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Testing for Over-Reaction and Under-Reaction in Chinese Shanghai Composite Index Constituent Stocks and Australian Resource Stocks

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Abstract

This paper describes a new formulation of the partial adjustment model (PAM) and its speed of adjustment coefficient. Speed of adjustment coefficients have been used to measure the efficiency or inefficiency in financial markets. Using the model by Amihud and Mendelson (1987), Damodaran (1993) and Brisely and Theobald (1996) and Theobald and Yallop (2004) have developed speed of adjustment coefficients for this purpose. Whilst their formulation suffers from non-synchronous problems, the formulation of the new PAM in this paper avoids such problems. The new PAM is used to measure the efficiency of CSC constituent stocks and Australian resource stocks. In both categories, some stocks over-react, some under-react and some fully adjust to new economic information and are efficient.

Keywords: efficient markets, partial adjustment models, China and Australia

1. Introduction

In an efficient market, observed price should include new information to reflect changes to its fundamental value. Such an adjustment should be immediate if the market is strongly efficient (Fama, 1991). Thus the adjustment speed of stock price to the changed fundamental value due to economic news determines the degree of efficiency in the stock market (Marisetty, 2003).

The literature of over-reactions (for example, DeBondt & Thaler, 1985, 1987), under-reactions (for example, Michaely et al., 1995; Bernard & Thomas, 1989) and other anomalies (for example, Jegadeesh and Titman, 1993, 2001) has led to a search for alternative theoretical models to describe the price adjustment process. Behavioural models have been subsequently developed to justify the under (over) reaction hypotheses (for example Barberis et al. 1998, Daniel et al. 1998; Hong & Stein 1999; Fama 1998). Differences exist in ways to measure the speed at which stocks adjust. Often, an event study is used to ascertain the dynamics of pricing around the time of a macroeconomic shock. However, speed is only determined for a predefined known event (Boulter, 2007). Amihud and Mendelson (1987) propose a model of price adjustment in which observed prices adjust towards their intrinsic values. A number of estimators have been subsequently developed in the literature. Damodaran (1993) and Brisley and Theobald (1996) estimate the speed of adjustment using the partial adjustment model. Theobald and Yallup (2004) compare the speed of price adjustments between large and small companies (Jang, 2009).

The purpose this paper is to estimate speed of adjustment within a new partial adjustment model (PAM), in order to investigate the efficiency of the Chinese Shanghai Composite index constituent stocks and the Australian resources stocks. The results have many implications for both researchers and practitioners. First, the price adjustment process in Chinese and Australian markets is mixed. Some stocks over-react, some under-react and some fully adjust to new economic information. Second, price over-reaction and under-reaction indicates inefficiencies in the information dissemination process in these markets. Third, the PAM demonstrates that these inefficiencies are short-term and that in the long-term there is equilibrium and the markets are efficient.

Since the reforms of 1978, China has financially deregulated and liberalised its market. However, China's financial system is still highly regulated. As a result, the Chinese and Australian financial markets cannot be fairly compared. China has recognised the dangers of a completely free global financial market without first having strong institutions. However, there is a strong impetus for China to open its doors more widely to the outside world, allowing foreign firms to engage in financial services. Further liberalisation is occurring in financial markets and in the future it is expected that the Chinese financial market will be more open and comparable with Australian markets.

1.1 Review of Relevant Literature

Black (1986) stated that the stock price consists of two factors, noise and the intrinsic value. Noise is intrinsic value minus the observed price. Amihud and Mendelson (1986) reduced the variance of noise into two parts; the intrinsic value variance which is the result of dissimilar valuations due to heterogeneous beliefs among investors and that which is the result of pure noise due to irrational behaviour. Amihud and Mendelson (1987) state that stock prices tend towards fundamentals by way of price adjustment such that (Marisetty, 2003):

$$P_t - P_{t-1} = g(V_t - P_{t-1}) + \mu_t \tag{1}$$

where (V_t) and (P_t) are in logarithms. (P_t-P_{t-1}) is the observed price change, (V_t-P_{t-1}) represents the information-induced change in price which adjusts by (g) which with value 1 represents full price adjustment towards the intrinsic value. The value of g between $0<g<1$ represents partial adjustment towards the intrinsic value. g with value 0 represents no adjustment and $g>1$ represents over-reaction of the price towards change in the intrinsic value to economic news (Marisetty, 2003).

