HOT AND COLD IPO MARKETS

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Abstract

The market for unseasoned equity has the unusual and distinguishing feature of periods of concentrated activity in terms of both volume and underpricing. This paper formally documents the existence of such periods using a regime-switching model that dates transitions between hot and cold states. A number of hot periods are identified over a 20-year period using a variety of IPO activity measures that capture different aspects of new issue volume, proceeds and underpricing. The study documents a leading relationship between underpricing and IPO volume of up to six months. This relationship supports the contention that the decision to issue is a function of current underpricing. We hypothesise reasons for this result and find supportive evidence through a VAR analysis that reveals the influence of stock market and business conditions. The results have implications for the information signal contained in current market conditions and the role of issuers, underwriters and investors.

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1. Introduction

An important distinguishing feature of the market for initial public offerings (IPOs) is the tendency of the market to undergo periods of concentrated activity whereby the number of new issues coming to the market and the extent of underpricing of the offer price relative to the initial trading price both appear to substantially increase. These “hot issue” periods attract enormous investor interest and media attention because of their perceived potential for short term trading profits. Much less academic attention has been directed towards formally identifying and examining the cyclical nature of hot and cold IPO markets, with the literature instead focusing on theoretical and cross-sectional explanations of IPO underpricing per se.

This paper focuses on hot and cold IPO market cycles, and examines four monthly measures of IPO activity (volume, average underpricing, gross proceeds, and total underpricing) over the period 1976 to 1998 in order to provide a multi-dimensional characterization and identification of hot and cold IPO markets.

Objective dating and characterization of hot and cold markets can be important for the development and empirical testing of models of IPO cycles. Moreover, institutional and retail investors are interested in IPO return behavior during different stages of the cycle. For instance, financial managers need to know how long favorable cyclical conditions for new issues persist because of the relatively long lead time required in an unseasoned issue. Characteristics of IPO cycles should also be of interest to regulators if they impinge on the efficiency and operation of capital markets.

The paper makes three contributions. First, it identifies in a quantitative manner hot and cold periods. While there is general acceptance in the literature that such periods exist, there has previously not been formal attempts to quantify these periodic
episodes. Second, using a regime-switching model the paper provides an objective
determination of the dates of hot issue periods. Again this represents the first attempt
in the literature to do so. Third, the paper examines relationships between IPO activity
variables and other factors and finds significant results that reveal an association
between various market and economic conditions in this market.

More specifically, application of Markov regime-switching to IPO data provides
a multi-dimensional characterization of IPO cycles in terms of active versus inactive
market volume, hot versus cold underpricing, and leading versus lagging market
features. This latter characterization is possible because a vector autoregression
analysis of leads from underpricing to IPO volume helps to indicate how long each
state of the cycle is likely to persist. Inter-relationship amongst IPO underpricing and
activity series indicate that underpricing leads the number of IPO issues by up to six
months, thus indicating significant activity momentum over shorter time intervals.
This documentation of these characteristics of the IPO cycle provide new insights to
researchers seeking explanations of IPO market cycles and to market participants who
are either seeking to bring new issues to the market or looking to invest in IPOs.

The organization of the paper is as follows. In section 2, prior evidence is
reviewed. The research method is described in section 3 while section 4 documents
characteristics of the data. Section 5 discusses the construction of the measures of IPO
activity. The results are presented and analyzed in sections 6 and 7. The paper is
concluded in section 8.
2. Prior Evidence

The significance of the IPO market cannot be understated. Almost 14,000 IPOs were issued in the United States equity market during the period 1960 to 1999, representing an average of around 29 IPOs per month. Over the period 1990-99, $269 billion was raised through the IPO market.

Prior studies have indicated that the level of IPO activity displays considerable variability, with concentrated periods of activity being apparent (e.g., Helwege and Liang 1996, James and Kieschnick 1997). Ibbotson and Jaffe (1975) first documented that the degree of IPO underpricing is cyclical, with monthly underpricing at the beginning and end of the 1960s (1959-1961 and 1968-1969) of around 80-100% (after adjusting for the market return) compared to an average of 12.6% over their sample period of 1960-70. Interestingly, they found that periods of extreme underpricing generally led a heavy volume of new issues, and used the popular press term “hot issue” market in order to describe this phenomenon. Ritter (1984), who documented a further hot issue market in 1980, characterized hot issue markets by an unusually high volume of new offerings, severe underpricing, and frequent oversubscription of offerings. Ibbotson et al (1994) confirmed the previously documented hot markets of the 1960s and 1980 and also observed the existence of hot issue markets in the mid-1980s and at the beginning of the 1990s. Hot issue IPO markets have also been documented in other markets, including the UK and South Korea in the late 1980s, and Germany during 1982-1983 and 1985-1986 (Ritter 1997).

Discussion of the time series properties of IPO cycles is limited. Ibbotson and Jaffe (1975) documented a high degree of autocorrelation in monthly underpricing which generally lasted for 11 months. Ibbotson et al (1994) described the level of

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1 Figures are constructed from various sources including Ibbotson et al. 1994, Securities Data Corporation and Wall Street Journal reports.
underpricing and IPO volume in terms of persistent processes where current period values are a good predictor of next period values. They observed that the first-order autocorrelation coefficients of monthly average initial returns and IPO volume are 0.66 and 0.89, respectively.

The level of IPO activity has traditionally been viewed in terms of two measures - a volume measure such as the number of new issues (Ritter 1984) and a pricing measure such as the average level of underpricing (Ibbotson and Jaffe 1975, Ritter 1984). Subsequent studies have generally used graphical and autocorrelation analysis to describe hot and cold periods, but have not attempted to clearly identify significant structural breaks that separate different regimes (eg. Ibbotson et al 1994, Loughran et al 1994). As noted above, objective identification of the timing and characteristics of hot periods can help researchers to construct theories and empirical tests that attempt to explain the existence of such periods.

Ritter argued that the hot market of 1980 may have been attributable to small, natural resource issues since only these issues appeared excessively underpriced during the period. For instance, an average initial return of 21.0% for non-natural resource issues was observed during 1980 compared to 15.8% during other periods. Natural resource issues, in contrast, had an average initial return of 110.9% during 1980 compared to only 18.3% during other periods. By applying Rock’s (1986) model, Ritter (1984) suggested a changing risk composition hypothesis to explain the 1980 hot issue market. He argued that if high risk IPOs represent an unusually large proportion of offerings in some specific periods, high average IPO underpricing should be observed in these periods. It is argued that natural resource issues are inherently of higher risk due to problems in valuation, increased information asymmetry and the industry’s high level of business risk. Ibbotson and Ritter (1995)
note, however, that the magnitude of swings in underpricing cannot be fully accounted for by changes in risk. The changing risk hypothesis also does not explain the related phenomenon of cycles in the volume of new issues.

