.e. on one hand, higher underpricing lowers a firm's litigation risk, and on the other hand, firms with higher litigation risk underprice their IPOs by a greater amount as a form of insurance. More recently, Turtle and Walker (2004) find no support for the lawsuit avoidance hypothesis for firms that went public in the U.S. between 1995 and 2000. They argue that two securities litigation reform acts, enacted in 1995 and 1998, have reduced litigation risk for new issues and have eliminated the need for issuers to buy litigation insurance through underpricing.

2.1.2.b The ownership dispersion hypothesis

Zingales (1995) and Booth and Chua (1996) suggest that the underpricing of IPOs can generate excess demand and disperse a firm's ownership structure. Brennan and Franks (1997) argue that underpricing diffuses ownership and protects insiders from hostile takeovers. Similarly, Aggarwal et al. (2002) argue that the dispersion of ownership will both increase the liquidity of the stock, and make it more difficult for outsiders to challenge management. Empirical support for this theory is offered by Krigman et al. (1999) and Ellis et al. (2000).

2.2. Cycles in IPO volume and initial returns

2.2.1. Business conditions/capital demand

There are various theories that try to explain the variation of IPO volume over time. The business conditions hypothesis argues that issue activities mirror the economic climate and will therefore be positively related to various macroeconomic measures. When the economy is expanding, the cost of equity capital is lower and firms tend to have higher demand for capital. The ability to issue new equity at lower cost motivates private firms to go public. Fama and French (1989) distinguish hot and cold issue markets by monthly industrial production. Choe et al. (1993) suggest that more firms have seasoned equity offerings when they face better economic conditions. Similarly, Ljungqvist (1997) finds that a positive macroeconomic condition increases the average initial returns. Ritter and Welch (2002) argue that market conditions are the most important factor in the decision to go public.

Lowry (2003) provides empirical evidence that companies' demand for capital explain a significant amount of the fluctuations in IPO volume. Lowry uses percentage growth in the real gross domestic product, percentage growth in real private, fixed nonresidential investment, the change in the number of new corporations and average real sales growth of public firms as proxies for capital demand. Consistent with the capital demand hypothesis, she finds that sales growth is positive related to IPO volume both on an aggregate level and at an industrial level.

2.2.2. Asymmetric information /adverse-selection

Rock (1986) argues that riskier firms should have higher initial returns than firms that are easier to evaluate. He suggests that a hot issue market takes place when a large proportion of the new issues have high risk; and that a cold issue market takes place when a large proportion of new issues have low risk. Lucas and McDonald (1990) argue that IPO volume is driven by time variations in the amount of asymmetric information over time. Choe et al. (1993) argue that periods of economic growth are associated with both greater volumes of equity issues as well as lower adverse selection costs. During periods of high information asymmetry, it is less attractive for issuers to pursue new issues since the benefits of issuing may not surpass the direct issue cost plus adverse selection cost. This causes a cyclic pattern in the new issues markets as issuer companies will postpone IPOs or seek alternative financing. Lucas and McDonald (1990) and Bayless and Chaplinsky (1996) find that hot market issues tend to be better quality firms. Similarly, Stoughton et al. (2001) suggest that being the first firm to go public may convey a strategic advantage relative to rival firms in the same market segment.

Lowry (2003) uses the dispersion of abnormal returns around public firms' earnings announcements and the dispersion of analyst forecasts of public firms' earnings, obtained from I/B/E/S, as proxies for the degree of information asymmetry. Pastor and Veronesi (2003) use a measure that proxies for new firm excess volatility by calculating the difference between the median return volatility of new firms and the volatility of the market. In addition, they use the log difference between the median market-to-book ratio of new firms and the median market-to-book ratio across all firms as a proxy for the prior uncertainty. Lowry (2003) does not find a significant relationship between asymmetric information and IPO volume. Pastor and Veronesi's (2003) findings are mixed. Consistent with the asymmetric information hypothesis, they find that new firm excess volatility is positively related to IPO volume, but that the excess market-to-book ratio of new firms is not.

2.2.3. Investor sentiment

Some researchers argue that changes in investor sentiment are a driving force behind the observed variations in IPO volume. The investor sentiment hypothesis is a synonym of the irrational investor hypothesis. Lee et al. (1991) argue that the large fluctuations in IPO volume are the result of market mispricing, i.e. firms time their IPOs by taking advantage of investor irrationality. Pagona et al. (1998) suggest that fluctuations in IPO volume are primarily caused by issuers' attempts to exploit industrial overvaluation, which is consistent with the over-optimism hypothesis. Lerner (1994) and Loughran and Ritter (1995) provide empirical results that are consistent with this hypothesis. Lerner et al. (2003) interpret that during low IPO volume periods private firms can not access the stock markets under favorable conditions, thus they have to seek less favorable financing methods. Similarly, Jindra (2001) finds that firms are willing to have seasoned equity offerings if they are overvalued.

Lee et al. (1991) argues that the discount rate of closed-end funds reflects the sentiment changes of individual investors that invest in these funds relative to a clientele that invests in the underlying assets. Following Lee et al., Lowry (2003) uses the discount rate of closed-end funds and future market returns as proxies for the level of investor optimism. Consistent with the investor sentiment hypothesis, she finds a significant negative relationship between the discount rate of closed-end funds and IPO volume.

Similarly, Charoenrook (2002) uses the index of consumer sentiment, constructed by the Survey Research Center of the University of Michigan, as a proxy for the level of optimism of a broad number of investors. Charoenrook (2002) finds that changes in consumer sentiment predict one-month and one-year ahead stock market returns.

2.3. Technological innovations

The technological innovations hypothesis suggests that hot issue markets can occur when there is a wave of IPOs by companies in the same industry that experienced a technological innovation. Chemmanur and Fulghieri (1999) suggest that hot issue markets occur when there are correlated productivity shocks across firms. Similarly, Maksimovic and Pichler (2001) suggest herding of IPOs in industries where new-entry risk is significant. Hoffmann-Burchardi (2001) argues that both the clustering and underpricing phenomena result from positive surprises about industry prospects. Benveniste et al. (2002) contend that bundling IPOs in an industry by investment banks induce hot issue markets. Ivanov and Lewis (2003) suggest that technological innovations are unlikely to be highly correlated across industries and that hot issue activities are concentrated within particular industries. In other words, hot issue markets are dominated by issues from a relatively small number of industries.

Empirical findings related to the technological innovations hypothesis are mixed. Ivanov and Lewis (2003) examine the correlation structure of new issue activity using industry level data. They find that the correlations across industries are significantly different, which is supportive of the technological innovation hypothesis.

On the contrary, Helwege and Liang (2003) find that both hot and cold market

IPOs are largely concentrated in the same narrow set of industries and that hot markets for many industries occur at the same time. Thus, they argue that technological innovations are not the major determinant of hot and cold issue markets. Rather, they argue that hot markets are driven by investor optimism.

