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Incorporating Weekend Information in Stock Prices: Evidence from Israeli Stock Market

Andrey Kudryavtsev[1], Gil Cohen[2] and Julia Pavlodsky[3]

Abstract

In present study, we contribute to the discussion on international stock market correlations, by analyzing interdependencies between stock returns in US and Israeli stock exchanges. In particular, we concentrate on the original feature of Tel Aviv Stock Exchange (TASE) where the trading week starts on Sunday and ends on Thursday, creating thus a unique kind of non-synchronous trading - a trading day when TASE is the only active stock exchange in the world. We find that TASE returns on Sundays are positively correlated with stock returns in the US on both previous Thursdays and Fridays that is, on both trading days in the US taking place during the weekend in Israel. On the other hand, S&P 500 returns on Mondays are positively correlated with TASE returns on the same Mondays, but *not* with TASE returns on preceding Sundays. Together, these findings imply that TASE stock prices on Sundays just "close up the differences" from the US exchanges by incorporating the news that arrive to the world markets during the weekends in Israel, but do not reflect any additional news of worldwide relevance arriving when the world markets are closed. Thus, world markets appear to "wake up" and deal with the new "weekend" information only on Mondays, which seems to contradict stock market efficiency in the international perspective.

[1]The Economics and Management Department, The Max Stern Academic College of Emek Yezreel, Emek Yezreel 19300, Israel, e-mail: andreyk@yvc.ac.il
[2]Carmel Academic Center Business School, Palmer 4, Haifa, Israel,
e-mail: gilc@carmel.ac.il
[3]Max Wertheimer Minerva Center for Cognitive Studies, Faculty of Industrial Engineering and Management, Technion, Haifa 32000, Israel,
e-mail: jsirota@tx.technion.ac.il

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1 Introduction

The process of globalization has penetrated virtually all spheres of human activity. Still, stock market trading is one of the fields where the results of globalization seem to be especially important and influential. The benefits and costs of international portfolio diversification need to be considered by anyone holding a financial portfolio. Similarly, the firm that is considering raising new resources needs to address the requirements of the global marketplace. The globalization process is being driven by technical changes and falling barriers to international transactions. It is further characterized by the exchange of knowledge and information among countries. These kinds of exchange are encouraged by the unprecedented decrease of information costs.

Recently, markets, businesses, regions and continents have become more interdependent upon one another. This phenomenon encourages a wide range of financial services and fundraising throughout the world. The globalization of economic activity, the increased world wealth, and the reduction in transaction costs associated with the information revolution all direct investors to consider the newly emerging financial markets. Portfolio selection models, and their success in real world applications, depend crucially on asset market correlations. In terms of risk reduction, the coefficient of correlation is the most important input into any asset allocation model. Therefore, the issue of correlations between returns in international equity markets draws a continuously increasing interest in modern financial literature (e.g., Grubel, 1968; Bertoneche, 1979; Hilliard, 1979; Grauer and Hackansson, 1987; Eun and Shim, 1989; Meric and Meric, 1989; Jeon and Von Furstenberg, 1990; Koch and Koch, 1991; French and Poterba, 1991; Birati and Shachmurove, 1992; Malliaris and Urrutia, 1992; Roll, 1992; Friedman and Shachmurove, 1997, Shachmurove, 2000, 2005).

There are a number of accepted stylized facts regarding stock market co-movements. First, correlations are generally lower between international than domestic markets. This has been the driving force behind the wealth of literature advocating international diversification, from Grubel (1968) to the present day. Second, correlations tend to increase in times of large shocks to returns, such as a stock market crash (see, for example, King and Wadhwani, 1990; Longin and Solnik, 1995). Third, according to the so-called "gravity models", correlations between two certain stock markets are directly proportional to the total capitalization of the markets and inversely proportional to the distance between the markets (e.g., Bergstrand, 1985; Feenstra, et al., 1998, Anderson and Van Wincoop, 2001).

