Takeover Waves and Influences of Financial and Economic Factors: A Re-examination using Markov Switching Model

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Abstract

We investigate the extent to which financial and macro-economic factors are able to predict takeover activity after controlling for the probability of takeover waves. In Australia, movements in the stock market do not appear to play a significant role in explaining the concentration of takeover activity, but interest rate does. A low interest rate environment is associated with higher aggregate takeover activity. Our findings are consistent with Shleifer and Vishny (1992)'s liquidity argument that can account for the clustering of takeover activity. We also extend our analysis to the biggest takeover market in the world, the US, and find that the US takeover market shows remarkably similar patterns.

Keywords: Merger waves, State-space model, Markov switching model, Macro-economic factors, Liquidity.

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1 Introduction

While takeovers are one of the most economically significant events in the corporate landscape market, many features remain perplexing. For instance, Brealey et al. (2000) include the timing of merger activity and its occurrence in waves in their list of ten major unsolved questions in finance. Although there is a substantial literature that focuses on the reasons why mergers take place, the majority of empirical studies investigate takeover motives at the micro or individual firm level.[2] There are few publications on the factors that explain the fluctuations in aggregate merger activity.[3] This study focuses on the investigation of financial and economic factors generating clusters of aggregate takeover activity in periods identified as belonging to wave and non-wave states.

Takeover waves are widely recognised in the literature[4] but empirical research on takeover motives has almost exclusively used single-state models without accounting for their existence. In this paper, we propose a model which incorporates the two distinct states[5] (wave and non-wave) of takeover activity identified in Duong et al. (2007). We also test the liquidity hypothesis, advanced by Shleifer and Vishny (1992), in explaining takeover activity that states that takeover waves will occur in periods of high liquidity in the debt market, corresponding with a low interest rate environment.

We start our analysis by examining the number of takeover bids to targets listed on the Australian Stock Exchange (ASX) over the period 1980-2004. We find that movements in the stock market do not play a significant role in explaining the concentration of takeover activity, but interest rate does. The level of interest rate is the only variable significantly associated with variations in the rate of takeover activity. Our findings are robust to both

[2] Literature has mostly focused on the effects on stockholder wealth and what types of firms are most likely to engage in merger activity (e.g. Andrade et al. (2001), Rau and Vermaelen (1998), Schwert (2000)).

[3] The exceptions are Nelson (1959), Melicher et al. (1983), Polonchek and Sushka (1987), Golbe and White (1988) for US market, and Easton (1994), Kendig (1997), Finn and Hodgson (2005) for Australian market. A summary of these studies will be in the *Literature Review* section.

[4] See Duong et al. (2007).

[5] Duong et al. (2007), in a study of Australian mergers and acquisitions (M&As), show that takeover activity can be characterised in two distinct states (wave and non-wave (normal)). Further details can be found in the *Methodology* section and the Appendix.

long-term and short-term interest rate measures.[6] Interest rate is significantly negative in both the wave and the non-wave states with a higher coefficient observed in the wave state. We further show that the level of interest rate is an important and relevant variable as residuals (from the regression) are not persistent when the interest rate variable is included in the model. Our analysis suggests also that our two-state model is significantly better than the single-state regression in which we ignore the existence of waves.

Our results are robust to changing our measure of takeover activity from the number of takeover bids to the proportion of bids relative to ASX-listed companies. Our findings are consistent with the argument advanced by Shleifer and Vishny (1992) that liquidity can account for the clustering of takeover activity. Historical aggregate takeover activity appears to move with the state of the debt market: the low level of the interest rate (i.e. high liquidity in the debt market) leads to a concentration of takeover bids. Our results are also consistent with recent developments in the Australian takeover market which has seen an unprecedented increase in M&A activity funded by private equity.[7] According to the Reserve Bank of Australia (RBA), the staggering rate of growth in this investment sector is driven by "unusual circumstances, including a very low cost of debt".[8] The RBA also believes that the current drop in liquidity caused by the prospect of higher interest rates is likely to result in far few takeover deals going ahead.[9]

Decomposition of the time series of aggregate takeover bids by method of payment also provides strong support for the liquidity hypothesis in the Australian market. Tests on the two series of cash-funded and stock-funded bids (normalised by the number of companies listed on the ASX) reveal that the interest rate variable is significantly negative in the wave state of the time series of cash deals, while no significance is discovered for the

[6] 10-year Treasury Bond is proxied for the long-term interest rate, 90-day bank bill is for the short-term interest rate.

[7] For examples, foreign private equity firms aimed massive takeover bids at some big Australian companies like Qantas and Coles in 2007.

[8] A Senate Committee was inquiry into private equity investment in Australia, in the wake of the failed $11 billion private equity bid for Qantas. Citation is from Mr. Battellino's (RBA deputy governor) speech when he gave evidence to the Senate inquiry on 25th July 2007 in Sydney.

[9] E. Alberici, "Private Equity Value Plummeting, Inquiry Hears", 25th July 2007, ABC news, http://www.abc.net.au/news/stories/2007/07/25/1988452.

series of stock deals.

We extend our analysis to the biggest takeover market in the world, the United States (US) market. The Australian and US takeover environments have some similarities and differences[10] which make it interesting to see if the liquidity explanation observed in Australia also applies in the US.[11] One example of the differences is found in the method of payment of the takeover offers. In an examination of the stock market misvaluation hypothesis in Australia, da Silva Rosa et al. (2006) document that a large majority of takeover bids in Australia since 1971 are cash-based bids. This is in contrast to the US market where 70% of all takeover deals in the 1990s included stocks as part of the consideration offered, with 58% entirely stock-financed (Andrade et al. (2001)).

The US time series is examined for the period of 1982-2004,[12] using the two-state regressions for the number of takeover bids and its proportion to the number of listed companies. The comparison between cash deals and stock deals is not undertaken since there is no wave recognised for the time series of stock bids.[13] With these caveats in mind, we find that the Australian results hold up remarkably well in the US market: the coefficient for the interest rate variable is negative and statistically significant in the wave state. The industrial production variable is statistically significant at 10% level, but only the interest variable is significant at 5% level (in the case of the number of bids) or 1% level (in the case of its proportion to the number of listed companies).

[10]As outlined in da Silva Rosa et al. (2006)'s study, similarities between the two countries include a shareholders' interest oriented corporate culture, a common law framework and an active market for corporate control characterised by temporal surges in M&A activity. They also point out methods for accounting for an acquisition (purchase or pooling), and M&A provisions of the *Corporation Act* and the *William Act* on their list of key differences in M&A regulatory regimes of the two countries.

[11]Shleifer and Vishny (1992) argued that asset liquidity helps account for the evidence of the 1980s takeover wave in the US. However, their theory has not been empirically tested. Our work will extend the period of examination to 2004 to cover for the recent merger waves.

[12]Missing variables in the US analysis are returns to the most active industry (in terms of receiving highest number of takeover bids) and the growth rate of private capital expenditure. However, these two variables are not proved to be statistically significant in the case of Australian market.

[13]The time series of stock bids (as a proportion to the number of US listed companies) only shows two spikes in 1998 and 2001 with the probabilities of 0.32 and 0.2 respectively. According to Duong et al. (2007), a wave is only recognised when the wave state probability is 0.5 or above.

The remainder of this paper is structured as follows: section 2 reviews the literature, and section 3 outlines the methodology of our model. Section 4 describes the data with empirical findings for the Australian market and the US market in section 5 and section 6. Finally, conclusions are in section 7.

2 Literature Review

A number of earlier studies (for example Nelson (1959), Melicher et al. (1983)) have linked the level of merger activity to specific variables that reflect economic activity and financial conditions. While it is generally accepted in the US literature that stock prices are positively related to takeover activity, there is less consensus on the effects of interest rates and industrial production on such activity. Nelson (1959) studies the U.S takeover market over the period 1895 to 1956 and finds that industrial production and stock prices are positively related to the level of takeover activity, though a negative relationship is found in some sub-periods. Weston (1961) finds that only stock prices are significantly related to U.S merger activity, but not industrial production. Steiner (1975) concludes that the number of M&As is positively associated with changes in stock prices and GNP level, suggesting that economic conditions are responsible for increases in M&A activity. His results are similar when the dollar value of acquiring assets is used as the dependent variable. Both Beckentein (1979) and Benzing (1991) report that stock prices and interest rates are positively related to merger activity, while the opposite result for interest rates is observed in Melicher et al. (1983). In the latter study, they examine the relationship between the acquisition level and changes in the expected level of economic growth and capital market conditions for the period of 1947-1977. They find that increases in stock market prices together with decreases in interest rates are followed by increases in takeover activity.

Adopting a slightly different approach, Polonchek and Sushka (1987) view M&As as capital budgeting decisions but still use information about economic conditions in their regression model. Analysing mergers of mining and manufacturing firms with assets over $10 millions during the period of 1956-1978, they find that factors representing the strength of the economy such as the unemployment rate and potential business output, are important in explaining merger activity. Golbe and White (1988) examine the link between the number of US takeovers over the period 1948-1979 and the economic situations in the preceding periods. Their results suggest that GNP is positively related to acquisition activity while real interest rates are negatively linked to takeovers.

The finding of a significantly positive relationship between stock market performance and takeover activity is also present in some Australian empirical studies. Bishop et al. (1987) and the Bureau of Industry Economics (1990) document a positive relationship between share market index and takeover activity. A similar conclusion is reached by Easton (1994) in his study of the relationship between share market performance and Australian takeover activity over the period 1946-1986. In addition, Kendig (1997) claims that takeover waves are caused by general over-reactions during periods of economic prosperity when she examines the number of takeovers from 1955 to 1995.

Recent theoretical models have also been developed to demonstrate how stock market mis-valuations can drive M&A activity. Shleifer and Vishny (2003) offer a speculative takeover model in which the share market is inefficient and routinely overprices stocks. Managers are assumed to be completely rational, and actively attempt to exploit what they perceive to be temporary valuation inefficiencies in the market by using their over-valued stocks to purchase relatively undervalued assets. Target managers accept over-valued bidder stocks because they have "short-time horizons" and they are willing to cash out their shares to generate private gains. Based on similar ideas of the relative mis-valuations of the merging firms and the market's mis-perception of synergies from the combination, Rhodes-Kropf and Viswanathan (2004) propose another explanation to account for the positive correlation between stock market performance and merger waves. Their model is different from Shleifer and Vishny (2003) in that target managers rationally accept over-valued bidders' equity not due to shorter time horizons but due to an error in valuing potential takeover synergies. Both models explain that aggregate merger wave is a result of over-valuation and dispersion of valuation of firms. Various empirical studies provide evidence consistent with the behavioural explanation of takeover activity (e.g. Rhodes-Kropf et al. (2005), Dong et al. (2006), Ang and Cheng (2006)).

However, Finn and Hodgson (2005) challenge this common belief of the stock market driving the level of takeover activity when investigating takeover announcements for ASX-listed target firms over the period 1972 to 1996. By using time-series techniques, they conclude that takeover and stock prices share a common trend, Australian aggregate merger activity is driven by fundamental economic factors rather than by speculative share market activity or managerial optimism. They find that economic shock, proxied by the growth in industrial production over the last four previous quarters, is the main factor to explain Australian M&A activity.

Building on studies on capital liquidity, we suggest a role of capital liquidity in explaining the clusters of the aggregate takeover activity. Shleifer and Vishny (1992), in a work on asset liquidity and debt capacity, posit that in order for the selling transactions to occur, buyers must be relatively unconstrained because if they are financially constrained, they cannot pay the fundamental values and sellers would delay the sales until the market becomes more liquid. As a result, they claim takeover waves will occur in periods with high corporate cash flows and less financial constraints in the market; enhanced liquidity makes debt financing more attractive for firms to finance their acquisitions. The underlying feature in their argument is that "the ability to borrow increases liquidity, which in turn raises the ability to borrow" and "not only does liquidity create debt capacity, but debt capacity creates liquidity". It is often observed that borrowing capacity is more accessible in a low interest rate environment. Therefore, in our study we refer to periods of low interest rates as periods of high capital liquidity and vice versa.

