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Abstract

Initial public offerings have been examined typically in the context of short-term and long-run stock price performance of individual issues. In this paper, the aggregate market for IPOs is examined. There has been some prior suggestion that the IPO market exhibits cyclical patterns which are characterised by a high volume of new issues and substantial underpricing, such that 'hot issue periods' exist. This paper tests for the existence of such periods in the Australian market using a Markov regime-switching model on a variety of constructed IPO activity measures. The results demonstrate that hot periods do exist but that they do not possess homogeneous features. A number of distinguishing features are also identified between industrial and resource sector IPOs. Further, a lead-lag relationship is identified for the industrial sector such that underpricing leads IPO volume for up to six months. The paper offers explanations for these findings that appear related to general stock market conditions and regulatory features.

1 Introduction

Initial public offerings (or IPOs) have attracted substantial investor and public interest. In part, this interest is stimulated through suggestions of underpricing. That is, there is a market folklore that potential trading profits can be made from 'mispricing', especially in the early days of listing. IPOs are a relatively frequent phenomenon. Over the period 1960-1996, there were 2,271 IPOs issued in the Australian equity market which translates to an average of around 7 new floats per month.¹ Government policy decisions over the last decade have fuelled further interest through the process of privatisation. Floats of public institutions such as the Commonwealth Bank, Qantas and Telstra and the demutualisation of several large entities such as AMP and the Australian Stock Exchange itself have done much to attract small investors to the stock market through IPO subscriptions.

Research into IPOs has generally fallen into three main categories. First, the issue of short-run performance has been subject to widespread research. This work has generally found that there is a frequent incidence of large initial returns in IPO stocks generated over the first few days of listing, that is IPOs tend to be underpriced (eg. Finn and Higham, 1988; How et al, 1995; Ibbotson et al, 1994; Lee et al, 1996; Loughran et al, 1994). Related to this, a number of papers have proposed theoretical models to explain this price behaviour (eg. Baron, 1982; Rock, 1986; Welch 1989,1992). Second, a group of papers have examined the long-run performance of IPOs. Generally, the tracking of price performance over a number of years following listing has shown that IPOs tend to under-perform established benchmarks (eg. Aggarwal et al, 1993; Lee et al, 1996; Ritter, 1991). A third category of research has

¹ Statistics are sourced from Annual Reports of Australian Stock Exchange, 1960-1997.

examined the characteristics associated with the issue itself such as the role of underwriters and investment banks (eg. Affleck-Graves and Miller, 1989; Carter and Manaster, 1990; Carter et al, 1998), the impact of auditor choice (eg. Beatty, 1989; Feltham et al, 1991; Firth and Smith, 1992) and the disclosure of prior information (eg. Chaney and Lewis, 1998; Firth, 1997; Kim and Ritter, 1999).

There has also been some attempt to examine the IPO market in aggregate. These studies have presented some evidence that cycles appear to exist in both the volume and the average initial returns of IPOs. These cycles give rise to the concept of 'hot' and 'cold' markets with a 'hot issue' market characterised by an unusually high volume of new offerings, severe underpricing, and frequent oversubscription of offerings (Ritter, 1984). However, the behaviour of the aggregate IPO market has received little attention and generally only been covered in the context of other issues.

The question of whether indeed hot issue periods exist is important, not only for corporate financial managers who may be interested in the optimal timing of issues, and institutional and retail investors who may be interested in return behaviour, but also for regulators as hot periods may be related to regulatory features and may impinge on the efficiency and operation of capital markets.

In this paper we focus exclusively on the aggregate IPO market to examine hot and cold issue periods in Australia. The paper's aim is to examine the existence of hot and cold markets using a long time-series and to analyse the relationships between various indicator variables during these cycles. The method involves fitting a Markov regime-switching model that allows for the identification of turning points in the IPO market. The advantage of this approach is that it defines in a quantitative manner any hot and cold issue periods. Such identification is potentially useful in any further examination of the impact of other variables on the market.

Four measures of IPO activity are developed in this paper that capture both volume and underpricing aspects of the market. A time series of IPO issues from 1976 to June 1997 is constructed for analysis. Given arguments concerning the potential differential behaviour and nature of the resource sector (How, 1996; Ritter, 1984), the analysis involves separate consideration of the industrial sector of the market. In brief, the results support the existence of hot issue periods across all measures of IPO activity. These measures capture different characteristics of the IPO market and we document that hot issue periods can be differentiated. Further, the relationship between the measures is examined and a lead in underpricing is revealed such that underpricing leads the number of IPO issues by around six months. We offer explanations for this result that yield insight into the market dynamics. Finally, resource sector IPOs are found to exhibit a substantial influence on the pricing measures of IPO activity. This latter result has implications for further work and an understanding of the market.

The contribution of the paper is to provide quantitative evidence on the behaviour of the aggregate IPO market. In so doing, it enhances existing knowledge in this area. IPOs have become a research topic in their own right and yet, there is still much which remains to be explained. The conjecture surrounding the existence, features and implications of hot issue markets is speculative and lacks a sound base of scientific evidence. This paper provides such a base. While we do not answer all the questions, we do provide a launching pad and a framework for future research. The insights gained in this study point to the influence of special characteristics of the Australian market and more generally, relationships between volume and pricing that aid in our understanding of IPO market behaviour.

The organisation of this paper is as follows. In section 2, prior research 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 analysed in section 6 and the paper is concluded in section 7.

2 Prior Evidence

The level of IPO activity has been viewed traditionally in terms of two measures - a volume measure such as the number of new issues (Loughran et al, 1994; Ritter, 1984) and a pricing measure such as the average level of underpricing (Ibbotson and Jaffe, 1975; Ritter, 1984). Variability across time in the volume of new issues has been documented in several markets. For instance, Helwege and Liang (1996) and James and Kieschnick (1997) report substantial variation in IPO volume in the USA, while Ritter (1997) documents periods of high IPO volume in the UK and South Korea in the late 1980s and in Germany during 1982-1983 and 1985-1986.

Variability across time in IPO underpricing has also been documented. Ibbotson and Jaffe (1975) present evidence that the degree of IPO underpricing is cyclical and concentrated in particular periods in the USA, while Ritter (1984) observes a hot issue market in 1980.² Ibbotson et al (1994) also observe hot issue markets during the 1960s, 1980, the mid-1980s and at the beginning of the 1990s. Loughran et al (1994) evaluate the question of timing across international markets and find that in 14 of the 15 countries studied, there is a tendency for high IPO volume periods to be associated with lower long-run IPO returns.