3. Data

Data on IPOs are obtained from the Securities Data Corporation (SDC) New Issues database. The data base includes 10,184 offerings over the period 1972 through 2001. We exclude offerings from closed-end mutual funds, ADRs, REITs, unit offerings and mutual-to-stock conversions. We also require price data for the firms to be available in the Center for Research in Security Prices (CRSP) database during the first 45 trading days after the IPO. This yields a sample of 8,160 observations. Taking into account that new issues of penny stocks are part of the IPO market, we do not exclude new issues in which offer price is below $5.00 as Loughran and Ritter (2002) and Lowry (2003) do. Loughran and Ritter (2002) suggest eliminating penny stock in IPO studies, since stocks with an offer price below $5.00 per share are subject to the provisions of the Securities Enforcement Remedies and Penny Stock Reform Act of 1990, aimed at reducing fraud and abuse in the penny stock market. We include penny stocks in our study in order to observe dynamic changes in the IPO market from a whole market perspective. In a robustness test, we will discuss interrelationships in the IPO market without the influence of penny stocks.

*** Insert Table 1 about here ***

Table 1 provides summary statistics for our IPO sample and reports IPO volume, average initial returns and aggregate gross proceeds of new issues per year. The table clearly shows the cyclical patterns of both IPO volume and initial returns. During our 30 year sample period, 8,160 companies went public. Their average initial return was approximately 17.19%, with total gross proceeds of $349.24 billion. Yearly IPO volume during our sample period ranges from a low of 4 IPOs in 1974/1975 to a high of 715 in 1996. Although we can observe a general upward trend in IPO volume over time, there have been intermittent troughs, particularly in 1974/1975, 1988-1990 and in 2001. On the other hand, we can observe a particularly strong IPO market in the years 1983, 1993-1996 and 1999. A similar pattern can be observed in initial returns. IPOs in 1974 had the lowest first day returns (0.68%), while the average first day returns during the 1999/2000 Internet bubble were 67.3% and 53.9%, respectively.

*** Insert Table 2 about here ***

Table 2 provides a univariate comparison of firm-specific data of hi-tech firms versus non-hi-tech firms, and of venture capital backed firms versus non-venture capital backed firms[1]. Venture backed IPOs are identified through venture capitalist information contained in the SDC database. We observe that the high tech IPOs are significantly more underpriced and have a higher post-IPO standard deviation than low-tech IPOs. On the other hand, the offer proceeds for high tech IPOs are significantly smaller than for low-tech IPOs. Assuming that high tech firms tend to have a higher level of ex-ante uncertainty compared to IPOs from firms in traditional industries, then our results are consistent with Rock (1986). Megginson and Weiss (1991) argue that new issues backed by venture capitalist have higher proceeds and lower initial returns. Our findings do not

[1] We follow the classification by Loughran and Ritter (2003) and Cliff and Denis (2003) into high-tech and low-tech firms. Hi-tech firms are those firms whose SIC codes match one of the following: 2833, 2834, 2835, 2836, 3571, 3572, 3575, 3577, 3578, 3661, 3663, 3669, 3674, 3812, 3823, 3825, 3826, 3827, 3829, 3841, 3845, 4812, 4813, 4899, 7370, 7371, 7372, 7373, 7374, 7375, 7377, 7378, 7379.

support their hypothesis. On the contrary, we find that venture capital backed issues are significantly more underpriced than non-venture capital backed IPOs. We find no significant difference between the proceeds of venture capital backed IPOs and non venture capital backed IPOs. We do find, however, that venture capital backed IPOs have a higher standard deviation in post-IPO returns suggesting that they are riskier issues.

*** Insert Table 3 about here***

Table 3 provides summary statistics for variables investigated in our research. For each variable we report the number of observations as well as the mean, median, standard deviation, minimum, and maximum. We define IPO volume as the number of IPOs per quarter. Following Lowry (2003), we deflate the number of IPOs per quarter by the number of public firms at the end of the previous quarter in order to avoid problems related to nonstationarity and series correlation. We calculate the initial return during a quarter as the equally-weighted mean IPO underpricing of firms that went public during that quarter.[2] Proceeds, obtained from SDC, are converted to year 2000 dollars based on CPI data from the Bureau of Labor Statistics. We use two proxies for the degree of asymmetric information. One is the post-IPO standard deviation of a firm's return, and the other is prior market volatility. Following Rock (1986) and McGuinness (1992), we use the standard deviation of IPO returns during the first 30 trading days, averaged quarterly. The post-IPO standard deviation captures the degree of asymmetric information from the viewpoint of investors. If investors think that the degree of

[2] For robustness, we also perform our analysis by using value-weighted mean underpricing during a quarter. Our results are quantitatively and qualitatively robust to either variable definition.

asymmetric information is high, then issuers have to underprice their IPOs sufficiently enough to attract investors. Thus, we hypothesize that initial returns are positively related to post-IPO standard deviation. On the other hand, prior market volatility is used to capture the degree of asymmetric information from the viewpoint of issuers. Prior market volatility is the annualized standard deviation of returns on the CRSP equally-weighted market index during the three months prior to the firm's IPO. If the prior market volatility is high, investors will find it difficult to evaluate the true value of an IPO. We hypothesize that the prior market volatility is negatively related to initial returns because investors are more cautions about investing in an IPO on its first trading day when markets are volatile and because they are unable to provide a clear price signal to the underwriters prior to the IPO for which the underwriter will compensate them. In short, we hypothesize that asymmetric information is an important determinant of initial returns.

We also investigate the influence of prior stock market returns on the IPO market as in Benveniste et al (2003). Prior market returns are the annualized returns during the three months prior to the firm's IPO using the equally-weighted portfolio of all NYSE, AMEX, and NASDAQ stocks as provided by CRSP. Following Pastor and Veronesi (2003), we use prior market returns as a proxy for the equity premium. To proxy for capital demand, we use the quarterly U.S. Gross Domestic Product, (GDP) obtained from the website of the U.S. Department of Commerce, Bureau of Economic Analysis (http://www.bea.doc.gov). To adjust for inflation, we convert all GDP data to year 2000 dollars based on CPI data from the Bureau of Labor Statistics. The risk-free rate is the annualized nominal yield on a three-month T-Bill during a quarter, obtained from the

Federal Reserve website (http://www.federalreserve.gov). The consumer sentiment index is constructed by the Survey Research Center at the University of Michigan. The index serves as a proxy for consumer sentiment during a given quarter. Furthermore, we construct a high-tech ratio, defined as the number of high tech IPOs divided by the total number of IPOs during a quarter, and a venture capital backed ratio, defined as the number of venture capital backed IPOs number to the total number of IPOs during a quarter. Both variables will allow us to control variables to control for any effects that concentration of high-tech IPOs or venture capital backed IPOs may have on IPO volume and initial returns in a given quarter.

4. Simultaneous equations approach

4.1. Methodology

We take into account that IPO volume and initial returns during a given time period may influence each other. In order to reveal the endogeneity between IPO volume and initial returns, we follow the methodology in Lowry and Shu (2002) and Lin et al. (2003) and apply a simultaneous equations approach. In the simultaneous system of equations, endogenous variables are determined jointly rather than sequentially. Thus a two-stage least squares (2SLS) regression of IPO volume and initial returns controls for endogeneity.

