REVISITING THE WEAK-FORM EFFICIENCY OF THE AUSTRALIAN STOCK MARKET

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Abstract

We use recent daily data and several testing procedures to re-investigate the weak-form efficiency of the Australian stock of the top 50 companies across different industries. Contrary to most prior studies, our results suggest that the Australian market is weak-form efficient with little or no evidence for short-term return predictability.

JEL Classification: G14

Keywords: Australian Stock Market, Weak-Form Market Efficiency, Short-Term Predictability, Filter-Rules Test

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1. Introduction

The stock market efficiency hypothesis of Fama (1970) and others is an important milestone for understanding the working of capital markets. Among different types of market efficiencies, the literature classifies a given market as weak-form efficient when current stock prices fully reflect all information contained in past prices, thus preventing investors from gain abnormal returns based on historical market information. There are two groups of procedures for testing weak-form market efficiency. The first group conducts statistical tests to check independence between rates of returns. The second group compares investments which are based on trading rules relative to those that are based on simple buy-and-hold strategies (Reilly and Brown, 2009).

Prior studies like Praetz (1969), Officer (1975) and Gaunt and Gray (2003) have examined the weak-form efficiency of the Australian stock market, but with conflicting results. We revisit this issue using updated data that reflect the recent advances in information and communication technologies that have undoubtedly altered the nature and dynamics of stock trading. Therefore, we offer new evidence on the efficiency of the Australian stock market. Moreover, our results are derived from a multitude of testing procedures (autocorrelation, runs, and filter-rules tests). To foreshadow what follow, all three tests unambiguously suggest that the Australian stock market is weak-form efficient and that short-term returns in this market are unpredictable.

Section 2 reviews the germane literature on testing market efficiency. Section 3 describes the data and its summary statistics. Section 4 discusses the testing methods and the empirical findings. Section 5 concludes.

2. Literature Review

We briefly review the literature on the weak-form market efficiency tests with emphasis on the Australian market. A large volume of literature has been dedicated to testing the weak-form market efficiency ever since Fama (1970) introduced the concept of market efficiency. Research on testing market efficiency may trace back to Lo and MacKinlay (1988) who report some evidence against the efficiency of the US stock market. Test results in Harvey (1993) also too indicate that stock returns in emerging markets are highly predictable. However, Urritia (1995) suggests that several Latin American stock markets are weak-form efficient, although evidence lacks consistency across different testing procedures.

For the Australian stock market, Praetz (1969) uses the autocorrelation and runs tests to examine returns dependencies finding only a frail indication of return predictability. However, Officer (1975) finds results supporting the presence of large negative or positive autocorrelations in most of lagged stock returns. Brown *et al.* (1983) as well as Gaunt and Gray (2003) report similar evidence

against weak-form efficiency in the Australian market. In summary, prior empirical studies generally conclude that stock returns in the Australian market are predictable and that the market is not weak-form efficient.

3. Data and Summary Statistics

Our daily data, sourced from *DataStream*, are closing stock prices representing the top 50 companies traded on the Australian Stock Exchange (ASX) over the period from January 4, 2000 to December 31, 2012 (3390 observations). The prices are adjusted by dividend distributions, new equity issuances and share buybacks. We select the top 50 companies based on their market capitalization as of December 6, 2012. Table 1 contains detailed descriptions of the companies and their associated industry categories.