Periods of hot issues are generally documented by reference to descriptive ex-post analysis, typically from a visual inspection of the data series or graphs thereof.

² For instance, Ibbotson and Jaffe (1975) document that the US IPO market exhibited significant underpricing at the beginning and end of the 1960s with the average monthly market-adjusted

Previous studies have not attempted to clearly identify structural breaks that separate the different regimes in the IPO market (eg. Ibbotson et al, 1994; Loughran et al, 1994). Hence, the questions of how frequent the hot issue markets are, dating when they occur, and identifying the features associated with these markets, remain answered. Without answers to such questions, it is difficult to construct further tests to explain the existence of hot issue periods.

There have been few attempts to explain the cyclical behaviour of IPO markets. By applying Rock's (1986) model, Ritter (1984) suggests a changing risk composition hypothesis to explain the 1980 hot issue market. He argues 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. Ritter suggests that the period of 1980 was characterised by a large number of small, natural resource issues and only these issues appeared excessively underpriced during the period.³ It is further argued that natural resource issues are inherently of higher risk due to problems in valuation, increased information asymmetry and that industry's high level of business risk. However as Ibbotson and Ritter (1995) note, the magnitude of the swings in underpricing cannot be fully accounted for by changes in risk of IPOs.

A second explanation of hot issue 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 other recent issues have risen in price (Rajan and Servaes, 1993). The argument is linked to similar arguments of investor sentiment used to explain apparent patterns in the stock market. To some extent, these

underpricing during hot periods of around 100% in contrast to the average level of underpricing across the whole period of 12.6%.

arguments are inconsistent with standard theory because they rely on some investor irrationality and/or market inefficiency. Moreover, the hypothesis of a positive feedback strategy does not explain how hot issue markets commence in the first instance.

Nevertheless, positive autocorrelation does appear to be a feature of IPO markets. Ibbotson et al (1994) observe that the first-order autocorrelation coefficients of monthly average initial returns and IPO volume are 0.66 and 0.89, respectively. Hence, Ibbotson et al describe both the level of underpricing and IPO volume in terms of persistent processes where current period values are a good predictor of next period values.

3 Research Method

If indeed, hot and cold periods exist in the market, an appropriate test is to examine structural breaks. Traditional tests for structural change include the Chow test, Cumulated Sum of Residual (CUSUM) and CUSUM Square (CUSUMSQ) tests. The Chow test requires prior knowledge (or at least speculation) of break points. If structural breaks cannot be identified ex-ante, then the strength of the Chow test diminishes (Gujarati, 1995). In this study, there is little theoretical basis on which to form prior knowledge. While standard CUSUM and CUSUMSQ tests can be applied to time-series data, they are also limited as clear identification of turning points of structural change is not generally possible. The recursive nature of the tests requires time to recognise a regime shift once it has occurred (Greene, 1993), especially when the shifts are large (Montgomery, 1991).

³ For non-natural resource issues, the average initial return of 21.0% was observed during 1980 compared to 15.8% during other periods. In contrast, for natural resource issues, the average initial return was 110.9% during 1980 compared to only 18.3% during other periods.

Instead, we employ a Markov regime-switching model proposed by Hamilton (1989). This model can be applied to time series subject to non-linear regime changes. In the model, the parameters are viewed as the outcomes of a discrete-state Markov process. The probabilities of a particular state can be determined from the data. An important practical advantage of the regime-switching model is its ability to identify regime shifts using data up to the specific observation to form a judgment.

Regime-switching models have been used in modelling non-linear structure of financial time series data. Hamilton and Lin (1996) use the model to capture the non-linear dynamics in the stock market and business cycle, while Schaller and Van Norden (1997) find strong evidence of regime switching in US stock market returns. Gray (1996) develops a regime-switching model with time-varying properties and applies it to interest rates.

In this study, we use Hamilton's approach to examine and date hot issue cycles in the Australian IPO market. Regime switching in the IPO market could arise in several ways. First, changes in economic conditions may induce regime switches. It appears logical to assume that changes in economic growth affect growth in the corporate sector and consequentially the propensity for firms to seek new equity from the market. For instance, Allen and Faulhaber (1989) suggest that the US hot issue market in 1980 was associated with the general economic conditions of the time including the 1979 oil crisis. Second, changes in investor sentiment may induce regime switches. Rajan and Servaes (1993) argue that an increase in investor sentiment may increase the number of new issues. Further, mutual fund net cash flows have been used as a measure of investor sentiment (Neal and Wheatley, 1998; Keim and Stambaugh, 1986). Ritter (1997) suggests that hot issue markets might be related to increases in mutual fund net cash flows. While increases in net cash flows increase

the demand for securities generally, IPOs attract specific attention as they represent a perceived extension of the investment set. Third, regime switches could be related to changes in general stock market conditions as issuers are expected to consider stock market conditions when timing their issues. Loughran et al (1994) and Rees (1997) provide supportive evidence through documentation of a positive relationship between stock market conditions and IPO activity in the USA.

In the context of IPO markets, two regimes can be identified as hot (state 0) and cold (state 1) periods. The probability that state 0 (1) will persist from one period to the next is given as q (p). Hence, the probability of moving from state 0 to state 1 is $1-q$, and conversely moving from state 1 to state 0 is $1-p$. For each regime, the probability rule to govern the likelihood of various observations is the normal density function with different means (a_{01} and a_{02}) and variances (\mathbf{s}_1 and \mathbf{s}_2).

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

$$Y_t = a_{01}(1 - S_t) + a_{02}S_t + [\mathbf{s}_1(1 - S_t) + \mathbf{s}_2S_t]\mathbf{e}_t \quad (1)$$

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 $\mathbf{e}_t \sim N(0, \mathbf{s}^2)$.

To obtain estimates of the parameter vector ($a_{01}, a_{02}, \mathbf{s}_1$ and \mathbf{s}_2), maximum likelihood estimation is used. The maximum likelihood estimate of the two transition probabilities ($1-q$ and $1-p$) is the fraction of time that the system is in one state before

moving to another state. Thus, 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.

