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# EFFECTS OF DAYLIGHT-SAVING TIME CHANGES ON STOCK MARKET VOLATILITY: A COMMENT[1, 2]

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*Summary.*—In a recent article in this journal, Berument, Dogan, and Onar (2010) challenged the existence of the previously documented daylight-saving effect. Kamstra, Kramer, and Levi's original finding (2000) was that average stock market returns on Mondays following time changes are economically and statistically significantly lower than typical Monday returns. Kamstra, *et al.* hypothesized that the effect may arise due to heightened anxiety or risk aversion on the part of market participants after they experience a 1-hr. disruption in their sleep habits, in accordance with prior findings in the psychology literature linking sleep desynchronosis with anxiety. Berument, *et al.* replicated the original findings using ordinary least squares estimation, but when they modeled the mean of returns using a method prone to producing biased estimates, they obtained puzzling results. The analysis here, based on standard, unbiased modeling techniques, shows that the daylight-saving effect remains intact in the U.S.

Berument, Dogan, and Onar (2010) revisited the daylight-saving anomaly in stock market returns that was first documented by Kamstra, Kramer, and Levi (2000). Their re-examination applied an exponential generalized autoregressive conditional heteroskedasticity (EGARCH) model to U.S. equity market returns over roughly the past 40 years. They extended their focus to include return volatility as well as the level of returns themselves, where the level of returns has been more typically the concern of previous studies of the influence of daylight-saving time changes on the stock market. They reported robustness checks, available in an appendix, using heteroskedastic corrections and alternative models. They also extended the original Kamstra, *et al.* sample period to include seven years of more recently available data, though they neglected data pre-1967, when, admittedly, the use of daylight-saving time adjustments was less uniformly observed in the U.S. than it is today. In describing their findings, they

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wrote, "The evidence gathered from the major U.S. stock markets for the period between 1967 and 2007 does support the existence of Daylight Saving Time effect neither in stock returns nor in volatility (p. 632)."

The primary concerns with the Berument, *et al.* (2010) article involve several points. The authors did not provide a balanced and complete review of the literature on the daylight-saving effect, they made use of a heavily overparameterized model which reduces the significance of parameter estimates, and they employed an estimation technique that is prone to producing biased coefficient estimates. Additionally, even adopting these overparameterized models and bias-prone techniques, the current authors found it was not possible to replicate important features of their empirical results, in particular the lack of a daylight-saving effect in the mean when estimating higher moments using maximum likelihood estimation techniques. However, it was possible to replicate their finding of little or no daylight-saving effect in the variance, which suggests there is no need to employ highly parameterized estimation techniques that explicitly model the variance of returns when estimating the daylight-saving effect.

Berument, *et al.*'s citations (2010) of the literature on the daylight-saving effect were incomplete, omitting Dowling and Lucey (2005), who documented a significant daylight-saving effect in Irish data, Dowling and Lucey (2008), who found mixed results on a shorter data set but from 40 countries, and who appear to have been the first to have considered daylight-saving effects on return variance, and Müller, Schiereck, Simpson, and Voigt (2009), who challenged the existence of a daylight-saving effect, focusing largely on data from Germany. Of the published papers which contest the finding of a daylight-saving effect, Pinegar (2002) and Lamb, Zuber, and Gandar (2004) shared a focus on the nonnormality of return data and incorrectly omitted large negative return data when arguing for the absence of a daylight-saving effect. Removing the largest negative values does (obviously) reduce the large negative magnitude of the daylight-saving effect, but it does not *explain* the greater frequency with which these large negative returns are realized following time changes. When dealing with returns, which are nonnormal and skewed by construction (having a minimum value of −100% and an unbounded maximum), trimming the tail of the distribution, in particular trimming only one tail of the distribution, can easily lead to invalid inference. Müller, *et al.* (2009) looked at a fairly short series, and further subdivided it into 5-yr. windows, compromising the power of any test of the daylight-saving effect. It should be noted that Kamstra, *et al.* (2000) also found small magnitude daylight-saving effects in Germany.

