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THE DAYLIGHT SAVING TIME ANOMALY IN STOCK RETURNS: FACT OR FICTION?

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Abstract

Stock market returns in 22 markets around the world show no evidence of a daylight saving time effect. Returns on the days following a switch from or to daylight saving time do not behave any differently from stock market returns on any other day of the week or month. These results reject earlier conclusions in the literature—based on less data—that investors' mood changes induced by changes in sleep patterns significantly affect stock returns.

JEL Classification: G10, G11, G12, G15

I. Introduction

According to Kamstra, Kramer, and Levi (2000) investors alter their trading behavior on Mondays after daylight saving time (DST) weekends because of changes in their sleep patterns. The empirical evidence in Kamstra, Kramer, and Levi suggests that in the United States, United Kingdom, Canada, and Germany, DST weekends are typically followed by large negative returns in market indices. Although transactions costs swamp any DST effect, what makes their study interesting is that it adds to the debate in the behavioral finance literature[1] as to whether external factors, such as weather, sunshine, or outcomes of sporting events, can cause investors' mood changes large enough to be observable in stock returns.

We test for the existence of a DST anomaly using a larger set of stock markets than Kamstra, Kramer, and Levi (2000) in 22 countries. This increases over fivefold the number of DST events, which gives us not only a larger sample of countries but also more variety of DST change dates. In these 22 stock markets,

[1] Saunders (1993) and Hirshleifer and Shumway (2003) find a strong relation between cloud cover and stock returns. Kamstra, Kramer, and Levi (2003), report evidence of a seasonal affective disorder (SAD) effect in stock returns due to changes in the number of hours of sunlight over a given year. Dichev and Janes (2003) and Yuan, Zheng, and Zhu (2006) relate stock returns to lunar phases. Cao and Wei (2005) link stock market returns to temperature variations.

returns on trading days after weekends with DST changes do not differ from trading days after average weekends. We find a significant and negative DST coefficient only for Luxembourg and only when Luxembourg goes off DST in the fall. For all other countries, our results indicate that trading days after DST changes are nothing special. These results hold when we control for the weekend effect, different months, and the 1987 and 1997 crashes. If we are as charitable as possible for a DST effect, leaving out a Monday dummy and considering DST on and off switches jointly, we find a significant effect in the United Kingdom and at the 10% level in the United States, but in the other 20 countries there is no significant DST effect. Apparently, a change in sleeping pattern caused by DST does not have a systematic effect on the mood of investors large enough to be discernible in stock returns.

Extending the sample size is important in assessing the existence of a DST effect. Kamstra, Kramer, and Levi (2002) point out that their small sample of DST observations may cause some test statistics to show insignificant results, even though point estimates suggest the effect may be present. Extending the data set with many (uncorrelated) observations seems a natural way to help resolve the current debate on the existence of a DST effect in stock returns.

Conclusions regarding the effects of DST changes in other areas also hinge on sample sizes. The basis for the speculation that DST changes affect financial markets is due to similar studies that examine DST effects on workplace and traffic accidents. For example, Monk (1980), Hicks, Lyndseth, and Hawkins (1983), and Coren (1996) find a positive relation between DST changes and an increase in traffic accidents. But Ferguson (1996) points out that Coren uses only two years of data, and a more thorough analysis would have found the reverse result. Highlighting the problem of small samples, Coate and Markowitz (2004) examine a different two years from Coren and do find the opposite—that DST decreases accidents. Using longer data periods, Ferguson et al. (1995) and Sood and Ghosh (2007) show that the level of pedestrian or vehicular accidents over the spring change is unaffected or actually decreases because of the hour of extra light.

Given that the appropriate data sample can be so important for the conclusions in an arena where one might easily understand the implications, it is much more important to carefully consider the data sample in a study testing the suggestion that sleep desynchronosis will result in financial loss—a suggestion considerably more controversial than the potential effect of sleep disruption on traffic accidents.

We are not the first to dispute the claim made by Kamstra, Kramer, and Levi (2000).[2] Pinegar (2002) finds that the statistical significance of their findings

[2]Many studies reexamine other claims made in this strand of the literature. For instance, Kelly and Meschke (2010) offer theoretical and empirical evidence against SAD and stock returns as documented by Kamstra, Kramer, and Levi (2003). Jacobsen and Marquering (2008) show that Kamstra, Kramer, and Levi (2003) and Cao and Wei (2005) measure a similar effect as already reported by Bouman and Jacobsen (2002) and that effects in these two studies may be a result of spurious correlation.

is overstated because of inappropriate use of test statistics. Kamstra, Kramer, and Levi assume normality for daily stock returns. Pinegar calculates the more common heteroskedasticity-consistent standard errors based on White (1980). Additionally, Pinegar and Lamb, Zuber, and Gandar (2004) show that results in Kamstra, Kramer, and Levi are driven by two international crises. Once these crises are removed, the apparent DST effects vanish. Worthington (2003) highlights the importance of addressing the correct and frequently changing dates for a country where there are multiple, simultaneously applicable standards. After accounting for multiple zones, changing dates, heteroskedasticity, and autocorrelation, he finds no DST effect in Australia.

