The Significance of Serial Cross-Correlations After Controlling for a Specific Factor Structure in Security Returns

Eric James Higgins
Kansas State University

David R. Peterson
Florida State University

Two important sources of predictability in security returns are serial cross-correlations and time-varying factors. Hameed (1997) finds that serial cross-correlation patterns in security returns do not exist after controlling for a general, time-varying factor structure in returns. This paper finds significant serial cross-correlations in daily returns after controlling for autocorrelation and the Fama and French (1993) factors. When returns are conditioned on prior market-wide information, serial cross-correlations in daily returns are found to be significant only after bad news.

Introduction

Two interesting sources of predictability that have been identified in security returns are serial cross-correlations and significant time-varying factor structures. Recent studies by Fargher and Weigand (1998) and Richardson and Peterson (1999) find the existence of significant serial cross-correlations in security returns. Hameed (1997) suggests that serial cross-correlations and time-varying factor structures may be related. He finds that a time-varying factor model can explain the existence of serial cross-correlation patterns in security returns. The purpose of this study is to extend the studies by Hameed (1997) and Fargher and Weigand (1998) by examining whether the Fama and French (1993) three-factor model accounts for serial cross-correlation patterns in daily security returns.

Most of the previous research on the existence of serial cross-correlations in security returns has focused on weekly security returns. Lo and MacKinlay (1990) document that the returns of small stocks lag the returns of large stocks. Boudoukh, Richardson, and Whitelaw (1994), however, suggest that serial cross-correlations in

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security returns are simply a manifestation of return autocorrelation and contemporaneous correlations among assets. Hameed (1997) supports this conclusion by finding that serial cross-correlations are not significant after controlling for portfolio return autocorrelation. Richardson and Peterson (1999) find, however, that significant serial cross-correlations exist in weekly returns after controlling for portfolio return autocorrelation.

Fargher and Weigand (1998) extend the literature on serial cross-correlations by examining daily returns. They find that significant serial cross-correlations exist in daily security returns after controlling for the existence of daily autocorrelations. They show, however, that the strength of the serial cross-correlations has decreased over time.

The literature on the existence of time-varying factors is also extensive. Keim and Stambaugh (1986) were among the first to find time-varying risk premiums that are related to a set of predictor variables reflective of levels of asset prices. One of the most studied factor models in recent financial research is that of Fama and French (1993). Fama and French find that a model containing risk premia related to size, book-to-market equity ratio (BE/ME), and the market explains a significant amount of variation in returns. The three factors are shown to account for the predictable variation in other factors such as the dividend yield and the earnings-price ratio.

Given that serial cross-correlations and time-varying factor models both appear to explain predictable variation in returns, it is likely that there is a relationship between these two sources of predictability. Recent studies examine the possible relationships between serial cross-correlations and time-varying factor models. Hameed (1997) shows that a general, time-varying, two-factor model can explain the existence of serial cross-correlation patterns in returns. McQueen, Pinegar, and Thorley (1996), however, show that significant serial cross-correlations occur after good news, even after controlling for a specific factor structure that includes the term spread, the dividend yield, the default spread, and the inflation rate. Thus, there is no clear answer as to whether significant serial cross-correlations exist after controlling for time-varying factors.

The recent studies on serial cross-correlations have left several unanswered questions, especially regarding the nature of serial cross-correlations in daily returns. First, are serial cross-correlations in daily returns significant after controlling for a specific factor structure such as that proposed by Fama and French (1993)? Hameed (1997) finds that serial cross-correlations in weekly returns are not robust to a general factor structure, but McQueen, Pinegar, and Thorley (1996) find that serial cross-correlations in monthly returns are significant after controlling for a specific factor structure. Second, is the significance of daily serial cross-correlations unidirectional? That is, do large-firm returns lead small-firm returns without the reverse being true? Brennan, Jegadeesh and Swaminathan (1993) show that it is important to consider bi-directional causality in security returns. Third, do serial cross-correlation patterns in daily returns exhibit the same asymmetric pattern documented by McQueen, Pinegar, and Thorley (1996)?

This study extends the current literature by examining these questions. First, we examine the significance of serial cross-correlations in daily returns after controlling for the specific factor structure in the three-factor model of Fama and French (1993). The Fama and French factors are chosen because of their significance in explaining return variation and their wide examination in the literature. Second, this study examines whether daily small-firm returns can be used to predict large-firm returns. Finally, this study examines whether there is a difference in daily serial cross-correlations when there is prior good news or bad news. Thus, this study provides further evidence documenting the predictability of security returns by further examining the significance of serial cross-correlations and the validity of the factors used in the Fama and French model.

The results of this study show that a significant first-order serial cross-correlation exists in security returns, after controlling for the Fama and French (1993) factors. Serial cross-correlations are not shown to be asymmetric. Lagged small-firm returns are found to predict large firm returns. Interestingly, serial cross-correlations between small and large firms are found to be significant only when prior information is bad. We conclude that serial cross-correlations are a significant source of predictability in security returns after controlling for a specific factor structure. Our results are not entirely consistent, however, with existing theories explaining the existence of serial cross-correlations in security returns.

Data Sources and Portfolio Formation

Size-Sorted Portfolios

Four size-sorted portfolios of daily security returns taken from the Center for Research in Security Prices (CRSP) database for New York Stock Exchange and American Stock Exchange (NYSE/AMEX) securities, from April 1, 1976 to December 30, 1994, are used to examine serial cross-correlations patterns.[1] Return portfolios for each dataset are formed yearly based on prior year values for size, where size is defined as the market value of equity on the last trading day of the prior year. To be included in the portfolio formation process, a firm must not have more than two consecutive non-trading days during the year. This screen eliminates firms with excessive non-trading, which may induce spurious predictability in returns. Also, a firm must have a closing price and number of shares outstanding available on the last trading day of the year. Annually, there are an average of 1383 securities in

[1] The starting date for the size-sorted return series is chosen to match the sample time period available for the creation of the Fama and French (1993) factors.

each portfolio with an average of 518 securities being eliminated by the non-trading screen.

Each security is examined individually for each day to determine if it is included in the return portfolios. Thus, on any given day, the number of securities in each portfolio and the composition of each portfolio are allowed to change. To be included in the daily return portfolios on any given day t + 1, a security must have a transaction price available on day t and on day t - 1.[2] This maximizes the number of securities in each portfolio that have returns calculated from transaction prices. This should reduce spurious autocorrelation and potentially serial cross-correlation arising from non-synchronous trading.

Development of the Three-Factor Model

In order to use the three-factor model of Fama and French (1993), two mimicking return portfolios that account for size effects and BE/ME effects need to be developed. Size and BE/ME-sorted portfolios of daily security returns are created from the CRSP database for NYSE/AMEX listed securities from April 1, 1976, to December 30, 1994. Return portfolios are formed yearly based on prior year values for size and BE/ME.

Size is defined as the market value of equity on the last trading day of the prior year. Book equity is defined as a firm's prior year-end book value of common equity plus any deferred taxes and investment tax credits for the prior year, taken from the Standard & Poor's COMPUSTAT data base.[3] This value for book equity is divided by the firm's market value of equity from the CRSP database on March 31 in the year that returns are to be calculated.

To be included in the portfolio formation process, a security must be included simultaneously on the CRSP and COMPUSTAT databases. Additionally, a firm must not have more than two consecutive non-trading days during the year.