Table 1. Summary Statistics

ASX Code	Industry	Mean (×100)	Std. Dev. (×100)	Median (×100)	Min (×100)	Max (×100)	Skewness	Kurtosis	Jarque-Bera	ρ(1)	Starting Day
AGK	Utilities	0.04	1.36	0.02	-18.18	7.07	-0.80	12.67	23042	-0.012	Jan 4, 2000
AIO†	Transportation	-0.10	4.74	0.00	-91.12	51.29	-3.30	110.34	739709	-0.109	Jun 7, 2007
AMC	Materials	0.03	1.52	0.02	-10.75	13.69	0.11	4.87	3361	-0.015	Jan 4, 2000
AMP	Insurance	-0.01	2.01	0.02	-44.36	20.98	-2.92	75.00	799408	0.025	Jan 4, 2000
ANZ	Banks	0.05	1.59	0.02	-11.54	13.68	0.06	8.28	9694	0.037	Jan 4, 2000
ASX	Diversified Financials	0.05	1.65	0.00	-14.07	17.75	0.36	10.88	16789	-0.023	Jan 4, 2000
AZJ	Transportation	0.07	1.59	0.00	-4.05	5.94	0.21	0.55	11	-0.102	Nov 23, 2010
BHP	Materials	0.05	1.96	0.01	-14.07	11.48	-0.20	3.96	2239	-0.028	Jan 4, 2000
BXB	Commercial Service	0.00	1.97	0.01	-35.23	13.96	-1.99	35.51	180302	0.011	Jan 4, 2000
CBA	Banks	0.05	1.41	0.00	-9.53	11.79	0.05	6.29	5594	0.013	Jan 4, 2000
CCL	Food Beverage	0.05	1.62	0.01	-11.89	12.44	0.08	5.40	4115	-0.076	Jan 4, 2000
CFX	Real Estate	0.04	1.49	0.03	-12.76	14.53	-0.13	9.56	12927	-0.094	Jan 4, 2000
CPU	Software & Services	0.01	2.37	0.01	-41.64	22.32	-1.38	34.33	167572	0.002	Jan 4, 2000
CSL	Pharmaceuticals, Biotechnology & Life Sciences	0.06	1.99	0.01	-12.01	26.76	0.88	14.93	31906	0.066	Jan 4, 2000
CWN†	Consumer Services	-0.01	2.03	0.02	-13.32	12.65	0.00	5.05	1410	-0.054	Dec 4, 2007
DXS	Real Estate	0.02	1.94	0.02	-26.14	10.69	-1.21	17.52	44160	-0.014	Jan 4, 2000
FMG	Materials	0.18	5.66	0.00	-69.33	69.33	0.50	24.11	82225	-0.030	Jan 4, 2000
GMG	Real Estate	0.07	3.25	0.01	-29.70	29.05	-0.41	14.69	30580	0.099	Jan 4, 2000
GPT	Real Estate	0.00	2.33	0.03	-39.16	18.40	-1.76	41.76	248106	0.113	Jan 4, 2000
IAG	Insurance	0.03	1.66	0.00	-16.15	11.57	-0.34	5.73	4483	-0.053	Aug 9, 2000
ILU	Materials	0.04	2.40	0.01	-27.55	17.02	-0.31	8.38	9980	-0.015	Jan 4, 2000
IPL	Materials	0.08	2.56	0.01	-36.27	20.62	-1.29	23.02	54990	0.033	Jul 29, 2003
LEI	Capital Goods	0.05	2.32	0.02	-25.63	14.43	-0.44	8.29	9815	0.028	Jan 4, 2000
LLC	Real Estate	-0.01	1.88	0.01	-17.71	8.66	-0.96	8.77	11397	0.016	Jan 4, 2000
MGR	Real Estate	0.01	2.20	0.03	-26.45	30.04	-0.16	27.70	108384	0.109	Jan 4, 2000
MQG	Diversified Financials	0.03	2.34	0.02	-26.38	32.11	0.26	20.01	56608	0.011	Jan 4, 2000
NAB	Banks	0.02	1.65	0.02	-14.46	16.03	-0.38	9.72	13427	0.041	Jan 4, 2000
NCM	Materials	0.05	2.52	0.00	-18.37	14.05	-0.11	3.80	2045	0.036	Jan 4, 2000
NWS	Media	0.00	2.12	0.00	-24.06	24.57	0.01	13.31	25013	-0.012	Jan 4, 2000
ORG	Energy	0.07	1.83	0.01	-11.08	28.70	1.28	21.76	67798	-0.036	Jan 4, 2000
ORI	Materials	0.05	1.83	0.01	-16.59	18.34	0.03	8.17	9424	0.030	Jan 4, 2000
OSH	Energy	0.04	2.59	0.00	-28.77	19.57	-0.41	10.66	16140	0.014	Jan 4, 2000
QAN	Transportation	-0.01	2.10	0.02	-20.66	23.45	-0.16	14.02	27797	0.009	Jan 4, 2000
QBE	Insurance	0.03	2.32	0.02	-52.59	41.88	-4.06	157.26	3502610	-0.072	Jan 4, 2000
RIO	Materials	0.04	2.31	0.02	-41.93	14.36	-2.06	36.74	193062	-0.004	Jan 4, 2000
SGP	Real Estate	0.03	1.84	0.03	-11.32	11.66	-0.26	8.12	9356	0.051	Jan 4, 2000
SHL	Health Care Equipment & Services	0.03	1.68	0.01	-22.55	9.40	-0.83	14.68	30831	-0.054	Jan 4, 2000
STO	Energy	0.05	1.95	0.00	-16.85	11.33	-0.22	5.13	3746	-0.003	Jan 4, 2000
SUN	Insurance	0.03	1.85	0.00	-29.47	11.43	-1.36	24.24	84040	0.015	Jan 4, 2000
SYD	Transportation	0.05	2.12	0.00	-25.17	9.94	-0.97	11.73	15074	-0.042	Mar 10, 2003

TCL	Transportation	0.04	1.71	0.02	-15.74	19.93	0.46	13.36	25337	-0.049	Jan 4, 2000
TLS	Telecommunication Service	0.01	1.36	0.02	-12.33	8.35	-0.64	6.14	5549	0.038	Jan 4, 2000
TOL	Transportation	0.07	2.04	0.01	-19.73	12.92	-0.25	8.40	9998	0.050	Jan 4, 2000
WBC	Banks	0.05	1.52	0.02	-11.79	8.61	-0.08	4.61	3004	0.007	Jan 4, 2000
WDC	Real Estate	0.03	1.74	0.01	-13.20	20.92	0.46	10.91	16926	-0.042	Jan 4, 2000
WES	Food & Stapling Retailing	0.06	1.68	0.02	-14.39	12.62	-0.40	8.69	10761	0.001	Jan 4, 2000
WOR	Energy	0.11	2.49	0.01	-16.25	20.74	0.20	7.12	5573	0.079	Nov 29, 2002
WOW	Food & Stapling Retailing	0.06	1.28	0.00	-11.33	6.38	-0.20	4.42	2786	-0.037	Jan 4, 2000
WPL	Energy	0.04	1.84	0.01	-11.93	12.09	-0.06	4.51	2880	0.023	Jan 4, 2000
WRT†	Real Estate	0.04	1.32	0.00	-4.53	5.31	0.29	1.29	44	-0.117	Dec 14, 2010