The topic of capital liquidity has been further expanded in the corporate restructuring literature. For instance, Schlingemann et al. (2002) make a similar argument in their study of divestitures and asset liquidity, showing that firms are more likely to sell corporate assets in the most liquid market. Harford (2005) illustrates that sufficient capital liquidity must be present to accommodate the asset reallocation, and an aggregate merger wave can be explained by a macro-level expansion in liquidity. In a recent study of unlisted targets, Officer (2007) finds strong support for the contention of the relationship between acquisition discounts and aggregate debt market liquidity; acquisition discounts for unlisted targets are significantly higher when debt capital is difficult or relatively more expensive to obtain. Officer (2007) states "Selling part, or the whole of an unlisted firm is a last-resort source of liquidity for owners that need sources of cash when borrowing additional funds is unappealing". The results from his paper implicitly imply that firms should not sell their unlisted assets, as a part (divestiture) or the whole (M&A), when the aggregate debt market liquidity condition is tighter since the sale price will be discounted more heavily.

Past papers (reviewed above) only use single-state models to study the relationship between the aggregate takeovers and economic variables. Our paper will address this issue by using a two-state method which is documented in the next section. Following the literature, we incorporate in our analysis variables that present macro-economic indicators, long-term interest rates and stock market returns. Macro-economic indicators included in our model are the growth rates of industrial production and of private capital expenditure.[14] The level of long-term interest rate (10-year Treasury Bond) and short-term interest (90-day bank bill) are chosen as proxies for the availability of liquidity in the debt market since the cost of obtaining liquidity via a bond issue or a bank loan should increase if the level of interest rate rises. In addition to aggregate stock market return,[15] we add one new variable to capture industry return in the Australian market.[16] We choose to include only the most active industry (in terms of incorporating the highest number of takeover bids) to proxy for the industry return as M&As tend to cluster around particular industries (Mitchell and Mulherin (1996), Harford (2005)). We classify all targets in our

[14]We are unable to obtain the growth rate of private capital expenditure variable in the US analysis.

[15]Calculated as the aggregate stock market return in excess of 90-day bank bill rate.

[16]For Australia, this variable is calculated as the [most active] industry stock market return in excess of 90-day bank bill rate. We are unable to obtain the most active industry returns in the US analysis.

sample according to Standards & Poors Global Industry Classification Standard (GICS)[17] and find that the most active industry is Metals & Mining (1,069 bids out of 4,570 total bids in our sample). Including both the aggregate and industry share market performance allow us to measure the additional impact for the industry other and above the aggregate market.

3 Methodology

The objective of this paper is to derive a model to explain which factors drive future merger movements, we thus restrict our attention to modeling the relationship between takeover and independent variables in previous quarters. We estimate the following specification (two-state Markov switching regression model) for each Australia and US market:

$$y_t = \alpha_{S_t} + \mathbf{A_{n,S_t}} \mathbf{Z_{t-1}} + e_t \tag{1}$$

Depending on each test requirement, y_t can be the number of total takeover bids, or proportion of total takeover bids (or cash-funded bids, or shares-based bids) to the number of listed companies. $\mathbf{Z_{t-1}}$ is a vector of n macro-economic and financial market predictors in previous quarter; and $\mathbf{A_{n,S_t}}$ are estimated parameters of these predictors on each state (the wave and non-wave state).

S_t is to describe the non-wave (normal) state ($S_t = 0$) or the wave state (S_t=1) of takeover time-series. For the Australian data, S_t are identified in Duong et al. (2007)'s work of modeling takeover waves by combining a State-Space model with a Gaussian Markov switching regime model. A definition of waves is defined by switches in the two unobserved states (wave state and non-wave (normal) state) which are characterised by two distinct

[17] As detailed in the *Data* section, our sample of Australian takeover bids cover for the period of 1980-2004. For the Australian market, the industry classification system was previously based on the ASX scheme which was replaced by Standard & Poors GICS in September 2002. Therefore, we need to reclassify all target companies according to the new GICS standards. For companies had the deals announced in the 1990s and later, we obtained their financial reports via Aspect Financial database and classified them by mapping their business operation to the GICS guide (obtained from the ASX website). For companies whose deals announced in the 1980s, we referred to the business operation section in *Jobson's Year Book of Public Companies* which are available in hard copies in the Department of Accounting and Finance, University of Western Australia.

autoregressive moving-average processes of orders 1 and 1 (ARMA(1,1)) governed by a constant transition probability law. As evidenced in Duong et al. (2007), the State-Space model with a Gaussian Markov switching regime ARMA(1,1) seems to capture the most interesting M&A wave characterisics of the Australian market.[18] However, its use in the US context may not provide intuitive explanation of the market movements as our preliminary investigation leads to a conjecture that the U.S. takeover time series do not favor a complicated model, and are more likely to lead to an over-fitting and unstable problem. As such, when using the Gaussian Markov switching AR(1) model, which is simpler than the ARMA(1,1), the prediction of waves appears more intuitive and the result is more stable. We are then motivated to use this simpler model for the US data. Therefore, for the US data, S_t are detected by using the Gaussian Markov switching model AR(1). Further details about the general methodology of detecting takeover waves by Duong et al. (2007) are provided in Appendix 1.

- We denote P_1 and P_0 are the probability of being in the wave sate and the non-wave (normal) state respectively when modeling the takeover time series.
- $P_0 = 1$ - P_1.
- Merger wave periods are identified when $P_1 \geq 0.5$.

Given information on the probability of being in a wave state (P_1) and a Gaussian assumption, the above equation (1) is reduced to the Least Squares estimates of the following model:

$$y_t = (\alpha_{S_t=1} P_1 + \alpha_{S_t=0} P_0) + (A_{n,S_t=1} P_1 + A_{n,S_t=0} P_0) Z_{t-1} + e_t \quad (2)$$

Each parameter is estimated for the wave state and the non-wave (normal) state separately. Standard errors and t-statistics are calculated for each parameter estimate. In our analysis below, variables which are statistically significant at the level of 10% or better

[18]Duong et al. (2007) actually compared 3 models to see which one give the best fit: Hamilton (1989) Markov switching model AR(1), Kendig (1997) Poisson Markov switching model AR(1), and their proposed State-Space model with a Gaussian Markov switching regime ARMA(1,1). The first model is a special case of a more general ARMA framework.

are presented in bold form.

As the wave state is the period of takeover concentration, we expect that the effects of the macro-economic and financial market variables (if have) in the wave state would be stronger. That is, the coefficient estimates of each parameter would be different across the sates, with higher magnitude for the wave state than for the non-wave (normal) state.

4 Data

Takeover data for the Australian market are collected over the period from 1980 to 2004,[19] giving a total of 100 quarterly observations. We incorporate all takeover announcements for Australian listed targets from several different sources but with same inclusion criteria. In order to minimise the number of missing observations from any one source, the sample of takeover offers come from three separate, often overlapping sources.

- **Bishop et al. (1987)'s study**: cover takeover information between January 1980 and June 1985.[20] Their database include all bids to listed target companies reported by the ASX.
- **Australian Financial Review (AFR) newspaper**: Data[21] were manually collected by reviewing AFR newspaper to find takeover offer announcements[22] for listed target companies in the ASX from early June 1985 to June 1995.
- **Thompson Financial's Securities Data Company (SDC) Platinum database**: SDC is a commercial database that includes information on takeover offers for all

[19]In Duong et al. (2007)'s work on takeover waves (which incorporates takeover time-series from 1972 to 2004), merger waves were only detected in the 1980s, 1990s and 2000s. As data for some macro-economic variables are only available for periods in the late 1970s, this paper only examines the influences of macro-economic and financial market variables on takeover waves during the period 1980-2004.

[20]The Centre of Independent Studies granted access to their data file, and Dr. Simmons (Australian Graduate School of Management (AGSM)) kindly provided electronic copy of the database. Their assistance is gratefully acknowledged.

[21]Data were collected for an Australian Research Council (ARC) project of Professor da Silva Rosa (The University of Western Australia).

[22]Announcement date is always taken from the ASX files.

Australian targets. The selection criteria were that each takeover offer had to have been announced between 1st January 1988 and 31st December 2004 and have an ASX-listed company as a target.

Data from each source are combined to form the time series. Any bid appearing in only one data source is added to the final sample. Any bid appearing in multiple sources is compared to ensure agreement on appropriate offer details. The reference date for takeover activity is always taken as the announcement date of the bid. In total 4,570 takeover bids (denoted by TAK) are announced for ASX-listed targets during the period 1980-2004, of which 3,199 bids (account for 70% of total bids) are purely cash-funded (denoted as TAK_c), and 461 bids (account for approximately 10% of total bids) are purely shares-based (denoted as TAK_{sh}).

The number of companies listed on ASX is obtained from combining two sources: Finn and Hodgson (2005) (for the period 1980-1996) and Share Price and Price Relative database (SPPR) (for the period 1997-2004).[23] The number of total bids, cash-funded bids and shares-fund bids are also normalised by the number of ASX listed companies (denoted as $\%TAK$, $\%TAK_c$, and $\%TAK_{sh}$ respectively).

Macro-economic variables are obtained from the Australian Bureau of Statistics (ABS). Data on private new capital expenditure variable (non-dwelling construction and equipment) are taken from ABS Catalogue 5206.0, Table 5. Total industrial production come from ABS Catalogue 5206.0, Table 37. We calculate quarterly growth rates on total industrial production and private new capital expenditure, which are denoted by TIP and CAE respectively.

The annual yields on 10-year Australian treasury bonds and 90-day Australian bank bills, proxy for long-term and short-term interest rates respectively (denoted by INT), are ob-

[23] There is a discrepancy between Finn and Hodgson (2005)'s data (which came from various ASX fact files) and SPPR source over the period 1987-1991, SPPR reports much higher number. After some discussions and checking with ASX source, we decide to use Finn and Hodgson (2005)'s data for earlier period.

tained directly from the Reserve Bank of Australia (RBA) website (Table F1 and F2), and being converted to effective quarterly rates.[24]

The return on ASX All Ordinaries Accumulation Index[25] in excess of the 90-day bank bill rate is a proxy for the aggregate market return (denoted by AOI). The abnormal excess return on the GICS Metals & Mining industry (denoted by IND_M) is derived as the residuals from the regression of this industry excess return[26] on the excess return of All Ordinaries Accumulation Index. This ensures that the Metals & Mining excess return is orthogonal to the All Ordinaries Accumulation excess return and measures the additional impact for the industry other and above the aggregate market.

For the US market, we use M&A data from 1982 to 2004.[27] Data which are similar to Australia are obtained from several sources. The number of takeover bids to listed targets on the US stock exchanges[28] is sourced from SDC database. The number of companies listed on the US Stock Exchanges comes from the Center for Research in Security Prices (CRSP)[29]. Data on industrial production and 3-month US Treasury Bill rate are from Datastream; data on 10-year US Treasury Bond come directly from the Federal Reserve Board website. The return on S&P 500 Accumulation Index in excess of 3-month US Treasury bill rate is a proxy for the aggregate stock market performance. We do not include the returns of the most active industry and private capital expenditure variables as we did for Australia as equivalent variables are not available. However, those two variables are not significant for the test using Australian data, so we omit them in our US sample.

[24]The formula for changing from an annual percentage rate to a quarterly one is:

$$\text{Quarterly Rate} = (1 + \text{Annual Rate})^{1/4} - 1$$

[25]Historical data on the index is supplied by Standard & Poors.

[26]The excess industry return is measured by the GICS Metals & Mining industry return (data is obtained in Share Price and Price Relative (SPPR) database) in excess of the 90-day bank bill rate

[27]We can only obtain data for US takeover bids since 1981. AR(1) Gaussian Markov Switching model requires 1 period for initalisation. Therefore, our period of examining is limited to 1982-2004.

[28]Namely, Nasdaq, New York and American stock exchange.

[29]provided by Wharton Research Data Services (WRDS).

A summary of data collection and data sources are listed in Table 1. Table 2 provides basic summary statistics for the variables used in subsequent analysis. In both tables, data for the Australian market are presented in Panel A and data for the US market are presented in Panel B. As evidenced in Table 2, over our sample period, Australian takeover market is much smaller than the U.S counterpart with the average number of takeover bids for each quarter is approximately five times lower (45.70 bids versus 213.98 bids). Similar figures are observed for cash bids (three times lower) and stock bids (six times lower). However, when these numbers are normalised by the number of exchange-listed companies, Australia account for bigger proportion with 3.74% for total bids, 2.65% for cash bids, and 0.37% for stock bids. The equivalent figures for the U.S market are 2.84%, 1.35% and 0.33% respectively.