We consider the following model:

$$\text{Initial Return} = \gamma_1 \text{ IPO Volume} + \alpha_1 X + \beta_1 X_1 + \varepsilon_1 \quad (1)$$

$$\text{IPO Volume} = \gamma_2 \text{ Initial Return} + \alpha_2 X + \beta_2 X_2 + \varepsilon_2 \quad (2)$$

where initial return is the quarterly average amount of underpricing and IPO volume is the number of IPO firms that went public during a given quarter, deflated by the total number of public companies in the last quarter obtained from CRSP. Both IPO volume and initial return are endogenous variables, i.e. they are determined within the system of equations. X, X_1 and X_2 are vectors of instrument variables. In detail, X is a vector of IPO characteristics that are common to both equations. X contains lagged initial returns, lagged volume, the high tech ratio, the venture capital backed ratio and a season dummy. The lagged endogenous variables are predetermined variables in that they are determined within the system by past values of the variables. The high tech ratio, venture capital backed ratio and season dummy are exogenous variables. X_1 is a vector of exogenous IPO characteristics that are idiosyncratic to initial returns, but not IPO volume. X_1

includes proceeds, prior market volatility and the post-IPO standard deviation of returns. X_2 is a vector of exogenous IPO variables that are directly related to IPO volume but not to initial return. X_2 includes the logged GDP, the consumer sentiment index, the prior market return, and the risk free rate. The first stage of the two-stage least squares (2SLS) estimation involves the creation of instrumental variables. The second stage substitutes the first-stage predicted values for endogenous variables and generates unbiased parameters in a standard OLS regression.

When there are high correlations between the structural form equations of the two stage least squares model, a two-stage least squares estimation is inefficient. To correct for this problem, we also present results for a three-stage least squares (3SLS) regression which takes the correlations between error terms of equations into account. If the disturbances in the different structural form equations are uncorrelated, 3SLS reduces to 2SLS. There are three steps in the process: first-stage regressions to get predicted values for the endogenous regressors; a second-stage to get residuals of each equation to estimate the cross-equation correlation matrix; and the final stage to secure generalized least-squares parameters.

4.2. Empirical results

Before we run the 2SLS regression, we analyze the correlation matrix of control variables grouped by variables that are hypothesized to have an impact on initial returns or IPO volume, respectively. The results are reported in Table 4. Judging by the magnitude and significance of the correlation coefficients, there appears to be no severe multicollinearity in our model.

*** Insert Table 4 about here ***

The results of 2SLS and 3SLS regressions are reported in Table 5. All the results are robust to serial correlation and heteroscedasticity. Because there are lagged endogenous variables in our model, a Durbin-Watson test is not appropriate for testing for autocorrelation in the model. We choose a Durbin h test instead. The p-value of the Durbin h test is 0.12, indicating that there is no significant autocorrelation in our model. We also performed a Lagrange multiplier test and exclude the possibility of heteroscedasticity in our model.

*** Insert Table 5 about here ***

Using a 2SLS model, we find no significant relationship between IPO volume and initial returns. Both IPO volume and initial returns show seasonal characteristics, i.e. we observe lower IPO volume and higher initial returns in the first season of the year. As expected, the high tech ratio and post-IPO standard deviation have a significant positive relationship with initial returns, while prior IPO market volatility has a significant negative relation with initial returns. On the other hand, we do not find a significant relationship between initial returns and proceeds or the venture capital backed ratio.

Unlike Lowry (2003) and Lin et al. (2003), we do not find support for the capital demand hypothesis, i.e. GDP does not have a significant relationship with IPO volume in our model. However, we find that prior market returns have a significant positive relationship with IPO volume, which means that the higher the prior market returns, the higher the IPO volume during the following quarter.

In panel B of table 5, we provide a cross-model correlation matrix computed from the two-stage least square residuals. We calculate cross-model correlations, covariances, the inverse of the correlation matrix, and the inverse of the covariance matrix. We find that the disturbances in the different structural form equations are correlated. Therefore, a 3SLS estimation approach is more appropriate than a 2SLS estimation.

The system weighted R square of the 3SLS model is 0.76, which is higher than either of the adjusted R squares of the 2SLS model. This supports our belief that a 3SLS model outperforms a 2SLS model when examining the relationship between initial returns and IPO volume. The results of the 3SLS estimation show that IPO volume has a significant positive influence on initial returns, but not vice versa. We also find that past IPO volume during the preceding three months has a significant negative influence on initial returns. On the other hand, IPO volume is positively influenced by IPO volume during the preceding two quarters and negatively influenced by IPO volume of preceding third quarter.

Our findings reveal a dynamic relationship between IPO volume and initial returns. We do not find support for the conventional wisdom that high IPO activity may follow high underpricing, but also reveal the interactive relationship. Our results give empirical support to the model of Hoffmann-Burchardi (2001), who hypothesizes that hot issue markets often coincide with more pronounced underpricing than cold issue markets. Consistent with McGuinness (1992), our proxy for ex-ante uncertainty has a significant positive relationship with initial returns. On the other hand, we observe that the prior market volatility is significantly negatively related to initial returns. This is consistent with a situation in which investors are hesitant to bid up the price of a new issue in early aftermarket trading and are not rewarded for revealing any pre-IPO price information because they are unable to determine the fair price for the firm. At the same time, the high tech ratio is significantly positively related to underpricing. We do not find a significant relationship between initial returns and aggregate quarterly proceeds. Beatty and Ritter (1986) and Habib and Ljungqvist (1998) observe a negative relationship between these variables at the firm level. Similar to the findings of Aggarwal et al. (2002), underpricing is not significantly related to our venture capital backed indicator. As in our 2SLS results, GDP and the index of consumer sentiment are not significantly related to IPO volume, suggesting that firms' demand for capital and investor sentiment are not important determinants of IPO volume, which is inconsistent with Choe et al. (1993) and Lowry (2003). We find that prior market returns are significantly positively related to IPO volume, which is consistent with the conventional belief that hot issue markets tend to follow periods of high market return, i.e. more firms choose to go public during bull market periods and keep waiting during bear markets. This empirical result is supportive of Pastor and Veronesi's (2003) model.

4.3. Robustness tests

We perform robustness tests using three different data sources and time periods. The first data set is collected from Jay Ritter's web site (http://bear.cba.ufl. edu/ritter/ipodata.html). It contains information on 12,105 IPOs from 1970 to 2001, excluding closed-end funds, ADRs, REITs, units, mutual-to-stock conversions, and issues in which the offer price is less than \$5. The second data set is the same as our original data set in table 1, but excludes IPOs with an offer price below \$5. The third data set is also based on our original data set, but is limited to the period from 1980 to 2001. We cannot calculate the high tech ratio and the venture capital backed ratio as well as proceeds and the standard deviation of post-IPO returns for Ritter's data. Therefore we drop these variables from our model.