4 Data

4.1 Sample

The sample is drawn from all new (listed) equity issues made on the Australian Stock Exchange during the period January 1976 to June 1997. There is no one readily accessible database that allows sufficient information to be drawn. Hence, a database is constructed drawing records from various sources, including the Securities Data Corporation database (SDC), the *Australian Financial Review*, Annual Reports of the Stock Exchange, Companies Department Weekly Schedules (CDWS) published by the ASX, the Corporate Adviser database and data compiled in earlier research.⁴ Information on these issues such as industry classification and proceeds are cross-checked with ASX annual reports, the *Australian Financial Review*, the *ASX Journal* and various issues of *Jobson's Year Book of Public Companies of Australia and New Zealand* and *Jobson's Mining Year Book*. Share price data are obtained from Datastream International and the core daily price database of Australian Capital Markets Ltd.

To ensure that only 'pure' common stock IPOs are included in the sample, the following selection criteria are employed:

- a) the issue must be of ordinary equity and issues involving debt, hybrid securities and derivatives are excluded;

⁴ We are grateful to Dave Allen and Frank Finn for providing advice and some data in respect of the early years of the sample.

- b) the IPO must be issued by an Australian based company;
- c) closed-end mutual funds, investment trusts and real estate investment trusts (REITs) are excluded due to their unique institutional set-up (see How and Low, 1993);
- d) stock issues with embedded convertible notes, warrants, options or other financial instruments are excluded;⁵
- e) companies formed through a Scheme of Arrangement are excluded due to the fact that a scheme of arrangement would normally result in a change of name and/or capital restructure of an existing listed company and therefore not represent unseasoned stock (How and Low, 1993); and
- f) companies transferred from the Second Board to the Main Board are excluded as they are not unseasoned stock in the true sense as their equity has previously been publicly listed.⁶

A final sample of 766 IPOs is obtained for the period January 1976 to June 1997.

4.2 *Summary Statistics*

Summarised results for IPOs by year are reported in Table 1. The initial return is calculated using the closing price on the first day of trading. The average initial return across all years is 37.1% and appears to be quite volatile across the years ranging from -3.52% in 1990 to 92.31% in 1994. The average initial return presented

⁵ There is no generic term for this kind of issue in Australia. However, in the USA such issues are often referred to as 'unit offerings' which consist of a bundle of common stock and other securities, typically warrants, sold together as a package. Research suggests that there is a difference in initial returns between unit and stock offerings (Schultz, 1993; Jain, 1994). Unit offerings are removed from the sample due to the complexity and problems in valuing unit offerings individually and the possible bias arising from the difference in underpricing between unit and ordinary stock IPOs.

⁶ The 'Second Board' market was first introduced in Australia in the early 1980s due to a growing recognition of the need to encourage smaller and less mature companies to list their shares through a junior market. The listing requirements of this Board were less stringent than the Main Board. The

in Table 1 is higher than the reported average initial return of 11.9% in Lee, Taylor and Walter (1996) and 29.2% in Finn and Higham (1988)⁷ who both examine Australian industrial sector IPOs whereas our study includes both industrial and resource sector IPOs. Moreover, the sample in Finn and Higham covers 1966-1978 and 93 IPOs and the sample in Lee et al covers 1976-1989 and 266 IPOs. Hence, our sample period is longer and substantially larger than both Finn and Higham (1988) and Lee et al (1996).

In our sample of 766 IPOs, there are 244 issues that can be identified as resource sector IPOs. The average initial underpricing for these IPOs is 46.5%. If IPOs from the resource sector are excluded, the average initial underpricing level falls to 23.3% for the remaining industrial sector IPOs which is more comparable with other Australian research.

The number of IPOs peaks in the mid-1980s (especially in 1985-1987) and then declines sharply with number of offerings falling following the stock market crash in 1987 and then increases again from 1992.⁸

Gross proceeds per year generally follow a similar trend to the number of issues with a sharp increase in 1986-87 and a major increase in 1991. The average issue size has generally increased over time with large values observed in 1991 and 1995.⁹

(Table 1 about here)

Second Board was abandoned soon after the introduction of the Stock Exchange Automated Trading System (SEATS) in October 1990.

⁷ The initial return used in Finn and Higham (1988) was adjusted for market return.

⁸ There is also some evidence of a possible secular trend with the early years exhibiting lower than average number of IPOs but higher than average underpricing. To some extent this feature is picked up in the detailed analysis of monthly observations later in the paper. Any induced bias in the correlation between these variables should work against significant positive correlations as discussed in section six.

⁹ The figures can be distorted by very large issues such as the Commonwealth Bank issue in 1991 and Qantas in 1995.

4.3 *Issues related to Resource Sector IPOs*

Australia is recognised as a major source of natural resources and the stock exchange traditionally has contained a relatively large proportion of resource sector stocks compared to other exchanges. For instance, resource sector listings averaged 31% as a proportion of listed stocks over the period 1974-93 peaking at 41% in 1991.¹⁰

As mentioned above, one of the traditional measures of the level of IPO activity is the average level of underpricing (e.g. Ibbotson and Jaffe, 1975; Ritter, 1984). This measure of underpricing has been criticised in the literature as it can be subject to undue influence by 'penny' stocks (Ibbotson and Ritter, 1995). Indeed, the hot market in the USA of 1980 has been attributed to small natural resource issues and these issues are generally smaller in both offer sizes and offer prices (Ritter, 1984).

As noted above, there are a total of 244 resource sector issues in the sample (32% of all IPOs). These IPOs have an average offer size of \$19 million compared to \$44 million for industrial sector IPOs. The average offer price of natural resource IPOs in the sample is \$0.41 which is considerably lower than the average offer price of \$1.00 for industrial sector IPOs.¹¹ Hence, resource sector IPOs tend to be smaller, lower priced and experience greater underpricing. Further support for the difference is provided by Michaely and Shaw (1994) who report that small IPOs experience more underpricing than large IPOs.¹² Jain (1995) suggests that this difference can be explained by the information asymmetry surrounding an issue where the information

¹⁰ Figures are sourced from Annual Reports of Stock Exchange of Melbourne (1974-1988) and the Australian Stock Exchange Yearbook 1994 (1989-1993).

¹¹ Some Australian natural resources companies also showed extremely high initial returns. For instance, the shares of Forrester Gold listed in June 1987 reported an initial return of 1,120%. Further, if the sample is ranked on the basis of underpricing, eight of the top 10 IPOs are resource sector stocks.