Notes: The firms are: AGK-AGL Energy, AIO-Asciano Group, AMC-Amcor, AMP, ANZ-ANZ Bank, ASX,AZJ-Aurizon Holdings Ltd, BHP-BHP BLT, BXB-Bramble Ltd, CBA-Commonwealth Bank, CCL-Coca Cola Amatil, CFX-CFS Retail Property Trust, CPU-Cshare, CSL, CWN-Crown, DXS-Dexux property Group, FMG-Fortescue, GMG-Goodman Group, GPT, IAG-Insurance Australia,ILU-Iluka Resources Ltd, IPL-Incitec PV, LEI-Leighton, LLC-Lend Lease Group, MGR-Mirvac Group, MQG-Macquarie Group, NAB-National Australian Bank, NCM-Newcrest, NWS-News Corporation, ORG-Origin Energy, ORI-Orica, OSH-Oil Search, QAN-Qantas, QBE-QBE Insurance, RIO-Rio Tinto, SGP-Stockland, SHL-Sonic Health, Sun-Sun Metway, SYD-Sydney Airport, TCL-Transurban, TLS-Telstra, TOL-Tollholdings, WBC-Westpac, WDC-Westfield, WES-Wesfarmer, WOR-Worleypars, WOW-Woolworths, WPL-Woodside, and WRT-Westfield Retail Trust. Jarque-Bera statistics for normality test are all significant at the 1% level. The ASX code of the firm that does not have more than 5 years' data is denoted with †. The data are daily starting from January 4, 2000 for most firms and end on 31 December 2012 for all firms. An † denotes firms with smaller data size (5 years or less).

The daily market return at day *t* is calculated as:

$$R_{i,t} = \ln(P_{i,t} / P_{i,t-1}) \quad (1)$$

where $P_{i,t}$ is the price of stock *i* at day *t*.

Table 1 reports the summary statistics of the daily returns on the top 50 Australian stocks. The sample means, standard deviations, medians, minimums, maximums, skewness, kurtosis, Jacaque-Bera statistics, and the first-order autocorrelation coefficients are presented. The median returns for most companies are close to zero, and all are less than 40 basis points. The return distributions for all the companies are non-normal. The Jarque-Bera statistics for normality are significant at the 1% level, suggesting the rejection of the null hypothesis. Furthermore, the kurtosis for most return series is significantly larger than 3, implying fat-tail distributions. Finally, the first-order autocorrelation coefficients for most companies are negative with absolute values lower than 0.1.

4. Testing Strategies and Results

The short-term predictability test examines whether returns in past trading days can predict today's returns. To do that, we use three procedures; namely, the correlation test, the runs test, and filter-rules test. We briefly explain below each of these procedures.

4.1 The Correlation Test

This test investigates the linear relationship between today's returns with past returns. The testing regression takes the following form:

$$r_{i,t} = \alpha_i + \beta_i r_{i,t-1-T} + \varepsilon_{i,t} \quad (2)$$

where α_i is the expected return of stock *i*, which is unrelated to past return; β_i measures the relationship between today's return with past return; $r_{i,t-1-T}$ represents past return of stock *i* , and $\varepsilon_{i,t}$ is the error term.

Table 2 presents the correlations estimates between current and past returns (where past returns are yesterday's return, returns two days ago, three days ago, four days ago, five days ago, and ten days ago). For most of the top 50 stocks, column 1 suggests that there is no relationship between today's return and yesterday's return. For example, for the big four banks, ANZ, CBA, NAB, and WBC, yesterdays' return cannot predict today's return at the 5% significance level. However, only for 12 out of these 50 stocks do the correlation coefficients prove significant at the 5% level. However, judged by the low values of the squared correlation coefficients (see Elton *et al*., 2010), past returns exhibit very weak power for predicting current returns. Moreover, the correlation coefficients for most of these 12 stocks lose significance at longer horizons. Taken together, results in Table 2 suggest that return the correlations for the top 50 stocks prove feeble at best.