On average, the quarterly excess return on ASX All Ordinaries Accumulation Index is lower than that of US S&P 500 Accumulation Index (1.28% per quarater versus 2.27%). In Australia, the excess return on Metal & Mining industry (orthogonal index) has a negative mean of -0.35% per quarter.[30] Australian long-term interest rate is, on average, higher than the US (2.38% per quarter versus 1.79%). Industrial production grows at the faster rate in the U.S than in Australia (0.73% per quarter versus 0.53%). The growth rate of private capital expenditure in Australia is around 0.69% per quarter over our 25-year sample.

While Table 2 shows all of the variables have substantial variation in each of the time periods (the standard deviations are large), it also indicates that some of the variables, especially for long-term interest rate (INT), are highly persistent (in the presence of high autocorrelation coefficients). Because the high autocorrelation coefficients suggest unit roots may be present in the data, and non-stationary variables can introduce econometric complexities, we conduct the augmented Dickey-Fuller (ADF) test for unit roots. The

[30]By definition, this series should have expected mean of zero (since they are regression residuals). We have run the regression (to obatain the orthogonal index) over the period from 1979 to 2004 so that we can have lagged values for our examination period of 1980-2004. The full series from 1979 to 2004 has average excess return of zero. This negative mean reports here is from the truncated series from 1980 to 2004.

test is run for all orders of time polynomial.[31] We omit the tables of results for the sake of brevity,[32] but the upshot from the test is that all data series, except for long-term interest rate (INT) generate test statistics that clearly reject the null at a 99% confidence level. In the other words, all data series are stationary, except for long-term interest rate which is non-stationary and integrated of order one (I(1)).

Unit roots present difficulties because in many econometric settings, including the classical regression framework, the standard asymptotic results may not be valid when the data are non-stationary. In the extreme, regressions involving non-stationary variables can yield spurious results, as Granger and Newbold (1974) demonstrated. Following Granger and Newbold (1974), we interpret a spurious regression as one in which the usual significance tests on the coefficients are not valid. The problem may come from either the numerator or the denominator of the t-ratio: the coefficient or the standard error. Ferson et al. (2003) found the problem is with the biased standard errors.[33] They further demonstrated that if the regression residuals have no persistence, even if a highly autocorrelated regressor is used, the spurious regression phenomenon is not a concern since the standard errors are well-behaved. We will prove that the residuals from our two-state model show no level of persistence in the later part of diagnostic check for the model specification (Section 5.1).

5 Evidence from Australian Market

5.1 Number of takeover bids - quarterly series

We start our analysis by examining the influence of variables in the past quarter (Z_{t-1}) to the number of takeover bids. Figure 1 shows the probability of being in a wave state (P_1) when modeling annual time series of the number of Australian takeover bids. We have used quarterly series in our regression, therefore, it is assumed that the probability

[31] We examine all possible combinations: no deterministic part, for constant term, for constant plus time-trend, and for higher order polynomial.

[32] The full results of the test are available from the authors on request.

[33] While Granger and Newbold (1974) did not study the slopes and standard errors to separate the effects, Ferson et al. (2003) replicated their study, and designed the simulations to examine the source of errors. They confirmed that the slopes are well-behaved, but the standard errors are biased.

of four quarters in a given year remains the same.[34] The results of various two-state regressions that establish the predictive ability of takeover activity are presented in Table 3. In Column (1) to Column (4), we run a two-state regression of takeover activity on the lagged value of each individual variable, namely share market performance (AOI and IND_M), long-term interest rate (INT), growth rate of industrial production (TIP) and of private capital expenditure (CAE). The Metal & Mining (M&M) industry share market performance and private capital expenditure variables are only statistically significant in the wave state while interest rate and industrial production variables are significant in both the wave and non-wave states.

To explore which variable remains statistically significant in multivariate models, we augment the specification in Column (1) by adding macro-economic predictors such as TIP and CAE (Column (5)), and long-term interest rate INT (Column (6)). Interestingly, the M&M industry share market performance variable is no longer significant when the long-term interest is included. Interest rate is the only variable which is negatively significant in both the wave and non-wave states, and with a larger magnitude in the wave state. Our findings are robust even after we control for all macro-economic variables (Column (8))[35] and replace the share market performance variables by the macro-variables (Column (7)). Similar results are still held if we replicate Table 3 by replacing the long-term interest rate (i.e. 10-year Treasury bond) by short-term interest rate (proxy by 90-day bank bill rate).[36]

Further analysis confirms the significance of the interest rate variable when explaining variations in the level of takeover activity. If the interest rate is an important variable in our regression model, we would expect no regression residuals left or higher adjusted R^2 when it is included in the model. The residuals from regressions in Table 3 Column (2), (6), (7) and (8) (which include interest rate variable) are purely a white-noise process,[37]

[34] Duong et al. (2007) has modeled both annual and quarterly time series of number of Australian bids. Waves were not recognised under the quarterly time series data.

[35] Finn and Hodgson (2005) also find that share market is independent to the takeover market. They prove the negative relationship between the past level of interest rate to the current takeover activity, but this relationship is not statistically significant at the conventional level.

[36] Results will be available from authors upon request.

[37] Ljung-Box test and ARCH test are carried to check for serial correlation and conditional homoscedas-

while the residuals in Column (1), (3), (4) and (5) (which do not include interest rate variable) are serially correlated and conditionally heteroscedastic. Furthermore, when the interest rate variable is incorporated in the regression model, the adjusted R^2 is nearly 70% whereas this figure reduces to below 60% when it is left out.

In summary, we have found that takeover activity is higher following a low interest rate environment in the previous quarter. An interesting empirical question is whether interest rate lead the takeover market by more than one quarter. We conducted similar analyses by using different lags for the independent variables: two quarter previous, three quarter previous, and four quarter previous. For brevity, we do not present the results[38] but a crucial upshot from the tests is that the level of interest rate is statistically significant for all regressions up to 4 lags. The significance is observed in both the wave state and the non-wave sate with bigger magnitude in the wave state.

The negative sign on the interest rate coefficient can be explained intuitively. Interest rate reflects inflationary expectations.[39] Higher inflation rate associated with higher interest rate is a negative signal to businesses. Higher inflation is generally associated with an increase in business uncertainty, a loss of confidence and a decrease in profit margins, all of which would dampen expectations and merger activity. In addition, it is widely accepted in the literature that asset liquidity plays an important role in the corporate restructuring process as it allows assets to be priced close to their fundamental values. For example, Shleifer and Vishny (1992) claim that a high volume of takeover transactions will occur in a liquid market with high cash flows and less financial constraints. They also believe that "the ability to borrow increases liquidity" which implies a relationship

ticity.

[38] The results for various combinations of variables at each lag (from two to four) like Table 3 are available from the authors upon request.

[39] The argument of positive relationship between inflation and interest rate has been generally supported by economists. For example, Rory Robertson, an economist at Macquarie Bank has recently mentioned that "There's a pattern here. Over the past 18 months the Reserve Bank has had four disturbing inflationary reports and two comforting inflationary reports. Each of the disturbing inflationary reports was followed by a rate hike, so the pattern has been if there was a disturbing inflationary report at the end of October then you would be right to expect a move in November." Cited in "RBA hints at further rates rise" by S. Long, ABC News, 13th August 2007, http://www.abc.net.au/news/stories/2007/08/13/2004030.htm?section=business.

between the interest rates and capital liquidity since borrowing capacity is more available in the low interest environment. Their argument has been used by Harford (2005) to show that a macro-level expansion in liquidity can explain the cluster of merger waves in the aggregate.[40] We assert that the level of interest rate can be used as a proxy for the availability of liquidity in the debt market since the cost of obtaining liquidity via a bond issue or a bank loan should increase if the level of interest rate increases. A low interest rate environment provides low cost of debt and reduces financial constraints in the market, and subsequently increases the volume of takeover transactions.

For comparative purposes, we also perform a regression analysis without taking into account takeover wave probabilities. Table 4 shows the results of single-state regressions. Compared with Table 3, it is clear that estimates of the single-state model tend to lie between the corresponding estimates for the two-state model. Since the coefficient estimates of our Markov switching model are very different across two states, assuming a constant coefficient model (single-state model) is insufficient. In addition, on average 69% of variation in takeover activity can be explained by the multiple two-state regression equation, while it is only approximately 21% in the case of the single-state regression equation. The higher adjusted R^2 suggests that our two-state regression model explains better the variations of takeover activity.

An examination of the regression residuals of both the single-state and two-state models also draw a further important inference. Ljung-Box test and ARCH test are performed to check for serial correlation and conditional heteroscedasticity in the residuals. It reveals that there is no extra structure left in the residuals in the case of the two-state model, while the single-state model's residuals show some persistence. Therefore, it can be concluded that our two-state regression model fits the data better than the single-state regression model.

[40]Please refer to the literature review section for a comprehensive argument.

5.2 Proportion of takeover bids to number of listed companies - quarterly series

The number of companies listed on the ASX has changed over time. In order to account for the growth of companies, we change the dependent variable from the number of takeover bids to the proportion relative to the number of companies listed on the ASX. The wave state probabilities of this time series is presented in Figure 2, and predictive regressions are shown in Table 5. The results are quite similar: the interest rate coefficient is negative in both the wave and non-wave states, and statistically significant in the wave state. In addition, industrial production and private capital expenditure variables are also significant (at 5% level) in the non-wave state. However, when we increase the confidence level to 99% (i.e. being equivalent to significance level of 1%), interest rate becomes the only significant variable remained. This further confirms the significance of interest rate amongst other variables in explaining takeover activity.

5.3 Proportion of cash/shares-based bids to number of listed companies - quarterly series

Although the tests in the previous sections provide a useful first cut at the question of what drives merger activity, the takeover data employed are so highly aggregated, and do not identify the method of payment in a merger. Faccio and Masulis (2005) argue that cash offers generally require debt financing since most bidders have limited cash and liquid assets. In making an M&A decision, a bidder is consequently faced with a choice between using debt or equity financing. In general, Faccio and Masulis (2005) contend that debt would dominate stock as the funding source for a cash payment given the lower debt flotation costs. Given this view, if the liquidity theory can explain merger activity, firms should have easier access to the credit market to finance acquisitions at times when liquidity is high (i.e. interest rate is low). Accordingly, we would expect to see in the time series a higher negative correlation between cash-funded mergers and the level of interest rate.

For our sample period from 1980-2004, there were 3,199 cash-based takeover bids accounting for 70% of all bids, while there were only 461 stock-based bids equivalent to 10% of all bids. We first normalise each time series by the number of companies listed on the ASX, and then apply ARMA(1,1) State-space Markov Switching approach. Figure 3 and **??** represent the wave state probabilities for the annual data of cash-funded bids and stock-funded bids respectively.

The results for cash deal regressions, reported in Table 6, indicate clearly that a low level of interest rate significantly leads to a higher proportion of cash bids in the wave state. In contrast to the case of total bids, the interest rate coefficient for the cash bids in the non-wave state is positive but very small in magnitude (only 0.04), and statistically insignificant. At the 5% significance level, both industrial production (in the non-wave state) and interest rate (in the wave state) are significant with higher t-statistic for interest rate variable.

Compared with cash deals, the results for stock-funded bids presented in Table 7 are consistent with the liquidity theory's expectation. Interest rate has no impact in the non-wave state, and reports a significant negative relationship (in much smaller magnitude) in the wave state. The interest rate coefficient for stock deals (Table 7) is nearly three times smaller than that of cash deals (Table 6). In terms of the statistical significance level, the interest rate coefficient for cash bids is significant at 5% level while it is 10% level for stock bids. The influence of share market performance to the proportion of stock deals is nearly zero.

The method of payment decomposition, as illustrated in Table 6 and 7, cast takeover activity behaviour in a light that strongly supports the liquidity argument. It indicates the co-movement between takeover bids and the level of interest rate is largely due to the behaviour of the cash deal component of takeover activity. This result is driven by the fact that cash bids in Australia account for approximately 70% of the total bids whereas this proportion is only 10% in case of stock bids.