A second explanation of hot periods concerns positive feedback strategies where investors assume positive correlation in initial IPO returns such that initial returns are likely to be bid up if the price of other recent issues has risen (Rajan and Servaes 1993). The argument is linked to similar arguments of investor sentiment used to explain apparent patterns in the stock market. These arguments are inconsistent with standard theory, to some extent, because they rely on investor irrationality or market inefficiency, and they do not explain how hot markets commence in the first instance.

The questions of how frequent hot issue markets are, what features are associated with these markets, and dating of their occurrences, remain largely unanswered. While evidence supports the existence of hot issue markets, it is based on descriptive ex-post analysis, thus leaving an important role for techniques that can objectively determine the timing and properties of hot and cold IPO markets.

3. Research Method

Objective determination of the existence of hot and cold periods in the IPO market requires the identification of a series of significant structural breaks in IPO activity and underpricing. Traditional econometric tests for structural change include the Chow test, Cumulated Sum of Residual (CUSUM) and CUSUM of Square (CUSUMSQ) tests. The Chow test requires prior knowledge (or at least a guess) of break points and sequential application of Chow tests is inefficient. If structural breaks cannot be identified ex-ante, then the strength of the Chow test diminishes
considerably (Gujarati 1995). CUSUM and CUSUMSQ tests are appropriate for time-series data, and can be used to identify the existence of significant structural change in a data set. However, identification of significant structural breaks beyond a first regime shift requires an extension of the traditional CUSUM technique. Moreover, the Chow and CUSUM tests are statistical tests and do not provide a modeling device.

Markov-based regime-switching can be used to model time series subject to non-linear regime changes (Hamilton, 1989). The concept behind regime-switching is to allow the parameters of a time-series process to take on different values which are dependent on the latent regime indicator (denoted as $S_t$). The unobservable regime indicator takes on different states, although applications tend to restrict it to just two states. The data are used to estimate the parameters in each state as well as the probability that the underlying process is in a particular state. The parameters are viewed as the outcomes of a discrete-state Markov process. An important practical advantage of the regime-switching model is its ability to quickly identify regime shifts, using all the data up to a specific month to form a judgment. The model can be used in the absence of perfect knowledge of historical regime shifts (Layton 1996). In the current context, the level of IPO activity may be subject to occasional and discrete shifts over time such that different regimes are observed. These regime shifts are the hot and cold issue periods.

Regime-switching models have recently been used extensively in modeling nonlinear structure of financial time series data. Schaller and Van Norden (1997) use the technique and find strong evidence of regime switching in US stock market returns, while Hamilton and Lin (1996) use the model to capture nonlinear dynamics in the stock market and the business cycle. Gray (1996) develops a regime-switching model with time-varying properties and applied it to interest rates. In an application of
the model, Hamilton (1989) uses a two-state version of the model applied to US GNP data. In the model the economy is assumed to be in either of two states (a recovery or a recession). Hamilton reports estimated parameters that reproduce characteristics of the US business cycle.

Regime switching in the IPO market could arise in several ways. Changes in economic conditions might induce regime switches. Allen and Faulhaber (1989) suggest, for instance, that the hot issue market in 1980 was associated with the 1979 oil crisis. More generally, changes in economic growth can affect growth in the corporate sector and consequently the propensity for firms to seek new equity from the market. Changes in investor sentiment might induce regime switches. Rajan and Servaes (1997) argue that an increase in investor sentiment may increase the number of new issues. Mutual fund net cash flows have been used as a measure of investor sentiment (Neal and Wheatley 1998, Keim and Stambaugh 1986), and Ritter (1997) suggests that hot issue markets might be related to increases in mutual fund net cash flows that raise the demand for securities such as IPOs. Regime switches could also be related to changes in stock market conditions. Loughran et al (1994) and Rees (1997) provide evidence of a positive relationship between stock market conditions and IPO activity. It is argued that issuers consider stock market conditions when timing their issues.

In the context of IPO markets, two regimes can be identified, a hot period (state 0) and a cold period (state 1). Therefore, the regime indicator, $S_t$, takes on the value of 1 when the IPO market is in cold periods and 0 when the IPO market is in hot periods. The probability that state 0 (1) will persist from one period to the next is given as $q$ ($p$). The probability of moving from state 0 to state 1 is $1-q$, and moving from state 1 to state 0 is $1-p$, so the regime is assumed to be unknown and is also independent
across time. For each regime, the probability rule to govern the likelihood of various observations is the normal density function, with different means \((a_{01} \text{ and } a_{02})\) and variances \((\sigma_1 \text{ and } \sigma_2)\). Hence, in hot periods, IPO activity measures are drawn from a distribution with a mean \(a_{01}\) and standard deviation, while in cold periods, IPO activity measures are drawn from a distribution with a mean \(a_{02}\) and standard deviation \(\sigma_2\). Thus, each regime is characterized by a different mean and standard deviation. The conditional distribution is then a mixture of normals.

Formally, let \(Y_t\) denote any measure of IPO activity, then:

\[
Y_t = a_{01}(1-S_t) + a_{02}S_t + [\sigma_1(1-S_t) + \sigma_2S_t]\epsilon_t
\]

where

\(S_t\) is a binary state variable that follows a first-order Markov Chain such that:

\[
\Pr(S_t = 0|S_{t-1} = 0) = q
\]

\[
\Pr(S_t = 1|S_{t-1} = 0) = 1 - q
\]

\[
\Pr(S_t = 1|S_{t-1} = 1) = p
\]

\[
\Pr(S_t = 0|S_{t-1} = 1) = 1 - p
\]

and \(\epsilon_t \sim N(0, \sigma^2)\).

To obtain estimates of the parameter vector \((a_{01}, a_{02}, \sigma_1 \text{ and } \sigma_2)\), maximum likelihood estimation is used (Hamilton, 1989). The maximum likelihood estimate of the two transition probabilities \((1-q \text{ and } 1-p)\) is the fraction of time that the system is in one state before moving to another state. In other words, the estimated transition probability, 1-\(q\), is the number of times state 0 is followed by state 1 divided by the number of times the process is in state 0. The benefit of using above process in modeling regime switching in the IPO activity is that it allows investors to generate
meaningful forecasts that take into account the possibility of the change from one regime to another. Furthermore, the transition probabilities obtained help to assess the duration of each regime. For instance, the expected duration of hot issue cycles can be obtained by calculating $(1-q)^{-1}$ and, conversely, for cold issue cycles the duration is calculated as $(1-p)^{-1}$.

4. Data

The IPO data set is constructed using files maintained by the Securities Data Corporation (SDC) on all registered security issues in the United States. These files are based primarily on information filed with the Securities and Exchange Commission (SEC) in public registration statements. Share price data are obtained from a combination of sources — SDC, Center for Research in Security Prices (CRSP) and Datastream International.

The following sample selection criteria are employed:

a) The IPO must be a common stock IPO. Issues under Rule 144A, Private Placements and Shelf Registrations are excluded from the data set;

b) Closed-end mutual funds and Real Estate Investment Trusts (REITs) are excluded;²

c) Unit offerings are excluded;³

d) A US based company must issue the IPO.