BE/ME-sorted returns are computed using methodology similar to Jaffe, Keim, and Westerfield (1989). Only firms with a December 31 fiscal year-end and firms that are not subsidiaries are included in the BE/ME sample. A firm must also have a year-end book value of equity available from the COMPUSTAT database and a price and current shares outstanding available from the CRSP database on March 31 to be included in the BE/ME sample.[4] Returns for the BE/ME series are calculated from April 1 to March 31 of the next year. This approach to calculating returns avoids the look-ahead bias associated with using year-end prices to calculate finan-

[2] This screening procedure is similar to that used by Chordia and Swaminathan (2000). They suggest that this procedure minimizes the impact of non-synchronous trading for NYSE/AMEX listed securities.

[3] This definition of book equity is similar to that of Fama and French (1993).

[4] Firms with negative BE/ME ratios are excluded.

cial ratios.[5] To be included in the size-sorted portfolios, a firm must have a closing price and number of shares outstanding available on the last trading day of the year.

After identifying the securities included in the portfolio formation process for a given year, the securities are sorted into four size portfolios, and each size portfolio is sorted into four portfolios based on BE/ME. This creates 16 size and BE/ME-sorted portfolios. Subtracting the average daily return of the largest size-sorted portfolios from the average daily return of the smallest size-sorted across each of the BE/ME categories creates the mimicking return portfolio for size. Subtracting the average daily return of the highest BE/ME-sorted portfolios from the average daily return of the lowest BE/ME-sorted portfolios across each of the size categories creates the mimicking return portfolio for the book-to-market equity ratio. Thus, this procedure creates a size-sorted return portfolio free of BE/ME effects and a BE/ME-sorted return portfolio free of size effects. The portfolio creation procedure is repeated each year and results in two daily return series that should account for size and book-to-market equity ratio effects in returns.

Methodology

For comparison with previous research and to examine further the behavior of daily serial cross-correlation patterns, the following regression model is estimated to determine if significant serial cross-correlation patterns exist in the daily return series after controlling for the three-factor model of Fama and French (1993):

$$\begin{aligned} R_{t,1} &= \alpha_1 M_t + \alpha_2 T_t + \alpha_3 W_t + \alpha_4 TH_t + \alpha_5 F_t + \beta_1 R_{t-1,1} + \beta_2 R_{t-2,1} + \beta_3 R_{t-3,1} \\ &+ \gamma_1 R_{t-1,4} + \gamma_{2t} R_{t-2,4} + \gamma_3 R_{t-3,4} + \delta_1 BEME_t + \delta_2 SIZE_t + \delta_3 MKT_t + \varepsilon_t \end{aligned} \tag{1}$$

where:

$R_{t,1}$, $R_{t-k,1}$ = Daily returns for the smallest-firm portfolio at time t and t - k, k = 1 to 3, respectively;

$R_{t-k,4}$ = Daily returns for the largest-firm portfolio at time t - k, k = 1 to 3;

M_t, T_t, W_t, TH_t, F_t = Dummy variables for the days of the week, Monday through Friday, respectively;

$BEME_t$, $SIZE_t$, and MKT_t = Risk premia at time t representing the BE/ME mimicking return portfolio, the size mimicking return portfolio, and the equally-weighted CRSP index return, respectively; and

ε_t = A random error term.

Fargher and Weigand (1998) find that only three lags of daily serial cross-correlation terms are significant; hence, only three lags are used in this paper. The daily dummy variables, included as intercepts, control for differences in daily mean

[5] Banz and Breen (1986) discuss the potential look-ahead bias that exists when using accounting data.

returns that may cause spurious autocorrelations and serial cross-correlations. The use of one dummy variable for each day of the week allows for the direct observation of the day-of-the-week pattern in security returns and is consistent with the methodology of Bessembinder and Hertzel (1993).

In equation (1), the β terms measure the daily autocorrelation coefficients, the γ terms measure the daily serial cross-correlation coefficients, and the δ terms measure the Fama and French (1993) factors. F-statistics are used to test the joint significance of the autocorrelation terms, the serial cross-correlation terms, and the Fama and French (1993) factors. For comparison purposes, equation (1) is estimated separately using only autocorrelation terms, serial cross-correlation terms, and the Fama and French factors. Additionally, equation (1) is estimated with the autocorrelation and serial cross-correlation terms together.

McQueen, Pinegar, and Thorley (1996) find that small firms have a slow response to good common news but not bad common news when examining monthly returns. This causes serial cross-correlations between large and small firms to only be significant when large firm returns are positive. As a test of the robustness of the results, equation (1) is estimated separately when returns of the largest size-sorted stock portfolio are up or down on the previous day. McQueen, Pinegar, and Thorley find that small stocks respond, at one lag, to both good news and bad news when using weekly returns. By examining daily security returns we are able to provide further evidence regarding the asymmetric response to information by small firms over shorter time intervals. Given the weekly return evidence found by McQueen, Pinegar, and Thorley, it is possible that small firms may respond differently to news when examining daily returns.

In addition, equation (1) is estimated with the largest size portfolio as the dependent variable. This allows for the testing of bi-directional Granger-causality. Most theories explaining the existence of serial cross-autocorrelations are based on informational differences between groups of informed and uninformed traders.[6] These economic theories do not make sense if lagged small-firm returns lead large-firm returns, as traders in large firms are generally assumed to be informed traders. Thus, examining whether small-firm returns lead large-firm returns provides evidence on the viability of these theories. Previous research using monthly and weekly security returns has documented an asymmetry in serial cross-correlations, lagged large-firm returns lead small-firm returns but not vice-versa, that is consistent with theories explaining the existence of serial cross-correlations. Thus, testing for bi-

[6] Examples of such theories can be found in Badrinath, Kale, and Noe (1995), Chan (1993), and Mech (1993).

directional Granger-causality provides a check of the consistency of daily return results with previous theoretical findings.[7]

Results

The Significance of Serial Cross-Correlations in Small-Firm Returns

Table 1 shows the results from the estimation of equation (1). Similar to Fargher and Weigand (1998), the sample is split into two time periods, 1976-1985 and 1986-1994. This allows us to determine if the market has improved in its ability to process information over the time period studied. If the market has become more efficient at processing information, we would expect to find that serial cross-correlations have become smaller or insignificant over time. Panel A contains results for the full sample, Panel B contains results for the 1976-1985 time period, and Panel C contains results for the 1986-1994 time period. In all tables, model 1 corresponds to the estimation of equation (1) with only autocorrelation terms, model 2 corresponds to estimation with only serial cross-correlation terms, model 3 corresponds to estimation with autocorrelation and serial cross-correlation terms, model 4 corresponds to estimation with only the Fama and French (1993) factors, and model 5 corresponds to the full estimation of equation (1).

For the entire time period, models 1 and 2 show that, separately, both autocorrelations and serial cross-correlations are significant sources of predictability in small-firm returns. We do show that serial cross-correlations appear to decrease over time when estimated separately, as shown by Fargher and Weigand (1998), indicating an improvement in the information processing ability of the market.