The Berument, *et al.* (2010) study included 15 lags in the mean equation of the model for returns, so that the effect of daylight-saving time changes on Monday returns is not just that which shows up on the Monday following the daylight-saving change. Specifically, if daylight saving has an effect on returns (or on volatility), that effect will be spread out if the specification of the mean effect includes many lagged impacts. That is, the daylight-saving Monday return continues to affect the mean return until the lagged returns run out. With the inclusion of 15 lags of the dependent variable, the daylight-saving coefficient estimate does not capture the full effect of the daylight-saving time change. Rather, the total effect of daylight saving requires taking account of the coefficients on the lags of the dependent variable. To properly estimate the total impact, one ideally requires an interaction term with the daylight-saving dummy and the lagged returns. It should be noted that with 15 lags in the specification, the addition of interaction terms would almost surely fail to reject the null hypothesis of no daylight-saving effect simply due to poor power properties: there are not enough daylight-saving Mondays available to estimate this many daylight-saving coefficients with precision. Finally, it is somewhat unusual to include so many lags in a regression on returns. While there can be some autocorrelation in daily returns (strictly speaking, including even one lag is inconsistent with efficient markets but may be necessary when dealing with index returns due to nonsynchronous trading of individual stocks in the index), the detection of autocorrelation at 15 lags is most likely spurious. There is some irony in this, given that Berument, *et al.* (2010) was rebutting the finding of a daylight-saving effect as *itself* spurious. It is also worth noting that market efficiency would suggest that the effect of daylight saving on stock returns may diminish after it has been identified and exploited by stock market participants. This is in accordance with prior research which suggests that some stock market anomalies become less prominent or disappear altogether after their discovery, perhaps in part through the actions of investors.[3] See, for instance, Dimson and Marsh (1999) and Schwert (2003).

Kamstra, *et al.* (2000) originally studied a stock index return series that ended on December 31, 1997. In their results, Berument, *et al.* (2010) reported in an appendix that they considered series that ended at that time and replicated the magnitude of the daylight-saving effect that was previously documented, based on estimations using ordinary least squares (OLS) estimation and heteroskedasticity-consistent standard errors. That is, using OLS and the original sample period, Berument, *et al.* found statis-

[3]For those hoping to profit by exploiting market anomalies, it is an unfortunate fact that knowledge of the anomaly works in the direction of reducing it. In particular, those who are least affected by daylight-saving clock adjustments will take advantage of asset price effects that arise due to the actions of those who are more affected, reducing the overall effect.

tically significant evidence of a daylight-saving effect in stock returns, but they did not mention this fact in their article.

In producing the results they reported in the main text of their article, Berument, *et al.* (2010) employed an EGARCH model instead of OLS. However, their estimate of the daylight-saving return based on EGARCH is *orders of magnitude* smaller than estimates that arise from OLS, which is very surprising.[4] Techniques for modeling the conditional variance, including EGARCH, are not expected to change estimates on the parameters of the mean so drastically.[5] Such extreme changes in coefficient estimates across different estimation techniques can be a signal of estimation instability.

Results presented below show that the very small daylight-saving effect Berument, *et al.* (2010) reported based on EGARCH could not be replicated, even using their data.[6] Instead, the EGARCH estimate of the mean daylight-saving effect was found to be about one-third the size of the unbiased and consistent estimate that arose from OLS estimation. Even this deviation from OLS in the estimation of a mean parameter is surprising, suggesting that EGARCH does not perform well in this context. As shown below, strong evidence of the daylight-saving effect was found when OLS or a wide variety of other common estimation techniques was employed, including GARCH and GMM. This strong effect was found across a range of U.S. stock indices. Even when EGARCH was used to estimate the magnitude of the daylight-saving effect, statistically significant evidence of a daylight-saving effect was still found, albeit smaller and less reliably significant than that produced by other techniques.

*Detailed Analysis*

Kamstra, *et al.* (2000) originally documented the existence of the daylight-saving effect in U.S. stock returns by considering returns on the S&P 500 Composite Index (which does not include dividends) and equal-weighted and value-weighted returns (including dividends) for the New York Stock Exchange (NYSE), American Stock Exchange (AMEX),

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[4]Techniques such as EGARCH that are based on maximum likelihood estimation can be biased (see, for instance, p. 247 of Davidson & MacKinnon, 1993, for an overview of this feature of maximum likelihood estimation), but this does not explain the orders of magnitude difference in coefficient estimates.

[5]EGARCH is expected to produce corrected (more efficient) estimates of the standard errors of parameters relative to methods such as OLS. See Engle (1982) for a discussion of properties of ARCH estimators.