Damodaran (1993) extended Amihud and Mendelsohn's (1986) model by measuring the speed of adjustment of stocks in response to macroeconomic shocks. He makes the assumption that speed of adjustment is not immediate. Damodaran (1993) divided time into daily units. He also assumes that the maximum time for price adjustment is 20 days based on experimental data. He derived his estimator from reducing the observed return variance into three parts (Marisetty, 2003; Boulter, 2007):

$$\mathrm{Var}(R_t) = v^2 + 2\sigma^2 + [(\tfrac{g}{2-g} - 1)v^2 + (\tfrac{2}{2-g} - 2)\sigma^2] \tag{2}$$

$$v^2 + 2\sigma^2 \tag{3}$$

$$[(\tfrac{g}{2-g} - 1)v^2 + (\tfrac{2}{2-g} - 2)\sigma^2] \tag{4}$$

Where (v^2) is the variance of the intrinsic value, ($2\sigma^2$) is the noise variance, and (4) is the variance relating to the price adjustment process (Boulter, 2007).

The estimator (g) arises from observed return variances that are calculated over different time intervals. Thus (R_{jt}) would be the return in time period (t) in which the return interval is (j) (Boulter, 2007). The variance:

$$Var(R_{jt}) = [\frac{g_j}{2-g_j} jv^2 + \frac{2}{(2-g_j)}\sigma^2] \tag{5}$$

It is assumed that an amount of return unit-intervals are enough to calculate the variances, so that (j = 1, 2, ...k), and that the limiting interval (k) is enough to allow (g) to equal one, allowing the variances in (j)and in (k) interval returns to be as follows (Boulter, 2007).

$$Var(R_{jt}) - \frac{Var(R_{kt})}{k} = v^2\left[\frac{g_j}{(2-g_j)} - 1\right] + 2\sigma^2[\frac{1}{(2-g_j)} - \frac{1}{k}] \tag{6}$$

where (v^2) and (σ^2) are functions of the covariance and variance in (k) intervals as follows:

$$v^2 = \frac{Var(R_{kt}) + 2Cov(R_{kt}, R_{kt-1})}{k} \tag{7}$$

$$\sigma^2 = -Cov(R_{kt}, R_{kt-1}) \tag{8}$$

Substituting (v^2) and (σ^2), in equation (5), and solving for (g), Damodaran's estimate of the speed of adjustment is as follows (Boulter, 2007):

$$g = \frac{\frac{Var(R_{j,t})}{j} + \frac{Var(R_{k,t})}{k}(j-1) + \frac{Cov(R_{k,t}, R_{k,t-1})}{j}}{\frac{Var(R_{j,t})}{j} + \frac{Var(R_{k,t})}{k}(2j-1) + \frac{2Cov(R_{k,t}, R_{k,t-1})}{k}} \tag{9}$$

If the market is efficient, then the faster (g) should converge to (1). Brisley and Theobald (1996) find an error within Damodaran's calculation which they correct. Their estimator is as follows (Boulter, 2007):

$$g = \frac{\frac{2[Var(R_{j,t})}{j} + \frac{2Cov\left(R_{k,t},R_{k,t-1}\right)]}{j}}{\frac{Var(R_{j,t})}{j} + \frac{Var(R_{k,t})}{k} + \frac{2Cov(R_{k,t},R_{k,t-1})}{k}} \quad (10)$$

The Damodaran (1993) estimator overstates the price response towards intrinsic value when adjustment is incomplete (Boulter, 2007). When the interval (*j*) approaches (*k*), the errors within the numerator and denominator increasingly dominate the equation, forcing the speed of adjustment coefficient towards one. The Brisley and Theobald (1996) derive an estimator that adjusts for this error.

Theobold and Yallup (2004) construct two estimators without the use a limiting interval, which assume a lagged price response caused by traders initially under or over-reacting to information (Boulter, 2007).