6 Evidence from the US market

In this section, we extend the empirical analysis documented in section 5 (for the Australian market) to the largest takeover market in the world, the US market. We are unable to control for two predictors (i.e. the most active industry return and the growth rate of private capital expenditure variables) used in the Australian market sample due to lack of data. As explained in the data collection section (Section 4), our analysis for the US market is limited to the period from 1982 to 2004 only. Therefore, our predictive regressions in Table 8 and 9 control for only 3 variables: the aggregate share market return, the level of interest rate, and the growth rate of industrial production. A summary of the US data is presented in Table 2 Panel B.

The Gaussian Markov switching model AR(1) is apply to each of the annual time series (i.e. the number of US bids and its proportion to the number of listed companies). Figures 5 and 6 show the wave state probabilities for the two series respectively. Similar to the Australian analysis, we have used quarterly series in our regressions. It is, thus, assumed that the probability of four quarters in a given year remain the same. The predictive two-state regressions for each of the above-mentioned time series are presented in Table 8 and Table 9 respectively.

The regression results for the number of takeover bids, reported in Table 8, show clearly that interest rate coefficients are negative in both states, but the statistical significance is only observed in the wave state. Industrial production (in the non-wave state) and interest rate (in the wave state) are both significant at 5% level, with higher t-statistic for interest rate variable.

The results for the proportion of takeover bids in Table 9 are similar. The impact of interest rate in the non-wave state is nearly nil, but reports a significantly negative (at 10% level) relationship in the wave state. The industrial production variable again shows its significance in the non-wave state but this disappears when the confidence level of the test is increased to 99% (i.e. equivalent to significance level of 1%). At this confidence level, only the interest rate variable retains its statistical significance.

We are not able to perform a comparison between cash deals and stock deals for the US as no obvious wave is recognised when modeling the time series of the proportion of stock bids.[41] If we conduct the two-state regressions on the proportion of cash bids, no significant variables are found, but the interest rate coefficient is negative in the wave state. When the US aggregate takeover bids are decomposed by method of payment, the liquidity argument is somewhat weakened. Differences in findings for the US and Australia markets could be due to differences in the method of payment in M&As. Stock and cash deals are evenly opened in the US takeovers whereas cash deals are dominant in Australia. In our sample, cash-only deals account for roughly 70% of all bids in Australia, whilst this proportion is almost halved (only 47%) in the US.

Results presented in Table 8 and Table 9 have clearly demonstrated that a low level of interest rate significantly lead to a larger proportion of takeover bids in the wave state. We, therefore, conclude that the basic finding that the level of interest rate can predict the concentration of takeover market extend beyond the Australian market to the US takeover market as well.

7 Conclusions

This paper investigates the extent to which macro-economic and financial factors influence the concentration of takeover activity in Australia and the US. Our innovation is to incorporate the probability of takeover waves into the regression analysis. In Australia, we collect the number of takeover bids for ASX-listed targets over the period of 25 years from 1980 to 2004. By examining both the number of bids and its proportion to the number

[41] We have defined a wave is recognised when the wave state probability is 0.5 or higher. For the time series of the proportion of stock bids, there are only two spikes in 1998 and 2001 with probability of 0.32 and 0.2 respectively.

of ASX-listed companies, we have found that share market performance does not explain the concentration of the takeover market. Instead, interest rates significantly predict subsequent changes in aggregate takeover activity. Our findings indicate that liquidity advanced by Shleifer and Vishny (1992) can reason for the clustering of takeover activity. Historical aggregate takeover activity is intimately tied to the level of the debt market: the low level of the interest rate (i.e. high liquidity in the debt market) ultimately lead to the concentration of takeover bids.

We also extend our analysis to the biggest takeover market in the world, the US market. However, we use data for only 23 years (from 1982 to 2004), and we are unable to obtain the same set of controls (e.g. returns to the most active industry (in terms of receiving highest number of takeover bids), and the growth rate of private capital expenditure). With these caveats in mind, we have found that the US takeover market show remarkably similar patterns.

Appendix 1: Methodology of Detecting Takeover Waves: A State-Space and Markov Switching Approach

The two-state Markov switching-regime model for ARMA(1,1) process can be represented by the following equation:

$$y_t - \mu_{S_t} = \phi(y_{t-1} - \mu_{S_{t-1}}) + e_t + \gamma e_{t-1} \tag{3}$$

where

- y_t is time series of the aggregate number of takeover bids.
- e_t - the error term - is normal, independently and identical distributed with $\mathrm{E}(e_t) = 0$
- ϕ and γ are the AR lag coefficient and the MA lag coefficient respectively.
- S_t is to describe the Markov state at time t and can take a value of 0 (non-wave (normal) state) or 1 (wave state)

$$\begin{cases} \text{If} & S_t = 1: \quad \mu_{S_t} = \mu_1, e_t \sim \mathcal{N}(0, \sigma_1^2) \\ \text{If} & S_t = 0: \quad \mu_{S_t} = \mu_0, e_t \sim \mathcal{N}(0, \sigma_0^2) \\ \text{where} & \mu_1 > \mu_0, \quad \sigma_1 > \sigma_0 \end{cases}$$

- μ_{S_t} refers to mean of the state

Each state is governed by a first-order Markov process with constant transition probabilities, so that the probability of being in any given state is dependent on the state in the previous time period. This, hence, introduces two other parameters, p_{00} and p_{11}, which respectively represent the probability of remaining in a normal state and in a wave state in the next period.

$$\begin{aligned} \text{Prob}[S_t = 1 | S_{t-1} = 1] &= p_{11} \\ \text{Prob}[S_t = 0 | S_{t-1} = 1] &= 1 - p_{11} \\ \text{Prob}[S_t = 0 | S_{t-1} = 0] &= p_{00} \\ \text{Prob}[S_t = 1 | S_{t-1} = 0] &= 1 - p_{00} \end{aligned}$$

These transition probabilities can be put in the following matrix notation:

$$P = \begin{bmatrix} p_{00} & 1 - p_{00} \\ 1 - p_{11} & p_{11} \end{bmatrix} \tag{4}$$

The equation (3) could be expressed in the following State-Space form:

$$\begin{cases} y_t &= \mathbf{H}\boldsymbol{\beta}_t + \mu_{S_t} \\ \boldsymbol{\beta}_t &= \mathbf{F}\boldsymbol{\beta}_{t-1} + \mathbf{v}_t \end{cases} \tag{5}$$

where the subscript S_t denotes Markov state-dependent quantities as follows

$$\mathbf{H} = [1 \quad \gamma]$$

$$\mathbf{F} = \begin{bmatrix} \phi & 0 \\ 1 & 0 \end{bmatrix}$$

$$\mathbf{v}_t = \begin{bmatrix} e_t \\ 0 \end{bmatrix}$$

$$e_t \sim \mathcal{N}(0, \sigma^2_{S_t})$$

This model can be reduced to the Gaussian Markov Switching model AR(1) (like Hamilton (1989)'s model) by setting $\gamma = 0$. Hence, it is clearly more general. Estimation of the model involves computing the maximum likelihood estimates of its coefficients along with the transition probabilities. The algorithm consists of several steps. First, the Kalman filter update is used to obtain the conditional parameters of the State-Space model corresponding to each possible path of state transitions. Then the Hamilton filter is used to update the state values. The final estimates at each time step are obtained via an approximation method to reduce the prohibitive computational cost. In what follows we give a highlight of the algorithms. Our notations mostly follow Kim and Nelson (1999).

Initialisation

The initialisation step specifies the following quantities

- Likelihood

$$l(\boldsymbol{\theta}) = 0$$

- Estimates of the state vector and covariance matrix at $t = 0$

$$\begin{aligned} \boldsymbol{\beta}_{0|0}^{j} &= (\mathbf{I} - \mathbf{F}_j)^{-1}\,\mathbf{0} = \mathbf{0}, \quad j = 0, 1 \\ \mathsf{vec}\left[\mathbf{P}_{0|0}^{j}\right] &= (\mathbf{I} - \mathbf{F}_j \otimes \mathbf{F}_j)^{-1}\,\mathsf{vec}\left[\mathbf{Q}_j\right], \end{aligned}$$

where $\mathsf{vec}\,[.]$ is the operator that converts a matrix into a column vector, $\otimes$ is the Kronecker product, and $\mathbf{Q}_j$ is the covariance matrix of $\mathbf{v}_t$ corresponding to the Markov state $S_t = j,\ j = 0, 1$

$$\mathbf{Q}_j = \begin{bmatrix} \sigma_j^2 & 0 \\ 0 & 0 \end{bmatrix}, \quad j = 0, 1.$$

- Estimates of the Markov state probabilities

$$\begin{aligned} \Pr[S_t = 0] &= \pi_0 = \frac{1 - p_{11}}{2 - p_{00} - p_{11}} \\ \Pr[S_t = 1] &= \pi_1 = \frac{1 - p_{00}}{2 - p_{00} - p_{11}}. \end{aligned}$$

Kalman filter

At time t we need to consider all possible transitions of Markov state $S_{t-1} = i$ to $S_t = j$ where $i, j = 0, 1$. There are four possible transitions $(0,0), (0,1), (1,0), (1,1)$. The Kalman filter update calculates the prediction and estimation of state vector and covariance matrix over every possible transition.

- Prediction of the state vector and covariance matrix over the transition (i, j)

$$\begin{aligned} \boldsymbol{\beta}_{t|t-1}^{(i,j)} &= \mathbf{F}_j \boldsymbol{\beta}_{t-1|t-1}^{i} \\ \mathbf{P}_{t|t-1}^{(i,j)} &= \mathbf{F}_j \mathbf{P}_{t|t-1}^{i} + \mathbf{Q}_j. \end{aligned}$$

Note that $\boldsymbol{\beta}_{t-1|t-1}^{i}$ and $\mathbf{P}_{t|t-1}^{i}$ are the (final) estimates of the state vector and covariance matrix corresponding to the state $S_{t-1} = i$ *only* which are available after the previous step.

The prediction error and its variance are given by

$$\begin{aligned} z_{t|t-1}^{(i,j)} &= y_t - \mathbf{H}_j \boldsymbol{\beta}_{t|t-1}^{(i,j)} \\ R_{t|t-1}^{(i,j)} &= \mathbf{H}_j \mathbf{P}_{t|t-1}^{(i,j)} \mathbf{H}_j^T. \end{aligned}$$

- Estimation of the state vector and covariance matrix over the transition (i, j)

$$\begin{aligned} \boldsymbol{\beta}_{t|t}^{(i,j)} &= \boldsymbol{\beta}_{t|t-1}^{(i,j)} + \mathbf{P}_{t|t-1}^{(i,j)} \mathbf{H}_j^T \left(R_{t|t-1}^{(i,j)} \right)^{-1} z_{t|t-1}^{(i,j)} \\ \mathbf{P}_{t|t}^{(i,j)} &= \left(\mathbf{I} - \mathbf{P}_{t|t-1}^{(i,j)} \mathbf{H}_j^T \left(R_{t|t-1}^{(i,j)} \right)^{-1} \mathbf{H}_j \right) \mathbf{P}_{t|t-1}^{(i,j)} \end{aligned}$$

Hamilton filter

Upon the availability of state vector and covariance estimates, the Hamilton filter is used to obtain the estimates of Markov state probabilities $\Pr[S_t = j \mid \Psi_t], j = 0, 1$ where $\Psi_t = [y_0, \ldots, y_t]$ denotes the information available up to time t.