[6]We are grateful to the authors for sharing their code and data with us. We found, however, a number of problems with their data. Wednesday, December 6, 2006, was mislabeled as Sunday, December 3, 2006; May 10, 2007, was mislabeled as May 3, 2007 (so that there were two observations for May 3 in their sample), and March 2, 1972, was missing altogether. We could not exactly replicate any result of Berument, *et al.*, even after adjusting for these data problems, but this might be a function of revisions of the data by the data provider, the Center for Research in Securities Prices (CRSP). We produced our results using data we collected ourselves from CRSP.

and NASDAQ indices.[7, 8] All series ended December 31, 1997. Berument, *et al.* (2010) employed 10 additional years of data in their main analysis. (In their Appendix, they considered the original sample period and replicated the statistical significance of the daylight-saving effect originally shown by Kamstra, *et al.*, 2000.) Here, the main analysis was restricted to the original sample period to avoid contamination from the influence of less affected market participants who may have attempted to exploit the anomaly.[9]

In the discussion that follows, results are considered based on OLS, GARCH, and EGARCH estimation for the NYSE value-weighted and equal-weighted index returns. Then results based on GMM estimation are considered. Finally, results based on the Standard and Poor's (S&P) 500 index returns, the American Exchange (AMEX) index returns, and NASDAQ equal-weighted and value-weighted index returns are examined. In all cases, data were obtained from the Center for Research in Securities Prices. When considering models that Berument, *et al.* explored, the number of lags of the dependent variable included as regressors was the same that Berument, *et al.* employed: two lags for NYSE value-weighted returns and 15 lags for NYSE equal-weighted returns.[10] With the exception of the GMM analysis, MacKinnon and White (1985) standard errors were employed, and significance was reported based on one-sided hypothesis tests, consistent with the hypothesis that daylight-saving time changes lead to lower returns on the trading day that follows.

The OLS model was:

$$R_t = \alpha_0 + \alpha_{Mon}\,Mon_t + \alpha_{DS}\,DS_t + \alpha_{Tax}\,Tax_t + \alpha_i\,\Sigma^n{}_{i=1}R_{t-i} + \varepsilon_t\ . \qquad [1]$$

Here, $R_t$ is the index return (value-weighted or equal-weighted where appropriate), $Mon_t$ is a dummy variable set to one on the first trading day of the week and zero otherwise, $DS_t$ is a dummy variable set to equal one on trading day immediately following a daylight-saving time change and zero otherwise, $Tax_t$ is a dummy variable set to equal one on the first

[7]Kamstra, *et al*. (2000) also considered several international indices, but we restricted our analysis to match the series of interest in Berument, *et al*.

[8]We note that Berument, *et al.* considered the same U.S. indexes Kamstra, *et al.* (2000) considered, with one exception: Kamstra, *et al.* considered the Standard & Poor's (S&P) 500 index return available through the Center for Research in Securities Prices (CRSP), whereas Berument, *et al.* reported having separately analyzed both value-weighted and equal-weighted S&P 500 index returns. We consulted the CRSP Data Description Guide for the CRSP U.S. Stock Database and the CRSP U.S. Index Database, and we could not find any mention of equal-weighted S&P 500 returns. To the best of our knowledge, the S&P 500 index is a value-weighted composite index for which no equal-weighted analogue is available.

[9]This is a well-documented phenomenon. See, for instance, Dimson and Marsh (1999) and Schwert (2003).

[10]We made use of 15 lags to conform with Berument, *et al*.'s parameterization, to facilitate direct comparison of results. We do not, ourselves, endorse this parameterization.

month of the tax year (January in the U.S.) and zero otherwise, and $\varepsilon_t$ is a residual. The α terms are model parameters: $\alpha_0$ is an intercept term, $\alpha_{Mon}$ is the Monday dummy variable coefficient estimate, $\alpha_{DS}$ is the daylight-saving coefficient estimate, $\alpha_{Tax}$ is the Tax variable coefficient estimate, and $\alpha_i$ (for $i = 1 \ldots n$) are the coefficient estimates on the $n$ lags of the dependent variable. Note that the tax-year dummy variable was included in accordance with the extensive literature that demonstrates unusually high returns at the start of the tax year, particularly in small firms, perhaps due to tax-loss selling in the preceding year. See, for instance, Brown, Keim, Kleidon, and Marsh (1983), Keim (1983), and Tinic and West (1984).

The GARCH model estimated was:

$$R_t = \alpha_0 + \alpha_{Mon} Mon_t + \alpha_{DS} DS_t + \alpha_{Tax} Tax_t + \alpha_i \Sigma^n_{i=1} R_{t-i} + \varepsilon_t \, , \quad [2]$$

with $\varepsilon_t \sim N(0, \sigma^2_t)$ and the conditional variance of the residual $\varepsilon_t$ modeled as $\sigma^2_t = \beta_0 + \beta_1 \varepsilon^2_{t-1} + \beta_2 \sigma^2_{t-1} + \beta_{Mon} Mon_t + \beta_{DS} DS_t$.