Another related issue studied in detail in previous literature dealing with stock market correlations refers to causal relationships between returns in different markets, which are extensively analyzed by Granger causality testing. In this respect, Eun and Shim (1989) examine the information transmission from the US to other markets, and argue for the US dominance in the international stock markets. On the other hand, a number of empirical studies conclude that there is no clear evidence of a causal relationship between international stock markets. Malliaris and Urrutia (1992) investigate the Granger causalities of six stock market indices before, during, and after the October 1987 crash to identify the origin of the crisis, and document no significant lead-lag relationship either in the pre- or in the post-crash period. Kwan et al. (1995) employ a similar methodology, examining the efficient market hypothesis in its weak form, and do not identify any dominant market. Similar conclusions are reported by Soydemir (2000), Drakos and Kutan (2005) and D'Ecclesia and Costantini (2006).

A possible reason for the latter results may be connected to the non-synchronous trading. Even though the research in this area is quite extensive, only a few studies have addressed the potentially serious "non-synchronous trading effect" problem in the use of data from stock exchanges in various countries. The consequence of this effect is that the time series of stock returns, covering the same corresponding periods, usually have unequal numbers of observations (using daily closing prices). These differences arise naturally from the fact that trading days in different countries are subject to different national and religious holidays, unexpected events, and other possible factors. Importantly, this effect can induce spurious cross-correlations of returns calculated from daily closing prices (first mentioned by Fisher, 1966; for more information see Campbell et al., 1997). The majority of studies neither precisely examines, nor accounts for this type of non-synchronicity of daily returns in tests for Granger causality. Many papers that perform correlation analyses use weekly or monthly data to avoid the non-synchronicity problem (e.g., Longin and Solnik, 1995; Theodossiou et al., 1997; Ramchand and Susmel, 1998; Masih and Masih, 2001, 2002). Such solutions, however, may lead to small sample sizes and cannot capture the information transmission in shorter (daily) time frames. Another reason for potential difficulties in correctly analyzing correlations between stock returns in different markets refers to the differences in the time zones between the markets.

Baumohl and Vyrost (2010) employ a novel approach to analyzing the causal relationships between different financial markets. Assuming that news of worldwide relevance for the stock markets immediately affect stock prices in the markets that are open at the moment, and are subsequently incorporated in stock prices in the markets that open later, Baumohl and Vyrost (2010) suggest that stock returns in markets that during a trading day are open earlier (e.g., Asian markets) are Granger caused by previous day's returns in markets that are open later (e.g., US) *and* Granger cause the same day's stock returns in markets that are open later (again, US). Their findings support their hypothesis for Asian, European and American stock markets, explaining why a number of previous

studies analyzing only the same day's returns in different markets fail to report Granger causality connections between the markets.

In present study, we further develop the issue of international stock market correlations by analyzing interdependencies between stock returns in US and Israeli stock exchanges. Because of the leading role of the US capital markets in the world of finance, in general, and because of the stable and friendly political and economic relationships between the US and Israel, the stock markets of the two states are strongly correlated (e.g., Shapira et al., 2009; Kenett et al., 2010). In addition, Shachmurove (2005) demonstrates that Tel Aviv Stock Exchange (TASE) returns Granger cause the same day's stock returns in the US, which in their turn, Granger cause the next day's TASE returns. This finding is actually in line with the above-mentioned intuition employed later on by Baumohl and Vyrost (2010), since because of the time zone differences, US stock exchanges open roughly at the end of the daily trading sessions on TASE.