*** Insert Table 6 about here ***

For each sample, the 3SLS regression results are robust with respect to significance and economic magnitude to those in Table 5, suggesting that the inclusion or exclusion of penny stocks does not have any significant impact on the relationship between IPO volume and initial returns and that the interaction of IPO volume and initial returns is persistent across different time periods. We argue that a 3SLS model is suitable to capture the dynamic endogeneity between IPO volume and initial returns, and that it overcomes some of the problems in 2SLS estimation. The dynamic relationship between IPO volume and initial returns can not be observed in 2SLS estimation, but it is clearly evident in a 3SLS model.

5. Technological innovations and fixed effects model

One hypothesis related to the IPO volume puzzle is that technological innovation leads to a hot issue market. With data from 1977 to 1982, Ritter (1984) finds that the hot issue market during that period is driven exclusively by natural resource issues and does not carry over to other industries. Hoffmann-Burchardi (2001) argues that the IPO clustering and high underpricing phenomena in a hot issue market result from the same underlying fact, i.e. a positive surprise about industry prospects. Helwege and Liang (2002) find that both hot and cold market IPOs are largely concentrated in the same narrow set of industries and that hot markets for many industries occur at the same time.

We break down our aggregate data set by industry in order to capture patterns in new issues activity on an industrial level. Following Helwege and Liang (2002), we categorize new issues into eleven major industries based on their truncated two-digit SIC code. These are the top 11 industries in terms of IPO activity, and account for about 65 percent of total IPO volume. Table 7 provides summary statistics for our IPO sample, categorized by industry. The business services sector (SIC 73), which includes software and internet companies, has both the highest average initial return and the most IPOs during our thirty year sample period. On average, there are about 11.53 new issues per quarter in the business services industry, which is more than twice the volume of any other industry. In total, the business services industry alone accounts for more than 16 percent of all offerings during the last thirty years.

*** Insert Table 7 about here ***

5.1. Cross-industry correlation of issue activity

Following Ivanov and Lewis (2003), we test the hypothesis by examining the correlation structure of issue activity by industry. If the technological innovations hypothesis holds, the correlation coefficients for issue activity between different industries will be different. Only industries that share similar underlying technologies should have positive and relatively high cross-industry correlations. On the other hand, IPO volume in less related industries is not expected to be as highly correlated.

*** Insert Table 8 about here ***

Table 8 reports the correlation matrix of the number of new issues across industries. The correlation coefficients are all positive but of different magnitude. While some of the correlation coefficients are close to one, others are close to zero. We observe particularly high correlations between chemicals and allied products (SIC 28) and the engineering and scientific instruments sector (SIC 38), between chemicals and allied products sector (SIC 28) and health services (SIC 80), and between communications (SIC 48) and business services sector (SIC 73), and between retailing sector (SIC 52-59) and health services sector (SIC 80). For each of these pairs, the correlation coefficient is above 0.7. Although most of these industries are closely related, the correlation between retailing and health services is somewhat surprising. The high correlation coefficients between those industries suggest that they benefit from the same technological innovations. On the other hand, we find that the oil and gas sector (SIC 13, 29) has a relatively low correlation with all other industries. Similarly, we observe low correlations between the industrial and commercial machinery and computer equipment sector (SIC 35) and the communications sector (SIC 48), between the industrial and commercial machinery and computer equipment sector (SIC 35) and the business services sector (SIC 73) and between the wholesale trade sector (SIC 50-51) and the business services sector (SIC 73). We could continue the list, but an important conclusion can already be drawn at this point: while related industries tend to have high correlation coefficients, we also observe high correlation coefficients for seemingly unrelated industries such as retailing and health services. On the other hand, industries that are clearly related such as the industrial and commercial machinery and computer equipment sector (SIC 35) and the communications sector (SIC 48) display comparatively low correlation coefficients. Thus, an analysis of cross-industry correlations provides at best mixed results.

5.2. Fixed-effects Model

To evaluate the technological innovation hypothesis in more detail, we apply a fixed-effects model to examine cross-sectional influences between the eleven industries. The fixed-effects model can be written as follows;

$$Y_{it} = \alpha + \beta X_{it} + \sum_{i=1}^{N-1} \gamma_i W_{it} + \sum_{t=1}^{T-1} \delta_t Z_{it} + \varepsilon_{it} \qquad (3)$$

where

Y_{it} is the aggregate IPO volume during quarter t excluding the IPO volume in industry i,

X_{it} is a matrix of independent variables,

W_{it} is an industry dummy with $W_{it}=1$, i=1 to N-1; and $W_{it}=0$ otherwise,

Z_{it} is a time period dummy with $Z_{it}=1$, t=1 to T-1; and $Z_{it}=0$ otherwise, N is the number of industries, and

T is the number of quarters.

Our goal is to examine the cross-sectional effects and test whether the number of new issues in each individual industry has a significant relationship with the number of new issues in the rest of the market. If the cross-sectional effects are positive and significant, the technological innovation hypothesis will be rejected. If all the cross-sectional effects are insignificant, there will be support for the technological innovations hypothesis.

*** Insert Table 9 about here ***

Results for the fixed-effects model are provided in table 9. Panel A of table 9 reports cross-sectional effects between the eleven industries. All cross-sectional effects are significant at the 0.1 percent level, i.e. the number of new issues in each individual industry is significantly positively related to the number of new issues in the rest of the market. Consistent with Helwege and Liang (2003), this result provides evidence against the technological innovations hypothesis.

Panel B of table 9 reports results for an ordinary least squares regression based on industry level data. Specifically, we regress the aggregate quarterly IPO volume for all industries except industry i, Y_{it}, against industrial IPO volume[3], industrial initial returns and the same factors we hypothesized to have an impact on IPO volume in our

[3] Industrial IPO volume is defined as the number of firms that went public during a quarter in an industry sector, deflated by the total numbers of public companies in the last quarter.

simultaneous equations model.[4] We find that industrial IPO volume has a significant positive impact on aggregate IPO volume, which is consistent with our cross-sectional effects analysis in panel A. Our findings provides additional evidence against the notion that aggregate hot markets are characterized by clusters of firms from particular industries for which a technological innovation or positive productivity shock has occurred. All other coefficients are consistent with our 3SLS analysis. Both prior market returns and the risk free rate have a significant positive influence on aggregate IPO volume, which is supportive of the hypothesis that more firms go public when they face better market conditions. Consistent with the capital demand hypothesis (Lowry (2003)), GDP is significantly positively related to IPO volume. A significant and positive relationship is also found between the index of consumer sentiment and aggregate IPO volume. This result lends support to the hypothesis that investor sentiment is an important determinant of IPO volume (Lowry (2003)).

[4] Note that we do not include the high-tech ratio in our model because industry differences are captured in more detail through the cross-sectional industry effects.