The EGARCH model estimated was:

$$R_t = \alpha_0 + \alpha_{Mon} Mon_t + \alpha_{DS} DS_t + \alpha_{Tax} Tax_t + \alpha_i \Sigma^n_{i=1} R_{t-i} + \varepsilon_t \, , \quad [3]$$

with $\varepsilon_t \sim N(0, \sigma^2_t)$, the conditional variance of the residual $\varepsilon_t$ modeled as $\ln(\sigma^2_t) = \beta_0 + \beta_1 g_{t-1} + \beta_2 \ln(\sigma^2_{t-1}) + \beta_{Mon} Mon_t + \beta_{DS} DS_t$, and $g_t = \beta_{1,1} \varepsilon_t / \sigma_t + | \varepsilon_t / \sigma_t | - (2/\pi)^{1/2}$. Here, the effect of $g_t$ is analogous to the effect arising from the lagged squared residual in a GARCH model.

Results for the NYSE equal-weighted and value-weighted indexes appear in Table 1. For the sake of brevity, only coefficient estimates, standard errors, and $p$ values associated with the key variables of interest are reported: the intercept, Monday dummy variable, daylight-saving dummy variable, and tax-year dummy variable. The first three rows of results correspond to the analysis of equal-weighted returns, and the last three rows report results based on value-weighted returns.

Consider first the case of OLS with equal-weighted NYSE data. The daylight-saving coefficient estimate is −0.279, which is statistically significant at conventional levels of significance; statistical significance is indicated with boldface font. (The signs and magnitudes of the intercept, Monday dummy variable, and tax-year dummy variable coefficient estimates are consistent with prior research in all rows of Table 1 and in other tables discussed below.) In the next row of Table 1, it can be seen that the use of GARCH leads to smaller coefficient estimates, but it also leads to more precisely estimated standard errors: the daylight-saving coefficient estimate remains statistically significant. In the third row, based on EGARCH estimation, evidence of smaller coefficient estimates continues, and the daylight-saving effect remains statistically significant. Note that GARCH and EGARCH, like any maximum likelihood method, can pro-

TABLE 1

The Daylight-saving Effect in U.S. Stock Returns: OLS, GARCH, and EGARCH Estimation

| | Intercept | Monday | DS | Tax |
|---|---|---|---|---|
| Equal-weighted | | | | |
| OLS: NYSE | **0.076** | **−0.212** | **−0.279** | **0.083** |
| *SE* | 0.011 | 0.024 | 0.174 | 0.033 |
| *p* | <.001 | <.001 | .054 | .006 |
| GARCH: NYSE | **0.084** | **−0.177** | **−0.107** | 0.033 |
| *SE* | 0.008 | 0.016 | 0.077 | 0.024 |
| *p* | <.001 | <.001 | .081 | .082 |
| EGARCH: NYSE | **0.060** | **−0.164** | **−0.117** | 0.021 |
| *SE* | 0.008 | 0.016 | 0.077 | 0.021 |
| *p* | <.001 | <.001 | .064 | .156 |
| Value-weighted | | | | |
| OLS: NYSE | **0.066** | **−0.115** | **−0.292** | 0.044 |
| *SE* | 0.011 | 0.027 | 0.193 | 0.034 |
| *p* | <.001 | <.001 | .065 | .100 |
| GARCH: NYSE | **0.074** | **−0.103** | **−0.155** | 0.030 |
| *SE* | 0.009 | 0.019 | 0.094 | 0.027 |
| *p* | <.001 | <.001 | .049 | .137 |
| EGARCH: NYSE | **0.053** | **−0.099** | −0.108 | 0.028 |
| *SE* | 0.009 | 0.019 | 0.092 | 0.024 |
| *p* | <.001 | <.001 | .119 | .120 |