When autocorrelation and serial cross-correlation terms are estimated jointly in model 3, the first two lags of autocorrelation terms remain significant and the first-order serial cross-correlation term remains significant. The second-order serial cross-correlation term is significant, but negative in sign. Similar results are shown in Panels B and C. For both time periods, small-firm returns exhibit positive first and second order autocorrelation terms. Also, in both time periods, small firm returns exhibit a significant positive first-order and a significant negative second order serial cross-correlation with large firm returns. Fargher and Weigand (1998) also find a negative second-order serial cross-correlation term. They show that the negative second-order serial cross-correlation occurs in the 1960s and 1970s and suggest that it indicates an overreaction and subsequent adjustment to common information. While our time period is shorter than that of Fargher and Weigand, due to the use of the Fama and French (1993) factors, we show a consistent negative second-order

[7] We also estimated all models including a GARCH (1,1) parameterization in the error term. While the GARCH parameters were generally significant, the main results of the paper were not substantially affected. Hence, the GARCH results are not reported in the paper.

Table 1—Autocorrelations, Serial Cross-Correlations, Fama and French (1993) Factors, and Tests of Significance for the Smallest Size-Sorted Portfolio

The following table shows parameter estimates and their t-statistics for regression models containing autocorrelations, serial cross-correlations, and Fama and French (1993) factors. Three time periods are examined: all days (Panel A), 1976-1985 (Panel B), and 1986-1994 (Panel C). M, T, W, TH, F are dummy variables for the days of the week. $R_{t-1,1}$ is the return for the smallest size-sorted portfolio on day t - k. $R_{t-k,4}$ is the return for the largest size sorted portfolio on day t - k. BEME, SIZE, and MKT are the Fama and French (1993) book-to-market, size, and market return factors on day t. F-tests are conducted to determine the significance of the Fama and French factors, serial cross-correlations, and autocorrelations, in Model 5. An asterisk indicates significance at the 5 percent level

Panel A: All Days

	Coefficient Estimates With t-Statistics in Parentheses				
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
M	-0.00202	-0.00104	-0.00172	-0.00013	-0.00050
	(-7.860)*	(-4.172)*	(-6.754)*	(-1.255)	(-4.924)*
T	0.00036	0.00054	-0.00006	0.00007	-0.00003
	(1.444)	(2.240)*	(-0.226)	(0.743)	(-0.349)
W	0.00185	0.00191	0.00179	0.00049	0.00043
	(7.455)*	(7.917)*	(7.291)*	(4.983)*	(4.424)*
TH	0.00164	0.00195	0.00178	0.00076	0.00069
	(6.671)*	(7.987)*	(7.345)*	(7.638)*	(7.177)*
F	0.00299	0.00356	0.00316	0.00107	0.00104
	(12.055)*	(14.566)*	(12.924)*	(10.459)*	(10.585)*
$R_{t-1,1}$	0.32276		0.11033		0.04954
	(22.320)*		(4.904)*		(5.426)*
$R_{t-2,1}$	0.02691		0.19084		0.03362
	(1.775)*		(8.380)*		(3.682)*
$R_{t-3,1}$	0.04255		0.03873		0.02030
	(2.949)*		(1.816)		(2.390)*
$R_{t-1,4}$		0.33632	0.27022		0.06527
		(25.364)*	(13.248)*		(7.914)*
$R_{t-2,4}$		0.01132	-0.14130		-0.02610
		(0.839)	(-6.829)*		(-3.157)*
$R_{t-3,4}$		0.06191	-0.01122		0.01090
		(4.671)*	(-0.562)		(1.375)
BEME				0.34122	0.31123
				(28.671)*	(26.717)*
SIZE				-0.79541	-0.73157
				(-101.668)*	(-89.527)*
MKT				0.94470	0.91381
				(157.105)*	(153.067)*
F-test for significance of Fama/French factors in model 5					8414.481*
F-test for significance of serial cross-correlation terms in model 5					24.063*
F-test for significance of autocorrelation terms in model 5					24.728*

Table 1 (cont.)—Autocorrelations, Serial Cross-Correlations, Fama and French (1993) Factors, and Tests of Significance for the Smallest Size-Sorted Portfolio

The following table shows parameter estimates and their t-statistics for regression models containing autocorrelations, serial cross-correlations, and Fama and French (1993) factors. Three time periods are examined: all days (Panel A), 1976-1985 (Panel B), and 1986-1994 (Panel C). M, T, W, TH, F are dummy variables for the days of the week. $R_{t-k,1}$ is the return for the smallest size-sorted portfolio on day t - k. $R_{t-k,4}$ is the return for the largest size sorted portfolio on day t - k. BEME, SIZE, and MKT are the Fama and French (1993) book-to-market, size, and market return factors on day t. F-tests are conducted to determine the significance of the Fama and French factors, serial cross-correlations, and autocorrelations, in Model 5. An asterisk indicates significance at the 5 percent level

Panel B: 1976-1985

	Coefficient Estimates With t-Statistics in Parentheses				
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
M	-0.00204	-0.00133	-0.00181	-0.00006	-0.00039
	(-5.869)*	(-3.295)*	(-5.215)*	(-0.529)	(-3.209)*
T	0.00034	0.00058	0.00023	0.00006	-0.00004
	(1.021)	(1.749)	(0.680)	(0.540)	(-0.304)
W	0.00162	0.00176	0.00160	0.00047	0.00043
	(4.842)*	(5.339)*	(4.762)*	(4.042)*	(3.681)*
TH	0.00160	0.00201	0.00175	0.00081	0.00076
	(4.819)*	(6.036)*	(5.295)*	(6.846)*	(6.672)*
F	0.00303	0.00354	0.00314	0.00082	0.00078
	(9.055)*	(10.618)*	(9.427)*	(6.853)*	(6.695)*
$R_{t-1,1}$	0.36929		0.19049		0.04554
	(18.411)*		(5.669)*		(3.533)*
$R_{t-2,1}$	0.00229		0.10432		0.04272
	(0.107)		(2.984)*		(3.771)*
$R_{t-3,1}$	0.06761		0.04317		0.00727
	(3.379)*		(1.345)		(0.654)
$R_{t-1,4}$		0.36470	0.22450		0.04083
		(18.352)*	(6.814)*		(3.527)*
$R_{t-2,4}$		0.03285	-0.08264		-0.03840
		(1.614)	(-2.468)*		(-3.312)*
$R_{t-3,4}$		0.09172	0.02640		0.01540
		(4.619)*	(0.831)		(1.400)
BEME				0.33134	0.30656
				(22.969)*	(21.403)*
SIZE				-0.86309	-0.80380
				(-84.874)*	(-73.134)*
MKT				0.97927	0.95444
				(129.121)*	(125.314)*
F-test for significance of Fama/French factors in model 5					6041.353*
F-test for significance of serial cross-correlation terms in model 5					7.279*
F-test for significance of autocorrelation terms in model 5					14.846*

Table 1 (cont.)—Autocorrelations, Serial Cross-Correlations, Fama and French (1993) Factors, and Tests of Significance for the Smallest Size-Sorted Portfolio

The following table shows parameter estimates and their t-statistics for regression models containing autocorrelations, serial cross-correlations, and Fama and French (1993) factors. Three time periods are examined: all days (Panel A), 1976-1985 (Panel B), and 1986-1994 (Panel C). M, T, W, TH, F are dummy variables for the days of the week. $R_{t-k,1}$ is the return for the smallest size-sorted portfolio on day t - k. $R_{t-k,4}$ is the return for the largest size sorted portfolio on day t - k. BEME, SIZE, and MKT are the Fama and French (1993) book-to-market, size, and market return factors on day t. F-tests are conducted to determine the significance of the Fama and French factors, serial cross-correlations, and autocorrelations, in Model 5. An asterisk indicates significance at the 5 percent level