¹² Further evidence is reported by Ibbotson et al (1994) and Chalk and Peavy (1987). For instance, Ibbotson et al (1994) report that for 2,439 US IPOs issued between 1975 and 1984, the average initial

asymmetry is more apparent for small IPOs than for large IPOs. The implication is that the valuation of small IPOs is more difficult than large IPOs due to a higher degree of information asymmetry. Given these characteristics, the following analysis contains a separate analysis of industrial sector IPOs.

5 Measures of IPO Activity

Following the literature, the level of IPO activity is examined through two broad measures being volume and underpricing. Consistent with these measures, four variables are developed that measure these aspects of IPO activity. Two of the variables concern volume and the other two variables concern underpricing. Each variable is measured on a monthly basis.

NOIPO is measured as the number of offerings in a month divided by the total number of IPOs over the sample period expressed as a percentage. Hence it is a measure of the relative number of issues in each month. It is the simplest measure and is consistent with previous literature that has examined the number of IPOs (eg. Ibbotson et al, 1994; Loughran et al, 1994).

GP is measured as the sum of individual issue proceeds in each month (adjusted for inflation) divided by total proceeds (adjusted for inflation) of all IPOs in the sample period expressed as a percentage.¹³ This measure is also relative and captures the monthly variation in total size of the issues.

VWUP is a measure of underpricing weighted by the relative size of the offer in each month. Hence, large underpricing observed in some small companies in a particular month will not significantly affect the measure. Ibbotson and Ritter (1995)

return on IPOs with an offer price of less than US\$3 is 42.8%, whereas it is only 8.6% for IPOs with an offer price higher than US\$3.

¹³ The inflation adjustment is undertaken by applying an inflation index to the level of IPO activity, where the inflation index is measured each month using January 1976 as the base month. The inflation rate data are obtained from the Australian Bureau of Statistics.

claim that a value-weighted measure of IPO underpricing reduces the influence of “penny stocks”. Therefore, our measure avoids this criticism by accounting for differences in firm/issue size within the month. VWUP is calculated as follows:

$$VWUP_t = \frac{\sum_{i=1}^N (\text{proceeds})_{i,t} \times (\text{IPO Underpricing})_{i,t}}{\sum_{i=1}^N (\text{proceeds})_{i,t}} \times 100 \quad (2)$$

where

$t = \text{month } 1, 2, \dots, T$ where $T = 258$;

$i = \text{company } 1, 2, \dots, N$ where N is the number of IPOs in month t ;

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

];

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

$(\text{offer price})_{i,t}$

The other underpricing measure, VUP, is also a value-weighted measure. This measure standardises by the total value of underpricing across the sample whereas VWUP standardises by size within each month. VUP represents the proportion of total value generated through underpricing across the sample realised in each month and is defined as:

$$VUP_t = \frac{\sum_{i=1}^N (\text{proceeds})_{i,t} \times (\text{IPO Underpricing})_{i,t}}{\sum_{t=1}^T \sum_{i=1}^N (\text{proceeds})_{i,t} \times (\text{IPO Underpricing})_{i,t}} \times 100 \quad (3)$$

All measures are constructed including and excluding resource sector IPOs in order to determine the influence of the resource sector. Summary statistics on the four measures for the full sample and industrial sector IPOs are reported in Tables 2a and

2b, respectively. In Table 2a, the proportion of the number of IPOs per month ranges from a low of zero (ie. no issues) to a monthly high of 3.00% while the relative proportion of gross proceeds ranges from zero to 8.51%. The average level of underpricing (VWUP) per month is 21.97% with a standard deviation of 50.85%. Hence as expected, larger issues are less underpriced, as evidenced by this figure which is lower than the simple average of 37.09% (from Table 1). Monthly VWUP ranges from 541.64% to overpricing of 82.00%. Note that the means for NOIPO, GP and VUP are all a proportional function of the sample period and only vary due to missing observations. In the last column of Table 2a, test statistics from the Dickey-Fuller test for stationarity are presented. These results suggest that all four series are stationary.

Table 2b reports the summary of each measure for industrial sector IPOs. Compared with the measures for the full sample reported in Table 2a, the ranges of the relative number of IPOs (NOIPO) and the relative proportion of gross proceeds (GP) are quite similar. However, the VWUP of industrial IPOs exhibits a lower mean value (15.92%) and standard deviation (34.92%) compared to the full sample. This is again consistent with the argument that resource sector IPOs exhibit greater underpricing.

[Tables 2a and 2b about here]

6 Empirical Results

6.1 Full Sample

The parameter estimates of the Markov regime-switching model for each of the four series across the full sample are reported in Table 3. A common characteristic

across all activity measures is the observation of higher means and standard deviations in hot periods than in cold periods. For instance, the average proportion of the number of issues per month (NOIPO) in hot periods is 0.81% of the sample with a standard deviation of 0.07%. In comparison, the average proportion of the number of issues is six times lower in cold periods (0.13%) with a much lower standard deviation (0.02%). Such results clearly indicate the difference in regimes.

Similar differences between the regimes are obtained for GP where the average proportion of gross proceeds per month in hot periods is 0.99% of the sample compared to only 0.04% in cold periods. Again, the standard deviation is much higher in hot periods than cold periods (0.13% vs 0.01%).

The two underpricing measures also exhibit substantially different parameters between regimes. VWUP is 64.93% on average in hot periods and only 8.09% in cold periods. Similarly, VUP is 1.27% in hot periods compared to only 0.02% in cold periods. The associated standard deviations reflect similar patterns.

In summary, hot periods are characterised by substantially higher means and standard deviations than cold periods in all volume and underpricing measures.

(Table 3 about here)

The estimated regime probabilities for each data point are reported in Figures 1a to 1d. These probabilities are used to determine the timing of phase shifts in each of the activity measures. A problem with the probability plots is determining the state when the probabilities are distant from either zero or unity. In the absence of any prior information, we set the transition level rule at a probability of 50%. Hence an observation is determined to be in a state (S_t) if the probability of being in that state exceeds 0.5.