*Note.*—All models are estimated using a sample period of January 3, 1967, to December 31, 1997, with the ending date chosen to align with Kamstra, *et al.*'s ending date (2000). OLS, GARCH, and EGARCH refer to the model estimation technique. Models were estimated for both equal-weighted and value-weighted returns. The number of lags of the dependent variable included as regressors was chosen to align with Berument, *et al.* (2010): two lags for the NYSE value-weighted case and 15 lags for the NYSE equal-weighted case. The number of observations was 7,803 (7,790) in cases where two (15) lags of the dependent variable were included. Monday is a dummy variable set to equal one on the first trading day of the week and zero otherwise, DS is a dummy variable set to equal one on the first trading day following a daylight-saving time change and zero otherwise, and Tax is a dummy variable set to equal one for the first month of the tax year (January in the U.S.) and zero otherwise. Standard errors and significance are based on MacKinnon and White's (1985) jackknife-based heteroskedasticity-consistent covariance matrix estimator. Coefficient estimates that are significant at the 10% level or better are indicated in bold.

duce biased coefficient estimates in finite samples. (See p. 247 of Davidson & MacKinnon, 1993, for an overview of this feature of maximum likelihood estimation.)

Consider now the value-weighted NYSE data. The results based on OLS and GARCH mirror those found using equal-weighted data, with a statistically significant daylight-saving effect. In the final row of the table, however, the use of EGARCH shrinks the parameter estimate considerably relative to the unbiased OLS estimate, and renders the daylight-saving effect nonsignificant. The models explored in Table 1 are highly parameterized, including up to 15 lags of the dependent variable, and modeling higher moments of the data in spite of the fact that Berument, *et* *al.* (and the current authors) find that daylight-saving time changes had no significant influence on volatility. Comparatively simple tests on the mean of the daylight-saving effect can be performed with regression analysis employing heteroskedasticity and autocorrelation consistent (HAC) standard errors. Use of HAC standard errors avoids the need to parameterize and quite possibly misspecify the conditional variance and also avoids the need to include so many, or perhaps any, lags in the mean equation.

When Hansen's generalized method of moments (GMM; 1982) was performed and Newey and West (1987) HAC standard errors calculated, strong evidence of a daylight-saving effect is observed.[11, 12] Results appear in Table 2, based again on NYSE equal-weighted and value-weighted returns. The daylight-saving coefficient estimate is negative and statistically significant for both cases. Furthermore, the daylight-saving coefficient estimates of about −0.3 are closest to the values reported for OLS in Table 1.

To demonstrate that the strong support for the daylight-saving effect is not unique to the NYSE index returns, in Table 3 we present results for a broader set of U.S. index returns, again based on GMM estimation with HAC standard errors. In all cases, the daylight-saving coefficient has the same sign, magnitude, and significance demonstrated in Tables 1 and 2 based on OLS and GMM estimation techniques. In short, there is strong, statistically significant evidence of the daylight-saving effect under a variety of model specifications and for a wide range of U.S. stock indexes.

As previously mentioned, it is conceivable that the daylight-saving effect may have been exploited by market participants since its existence was first publicized. Nonetheless, in untabulated analysis, U.S. index return data were collected over the extended period Berument, *et al.* studied (1967–2007) and the Kamstra, *et al.* model was estimated on the extended sample period. Results were consistent with Kamstra, *et al.*: economically large negative returns on daylight-saving Mondays, albeit somewhat smaller and less statistically significant than was shown for the original sample period.

*Conclusion*

Basically, the question of whether a daylight-saving effect exists and is noteworthy is answered by considering the mean daylight-saving Monday return: is this mean return economically large and statistically sig-

[11]GMM has been carefully studied in the context of systems of stock and bond portfolios by Ferson and Foerster (1994). Ferson and Foerster considered monthly U.S. Treasury returns and monthly U.S. stock returns, relying on generalized method of moments (GMM) estimation and HAC standard errors to correctly estimate the covariance of their parameters in the presence of autocorrelation and autoregressive conditional heteroskedasticity. GMM is widely used by researchers studying equity return data. See, for instance, Hodrick and Zhang (2001), Jagannathan and Wang (2007), Bekaert, Engstrom, and Xing (2009), and Albuquerque, Bauer, and Schneider (2009) for just a few recent examples.

[12]We follow Newey and West (1994) and use the Bartlett kernel and an automatic bandwidth parameter (autocovariance lags) equal to the integer value of $4(T/100)^{2/9}$.