Table 2. Daily Correlation Coefficients

	1		2		3		4		5		10	
ASX Code	β_i	*t-stat*	β_i	*t-stat*	β_i	*t-stat*	β_i	*t-stat*	β_i	*t-stat*	β_i	*t-stat*
AGK	-0.01	(-0.56)	-0.05**	(-2.55)	0.00	(0.17)	-0.01	(-0.45)	-0.05**	(-2.35)	-0.01	(-0.31)
AIO†	-0.11	(-1.28)	-0.09	(-1.58)	-0.05	(-0.84)	-0.09	(-1.56)	0.09**	(2.34)	-0.02	(-0.44)
AMC	-0.01	(-0.67)	-0.05**	(-2.02)	-0.03	(-1.44)	0.01	(0.23)	-0.05**	(-2.52)	0.02	(0.67)
AMP	0.02	(0.98)	0.01	(0.33)	-0.05**	(-2.20)	-0.02	(-0.77)	0.00	(0.22)	0.03*	(1.75)
ANZ	0.04	(1.31)	-0.06**	(-2.23)	-0.08**	(-2.61)	-0.02	(-0.72)	0.05*	(1.77)	0.03	(0.99)
ASX	-0.02	(-0.95)	-0.06**	(-2.04)	0.01	(0.48)	0.00	(0.11)	0.01	(0.35)	-0.01	(-0.41)
AZJ	-0.10**	(-2.22)	-0.02	(-0.47)	-0.06	(-1.25)	-0.05	(-1.11)	-0.09	(-1.64)	0.01	(0.16)
BHP	-0.03	(-1.10)	-0.03	(-1.05)	-0.03	(-0.91)	0.01	(0.23)	-0.02	(-0.55)	-0.02	(-0.94)
BXB	0.01	(0.45)	-0.09**	(-4.42)	-0.03	(-1.32)	0.00	(0.03)	0.00	(-0.06)	-0.01	(-0.63)
CBA	0.01	(0.46)	-0.02	(-0.69)	-0.04	(-1.19)	0.01	(0.30)	0.01	(0.34)	-0.01	(-0.26)
CCL	-0.08**	(-3.41)	-0.05**	(-2.27)	-0.01	(-0.47)	-0.03	(-1.31)	0.00	(-0.02)	-0.02	(-1.02)
CFX	-0.09**	(-3.01)	-0.08**	(-2.49)	-0.01	(-0.27)	-0.04*	(-1.65)	-0.08**	(-2.32)	0.07**	(2.07)
CPU	0.00	(0.08)	-0.04*	(-1.87)	-0.01	(-0.40)	-0.01	(-0.62)	0.00	(0.05)	0.00	(0.02)
CSL	0.07**	(3.15)	-0.06**	(-2.74)	-0.04**	(-2.33)	0.01	(0.49)	-0.03*	(-1.78)	-0.01	(-0.35)
CWN†	-0.05	(-1.16)	0.04	(0.96)	0.02	(0.69)	0.00	(-0.06)	0.01	(0.18)	0.03	(0.78)
DXS	-0.01	(-0.45)	-0.02	(-0.52)	-0.07**	(-1.96)	-0.03	(-0.85)	-0.03	(-0.76)	0.02	(0.35)
FMG	-0.03	(-0.82)	-0.03	(-1.23)	-0.05	(-1.06)	0.01	(0.22)	0.01	(0.26)	-0.01	(-0.52)
GMG	0.10**	(2.15)	-0.03	(-0.82)	-0.01	(-0.47)	0.00	(-0.01)	0.04	(1.00)	0.01	(0.39)
GPT	0.11**	(2.00)	0.01	(0.23)	-0.03	(-0.50)	-0.08	(-1.52)	-0.09*	(-1.78)	0.03	(0.62)
IAG	-0.05**	(-2.57)	-0.03	(-1.32)	-0.02	(-0.98)	-0.02	(-0.82)	0.01	(0.66)	0.02	(1.02)
ILU	-0.01	(-0.61)	0.00	(0.14)	-0.03	(-1.41)	0.00	(-0.06)	0.02	(0.92)	-0.03	(-1.49)
IPL	0.03	(1.13)	-0.02	(-0.73)	-0.05*	(-1.84)	-0.03	(-0.93)	-0.01	(-0.24)	0.02	(0.86)
LEI	0.03	(1.28)	-0.07**	(-2.26)	-0.03	(-1.08)	-0.02	(-0.61)	0.04	(1.41)	0.00	(-0.02)
LLC	0.02	(0.56)	-0.04*	(-1.84)	-0.05**	(-2.45)	0.00	(-0.11)	-0.01	(-0.23)	0.00	(0.04)