First, we compute over each possible transition $S_{t-1} = i, S_t = j$:

$$\Pr(S_t, S_{t-1}|\Psi_{t-1}) = \Pr(S_t|S_{t-1}) \Pr(S_{t-1}|\Psi_{t-1}).$$

Note that $\Pr(S_t|S_{t-1}) = p_{ij}$ is from the Markov transition matrix while $\Pr(S_{t-1}|\Psi_{t-1})$ is available from the previous step. The fitness of the observation y_t to the model obtained up to time $t-1$ is given by

$$f(y_t|\Psi_{t-1}) = \sum_{S_t} \sum_{S_{t-1}} f(y_t|S_t, S_{t-1}, \Psi_{t-1}) \Pr(S_t, S_{t-1}|\Psi_{t-1}),$$

where $f(y_t|S_t, S_{t-1}, \Psi_{t-1})$ is completely specified given the Markov model (3):

$$f(y_t|S_t, S_{t-1}, \Psi_{t-1}) = \frac{1}{\sqrt{2\pi \, |R_{t|t-1}^{(i,j)}|}} \exp \left\{ -\frac{1}{2} \frac{\left(z_{t|t-1}^{i,j} \right)^2}{R_{t|t-1}^{(i,j)}} \right\}.$$

Next, the probability of the transition given the new observation is

$$\Pr[S_t, S_{t-1}|\Psi_t] = \frac{f(y_t|S_t, S_{t-1}, \Psi_{t-1}) \Pr(S_t, S_{t-1}|\Psi_{t-1})}{f(y_t|\Psi_{t-1})},$$

from which one can derive

$$\Pr[S_t|\Psi_t] = \sum_{S_{t-1}} \Pr[S_t, S_{t-1}|\Psi_t].$$

It is also noted that the log-likelihood function is updated via

$$l(\boldsymbol{\theta}) \to l(\boldsymbol{\theta}) + \ln(f(y_t|\Psi_{t-1})).$$

Approximation

In the Kalman filter part, we have only obtained the estimation of the state vector and covariance matrix of every possible transition path. To make the algorithm work recursively, we need to obtain the estimate of the state vector and covariance matrix for the state S_t *only*. Exact inference method would require prohibitive computational cost when the number of observations become large. To overcome this problem, Kim and Nelson (1999) suggest the following approximation

$$\begin{aligned} \boldsymbol{\beta}^j_{t|t} &= \frac{\sum_{i=0}^1 \Pr[S_{t-1}=i, S_t=j|\Psi_t]\boldsymbol{\beta}^{(i,j)}_{t|t}}{\Pr[S_t=j|\Psi_t]} \\ \mathbf{P}^j_{t|t} &= \frac{\sum_{i=0}^1 \Pr[S_{t-1}=i, S_t=j|\Psi_t]\left(\mathbf{P}^{(i,j)}_{t|t} + (\boldsymbol{\beta}^j_{t|t} - \boldsymbol{\beta}^{(i,j)}_{t|t})(\boldsymbol{\beta}^j_{t|t} - \boldsymbol{\beta}^{(i,j)}_{t|t})^T\right)}{\Pr[S_t=j|\Psi_t]]}. \end{aligned}$$

Related Issues

The above three steps complete the algorithm. For every observation y_t, one needs to run the Kalman filter, the Hamilton filter, and the approximation procedure. This recursive update is repeated until the last observation y_N. In theory, one can run another backward procedure, which is called smoothing which is hoped to further improve the estimates at each time index taking into account the whole information Ψ_T rather than only the information Ψ_t available up to time t. However, we notice that for the State-Space model, this would require a number of approximations for which the accuracy appears rather poor and no gain seems to be attained. Hence, we do not consider smoothing.

Now, for each set of parameters $\boldsymbol{\theta} = [p_{00}, p_{11}, \mu_0, \sigma_0, \mu_1, \sigma_1, \phi, \gamma]$ we can obtain the log-likelihood over the observed data Ψ_T. The maximum likelihood estimate of $\boldsymbol{\theta}$ is therefore the value of $\hat{\boldsymbol{\theta}}$ that solve the following problem

$$\hat{\boldsymbol{\theta}} = \arg\max_{\boldsymbol{\theta}} \; l(\boldsymbol{\theta}).$$

Note that the above problem is not an unconstrained optimisation problem as the parameters of $\boldsymbol{\theta}$ must satisfy

$$0 < p_{00}, p_{11} < 1 \tag{6}$$

$$0 < \mu_0 < \mu_1 \tag{7}$$

$$0 < \sigma_0 < \sigma_1. \tag{8}$$

To solve this problem, we first obtain an initial estimate from a coarse grid search. Then we use the function `fmincon` in Matlab to find the final estimate that satisfies the above constraints.

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Table 1: **Source of data**

Variables	**Measures**	**Source**	**Symbol**
Panel A: Australian Data			
Number of takeover bids	A total number of takeover bids announced to target companies listed on the ASX	Combination from 3 sources: • Centre of Independent Studies: Bishop et al. (1987)'s study • Australian Financial Review newspaper • Thompson Financial's Securities Data Company (SDC) Platinum database	TAK
Aggregate stock market performance	The return on ASX All Ordinaries Accumulation Index in excess of the 90-day bank bill rate	From 2 sources • Standard & Poors • The Reserve Bank of Australia (RBA)	AOI
Metals & Mining industry stock performance	The excess return on GICS Metals & Mining industry, measured as the residuals from the regression of this industry excess return (the GICS Metals & Mining industry return in excess of 90-day bank bill rate) on the excess return of All Ordinaries Accumulation Index	From 2 sources: • Standard & Poors • Share Price & Price Relative (SPPR) database	IND_M
Long-term interest rate	The yield on 10-year Treasury Bond	RBA table "Interest Rates and Yields: Money Market and Commonwealth Government Securities"	INT
Macroeconomic variable	Growth rate of industrial production	ABS Catalogue 5206.0, Table 37 Indexes of Industrial Production.	TIP
Macroeconomic variable	Growth rate of private new capital expenditure (non-dwelling construction plus machinery and equipment)	ABS Catalogue 5206.0, Table 5 Expenditure on Gross Domestic Product (GDP), Australia: Implicit price deflator	CAE
Panel B: US Data			
Number of takeover bids	A total number of takeover bids announced to target companies listed on the US stock exchanges (namely, Nasdaq, New York and American stock exchange)	Thompson Financial's Securities Data Company (SDC) Platinum database	TAK
Aggregate stock market performance	The return on S&P 500 Accumulation Index in excess of 3-month US Treasury bill rate	From 2 sources: • Standard & Poors • Datastream	S&P500
Long-term interest rate	The yield on 10-year Government Bond (Treasury Constant Maturities Nominal 10 years (TCM))	The Federal Reserve Board website	INT
Macroeconomic variable	Growth rate of industrial production	Datastream.	TIP

Table 2: **Summary statistics**.

The table presents summary statistics of the variables used in the econometric analysis. Panel A contains data about Australian market. All variables are expressed in quarterly series 1980-2004. TAK is total number of takeover bids of ASX-listed target companies; TAK_c and TAK_{sh} are the number of cash-based bids and share-based bids. Those three numbers are normalised by the number of listed companies on ASX, denoted by $\%TAK$, $\%TAK_c$ and TAK_{sh}. AOI is the excess return on ASX All Ordinaries Accumulation Index, proxy for the aggregate stock market return. IND_M is the excess return on Metals & Mining industry, measured as the residuals from the regression of the excess industry return (GICS Metals & Mining Industry) on the excess market return (ASX All Ordinaries Accumulation Index). INT is the yield on 10-year Treasury Bonds, a proxy for long-term interest rate. TIP and CAE represent the growth rate of total industrial production and private new capital expenditure. Panel B contains similar data of US market; S&P500 is returns on S&P500 Accumulation Index in excess of 3-month US Treasury Bill rate; quarterly sample period from 1982-2004. All data (except TAK, TAK_c and TAK_{sh}) are in quarterly percentage points.

Variables	Quarters	Mean	Median	Standard Deviation	Max	Min	Autocorrelation Lag 1	Lag 2	Lag 3	Lag 4
Panel A: Australian Data (1980-2004)										
TAK	100	45.70	43	21.99	137	9	0.93	0.89	0.86	0.84
TAK_c	100	31.99	27.5	16.34	100	7	0.92	0.88	0.82	0.79
TAK_{sh}	100	4.61	4	3.19	15	0	0.85	0.83	0.84	0.81
$\%TAK$	100	3.74	3.49	1.47	9.71	0.91	0.93	0.9	0.86	0.85
$\%TAK_c$	100	2.65	2.55	1.16	7.09	0.71	0.92	0.88	0.83	0.8
$\%TAK_{sh}$	100	0.37	0.33	0.24	1.04	0	0.83	0.82	0.83	0.8
AOI	100	1.28	1.39	9.21	25.21	-43.41	-0.05	0.09	0.03	-0.11
IND_M	100	-0.35	-0.14	7.23	26.75	-21.06	-0.15	-0.11	0.13	-0.12
INT	100	2.38	2.38	0.81	3.87	1.23	0.99	0.98	0.97	0.96
TIP	100	0.53	0.48	1.6	4.35	-5.38	0.14	0.11	0.09	0
CAE	100	0.69	0.57	1.29	3.57	-1.62	0.7	0.63	0.57	0.45
Panel B: US Data (1982-2004)										
TAK	92	213.98	205	94.29	441	46	0.99	0.98	0.97	0.96
TAK_c	92	101.23	95	52.89	233	19	0.98	0.97	0.95	0.94
TAK_{sh}	92	26.07	18	20.03	78	3	0.96	0.95	0.94	0.92
$\%TAK$	92	2.84	2.91	1.06	5.39	0.83	0.99	0.98	0.97	0.96
$\%TAK_c$	92	1.35	1.28	0.64	3.01	0.34	0.98	0.97	0.95	0.94
$\%TAK_{sh}$	92	0.33	0.26	0.22	0.9	0.05	0.96	0.95	0.94	0.92
S&P500	92	2.27	3.42	8.13	20.22	-23.93	0.07	0.08	0.03	0.08
INT	92	1.79	1.71	0.59	3.4	0.82	0.98	0.96	0.94	0.92
TIP	92	0.73	0.94	1.99	5.22	-5.3	0.17	-0.11	0.05	0.59

Table 3: **Predictive regressions of Australian takeover bids (number) on explanatory variables lagged by one quarter - Two-state model**.

Regressions take the form: $TAK_t = (\alpha_{S_t=1}P_1 + \alpha_{S_t=0}P_0) + (A_{n,S_t=1}P_1 + A_{n,S_t=0}P_0)Z_{t-1} + e_t$. The table presents the results from forecasting takeover activity in quarter t using all macro-economic and financial market variables lagged by one quarter. TAK is total number of takeover bids of ASX-listed target companies. P_1 and P_0 are probability of being in a wave state and in a non-wave state when modeling TAK annual time series by ARMA(1,1) State-space Markov Switching model. Z_{t-1} contains the independent variables in previous quarter (AOI is excess returns of All Ordinaries Accumulation Index; IND_M is excess returns on Metals & Mining industry (orthogonal index); INT is 10-year Government Bond rate; TIP and CAE represent the growth rate of total industrial production and private new capital expenditure). The sample period is quarterly 1980-2004. Standard errors appear in parentheses below the parameter estimates. Bold figures indicate that the coefficients are significant at 10% or better, with superscript ^{a}, ^{b}, or ^{c} indicate significance level of 1%, 5%, or 10%.

Dependent variable: Number of Australian takeover bids at time t

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept, Non-wave	**28.28**^{a}	**41.6**^{a}	**26.8**^{a}	**30.56**^{a}	**29.71**^{a}	**41.93**^{a}	**39.72**^{a}	**40.82**^{a}
	(2.27)	**(5.39)**	**(2.33)**	**(2.72)**	**(2.65)**	**(5.39)**	**(5.77)**	**(5.81)**
Intercept, Wave	**79.08**^{a}	**133.72**^{a}	**82.65**^{a}	**81.12**^{a}	**83.03**^{a}	**131.71**^{a}	**138.04**^{a}	**131.65**^{a}
	(3.61)	**(9.52)**	**(3.88)**	**(3.71)**	**(3.76)**	**(9.62)**	**(10.73)**	**(11.77)**
AOI_{t-1}, Non-wave	-0.21				-0.22	-0.17		-0.22
	(0.26)				(0.24)	(0.21)		(0.21)
AOI_{t-1}, Wave	0.53				0.57	0.22		0.21
	(0.35)				(0.37)	(0.28)		(0.33)
$IND_{M_{t-1}}$, Non-wave	0.17				0.03	0.03		0.07
	(0.3)				(0.28)	(0.24)		(0.24)
$IND_{M_{t-1}}$, Wave	**0.83**^{c}				**1.53**^{a}	0.58		0.59
	(0.49)				**(0.48)**	(0.39)		(0.46)
INT_{t-1}, Non-wave		**-5.41**^{a}				**-5.42**^{b}	**-4.63**^{c}	**-5.21**^{b}
		(2.08)				**(2.08)**	**(2.58)**	**(2.60)**
INT_{t-1}, Wave		**-23.53**^{a}				**-22.89**^{a}	**-25.97**^{a}	**-22.79**^{a}
		(3.93)				**(3.95)**	**(4.88)**	**(5.38)**
TIP_{t-1}, Non-wave			**2.15**^{c}		2.00		1.12	1.51
			(1.27)		(1.23)		(1.02)	(1.06)
TIP_{t-1}, Wave			**-4.45**^{b}		-4.33		0.58	-0.38
			(2.46)		(2.94)		(2.15)	(2.66)
CAE_{t-1}, Non-wave				-2.13	-1.50		-0.65	-0.04
				(1.64)	(1.59)		(1.68)	(1.71)
CAE_{t-1}, Wave				**-7.16**^{b}	**-10.22**^{b}		2.71	0.07
				(3.81)	**(4.03)**		(3.70)	(4.29)
Adjusted R^2	0.53	0.70	0.54	0.56	0.59	0.70	0.70	0.69
No. of observations	100	100	100	100	100	100	100	100
Regression residuals								
- Serial correlation	Yes	No	Yes	Yes	Yes	No	No	No
- Heteroscedasticity	Yes	No	Yes	Yes	Yes	No	No	No

Table 4: **Predictive regressions of Australian takeover bids (number) on explanatory variables lagged by 1 quarter - Single-state model**.