Panel C: 1986-1994

	Coefficient Estimates With t-Statistics in Parentheses				
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
M	-0.00201	-0.00101	-0.00163	-0.00022	-0.00059
	(-5.272)*	(-2.754)*	(-4.364)*	(-1.351)	(-3.581)*
T	0.00038	0.00048	-0.00037	0.00009	-0.00007
	(1.035)	(1.361)	(-1.025)	(0.561)	(-0.428)
W	0.00208	0.00205	0.00202	0.00052	0.00045
	(5.668)*	(5.802)*	(5.581)*	(3.261)*	(2.841)*
TH	0.00169	0.00191	0.00181	0.00074	0.00064
	(4.621)*	(5.338)*	(5.110)*	(4.513)*	(4.097)*
F	0.00295	0.00358	0.00318	0.00128	0.00124
	(8.002)*	(9.958)*	(8.897)*	(7.720)*	(8.063)*
$R_{t-1,1}$	0.27789		0.04774		0.04304
	(13.302)*		(1.539)		(3.126)*
$R_{t-2,1}$	0.04464		0.24876		0.03729
	(2.062)*		(8.055)*		(2.702)*
$R_{t-3,1}$	0.01922		0.03663		0.02834
	(0.922)		(1.251)		(2.201)*
$R_{t-1,4}$		0.31118	0.29426		0.08920
		(17.365)*	(11.193)*		(7.583)*
$R_{t-2,4}$		-0.00838	-0.17219		-0.02411
		(-0.463)	(-6.428)*		(-2.032)*
$R_{t-3,4}$		0.03597	-0.04263		0.00628
		(2.008)*	(-1.640)		(0.549)
BEME				0.35722	0.32315
				(18.955)*	(17.651)*
SIZE				-0.74062	-0.67626
				(-63.003)*	(-56.081)*
MKT				0.90776	0.87469
				(98.397)*	(96.063)*
F-test for significance of Fama/French factors in model 5					3175.760*
F-test for significance of serial cross-correlation terms in model 5					20.566*
F-test for significance of autocorrelation terms in model 5					10.706*

serial cross-correlation across our entire sample. While cross-autocorrelations are significant only at one lag, our results show that the lagged response to information by small firms is a consistent phenomenon in both long-run returns and short-run returns. Thus, our results strengthen the contention that there is a delayed response to market wide information by small stocks.

When the Fama and French (1993) factors are included in model 5 all three lags of autocorrelations are significant, and the first-order serial cross-correlation term is significant across the entire time period. The F-statistic for the Fama and French factors is 8418.481, while the F-statistics for both the autocorrelation and serial cross-correlation terms are both around 24. The F-tests show the dominance in explanatory power of the Fama and French factors. The F-tests show, however, that autocorrelations and serial cross-correlations still explain a significant proportion of the variation in small-firm returns. Results from the two separate time periods, shown in Panels B and C, are similar. The third-order autocorrelation coefficient is not significant in the 1986-1994 time period, however. Thus, after controlling for the Fama and French factors, it appears that the predictive ability of cross-autocorrelations does not change over time. It may be that some of the increased price response by small firms to market wide information found by Fargher and Weigand (1998) is captured by the Fama and French factors.

The Significance of Serial Cross-Correlations in Large-Firm Returns

Previous studies on serial cross-correlations with weekly and monthly returns have shown that large-firm returns lead small-firm returns, but not vice-versa. This phenomenon has not been examined for daily stock returns, however. Table 2 shows the results from the estimation of equation (1) using large-firm returns as the dependent variable. Panel A contains results for the entire time period, Panel B contains results for the 1976-1985 time period, and Panel C contains results for the 1986-1994 time period.

It does appear that small-firm returns may explain large firm returns. In model 3, for all three time periods, when both lagged small and large firm returns are included as independent variables, a negative first-order serial cross-correlation between small and large firm returns exists. For the entire time-series of observations the coefficient is large in magnitude, -0.14675, and significant. The second-order serial cross-correlation term is significant and positive over the entire time-series of observations. The second order serial cross-correlation term is only significant in the 1986-1994 time period, however.

When the Fama and French (1993) factors are included, shown in model 5, the second-order serial cross-correlation term becomes insignificant in all three time periods. The first-order serial cross-correlation term is still negative and significant, however. There is also a significant, positive, first-order autocorrelation in large-firm

Table 2—Autocorrelations, Serial Cross-Correlations, Fama and French (1993) Factors, and Tests of Significance for the Largest Size-Sorted Portfolio

The following table shows parameter estimates and their t-statistics for regression models containing autocorrelations, serial cross-correlations, and Fama and French (1993) factors. Three time periods are examined: all days (Panel A), 1976-1985 (Panel B), and 1986-1994 (Panel C). For all models, returns for the largest size-sorted portfolio on day t are the dependent variables. M, T, W, TH, F are dummy variables for the days of the week. $R_{t-k,1}$ is the return for the smallest size-sorted portfolio on day t - k. $R_{t-k,4}$ is the return for the largest size sorted portfolio on day t - k. BEME, SIZE, and MKT are the Fama and French (1993) book-to-market, size, and market return factors on day t. F-tests are conducted to determine the significance of the Fama and French factors, serial cross-correlations, and autocorrelations in Model 5. An asterisk indicates significance at the 5 percent level

Panel A: All Days

	Coefficient Estimates With t-Statistics in Parentheses				
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
M	-0.00080	-0.00068	-0.00035	-0.00016	-0.00014
	(-2.807)*	(-2.496)*	(-1.227)	(-3.583)*	(-3.083)*
T	0.00074	0.00067	0.00047	0.00012	0.00011
	(2.676)*	(2.520)*	(1.716)	(2.737)*	(2.673)*
W	0.00130	0.00110	0.00123	0.00006	0.00006
	(4.762)*	(4.164)*	(4.517)*	(1.421)	(1.317)
TH	0.00039	0.00037	0.00054	0.00011	0.00013
	(1.423)	(1.393)	(2.010)*	(2.618)*	(3.036)*
F	0.00074		0.00099	0.00008	0.00014
	(2.712)*		(3.649)*	(1.824)	(3.299)*
$R_{t-1,1}$	0.09533		-0.14675		-0.03046
	(5.975)*		(-5.889)*		(-7.714)*
$R_{t-2,1}$	-0.01393		0.08144		0.00433
	(-0.833)		(3.228)*		(1.095)
$R_{t-3,1}$	-0.03975		-0.03590		-0.00033
	(-2.496)*		(-1.520)		(-0.091)
$R_{t-1,4}$		0.18868	0.29364		0.06680
		(12.989)*	(12.997)*		(18.725)*
$R_{t-2,4}$		-0.02481	-0.05354		0.00042
		(-1.679)	(-2.336)*		(0.118)
$R_{t-3,4}$		-0.01096	0.00457		0.00946
		(-0.754)	(0.207)		(2.757)*
BEME				0.00963	0.01168
				(1.865)	(2.319)*
SIZE				-0.00894	0.00551
				(-2.631)*	(1.559)
MKT				0.99321	0.98233
				(380.528)*	(380.376)*
F-test for significance of Fama/French factors in model 5					63925.691*
F-test for significance of serial cross-correlation terms in model 5					20.576*
F-test for significance of autocorrelation terms in model 5					124.946*