Unlike Shachmurove (2005) who analyzes the inter-market correlations all over the trading week, we concentrate on the original feature of the TASE where the trading week starts on Sunday and ends on Thursday, creating thus a unique kind of non-synchronous trading, namely, a "stand-alone" trading day (Sunday), when the TASE is the only active stock exchange in the world. We find that TASE returns on Sundays are positively and significantly correlated with stock returns in the US, as proxied by S&P 500, on both previous Thursdays and Fridays, that is, on both trading days in the US taking place during the weekend in Israel. On the other hand, S&P 500 returns on Mondays are highly positively correlated with TASE returns on the same Mondays, but *not* with TASE returns on preceding Sundays. Regarded together, these findings imply that TASE stock prices on Sundays just "close up the difference" from the US exchanges by incorporating the news that arrive to the world markets during the weekends in Israel, but do not reflect any additional news of worldwide relevance arriving on Saturdays and Sundays. Of course, TASE is a relatively small stock exchange, and therefore, the fact that Monday returns on TASE are significantly correlated with Monday returns on S&P 500 is probably due to positive correlation of the former with the returns in larger Asian and European markets. In other words, markets all around the world appear to "wake up" and start to deal with the new "weekend" information only on Mondays, which seems to contradict stock market efficiency in the international perspective.

2 Data description

In order to analyze the stock return correlations between the US and the Israeli stock markets, we employ daily values of S&P 500 Index and TA 25 Index[4],

[4] As appears from its name, TA 25 Index lists the prices of 25 stocks with the highest market capitalization on TASE, and serves as its major "reference" index.

respectively, for the period from January 1, 2000 to December 31, 2011. Both indexes are value-weighted and corrected for distributions, such as cash and stock dividends.

For both indexes we calculate their daily returns, as proxies for daily market returns in the US and Israel. Table 1 reports the basic descriptive statistics for the returns on both indexes, by weekdays.[5] We may observe that during the sample period, average S&P 500 returns were quite similar for all the weekdays, while average TA 25 were strikingly the highest on Sundays. Interestingly, this latter result is consistent with findings by Lauterbach and Ungar (1992, 1995) who document the same return pattern for a number of TASE stock indexes in 1977-1991 and explain it by the existence of additional compensation demanded for the illiquidity and greater risk of investing during market closures.

Table 1: S&P 500 and TA 25 daily returns, by weekdays: Descriptive statistics for the sample period (January 1, 2000 – December 31, 2011)

Panel A: S&P 500 returns						
Statistics	Daily returns on:					
	Monday	Tuesday	Wednesday	Thursday	Friday	All the week
Mean, %	-0.004	0.046	-0.009	0.044	-0.056	0.004
Median, %	0.028	0.026	0.069	0.118	0.043	0.055
Standard	1.539	1.445	1.347	1.389	1.196	1.386
Deviation, %	11.580	10.789	5.738	6.921	6.325	11.580
Maximum, %	-8.930	-5.740	-9.035	-7.617	-5.828	-9.035
Minimum,%	567	618	621	608	605	3019
No. of observations						
Panel B: TA 25 returns						
Statistics	Daily returns on:					
	Sunday	Monday	Tuesday	Wednesday	Thursday	All the week
Mean, %	0.121	0.062	0.002	-0.001	-0.008	0.036
Median, %	0.170	0.099	-0.033	-0.041	0.003	0.046
Standard	1.764	1.105	1.245	1.322	1.332	1.372
Deviation, %	8.439	5.336	4.573	4.003	5.330	8.439

[5] Because of the holidays both in the US and in Israel, the number of trading weekdays in our sample is always less than 626 which is the total number of weeks in our sample.

Maximum, %	-7.365	-4.013	-5.207	-4.310	-7.975	-7.975
Minimum,%	598	596	580	584	589	2947
No. of observations						

3 Results

3.1 Index return autocorrelations

Before proceeding to the analysis of inter-market return correlations resulting from the non-synchronous trading, we take a short look on the correlations of both indexes' returns "with themselves taken with a lag of one day", that is, on the first-order autocorrelations of index returns. We perform this kind of autocorrelation analysis separately by weekdays. Table 2 presents the results and demonstrates that:

- S&P 500 returns on Tuesdays and Wednesdays are significantly negatively correlated with previous days' (Mondays' and Tuesdays', respectively) returns. For other weekdays, including over the weekend, the autocorrelations are non-significant.
- There are no significant autocorrelations in TA 25 returns, except for Sundays when some kind of "momentum continuation" from the end of the previous week may be observed.
- Overall, for both indexes, first-order autocorrelation coefficients and even their signs differ between the weekdays, and therefore, there is probably no beneficial trading strategy taking advantage of the autocorrelations in either of the indexes.