6. Conclusions

We study the dynamic relationship between IPO volume and initial returns over the period from 1972 to 2001. By taking the endogenous interrelationship between IPO volume and initial returns into account, and applying a three stage least squares regressions model, we find that higher IPO volume in concurrent quarter and lower IPO volume in preceding quarter lead to higher initial returns. In other words, the underpricing of a new issue is affected not only by the concurrent number of new issues but also by the number of new issues in prior periods. On the other hand, we find no support for the hypothesis that higher initial returns cause increased IPO volume. Our findings shed light on the dynamic relationships in the IPO market and help explain the occurrence of hot and cold issue markets. We find that measures of ex-ante uncertainty are positively related to initial returns. This is in supportive of the hypothesis that underpricing is positively related to the degree of asymmetric information. We also find a significant positive relationship between prior market returns and IPO volume, which is consistent with the hypothesis that IPO waves are preceded by favorable market conditions (Pastor and Veronesi (2003)).

Lowry (2003) argues that firms' capital demands and investor sentiment are important determinants of IPO volume. Our findings for the two hypotheses are mixed. In our 3SLS model, we do not find support for the theories, i.e. there is no support for Lowry's hypotheses when considering aggregate level data. However, in our fixed-effects model that is based on industry level data, we find that GDP and the index of consumer sentiment are significantly positively related to the aggregate number of new issues.

Hence, we argue that business conditions and investor sentiment have more importance on issue activity at an industrial level.

In addition to exploring the hot and cold issue market puzzle and the interrelationship between IPO volume and initial returns, we examine the technological innovations hypothesis that suggests that hot issue markets are largely driven by small number industries that have benefited from technological innovations of positive productivity shocks. We analyze the correlation matrix of the eleven most active IPO industries, and find mixed evidence for the hypothesis that hot and cold IPO markets are concentrated in specific industries. Furthermore, we employ a fixed-effects model in our analysis and find that the number of new issues in the eleven most active IPO industries is significantly positively related to aggregate IPO volume in the rest of the market. This provides empirical evidence against the technological innovations hypothesis and suggests that aggregate hot issue markets occur across a broad range of industries at the same time.

In summary, this paper sheds light on the hot and cold issue market puzzle. On one hand, our simultaneous equations model reveals the dynamic endogeneity of IPO volume and initial returns. On the other hand, the analysis of industry correlations and the fixed-effects model reject the notion that technological innovations trigger aggregate hot issue markets.

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Appendix 1: Variable Definitions

Variable	Data Sources	Description
Underpricing	SDC, CRSP	Percentage return from offer price (SDC) to first-day closing price (CRSP)
Initial Return	SDC	Average IPO underpricing of firms that went public during a quarter
Numbers of IPOs	SDC	Number of firms that went public during a quarter
IPO Volume	SDC, CRSP	Number of firms that went public during a quarter, deflated by the total numbers of public companies in the last quarter
Proceeds	SDC, BLS	Offer proceeds converted to year 2000 dollars based on CPI data from the Bureau of Labor Statistics (BLS)
Tech Dummy	SDC	Tech dummy (=1 if the firm is a technology firm, 0 otherwise); We follow Loughran and Ritter (2003) and Cliff and Denis (2004) and categorize firms with the following SIC codes as tech firms: 2833, 2834, 2835, 2836, 3571, 3572, 3575, 3577, 3578, 3661, 3663, 3669, 3674, 3812, 3823, 3825, 3826, 3827, 3829, 3841, 3845, 4812, 4813, 4899, 7370, 7371, 7372, 7373, 7374, 7375, 7377, 7378, 7379.
High Tech Ratio (HT-Ratio)	SDC	Ratio of the number of high tech IPOs divided by the total the numbers of IPOs during a quarter
Prior Mkt Return	CRSP	Annualized return on the CRSP equally-weighted market index during the three months prior to the firm's IPO
Prior Mkt Volatility	CRSP	Annualized standard deviation of returns on the CRSP equally-weighted market index during the three months prior to the firm's IPO
Risk-Free Rate	Federal Reserve Website (http://www.federalreserve.gov/releases)	Annualized average nominal yield on a three-month T-Bill during a quarter
Log(GDP)	US Department of Commerce, Bureau of Economic Analysis (http://www.bea.doc.gov) BLS	Log of the quarterly U.S. Gross Domestic Product converted to year 2000 dollars based on CPI data from the Bureau of Labor Statistics (BLS)
Venture Capital Backed Ratio (VB-Ratio)	SDC	Ratio of the number of venture capital backed IPOs to the total number of IPOs during a quarter
Post-IPO standard deviation	CRSP	Standard deviation of returns during the first 30 trading days after an IPO, averaged quarterly
Index of Consumer Sentiment (ICS)	University of Michigan	Consumer sentiment index as constructed by the Survey Research Center of the University of Michigan. The index serves as a proxy for consumer sentiment during a given quarter
Season Dummy		Dummy variable (=1 if the IPO was issued in the first quarter, 0 otherwise)

Table 1: Descriptive Statistics on IPOs, 1972-2001

This table provides descriptive statistics for all IPOs between 1972 and 2001. The sample consists of all IPOs available in the Securities Data Company (SDC) New Issues database. The data base includes 10,184 offerings over the period 1972 through 2001. We exclude offerings from closed-end mutual funds, ADRs, REITs, unit offerings and mutual-to-stock conversions. We also require that the firms have price data available in the Center for Research and Security Prices (CRSP) database during the first 45 trading day of IPOs. This yields a sample of 8,160 observations. For each year, we report the number of IPOs, the equally weighted first day return during the year and aggregate proceeds in US$ million, converted to year 2000 dollars.

Year	Number of IPOs	Average First Day Return	Aggregate Gross Proceeds (in $ million)
1972	27	4.18%	1,013.7
1973	45	6.52%	789.3
1974	4	0.68%	85.8
1975	4	8.68%	155.4
1976	28	3.74%	622.1
1977	17	9.31%	368.0
1978	22	20.32%	521.6
1979	48	12.90%	798.1
1980	98	26.16%	2,208.2
1981	250	8.68%	4,814.6
1982	93	11.87%	1,969.2
1983	587	12.18%	19,201.8
1984	278	3.88%	4,975.7
1985	287	16.25%	12,300.6
1986	583	8.99%	23,701.2
1987	438	9.00%	17,672.5
1988	184	10.99%	6,478.7
1989	174	11.85%	8,584.4
1990	149	11.79%	5,418.3
1991	330	12.64%	15,192.7
1992	447	10.08%	22,964.1
1993	697	10.15%	51,178.4
1994	528	8.81%	28,784.2
1995	488	21.01%	26,400.1
1996	715	17.77%	36,121.4
1997	486	13.19%	30,975.8
1998	299	19.36%	21,831.1
1999	467	67.30%	37,727.6
2000	308	53.90%	29,832.0
2001	79	13.23%	8,973.2
Total	8,160	17.19%	421,660.1

Table 2: Univariate Statistics in Firm Specific Data

This table provides a univariate comparison of hi-tech firms versus non-hi-tech firms, and of venture capital backed firms versus non-venture capital backed firms in firm specific data. Underpricing is the percentage return from offer price, obtained from SDC, to first-day closing price, obtained from CRSP, of new issue. Post-IPO standard deviation is the standard deviation of IPO returns in first 30 trading days. Proceeds are the offer proceeds converted to year 2000 dollars based on CPI data from the Bureau of Labor Statistics (BLS). We follow the classification by Cliff and Dennis (2003) into high-tech and low-tech firms. Hi-tech firms are those firms whose SIC codes match one of the following: 2833, 2834, 2835, 2836, 3571, 3572, 3575, 3577, 3578, 3661, 3663, 3669, 3674, 3812, 3823, 3825, 3826, 3827, 3829, 3841, 3845, 4812, 4813, 4899, 7370, 7371, 7372, 7373, 7374, 7375, 7377, 7378, 7379. Venture backed IPOs are identified through venture capitalist information contained in the SDC database. In column four and column seven we report p-value of a t-test for differences in means and of a Wilcoxon test for differences in medians for each comparison of subsamples.