MGR	0.11**	(2.05)	0.06	(1.10)	-0.06	(-1.09)	-0.01	(-0.30)	-0.06	(-1.62)	0.00	(0.04)
MQG	0.01	(0.28)	-0.01	(-0.38)	-0.03	(-0.78)	-0.04	(-1.12)	0.00	(0.12)	0.03	(1.11)
NAB	0.04*	(1.76)	-0.04	(-1.42)	-0.07**	(-2.18)	-0.05*	(-1.69)	0.01	(0.48)	0.02	(0.49)
NCM	0.04	(1.60)	-0.03	(-1.57)	-0.02	(-0.83)	0.00	(-0.11)	-0.01	(-0.72)	-0.02	(-0.78)
NWS	-0.01	(-0.46)	-0.01	(-0.58)	-0.04	(-1.37)	-0.02	(-0.67)	0.01	(0.57)	0.02	(0.68)
ORG	-0.04	(-1.27)	-0.05**	(-2.25)	-0.02	(-1.09)	-0.02	(-0.77)	0.00	(0.05)	-0.03	(-1.13)
ORI	0.03	(1.16)	-0.03	(-1.23)	-0.04*	(-1.66)	-0.04	(-1.39)	0.01	(0.29)	0.01	(0.40)
OSH	0.01	(0.53)	-0.04*	(-1.65)	-0.04**	(-2.10)	0.01	(0.17)	-0.01	(-0.26)	0.01	(0.27)
QAN	0.01	(0.35)	-0.02	(-0.82)	0.04	(1.39)	-0.04	(-1.61)	-0.02	(-1.02)	0.01	(0.27)
QBE	-0.07	(-0.61)	-0.05	(-1.28)	0.13	(1.15)	-0.11	(-1.33)	-0.03	(-0.77)	0.02	(0.83)
RIO	0.00	(-0.12)	-0.04	(-1.26)	-0.04	(-0.94)	0.05	(1.09)	0.00	(0.09)	-0.01	(-0.23)
SGP	0.05	(1.52)	-0.07*	(-1.94)	-0.11**	(-3.27)	0.00	(0.12)	-0.04	(-0.94)	0.00	(0.01)
SHL	-0.05**	(-2.61)	0.00	(-0.15)	-0.04**	(-1.98)	0.01	(0.42)	-0.01	(-0.75)	0.01	(0.30)
STO	0.00	(-0.13)	-0.05	(-1.52)	-0.02	(-0.96)	0.02	(0.57)	-0.01	(-0.34)	-0.01	(-0.37)
SUN	0.02	(0.58)	-0.06**	(-2.22)	-0.03	(-1.00)	0.00	(-0.11)	-0.02	(-0.77)	0.03	(0.93)
SYD	-0.04	(-1.46)	-0.03	(-1.12)	-0.02	(-0.68)	0.01	(0.36)	0.00	(-0.19)	-0.02	(-0.62)
TCL	-0.05*	(-1.90)	0.01	(0.29)	-0.02	(-1.02)	0.01	(0.45)	0.00	(0.07)	0.01	(0.40)
TLS	0.04*	(1.72)	-0.06**	(-2.88)	-0.05**	(-2.32)	0.00	(-0.20)	0.00	(-0.03)	-0.04**	(-2.44)
TOL	0.05**	(2.09)	-0.02	(-0.94)	-0.01	(-0.67)	-0.02	(-1.22)	0.01	(0.51)	0.03*	(1.92)
WBC	0.01	(0.31)	-0.06*	(-1.90)	-0.02	(-0.60)	0.01	(0.26)	-0.01	(-0.39)	0.00	(-0.15)
WDC	-0.04	(-1.45)	-0.05*	(-1.89)	-0.07**	(-2.31)	-0.04*	(-1.69)	-0.07**	(-2.19)	0.05*	(1.76)
WES	0.00	(0.02)	-0.02	(-0.68)	-0.03	(-1.31)	-0.04	(-1.25)	0.01	(0.55)	-0.01	(-0.43)
WOR	0.08**	(2.69)	0.02	(0.85)	-0.09**	(-3.09)	-0.03	(-1.02)	0.00	(0.05)	0.03	(0.96)
WOW	-0.04	(-1.45)	0.00	(-0.22)	-0.07**	(-3.39)	-0.02	(-0.86)	0.01	(0.29)	-0.01	(-0.32)
WPL	0.02	(0.95)	-0.02	(-0.93)	-0.04*	(-1.88)	-0.02	(-0.72)	0.00	(0.10)	0.00	(-0.10)
WRT†	-0.12**	(-2.08)	-0.06	(-1.47)	0.10	(1.50)	-0.12**	(-2.23)	-0.10**	(-2.31)	-0.07	(-1.38)