Partial adjustment may be caused by non-synchronous trading as pointed out by Lo and MacKinlay (1990). They state that the speed of adjustment is a function of the autocorrelation and cross-autocorrelation terms within returns, caused by trading that is which is cyclical due to recurrences in trading activity. The under-reaction of stock prices will cause the series will be positively correlated and the over-reaction results in negative correlation. The time taken for intrinsic value to adjust is how long it takes to allow the positive or negative autocorrelation within the observed return series to dissolve.

Theobold and Yallup (2004) state that auto-covariances for lags one and two can be derived as:

$$Cov\{R_t,R_{t-1}\} = \frac{g}{2-g}[(1-g)v^2 - \sigma^2] \quad (11)$$

and lag two (-2) as:

$$Cov\{R_t,R_{t-2}\} = g\,\frac{(1-g)}{2-g}[(1-g)v^2 - \sigma^2] \quad (12)$$

Since the cross-covariance between them are zero at all lags, the coefficient (*g*) may be expressed as a function of the auto-covariance structure:

$$1 - g = \frac{Cov\{R(t),R(t-2)\}}{Cov\{R(t),R(t-1)\}} \quad (13)$$

The auto-covariance estimator is easy to estimate. A problem is the effect of non-synchronous trading. This occurs when thin trading occurs prices do not change over a long time, which leads to runs of zeros within the return series. This could result in autocorrelation that is distinct from traders under or over-reaction to information (Boulter, 2007).

1.2 The New Partial Adjustment Model

The PAM assumes the long-run equilibrium equation is given by the single-index model:

$$R_t = a + \beta R_m + e \quad (14)$$

Where R_t is the target return; a is the excess return; B is the sensitivity of the stock to the market, R_m is the market return; and e is the residual.

Similar to the model of Amihud and Mendelson (1987), the impact from noise trading is the difference between the fundamental return and the observed return.

The following hypothesis known as the PAM is postulated:

$$R_t - R_{t-1} = \delta(R_t - R_{t-1}) \quad (15)$$

$$R_t - R_{t-1} = \delta\big((a + \beta R_m + e) - R_{t-1}\big) \quad (16)$$

$$R_t = \delta a + \delta\beta R_m + (1-\delta)R_{t-1} + \delta e \quad (17)$$

$$R_t = \delta a + \delta\beta R_m + (1-\delta)\beta R_{m_{t-1}} + \delta e \quad (18)$$

Where R_t is the return in time period t, R_{t-1} is the return in time period t-1, δ is the speed of adjustment coefficient and e is the error term E[e]=0 and E~ N(0, σ^2). When δ equals 0 there is no adjustment, when δ equals 1 there is full adjustment and the market is efficient, when δ is greater than 1 there is an over-reaction to economic information and when δ lies between 0 and 1 there is partial adjustment or under-reaction to economic information.

There should be no opportunity to use information gathered in period t-1 to provide a correct assessment of the expected return. The information available at t-1, the time series of past returns, should not be able to be used to correctly determine the expected return. By using past information in this way makes this approach a test of weak form market efficiency. If the variance of e is high then that would be evidence against weak form market efficiency, in addition to the value of the speed of adjustment.

The first step is to calculate the alpha (excess return) and beta (systematic risk) by regression the stock's return against the market return. The beta is multiplies by the market return and added to alpha. The proxy used for the lagged return is $\beta R_{m(t-1)}$. The stochastic explanatory variable R_{t-1} may be correlated with the error term, which would make the OLS estimator biased and inconsistent so that the estimates would not approximate their true population values. This correlation can be removed by finding a suitable proxy for R_{t-1}. Such a proxy is $\beta R_{m(t-1).}$

The single-index model is used in the PAM instead of a multi-factor model because the object of the PAM is to calculate the speed of adjustment coefficient. A multi-factor model would introduce too many terms in the PAM and would lead to difficulties in finding an appropriate proxy for R_{t-1}.

There is no autocorrelation or auto-covariance structure in this formulation of the PAM. It therefore avoids the problem of nonsynchronous or infrequent trading that effect many of the other models which estimate the speed of adjustment.