In a reply to Pinegar (2002), Kamstra, Kramer, and Levi (2002) take issue with Pinegar's statistical arguments but also reemphasize a point made in Kamstra, Kramer, and Levi (2000) that the economic significance of a large market such as the United States reacting to a DST event, in and of itself, makes the event worthy of notice. However, it is possible that the noted United States effect is a statistical artifact and therefore the economic significance is spurious. To help control for that possibility, Kamstra, Kramer, and Levi (2000) add three other countries: Canada, United Kingdom, and Germany. Unfortunately, the Canadian stock market has high correlation with the United States ($\rho = 0.66$ over their sample period). To make matters worse, once Canada began observing DST, its DST date changes have been identical to those of the United States. Therefore, the addition of Canada is not of much help with statistical robustness. Between the United Kingdom and Germany, the correlation is not as high ($\rho = 0.43$ over their sample period), and although the DST changes are not all the same as the United States and Canada, most of these two countries' spring changes have been at the same time, even before 1996 when most countries began changing together.

To distinguish between spurious economic significance and true statistical significance, the obvious solution is to use a larger data sample—more countries, over more years, with diverse dates. Kamstra, Kramer, and Levi (2000) argue this point (p. 1007), claiming that they would be unlikely to find a similar pattern in a country that observes DST on other dates altogether if the DST effect was spurious in the North American data.

We agree, but a priori, there is no clear reason why one should restrict attention to only four countries—especially countries that are likely to have similar results. In cases like this, where there is no reason to expect investors across countries to act fundamentally differently and where results should not depend on the economic size of markets, using a large number of countries is a useful approach to avoid inferences based on spurious results. We examine 22 countries over about a one-third longer time span; this results in about 1,150 DST events as opposed to approximately 200 in Kamstra, Kramer, and Levi's (2000) study with a large variation in DST dates. This much larger sample with different DST dates helps ensure statistically sound results.

II. Data

Stock Market Data

We use daily stock returns of value-weighted indices for 22 of the countries that made up the MSCI World Index during most of our sample period: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Luxembourg, the Netherlands, Norway, New Zealand, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.[3] Data are from Global Financial Data, all in home currency, and all local holidays assigned missing returns (unlike Datastream, Global Financial Data does not "fill in" missing data). For most countries, Global Financial Data has multiple composite indices. In each case, we choose the most broad and comprehensive index available. For every country we have long daily data series available, and all these countries have DST changes over a large part of our sample. All series end in December 2005. Table 1 contains summary statistics for all indices.

It is well known that daily stock returns show high kurtosis. Our data are no different; we find for all series extremely high estimates for kurtosis. As pointed out by Pinegar (2002), this invalidates the use of test statistics based on normality as done by Kamstra, Kramer, and Levi (2000). They use normal standard errors rather than commonly used corrections such as White or Newey–West standard errors. Daily data are well known to be heteroskedastic, and as these traditional standard errors may overstate significance, we use White (1980) standard errors in our regressions.[4]

DST Changes

From the first inspiration in 1784 by Benjamin Franklin, DST has been controversial. Opponents have been primarily either those whose schedules were tied to the sun (such as farmers) or those who would not benefit from its usage (e.g., those living in mid-latitudes). As a result, acceptance of DST was slow and progressed inconsistently. Often when one region enacted DST, a neighboring region would reject it. It was nearly 200 years before national standards began to appear (see Prerau 2005). Italy introduced a national DST standard in May 1966.[5] The United States followed in 1967, Hong Kong in 1969, and the United Kingdom and

[3] We omit Japan and Singapore, as neither country has observed DST, except temporarily during World War II (during which we have no returns data). Luxembourg is no longer part of the MSCI Index.

[4] We also examine dates and periods with and without error correction in Kamstra, Kramer, and Levi (2000). Before correction, we find the results they do. After employing White standard errors, the significant effects nearly all disappear. See Appendix A for details.

[5] Before national standards, DST policies often varied from one region to the next. Because this would dissipate any generalized DST effect, for each country we begin the data series with the national standardization (or the first return, whichever is later).

TABLE 1. Summary Results on Value-Weighted Morgan Stanley Capital International Reinvestment Indices.

Country[a]	Starting Date of Returns	1st DST Date in Our Sample[b]	Mean	Std. Dev.	Skewness	No. of Kurtosis	Obs. Obs.
Australia (Sydney)	07-Jan-58	31-Oct-71	0.029	0.842	−3.707	124.373	11,982
Austria	08-Jan-62	06-Apr-80	0.015	0.692	−0.329	21.706	10,783
Belgium	03-Jan-85	31-Mar-85	0.035	0.903	−0.220	15.773	5,141
Canada (Toronto)	05-Jan-76	25-Apr-76	0.032	0.843	−0.968	17.155	7,479
Denmark	18-Jan-79	06-Apr-80	0.043	0.829	−0.528	8.772	6,645
Finland	05-Jan-87	29-Mar-87	0.042	1.735	−0.439	11.641	4,674
France	18-Sep-68	28-Mar-76	0.032	1.057	−0.568	11.942	9,151
Germany	05-Jan-70	06-Apr-80	0.025	1.118	−0.376	12.981	12,248
Greece	03-Aug-89	24-Sep-89	0.057	1.725	0.103	8.362	4,223
Hong Kong	25-Nov-69	19-Apr-70[c]	0.051	1.909	−1.378	35.441	8,822
Ireland	05-Jan-87	29-Mar-87	0.039	1.048	−0.959	15.299	4,649
Italy	14-Dec-56	22-May-66	0.025	1.234	−0.378	9.538	11,986
Luxembourg	03-Jan-85	31-Mar-85	0.045	0.892	−0.381	17.280	5,189
Netherlands	03-Jan-80	06-Apr-80	0.036	1.157	−0.336	10.589	6,506
New Zealand	06-Jan-70	03-Nov-74	0.024	0.856	−1.216	26.845	8,870
Norway	04-Jan-83	27-Mar-83	0.057	1.179	−1.433	28.564	5,686
Portugal	03-Jan-86	30-Mar-86	0.044	1.131	−0.773	30.322	4,656
Spain	13-Sep-71	13-Apr-74	0.033	1.096	−0.203	8.406	7,751
Sweden	03-Jan-80	06-Apr-80	0.059	1.215	−0.202	8.870	6,410
Switzerland	06-Jan-69	29-Mar-81	0.020	0.931	−0.852	13.955	9,160
United Kingdom (London)	02-Jan-69	31-Oct-71	0.029	1.021	−0.298	11.103	9,276
United Sates (New York)	04-Jan-28	30-Apr-67	0.021	1.167	−0.469	23.356	19,583

Note: This table gives descriptive statistics for daily index returns for 22 countries. The starting date for each country is given in the third column, and the ending date for all series is December 30, 2005. All indices are value weighted, in domestic currency, including dividend distributions. The mean, standard deviation, maximum, and minimum are all in percentages. DST = daylight savings time.