A further issue arises, as the switching model can be too sensitive and at times provides transition reversals across consecutive months. To overcome this problem, we define a state as one where at least six consecutive probabilities are greater than 0.5. The rationale is that hot 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 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; Bruce et al, 1997). Given that market conditions are likely to influence the manager's decision, temporal swings of one month are not especially relevant and hence we argue that six consecutive months is more realistic with market practice.¹⁴

(Figures 1a to 1d about here)

Using the regime probabilities and transition rules, hot and cold issue periods for all IPOs are identified and reported in Table 4. Although there are common hot periods in the two volume measures (NOIPO and GP), the starting and ending dates of hot periods in the two measures are somewhat different. The expected duration of a hot issue period is 14 months using NOIPO and 4 months using GP.¹⁵

The two underpricing measures give different signals compared with the two volume measures. Using VWUP, hot periods appear less persistent. The expected duration of a hot period is only 1 month using VWUP but 3 months using VUP. Of note, the hot period identified by VWUP in November 1980 to May 1981 is consistent

¹⁴ Alternative state definitions were employed including consecutive probabilities of greater than 0.5 for at least three consecutive months and generally our conclusions remain unchanged.

¹⁵ The expected duration of each hot issue cycle can be calculated using $(1-q)^{-1}$ and conversely for cold issue cycles can be calculated as $(1-p)^{-1}$.

with the hot issue period observed by Ritter (1984) using US data.¹⁶ This finding implies some correlation between US and Australian IPO markets.

Of note, the crash of October 1987 has a strong influence with both volume and underpricing measures shifting from a hot state to a cold state soon after the crash.

(Table 4 about here)

6.2 *Industrial Sector IPOs*

As discussed above, there are features to distinguish between resource and industrial sector IPOs. Hence, the analysis is repeated on the sample of industrial sector IPOs. Table 5 reports the parameter estimates of the Markov regime-switching model for each of the four series for this sample. Consistent with Table 3, the results clearly indicate the difference in regimes where means and standard deviations of the IPO activity measures are much higher in hot periods than in cold periods. Again, the lower underpricing (VWUP) for industrial sector IPOs is apparent.

(Table 5 about here)

Hot and cold issue periods for industrial IPOs are identified and reported in Table 6 using the regime probabilities and transition rules following the earlier procedure. The two volume measures, NOIPO and GP, exhibit similar hot issue periods to those identified in the full sample and are generally consistent with each other. One difference between two measures is the period of August 1988 to April 1989, where NOIPO is in a hot state and GP is in a cold state.

The transition probability of moving from hot to cold periods for VWUP has decreased whereas for GP and VUP the transition probabilities of moving from hot to

¹⁶ The hot issue period observed by Ritter (1984) was January 1980 to March 1981.

cold periods have increased. In other words, hot periods identified in VWUP become more persistent while hot periods identified in VUP and GP become less persistent for the industrial sector. This feature is also reflected in estimates of s_1 and s_2 which have decreased compared to the full sample implying a decrease in the variability of VWUP in hot and cold periods. The implication again is that resource sector IPOs are relatively more underpriced and smaller in size compared to industrial IPOs. Hence, after removing the resource sector IPOs, VWUP becomes more stable. Of note, the hot and cold periods for NOIPO remain almost the same.

(Table 6 about here)

The results again show the influence of the crash of October 1987 with all measures shifting from a hot state to a cold state soon thereafter. The two pricing measures, VWUP and VUP identify a hot period between late 1983 and December 1987 ending two months after the crash. However, the ending months for the two volume measures vary. The hot period for NOIPO ends in January 1988 which is one month later than the pricing measures while GP ends in October 1987 which is two months earlier than the pricing measures. There are some implications that follow.

First, the number of IPOs measure (NOIPO) is not as dynamic in its response to the crash compared to the price based measure (GP). The persistence in NOIPO during adverse market conditions supports the argument that even if issuers respond to market conditions when timing decisions, the lag induced by institutional and regulatory requirements exposes issuers to the risk of making an issue during market downturns.

Second, the lagged response to the crash can also be explained by Australian regulatory environment where there is a significant difference in elapsed times

between the closing date of offer and actual date of listing in the ASX. Based on a survey of 243 IPOs listed on the ASX between 1993 and 1997, the average number of days elapsed between the closing date of offer and the first date of market trading is 25 days with a minimum of 3 days and a maximum of 133 days.¹⁷ With the existence of significant elapsed times between offer close and the subsequent listing date in Australia, a market downturn exposes an issuer to a greater risk of an 'unsuccessful' offer. Moreover, if the close of an offer is followed by a market downturn, the time before listing exposes investors to the risk where potential returns from the issue are less than their expected value.

Third, as indicated in Table 6, the response of GP to the crash is quicker than NOIPO which suggests that IPOs issued immediately following the crash were mainly small issues. Indeed, the average size of issues following the crash through to January 1988 was \$8.7 million compared to an average across the sample period of \$44 million. Moreover, these issues were overpriced by an average of 13.0%. In a market downturn, large companies may have greater capacity to withdraw their offers or indeed may be bound by stricter underwriting clauses which require withdrawal because of their size. The relative costs to small firms from withdrawal may necessitate the offer proceeding despite adverse market conditions.

6.3 *Explanatory Relationships*

A casual observation of Table 4 and especially Table 6 indicates some possible 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 instance, in Table 6 a hot period in VWUP

¹⁷ Data are obtained from SDC IPO database.

commenced in June 1983 and is followed by a hot period in the volume measures in February 1984, a hot period commenced in VWUP in July 1988 and is followed by a hot period in NOIPO in August 1988, and a hot period commenced in August 1991 in the underpricing measures and is followed by a hot period in NOIPO in November 1991. These are just casual observations and we now turn to statistical analysis of the relationship between the measures.

Table 7 reports the regression results between current, lead and lagged series of VWUP against the volume measures for the full sample. There is some evidence that underpricing leads IPO volume as evidenced by the significant lags of VWUP on NOIPO (at lags 2 and 5). In relation to GP, there is a significant negative correlation at VWUP lead of 2 and lag of 6 but we do not place much emphasis on these results due to the insignificant F-statistic. Nevertheless, the findings in respect of NOIPO are consistent with an argument that small issues tend to track underpricing trends whereas the larger issues are somewhat independent of such trends.

The evidence is stronger for the industrial sector as presented in Table 8. From this table there is a contemporaneous correlation between the VWUP and NOIPO. While the leads of VWUP show no correlation with NOIPO up to 6 months, the lags of VWUP are correlated with NOIPO up to six months although the first lag of VWUP is not significant. Hence, underpricing appears to lead IPO volume by up to six months. The finding supports the argument that the decision to issue is a function of current observed underpricing (Rock, 1986; Firth, 1997). However, again the relationship is observed for NOIPO but not GP consistent with the above argument that it is the smaller issues that tend to track underpricing.