Notes: See notes to Table 1. The ** and * denote statistical significance at the 5% and 10% levels, respectively.

4.2 The Runs Test

Some might object to the above correlation test on the grounds that it may be seriously driven by some extreme observations (Elton *et al.*, 2010). To address this objection, we supplement the above results by using the correlation test which is based on sign changes of prices and can thus remove this outlier noise. Runs test tabulates the number of sequence of consecutive positive (+) and negative

(−) returns. For example, a sequence of returns such as + − − − + + + 0 has four runs: a run of one +, a run of three −, and a run of three +, and a run of no change. The actual number of runs is calculated by counting the number of runs in the sequence of returns. The expected number of runs is calculated as:

$$Expected\ Runs = \left[N \times (N+1) - (N_1^2 + N_2^2 + N_3^2) \right] / N \quad (3)$$

where N is the number of total returns, N_1 is the number of positive returns, N_2 is the number of no changes in prices, and N_3 is the number of negative returns. Table 3 presents the results.

Table 3. Total Actual and Expected Numbers of Runs for One-, Four-, Nine-, and Sixteen-Day Differencing Intervals

	Daily		Four-Day		Nine-Day		Sixteen-Day	
ASX Code	Actual	Expected	Actual	Expected	Actual	Expected	Actual	Expected
AGK	1714	1684.0	447	418.7	198	186.2	109	103.6
AIO†	798	810.4	185	191.2	81	83.8	47	46.5
AMC	1703	1686.3	438	423.9	197	189.0	116	106.4
AMP	1778	1716.8	454	424.3	201	191.7	104	106.1
ANZ	1648	1686.0	441	416.4	178	185.9	106	103.6
ASX	1764	1864.0	430	432.9	191	188.8	97	103.3
AZJ	347	339.7	86	73.3	36	33.5	21	20.6
BHP	1688	1683.8	429	421.7	191	186.4	108	104.5
BXB	1711	1686.9	474	424.5	184	187.6	114	106.0
CBA	1779	1840.6	453	422.1	179	183.7	102	102.5
CCL	1737	1679.7	462	423.1	187	187.5	116	104.8
CFX	1648	1600.2	455	412.1	211	185.9	110	104.5
CPU	1682	1685.2	428	424.0	192	188.9	106	106.1
CSL	1604	1691.7	437	421.4	201	187.8	103	103.9
CWN†	687	671.4	176	166.8	72	73.5	46	41.4
DXS	1640	1593.4	456	413.7	211	185.4	114	102.9
FMG	1787	2205.3	476	502.4	205	207.2	108	113.0
GMG	1717	1812.2	446	425.3	185	184.4	112	105.2
GPT	1627	1644.3	456	420.4	204	185.7	108	103.6
IAG	1967	1907.6	468	439.1	189	189.6	105	106.6
ILU	1736	1748.1	453	429.2	198	189.9	119	106.9
IPL	1231	1307.5	320	310.2	146	133.9	77	75.1
LEI	1653	1689.0	431	420.6	192	187.1	94	103.3
LLC	1637	1687.5	432	424.1	200	188.0	108	105.8
MGR	1625	1667.4	450	422.6	175	186.7	108	103.9
MQG	1577	1687.8	446	420.8	176	186.9	104	105.0
NAB	1659	1689.0	424	419.4	192	185.4	100	102.9
NCM	1696	1772.5	450	423.2	196	188.2	111	105.5
NWS	1695	1694.9	430	424.4	193	188.9	105	106.1
ORG	1725	1682.9	443	421.2	205	184.2	109	105.5
ORI	1675	1687.9	431	420.2	182	184.8	112	105.2
OSH	1993	2036.0	483	458.3	193	195.5	107	109.7
QAN	1714	1777.0	446	434.0	201	190.0	102	107.3
QBE	1679	1690.0	473	420.8	211	186.9	98	104.5
RIO	1674	1686.5	427	421.2	202	185.9	122	105.0
SGP	1657	1662.9	450	420.2	206	185.7	108	102.5
SHL	1761	1689.6	446	422.8	192	186.2	116	106.0
STO	1913	1877.6	474	435.3	201	189.0	112	107.4
SUN	1926	1895.9	457	438.9	183	188.2	110	104.8
SYD	1533	1541.0	353	351.6	144	145.5	79	82.8
TCL	1762	1731.6	455	428.6	203	188.1	98	105.6
TLS	1637	1681.5	444	423.9	199	188.2	112	106.4
TOL	1599	1683.9	410	422.0	189	185.9	103	103.9
WBC	1653	1685.6	439	417.2	196	185.9	102	102.5
WDC	1717	1691.3	476	423.9	199	186.9	104	105.6
WES	1681	1680.1	436	418.7	189	184.5	104	105.2
WOR	1288	1379.3	326	330.9	139	144.4	82	77.1
WOW	1834	1864.2	453	429.2	177	189.9	112	100.8
WPL	1681	1689.3	465	422.6	190	188.4	113	106.2
WRT†	345	332.2	76	74.8	43	34.7	19	18.6

Notes: See notes to Tables 1 and 2.

The runs results displayed in Table 3 are for one, four, nine, and sixteen days intervals. As seen in the table, the relationships between today's stock return and yesterday's stock return for the vast majority of stocks are generally weak as the actual number of runs in each case is quite close to the expected number of runs. As Fama (1965) points out, if the number of actual runs is less than the expected number, this implies a positive relationship between the returns. Take GPT for one-day interval as an example. The actual number of runs is 1627, which is less than the expected number of 1644.3, suggesting a positive relationship. Indeed, as shown in Table 1, the correlation coefficients between today's return and yesterday's return for most companies are very small and most are statistically insignificant at the conventional level.

Therefore, similar to the verdict from the correlation test, the results we obtain from the correlation test indicate that the prices of the top 50 stocks in the Australian market generally follow a random-walk path. Although a few prices appear to divert from this path, the evidence is too weak to support the possibility of gaining trading benefits net of transaction costs. We further discuss this issue below.

4.3 The Filter-Rules Test

We devote this sub-section to testing whether a trading rule based on a particular return pattern can be used to gain excess profit. One example of a trading rule is the filter rule pioneered by Alexander (1961). According to this rule, a stock is purchased when it rises by X% from the previous price and held until its price drops by X% at which the stock will be (short) sold. Another simpler trading rule is the buy-and-hold strategy. Following Fama and Blume (1966), we compare the performance of the filter rule relative to the buy-and-hold rule for the top 50 Australian stocks. Table 4 reports the results.

Table 4. Return Comparisons using the Filter Rule versus the Simple Buy-and-Hold Rile