[a]For most countries, DST is standard throughout, but four countries have multiple standards. In each of those, we use the DST dates for the city where the primary stock exchange is located, which also happens to represent the majority DST standard of the country.

[b]Many countries had some DST changes before this date; we begin where we have returns data (see Appendix B for date details).

[c]Hong Kong DST ends October 19, 1980; for all other countries, DST goes through fall 2005.

Australia in 1971. From the mid to late 1970s, other countries began enacting national DST standards until 1980, at which time most of continental Europe agreed to go on and off DST, respectively, on the first Sunday in April and the last Sunday in September.[6] Over the next two years, Sweden and Switzerland joined, and there were a few refinements and modifications over the next decade or so, with each change moving closer to the near standardization we have now.

[6]All of these dates are from Shanks and Pottenger (2003).

DST Date Selection

For each country, we record the exact date that each DST change occurs (after national standardization) during the period for which we have stock index daily returns.

Thus, in the United Kingdom, for example, although there have been regular DST events since 1916, they stayed "on" DST from February 18, 1968 until fall 1971. Our United Kingdom stock index returns data begin in January 1969; therefore, our first DST event for the United Kingdom is their fall change October 31, 1971.

France is typical of the Euro countries. DST events began in 1916 and were fairly consistent through World War II. At the close of the war, France went off DST and did not resume until spring 1976. Our French returns data begin September 1968; therefore, our first DST event for France is the spring DST change March 28, 1976. Other countries vary considerably as to when they resumed after World War II (e.g., 1966 for Italy, 1981 for Switzerland), but they all follow the same pattern.

There are four countries that present a challenge when defining DST dates: Australia, Canada, the United Kingdom, and the United States. For each of these, over the years and even now, there have been multiple, simultaneous DST standards. To minimize the dissipation of any DST effect that multiple standards would cause, we begin our data for any given country when the DST standard became nationalized or widespread. In Australia and Canada, there are still large areas that use different standards; therefore, we use the DST standard in the city of the primary stock exchange: Sydney for Australia and Toronto for Canada. In both countries, this is also the standard that represents the majority of the country.

In the United Kingdom, nationalization occurred at about the same time as our returns data begin. However, in the United States we have returns data from 1928, but standards were not nationalized until 1967. Our first DST standardized event for the United States is therefore April 30, 1967.[7] In both countries, there are some regional exceptions to the national standard, but the standard for the primary stock exchange city (London for the United Kingdom and New York for the United States) also represents the majority of the country.

For all 22 countries, even after a standard was in place, there were modifications—sometimes temporary and sometimes permanent. For example, when standards in the United States were nationalized in 1967, DST began on the fourth Sunday in April. However, in response to the 1973 oil crisis, in 1974 DST began on the first Sunday in January, in 1975 it changed to the last Sunday in February, and in 1976 it returned to the last Sunday in April. Finally, in 1987 it changed "permanently" to the first Sunday in April.

[7]There was one national DST event shortly after the close of World War II; on September 30, 1945, DST was repealed and not resumed nationally until standardization began in 1967.

There have been similar refinements and temporary changes in all of our 22 countries (Shanks and Pottenger 2003; Prerau 2005). For each country, we record the exact date of each DST change rather than follow something like a simple "first Sunday" algorithm.[8]

Current Standards

As of the end of our sample period in 2005, most Northern Hemisphere MSCI countries go on and Australia goes off DST on the last Sunday in March; the United States and Canada go on one week later (on the first Sunday in April), and New Zealand goes off one week earlier (on the third Sunday in March). In October, all countries except New Zealand change on the last Sunday, and New Zealand goes on DST on the first Sunday.

For each country, we use dates of DST changes from Shanks and Pottenger (2003), noting when each actually occurred.[9] In Table 1 we report the start of DST changes for every country in our sample.

III. Methodology and Results

To test for the existence of a DST effect,[10] we use regressions of the form:

$$r_t = \mu + \alpha_1 DST_t^{spring} + \alpha_2 DST_t^{fall} + \alpha_3 Monday_t + \varepsilon_t, \tag{1}$$

where the DST dummy equals 1 on the Monday after there has been a DST change.[11] To separate a possible weekend effect from a DST effect, we include a Monday dummy. Moreover, to give the DST effect the benefit of the doubt, we do not adjust for the large events in our sample that coincide with the DST changes noted by Pinegar (2002).

[8] We present a complete list of DST dates in Appendix B.

[9] Some of our dates differ from Kamstra, Kramer, and Levi (2000). After date correction and at a 5% level, significant effects vanish (see Appendix A for details).

[10] Ideally, we would test the spring and fall DST dates for countries that follow DST against a control sample of countries that do not. However, that would require that all countries have DST changes at the same time; unfortunately, it has only been in the last decade that most countries change at the same time, and even now both spring and fall DST changes are not unique across countries. In this case we must treat each DST event for each country as a separate event.