	Hi-Tech Mean Median	Non-Hi-Tech Mean Median	T test Wilcoxon test (p value)	VC-Backed Mean Median	Non-VC-Backed Mean Median	T test Wilcoxon test (p value)
N	2683	5477		2661	5499	
Underpricing	25.00%	13.36%	<0.0001	25.54%	13.13%	<0.0001
	9.10%	3.95%	<0.0001	8.92%	3.92%	<0.0001
Post-IPO	0.0456	0.0334	<0.0001	0.0468	0.0333	<0.0001
Std. Dev.	0.0388	0.0299	<0.0001	0.0397	0.0291	<0.0001
Proceeds	48.43	53.26	0.0113	45.00	54.91	<0.0001
	29.04	24.72	0.0002	34.12	20.61	<0.0001

Table 3: Descriptive Statistics

This table provides summary statistics for variables used in our two-stage regression and three-stage least squares regression. For each variable we report the number of observations as well as the mean, median, standard deviation, minimum, and maximum. Note that there were no IPOs in 6 quarters. Therefore, some of the variables during these quarters are undefined and are omitted from our calculations.

Variables	N	Mean	Median	Std. Dev.	Min	Max
Number of IPOs	120	68.00	51.50	61.18	0	238
Initial Return	114	15.53%	11.67%	16.26%	-0.79%	95.09%
Prior Mkt Volatility	120	0.0061	0.0052	0.0032	0.0025	0.0248
Proceeds ($ million)	120	3,513.83	1,879.41	3,846.00	0	16,201.02
Post-IPO Standard Deviation	114	0.0364	0.0338	0.0140	0.0166	0.0946
Log(GDP)	120	3.800	3.802	0.1157	3.602	3.9951
Prior Mkt Return	120	1.15%	1.14%	4.06%	-10.84%	13.98%
Risk-Free Rate	120	6.60%	5.74%	2.65%	1.91%	15.05%
ICS	120	86.12	90.33	12.94	54.43	110.13
VB-Ratio	114	0.3124	0.2843	0.1625	0	1
HT-Ratio	116	0.3056	0.2996	0.1554	0	0.7115

Table 4: Correlation Matrix of Independent Variables

We present a correlations matrix for all independent variables used in our two-stage and three-stage least squares estimation. For each pair of variables, we report the correlation coefficient, p-value and the sample size in quarters. Panel A presents the correlations matrix for variables that are hypothesized to have an impact on initial returns. Panel B presents correlation coefficients for variables hypothesized to have an impact on IPO volume.

Panel A. Grouped by variables having impact on initial IPO returns

		Prior Mkt Volatility	Proceeds	Post-IPO Std. Dev.	Season Dummy	VB-Ratio	HT-Ratio
Prior Mkt Volatility	Correlation	1					
	P Value						
	N	120					
Proceeds	Correlation	-0.1695	1				
	P Value	0.0557					
	N	120	120				
Post-IPO Std. Dev.	Correlation	0.5288	0.3476	1			
	P Value	<0.0001	0.0001				
	N	114	114	114			
Season Dummy	Correlation	0.0022	-0.0575	-0.0063	1		
	P Value	0.9796	0.5187	0.9457			
	N	120	120	114	120		
VB-Ratio	Correlation	0.1046	0.0680	0.1647	0.2698	1	
	P Value	0.2636	0.4700	0.0771	0.0034		
	N	114	114	114	114	114	
HT-Ratio	Correlation	0.1557	0.1461	0.2329	0.2940	0.5212	1
	P Value	0.0951	0.1191	0.0119	0.0014	<0.0001	
	N	114	114	114	114	114	114

Panel B. Grouped by variables having impact on IPO volume

		Log(GDP)	Prior Mkt Return	Risk-Free Rate	ICS	Season Dummy	VB-Ratio	HT-Ratio
Log(GDP)	Correlation	1						
	P Value							
	N	120						
Prior Mkt Return	Correlation	0.0026	1					
	P Value	0.9768						
	N	120	120					
Risk-Free Rate	Correlation	-0.3196	-0.1109	1				
	P Value	0.0002	0.2125					
	N	120	120	120				
ICS	Correlation	0.6164	-0.0771	-0.4226	1			
	P Value	0.0001	0.3868	0.0001				
	N	120	120	120	120			
Season Dummy	Correlation	-0.0239	0.3302	0.0147	-0.0077	1		
	P Value	0.7884	0.0001	0.8689	0.9306			
	N	120	120	120	120	120		
VB-Ratio	Correlation	0.4169	0.1581	-0.0970	0.0753	-0.0483	1	
	P Value	<0.0001	0.0900	0.3002	0.4218	0.6066		
	N	114	114	114	114	114	114	
HT-Ratio	Correlation	0.4947	0.0641	0.0849	0.2449	0.0578	0.5212	1
	P Value	0.0001	0.4938	0.3647	0.0081	0.5374	<0.0001	
	N	114	114	114	114	114	114	114

Table 5: Simultaneous Equations Approach

In panel A, we provide results of a two-stage least squares regression and a three-stage least squares regression to test the relationship between quarterly aggregate IPO volume and initial returns. Our sample consists of 8,160 IPOs from 1972 to 2001. Coefficients are reported with p values below. In a simultaneous system of equations, endogenous variables are determined jointly rather than sequentially. Thus a two-stage least squares regression of IPO volume and initial returns controls for endogeneity between the variables. We consider the following model:

$$\text{Initial Return} = \gamma_1 \text{Volume} + \alpha_1 X + \beta_1 X_1 + \varepsilon_1$$
$$\text{Volume} = \gamma_2 \text{ Initial return} + \alpha_2 X + \beta_2 X_2 + \varepsilon_2$$