ASX Code	Filter Size:															
	0.5%		1%		1.5%		2%		2.5%		3%		4%		5%	
	F	B	F	B	F	B	F	B	F	B	F	B	F	B	F	B
AGK	-0.139	0.112	-0.134	0.111	-0.128	0.111	-0.127	0.115	-0.145	0.115	-0.158	0.113	-0.173	0.118	-0.185	0.140
AIO†	-0.459	-0.244	-0.389	-0.244	-0.321	-0.244	-0.272	-0.248	-0.234	-0.264	-0.241	-0.264	-0.069	-0.283	-0.268	-0.328
AMC	-0.134	0.077	-0.145	0.077	-0.110	0.076	-0.173	0.075	-0.129	0.072	-0.114	0.072	-0.092	0.071	-0.087	0.048
AMP	-0.059	-0.019	-0.019	-0.020	0.025	-0.021	0.033	-0.021	0.052	-0.029	0.057	-0.029	0.017	-0.029	-0.082	-0.015
ANZ	-0.056	0.115	-0.034	0.114	-0.085	0.116	-0.118	0.116	-0.134	0.116	-0.105	0.105	-0.119	0.105	-0.167	0.101
ASX	0.060	0.119	-0.035	0.118	-0.151	0.121	-0.196	0.125	-0.208	0.123	-0.264	0.123	-0.289	0.147	-0.281	0.152
AZJ	-0.433	0.179	-0.498	0.179	-0.372	0.178	-0.382	0.185	-0.369	0.185	-0.411	0.185	-0.315	0.185	-0.247	0.185
BHP	-0.187	0.128	-0.117	0.128	-0.208	0.125	-0.205	0.126	-0.216	0.126	-0.234	0.126	-0.220	0.134	-0.290	0.170
BXB	-0.084	0.009	-0.089	0.008	-0.062	0.006	-0.064	0.006	0.002	0.006	-0.036	0.006	-0.089	-0.005	-0.122	-0.005
CBA	-0.004	0.118	-0.079	0.116	-0.125	0.116	-0.150	0.105	-0.159	0.104	-0.136	0.101	-0.163	0.100	-0.193	0.121
CCL	-0.286	0.128	-0.257	0.130	-0.273	0.128	-0.281	0.133	-0.214	0.132	-0.214	0.123	-0.248	0.137	-0.272	0.124
CFX	-0.375	0.104	-0.325	0.104	-0.308	0.104	-0.252	0.104	-0.207	0.107	-0.173	0.100	-0.183	0.100	-0.180	0.100
CPU	-0.122	0.031	-0.217	0.032	-0.097	0.028	-0.111	0.030	-0.090	0.030	-0.084	0.030	-0.092	0.025	-0.130	0.025
CSL	0.097	0.163	0.049	0.164	-0.003	0.164	-0.076	0.164	-0.128	0.164	-0.181	0.159	-0.251	0.159	-0.275	0.159
CWN†	-0.395	-0.013	-0.334	-0.016	-0.320	-0.015	-0.286	-0.021	-0.255	-0.032	-0.167	-0.028	-0.106	-0.207	-0.166	-0.183
DXS	-0.239	0.061	-0.145	0.060	-0.128	0.059	-0.102	0.059	-0.077	0.059	-0.090	0.059	-0.102	0.059	-0.073	0.041
FMG	n/a	0.442	n/a	0.442	n/a	0.442	n/a	0.442	n/a	0.442	n/a	0.442	n/a	0.442	n/a	0.436
GMG	-0.031	0.174	-0.040	0.174	-0.080	0.174	-0.077	0.180	-0.127	0.180	-0.201	0.176	-0.290	0.155	-0.281	0.155
GPT	-0.045	0.006	0.000	0.005	0.005	0.005	-0.015	0.004	-0.005	0.000	-0.007	0.002	0.007	0.002	0.034	-0.027
IAG	-0.224	0.079	-0.248	0.079	-0.194	0.077	-0.162	0.075	-0.163	0.075	-0.164	0.066	-0.127	0.048	-0.140	0.048
ILU	-0.092	0.101	-0.087	0.101	-0.130	0.101	-0.113	0.101	-0.150	0.101	-0.146	0.101	-0.257	0.099	-0.260	0.095
IPL	0.043	0.196	-0.101	0.196	-0.218	0.196	-0.223	0.195	-0.226	0.195	-0.340	0.192	-0.418	0.200	-0.476	0.225
LEI	-0.050	0.124	-0.082	0.124	-0.110	0.124	-0.163	0.124	-0.225	0.121	-0.236	0.121	-0.182	0.121	-0.243	0.121
LLC	0.037	-0.019	-0.019	-0.019	-0.044	-0.022	-0.051	-0.022	-0.059	-0.025	-0.039	-0.025	-0.034	-0.025	-0.077	-0.037
MGR	0.090	0.029	0.040	0.029	-0.013	0.028	-0.021	0.028	-0.036	0.028	-0.051	0.024	-0.027	0.008	-0.052	-0.001
MQG	0.200	0.064	0.124	0.064	-0.053	0.064	-0.123	0.063	-0.156	0.059	-0.177	0.054	-0.133	0.040	-0.154	0.035
NAB	-0.001	0.059	0.003	0.058	0.004	0.060	0.009	0.053	-0.017	0.052	-0.024	0.052	-0.039	0.052	-0.072	0.054
NCM	0.119	0.121	0.133	0.121	0.041	0.131	-0.089	0.134	-0.210	0.139	-0.241	0.139	-0.279	0.142	-0.302	0.142
NWS	-0.026	-0.009	0.041	-0.009	0.055	-0.009	0.062	-0.009	0.040	-0.011	-0.038	-0.011	-0.077	-0.018	-0.082	-0.046
ORG	-0.217	0.172	-0.208	0.173	-0.197	0.173	-0.266	0.173	-0.257	0.173	-0.233	0.173	-0.215	0.166	-0.263	0.203
ORI	-0.059	0.133	-0.076	0.133	-0.103	0.133	-0.171	0.133	-0.201	0.136	-0.202	0.144	-0.233	0.144	-0.195	0.144
OSH	-0.189	0.107	-0.178	0.109	-0.188	0.108	-0.186	0.108	-0.202	0.108	-0.224	0.117	-0.221	0.109	-0.203	0.117
QAN	-0.017	-0.023	-0.008	-0.024	-0.002	-0.025	-0.017	-0.025	-0.041	-0.025	-0.018	-0.036	-0.032	-0.036	-0.040	-0.036
QBE	-0.120	0.078	-0.112	0.078	-0.193	0.078	-0.195	0.075	-0.226	0.091	-0.232	0.091	-0.236	0.092	-0.247	0.092