Regressions take the form: $TAK_t = \alpha + A_n.Z_{t-i} + e_t$. The table presents the results from forecasting takeover activity in quarter t using all macro-economic and financial market variables lagged by one quarter. TAK is total number of takeover bids of ASX-listed target companies. Z_{t-1} contains the independent variables in previous quarter (AOI is excess returns of All Ordinaries Accumulation Index; IND_M is excess returns on Metals & Mining industry (orthogonal index); INT is 10-year Government Bond rate; TIP and CAE represent the growth rate of total industrial production and private new capital expenditure). The sample period is quarterly 1980-2004. Standard errors appear in parentheses below the parameter estimates. Bold figures indicate that the coefficients are significant at 10% or better, with superscript ^{a}, ^{b}, or ^{c} indicate significance level of 1%, 5%, or 10%.

Dependent variable: Number of Australian takeover bids at time t

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	**45.73^a**	**74.93^a**	**44.89^a**	**50.26^a**	**50.06^a**	**74.45^a**	**69.78^a**	**68.85^a**
	(2.2)	**(6.23)**	**(2.32)**	**(2.38)**	**(2.41)**	**(6.3)**	**(6.63)**	**(6.75)**
AOI_{t-1}	0.04				0.09	-0.05		0.01
	(0.24)				(0.22)	(0.22)		(0.21)
$IND_{M_{t-1}}$	0.41				0.39	0.23		0.26
	(0.3)				(0.27)	(0.27)		(0.26)
INT_{t-1}		**-12.21^a**				**-11.96^a**	**-9.23^a**	**-8.77^a**
		(2.47)				**(2.49)**	**(2.91)**	**(2.96)**
TIP_{t-1}			1.43		0.31		0.7	0.64
			(1.38)		(1.27)		(1.22)	(1.22)
CAE_{t-1}				**-6.04^a**	**-6.61^a**		**-3.39^c**	**-3.53^c**
				(1.59)	**(1.57)**		**(1.82)**	**(1.83)**
Adjusted R^2	0.01	0.2	0.01	0.13	0.14	0.19	0.21	0.21
No. of observations	100	100	100	100	100	100	100	100
Regression residuals								
- Serial correlation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
- Heteroscedasticity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 5: **Predictive regressions Australian Takeover Bids (as a proportion to number of listed companies) on explanatory variables lagged by 1 quarter - Two-state Model**.

Regressions take the form: $\%TAK_t = (\alpha_{S_t=1}P_1 + \alpha_{S_t=0}P_0) + (A_{n,S_t=1}P_1 + A_{n,S_t=0}P_0)Z_{t-i} + e_t$. The table presents the results from forecasting takeover activity in quarter t using all macro-economic and financial market variables lagged by one quarter. %TAK is the percentage of Australian takeover bids to the number of companies listed on the ASX. P_1 and P_0 are probability of being in a wave state and in non-wave state when modeling $\%TAK$ annual time series by ARMA(1,1) State-space Markov Switching model. Z_{t-1} contains the independent variables in previous quarter (AOI is excess returns of All Ordinaries Accumulation Index; IND_M is excess returns on Metals & Mining industry (orthogonal index); INT is 10-year Australian Government Bond rate; TIP and CAE represent the growth rate of total industrial production and private new capital expenditure). The sample period is quarterly 1980-2004. Standard errors appear in parentheses below the parameter estimates. Bold figures indicate that the coefficients are significant at 10% or better, with superscript ^{a}, ^{b}, or ^{c} indicate significance level of 1%, 5%, or 10%.

Dependent variable: Proportion of Australian Takeover Bids at time t

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept, Non-wave	**3.42**^{a}	**4.44**^{a}	**3.33**^{a}	**3.65**^{a}	**3.58**^{a}	**4.41**^{a}	**4.06**^{a}	**4.01**^{a}
	(0.13)	**(0.37)**	**(0.13)**	**(0.14)**	**(0.14)**	**(0.37)**	**(0.37)**	**(0.38)**
Intercept, Wave	**6.6**^{a}	**9.71**^{a}	**6.52**^{a}	**6.72**^{a}	**6.23**^{a}	**9.89**^{a}	**9.79**^{a}	**10.39**^{a}
	(0.45)	**(1.16)**	**(0.44)**	**(0.4)**	**(0.45)**	**(1.23)**	**(1.14)**	**(1.58)**
AOI_{t-1}, Non-wave	-0.0002				0.006	-0.004		-0.003
	(0.01)				(0.01)	(0.01)		(0.01)
AOI_{t-1}, Wave	0.09				-0.02	0.09		0.07
	(0.08)				(0.09)	(0.07)		(0.1)
$IND_{M_{t-1}}$, Non-wave	0.01				0.01	0.01		0.01
	(0.02)				(0.02)	(0.02)		(0.02)
$IND_{M_{t-1}}$, Wave	-0.02				0.14	-0.07		-0.08
	(0.08)				(0.11)	(0.08)		(0.13)
INT_{t-1}, Non-wave		**-0.41**^{a}				**-0.4**^{a}	-0.23	-0.21
		(0.15)				**(0.15)**	(0.16)	(0.17)
INT_{t-1}, Wave		**-1.51**^{a}				**-1.63**^{a}	**-1.71**^{a}	**-1.98**^{a}
		(0.56)				**(0.58)**	**(0.56)**	**(0.72)**
TIP_{t-1}, Non-wave			**0.18**^{b}		**0.16**^{b}		**0.17**^{b}	**0.17**^{b}
			(0.08)		**(0.07)**		**(0.07)**	**(0.07)**
TIP_{t-1}, Wave			-0.88		**-1.18**^{c}		**-1.14**^{b}	-0.87
			(0.58)		**(0.7)**		**(0.54)**	(0.68)
CAE_{t-1}, Non-wave				**-0.29**^{a}	**-0.27**^{a}		**-0.2**^{b}	**-0.21**^{b}
				(0.09)	**(0.09)**		**(0.1)**	**(0.1)**
CAE_{t-1}, Wave				-0.94	-1.76		-0.01	0.69
				(0.83)	(1.08)		(0.82)	(1.37)
Adjusted R^2	0.35	0.44	0.39	0.42	0.44	0.43	0.49	0.47
No, of observations	100	100	100	100	100	100	100	100

Table 6: **Predictive regressions of Australian cash bids (as a proportion to number of listed companies) on explanatory variables lagged by 1 quarter - Two-state model**.

Regressions take the form: $\%TAK_{c_t} = (\alpha_{S_t=1}P_1 + \alpha_{S_t=0}P_0) + (A_{n,S_t=1}P_1 + A_{n,S_t=0}P_0)Z_{t-i} + e_t$. The table presents the results from forecasting cash-based bids in quarter t using all macro-economic and financial market variables lagged by one quarter. $\%TAK_c$ is the percentage of Australian cash-based bids to the number of companies listed on the ASX. P_1 and P_0 are probability of being in a wave state and in a non-wave state when modeling $\%TAK_c$ annual time series by ARMA(1,1) State-space Markov Switching model. Z_{t-1} contains the independent variables in previous quarter (AOI is excess returns of All Ordinaries Accumulation Index; IND_M is excess returns on Metals & Mining industry (orthogonal index); INT is 10-year Australian Government Bond rate; TIP and CAE represent the growth rate of total industrial production and private new capital expenditure). The sample period is quarterly 1980-2004. Standard errors appear in parentheses below the parameter estimates. Bold figures indicate that the coefficients are significant at 10% or better, with superscript ^{a}, ^{b}, or ^{c} indicate significance level of 1%, 5%, or 10%.

Dependent variable: Proportion of Australian Cash-funded Takeover Bids at time t

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept, Non-wave	**2.41^a**	**2.65^a**	**2.35^a**	**2.53^a**	**2.46^a**	**2.63^a**	**2.4^a**	**2.36^a**
	(0.1)	**(0.32)**	**(0.11)**	**(0.11)**	**(0.12)**	**(0.32)**	**(0.33)**	**(0.33)**
Intercept, Wave	**4.69^a**	**6.67^a**	**4.62^a**	**4.84^a**	**4.41^a**	**6.77^a**	**6.66^a**	**7.05^a**
	(0.36)	**(0.99)**	**(0.36)**	**(0.34)**	**(0.38)**	**(1.05)**	**(0.99)**	**(1.37)**
AOI_{t-1}, Non-wave	0.0003				0.004	-0.0005		0.002
	(0.01)				(0.01)	(0.01)		(0.01)
AOI_{t-1}, Wave	**0.12^c**				0.03	**0.13^b**		0.1
	(0.06)				(0.08)	**(0.06)**		(0.09)
$IND_{M_{t-1}}$, Non-wave	0.005				0.0002	0.004		0.004
	(0.01)				(0.01)	(0.01)		(0.01)
$IND_{M_{t-1}}$, Wave	-0.04				0.08	-0.08		-0.07
	(0.06)				(0.09)	(0.07)		(0.12)
INT_{t-1}, Non-wave		-0.09				-0.08	0.03	0.04
		(0.12)				(0.12)	(0.14)	(0.14)
INT_{t-1}, Wave		**-0.92^c**				**-1.04^b**	**-1.07^b**	**-1.26^b**
		(0.48)				**(0.49)**	**(0.48)**	**(0.63)**
TIP_{t-1}, Non-wave			**0.13^b**		**0.12^b**		**0.12^b**	**0.12^b**
			(0.06)		**(0.06)**		**(0.06)**	**(0.06)**
TIP_{t-1}, Wave			**-0.95^b**		**-0.98^c**		**-1.14^b**	-0.79
			(0.48)		**(0.58)**		**(0.48)**	(0.58)
CAE_{t-1}, Non-wave				**-0.13^c**	-0.12		-0.13	-0.14
				(0.08)	(0.07)		(0.09)	(0.09)
CAE_{t-1}, Wave				-0.83	-1.15		-0.2	0.42
				(0.7)	(0.91)		(0.7)	(1.19)
Adjusted R^2	0.31	0.33	0.35	0.34	0.35	0.33	0.38	0.36
No. of observations	100	100	100	100	100	100	100	100

Table 7: **Predictive regressions of Australian shares-based bids (as a proportion to number of listed companies) on explanatory variables at each of previous 4 quarters - Two-state model**.