Table 2 (cont.)—Autocorrelations, Serial Cross-Correlations, Fama and French (1993) Factors, and Tests of Significance for the Largest Size-Sorted Portfolio

The following table shows parameter estimates and their t-statistics for regression models containing autocorrelations, serial cross-correlations, and Fama and French (1993) factors. Three time periods are examined: all days (Panel A), 1976-1985 (Panel B), and 1986-1994 (Panel C). For all models, returns for the largest size-sorted portfolio on day t are the dependent variables. M, T, W, TH, F are dummy variables for the days of the week. $R_{t-k,1}$ is the return for the smallest size-sorted portfolio on day t - k. $R_{t-k,4}$ is the return for the largest size sorted portfolio on day t - k. BEME, SIZE, and MKT are the Fama and French (1993) book-to-market, size, and market return factors on day t. F-tests are conducted to determine the significance of the Fama and French factors, serial cross-correlations, and autocorrelations in Model 5. An asterisk indicates significance at the 5 percent level

Panel B: 1976-1985

	Coefficient Estimates With t-Statistics in Parentheses				
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
M	-0.00124	-0.00113	-0.00079	-0.00014	-0.00012
	(-3.456)*	(-3.252)*	(-2.216)*	(-2.018)*	(-1.913)
T	0.00063	0.00064	0.00061	0.00015	0.00017
	(1.791)	(1.897)	(1.762)	(2.292)*	(2.716)*
W	0.00100	0.00089	0.00093	0.00001	0.00000
	(2.875)*	(2.667)*	(2.710)*	(0.233)	(0.029)
TH	0.00058	0.00063	0.00080	0.00015	0.00019
	(1.694)	(1.863)	(2.354)*	(2.350)*	(3.047)*
F	0.00110	0.00117	0.00136	0.00005	0.00011
	(3.174)*	(3.453)*	(3.972)*	(0.323)	(1.770)
$R_{t-1,1}$	0.13522		-0.14621		-0.04995
	(6.501)*		(-4.245)*		(-6.961)*
$R_{t-2,1}$	-0.02047		0.02557		0.00790
	(-0.926)		(0.714)		(1.223)
$R_{t-3,1}$	-0.01020		-0.01039		-0.00365
	(-0.402)		(-0.316)		(-0.614)
$R_{t-1,4}$		0.22607	0.33973		0.08934
		(11.217)*	(10.059)*		(14.434)*
$R_{t-2,4}$		0.00520	0.01235		-0.00679
		(0.252)	(0.360)		(-1.096)
$R_{t-3,4}$		0.01498	0.02518		0.01579
		(0.744)	(0.0772)		(2.684)*
BEME				0.00255	0.00983
				(0.323)	(1.283)
SIZE				-0.01852	-0.00412
				(-3.337)*	(-0.768)
MKT				0.98856	0.97662
				(238.762)*	(239.812)*
F-test for significance of Fama/French factors in model 5					24386.311*
F-test for significance of serial cross-correlation terms in model 5					17.255*
F-test for significance of autocorrelation terms in model 5					76.269*

Table 2 (cont.)—Autocorrelations, Serial Cross-Correlations, Fama and French (1993) Factors, and Tests of Significance for the Largest Size-Sorted Portfolio

The following table shows parameter estimates and their t-statistics for regression models containing autocorrelations, serial cross-correlations, and Fama and French (1993) factors. Three time periods are examined: all days (Panel A), 1976-1985 (Panel B), and 1986-1994 (Panel C). For all models, returns for the largest size-sorted portfolio on day t are the dependent variables. M, T, W, TH, F are dummy variables for the days of the week. $R_{t-k,1}$ is the return for the smallest size-sorted portfolio on day t - k. $R_{t-k,4}$ is the return for the largest size sorted portfolio on day t - k. BEME, SIZE, and MKT are the Fama and French (1993) book-to-market, size, and market return factors on day t. F-tests are conducted to determine the significance of the Fama and French factors, serial cross-correlations, and autocorrelations in Model 5. An asterisk indicates significance at the 5 percent level

Panel C: 1986-1994

	Coefficient Estimates With t-Statistics in Parentheses				
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
M	-0.00032	-0.00028	0.00011	-0.00019	-0.00015
	(-0.712)	(-0.644)	(0.257)	(-3.171)*	(-2.555)*
T	0.00085	0.00068	0.00035	0.00009	0.00006
	(1.989)*	(1.644)	(0.800)	(1.584)	(1.031)
W	0.00162	0.00131	0.00157	0.00011	0.00011
	(3.791)*	(3.171)*	(3.660)*	(1.924)	(1.907)
TH	0.00018	0.00012	0.00028	0.00007	0.00008
	(0.412)	(0.289)	(0.676)	(1.318)	(1.408)
F	0.00036	0.00046	0.00060	0.00011	0.00017
	(0.828)	(1.103)	(1.418)	(1.880)	(2.989)*
$R_{t-1,1}$	0.05565		-0.15574		-0.02498
	(2.290)*		(-4.237)*		(-5.072)*
$R_{t-2,1}$	-0.01281		0.11658		0.00613
	(-0.508)		(3.186)*		(1.241)
$R_{t-3,1}$	-0.06979		-0.05991		0.00151
	(-2.877)*		(-1.727)		(0.329)
$R_{t-1,4}$		0.15665	0.26075		0.05482
		(7.466)*	(8.370)*		(13.031)*
$R_{t-2,4}$		-0.05026	-0.09487		0.00283
		(-2.370)*	(-2.989)*		(0.667)
$R_{t-3,4}$		-0.03440	-0.01386		0.00446
		(-1.641)	(-0.450)		(1.092)
BEME				0.01486	0.01390
				(2.217)*	(2.123)*
SIZE				-0.00323	0.01038
				(-0.773)	(2.406)*
MKT				0.99555	0.98576
				(303.351)*	(302.715)*
F-test for significance of Fama/French factors in model 5					42392.575*
F-test for significance of serial cross-correlation terms in model 5					8.778*
F-test for significance of autocorrelation terms in model 5					58.812*

returns in all three time periods. Another interesting result occurs for large-firm returns when looking at the Fama and French factors. The size factor is not significant for the entire time-series of observations but is positive and significant in the 1986-1994 time period. Thus, it appears that there is more predictability in large firm returns in the 1986-1994 time period.

The fact that lagged small-firm returns lead large-firm returns is problematic for most theories explaining the existence of serial cross-correlations in returns. Most theories explaining the existence of serial cross-correlations are based on informational differences between traders of large firms and small firms. Thus, the documentation of bi-directional predictability casts doubt on the validity of these theories for daily security returns. The results found here do not suggest, however, that the traders of large firms are in some way reacting to information contained in small firm returns, given the negative serial cross-correlation. It seems unlikely that traders of large-firm returns would sell in response to increases in small-firm returns.

Autocorrelations and Serial Cross-Correlations in Small-Firm Returns When Conditioned on Prior Information

McQueen, Pinegar, and Thorley (1996) find that serial cross-correlations in monthly returns are significant only when the prior returns of large firms are positive. We examine this phenomenon by estimating equation (1) conditioned upon the sign of the large-firm returns on the previous day. Table 3 contains the results of these estimations when large-firm returns are positive and Table 4 contains the results of these estimations when large-firm returns are negative. Again, the sample is split into three time periods. Panel A contains results for the entire time period, Panel B contains results for the 1976-1985 time period, and Panel C contains results for the 1986-1994 time period.