A final sample of 6,632 IPOs is obtained for the period January 1976 to June 1998.

² Closed-end mutual funds and REITs tend to be overpriced rather than underpriced (Peavy 1990, Wang et al 1992, Nelling et al 1995, Sirmans et al 1987), so this study follows Ibbotson et al (1994) in excluding closed-end mutual funds and REITs from the sample.

³ Unit offerings are complex instruments that consist of a bundle of common stock offerings and other securities (usually warrants) sold together as a package. Unit offerings are removed from the sample
Summary statistics for the sample are presented in Table 1. Table 1 indicates the number of offerings peaked in 1996 after increasing sharply over most of the sample period. The average size of offerings also increased sharply from US$7.0 million in 1976 to US$69.1 million in 1998, with the sample average being $29.6 million. The monthly average of initial returns on the first day of listing ranges from 0.77% in 1976 to 28.51% in 1980, with the average for the overall sample being 10.19%. These figures are slightly lower than results from earlier time periods such as a 15.26% average initial return for the period 1960-1992 (Ibbotson et al 1994).

(Table 1 about here)

5. Measures of IPO Activity

IPO activity has traditionally been viewed in terms of three measures - a volume measure such as the number of IPO issues, a pricing measure such as the average level of underpricing, and a value measure such as the total value of new issues. This paper examines the three traditional measures of IPO activity as well as a fourth measure, the total value of underpricing, which captures the economic importance of IPO underpricing. The volume measure, the number of IPOs per month (NOIPO) expressed as a percentage of the total number of IPOs in the data set, is consistent with previous work (eg. Ibbotson et al 1994, Loughran et al 1994). The total value measure, the inflation-adjusted gross value of IPO proceeds per month (GP), is also expressed as a percentage of total proceeds in the entire data set and is also consistent with the literature (Rees, 1997). These activity measures, taken due to differences in underpricing between unit and stock IPOs as well as complexities involved in valuing unit offerings (Schultz 1993, Jain 1994).  

4 The inflation adjustment as the level of IPO activity divided by an inflation index, where the inflation index is measured each month using January 1976 as the base month. The inflation rate data are obtained from the Federal Reserve Bank of St Louis.
together, indicate how many IPOs occurred in a month and whether the IPOs that occurred during the month were important from a value perspective.

The IPO underpricing measure used in this paper, value-weighted underpricing (VWUP), improves upon previous measures of underpricing by weighting each issue’s contribution to monthly underpricing according to the relative size of the issue within the month:

\[
VWUP_t = \frac{\sum_{i=1}^{N} \text{(proceeds)}_{i,t} \times \text{(IPO Underpricing)}_{i,t}}{\sum_{i=1}^{N} \text{(proceeds)}_{i,t}} \times 100
\]  

(2)

where

\(t=\) month 1, 2, ..., T where \(T = 270\);

\(i=\) company 1, 2, …, N where \(N\) is the number of IPOs in month \(t\);

\((\text{proceeds})_{i,t} = [(\text{number of shares issued})_{i,t} \times (\text{inflation adjusted offer price})_{i,t}]\);

\((\text{IPO Underpricing})_{i,t} = [(\text{closing price on first day trading})_{i,t} - (\text{offer price})_{i,t}] / (\text{offer price})_{i,t}\)

This avoids the problem whereby traditional arithmetic average measures of underpricing are subject to too much influence from small ‘penny’ stocks (Ibbotson and Ritter 1995). 5

The final measure of IPO activity, the value of underpricing (VUP), measures the total value of underpricing in a particular month divided by total value of underpricing in the entire sample (expressed as a percentage), thereby indicating whether underpricing in a particular month is economically important:

\[
VUP_t = \frac{\sum_{i=1}^{T} \sum_{i=1}^{N} \text{(proceeds)}_{i,t} \times \text{(IPO Underpricing)}_{i,t}}{\sum_{i=1}^{T} \sum_{i=1}^{N} \text{(proceeds)}_{i,t} \times \text{(IPO Underpricing)}_{i,t}} \times 100
\]  

(3)
The underpricing measures, taken together indicate whether underpricing occurred in a particular month as well as whether the underpricing was important (see also Loughran and Ritter, 1999).

Summary statistics for the four IPO activity measures are reported in Table 2. The relative number of IPOs (NOIPO) ranges from a low of zero (i.e. no issues) to a monthly high of 1.36%, and the relative proportion of gross proceeds ranges from zero to 2.11%. The underpricing series exhibit greater volatility, as expected. The average VWUP per month is 8.67%, thus implying larger issues are less underpriced since this figure is lower than the simple sample average for underpricing of 10.19% (see Table 1). Monthly VWUP ranges from underpricing of 70.38% to overpricing of 15.56%. In the last column of Table 2, test statistics for the Dickey-Fuller test for stationarity are presented. These results suggest that the four series are stationary.

(Table 2 about here)

Figures 1a to 1d present graphs of the four measures of IPO activity. In Figure 1a, NOIPO shows a clear pattern of active and inactive periods prior to 1991, with activity spikes in 1981, 1984 and 1987. The series becomes more volatile after 1991. Figure 1b shows that gross proceeds (GP) generally follows the pattern of the NOIPO series, although it is interesting to note the period 1980-81 during which time peaks in GP are generally of a much smaller relative magnitude than are peaks in NOIPO. This observation supports Ritter’s (1984) argument that this period was driven by a relatively large number of small issues.

Casual observation suggests that the two underpricing series, illustrated in Figures 1c and 1d, do not track the volume and gross proceeds series particularly well.

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5 A monthly index of equal weighted underpricing is also constructed. This index is highly correlated with the value weighted underpricing index (correlation = 0.8972).
The two underpricing series also reveal important differences. Figure 1c, which plots the VWUP series, reveals large spikes around 1979, 1980, 1981, 1983 and a generally high level from around 1989 onward. The large spikes during 1980-81 may be surprising, and are of a considerably greater magnitude than the spikes in the VUP series illustrated in Figure 1d. This may be explained by the observation that most issues around this time period were small, so underpricing of small issues was relatively important within these months even though the total value of underpricing during these months was unimportant overall.

Figure 1d indicates that the pattern of VUP is more consistent with the volume series pattern than is the VWUP pattern. The VUP series exhibits some small spikes around 1983 and 1987 and then reaches a high but relatively stable level throughout the 1990s, with some large values around 1996. Also of note, spikes in the VUP series appear to lead spikes in the volume and gross proceeds series by up to a year.

(Figures 1a to 1d about here)

6. Regime Switching Results

CUSUM and CUSUMSQ tests conducted on the four IPO activity measures to ascertain the existence of structural breaks provide strong evidence that structural breaks exist in each series. The Markov regime-switching model is applied to determine the turning points between regimes that are initially suggested by the CUSUM and CUSUMSQ tests.