Table 2: First-order autocorrelations of S&P 500 and TA 25 daily returns, by weekdays

Panel A: S&P 500 returns				
Correlation coefficients between index returns, by weekdays (No. of pairs of weekdays in the sample)[a]				
Monday – previous Friday	Tuesday – Monday	Wednesday - Tuesday	Thursday - Wednesday	Friday – Thursday
0.011 (566)	***-0.190 (560)	***-0.155 (614)	*-0.071 (604)	-0.036 (588)
Panel B: TA 25 returns				
Correlation coefficients between index returns, by weekdays (No. of pairs of weekdays in the sample)				
Sunday –	Monday –	Tuesday –	Wednesday -	Thursday -

Previous Thursday	Sunday	Monday	Tuesday	Wednesday
***0.116 (598)	-0.015 (581)	-0.021 (567)	0.015 (556)	-0.033 (571)

Asterisks denote 2-tailed p-values: *p<0.10; **p<0.05; ***p<0.01

[a] Numbers of weekday pairs are different because of the holidays in the US (Panel A) and Israel (Panel B).

Since US stock exchanges and the TASE work non-synchronously, we may expect that, in line with Shachmurove (2005) and Baumohl and Vyrost (2010), the information of worldwide relevance arriving at one of the stock exchanges at the time when the other one is closed will immediately affect stock prices in the stock exchange that is open and will subsequently be reflected in stock prices in the other one as soon as it opens. In other words, we expect that S&P 500 returns will be positively correlated with TA 25 returns on the next trading day, which in their turn, will be positively correlated with the same day's S&P 500 returns (though, as appears from Table 2, both S&P 500 and TA 25 returns on two subsequent trading days are usually not, and sometimes even negatively, correlated). We separately test both relationships of this "temporal chain" in the next two Subsections.

3.2 S&P 500 returns predicting the next day's TA 25 returns

In Table 3, we report, by weekdays, correlation coefficients between S&P 500 daily returns and TA 25 returns on the next trading day. Importantly, since both Thursday and Friday trading sessions in the US stock exchanges take place during the weekend in Israel (after TASE closing on Thursday), we also report the correlation coefficient between S&P 500 returns on Thursdays and TA 25 returns on the following Sundays, and cumulative S&P 500 returns on Thursdays and Fridays and TA 25 returns on the following Sundays.

Table 3: Effect of S&P 500 daily returns on TA 25 returns on the next trading day, by weekdays

Correlation coefficients between index returns, by weekdays (No. of pairs of weekdays in the sample) [a]					
S&P Monday – TA Tuesday	S&P Tuesday – TA Wednesday	S&P Wednesday – TA Thursday	S&P Thursday – TA next Sunday	S&P Friday – TA next Sunday	S&P Thursday plus Friday – TA next Sunday
***0.162 (521)	***0.233 (576)	***0.269 (584)	***0.262 (580)	***0.462 (581)	***0.493 (564)

Asterisks denote 2-tailed p-values: *p<0.10; **p<0.05; ***p<0.01

[a] Numbers of weekday pairs are different because of the holidays in the US and Israel.

Consistently with Shachmurove (2005), we find that all the respective correlation coefficients are significantly positive. Moreover:

- The correlation coefficient between S&P 500 returns on Fridays and TA 25 on the following Sundays is significantly higher (at the 1% significance level) than the correlation coefficients for all other pairs of weekdays[6].
- S&P 500 returns on Thursdays are also positively and significantly correlated with TA 25 returns on the following Sundays.
- The correlation between the cumulative S&P 500 returns on Thursdays and Fridays and TA 25 returns on the following Sundays shows up an impressive coefficient of 0.493, which is, of course, highly significant.