For the entire time series of observations and for the 1986-1994 time period, model 5 of Table 3 shows that after controlling for autocorrelations and the Fama and French (1993) factors serial cross-correlations are not significant when prior large-firm returns are positive. An F-test indicates that the serial cross-correlations do not explain a significant amount of variation in returns. Interestingly, in the 1976-1985 time period, there is a significant negative second order serial cross-correlation in returns when prior large firm returns are negative. Thus, consistent with Fargher and Weigand (1998), the market is apparently becoming more efficient at processing information, at least when there is good news.

The opposite result is shown in model 5 of Table 4. When large-firm returns are negative, serial cross-correlation terms are significant. This result is consistent across the three time periods. Also, for all three time periods, there is a significant, positive first-order serial cross-correlation coefficient. Similar to the results in Table 1, there is a significant negative second-order serial cross-correlation coefficient for the entire time period and in the 1986-1994 time period. Interestingly, the first-order

Table 3—Autocorrelations, Serial Cross-Correlations, Fama and French (1993) Factors, and Tests of Significance for the Smallest Size-Sorted Portfolio When Prior Large-Firm Returns Are Positive

The following table shows parameter estimates and their t-statistics for regression models containing autocorrelations, serial cross-correlations, and Fama and French (1993) factors when the return of the largest size-sorted portfolio is positive on the previous day. Three time periods are examined: all days (Panel A), 1976-1985 (Panel B), and 1986-1994 (Panel C). For all models, returns for the smallest size-sorted portfolio on day t are the dependent variables. M, T, W, TH, F are dummy variables for the days of the week. $R_{t-k,1}$ is the return for the smallest size-sorted portfolio on day t - k. $R_{t-k,4}$ is the return for the largest size sorted portfolio on day t - k. BEME, SIZE, and MKT are the Fama and French (1993) book-to-market, size, and market return factors on day t. F-tests are conducted to determine the significance of the Fama and French factors, serial cross-correlations, and autocorrelations in Model 5. An asterisk indicates significance at the 5 percent level

Panel A: All Days

	Coefficient Estimates With t-Statistics in Parentheses				
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
M	-0.00025	0.00075	-0.00040	0.00042	-0.00046
	(-0.823)	(2.434)*	(-1.293)	(3.142)*	(-3.097)*
T	0.00033	0.00062	0.00007	0.00072	0.00016
	(1.114)	(1.948)	(0.247)	(5.284)*	(1.027)
W	0.00236	0.00247	0.00231	0.00123	0.00081
	(8.084)*	(7.900)*	(7.404)*	(9.033)*	(5.435)*
TH	0.00225	0.00264	0.00215	0.00135	0.00085
	(7.884)*	(8.753)*	(7.280)*	(10.195)*	(5.966)*
F	0.00379	0.00428	0.00364	0.00169	0.00121
	(12.874)*	(13.853)*	(12.029)*	(12.061)*	(8.191)*
$R_{t-1,1}$	0.26886		0.26036		0.11577
	(13.026)*		(9.780)*		(8.848)*
$R_{t-2,1}$	0.07256		0.14980		0.03284*
	(4.226)*		(5.870)*		(2.682)*
$R_{t-3,1}$	0.06602		0.01116		0.01010
	(4.010)*		(0.445)		(0.919)
$R_{t-1,4}$		0.19056	0.04101		0.00105
		(8.226)*	(1.424)		(0.076)
$R_{t-2,4}$		0.03645	-0.09884		-0.01558
		(2.266)*	(-4.261)*		(-1.404)
$R_{t-3,4}$		0.08919	0.04710		0.01768
		6.027)*	(2.083)*		(1.641)
BEME				0.33829	0.30651
				(20.812)*	(19.015)*
SIZE				-0.72720	-0.67501
				(-61.524)*	(-55.348)*
MKT				0.88612	0.86241
				(94.816)*	(93.224)*
F-test for significance of Fama/French factors in model 5					2990.025*
F-test for significance of serial cross-correlation terms in model 5					1.437
F-test for significance of autocorrelation terms in model 5					34.843*

Table 3 (cont.)—Autocorrelations, Serial Cross-Correlations, Fama and French (1993) Factors, and Tests of Significance for the Smallest Size-Sorted Portfolio When Prior Large-Firm Returns Are Positive

The following table shows parameter estimates and their t-statistics for regression models containing autocorrelations, serial cross-correlations, and Fama and French (1993) factors when the return of the largest size-sorted portfolio is positive on the previous day. Three time periods are examined: all days (Panel A), 1976-1985 (Panel B), and 1986-1994 (Panel C). For all models, returns for the smallest size-sorted portfolio on day t are the dependent variables. M, T, W, TH, F are dummy variables for the days of the week. $R_{t-1,1}$ is the return for the smallest size-sorted portfolio on day t - k. $R_{t-k,4}$ is the return for the largest size sorted portfolio on day t - k. BEME, SIZE, and MKT are the Fama and French (1993) book-to-market, size, and market return factors on day t. F-tests are conducted to determine the significance of the Fama and French factors, serial cross-correlations, and autocorrelations in Model 5. An asterisk indicates significance at the 5 percent level

Panel B: 1976-1985

	Coefficient Estimates With t-Statistics in Parentheses				
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
M	-0.00011	0.00078	-0.00028	0.00037	-0.00037
	(-0.249)	(1.807)	(-0.626)	(2.357)*	(-2.089)*
T	0.00040	0.00070	-0.00002	0.00062	0.00004
	(0.889)	(1.527)	(-0.052)	(3.672)*	(0.225)
W	0.00269	0.00264	0.00235	0.00116	0.00079
	(6.376)*	(5.867)*	(5.227)*	(7.044)*	(4.371)*
TH	0.00249	0.00280	0.00229	0.00142	0.00098
	(5.919)*	(6.413)*	(5.293)*	(8.749)*	(5.611)*
F	0.00417	0.00459	0.00393	0.00148	0.00106
	(10.003)*	(10.793)*	(9.245)*	(8.909)*	(6.028)*
$R_{t-1,1}$	0.28985		0.22852		0.10674
	(9.182)*		(5.441)*		(6.032)*
$R_{t-2,1}$	0.03117		0.14299		0.06374
	(1.272)		(3.489)*		(3.863)*
$R_{t-3,1}$	0.03027		0.02936		0.00798
	(1.359)		(0.804)		(0.544)
$R_{t-1,4}$		0.23947	0.10270		-0.00805
		(7.131)*	(2.334)*		(-0.448)
$R_{t-2,4}$		0.01223	-0.12040		-0.05738
		(0.518)	(-3.107)*		(-3.674)*
$R_{t-3,4}$		0.02996	-0.02315		-0.00211
		(1.341)	(-0.636)		(-0.144)
BEME				0.32556	0.29045
				(15.986)*	(14.429)*
SIZE				-0.78110	-0.72241
				(-47.316)*	(-41.925)*
MKT				0.93505	0.91322
				(81.741)*	(80.424)*
F-test for significance of Fama/French factors in model 5					2310.987*
F-test for significance of serial cross-correlation terms in model 5					5.0139*
F-test for significance of autocorrelation terms in model 5					23.259*