The parameter estimates of the Markov regime-switching model for each of the four series are provided in Table 3. A common characteristic across all of the IPO activity measures is the observation of higher means and standard deviations in hot periods than in cold periods. For instance, the proportion of the number of issues per
month (NOIPO) in active periods is 0.59% of the sample with a standard deviation of 0.25%. In comparison, the average proportion of the number of issues is almost five times lower in cold periods (0.13%) with much lower volatility (standard deviation of 0.10%). Significant differences between regimes are obtained for GP where the average proportion of gross proceeds per month in hot periods is 0.69% of the sample compared to only 0.09% in cold periods. Again, the standard deviation is much higher in hot periods than cold periods (0.37% vs 0.09%).

The two underpricing measures also exhibit substantially different parameters between regimes. VWUP is 14.09% on average in hot periods and only 3.33% in cold periods. VUP is 0.69% in hot periods compared to only 0.03% in cold periods. The standard deviations reflect similar patterns.

In summary, hot periods are characterized by substantially higher means and standard deviations than cold periods in all IPO activity and underpricing series.

(Table 3 about here)

The estimated regime probabilities for each data point are reported in Figures 2a to 2d. These probabilities are used to determine the timing of shifts in each of the activity measures. A regime switch is defined as having occurred if the probability of being in the new state is greater than 0.5 for at least six consecutive months. The rationale for this rule is that hot and cold periods are likely to be driven by fundamental shifts in economic factors or investor sentiment. Such shifts are likely to have a temporal effect of much greater than one month. Moreover, institutional and regulatory features induce lags between the corporate manager’s decision to issue and the listing date. These lags have been estimated to be somewhere between three to six months (Lipman 1997). Given that market conditions are likely to influence the

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6 The results of these tests are not reported here but are available upon request.
manager’s decision, temporal swings of less than six months are not especially relevant. A similar widely-accepted “six month” rule is used by the National Bureau of Economic Research (NBER) to determine the minimum length of a phase of the business cycle.

(Figure 2a to 2d about here)

Hot and cold issue periods are identified using the regime probabilities and transition rules and are reported in Table 4 and Figure 3. Table 5 indicates that for all the IPO activity measures, the estimated means and standard deviations for hot periods are all significantly different from the estimated means and standard deviations for cold periods.

(Tables 4 and 5 and Figure 3 about here)

The two activity measures NOIPO and GP exhibit similar hot issue periods. The hot periods are almost identical between these measures, except for the period of April to December 1981, where NOIPO is in a hot state and GP is in a cold state. Of note, the crash of October 1987 has a strong influence on the market with both volume measures shifting to a cold state in November 1987 that lasts until May 1991. Interestingly, the regime-switching model does not identify the hot issue period of 1980 observed by Ritter (1984) because the large number of IPOs in the 1990s reduces the relative influence of the 1980 period. The expected duration of a hot issue period is 46 months using NOIPO and 35 months using GP.

The two underpricing measures give different signals. VWUP provides a greater frequency of transitions wherein hot periods appear more volatile and less persistent compared to VUP. The expected duration of a hot period using VWUP is

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7 Alternative state definitions were employed including probabilities of greater than 0.5 for at least three consecutive observations; the conclusions remain unchanged.

8 The expected duration of each hot issue cycle can be calculated using \((1-q)^{-1}\) and, conversely, for cold issue cycles it is calculated as \((1-p)^{-1}\).
only 10 months compared to 24 months using VUP. The hot period identified by VWUP in August 1980 to July 1981 is consistent with the hot issue period observed by Ritter (1984). The finding of a hot state in this period using VWUP but not for the other three measures is further support for Ritter’s (1984) argument that high IPO underpricing in 1980 was driven by small issues.

VWUP is the only measure that does not identify a hot period immediately prior to the crash in 1987. In comparison, VUP identifies a hot period between October 1985 and September 1987 ending one month before the crash even though the hot period in the volume measures persisted until November 1987. This difference can be explained due to the difficulty in recalling an issue once it has commenced. Hence, the volume measures are not as dynamic in their response as price-based measures such as VUP. The persistence in the volume measures during adverse market conditions supports the argument that even if issuers respond to market conditions when making timing decisions, the lag induced by institutional and regulatory requirements exposes issuers to the risk of making an issue during market downturns.

A casual observation of Table 4 and Figure 3 indicates lead-lag features between the volume and underpricing measures. Specifically, the hot periods in the underpricing measures appear to lead the hot periods in the volume measures. For example, hot periods in VWUP commenced in August 1980, November 1982, and March 1983 followed by active periods in NOIPO in April 1981, March 1983, and May 1991, respectively.

The most common hot issue period observed across all measures of IPO activity is May 1991 to June 1998, thus providing a further indication of a strong correlation

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9 The hot issue period observed by Ritter (1984) was January 1980 to March 1981.
between IPO activity and stock market conditions since a bull market occurred during most of the 1990s. All IPO activity measures indicate a sustained hot issue period between 1991 and 1998, a time period that is also associated with strong business conditions. In the next section we explore these issues further by examining the relationships among IPO activity series and economic conditions.

7. Explanatory Relationships

The regime-switching results suggest a potential lead-lag relationship between the volume and underpricing measures as well as correlations among IPO activity and market conditions. We first examine the lead-lag features in the IPO market itself. Spearman correlation tests are used to test the lead-lag relationship between the estimated probabilities for the IPO volume and underpricing series. Table 6 reports the Spearman Rank correlation coefficients between current and lagged estimated probabilities of NOIPO and VWUP.

From Table 6, there is a contemporaneous correlation between the two series. The estimated probabilities of VWUP show no correlation with lagged probabilities of NOIPO, but the probabilities of NOIPO show strong correlation with lagged probabilities of VWUP up to six months. This evidence supports a lead-lag relationship from underpricing to IPO volume. The finding supports the argument that the decision to issue is a function of current observed underpricing (Rock 1986, Firth 1997). The lead of underpricing to IPO volume may be explained through the information signal of current underpricing. When potential issuers observe high levels

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10 Choe et al (1993) document that the frequency of seasoned offerings also rises in economic upturns using US data from 1971 to 1991. They argue that firms will issue equity when the effects of adverse selection are less important due to improved business conditions.

11 The power of conventional tests (such as OLS based tests) is limited by the nature of the probability distributions, as by definition the probabilities lie between zero and one. Hence we use the Spearman correlation test.
of current underpricing, they may take this as a signal of improved valuations. As a result, in their desire to increase the proceeds from the IPO, issuers then seek to take advantage of the perceived improvement in valuations. Moreover, IPO issuers cannot respond instantaneously to market conditions due to a three- to six-month lag during which time various activities are undertaken to fulfil legal requirements and promote the issue (Lipman 1997). This institutional induced lag then results in correlations over several months. An alternative explanation concerns the role of underwriters and promoters. Issuers, particularly novice issuers, often rely upon the advice of their underwriter in timing their issue. If underwriters perceive improved market conditions they may be able to convince the issuer to go public informing them that proceeds will be greater than initially thought. At the same time, underpricing can still occur leaving the underwriters with the opportunity to offer stag profits of greater value, due to the larger number of issues and potentially greater underpricing, to valued clients.