[11] There were no instances where a holiday followed a DST change. There were a few instances when the DST change did not occur on a Sunday. All but two occurred before the first return in our data sample. For the United States, there were two changes (on a Monday and a Tuesday) around World War II; we drop these as being different events and therefore not comparable (a Sunday change to a Monday return is a one-day physiological event; a Monday change to a Monday return is a zero-day event).

The first question we address is whether stock returns after DST changes are different from returns on normal trading days. We test this hypothesis using equation (1). In the robustness checks that follow, we consider several variations of this equation.

We report the results in Table 2. In line with the literature, the Monday dummy in our analysis is frequently negative and significant. With respect to the DST coefficients, we find a significant DST fall effect for Luxembourg only. Although we find negative effects for Canada, the United Kingdom, and the United States, these are not significant. For Germany, we observe an insignificant positive spring effect. For the remaining 18 countries, we find no indication of significant DST effects, except for a positive significant fall effect in Hong Kong at the 10% level. Considering that when based on usual confidence levels, one might find spurious significant results in 5% or 10% of the sample, in our study these significant results for Luxembourg (negative) and Hong Kong (positive) seem attributable to mere chance. The absence of a clear pattern in the signs of the DST coefficients confirms that conclusion.

Robustness Checks

Few control variables are likely to show strong correlations with the DST variables; in our analysis, we can treat most potential control variables as white noise with respect to the DST variables. Moreover, we use heteroskedasticity-consistent standard errors, which assures robustness against more specific models of heteroskedasticity such as autoregressive conditional heteroskedasticity (ARCH) and generalized autoregressive conditional heteroskedasticity (GARCH) models. However, there are a number of checks we need to perform.

Our first check is to see what happens if we leave out the Monday dummy and test the significance of both DST coefficients jointly. Even though this biases our test in favor of a DST effect, we find a significant effect only for the United Kingdom and only at the 10% level for the United States (consistent with Kamstra, Kramer, and Levi 2000). For both countries, the DST fall switch drives the result.[12] In all other countries, DST coefficients remain insignificant. Contrary to what one would expect if there were a DST effect, many countries show mean positive returns after DST changes, both in the joint estimation and for the separated spring and fall effects. If we estimate all country equations jointly using generalized method of moments and White's (1980) heteroskedasticity-consistent covariance matrix, we also reject the joint hypothesis that the dummy coefficients are significantly different from zero (p-value $= .11$). Even if we give the DST effect the benefit of

[12]We do not report these results in a separate table but they are available on request from the authors.

TABLE 2. Regression of Index Returns on a Monday Dummy and Two Daylight Saving Time (DST) Dummies: One-Hour Increase or Decrease.

Country	Const.	DST Change: Spring	DST Change: Fall	Monday	Chi-square [*p*-value]
Australia	0.037**	−0.207	0.112	−0.041**	1.326
	(4.45)	(−0.84)	(0.68)	(−1.96)	[.52]
Austria	0.012**	−0.018	0.325	0.010	2.159
	(1.77)	(−0.15)	(1.50)	(0.54)	[.34]
Belgium	0.045**	−0.225	0.003	−0.048	0.498
	(3.38)	(−0.82)	(0.02)	(−1.34)	[.78]
Canada	0.047**	−0.040	−0.325	−0.073**	0.546
	(4.51)	(−0.31)	(−0.89)	(−2.78)	[.76]
Denmark	0.056**	0.261	0.119	−0.072**	3.551
	(5.05)	(1.40)	(0.51)	(−2.71)	[.17]
Finland	0.045	−0.282	−0.282	−0.007	0.730
	(1.58)	(−0.68)	(−0.61)	(−0.12)	[.69]
France	0.039**	0.225	−0.049	−0.042	0.915
	(3.27)	(0.82)	(−0.21)	(−1.43)	[.63]
Germany	0.032**	−0.129	0.190	−0.038	0.430
	(3.04)	(−0.44)	(0.48)	(−1.34)	[.81]
Greece	0.082**	−0.338	−0.113	−0.118	0.307
	(3.01)	(−0.90)	(−0.20)	(−1.43)	[.86]
Hong Kong	0.088**	−0.150	1.092	−0.201**	3.696
	(4.31)	(−0.25)	(1.64)	(−3.11)	[.16]
Ireland	0.046**	−0.230	−0.753	−0.017	2.185
	(2.79)	(−0.81)	(−1.37)	(−0.42)	[.34]
Italy	0.050**	0.018	0.148	−0.128**	2.030
	(4.18)	(0.08)	(0.72)	(−4.01)	[.36]
Luxembourg	0.046**	0.037	−0.291**	0.002	3.900
	(3.38)	(0.22)	(−2.03)	(0.06)	[.14]
Netherlands	0.050**	−0.320	−0.252	−0.060	1.035
	(3.27)	(−0.95)	(−0.98)	(−1.47)	[.60]
New Zealand	0.031**	−0.337	−0.089	−0.027	0.937
	(3.10)	(−1.01)	(−0.60)	(−1.09)	[.63]
Norway	0.072**	0.014	0.019	−0.073**	0.257
	(4.24)	(0.06)	(0.08)	(−1.70)	[.88]
Portugal	0.057**	−0.076	0.201	−0.082**	1.212
	(3.07)	(−0.43)	(0.81)	(−2.14)	[.55]
Spain	0.021**	−0.048	−0.121	0.096**	1.048
	(1.67)	(−0.25)	(−0.44)	(2.17)	[.59]
Sweden	0.067**	−0.241	−0.229	−0.030	0.731
	(4.09)	(−0.81)	(−0.63)	(−0.73)	[.69]
Switzerland	0.039**	−0.164	−0.004	−0.093**	0.185
	(3.75)	(−0.56)	(−0.02)	(−3.42)	[.91]
United Kingdom	0.050**	−0.217	−0.325	−0.100**	0.958
	(4.37)	(−1.12)	(−1.19)	(−3.48)	[.62]
United States	0.055**	−0.013	−0.382	−0.121**	1.349
	(7.36)	(−0.10)	(−1.25)	(−5.90)	[.51]