(Tables 7 and 8 about here)

The most common hot issue period observed across all measures of IPO activity is around mid 1991 to June 1997. This period is the longest of all hot periods documented over the sample. As with the transition to the cold period associated with the crash of October 1987, there appears to be a correlation between IPO activity and stock market conditions.¹⁸ For instance, from the early 1990s it is widely recognised that the stock market has been experiencing a sustained bull run during which market indicators and price-earnings ratios rose substantially and dividend-to-price ratios have fallen.¹⁹ Other factors which may also be relevant include investor sentiment, the regulatory environment, the economic climate, interest rates, managed fund flows and the level of stock market volatility. We leave detailed analysis of these arguments to further work.

7 Conclusion

In this paper we have documented and analysed the behavior of the aggregate Australian IPO market. The aim was to analyse the existence of hot and cold issue periods in the Australian market. Through the development of a series of activity variables, different characteristics of the market were examined through focussing on volume and underpricing measures of new issues. Moreover, the influence of the resource sector was highlighted and IPO activity was explored with and without stocks in this sector. Resource sector issues are relatively smaller in size and price, and exhibit greater underpricing.

¹⁸ Of note, Choe et al (1993) document that the frequency of seasoned offerings also rises in economic upturns using US data from 1971 to 1991. They identify a positive relationship between equity issue volume and economic activity arguing that firms will issue equity when the effects of adverse selection, as a proportion of investment returns, are less important in the situation of improved business conditions.

¹⁹ During the period of 1991 to 1997, All Ordinaries index increased from 1280 to 2721 and the price-earnings ratio increased from 11 to 22.9. Over the same period, the market dividend yield decreased from 7.0% to 3.7%.

Through the application of a Markov regime-switching model, a number of regime switches are documented between hot and cold issue markets over the period 1976 to 1997. In summary, hot issue periods do appear to exist in the Australian IPO market and are characterised initially by a large degree of underpricing followed by unusually high new issue volume. The activity measures studied here indicate that different periods can be characterised by differences in the types of issues. While the number of issues and total size of issues in each month are generally correlated, at times the measures of underpricing yield different results. Hence we argue that hot issue periods are not identical. Hot issue periods appear related to the general stock market condition, which supports the hypothesis that managers time their issues to attempt to take advantage of favorable market conditions. However, this timing comes at a risk for both issuers and investors due to the institutional and regulatory requirements in Australia. Importantly, a lead-lag relationship is identified, particularly for the industrial sector, such that underpricing measures lead volume by up to six months. These results provide new insights into the IPO market.

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**Table 1: Summary Statistics of IPOs Classified by Year
Jan 1976 - June 1997**

Year	No of Offerings	Average Initial Return per Year	Gross Proceeds per Year (A\$ mill)	Average Proceeds per Year (A\$ mill)
1976	9	0.6731	88	10
1977	5	0.3379	34	7
1978	2	0.7000	15	8
1979	10	0.2935	56	6
1980	21	0.8733	146	7
1981	25	0.1637	313	13
1982	10	0.1431	487	49
1983	19	0.4966	74	4
1984	39	0.1772	324	8
1985	62	0.2684	564	9
1986	94	0.2799	1,029	11
1987	160	0.4092	2,521	16
1988	21	0.6196	328	16
1989	19	0.1723	393	21
1990	7	-0.0352	140	20
1991	10	0.0043	2,234	223
1992	33	0.0708	3,265	99
1993	62	0.2345	4,809	78
1994	70	0.9231	5,105	73
1995	20	0.1739	3,492	175
1996	42	0.1874	1,584	38
1997	26	0.5689	871	33.5
Overall	766	0.3709	27,870	36

Notes:

1. The figures for 1997 are for half-year.
2. 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 2a: Summary Statistics of IPO Activity
Jan 1976 - June 1997**

	Mean	Standard Deviation	Minimum	Maximum	No of Observations	Dickey-Fuller Test Statistic
NOIPO	0.3906	0.5051	0.0000	3.0026	258	-3.6325*
GP	0.3906	0.8738	0.0000	8.5070	257	-5.0887*
VWUP	21.9740	50.8548	-82.0000	541.6362	257	-7.6844*
VUP	0.3891	1.1687	-0.4246	9.9690	256	-7.6203*

Notes:

1. GP and VUP are adjusted for inflation.
2. Due to insufficient information, there are two missing values in both GP and VWUP and one missing value in VUP.
3. Note the means for NOIPO, GP and VUP are a proportional function over the sample period.
4. * denotes significance at 5% level.

**Table 2b: Summary Statistics of IPO Activity in the Industrial Sector
Jan 1976 - June 1997**

	Mean	Standard Deviation	Minimum	Maximum	No of Observations	Dickey-Fuller Test Statistic
NOIPO	0.3876	0.5435	0.0000	3.2630	258	-3.5533*
GP	0.3891	1.0326	0.0000	10.3439	257	-5.2653*
VWUP	15.9156	34.9156	-66.0000	277.5484	255	-6.6954*
VUP	0.3906	1.0776	-0.2947	11.0292	256	-6.6364*

Note:

1. GP and VUP are adjusted for inflation.
2. Due to insufficient information, there is one missing value in GP, two in VUP and three in VWUP.
3. Note the means for NOIPO, GP and VUP are a proportional function over the sample period.
4. * denotes significance at 5% level.

**Table 3: Maximum Likelihood Estimates from the Markov Regime Switching Model for Full Sample
Jan 1976 - June 1997**

$$Y_t = a_{01}(1 - S_t) + a_{02}S_t + [\mathbf{s}_1(1 - S_t) + \mathbf{s}_2 S_t] \mathbf{e}_t$$

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

Parameter	NOIPO		GP		VWUP		VUP	
	Estimate	Standard Error	Estimate	Standard Error	Estimate	Standard Error	Estimate	Standard Error
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$1-q$	0.0724*	0.0316	0.2840*	0.0547	0.7234*	0.1036	0.3577*	0.0724
$1-p$	0.0490*	0.0208	0.1736*	0.0343	0.2320*	0.0431	0.1245*	0.0221
a_{01}	0.8109*	0.0728	0.9850*	0.1273	64.9301*	12.8491	1.26748	0.0511
a_{02}	0.1374*	0.0177	0.0368*	0.0052	8.0900*	1.1001	0.0239*	0.0020
\mathbf{s}_1	0.6038*	0.0435	1.2153*	0.0876	87.9562*	8.1965	0.8536*	0.0042
\mathbf{s}_2	0.1395*	0.0157	0.0481*	0.0050	12.3097*	1.3266	0.0467*	0.0001

*denotes significance at 5% level.