(Table 6 about here)

The regime-switching results suggest it is also important to examine the effects of the stock market and business conditions on the relationship between the underpricing and volume series. Moreover, given our arguments above, the valuation signal in current underpricing suggests that the stock market itself has a role to play. In order to conduct this analysis, we employ a vector auto-regression (VAR).

Three variables are selected to measure market and business conditions. They are the term premium, the monthly percentage change in the business cycle as proxied by the NBER index of leading indicators, and the monthly percentage change in the S&P 500 index.\(^\text{12}\) The selection of these variables is guided by theory and prior empirical evidence. Loughran et al. (1994) hypothesize that IPOs are timed to take

\(^{12}\) Dickey-Fuller stationary tests are conducted on these three variables and the results indicate that they are all stationary.
advantage of windows of opportunity created when the stock market is rising and investors place high valuations on the future growth opportunities of firms. Choe et al. (1993) develop a model in which firms choose between issuing equity and debt across business cycle expansions and contractions. They observe that, in general, a firm will issue equity when the stock market is high and will avoid issuing equity when the stock market is undervalued (see also Myers and Majluf 1984). Business expansions are also associated with more profitable investment opportunities that can lead to IPOs. Finally, Chen et al (1986) argue that the term premium is a reasonable measure of future business conditions. Harvey (1988) further suggest the term premium is a useful predictor of future economic growth and is more accurate than either the share market or prior values of GDP. Interest rates on 10-year Treasury bonds and 3-month Treasury bills are used to measure long-term and short-term interest rates.¹³ The term premium is calculated using the monthly interest rate on the 10-year Treasury bond less the monthly interest rate on the 3-month Treasury bill.

The form of the VAR is:

\[
\text{NOIPO}_t = a_1 + \sum_{j=1}^{m} \beta_j \text{NOIPO}_{t-j} + \sum_{j=1}^{m} \chi_j \text{VWUP}_{t-j} + \sum_{j=1}^{m} \delta_j \text{TP}_{t-j} + \sum_{j=1}^{m} \phi_j \text{SP}_{t-j} + \sum_{j=1}^{m} \psi_j \text{BCI}_{t-j} + \mu_{1,t}
\]

\[
\text{VWUP}_t = a_2 + \sum_{j=1}^{m} \gamma_j \text{VWUP}_{t-j} + \sum_{j=1}^{m} \eta_j \text{NOIPO}_{t-j} + \sum_{j=1}^{m} \sigma_j \text{TP}_{t-j} + \sum_{j=1}^{m} \theta_j \text{SP}_{t-j} + \sum_{j=1}^{m} \psi_j \text{BCI}_{t-j} + \mu_{2,t}
\]

where:

- \( \text{TP}_t \) is the term premium in percentage terms;
- \( \text{SP}_t \) is the monthly percentage change in the S&P 500 index;
- \( \text{BCI}_t \) is the monthly percentage change in the business cycle leading indicator;
- \( m \) is the number of lags;
- \( \mu_{1,t} \) and \( \mu_{2,t} \) are the error terms.

¹³ The data are collected from the Federal Reserve Bank of St Louis.
A critical issue in VAR analysis is selection of the number of lags to be included in the model. The selection of appropriate lag length is important because degrees of freedom are wasted if the lag length is too large and the model is misspecified if the lag length is too small. A rule is thus applied whereby the selection of lag length is determined by minimising the Akaike Information Criteria (AIC) across the lag length that eliminates any significant residual autocorrelation.\(^\text{14}\) In the event that the AIC is unable to distinguish clearly between alternative lag specifications, the likelihood ratio test for reduction in the number of lags in the VAR model is used. Based on these criteria, a VAR model with thirteen lags is applied.

Diagnostic results on the VAR analysis are reported in Table 7, including R-square, F-statistic and Wald tests.\(^\text{15}\) The Wald tests focus on the statistical impact of each of the explanatory variable groups (NOIPO, VWUP, TP, SP and BCI) included in the regressions. Given the possibility of multi-collinearity, emphasis on individual t-tests might be misplaced so the Wald tests form the basis of the following discussion. The Wald tests utilize White’s adjusted covariance matrix to correct for heteroskedasticity.

(Table 7 about here)

Some of the lagged dependent variable coefficients are statistically significant in both regressions (results not reported), and the Wald tests tend to highlight the statistical importance of these groups of variables. The first-order lag coefficient for underpricing (VWUP) is 0.34 and for IPO volume (NOIPO) the first-order lag

\(^{14}\) AIC is a goodness-of-fit measure that can be used to compare one model to another, with lower values indicating a more desirable model.

\(^{15}\) Given the number of parameters in the 13-lag model, their estimated values are not reported here.
coefficient is 0.48 with both values statistically significant.\textsuperscript{16} The Wald test for the significance of lagged NOIPO and VWUP in their own regressions supports the autocorrelation features of underpricing and IPO volume. Significant coefficients are observed out to 13 lags for NOIPO and 12 lags for VWUP, although not every lag is significant. Hence, time-series persistence is evident in both the variables.

The Wald test indicates that the coefficients on lagged values of VWUP are statistically significant in the NOIPO regression. This is consistent with the correlation results reported in Table 6, that is, underpricing leads IPO volume. Reasons for this relationship were discussed earlier which support the argument that the decision to issue is a function of current observed underpricing such that current underpricing contains value relevant information. Also consistent with Table 6, there is no statistical significance attached to the lagged NOIPO variables included in the VWUP regression. Hence, there is no lead from IPO volume to underpricing.

We now turn to the economic indicator variables. Both the lagged term premium (TP) and the lagged market returns as measured by returns on the S&P500 index (SP) exhibit explanatory power over IPO volume (NOIPO), with statistically significant Wald test statistics. Both variables exhibit significant positive lag coefficient estimates. This is consistent with the findings of Loughran et al (1994) who suggest a link between equity market performance and the market for IPOs and Choe et al (1993) who also argue for the impact of business conditions on IPOs, although the Wald test for lags of the business cycle variable is not significant. Hence there is evidence that market conditions lead IPO volume, with is again consistent with an expectation of increased proceeds from the issue leading to a higher frequency

\textsuperscript{16} These coefficient estimates are somewhat smaller than the respective figures of 0.66 and 0.89 reported by Ibbotson et al (1994) though they are both statistically significant. The more extensive model specification used in this paper may explain the difference in magnitude between these coefficient estimates and those of Ibbotson et al (1994).
of new issues. Of note, the $R^2$ (adjusted $R^2$) is perhaps surprisingly high indicating the strength of the explanatory variables.

In relation to underpricing, only the lags on the S&P500 returns are significant in the Wald test, and the significant lags are again positive in sign. This result is perhaps unsurprising given the strong autocorrelation in the underpricing series and the fact that underpricing itself is inevitably driven in part by the stock market return. However, this result does suggest that current stock market conditions provide some predictive power over the degree of future underpricing. This finding is consistent with the hypothesis that underwriters observe current market conditions and see windows of opportunity to both convince new issuers to go public and at the same time list the issues at below market value so to provide benefits of underpricing to valued clients. That is, strong continuing market conditions allow the issuer, underwriter and investors to benefit from improved valuation signals.