In order to further test if the effects of S&P 500 returns on Thursdays and Fridays on TA 25 returns on the following Sundays are independent and not driven by the same information inflows or autocorrelations, we run the following regression:

$$TA\_Sun_t = \beta_0 + \beta_1 SP\_Thu_{t-1} + \beta_2 SP\_Fri_{t-1} + \beta_3 TA\_Thu_{t-1} + \varepsilon_t \qquad (1)$$

where: TA_Sun_t is TA 25 return on Sunday in week *t*; SP_Thu_{t-1} is S&P 500 return on Thursday in week *t-1*; SP_Fri_{t-1} is S&P 500 return on Friday in week *t-1*; and TA_Thu_{t-1} is TA 25 return on Thursday in week *t-1*.[7]

Table 4 concentrates the regression coefficients, demonstrating that both Thursdays' and Fridays' returns on S&P 500 remain highly significant (and directly proportional) predictors of the following Sundays' returns on TA 25, even after controlling for the effects of each other and for the potential effect of the first-order autocorrelation in TA 25 returns, which in its turn, becomes non-significant in this kind of analysis. The results in this Subsection clearly show that TA 25 returns on the first trading day of the week (Sunday) incorporate the information arriving at the world markets during the weekends in Israel.

Table 4: Explaining TA 25 returns on Sundays by S&P 500 and TA 25 returns at the end of the previous weeks: Regression analysis

Coefficients	Coefficient estimates (t-statistics)
β_0 (Intercept)	**0.001 (2.32)
β_1 (SP_Thu_{t-1})	***0.315 (6.42)

[6] We test for the equality of correlation coefficients employing Fisher r-to-z transformation.

[7] Since because of the holidays in the US and Israel, we have some missing data for certain weeks, we run regression (1) for 533 weeks, for which all the data are present.

β_2 (SP_Fri_{t-1})	***0.690 (12.62)
β_3 (TA_Thu_{t-1})	0.064 (1.28)
Adjusted R-squared	0.276

Asterisks denote 2-tailed p-values: *p<0.10; **p<0.05; ***p<0.01

In the next Subsection, we perform a symmetric analysis of the effect of TA 25 returns on the same day's S&P 500 returns, and in particular, of the effect of TA 25 returns registered during the weekends in the US on S&P 500 returns on the first trading day of the week (Monday).

3.3 TA 25 returns predicting the same day's S&P 500 returns

In Table 5, we present, by weekdays, correlation coefficients between TA 25 daily returns and S&P 500 returns on the same trading day, starting of course, chronologically later. Importantly, since both Sunday and Monday trading sessions on TASE take place during the weekend in the US (before the opening of the US stock exchanges on Monday), we also report the correlation coefficient between TA 25 returns on Sundays and S&P 500 returns on Mondays, and cumulative TA 25 returns on Sundays and Mondays and S&P 500 returns on Mondays.

Table 5: Effect of TA 25 daily returns on S&P 500 returns on the same trading day, by weekdays

Correlation coefficients between index returns, by weekdays (No. of pairs of weekdays in the sample) [a]					
TA Tuesday – S&P Tuesday	TA Wednesday – S&P Wednesday	TA Thursday – S&P Thursday	TA Sunday – S&P Monday	TA Monday – S&P Monday	TA Sunday plus Monday – S&P Monday
***0.268 (572)	***0.233 (579)	***0.304 (572)	0.055 (540)	***0.475 (538)	***0.307 (523)

Asterisks denote 2-tailed p-values: *p<0.10; **p<0.05; ***p<0.01[a] Numbers of weekday pairs are different because of the holidays in the US and Israel.

Consistently with Shachmurove (2005), we find that all the "same day" correlations between TA 25 and S&P 500 returns are significantly positive. Moreover:

- The correlation coefficient between TA 25 and S&P 500 returns on Mondays is significantly higher (at the 1% significance level) than the correlation coefficients for all other pairs of weekdays.
- TA 25 returns on Sundays are *not* significantly correlated with S&P 500 returns on subsequent Mondays.