Table 3 (cont.)—Autocorrelations, Serial Cross-Correlations, Fama and French (1993) Factors, and Tests of Significance for the Smallest Size-Sorted Portfolio When Prior Large-Firm Returns Are Positive

The following table shows parameter estimates and their t-statistics for regression models containing autocorrelations, serial cross-correlations, and Fama and French (1993) factors when the return of the largest size-sorted portfolio is positive on the previous day. Three time periods are examined: all days (Panel A), 1976-1985 (Panel B), and 1986-1994 (Panel C). For all models, returns for the smallest size-sorted portfolio on day t are the dependent variables. M, T, W, TH, F are dummy variables for the days of the week. $R_{t-k,1}$ is the return for the smallest size-sorted portfolio on day t - k. $R_{t-k,4}$ is the return for the largest size sorted portfolio on day t - k. BEME, SIZE, and MKT are the Fama and French (1993) book-to-market, size, and market return factors on day t. F-tests are conducted to determine the significance of the Fama and French factors, serial cross-correlations, and autocorrelations in Model 5. An asterisk indicates significance at the 5 percent level

Panel C: 1986-1994

	Coefficient Estimates With t-Statistics in Parentheses				
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
M	-0.00042	0.00064	-0.00057	0.00043	-0.00056
	(-0.977)	(1.438)	(-1.296)	(1.940)	(-2.338)*
T	0.00026	0.00051	0.00015	0.00079	0.00024
	(0.652)	(1.166)	(0.342)	(3.710)*	(1.017)
W	0.00194	0.00217	0.00206	0.00124	0.00076
	(4.809)*	(4.989)*	(4.720)*	(5.768)*	(3.233)*
TH	0.00196	0.00231	0.00185	0.00124	0.00066
	(5.035)*	(5.533)*	(4.513)*	(5.962)*	(3.005)*
F	0.00327	0.00374	0.00319	0.00179	0.00123
	(7.820)*	(8.339)*	(7.341)*	(7.819)*	(5.157)*
$R_{t-1,1}$	0.25985		0.27350		0.12175
	(9.385)*		(7.860)*		(6.353)*
$R_{t-2,1}$	0.10263		0.14860		0.01863
	(4.228)*		(4.465)*		(1.027)
$R_{t-3,1}$	0.10451		0.02259		0.01684
	(4.224)*		(0.634)		(0.875)
$R_{t-1,4}$		0.16573	0.01902		0.01563
		(5.095)*	(0.491)		(0.748)
$R_{t-2,4}$		0.05830	-0.07092		0.01100
		(2.661)*	(-2.445)*		(0.701)
$R_{t-3,4}$		0.12933	0.08100		0.03822
		(6.453)*	(2.791)*		(2.434)*
BEME				0.37018	0.33984
				(14.762)*	(13.839)*
SIZE				-0.68979	-0.63832
				(-40.956)*	(-36.976)*
MKT				0.83231	0.80516
				(55.994)*	(54.970)*
F-test for significance of Fama/French factors in model 5					1049.672*
F-test for significance of serial cross-correlation terms in model 5					2.467
F-test for significance of autocorrelation terms in model 5					16.360*

Table 4—Autocorrelations, Serial Cross-Correlations, Fama and French (1993) Factors, and Tests of Significance for the Smallest Size-Sorted Portfolio When Prior Large-Firm Returns are Negative

The table shows parameter estimates and t-statistics for regression models containing autocorrelations, serial cross-correlations, and Fama and French (1993) factors when the return of the largest size-sorted portfolio is negative on the previous day. Three time periods are examined: all days (Panel A), 1976-1985 (Panel B), and 1986-1994 (Panel C). For all models, returns for the smallest size-sorted portfolio on day t are the dependent variables. M, T, W, TH, F are dummy variables for the days of the week. $R_{t-1,1}$ is the return for the smallest size-sorted portfolio on day t - k. $R_{t-k,4}$ is the return for the largest size sorted portfolio on day t - k. BEME, SIZE, and MKT are the Fama and French (1993) book-to-market, size, and market return factors on day t. F-tests are conducted to determine the significance of the Fama and French factors, serial cross-correlations, and autocorrelations in Model 5. An asterisk indicates significance at the 5 percent level

Panel A: All Days

	Coefficient Estimates With t-Statistics in Parentheses				
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
M	-0.00417	-0.00176	-0.00208	-0.00066	-0.00028
	(-9.128)*	(-3.772)*	(-4.330)*	(-4.296)*	(-1.716)
T	0.00037	0.00218	0.00142	-0.00050	0.00001
	(0.843)	(5.002)*	(3.170)*	(-3.671)*	(0.098)
W	0.00141	0.00301	0.00284	-0.00016	0.00036
	(3.200)*	(7.012)*	(6.424)*	(-1.179)	(2.356)*
TH	0.00103	0.00276	0.00276	0.00024	0.00085
	(2.299)*	(6.094)*	(6.088)*	(1.607)	(5.516)
F	0.00233	0.00444	0.00418	0.00063	0.00126
	(5.369)*	(10.063)*	(9.320)*	(4.333)*	(8.121)*
$R_{t-1,1}$	0.29623		-0.04034		-0.00381
	(10.975)*		(-1.052)		(-0.292)
$R_{t-2,1}$	-0.02581		0.23425		0.04109
	(-0.968)		(5.870)*		(3.031)*
$R_{t-3,1}$	0.01572		0.06232		0.02736
	(0.628)		(1.768)		(2.299)*
$R_{t-1,4}$		0.47318	0.50579		0.11372
		(17.216)*	(12.678)*		(8.189)*
$R_{t-2,4}$		-0.02017	-0.16883		-0.03503
		(-0.916)	(-4.694)*		(-2.879)*
$R_{t-3,4}$		-0.00924	-0.09182		0.01126
		(-0.387)	(-2.668)*		(0.970)
BEME				0.33740	0.30883
				(20.175)*	(18.714)*
SIZE				-0.81841	-0.75951
				(-79.339)*	(-68.492)*
MKT				0.96353	0.94260
				(123.030)*	(121.035)*
F-test for Fama/French factors in model 5					5483.055*
F-test for serial cross-correlation terms in model 5					25.450*
F-test for autocorrelation terms in model 5					6.4103*

Table 4 (cont.)—Autocorrelations, Serial Cross-Correlations, Fama and French (1993) Factors, and Tests of Significance for the Smallest Size-Sorted Portfolio When Prior Large-Firm Returns are Negative

The following table shows parameter estimates and their t-statistics for regression models containing autocorrelations, serial cross-correlations, and Fama and French (1993) factors when the return of the largest size-sorted portfolio is negative on the previous day. Three time periods are examined: all days (Panel A), 1976-1985 (Panel B), and 1986-1994 (Panel C). For all models, returns for the smallest size-sorted portfolio on day t are the dependent variables. M, T, W, TH, F are dummy variables for the days of the week. $R_{t-k,1}$ is the return for the smallest size-sorted portfolio on day t - k. $R_{t-k,4}$ is the return for the largest size sorted portfolio on day t - k. BEME, SIZE, and MKT are the Fama and French (1993) book-to-market, size, and market return factors on day t. F-tests are conducted to determine the significance of the Fama and French factors, serial cross-correlations, and autocorrelations in Model 5. An asterisk indicates significance at the 5 percent level