TABLE 2

The Daylight-saving Effect in U.S. Stock Returns: GMM Estimation

| | Intercept | Monday | DS | Tax |
|---|---|---|---|---|
| Equal-weighted | | | | |
| GMM: NYSE | **0.088** | **–0.173** | **–0.319** | **0.175** |
| *SE* | 0.011 | 0.022 | 0.179 | 0.050 |
| *p* | <.001 | <.001 | .037 | <.001 |
| Value-weighted | | | | |
| GMM: NYSE | **0.070** | **–0.107** | **–0.292** | 0.051 |
| *SE* | 0.011 | 0.027 | 0.187 | 0.042 |
| *p* | <.001 | <.001 | .059 | .110 |

*Note.*—All models are estimated using a sample period of January 3, 1967, to December 31, 1997, with the ending date chosen to align with Kamstra, *et al.*'s ending date (2000). The model estimation technique is GMM, with no lags of the dependent variable included. Models were estimated for both equal-weighted and value-weighted returns. The number of observations was 7,805. Monday is a dummy variable set to equal one on the first trading day of the week and zero otherwise, DS is a dummy variable set to equal one on the first trading day following a daylight-saving time change and zero otherwise, and Tax is a dummy variable set to equal one for the first month of the tax year (January in the U.S.) and zero otherwise. Standard errors and significance are based on MacKinnon and White's (1985) jackknife-based heteroskedasticity-consistent covariance matrix estimator. Coefficient estimates that are significant at the 10% level or better are indicated in boldface.

nificant? Estimation of the return indicates the answer is "yes," and Berument, *et al.*'s own estimate of this mean return, as can be discerned in their Appendix (available through the journal editorial office, on request), confirms this. The results presented by Berument, *et al.* convince one only that a specification that includes many (possibly spuriously significant) lags of returns and uses a (possibly biased) maximum likelihood estimation technique such as EGARCH must be evaluated with some skepticism. Further, one must pay attention to warning signs such as large differences in parameter estimates of mean effects across different estimation techniques. In light of the statistically significant evidence in favor of the daylight-saving effect, and in light of the lack of evidence of the daylight-saving effect in return variances, the use of highly parameterized techniques for modeling variances, such as EGARCH, seems inappropriate. In spite of this, application of even overparameterized GARCH and EGARCH models demonstrates a large and economically significant daylight-saving effect, as does application of OLS and GMM which are arguably more suitable in a context where one is interested in examining effects on mean returns, not the variance of returns. The original findings of Kamstra, *et al.* (2000) remain convincing: there is statistically significant evidence that daylight-saving time changes are associated with an economically large impact on U.S. stock index returns.

TABLE 3

THE DAYLIGHT-SAVING EFFECT IN U.S. STOCK RETURNS: GMM ESTIMATION AND ALTERNATIVE INDICES

| GMM | Intercept | Monday | DS | Tax |
|---|---|---|---|---|
| S&P 500 | **0.055** | **–0.101** | **–0.299** | 0.054 |
| *SE* | 0.011 | 0.029 | 0.195 | 0.042 |
| *p* | <.001 | <.001 | .062 | .103 |
| NASDAQ equal-weighted | **0.125** | **–0.250** | **–0.332** | **0.286** |
| *SE* | 0.012 | 0.016 | 0.204 | 0.048 |
| *p* | <.001 | <.001 | .052 | <.001 |
| NASDAQ value-weighted | **0.090** | **–0.229** | **–0.344** | **0.124** |
| *SE* | 0.014 | 0.026 | 0.252 | 0.053 |
| *p* | <.001 | <.001 | .086 | .009 |
| AMEX equal-weighted | **0.116** | **–0.234** | **–0.319** | **0.366** |
| *SE* | 0.013 | 0.020 | 0.183 | 0.061 |
| *p* | <.001 | <.001 | .041 | <.001 |
| AMEX value-weighted | **0.082** | **–0.236** | **–0.272** | **0.139** |
| *SE* | 0.013 | 0.024 | 0.198 | 0.050 |
| *p* | <.001 | <.001 | .085 | .003 |

*Note.*—All models are estimated using a sample period of January 3, 1967, to December 31, 1997, with the ending date chosen to align with Kamstra, *et al.*'s ending date (2000). The model estimation technique is GMM, with no lags of the dependent variable included as regressors. Models were estimated for the S&P 500 index returns, value-weighted and equal-weighted NASDAQ index returns, and value-weighted and equal-weighted American Exchange (AMEX) index returns. The number of observations was 7,805. Monday is a dummy variable set to equal one on the first trading day of the week and zero otherwise, DS is a dummy variable set to equal one on the first trading day following a daylight-saving time change and zero otherwise, and Tax is a dummy variable set to equal one for the first month of the tax year (January in the U.S.) and zero otherwise. Standard errors and significance are based on MacKinnon and White's (1985) jackknife-based heteroskedasticity-consistent covariance matrix estimator. Coefficient estimates that are significant at the 10% level or better are indicated in boldface.

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