where initial return is the quarterly average amount of underpricing; volume is the number of IPO firms that went public during a given quarter deflated by the total number of public companies in the last quarter; X is a vector of exogenous IPO characteristics that are common to both equations, i.e., control variables; X_1 is a vector of exogenous IPO characteristics that are uniquely related to the amount of underpricing, but not volume (identifying variables); and X_2 is a vector of exogenous IPO variables that are directly related to IPO volume but not to initial return. In detail, X includes lagged initial returns, lagged volume, the high-tech ratio, the venture capital backed ratio and a season dummy. X_1 includes proceeds, prior market volatility and post-IPO standard deviation. X_2 includes the logged GDP, the consumer sentiment index, the prior market return, and the risk free rate. The first stage of a two-stage least squares (2SLS) estimation involves the creation of instrumental variables that are then used as predicted variables in the second stage estimation. The second stage substitutes the first-stage predicted values for endogenous variables and generates unbiased parameters in a standard OLS regression. A three-stage least squares regression (3SLS) takes the correlations between equations into account. There are three steps in the process: first-stage regressions to get predicted values for the endogenous regressors; a second-stage to get residuals of each equation to estimate the cross-equation correlation matrix; and the final stage to secure generalized least-squares parameter. In panel B, we provide a cross-model correlation matrix computed from the two-stage least square residuals. We calculate the cross-model correlations, covariances, the inverse of the correlation matrix, and the inverse of the covariance matrix. For each regression model we report parameter estimates with p-values below.

Panel A. Simultaneous Regression Results

	Model			
	2SLS		3SLS	
	Initial Return	IPO Volume	Initial Return	IPO Volume
IPO Volume	11.0787		16.4840	
	0.1663		0.0381	
Initial Return		-0.0011		-0.0007
		0.8816		0.9181
Intercept	-0.1933	-0.0140	-0.2045	-0.0305
	0.0036	0.6626	0.0381	0.3093
Prior Mkt Volatility	-15.1103		-13.1277	
	0.0020		0.0042	
Proceeds	-0.0010		-0.001	
	0.3444		0.4699	
Post-IPO	10.7265		10.3680	
Standard Deviation	<0.0001		<0.0001	
Log(GDP)		0.0034		0.0066
		0.6934		0.4095
Prior Mkt Return		0.0503		0.0555
		0.0023		0.0005
Risk-Free Rate		0.0114		0.0240
		0.6328		0.2906
ICS		0.0031		0.0079
		0.5921		0.1493
Season Dummy	0.0955	-0.0050	0.1169	-0.0052
	0.0109	0.0002	0.0018	0.0001
HT-Ratio	0.2265	-0.0007	0.2335	-0.0016
	0.0454	0.9004	0.0391	0.7671
VB-Ratio	-0.0862	0.0054	-0.1324	0.0063
	0.4550	0.3217	0.2506	0.2411
Volume lag1	-8.1513	0.8081	-12.6255	0.8127
	0.0841	<0.0001	0.0069	<0.0001
Volume lag2	0.2284	0.2038	-1.3062	0.2008
	0.9352	0.0725	0.6407	0.0764
Volume lag3	-0.3521	-0.2153	0.8813	-0.2312
	0.8984	0.0593	0.7478	0.0429
Volume lag4	-0.4009	-0.0012	-0.4427	-0.0263
	0.8644	0.9901	0.8503	0.7970
IR lag1	0.0974	0.0044	0.0697	0.0032
	0.3391	0.3522	0.4927	0.4996
IR lag2	-0.2333	0.0023	-0.2530	0.0014
	0.0227	0.5675	0.0137	0.7240
IR lag3	0.1249	-0.0037	0.1546	-0.0046
	0.2408	0.4370	0.1469	0.3317
IR lag4	-0.0346	-0.0080	0.0108	-0.0081
	0.7179	0.0582	0.9102	0.0560
Adjusted R-Square/ System-weighted R-Square	0.64	0.69	0.76	

Panel B. Cross-Equation Relationships

		Initial Return	IPO Volume
Cross-Equation Correlation	Initial Return	1	-0.3809
	IPO Volume	-0.3809	1
Cross-Equation Covariance	Initial Return	0.0107	-0.0002
	IPO Volume	-0.0002	0.00002
Cross-Equation Inverse Correlation	Initial Return	1.1697	0.4455
	IPO Volume	0.4455	1.1697
Cross-Equation Inverse Covariance	Initial Return	109.5	962.4
	IPO Volume	962.4	5,8303.6

Table 6: Robustness Test of the Three-Stage Least Squares Regression

We perform robustness tests using three different data sources and time periods. The first data set is collected from Jay Ritter's web site (http://bear.cba.ufl.edu/ritter/ipodata.html). It contains information on 12,105 IPOs from 1970 to 2001, excluding closed-end funds, ADRs, REITs, unit offerings, mutual-to-stock conversions, and issues in which the offer price is less than $5. The second data set is the same as our original data set in table 1, but excludes IPOs with an offer prices below $5. The third data set contains our original data, but is limited to the period from 1980 to 2001. For each dataset, we perform a three-stage least squares regression. We report coefficient estimates with p-values below. Note that for Ritter's dataset, we could not construct variables related to proceeds, post-IPO standard deviations, the high-tech ratio and the venture capital backed ratio. Thus, we perform the regression for Ritter's dataset without these variables.

Data Source	Ritter's data		IPOs excluded with offer price below 5$		IPOs issued after 1980	
	Initial Return	IPO Volume	Initial Return	IPO Volume	Initial Return	IPO Volume
IPO Volume	27.4413		15.6441		12.6208	
	0.0382		0.1038		0.0363	
Initial Return		-0.1445		-0.0029		-0.0014
		0.2752		0.7246		0.8480
Intercept	-0.0757	-0.0748	-0.1693	-0.0269	-0.1553	0.0799
	0.4049	0.4591	0.0085	0.3284	0.0301	0.1522
Prior Mkt	12.2761		-16.0603		-17.0977	
Volatility	0.2212		0.0003		0.0003	
Proceeds			-0.0001		-0.0001	
			0.6263		0.4282	
Post-IPO			9.4640		14.3878	
Standard Deviation			<0.0001		<0.0001	
Log(GDP)		0.0146		0.0062		-0.023
		0.5012		0.4026		0.1171
Prior Mkt Return		0.2166		0.0541		0.0480
		0.1757		0.0008		0.0092
Risk Free Rate		0. 1143		0.0088		-0.0300
		0.3638		0.6505		0.4126
ICS		0.0003		0.0058		0.0158
		0.4545		0.2129		0.0239
Season Dummy	0.1460	-0.0014	0.0962	-0.0050	0.1253	-0.0052
	0.0096	0.7702	0.0211	<0.0001	0.0009	0.0004
HT-Ratio			0.2143	-0.0002	0.0500	-0.0035
			0.0185	0.9753	0.7403	0.6443
VB-Ratio			-0.0933	0.0042	-0.2852	0.0144
			0.3216	0.4574	0.0438	0.0531
Volume lag1	-24.2828	0.7649	-13.1472	0.8117	-11.3863	0.7283
	0.0283	0.0103	0.0255	<0.0001	0.0021	<0.0001
Volume lag2	-5.9850	0.0922	-0.0990	0.1895	0.0799	0.1990
	0.2277	-0.0139	0.9716	0.0991	0.9747	0.0862
Volume lag3	5.5679	-0.4466	2.8302	-0.2427	-0.7582	-0.2239
	0.2833	0.2877	0.3165	0.0340	0.7647	0.0579
Volume lag4	-0.3856	0.0957	-2.9696	-0.0003	-1.1683	-0.0707
	0.9080	0.7389	0.1925	0.9975	0.6209	0.5289
IR lag1	0.3684	0.0766	0.1993	0.0055	-0.0085	0.0021
	0.0164	0.2308	0.0839	0.3922	0.9307	0.6595
IR lag2	-0.1759	-0.0109	-0.2892	0.0005	-0.2215	0.0009
	0.2255	0.5364	0.0104	0.9240	0.0222	0.8360
IR lag3	0.3481	0.0410	0.0852	-0.0027	0.1173	-0.0036
	0.0095	0.2989	0.5010	0.6272	0.2548	0.4667
IR lag4	0.0930	-0.0139	0.0865	-0.0071	-0.0441	-0.0069
	0.5135	0.2696	0.3854	0.1123	0.6441	0.1383
System-weighted R-Square	0.60		0.81		0.77	