8. Conclusions

This paper analyzes the behavior of the US IPO market to formally document the existence of hot and cold issue periods and to examine different characteristics of the market focussing on the volume and underpricing of new issues.

The application of a Markov regime-switching model documents a number of regime switches between hot and cold issue markets over the period 1976 to 1998. Hot periods are characterized by high volume and underpricing measures. The results generally confirm previous more 'speculative' evidence of hot issue periods. Nevertheless, the objective dating of hot periods is a contribution itself. The paper then documents a leading relationship between underpricing and IPO volume of up to six months. This relationship supports the contention that the decision to issue is a
function of current underpricing. We hypothesise that current underpricing contains value relevant information and that issuers and/or underwriters take advantage of this signal. Support for this argument is provided by a VAR analysis that reveals that lags of stock market conditions and business conditions, as proxied by the term premium, contain significant explanatory power over the number of new issues. However, we note that timing the market comes at a risk, as the IPO volume measures are relatively slow to respond to downturns in the market. In relation to underpricing itself, we document a strong autocorrelation in the series and a significant relationship with lags of the stock market returns. This result suggests that current stock market conditions provide some predictive power over the degree of future underpricing which is valuable information to issuers, underwriters and investors. Overall, the results yield new insights into the IPO market that pave the way for a richer understanding of this important and intriguing area.
References


Table 1: Descriptive Statistics of IPOs Classified by Year

Sample based on 6,632 unseasoned offerings listed in the USA over January 1976 to June 1998. The figures for 1998 are only for half-year. Average initial return is calculated as the return of the closing price on the first day of trading from the offer price averaged across IPOs.

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Offerings</th>
<th>Average Initial Return per Year</th>
<th>Gross Proceeds per Year (US $ Mil.)</th>
<th>Average Proceeds per Year (US $ Mil.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1976</td>
<td>37</td>
<td>0.00767</td>
<td>260</td>
<td>7.0</td>
</tr>
<tr>
<td>1977</td>
<td>24</td>
<td>0.07988</td>
<td>138</td>
<td>5.7</td>
</tr>
<tr>
<td>1978</td>
<td>34</td>
<td>0.12095</td>
<td>210</td>
<td>6.2</td>
</tr>
<tr>
<td>1979</td>
<td>58</td>
<td>0.08137</td>
<td>377</td>
<td>6.5</td>
</tr>
<tr>
<td>1980</td>
<td>120</td>
<td>0.28509</td>
<td>1,173</td>
<td>9.8</td>
</tr>
<tr>
<td>1981</td>
<td>291</td>
<td>0.13473</td>
<td>2,765</td>
<td>9.5</td>
</tr>
<tr>
<td>1982</td>
<td>97</td>
<td>0.10457</td>
<td>1,152</td>
<td>11.9</td>
</tr>
<tr>
<td>1983</td>
<td>574</td>
<td>0.10187</td>
<td>11,662</td>
<td>20.3</td>
</tr>
<tr>
<td>1984</td>
<td>251</td>
<td>0.04236</td>
<td>2,770</td>
<td>11.0</td>
</tr>
<tr>
<td>1985</td>
<td>270</td>
<td>0.04661</td>
<td>5,996</td>
<td>22.2</td>
</tr>
<tr>
<td>1986</td>
<td>561</td>
<td>0.06133</td>
<td>16,658</td>
<td>29.7</td>
</tr>
<tr>
<td>1987</td>
<td>400</td>
<td>0.06003</td>
<td>12,399</td>
<td>31.0</td>
</tr>
<tr>
<td>1988</td>
<td>158</td>
<td>0.06846</td>
<td>4,664</td>
<td>29.5</td>
</tr>
<tr>
<td>1989</td>
<td>135</td>
<td>0.09205</td>
<td>4,807</td>
<td>35.6</td>
</tr>
<tr>
<td>1990</td>
<td>131</td>
<td>0.10785</td>
<td>4,122</td>
<td>31.5</td>
</tr>
<tr>
<td>1991</td>
<td>302</td>
<td>0.12294</td>
<td>14,203</td>
<td>47.0</td>
</tr>
<tr>
<td>1992</td>
<td>415</td>
<td>0.10739</td>
<td>19,747</td>
<td>47.6</td>
</tr>
<tr>
<td>1993</td>
<td>525</td>
<td>0.12748</td>
<td>26,550</td>
<td>50.6</td>
</tr>
<tr>
<td>1994</td>
<td>414</td>
<td>0.09215</td>
<td>15,180</td>
<td>36.7</td>
</tr>
<tr>
<td>1995</td>
<td>462</td>
<td>0.21576</td>
<td>23,947</td>
<td>51.8</td>
</tr>
<tr>
<td>1996</td>
<td>695</td>
<td>0.17302</td>
<td>37,600</td>
<td>54.1</td>
</tr>
<tr>
<td>1997</td>
<td>471</td>
<td>0.14815</td>
<td>26,900</td>
<td>57.1</td>
</tr>
<tr>
<td>1998</td>
<td>207</td>
<td>0.14646</td>
<td>14303</td>
<td>69.1</td>
</tr>
<tr>
<td>Total</td>
<td>6,632</td>
<td>0.10192</td>
<td>247,583</td>
<td>29.6</td>
</tr>
</tbody>
</table>
Table 2: Summary Statistics of Measures of IPO Activity

Sample based on 6,632 unseasoned offerings listed in the USA over January 1976 to June 1998. NOIPO represents the percentage of unseasoned issues in each month; GP is a percentage measure of the gross proceeds raised from unseasoned issues each month; VWUP is a value-weighted underpricing measure; VUP is a measure of total value of underpricing in each month relative to the sample. The Dickey-Fuller test statistic is a test of stationarity in each series. Note the means for NOIPO, GP and VUP are a proportional function over the sample period.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Dickey-Fuller Test Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOIPO</td>
<td>0.3704</td>
<td>0.3011</td>
<td>0.0000</td>
<td>1.3571</td>
<td>-2.88*</td>
</tr>
<tr>
<td>GP</td>
<td>0.3704</td>
<td>0.4017</td>
<td>0.0000</td>
<td>2.1132</td>
<td>-2.87*</td>
</tr>
<tr>
<td>VWUP</td>
<td>8.6667</td>
<td>9.4220</td>
<td>-15.5557</td>
<td>70.3829</td>
<td>-6.44*</td>
</tr>
<tr>
<td>VUP</td>
<td>0.3704</td>
<td>0.6092</td>
<td>-0.2064</td>
<td>4.8029</td>
<td>-3.39*</td>
</tr>
</tbody>
</table>

* denotes significance at 5%
Table 3: Maximum Likelihood Estimates from the Markov Regime Switching Model