Regressions take the form: $\%TAK_{sh_t} = (\alpha_{S_t=1}P_1 + \alpha_{S_t=0}P_0) + (A_{n,S_t=1}P_1 + A_{n,S_t=0}P_0)Z_{t-i} + e_t$. The table presents the results from forecasting shares-based bids in quarter t using all macro-economic and financial market variables lagged by one quarter. $\%TAK_{sh}$ is the percentage of Australian shares-based bids to the number of companies listed on the ASX. P_1 and P_0 are probability of being in a wave state and in non-wave state when modeling $\%TAK_{sh}$ annual time series by ARMA(1,1) State-space Markov Switching model. Z_{t-1} contains the independent variables in previous quarter (AOI is excess returns of All Ordinaries Accumulation Index; IND_M is excess returns on Metals & Mining industry (orthogonal index); INT is 10-year Australian Government Bond rate; TIP and CAE represent the growth rate of total industrial production and private new capital expenditure). The sample period is quarterly 1980-2004. Standard errors appear in parentheses below the parameter estimates. Bold figures indicate that the coefficients are significant at 10% or better, with superscript ^{a}, ^{b}, or ^{c} indicate significance level of 1%, 5%, or 10%.

Dependent variable: Proportion of Australian Shares-based Takeover Bids at time t

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept, Non-wave	**0.29**^{a}	**0.32** ^{a}	**0.28**^{a}	**0.32**^{a}	**0.3**^{a}	**0.32**^{a}	**0.29**^{a}	**0.26**^{a}
	(0.02)	**(0.08)**	**(0.02)**	**(0.02)**	**(0.03)**	**(0.08)**	**(0.08)**	**(0.08)**
Intercept, Wave	**0.89**^{a}	**2.44**^{a}	**0.95**^{a}	**0.83**^{a}	**0.91**^{a}	**2.37**^{a}	**2.4**^{a}	**2.51**^{a}
	(0.07)	**(0.85)**	**(0.09)**	**(0.09)**	**(0.16)**	**(0.85)**	**(0.85)**	**(0.87)**
AOI_{t-1}, Non-wave	0.002				0.003	0.002		0.003
	(0.003)				(0.003)	(0.002)		(0.003)
AOI_{t-1}, Wave	0.006				-0.002	0.004		-0.005
	(0.006)				(0.01)	(0.006)		(0.01)
$IND_{M_{t-1}}$, Non-wave	0.002				0.002	0.002		0.002
	(0.003)				(0.003)	(0.003)		(0.003)
$IND_{M_{t-1}}$, Wave	0.003				-0.002	0.002		-0.001
	(0.009)				(0.02)	(0.008)		(0.02)
INT_{t-1}, Non-wave		-0.02				-0.02	-0.005	0.003
		(0.03)				(0.03)	(0.03)	(0.03)
INT_{t-1}, Wave		**-0.52**^{c}				**-0.49**^{c}	**-0.48**^{b}	**-0.51**^{b}
		(0.28)				**(0.28)**	**(0.27)**	**(0.28)**
TIP_{t-1}, Non-wave			0.02		0.02		0.02	0.02
			(0.01)		(0.01)		(0.01)	(0.01)
TIP_{t-1}, Wave			-0.06		-0.07		-0.06	-0.09
			(0.04)		(0.07)		(0.04)	(0.07)
CAE_{t-1}, Non-wave				**-0.04**^{b}	**-0.04**^{b}		-0.02	-0.03
				(0.02)	**(0.02)**		(0.02)	(0.02)
CAE_{t-1}, Wave				0.05	0.06		0.03	0.05
				(0.09)	(0.18)		(0.08)	(0.18)
Adjusted R^2	0.39	0.43	0.41	0.42	0.42	0.42	0.44	0.43
No. of observations	100	100	100	100	100	100	100	100

Table 8: **Predictive regressions of US takeover bids (number) on explanatory variables lagged by one quarter - Two-state model.**

Regressions take the form: $TAK_t = (\alpha_{S_t=1}P_1 + \alpha_{S_t=0}P_0) + (A_{n,S_t=1}P_1 + A_{n,S_t=0}P_0)Z_{t-1} + e_t$. The table presents the results from forecasting shares-based bids in quarter t using all macro-economic and financial market variables lagged by one quarter. TAK is total number of takeover bids of US listed target companies. P_1 and P_0 are probability of being in a wave state and in a non-wave state when modeling TAK annual time series by AR(1) Markov Switching model. Z_{t-1} contains the independent variables in previous quarter (S&P500 is returns of S&P500 Accumulation Index in excess of US 3-month Treasury bill rate; INT is 10-year US Government Bond rate; TIP represents the growth rate of total industrial production). The sample period is quarterly 1982-2004. Standard errors appear in parentheses below the parameter estimates. Bold figures indicate that the coefficients are significant at 10% or better, with superscript ^{a}, ^{b}, or ^{c} indicate significance level of 1%, 5%, or 10%.

Dependent variable: Number of US takeover bids at time t

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept, Non-wave	**123.33**^{a}	**189.48**^{a}	**120.53**^{a}	**183.44**^{a}	**117.06**^{a}	**182.85**^{a}	**171.99**^{a}
	(12.56)	**(37.49)**	**(12.32)**	**(38.44)**	**(12.92)**	**(36.85)**	**(37.64)**
Intercept, Wave	**326.65**^{a}	**460.31**^{a}	**320.66**^{a}	**475.8**^{a}	**323.19**^{a}	**460.21**^{a}	**482.97**^{a}
	(15.03)	**(83.08)**	**(16.7)**	**(85.89)**	**(17.02)**	**(81.64)**	**(83.53)**
$S\&P500_{t-1}$, Non-wave	0.49			0.71	1.35		1.6
	(1.56)			(1.43)	(1.56)		(1.42)
$S\&P500_{t-1}$, Wave	-0.72			-1.17	-1.14		-1.66
	(1.92)			(1.78)	(1.91)		(1.76)
INT_{t-1}, Non-wave		**-35.98**^{c}		**-33.75**^{c}		**-34.48**^{c}	-30.83
		(19.48)		**(19.7)**		**(18.96)**	(19.07)
INT_{t-1}, Wave		**-74.2**^{c}		**-80.75**^{c}		**-76.32**^{c}	**-86.72**^{b}
		(44.69)		**(45.57)**		**(43.47)**	**(44.1)**
TIP_{t-1}, Non-wave			**9.57**^{c}		**10.29**^{c}	**9.18**^{c}	**9.92**^{c}
			(5.62)^c		**(5.75)**	**(5.09)**	**(5.2)**
TIP_{t-1}, Wave			3.06		3.82	3.19	4.34
			(8.67)		(8.83)	(7.86)	(7.96)
Adjusted R^2	0.48	0.57	0.5	0.56	0.5	0.58	0.58
No. of observations	92	92	92	92	92	92	92

Table 9: **Predictive regressions of US takeover bids (as a proportion to number of listed companies) on explanatory variables lagged by one quarter - Two-state model**.

Regressions take the form: $\%TAK_t = (\alpha_{S_t=1}P_1 + \alpha_{S_t=0}P_0) + (A_{n,S_t=1}P_1 + A_{n,S_t=0}P_0)Z_{t-i} + e_t$. The table presents the results from forecasting proportion of US takeover bids in quarter t using all macro-economic and financial market variables lagged by one quarter. %TAK is the proportion of US takeover bids to the number of listed companies. P_1 and P_0 are probability of being in a wave state and in a non-wave state when modeling %TAK annual time series by AR(1) Markov Switching model. Z_{t-1} contains the independent variables in previous quarter (S&P500 is returns of S&P500 Accumulation Index in excess of US 3-month Treasury bill rate; INT is 10-year US Government Bond rate; TIP represents the growth rate of total industrial production). The sample period is quarterly 1982-2004. Standard errors appear in parentheses below the parameter estimates. Bold figures indicate that the coefficients are significant at 10% or better, with superscript ^{a}, ^{b}, or ^{c} indicate significance level of 1%, 5%, or 10%.

Dependent variable: Proportion of US takeover bids at time t

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept, Non-wave	**2.29**^{a}	**1.95**^{a}	**2.22**^{a}	**1.9**^{a}	**2.21**^{a}	**1.94**^{a}	**1.9**^{a}
	(0.11)	**(0.37)**	**(0.11)**	**(0.38)**	**(0.11)**	**(0.36)**	**(0.37)**
Intercept, Wave	**6.69**^{a}	**28.7**^{a}	**6.58**^{a}	**29.71**^{a}	**6.61**^{a}	**27.8**^{a}	**28.39**^{a}
	(0.48)	**(4.82)**	**(0.52)**	**(5.02)**	**(0.52)**	**(4.8)**	**(4.94)**
$S\&P500_{t-1}$, Non-wave	-0.003			-0.004	0.003		0.001
	(0.01)			(0.01)	(0.01)		(0.01)
$S\&P500_{t-1}$, Wave	0.03			-0.02	0.02		-0.02
	(0.05)			(0.04)	(0.05)		(0.04)
INT_{t-1}, Non-wave		0.06		0.08		0.03	0.05
		(0.18)		(0.19)		(0.18)	(0.18)
INT_{t-1}, Wave		**-10.44**^{a}		**-10.92**^{a}		**-9.98**^{a}	**-10.26**^{a}
		(2.3)		**(2.39)**		**(2.27)**	**(2.34)**
TIP_{t-1}, Non-wave			**0.11**^{b}		**0.11**^{b}	**0.11**^{b}	**0.11**^{b}
			(0.05)		**(0.05)**	**(0.04)**	**(0.04)**
TIP_{t-1}, Wave			0.1		0.05	-0.18	-0.14
			(0.36)		(0.37)	(0.3)	(0.31)
Adjusted R^2	0.42	0.6	0.47	0.59	0.46	0.62	0.61
No. of observations	92	92	92	92	92	92	92

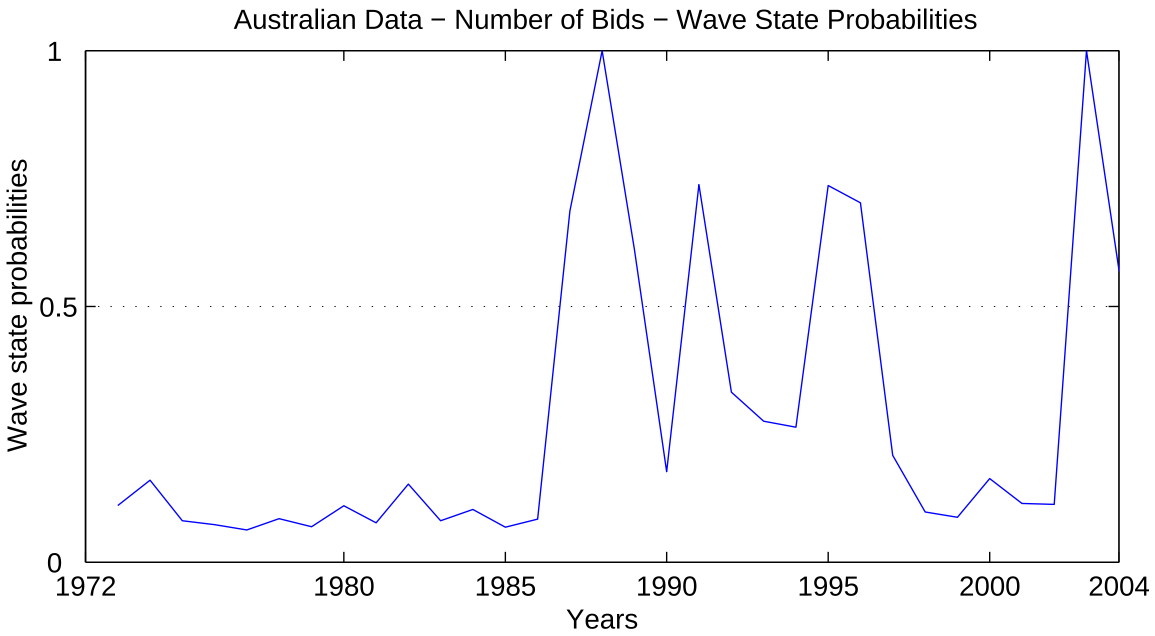

Figure 1: Australian Data - Number of Takeover Bids - Probabilities of Wave State under ARMA(1,1) State-Space Markov Switching Model