Table 7: Descriptive Statistics of Issue Activity in Industrial Level

We provide summary statistics for our IPO sample, categorized by industry. We follow the industry classification by Helwege and Liang (2002) and group firms into eleven major industries based on their two-digit SIC code. In the third column, we report the total number of IPOs in each industry. In columns four to six we calculate the mean, median and standard deviation for the number of IPOs per quarter. In the last column, we calculate the equally weighted mean underpricing for all firms in each sector.

Industry	Two Digit SIC code	Number of IPOs				Initial Return
		Total	Mean	Median	Std. Dev.	
Oil Gas	13,29	153	1.32	1	1.97	7.44%
Chemicals and Allied Products	28	440	3.79	2	4.46	12.73%
Industrial and Commercial Machinery and Computer Equipment	35	492	4.24	3	3.78	17.22%
Electronic, Electrical Equipment and Components	36	602	5.19	4	5.04	26.44%
Engineering and Scientific Instruments	38	503	4.34	3	4.78	17.18%
Communications	48	295	2.54	1	3.56	19.34%
Wholesale Trade	50-51	338	2.91	2	3.11	15.03%
Retailing	52-59	634	5.47	3	5.77	14.14%
Business Services	73	1,337	11.53	6	14.90	35.19%
Health Services	80	293	2.52	1	3.19	10.35%
Engineering, Accounting, Research, Management and Related Services	87	280	2.41	2	2.67	15.19%
Other		2,793	24.09	16	24.49	10.32%

Table 8: Correlation of IPO Volume Classified by Industry

We present a correlations matrix for quarterly IPO volume by industry. For each pair of industries, we report the correlation coefficient and p-value. Our sample consists of 120 quarters of IPO volume aggregated by industry.

		SIC 13,29	SIC 28	SIC 35	SIC 36	SIC 38	SIC 48	SIC 50-51	SIC 52-59	SIC 73	SIC 80	SIC 87
SIC 13,29	Correlation	1										
	P value											
SIC 28	Correlation	0.0967	1									
	P value	0.3020										
SIC 35	Correlation	0.3834	0.5738	1								
	P value	<0.0001	<0.0001									
SIC 36	Correlation	0.1790	0.6415	0.6397	1							
	P value	0.0545	<0.0001	<0.0001								
SIC 38	Correlation	0.2807	0.7800	0.5915	0.6047	1						
	P value	0.0023	<0.0001	<0.0001	<0.0001							
SIC 48	Correlation	0.0890	0.4173	0.3609	0.6147	0.3834	1					
	P value	0.3423	<0.0001	<0.0001	<0.0001	<0.0001						
SIC 50-51	Correlation	0.1902	0.5269	0.6827	0.5253	0.5395	0.4207	1				
	P value	0.0409	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001					
SIC 52-59	Correlation	0.1220	0.6368	0.6839	0.6408	0.6437	0.4769	0.7167	1			
	P value	0.1920	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001				
SIC 73	Correlation	0.0532	0.4495	0.3607	0.5715	0.4279	0.8229	0.3858	0.4298	1		
	P value	0.5710	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001			
SIC 80	Correlation	0.0727	0.7423	0.5751	0.5241	0.6474	0.2465	0.5767	0.7193	0.2870	1	
	P value	0.4378	<0.0001	<0.0001	<0.0001	<0.0001	0.0076	<0.0001	<0.0001	0.0018		
SIC 87	Correlation	0.2433	0.6605	0.5411	0.6362	0.5723	0.5459	0.4731	0.5724	0.4919	0.4790	1
	P value	0.0085	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	

Table 9: Fixed-Effects Analysis of IPO Volume

We apply a fixed-effects model to examine the cross sectional influences between eleven industries. Our industry classification follows Helwege and Liang (2002). The fixed-effects model can be written as follows:

$$Y_{it} = \alpha + \beta X_{it} + \sum_{i=1}^{N-1} \gamma_i W_{it} + \sum_{t=1}^{T-1} \delta_t Z_{it} + \varepsilon_{it}$$

Where

Y_{it} is the aggregate IPO volume during quarter t excluding the IPO volume in industry i,
X_{it} is a vector of control variables
W_{it} is an industry dummy with $W_{it}=1$, i=1 to N-1; $W_{it}=0$ otherwise
Z_{it} is a time period dummy with $Z_{it}=1$, t=1 to T-1; $Z_{it}=0$ otherwise
N is the number of industries, and
T is the number of quarters.

In panel A, we report cross sectional effects between quarterly IPO volume in each industry and aggregate IPO volume in all other industries. For each effect we report the parameter estimate and the corresponding p-value. In panel B, we provide regression results for our fixed effects model. We regress aggregate IPO volume excluding industry i against industrial IPO volume and the initial return in each industry. Other regressors include prior market returns, logged GDP, the risk-free rate, the index of consumer sentiment and a season dummy. For each variable, we report the estimated parameter and the corresponding p-value.

Panel A. Cross Sectional Effects

Cross Sectional Effect	Parameter Estimate	P value
SIC 13,29	0.0085	<0.0001
SIC 28	0.0078	<0.0001
SIC 35	0.0064	<0.0001
SIC 36	0.0061	<0.0001
SIC 38	0.0064	<0.0001
SIC 48	0.0076	<0.0001
SIC 50-51	0.0077	<0.0001
SIC 52-59	0.0067	0.0001
SIC 73	0.0040	<0.0001
SIC 80	0.0075	<0.0001
SIC 87	0.0075	<0.0001
F test	0.0001	

Panel B. Regression Results

Variables	Parameter Estimate	P value
Intercept	-0.0754	<0.0001
Industrial IPO Volume	2.0024	<0.0001
Industrial Initial Return	-0.0008	0.3521
Prior Mkt Return	0.0104	0.0099
Log(GDP)	0.0222	<0.0001
Risk-Free Rate	0.0192	0.0049
ICS	0.0071	<0.0001
Season Dummy	0.0005	<0.0001
R square	0.37	