Note: This table reports coefficient estimates from 22 country regressions of index returns on a constant, a Monday dummy, and two dummies for the Monday following a DST change: one dummy for an hour increase and one for an hour decrease (DST spring or fall). All indices are value weighted, in domestic currency, including dividend distributions. We present parameter estimates (in percentages) with associated t-statistics in parentheses, calculated using White's (1980) heteroskedasticity-robust standard errors. For each regression, we report in the last column the chi-square realization and p-value in square brackets for a chi-square test for whether DST days (spring and fall) are different from all other trading days.

**Significant at the 5% level.

the doubt, our data do not support the existence of a DST effect in stock market returns.

Pinegar (2002) and Lamb, Zuber, and Gandar (2004) note that eliminating October 1987 and October 1997 from the United States data causes the DST effect to vanish. Kamstra, Kramer, and Levi (2002) suggest that the crashes are exactly what one might expect from desynchronosis. However, in Kamstra, Kramer, and Levi (2000), they suggest (as noted earlier) that any real phenomenon should show up in other countries as well. We apply a crash dummy to our previous regressions across all countries (see Table 3), confirming the results of Pinegar and Lamb, Zuber, and Gandar. All countries, of course, have a significant and negative coefficient for the crashes; however, for the noncrash DST events, the DST effect is essentially nonexistent.[13]

There is some evidence in the literature suggesting that there is variation in stock returns across different months, and most DST changes occur in April and October. To control for any month effect, we include a dummy variable for the months in which we observe DST changes. These results, reported in Table 4, show that our original results are hardly affected.

IV. Summary and Conclusion

Kamstra, Kramer and Levi (2000) find that sleep desynchronosis from DST changes results in an observable negative effect on stock returns. Several authors question this result, focusing on Kamstra, Kramer, and Levi's statistical technique and the effect of outliers. Although these studies cast doubt on the validity of their results, all studies were subject to the same limited data samples and there was still the possibility that the Kamstra, Kramer, and Levi findings were due to a real physiological and economic event rather than a spurious statistical artifact.

We extend the work of previous authors, primarily by examining 22 countries instead of 4 but also by looking at a longer time span. This provides us with more than five times as many observations as Kamstra, Kramer, and Levi (2000) and gives us more varied "event dates." That, along with proper standard error corrections and several robustness checks, ensures that our results are a more conclusive answer to the question of whether the DST effect is real or spurious. We find no evidence of an observable DST effect in stock returns. Our results reject earlier conclusions that investors' mood changes induced by changes in sleep patterns due to DST significantly affect stock returns.

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[13] Austria has a significant positive fall coefficient, but as this is 1 result out of 44, at conventional confidence levels, it does not indicate a significant effect.

TABLE 3. Regression of Index Returns on a Crash Dummy, Monday Dummy, and Two Daylight Saving Time (DST) Dummies: One-Hour Increase or Decrease.

Country	Const.	DST Change Spring	DST Change Fall	Monday	Crash	Chi-square [p-value]
Australia	0.037**	0.093	0.110	−0.039**	−5.155**	1.024
	(4.45)	(0.77)	(0.67)	(−1.86)	(−4.23)	[.60]
Austria	0.013**	−0.021	0.428**	0.013	−2.606**	4.640
	(1.83)	(−0.17)	(2.14)	(0.66)	(−13.11)	[.10]
Belgium	0.046**	−0.230	0.173	−0.039	−3.544**	2.069
	(3.36)	(−0.84)	(1.15)	(−1.13)	(−5.20)	[.36]
Canada	0.047**	−0.046	0.170	−0.068**	−7.268**	1.763
	(4.49)	(−0.35)	(1.27)	(−2.57)	(−13.37)	[.41]
Denmark	0.056**	0.256	0.169	−0.065**	−1.411**	2.390
	(5.05)	(1.37)	(0.74)	(−2.44)	(−8.87)	[.30]
Finland	0.045	−0.290	−0.088	0.005	−3.697**	0.549
	(1.57)	(−0.70)	(−0.25)	(0.08)	(−2.47)	[.76]
France	0.040**	0.220	0.149	−0.035	−5.971**	1.019
	(3.29)	(0.79)	(0.63)	(−1.19)	(−2.61)	[.60]
Germany	0.033**	−0.133	0.380	−0.035	−4.841**	1.213
	(3.10)	(−0.45)	(1.00)	(−1.23)	(−5.83)	[.55]
Greece	0.080**	−0.341	0.048	−0.113	−2.627**	0.834
	(2.96)	(−0.91)	(0.08)	(−1.39)	(−4.60)	[.66]
Hong Kong	0.089**	−0.172	1.062	−0.170**	−23.176**	2.650
	(4.35)	(−0.29)	(1.60)	(−2.87)	(−1.90)	[.27]
Ireland	0.045**	−0.235	−0.756	−0.010	−3.500**	2.531
	(2.75)	(−0.82)	(−1.37)	(−0.23)	(−8.20)	[.28]
Italy	0.051**	0.012	0.257	−0.123**	−4.067**	1.950
	(4.30)	(0.06)	(1.39)	(−3.84)	(−8.49)	[.38]
Luxembourg	0.046**	−0.025	−0.260	0.010	−0.590**	0.315
	(3.40)	(−0.19)	(−1.52)	(0.31)	(−4.47)	[.31]
Netherlands	0.048**	−0.329	−0.043	−0.046	−5.530**	0.978
	(3.17)	(−0.97)	(−0.18)	(−1.15)	(−3.48)	[.61]
New Zealand	0.031**	−0.337	−0.089	−0.028	−3.016	1.340
	(3.08)	(−1.01)	(−0.59)	(−1.11)	(−4.81)	[.51]
Norway	0.072**	0.009	0.190	−0.067	−3.893**	0.745
	(4.28)	(0.04)	(0.86)	(−1.57)	(−3.46)	[.69]
Portugal	0.058**	−0.080	0.335	−0.079**	−2.455**	2.455
	(3.16)	(−0.44)	(1.49)	(−2.10)	(−11.11)	[.29]
Spain	0.021	−0.055	0.039	0.108**	−5.168**	0.107
	(1.64)	(−0.28)	(0.17)	(2.46)	(−14.04)	[.95]
Sweden	0.067**	−0.249	−0.025	−0.021	−5.358**	0.700
	(4.15)	(−0.83)	(−0.08)	(−0.51)	(−8.94)	[.70]
Switzerland	0.040**	−0.171	0.271	−0.087**	−6.788**	1.454
	(3.84)	(−0.58)	(1.05)	(−3.25)	(−2.54)	[.48]
United Kingdom	0.050**	−0.254	0.104	−0.099**	−4.912**	1.859
	(4.37)	(−1.22)	(0.59)	(−3.45)	(−2.69)	[.39]
United States	0.051**	0.016	0.048	−0.146**	−7.831**	0.140
	(5.75)	(0.12)	(0.36)	(−6.02)	(−14.08)	[.93]