**Table 4: Chronology of IPO Activity Based on Transition Probabilities from the
Regime-Switching Model for Full Sample
Jan 1976 - June 1997**

Hot Periods	Cold Periods
<u>Number of IPOs (NOIPO)</u>	
	Jan 76 – Jan 84
Feb 84 – Dec 87	Jan 88 – Jun 92
Jul 92 – Feb 95	Mar 95 – Jul 96
Aug 96 – Jun 97	
<u>Gross Proceeds (GP)</u>	
	Jan 76 – May 85
Jun 85 – Nov 87	Dec 87 – Jul 91
Aug 91 – Sep 92	Oct 92 – Jun 93
Jul 93 – Jan 95	Feb 95 – May 96
Jun 96 – Jun 97	
<u>Value-Weighted IPO Underpricing (VWUP)</u>	
	Jan 76 – Oct 80
Nov 80 – May 81	Jun 81 – Jan 87
Feb 87 – Nov 87	Dec 87 – Jun 97
<u>Value of Underpricing (VUP)</u>	
	Jan 76 – Apr 85
May 85 – Nov 87	Dec 87 – Dec 91
Jan 92 – Jul 92	Aug 92 – Jun 93
Jul 93 – Nov 94	Dec 94 – Jul 96
Aug 96 – Jun 97	

**Table 5: Maximum Likelihood Estimates from the Markov Regime Switching Model
for Industrial IPOs
Jan 1976 - June 1997**

$$Y_t = a_{01}(1 - S_t) + a_{02}S_t + [s_1(1 - S_t) + s_2S_t]e_t$$

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

Parameter	NOIPO		GP		VWUP		VUP	
	Estimate	Standard Error	Estimate	Standard Error	Estimate	Standard Error	Estimate	Standard Error
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$1-q$	0.0622*	0.0295	0.6234*	0.0240	0.4596*	0.1399	0.9835*	0.0018
$1-p$	0.0503*	0.0220	0.1640*	0.0113	0.2752*	0.0285	0.2751*	0.0244
a_{01}	0.7992*	0.0639	1.2562*	0.0720	42.5124*	5.6755	1.2916*	0.2606
a_{02}	0.0977*	0.0126	0.0274*	0.0041	1.8805*	0.9835	0.0208*	0.0071
s_1	0.6307*	0.0437	1.3055*	0.0199	41.7006*	9.6312	1.6095*	0.1089
s_2	0.1345*	0.0106	0.0484*	0.0026	4.2267*	1.8468	0.0516*	0.0096

*denotes significance at 5% level.

**Table 6: Chronology of IPO Activity Based on Transition Probabilities from
the Regime-Switching Model for Industrial IPOs
Jan 1976 - June 1997**

Hot Periods	Cold Periods
<u>Number of IPOs (NOIPO)</u>	
	Jan 76 – Jan 84
Feb 84 – Jan 88	Feb 88 – Jul 88
Aug 88 – Apr 89	May 90 – Oct 91
Nov 91 – Jun 97	
<u>Gross Proceeds (GP)</u>	
	Jan 76 – Jan 84
Feb 84 – Aug 84	Sep 84 – May 85
Jun 85 – Oct 87	Nov 87 – Jul 91
Aug 91 – Sep 92	Oct 92 – Jun 93
Jul 93 – Jun 97	
<u>Value-Weighted IPO Underpricing (VWUP)</u>	
Apr 76 – Jan 78	Feb 78 – Aug 79
Sep 79 – Sep 82	Oct 82 – May 83
Jun 83 – Dec 87	Jan 88 – Jun 88
Jul 88 – May 90	Jun 90 – Jul 91
Aug 91 – Jun 97	
<u>Value of Underpricing (VUP)</u>	
	Jan 76 – Oct 83
Nov 83 – Dec 87	Jan 88 – Jul 91
Aug 91 – Nov 94	Dec 94 – May 95
Jun 95 – Jun 97	

Table 7: Regression Results of Lead-lag Relationship between VWUP, NOIPO and GP for Full Sample

Variables	NOIPO		GP	
	Coefficient	Standard Error	Coefficient	Standard Error
Constant	0.2822*	0.0844	0.5203*	0.1402
VWUP Lead 1	-0.0003	0.0004	-0.0008	0.0006
VWUP Lead 2	0.0001	0.0005	-0.0011*	0.0005
VWUP Lead 3	-0.0004	0.0006	-0.0003	0.0006
VWUP Lead 4	-0.0003	0.0006	-0.0009	0.0006
VWUP Lead 5	0.0003	0.0007	-0.0007	0.0008
VWUP Lead 6	0.0003	0.0005	0.0004	0.0009
VWUP	0.0005	0.0004	-0.0002	0.0005
VWUP Lag 1	0.0005	0.0007	0.0010	0.0014
VWUP Lag 2	0.0014*	0.0006	0.0004	0.0006
VWUP Lag 3	0.0008	0.0008	-0.0004	0.0006
VWUP Lag 4	0.0011	0.0007	-0.0006	0.0006
VWUP Lag 5	0.0013*	0.0006	-0.0002	0.0008
VWUP Lag 6	0.0005	0.0006	-0.0012*	0.0006
F-statistic	1.0925		0.3246	
R-square	0.0609		0.0189	

Notes:

1. Standard errors are adjusted for autocorrelation and heteroscedasticity using the Newey-West correction.
2. * denotes significance at 5% level