2. Method

The sample consists of 533 weekly observations from 1 Jan 2003 to 1 Mar 2013 of the Chinese Shanghai Composite Index and 33 Australian Resource stocks. All variables were converted to natural logarithms. The financial data was collected from Yahoo Finance.

3. Results

Table 1 shows the diagnostics of the PAM.

Table 1. The diagnostics of the partial adjustment model

STOCK	COEFF	t –Stat	R-SQR	DW	STOCK	COEFF	t –Stat	R-SQR	DW
600519.ss	-0.06635	-1.44072	0.032405	2.546665	NCM.AX	-0.56368	-6.68554	0.016583	2.426353
600583.ss	-0.03076	-1.02931	0.044919	2.079458	OGC.AX	-0.07514	-1.75907	0.001275	1.990348
600050.ss	-0.01269	-0.8975	0.235009	1.994056	MDL.AX	-0.04556	-0.50602	0.000107	1.983126
600018.SS	-0.00784	-0.26498	0.049202	1.933736	GDO.AX	-0.04175	-0.10994	0.03068	1.436451
600016.SS	-0.00712	-0.4774	0.355705	1.986318	KCN.AX	-0.0306	-0.66951	0.000281	1.975596
600879.ss	0.021735	1.057289	0.092408	1.945672	AGG.AX	-0.01143	-0.7894	0.000245	2.262396
600036.SS	-0.003	-0.24223	0.462789	2.052398	AAI.AX	-0.00767	-0.51201	0.002521	2.108659
600000.SS	-3.21E-17	-0.79028	1	1.981371	SBM.AX	-0.0073	-0.13522	0.002402	2.442574
600642.ss	0.013576	0.825776	0.150931	1.974525	CDU.AX	-0.00323	-0.07279	0.000717	1.983054
600037.ss	0.003705	0.193506	0.112075	1.929668	RRL.AX	-0.00172	-0.05083	0.001636	2.023806
600795.ss	0.022067	2.170131	0.445671	1.954692	IGO.AX	0.001197	0.038107	0.002755	2.045536
601600.ss	0.074653	4.453399	0.145518	1.925693	SPH.AX	0.007957	0.203515	0.000298	2.137731
600331.ss	0.008561	0.344598	0.059474	1.961403	BHP.AX	0.008888	0.914902	0.016881	2.092183
600688.ss	0.041387	2.283704	0.125279	1.80875	MGX.AX	0.010172	0.476272	0.005139	2.000023
600832.ss	-0.00571	-0.28819	0.090846	1.980106	RSG.AX	0.010207	0.278675	0.000342	2.02444
600028.SS	0.020931	1.5681	0.249952	1.987171	IGR.AX	0.010456	0.219221	0.002899	2.213796
600104.ss	0.021224	1.219567	0.14363	1.963668	LYC.AX	0.011292	0.403605	0.004726	2.129354
600887.ss	0.007357	0.280681	0.071196	1.916792	SDL.AX	0.014483	0.313774	0.000354	1.998599
600811.ss	0.0205	1.320724	0.17357	1.896156	PNA.AX	0.014727	0.50289	0.001281	2.005987
600100.ss	0.026794	1.368446	0.099737	2.011594	ARI.AX	0.01512	0.899238	0.008397	2.108659
600009.SS	0.029477	1.679053	0.177301	1.919847	AQP.AX	0.019917	1.183306	0.016273	1.945965
600011.SS	0.03002	1.716363	0.130375	1.918208	BSL.AX	0.022004	0.903593	0.001078	1.960833
600269.ss	0.033465	2.489689	0.027937	1.917883	GBG.AX	0.023421	0.927618	0.006369	2.132077
600005.SS	0.034558	2.030829	0.171972	1.927024	TRY.AX	0.030744	1.726071	0.006125	1.947409
600026.SS	0.035863	2.704828	0.239411	1.914828	OZL.AX	0.044024	1.962422	0.013189	2.066952
600111.ss	0.040196	1.806807	0.076551	2.057708	SGM.AX	0.044598	0.355612	0.002634	2.07253
600717.ss	0.006255	0.30894	0.129601	2.049608	IMD.AX	0.060852	2.052789	0.006355	1.995376
600177.ss	0.045696	2.542071	0.166572	2.003923	IRN.AX	0.06988	1.460731	0.00259	2.126806
600309.ss	0.050824	2.476643	0.106353	1.924252	EVN.AX	0.083956	2.025263	0.002926	2.155215
600362.ss	0.056557	3.709431	0.162702	1.931578	GRR.AX	0.102273	2.419297	0.006435	1.96512
600019.SS	0.057511	4.229059	0.261901	1.919321	RIO.AX	0.103299	1.374927	0.002429	2.10072
600320.ss	0.06011	2.597692	0.084937	2.068515	SIR.AX	0.104174	2.051616	0.003681	2.044306
600601.ss	0.003077	0.170727	0.123513	2.011847	WSA.AX	0.104422	0.556284	0.000178	2.135877