- The correlation coefficient between the cumulative TA 25 returns on Sundays and Mondays and S&P 500 returns on Mondays is positive, yet, significantly lower than the respective correlation coefficient with only Monday returns on TA 25 being employed.

In order to better understand how the new information arriving at weekends is incorporated in TA 25 and S&P 500 returns at the beginning of the trading week, similarly to the previous Subsection, we perform multifactor regression analysis, as follows:

$$SP\_Mon_t = \gamma_0 + \gamma_1 TA\_Sun_t + \gamma_2 TA\_Mon_t + \gamma_3 SP\_Fri_{t-1} + \varepsilon_t \quad (2)$$

where: SP_Mon_t is S&P 500 return on Monday in week *t*; TA_Sun_t is TA 25 return on Sunday in week *t*; TA_Mon_t is TA 25 return on Monday in week *t*; and SP_Fri_{t-1} is S&P 500 return on Friday in week *t-1*.[8]

Table 6 concentrates the regression coefficients, demonstrating that Mondays' returns on TA 25 remain a highly significant (and directly proportional) predictor of the same Mondays' returns on S&P 500, even after controlling for the effects of TA 25 returns on Sundays and first-order autocorrelations in S&P 500 returns. On the other hand, TA 25 returns on Sundays remain non-significantly correlated with S&P 500 returns on the following Mondays.

Table 6: Explaining S&P 500 returns on Mondays by preceding S&P 500 and TA 25 returns: Regression analysis

Coefficients	Coefficient estimates (t-statistics)
γ_0 (Intercept)	-0.001 (-1.19)
γ_1 (TA_Sun_t)	0.058 (1.60)
γ_2 (TA_Mon_t)	***0.627 (12.57)
γ_3 (SP_Fri_{t-1})	-0.006 (-0.11)
Adjusted R-squared	0.237

Asterisks denote 2-tailed p-values: *p<0.10; **p<0.05; ***p<0.01

The results in this Subsection suggest that TA 25 returns on Sundays hardly incorporate any information arriving on Saturdays and Sundays that may be relevant for worldwide stock returns on Mondays. This new information seems to affect TA 25 returns only on Mondays, like in the rest of the world.

Overall, the results discussed in Subsections 3.2 and 3.3 imply that on Sundays, when all other stock exchanges are closed, stock traders on TASE do not manage to correctly predict how the new information arriving during the weekends would

[8] Since because of the holidays in the US and Israel, we have some missing data for certain weeks, we run regression (2) for 507 weeks, for which all the data are present.

affect stock market indexes around the world on the subsequent Mondays. Sunday returns on TASE seem just "to close up the differences" from the US stock exchanges arising as a result of Thursdays' and Fridays' trading sessions in the US taking place at the time when TASE is closed.

4 Conclusion

In present study, we make an effort to better understand when and how does the new information of worldwide relevance affect stock prices in different markets. We analyze the correlations of weekday returns on S&P 500 and TA 25 stock indexes, and arrive at conclusion that TA 25 returns on Sundays are significantly affected only by the weekend information which has been already reflected in the US stock market quotes on the days when TASE is closed, i.e., on Thursdays and Fridays, but not by information arriving when both US and Israeli stock exchanges are closed, i.e. from Friday afternoon in the US and till Sunday morning in Israel. This latter information is incorporated in S&P 500 and TA 25 returns only on Mondays.

Our findings suggest that TASE does not adequately reflect the latest information on Sundays and similarly to other stock exchanges worldwide, "wakes up" only on Mondays. This is a contradiction to stock market efficiency, since an investor who is capable of correctly interpreting world news arriving on Saturdays and Sundays seems to be able of taking advantage of that by buying or selling TASE stocks on Sundays when their prices are not adjusted to these news, yet.

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