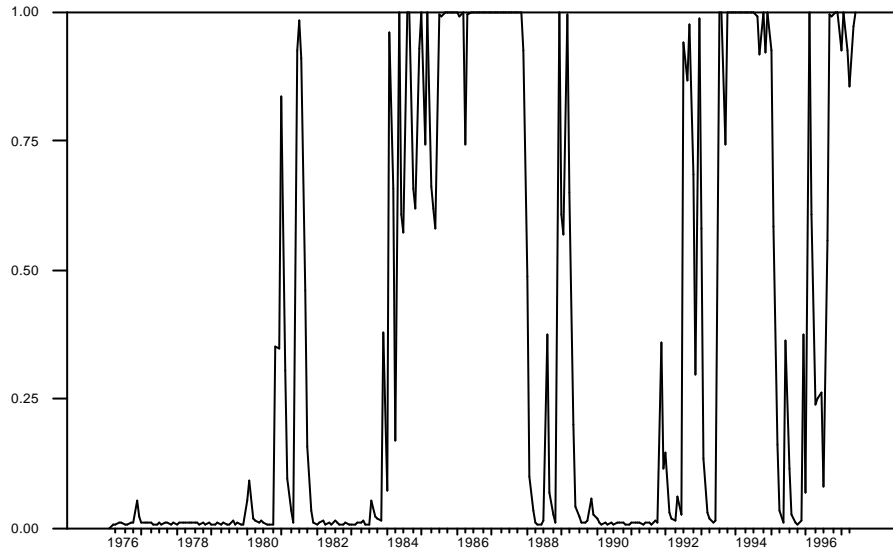
Table 8: Regression Results of Lead-lag Relationship between VWUP, NOIPO and GP for Industrial Sector IPOs

Variables	NOIPO		GP	
	Coefficient	Standard Error	Coefficient	Standard Error
Constant	0.1250	0.0760	0.3645*	0.1426
VWUP Lead 1	-0.0001	0.0007	-0.0018*	0.0009
VWUP Lead 2	0.0007	0.0009	-0.0020	0.0011
VWUP Lead 3	0.0005	0.0008	-0.0002	0.0012
VWUP Lead 4	0.0002	0.0011	-0.0021	0.0011
VWUP Lead 5	0.0009	0.0010	0.0008	0.0019
VWUP Lead 6	-0.0009	0.0009	0.0025	0.0022
VWUP	0.0019*	0.0008	-0.0001	0.0007
VWUP Lag 1	0.0004	0.0007	0.0004	0.0012
VWUP Lag 2	0.0020**	0.0011	0.0019	0.0014
VWUP Lag 3	0.0023*	0.0009	-0.0008	0.0010
VWUP Lag 4	0.0027*	0.0013	-0.0001	0.0012
VWUP Lag 5	0.0043*	0.0016	0.0007	0.0013
VWUP Lag 6	0.0032*	0.0016	-0.0013	0.0011
F-statistics	3.3220*		0.6020	
R-square	0.1754		0.0371	

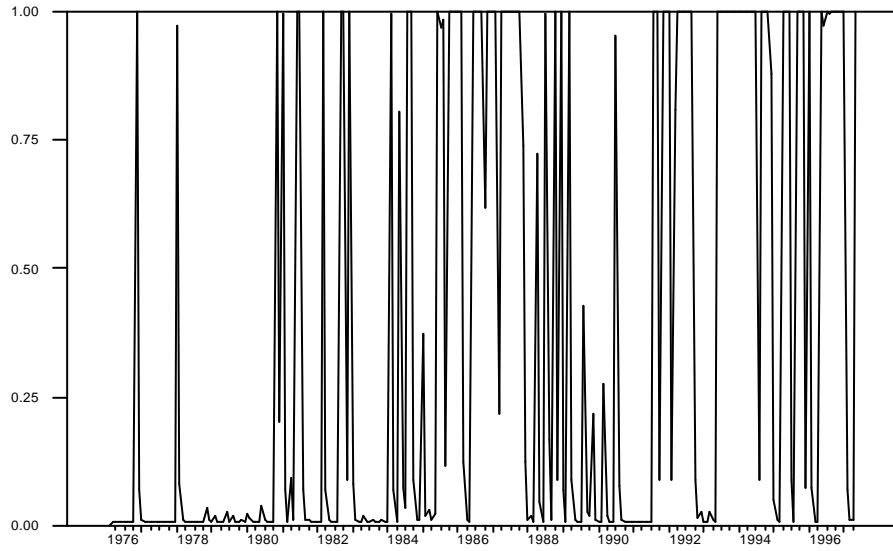
Notes:

3. Standard errors are adjusted for autocorrelation and heteroscedasticity using the Newey-West correction.
4. * denotes significance at 5% level, ** denotes significance at 10% level.

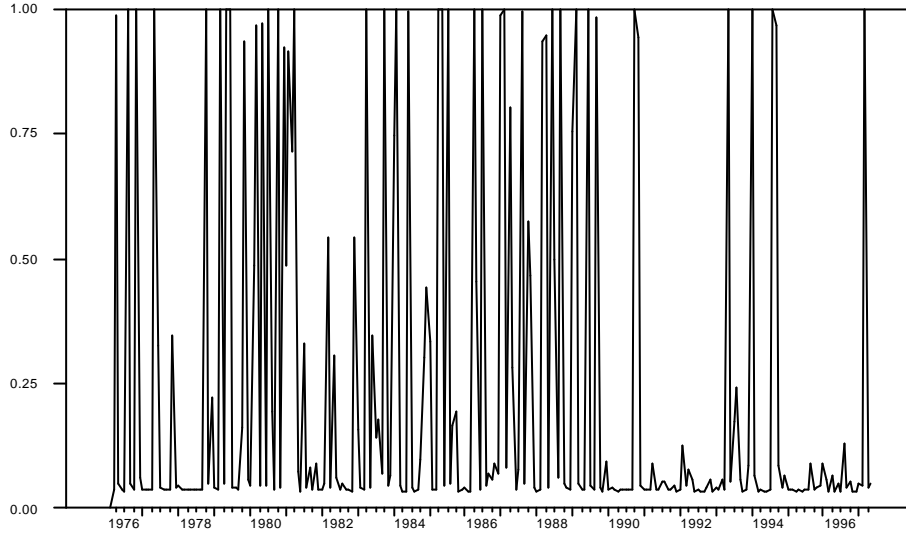
**Figure 1a: Regime Probability of Being in Hot Periods using NOIPO
Full Sample Jan 1976 - June 1997**



**Figure 1b: Regime Probability of Being in Hot Periods using GP
Full Sample Jan 1976 - June 1997**



**Figure 1c: Regime Probability of Being in Hot Periods using VWUP
Full Sample Jan 1976 - June 1997**



**Figure 1d: Regime Probability of Being in Hot Periods using VUP
Full Sample Jan 1976 - June 1997**