Table 4. continued

RIO	-0.060	0.092	-0.109	0.092	-0.179	0.092	-0.249	0.084	-0.228	0.084	-0.264	0.085	-0.280	0.085	-0.348	0.102
SGP	-0.048	0.080	-0.112	0.079	-0.174	0.080	-0.193	0.079	-0.176	0.079	-0.182	0.079	-0.163	0.075	-0.101	0.065
SHL	-0.159	0.080	-0.188	0.080	-0.201	0.079	-0.235	0.079	-0.210	0.079	-0.171	0.072	-0.158	0.072	-0.159	0.071
STO	-0.137	0.117	-0.171	0.116	-0.190	0.116	-0.210	0.119	-0.223	0.119	-0.213	0.119	-0.262	0.116	-0.218	0.116
SUN	-0.094	0.075	-0.057	0.075	-0.097	0.075	-0.071	0.075	-0.112	0.070	-0.049	0.060	-0.047	0.057	-0.069	0.054
SYD	-0.150	0.118	-0.262	0.118	-0.190	0.118	-0.226	0.119	-0.234	0.110	-0.231	0.110	-0.276	0.139	-0.285	0.152
TCL	-0.260	0.090	-0.239	0.092	-0.286	0.090	-0.257	0.088	-0.213	0.088	-0.172	0.088	-0.174	0.094	-0.175	0.094
TLS	0.031	0.013	0.005	0.012	-0.019	0.012	-0.033	0.005	-0.015	0.002	0.008	-0.025	0.003	-0.025	-0.010	-0.025
TOL	0.022	0.164	-0.015	0.166	-0.081	0.166	-0.153	0.166	-0.229	0.166	-0.222	0.166	-0.226	0.156	-0.261	0.156
WBC	-0.018	0.118	-0.086	0.117	-0.107	0.118	-0.133	0.102	-0.186	0.103	-0.173	0.105	-0.128	0.106	-0.144	0.104
WDC	-0.070	0.069	-0.144	0.069	-0.197	0.069	-0.188	0.061	-0.187	0.061	-0.223	0.063	-0.199	0.055	-0.164	0.055
WES	-0.073	0.144	-0.094	0.143	-0.110	0.140	-0.159	0.142	-0.150	0.142	-0.183	0.142	-0.216	0.142	-0.221	0.152
WOR	0.154	0.276	0.014	0.277	-0.025	0.275	-0.131	0.277	-0.192	0.277	-0.299	0.299	-0.321	0.299	-0.350	0.322
WOW	-0.165	0.162	-0.135	0.163	-0.199	0.166	-0.192	0.161	-0.199	0.161	-0.181	0.161	-0.238	0.188	-0.232	0.188
WPL	0.006	0.109	-0.046	0.110	-0.105	0.110	-0.152	0.113	-0.154	0.113	-0.155	0.109	-0.190	0.109	-0.202	0.109
WRT†	-0.341	0.108	-0.356	0.112	-0.322	0.113	-0.308	0.133	-0.137	0.133	0.058	-0.005	0.017	-0.005	-0.031	-0.005

Notes: See notes to tables 1and 2. "F" denotes returns using the filter rule while "B" denote returns obtained using the buy-and- hold strategy. The percentages X% in the filter rule are alternatively set at 0.5%, 1%, 1.5%, 2%, 2.5%, 3%, 4%, and 5%.The "n/a" denotes that the returns under the strategy is unusually large (compared to others) due to some extreme price movements in the return series.

These results show that for some negatively correlating stocks such as CCL and CFX, the simple buy-and-hold strategy performs better than the filter rule for all filters ranging from 0.5% to 5%. For example, under the filter size of 0.5%, the CCL has a negative return of -0.286 under the filter rule, but a positive return of 0.128 under the buy-and-hold rule. Even for some positively correlated stocks (at 1 day lag) the filter rule does not outperform the buy-and-hold strategy. For example, the GPT with the filter size of 0.5% has a negative return under the filter technique but a positive return using the buy-and-hold rule.

In sum, the simple buy-and-hold strategy generally outperforms the filter rule, an outcome pointing again to the random-walk behavior in the Australian stock market.

5. Conclusion

This paper uses alternative procedures to test the weak-form efficiency hypothesis in the Australian market as represented by the top 50 stocks across different sectors. The results based on daily data from January 2000 to December 2012 indicate that there are no noticeable autocorrelations between the returns in most of the stocks with very limited ability to forecast current short-term returns using past return information. Moreover, simple buy-and-hold routines generally outperform the filter-rule trading strategy for most of the Australian stocks. Therefore, results from alternative tests generally suggest that prices of the top 50 Australian stocks behave in a random-walk fashion and that the Australian market is weak-form efficient.

From a practical standpoint, these results imply that investors and fund managers cannot gain abnormal returns in the Australian market from trading strategies based on historical stock prices. However, from the policy makers' perspective, our evidence of an efficient Australian market could be a testimony for prudent regulations and competent market administrators.

This paper can be extended in several fruitful directions. In particular, our data comprise of the top 50 Australian companies which, given their size and might, generally tend to perform more efficiently relative to small firms. Therefore, it seems useful to investigate the weak-form efficiency in Australia when the market is represented by small and medium size firms. In addition, the linear correlation test may be inappropriate for testing market efficiency since changes in stock prices tend to follow non-linear paths. Non-linear correlation tests such as those discussed in Hinich (1996) may provide interesting insights into the behavior of the Australian market.

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