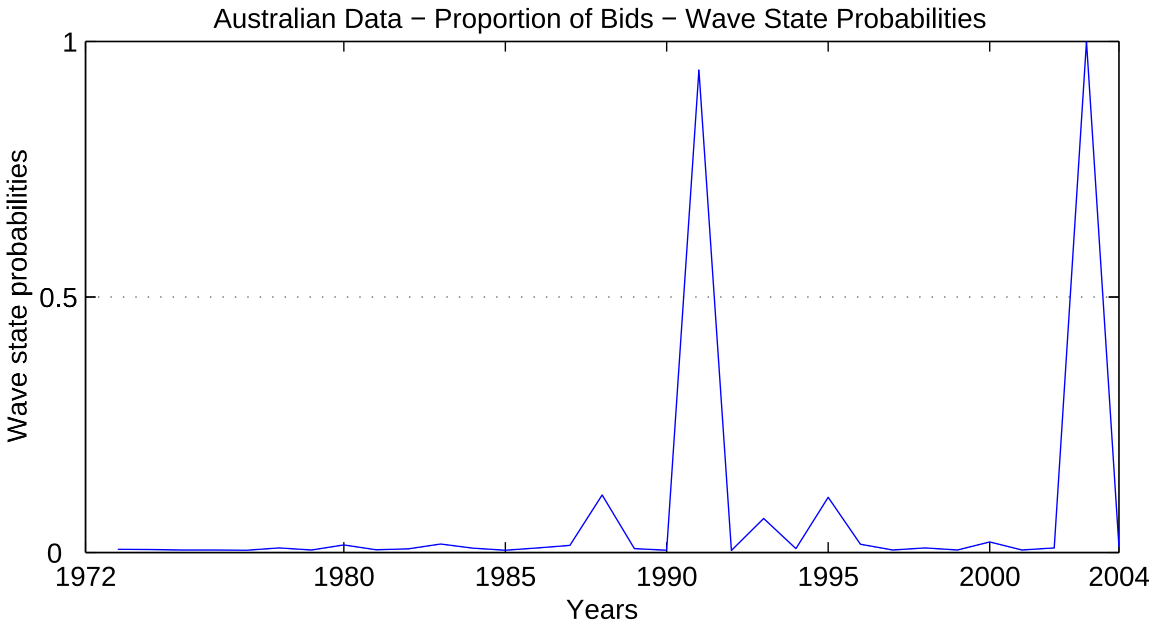

Figure 2: Australian Data - Proportion of Takeover Bids to Number of Listed Companies - Probabilities of Wave State under ARMA(1,1) State-Space Markov Switching Model

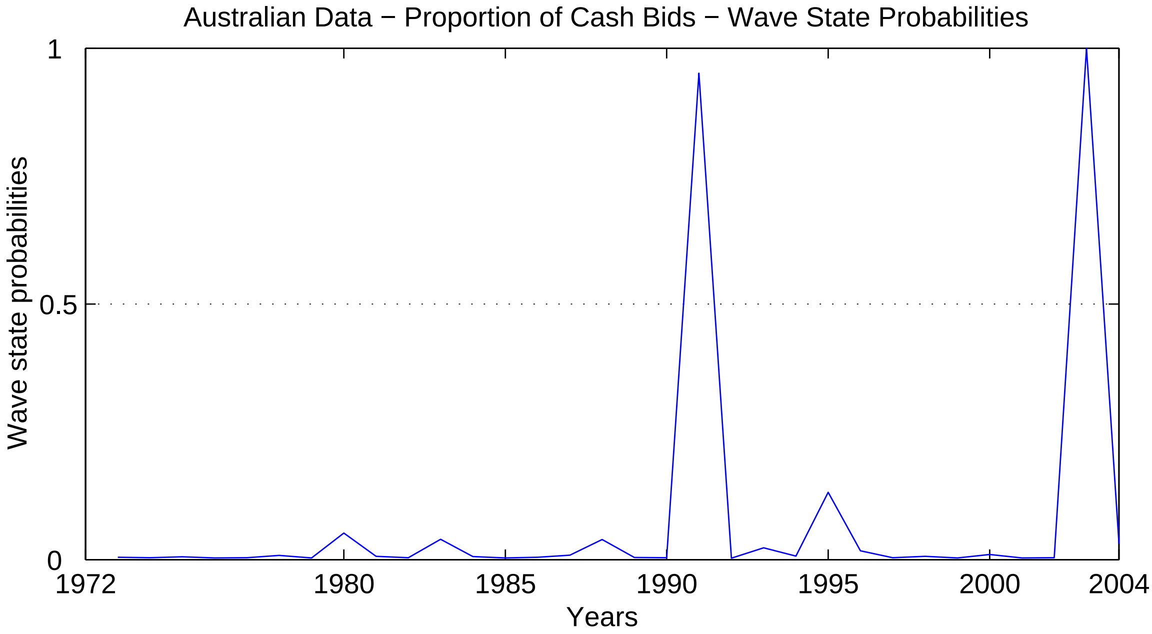

Figure 3: Australian Data - Proportion of Cash Bids to Number of Listed Companies - Probabilities of Wave State under ARMA(1,1) State-Space Markov Switching Model

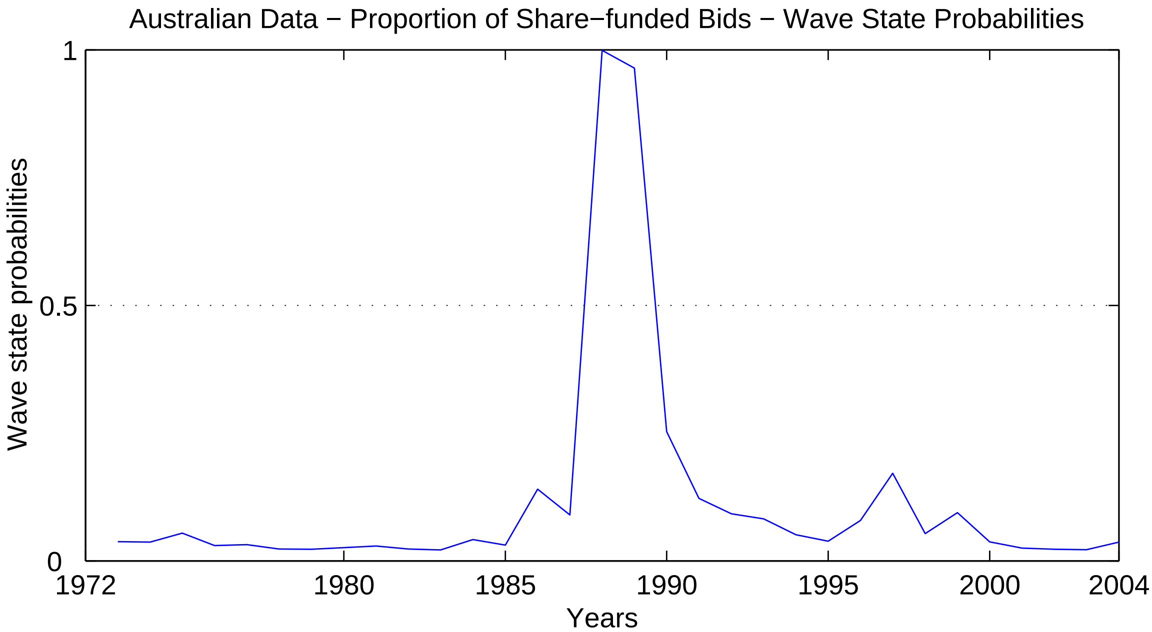

Figure 4: Australian Data - Proportion of Share-funded Bids to Number of Listed Companies - Probabilities of Wave State under ARMA(1,1) State-Space Markov Switching Model

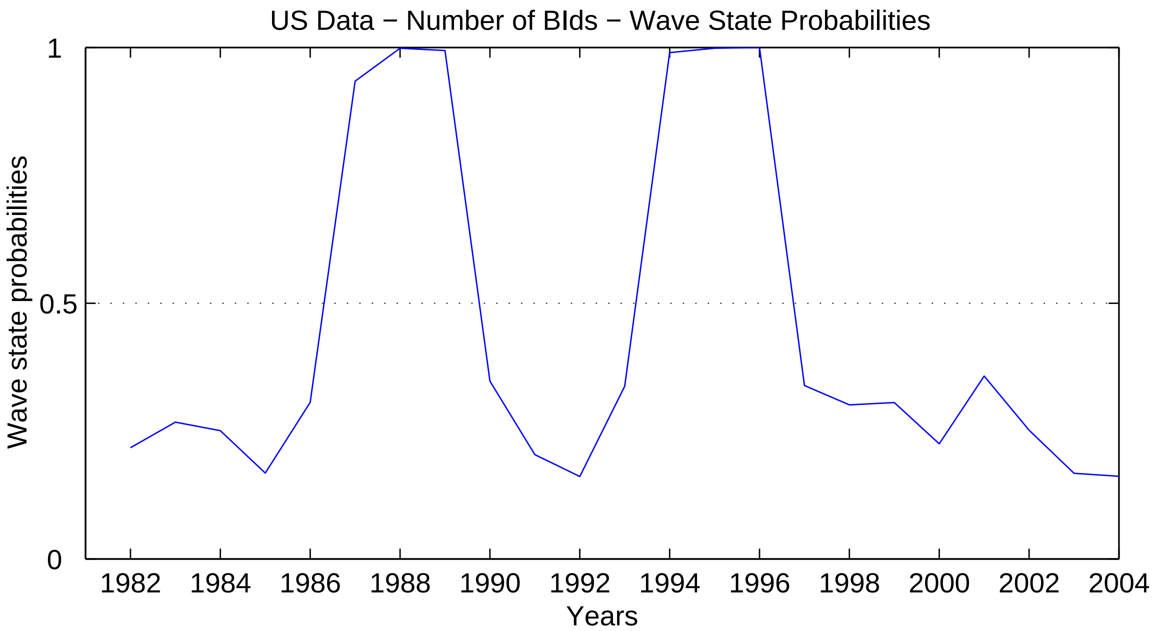

Figure 5: US Data - Number of Takeover Bids - Probabilities of Wave State under AR(1) Gaussian Markov Switching Model

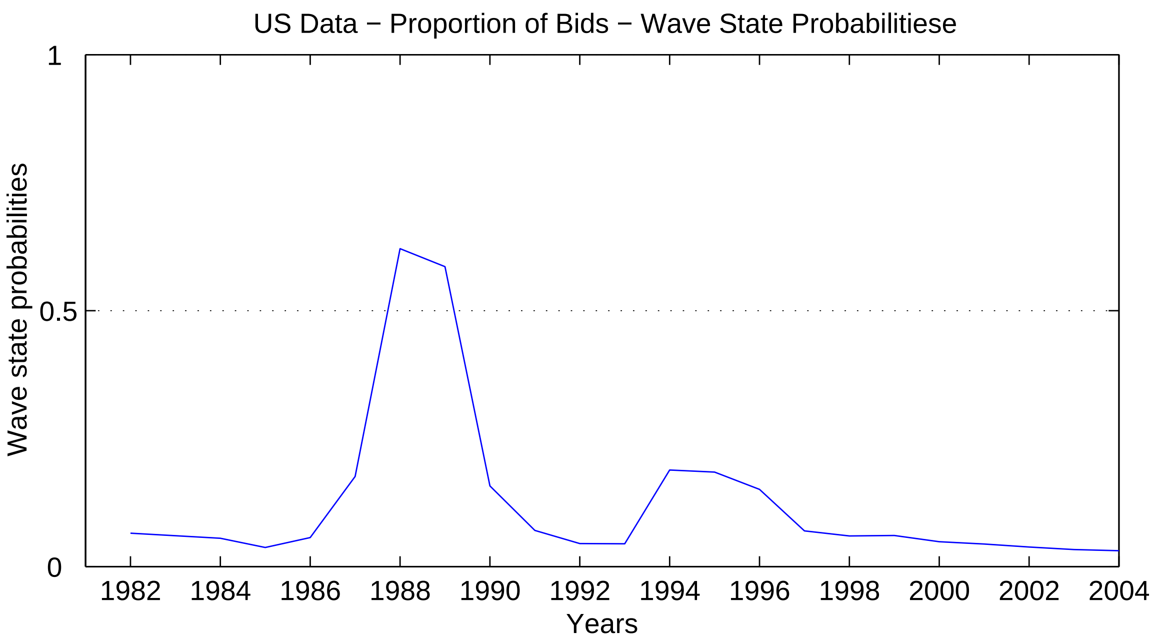

Figure 6: US Data - Proportion of Takeover Bids to Number of Listed Companies - Probabilities of Wave State under AR(1) Gaussian Markov Switching Model