Note: This table reports coefficient estimates from 22 country regressions of index returns on a constant, a "market crash" dummy (corresponding to the October stock market crashes in 1987 and 1997), a Monday dummy, and two dummies for the Monday following a DST change: one dummy for an hour increase and one for an hour decrease (DST spring or fall). All indices are value weighted, in domestic currency, including dividend distributions. We present parameter estimates (in percentages) with associated t-statistics in parentheses, calculated using White's (1980) heteroskedasticity-robust standard errors. For each regression, we report in the last column the chi-square realization and p-value in square brackets for a chi-square test for whether DST days (spring and fall) are different from all other trading days.

**Significant at the 5% level.

TABLE 4. Regression of Index Returns on a Month Dummy and Daylight Saving Time (DST) Dummy: One-Hour Increase or Decrease.

Country	Const.	DST Change: Spring	DST Change: Fall	Monday	Month	Chi-square [p-value]
Australia	0.043**	−0.184	0.137	−0.042**	−0.036	1.261
	(5.23)	(−0.74)	(0.83)	(−1.99)	(−1.42)	[.53]
Austria	0.018**	−0.001	0.332	0.010	−0.031**	2.344
	(2.35)	(−0.01)	(1.53)	(0.53)	(−1.71)	[.31]
Belgium	0.046**	−0.224	0.004	−0.074**	−0.038	0.793
	(3.35)	(−0.82)	(0.02)	(−2.80)	(−1.19)	[.67]
Canada	0.054**	−0.046	−0.300	−0.072**	−0.038	0.793
	(4.93)	(−0.35)	(−0.82)	(−2.71)	(−1.19)	[.67]
Denmark	0.056**	0.263	0.120	−0.072**	−0.002	2.187
	(4.84)	(1.39)	(0.51)	(−2.71)	(−0.05)	[.33]
Finland	0.026	−0.354	−0.315	−0.006	0.114	1.182
	(0.86)	(−0.86)	(−0.68)	(−0.09)	(1.52)	[.55]
France	0.038**	0.220	−0.052	−0.042	0.012	0.679
	(2.89)	(0.79)	(−0.22)	(−1.43)	(0.37)	[.71]
Germany	0.031**	−0.137	0.188	−0.038	0.013	0.440
	(2.65)	(−0.46)	(0.48)	(−1.34)	(0.43)	[.80]
Greece	0.108**	−0.237	−0.061	−0.123	−0.151**	0.389
	(3.64)	(−0.62)	(−0.11)	(−1.48)	(−2.11)	[.82]
Hong Kong	0.100**	−0.162	1.148**	−0.201**	−0.066	3.040
	(4.47)	(−0.27)	(1.72)	(−3.11)	(−1.04)	[.22]
Ireland	0.044**	−0.240	−0.765	−0.017	0.015	2.572
	(2.55)	(−0.83)	(−1.38)	(−0.41)	(0.31)	[.28]
Italy	0.053**	0.022	0.151	−0.129**	−0.012	0.547
	(4.00)	(0.10)	(0.73)	(−4.01)	(−0.04)	[.76]
Luxembourg	0.050**	−0.007	−0.405**	0.005	−0.022	10.676**
	(3.45)	(−0.05)	(−3.26)	(0.15)	(−0.59)	[.01]
Netherlands	0.044**	−0.342	−0.260	−0.060	0.039	2.008
	(2.71)	(−1.01)	(−1.01)	(−1.46)	(0.86)	[.37]
New Zealand	0.033**	−0.326	−0.078	−0.028	−0.014	1.180
	(3.26)	(−0.98)	(−0.51)	(−1.12)	(−0.50)	[.55]
Norway	0.074**	0.021	0.023	−0.074**	−0.012	0.017
	(4.23)	(0.09)	(0.10)	(−1.71)	(−0.23)	[.99]
Portugal	0.061**	−0.066	0.206	−0.082**	−0.018	0.837
	(2.99)	(−0.36)	(0.83)	(−2.15)	(−0.40)	[.66]
Spain	0.027**	−0.031	−0.113	0.096**	−0.032	0.195
	(1.98)	(−0.16)	(−0.41)	(2.16)	(−0.87)	[.91]
Sweden	0.069**	−0.237	−0.227	−0.030	−0.009	1.001
	(3.98)	(−0.79)	(−0.62)	(−0.73)	(−0.19)	[.61]
Switzerland	0.035**	−0.178	−0.009	−0.094**	0.023	0.367
	(3.17)	(−0.61)	(−0.04)	(−3.41)	(0.80)	[.83]
United Kingdom	0.053**	−0.239	−0.170	−0.103**	−0.017	1.741
	(4.37)	(−1.14)	(−0.68)	(−3.53)	(−0.55)	[.42]
United States	0.052**	−0.010	−0.397	−0.121**	0.021	1.691
	(6.36)	(−0.07)	(−1.30)	(−5.90)	(1.01)	[.43]