Sample based on 6,632 unseasoned offerings listed in the USA over January 1976 to June 1998. NOIPO represents the percentage of unseasoned issues in each month; GP is a percentage measure of the gross proceeds raised from unseasoned issues each month; VWUP is a value-weighted underpricing measure; VUP is a measure of total value of underpricing in each month relative to the sample. The Markov regime-switching model is given by:

\[ Y_t = a_{01}(1 - S_t) + a_{02}S_t + \sigma_1(1 - S_t) + \sigma_2 S_t \varepsilon_t \]

where \( S_t \) denotes the state of the world for hot \( (S_t = 0) \) and cold \( (S_t = 1) \) markets. \( S_t \) is a binary state variable that follows a first-order Markov Chain such that:

\[ \Pr(S_t = 0 | S_{t-1} = 0) = q, \ Pr(S_t = 1 | S_{t-1} = 0) = 1 - q, \ Pr(S_t = 1 | S_{t-1} = 1) = p, \ Pr(S_t = 0 | S_{t-1} = 1) = 1 - p \]

and \( \varepsilon_t \sim N(0, \sigma^2) \).

| Parameter | NOIPO | | GP | | VWUP | | VUP | |
|-----------|-------|---|---|---|---|---|---|
|           | Estimate | Standard Error | Estimate | Standard Error | Estimate | Standard Error | Estimate | Standard Error |
| 1-\( q \) | 0.0219* | 0.0099 | 0.0290 | 0.0161 | 0.1032* | 0.0335 | 0.0407* | 0.0157 |
| 1-\( p \) | 0.0319* | 0.0149 | 0.0325* | 0.0160 | 0.1052* | 0.0318 | 0.0509* | 0.0202 |
| \( a_{01} \) | 0.5929* | 0.0235 | 0.6927* | 0.0332 | 14.0887* | 1.1992 | 0.6912* | 0.0619 |
| \( a_{02} \) | 0.1274* | 0.0109 | 0.0879* | 0.0082 | 3.3250* | 0.4329 | 0.0301* | 0.0035 |
| \( \sigma_1 \) | 0.2457* | 0.0135 | 0.3730* | 0.0230 | 10.2330* | 0.7070 | 0.7101* | 0.0441 |
| \( \sigma_2 \) | 0.0956* | 0.0077 | 0.0897* | 0.0068 | 3.7170* | 0.4272 | 0.0380* | 0.0029 |

* denotes significance at 5%
Table 4: Chronology of IPO Activity Based on Transition Probabilities From the Regime-Switching Model

Sample based on 6,632 unseasoned offerings listed in the USA over January 1976 to June 1998. NOIPO represents the percentage of unseasoned issues in each month; GP is a percentage measure of the gross proceeds raised from unseasoned issues each month; VWUP is a value-weighted underpricing measure; VUP is a measure of total value of underpricing in each month relative to the sample. Transition probabilities are taken from the Markov regime-switching model given by:

\[ Y_t = a_{01}(1 - S_t) + a_{02}S_t + [\sigma_1(1 - S_t) + \sigma_2S_t]\epsilon_t \]

where \( S_t \) denotes the state of the world for hot (\( S_t = 0 \)) and cold (\( S_t = 1 \)) markets.

Transition rules are invoked such that a hot period requires the probability of \( S_t = 1 \) exceeding 50% for at least six consecutive months.

<table>
<thead>
<tr>
<th>Hot Periods</th>
<th>Cold Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of IPOs (NOIPO)</strong></td>
<td></td>
</tr>
<tr>
<td>Apr 81 – Dec 81</td>
<td>Jan 76 – Mar 81</td>
</tr>
<tr>
<td>Mar 83 – Sep 84</td>
<td>Jan 76 – Mar 81</td>
</tr>
<tr>
<td>Jul 85 – Nov 87</td>
<td>Jan 76 – Mar 81</td>
</tr>
<tr>
<td>May 91 – Jun 98</td>
<td>Jan 76 – Mar 81</td>
</tr>
<tr>
<td><strong>Gross Proceeds (GP)</strong></td>
<td></td>
</tr>
<tr>
<td>Mar 83 – Feb 84</td>
<td>Jan 76 – Feb 83</td>
</tr>
<tr>
<td>Oct 85 – Nov 87</td>
<td>Jan 76 – Feb 83</td>
</tr>
<tr>
<td>May 91 – Jun 98</td>
<td>Jan 76 – Feb 83</td>
</tr>
<tr>
<td><strong>Value-Weighted IPO Underpricing (VWUP)</strong></td>
<td></td>
</tr>
<tr>
<td>Sep 77 – Oct 78</td>
<td>Jan 76 – Aug 77</td>
</tr>
<tr>
<td>Aug 80 – Jul 81</td>
<td>Jan 76 – Aug 77</td>
</tr>
<tr>
<td>Nov 82 – Jul 83</td>
<td>Jan 76 – Aug 77</td>
</tr>
<tr>
<td>Dec 90 – Mar 92</td>
<td>Jan 76 – Aug 77</td>
</tr>
<tr>
<td>Nov 92 – Jun 98</td>
<td>Jan 76 – Aug 77</td>
</tr>
<tr>
<td><strong>Value of Underpricing (VUP)</strong></td>
<td></td>
</tr>
<tr>
<td>Nov 82 – Dec 83</td>
<td>Jan 76 – Oct 82</td>
</tr>
<tr>
<td>Oct 85 – Sep 87</td>
<td>Jan 76 – Oct 82</td>
</tr>
<tr>
<td>Feb 90 – Jul 90</td>
<td>Jan 76 – Oct 82</td>
</tr>
<tr>
<td>Mar 91 – Jun 98</td>
<td>Jan 76 – Oct 82</td>
</tr>
</tbody>
</table>
Table 5: Tests of the Difference in Mean Values and Standard Deviations of IPO Activity Measures between Hot and Cold IPO Periods

Sample based on 6,632 unseasoned offerings listed in the USA over January 1976 to June 1998. NOIPO represents the percentage of unseasoned issues in each month; GP is a percentage measure of the gross proceeds raised from unseasoned issues each month; VWUP is a value-weighted underpricing measure; VUP is a measure of total value of underpricing in each month relative to the sample.

The values of means and standard deviations are slightly different compared to the parameter values in Table 3 due to the transition rules where a hot period requires the probability of $S_t = 1$ exceeding 50% for at least six consecutive months. The F-test is based on the null hypothesis of equality of the variances between the hot and cold periods. The t-test is based on the null hypothesis of equality of means of the hot and cold periods.