Panel B: 1976-1985

Variable	Coefficient Estimates With t-Statistics in Parentheses				
	Model 1	Model 2	Model 3	Model 4	Model 5
M	-0.00423	-0.00217	-0.00279	-0.00043	-0.00026
	(-6.979)*	(-3.336)*	(-4.128)*	(-2.350)*	(-1.293)
T	0.00016	0.00187	0.00141	-0.00030	-0.00005
	(0.275)	(3.060)*	(2.266)*	(-1.901)	(-0.243)
W	0.00044	0.00209	0.00170	-0.00007	0.00017
	(0.765)	(3.497)*	(2.761)*	(-0.413)	(0.929)
TH	0.00083	0.00257	0.00223	0.00035	0.00070
	(1.452)	(4.119)*	(3.521)*	(2.001)*	(3.716)*
F	0.00187	0.00353	0.00312	0.00034	0.00064
	(3.206)*	(5.613)*	(4.863)*	(1.945)	(3.275)*
$R_{t-1,1}$	0.30123		0.11411		-0.00159
	(7.880)*		(2.035)*		(-0.093)
$R_{t-2,1}$	-0.01421		0.06741		0.02762
	(-0.382)		(1.145)		(1.574)
$R_{t-3,1}$	0.14082		0.06739		0.00787
	(3.943)*		(1.207)		(0.472)
$R_{t-1,4}$		0.45690	0.34757		0.06253
		(9.026)*	(4.676)*		(2.365)*
$R_{t-2,4}$		0.03957	-0.04288		-0.02219
		(1.136)	(-0.748)		(-1.297)
$R_{t-3,4}$		0.18479	0.10439		0.03885
		(5.258)*	(1.897)		(2.365)*
BEME				0.32018	0.30827
				(16.224)*	(15.515)*
SIZE				-0.88347	-0.84885
				(-66.448)*	(-58.399)*
MKT				0.98225	0.97364
				(92.642)*	(92.240)*
F-test for Fama/French factors in model 5					3816.991*
F-test for serial cross-correlation terms in model 5					4.911*
F-test for autocorrelation terms in model 5					1.411

Table 4 (cont.)—Autocorrelations, Serial Cross-Correlations, Fama and French (1993) Factors, and Tests of Significance for the Smallest Size-Sorted Portfolio When Prior Large-Firm Returns are Negative

The following table shows parameter estimates and their t-statistics for regression models containing autocorrelations, serial cross-correlations, and Fama and French (1993) factors when the return of the largest size-sorted portfolio is negative on the previous day. Three time periods are examined: all days (Panel A), 1976-1985 (Panel B), and 1986-1994 (Panel C). For all models, returns for the smallest size-sorted portfolio on day t are the dependent variables. M, T, W, TH, F are dummy variables for the days of the week. $R_{t-1,1}$ is the return for the smallest size-sorted portfolio on day t - k. $R_{t-k,4}$ is the return for the largest size sorted portfolio on day t - k. BEME, SIZE, and MKT are the Fama and French (1993) book-to-market, size, and market return factors on day t. F-tests are conducted to determine the significance of the Fama and French factors, serial cross-correlations, and autocorrelations in Model 5. An asterisk indicates significance at the 5 percent level

Panel C: 1986-1994

	Coefficient Estimates With t-Statistics in Parentheses				
Variable	Model 1	Model 2	Model 3	Model 4	Model 5
M	-0.00387	-0.00107	-0.00104	-0.00082	-0.00016
	(-5.679)*	(-1.629)	(-1.526)	(-3.305)*	(-0.633)
T	0.00084	0.00258	0.00162	-0.00068	0.00012
	(0.225)	(4.059)*	(2.462)*	(-2.928)*	(0.479)
W	0.00247	0.00392	0.00403	-0.00022	0.00068
	(3.679)*	(6.333)*	(6.327)*	(-0.959)	(2.789)*
TH	0.00129	0.00319	0.00342	0.00019	0.00109
	(1.847)	(4.818)*	(5.169)*	(0.761)	(4.351)*
F	0.00293	0.00552	0.00538	0.00093	0.00201
	(4.565)*	(8.989)*	(8.547)*	(3.985)*	(8.204)*
$R_{t-1,1}$	0.32057		-0.15496		-0.01671
	(8.301)*		(-2.847)*		(-0.816)
$R_{t-2,1}$	-0.09868		0.29881		0.06151
	(-2.471)*		(5.245)*		(2.840)*
$R_{t-3,1}$	-0.10840		0.04804		0.03624
	(-2.988)*		(1.038)		(2.097)*
$R_{t-1,4}$		0.50190	0.60811		0.17001
		(15.488)*	(12.485)*		(8.736)*
$R_{t-2,4}$		-0.07427	-0.21844		-0.05240
		(-2.658)*	(-4.662)*		(-2.972)*
$R_{t-3,4}$		-0.17232	-0.22279		-0.02675
		(5.415)*	(-5.110)*		(-1.621)
BEME				0.34811	0.30208
				(12.688)*	(11.435)*
SIZE				-0.76480	-0.66527
				(-47.759)*	(-38.634)*
MKT				0.93776	0.89136
				(79.540)*	(75.203)*
F-test for Fama/French factors in model 5					2017.024*
F-test for serial cross-correlation terms in model 5					28.673*
F-test for autocorrelation terms in model 5					4.249*

autocorrelation coefficient is not significant across all three time periods when prior large firm returns are negative. Thus, it appears that small-firms tend to follow large-firms, on a daily basis, after bad news and not good news. Also, it appears that after bad news small-firm returns are unrelated to their own prior day's returns.

McQueen, Pinegar, and Thorley (1996) contend that the asymmetric response to good news may be associated with investor trading behavior or with a turn-of-the-year effect. Our finding of a lagged response to common information after bad news also can be explained in the context of investor trading behavior in association with the day-of-the-week effect. Several studies have shown that returns on Monday are only negative when returns on Friday are negative. This is consistent with the work of Abraham and Ikenberry (1994), who show that that individuals are more likely to sell after the weekend when there has been bad news. Thus, if there is a lagged response in processing information by investors in small stocks, it makes sense that this would occur after bad news when examining daily returns. Therefore, our finding of a lagged response to bad news in daily returns is not necessarily inconsistent with the economic rationale given by McQueen, Pinegar, and Thorley for the existence of a lagged response to good news in monthly returns.

Conclusions

This study compares the predictive ability of serial cross-correlations in security returns with the predictive ability of the Fama and French (1993) factors. Also, this study provides further documentation of the significance of serial cross-correlation patterns in daily security returns. The study examines the significance of serial cross-correlations after controlling for good news and bad news in security returns. Also, the study examines whether there is an asymmetry in daily serial cross-correlations as has been documented in monthly and weekly security returns.

We find evidence of a significant serial cross-correlation pattern between large and small firms, after controlling for the Fama and French (1993) factors. We show that large-firm returns do lead small firm returns. We also find evidence of a significant negative relationship between large-firm returns and lagged small-firm returns, which is inconsistent with previous results using monthly and weekly returns. We document a bad news effect in serial cross-correlations as well. Large-firm returns lead small firm returns only when prior large-firm returns are negative. We also show that there are some differences in the predictability of large and small firm returns through time. While we are not able to show that serial cross-correlations dominate a factor structure in predicting returns, we do document their significance given a specific factor structure.

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