Note: This table reports coefficient estimates from 22 country regressions of index returns on a constant, a DST month dummy (corresponding to the month in which the DST changes typically take place) and a dummy for the Monday following a DST change: one-hour increase or decrease (spring or fall). All indices are value weighted, in domestic currency, including dividend distributions. We present parameter estimates (in percentages) with associated t-statistics in parentheses, calculated using White's (1980) heteroskedasticity-robust standard errors. For each regression, we report in the last column the chi-square realization and p-value in square brackets for a chi-square test for whether DST days (spring and fall) are different from all other trading days

**Significant at the 5% level.

Appendix A: ''Replicating" Kamstra, Kramer, and Levi (2000, 2002)

For the United States, United Kingdom, and Germany, Kamstra, Kramer, and Levi's (2000) dates for daylight savings time (DST) changes differ slightly from ours. Although we do not believe these differences are a significant explanation for our contrasting conclusions, they may explain some of the apparent discrepancies.

For the United States, Kamstra, Kramer, and Levi (2000) note:

> In the United States and Canada, until 1986, the Spring time change always occurred on the last Sunday in April. As of 1987, the Spring time change takes place on the first Sunday in April. The Fall time change has always occurred on the last Sunday in October. There were no time changes during World War Two or in the year 1974; clocks were kept ahead in both periods to conserve energy. (pp. 1006–07)

Although we agree there was a spring change in January 1974 (implied by the wording of that last sentence), we also record a fall DST event in 1974 (which Kamstra, Kramer, and Levi 2000 do not) and an earlier than usual spring DST change in February 1975. We use a more recent Shanks source (Shanks and Pottenger 2003) than that used by Kamstra, Kramer, and Levi (Shanks 1985), and we cross-checked our dates with several relevant Internet sites (e.g., www.timeanddate.com) as well as an online version of the Doane source Kamstra, Kramer, and Levi cite. We believe our data to be correct.

For the United Kingdom, regarding the fall DST change, Kamstra, Kramer, and Levi (2000, p. 1007) state:

> The Fall daylight saving change in the United Kingdom was on October 31 in 1971, on the fourth Sunday in October from 1972 to 1984, and on the last Sunday in October from 1985 onward.

Kamstra, Kramer, and Levi's (2000) source is Shanks (1985), so they may have missed changes to post-1985 DST dates. Our date differences seem to stem from the difference between the fourth and last Sundays of October. Obviously, this only matters in months that have five Sundays. From 1985 to 1999 (the end of their data sample), October had five Sundays in the years 1988, 1989, 1993–1995, and 1999. Although we did not use an algorithm, our dates conform to a "fourth Sunday" rule for all of those years except 1989, where it is the last (fifth) Sunday. Although this may seem unusual, so have many other DST date changes that have occurred over the years. We cross-checked the dates from Shanks and Pottenger (2003) with several online sources and believe it to be correct.

For Germany, from Kamstra, Kramer, and Levi (2000):

> In 1980 the Spring change occurred on May 5 and on the last Sunday in March from 1981 onward, whereas the Fall change took place on the last Sunday in September from 1980 onward. (p. 1007)

Shanks and Pottenger (2003) show the 1980 spring DST change occurring on April 6 rather than May 5. This is confirmed with several other sources and is the same as the 1980 spring change for all other European countries except the United Kingdom (which was in March that year).

The final difference begins in 1996. In that year, Germany changed, along with the rest of Europe, to a "last Sunday in October" rule for the fall change. Therefore, we have DST fall changes in October for 1996–1999 rather than in September as stated by Kamstra, Kramer, and Levi (2002). Again, we believe this is because Kamstra, Kramer, and Levi used outdated source material.[14]

As the difference in our results for the four countries that Kamstra, Kramer, and Levi (2000) examine could be caused either by the different sample period or different dates, we conduct regressions on the same years as Kamstra, Kramer, and Levi using their version of the dates (with and without error correction) as well as our version of the dates.

In Panel A of Table A1 are our results, which should most resemble Kamstra, Kramer, and Levi's (2000) results—the years their study spans, their DST dates, and no error correction (and no correction for the 1987 and 1997 outliers). We find here, as do they, significantly negative results for Canada, the United Kingdom, and the United States. In Panel B, contrary to a footnote in Kamstra, Kramer, and Levi, we find that after using White error correction, the significant results disappear, except for the spring change in the United Kingdom. Finally, in Panel C, using the DST dates we identified and with error correction, the DST effect vanishes at the 5% level, though the United States fall change is significant at only the 10% level.