Note: COEFF means coefficient; t-Stat means t-statistic; R-SQR means R^2 coefficient; DW means Durbin-Watson.

The Table 5 shows that the results were not significant for the following stocks: 600019; 600026; 600177; 600269; 600309; 600320; 600362; 600688; 600795; 601600; EVN.AX; GRR.AX; IMD.AX; NCM.AX;

OZL.AX; SIR.AX.

Table 2 shows the results of the speed of adjustment coefficients for Chinese and Australian stocks.

Table 2. The speeds of adjustments for the CSC constituent stocks and Australian resources stocks

STOCK	SPEED	BETA	MCAP(mil)	STOCK	SPEED	BETA	MCAP(mil)
600519.ss	1.066353	1.069409	$26,386.08	NCM.AX	1.563677	1.153444	$14,399.05
600583.ss	1.030761	1.06963	$3,867.24	OGC.AX	1.075138	1.194804	$1,362.91
600050.ss	1.012694	0.829947	$12,033.81	MDL.AX	1.045558	1.066206	$275.68
600018.SS	1.007835	1.124973	$9,494.85	GDO.AX	1.041748	0.810438	$339.97
600016.SS	1.007121	0.581978	$40,444.84	KCN.AX	1.030601	0.991805	$531.40
600879.ss	1.005713	1.263689	$1,123.44	AGG.AX	1.011431	1.425217	$1,831.00
600036.SS	1.002997	1.290845	$42,476.33	AAI.AX	1.00767	0.133171	$8,500.00
600000.SS	1.000000	1.062374	$29,108.07	SBM.AX	1.007299	1.45542	$514.92
600642.ss	0.996923	1.110974	$3,293.45	CDU.AX	1.003231	0.299662	$663.59
600037.ss	0.996295	0.816957	$1,051.03	RRL.AX	1.001721	0.268901	$1,878.68
600795.ss	0.993745	1.15492	$7,910.94	IGO.AX	0.998803	0.838099	$859.34
601600.ss	0.992643	1.359832	$7,473.80	SPH.AX	0.992043	1.794434	$676.63
600331.ss	0.991439	1.029045	$872.43	BHP.AX	0.991112	0.63847	$161,632.00
600688.ss	0.986424	1.114578	$5,543.39	MGX.AX	0.989828	1.083146	$512.57
600832.ss	0.9795	0.829772	$2,698.61	RSG.AX	0.989793	1.435691	$729.91
600028.SS	0.979069	1.062374	$104,374.24	IGR.AX	0.989544	0.876141	$485.90
600104.ss	0.978776	0.839762	$25,140.50	LYC.AX	0.988708	0.996607	$1,009.81
600887.ss	0.978265	0.885271	$8,758.22	SDL.AX	0.985517	1.530724	$645.14
600811.ss	0.977933	1.158478	$1,484.06	PNA.AX	0.985273	1.334658	$1,406.99
600100.ss	0.973206	0.837848	$2,139.77	ARI.AX	0.98488	0.566847	$1,020.40
600009.SS	0.970523	0.996509	$3,945.50	AQP.AX	0.980083	0.555988	$316.00
600011.SS	0.96998	1.269564	$14,692.24	BSL.AX	0.977996	0.76673	$2,651.66
600269.ss	0.966535	0.892821	$1,231.68	GBG.AX	0.976579	0.788386	$283.51
600005.SS	0.965442	1.096068	$4,305.68	TRY.AX	0.969256	1.808882	$173.96
600026.SS	0.964137	0.977953	$1,969.20	OZL.AX	0.955976	1.33193	$1,440.00
600111.ss	0.959804	0.84184	$10,891.46	SGM.AX	0.955402	1.680748	$1,936.85
600717.ss	0.958613	1.128586	$1,563.89	IMD.AX	0.939148	0.942622	$271.51
600177.ss	0.954304	1.148483	$2,676.71	IRN.AX	0.93012	0.980166	$409.07
600309.ss	0.949176	1.035379	$6,034.06	EVN.AX	0.916044	0.786781	$902.82
600362.ss	0.943443	1.032142	$10,341.67	GRR.AX	0.897727	0.819006	$219.73
600019.SS	0.942489	1.091093	$12,881.11	RIO.AX	0.896701	1.335901	$85,933.67
600320.ss	0.93989	1.010157	$1,965.18	SIR.AX	0.895826	1.682214	$788.42
600601.ss	0.925347	0.923437	$796.68	WSA.AX	0.895578	1.742187	$574.78