<table>
<thead>
<tr>
<th></th>
<th>NOIPO</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>VWUP</th>
<th></th>
<th></th>
<th>VUP</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hot</td>
<td>Cold</td>
<td>Hot</td>
<td>Cold</td>
<td>Hot</td>
<td>Cold</td>
<td>Hot</td>
<td>Cold</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>0.5868</td>
<td>0.1267</td>
<td>0.6947</td>
<td>0.0949</td>
<td>13.8240</td>
<td>4.6023</td>
<td>0.7140</td>
<td>0.0417</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.2509</td>
<td>0.0981</td>
<td>0.3783</td>
<td>0.1072</td>
<td>9.4173</td>
<td>7.1906</td>
<td>0.7241</td>
<td>0.0983</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-stat</td>
<td>6.55*</td>
<td></td>
<td>12.44*</td>
<td></td>
<td>1.72*</td>
<td></td>
<td>112.36*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-stat</td>
<td>20.26*</td>
<td></td>
<td>17.08*</td>
<td></td>
<td>8.84*</td>
<td></td>
<td>10.62*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* denotes significance at 5%
Table 6: Spearman Rank Correlation Coefficients of Estimated Probabilities between NOIPO and VWUP

Sample based on 6,632 unseasoned offerings listed in the USA over January 1976 to June 1998. NOIPO represents the percentage of unseasoned issues in each month; VWUP is a value-weighted underpricing measure; NOIPO_m denotes the lagged terms for NOIPO, where m= 1,2,…,6; VWUP_m denotes the lagged terms for VWUP, where m= 1,2,…,6

<table>
<thead>
<tr>
<th></th>
<th>NOIPO</th>
<th>NOIPO_1</th>
<th>NOIPO_2</th>
<th>NOIPO_3</th>
<th>NOIPO_4</th>
<th>NOIPO_5</th>
<th>NOIPO_6</th>
</tr>
</thead>
<tbody>
<tr>
<td>VWUP</td>
<td>0.1678*</td>
<td>0.1122</td>
<td>0.0690</td>
<td>0.0338</td>
<td>-0.0079</td>
<td>-0.0299</td>
<td>-0.0473</td>
</tr>
<tr>
<td>VWUP_1</td>
<td>0.2346*</td>
<td>0.1660*</td>
<td>0.1104</td>
<td>0.0673</td>
<td>0.0321</td>
<td>-0.0098</td>
<td>-0.0317</td>
</tr>
<tr>
<td>VWUP_2</td>
<td>0.2665*</td>
<td>0.2321*</td>
<td>0.1636*</td>
<td>0.1085</td>
<td>0.0655</td>
<td>0.0300</td>
<td>-0.0111</td>
</tr>
<tr>
<td>VWUP_3</td>
<td>0.3039*</td>
<td>0.2613*</td>
<td>0.2270*</td>
<td>0.1607*</td>
<td>0.1050</td>
<td>0.0615</td>
<td>0.0290</td>
</tr>
<tr>
<td>VWUP_4</td>
<td>0.3536*</td>
<td>0.2989*</td>
<td>0.2564*</td>
<td>0.2243*</td>
<td>0.1575*</td>
<td>0.1010</td>
<td>0.0605</td>
</tr>
<tr>
<td>VWUP_5</td>
<td>0.3735*</td>
<td>0.3493*</td>
<td>0.2946*</td>
<td>0.2543*</td>
<td>0.2216*</td>
<td>0.1542*</td>
<td>0.1001</td>
</tr>
<tr>
<td>VWUP_6</td>
<td>0.3855*</td>
<td>0.3704*</td>
<td>0.3461*</td>
<td>0.2929*</td>
<td>0.2526*</td>
<td>0.2191*</td>
<td>0.1537*</td>
</tr>
</tbody>
</table>

* denotes significance at 5%
Table 7: Diagnostic Results of VAR Analysis on IPO Activity Measures and Economic Variables

Sample based on 6,632 unseasoned offerings listed in the USA over January 1976 to June 1998.

The VAR takes the form:

\[ NOIPO_t = a_1 + \sum_{j=1}^{13} \beta_j NOIPO_{t-j} + \sum_{j=1}^{13} \gamma_j VWUP_{t-j} + \sum_{j=1}^{13} \delta_j TP_{t-j} + \sum_{j=1}^{13} \phi_j SP_{t-j} + \sum_{j=1}^{13} \chi_j BCI_{t-j} + \mu_{1,t} \]

\[ VWUP_t = a_2 + \sum_{j=1}^{13} \eta_j NOIPO_{t-j} + \sum_{j=1}^{13} \vartheta_j TP_{t-j} + \sum_{j=1}^{13} \theta_j SP_{t-j} + \sum_{j=1}^{13} \psi_j BCI_{t-j} + \mu_{2,t} \]

NOIPO represents the percentage of unseasoned issues in each month; VWUP is a value-weighted underpricing measure; \( TP \) is the number of IPOs in each month; \( TP \) is the term premium in percentage terms; \( SP \) is the monthly percentage change in the S&P 500 index; \( BCI \) is the monthly percentage change in the business cycle leading indicator; \( \mu_{1,t} \) and \( \mu_{2,t} \) are the error terms.

Individual parameter values are not reported. T-statistics and Wald-tests are corrected for heteroskedascity using White's correction. The R-square, F-statistic and Wald tests of parameter restrictions are reported for the 13 lags VAR. The Wald tests are tests of variable exclusion.

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>NOIPO</th>
<th>VWUP</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-square</td>
<td>0.812</td>
<td>0.544</td>
</tr>
<tr>
<td>Adjusted R-square</td>
<td>0.748</td>
<td>0.389</td>
</tr>
<tr>
<td>F-statistic</td>
<td>12.701*</td>
<td>3.507*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wald-Tests</th>
<th>Chi-square</th>
<th>Prob.</th>
<th>Chi-square</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lagged NOIPO</td>
<td>179.635*</td>
<td>0.000</td>
<td>13.654</td>
<td>0.399</td>
</tr>
<tr>
<td>Lagged VWUP</td>
<td>21.829**</td>
<td>0.058</td>
<td>56.670*</td>
<td>0.000</td>
</tr>
<tr>
<td>Lagged TP</td>
<td>20.778**</td>
<td>0.077</td>
<td>15.928</td>
<td>0.253</td>
</tr>
<tr>
<td>Lagged SP</td>
<td>41.835*</td>
<td>0.000</td>
<td>29.545*</td>
<td>0.005</td>
</tr>
<tr>
<td>Lagged BCI</td>
<td>8.639</td>
<td>0.800</td>
<td>13.768</td>
<td>0.390</td>
</tr>
</tbody>
</table>

* denotes significance at 5%
** denotes significance at 10%
Figure 1a: NOIPO during the period January 1976 to June 1998

Figure 1b: GP during the period January 1976 to June 1998
Figure 1c: VWUP during the period January 1976 to June 1998

Figure 1d: VUP during the period January 1976 to June 1998
Figure 2a: Regime Probability of Being in Hot Periods using NOIPO

Figure 2b: Regime Probability of Being in Hot Periods using GP
Figure 2c: Regime Probability of Being in Hot Periods using VWUP

Figure 2d: Regime Probability of Being in Hot Periods using VUP
Figure 3: Dated Hot Issue Periods based on Transition Probabilities from a Regime-Switching Model for IPO Activity Measures