Note: STOCK is the Chinese and Australian stock, BETA is systematic risk, MCAP is market capitalisation, SPEED is the speed of adjustment coefficient from the PAM.

Table 2 show that the 33 Australian and Chinese financial stocks are ranked in order from the fastest speed of adjustment to the slowest speed of adjustment. The fastest Chinese and Australian stocks are 600519.ss and NCM.AX, with speeds of 1.07 and 1.56, which is followed by 600583.ss and OGC.AX with speeds of 1.03 and 1.08. The slowest speeds of adjustment are 600601.ss and WSA.AX with speeds of 0.92 and 0.90. The second slowest 9and third slowest are 600320.ss (0.94) and SIR.AX (0.90) and 600019.ss (0.94) and RIO.AX (0.90) respectively.

It may be recalled that a speed of adjustment of 1 means the stocks fully adjust to new information and that they are efficient. A speed greater than 1 means the stocks over-react and a speed of $0 < \delta < 1$ means the stock under-react. Remember that over-reaction leads to contrarian strategies and that under-reaction leads to momentum strategies. Thus both contrarian and momentum strategies should be profitable in this sample. Small cap stocks tended to over-react and under-react and thus were inefficient. Large and medium cap stocks tended to fully adjust and thus were efficient.

4. Discussion

In this paper a new PAM was developed which does not suffer from the problem of non-synchronous trading because it does not make use of auto-correlation structures in its formulation. The new measure reports that for both Chinese and Australian markets there are short-term inefficiencies. These occur mainly in small cap stocks which under-react and over-react to new economic information. By the very nature of the PAM there is a long-term equilibrium. Therefore markets are efficient in the long-term.

Out of sixty-six stocks in table two, seven Chinese and ten Australian stocks have (*g)* greater than one. This does not provide overwhelming evidence of overreaction of the prices in response to the arrival of new information.

Twenty-five Chinese and twenty-three Australian stocks have g less than one, suggesting under reaction or slow adjustment process. The results indicate that speed of adjustment is quite slow in China and Australia. The traders tend to under-react to the information arrival. The results provide qualified support for Debondt and Thaler (1985) investor overreaction theory.

Chinese and Australian stocks exhibit variation in their speed of adjustments, indicating the prominent role of firm-specific factors in the price adjustment process. This may be explained as being the result of inefficiency in the information dissemination process. Traders are comprised of informed and uninformed traders. Informed traders have private information beyond the market information. Uninformed investors are limited to market information. Market information is generally shared by the informed and uninformed. Thus speed of adjustment due to market information will be faster than firm-specific information. Uninformed traders may observe the trading behaviours of informed traders for their investments decisions. There is evidence of asymmetries (Marisetty, 2003).

The results imply the speed of adjustment process in Chinese and Australian markets is very slow. This indicates inefficiencies in the information dissemination process. Due to the lack of private information uninformed investors may exhibit herd behaviour resulting momentum effects.

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