[14]We could have the same problem. Our source is dated 2003, and our sample period runs through 2005 (in fact, New Zealand revised DST dates in 2006, and the United States did so in 2007). However, we checked with online sources and believe there were no modifications to DST dates in 2004 or 2005 for our sample countries.

TABLE A1. Comparison of Results.

Country/Period	Const.	DST Change Spring	DST Change Fall
Panel A. Kamstra, Kramer, and Levi Daylight Savings Time (DST) Dates			
Canada	0.035	−0.209	−0.419**
1969–1998	(3.46)	(−1.29)	(−2.60)
Germany	0.026	−0.13	−0.234
1973–1998	(2.19)	(−0.55)	(−0.14)
United Kingdom	0.039	−0.427**	−0.467**
1969–1998	(3.36)	(−2.20)	(−2.46)
United States	0.024	−0.153	−0.593**
1967–1997	(2.76)	(−0.72)	(−2.79)
Panel B. Kamstra, Kramer and Levi DST Dates with White Standard Errors			
Canada	0.035	−0.209	−0.419
1969–1998	(3.49)	(−1.59)	(−0.92)
Germany	0.026	−0.13	−0.234
1973–1998	(2.20)	(−0.43)	(−0.08)
United Kingdom	0.039	−0.427**	−0.467
1969–1998	(3.38)	(−2.36)	(−1.47)
United States	0.024	−0.153	−0.593
1967–1997	(2.76)	(−1.07)	(−1.58)
Panel C. Our DST Dates with White Standard Errors			
Canada	0.034	−0.100	−0.386
1969–1998	(3.54)	(−0.78)	(−1.06)
Germany	0.025	−0.134	0.210
1973–1998	(2.51)	(−0.46)	(0.59)
United Kingdom	0.032	−0.282	−0.351
1969–1998	(3.00)	(−1.46)	(−1.28)
United States	0.022	−0.056	−0.541
1967–1997	(2.69)	(−0.42)	(−1.71)

Note: This table reports coefficient estimates for the four countries used in Kamstra, Kramer, and Levi (2000, 2002). DST dates in Panels A and B are those defined by Kamstra, Kramer, and Levi, and those in Panel C are our date definitions. Regressions are index returns on a constant and a dummy for the trading day following the weekend of a DST change: one-hour increase for the spring change or decrease for the fall change. All indices are value weighted, in domestic currency, including dividend distributions. We present parameter estimates (in percentages) with associated t-statistics in parentheses, calculated with and without White's (1980) heteroskedasticity-robust standard errors.

**Significant at the 5% level.

APPENDIX B. Daylight Savings Time (DST) Dates.

		Countries in KKL				Additional Countries in Our Study																	
						Northern																Southern	
Date	Non-Sunday	United States	Canada	United Kingdom	Germany	Austria	Belgium	Denmark	Finland	France	Greece	Hong Kong	Ireland	Italy	Luxembourg	Netherlands	Norway	Portugal	Spain	Sweden	Switzerland	Australia	New Zealand
9-Feb-42	*	S																					
30-Sep-45		F																					
22-May-66														S									
25-Sep-66														F									
30-Apr-67		S																					
28-May-67														S									
24-Sep-67														F									
29-Oct-67		F																					
28-Apr-68		S																					
26-May-68														S									
22-Sep-68														F									
27-Oct-68		F																					
27-Apr-69		S																					
1-Jun-69														S									
28-Sep-69														F									
26-Oct-69		F																					
19-Apr-70												S											
26-Apr-70		S																					
31-May-70														S									
27-Sep-70														F									
18-Oct-70												F											
25-Oct-70		F																					
18-Apr-71												S											
25-Apr-71		S																					
23-May-71														S									
26-Sep-71														F									
17-Oct-71												F											
31-Oct-71		F		F																		S	

(Continued)

APPENDIX B. Continued.

		Countries in KKL				Additional Countries in Our Study																	
						Northern																Southern	
Date	Non-Sunday	United States	Canada	United Kingdom	Germany	Austria	Belgium	Denmark	Finland	France	Greece	Hong Kong	Ireland	Italy	Luxembourg	Netherlands	Norway	Portugal	Spain	Sweden	Switzerland	Australia	New Zealand
27-Feb-72																						F	
19-Mar-72				S																			
16-Apr-72												S											
30-Apr-72		S																					
28-May-72														S									
1-Oct-72														F									
22-Oct-72												F											
29-Oct-72		F		F																		S	
4-Mar-73																						F	
18-Mar-73				S																			
22-Apr-73												S											
29-Apr-73		S																					
3-Jun-73														S									
30-Sep-73														F									
21-Oct-73												F											
28-Oct-73		F		F																		S	
30-Dec-73												S											
6-Jan-74		S																					
3-Mar-74																						F	
17-Mar-74				S																			
14-Apr-74																			S				
26-May-74														S									
29-Sep-74														F									
6-Oct-74																			F				
20-Oct-74												F											
27-Oct-74		F		F																		S	
3-Nov-74																							S

(Continued)

APPENDIX B. Continued.

		Countries in KKL				Additional Countries in Our Study																	
						Northern																Southern	
Date	Non-Sunday	United States	Canada	United Kingdom	Germany	Austria	Belgium	Denmark	Finland	France	Greece	Hong Kong	Ireland	Italy	Luxembourg	Netherlands	Norway	Portugal	Spain	Sweden	Switzerland	Australia	New Zealand
23-Feb-75		S																					F
2-Mar-75																						F	
16-Mar-75				S																			
13-Apr-75																			S				
20-Apr-75												S											
1-Jun-75														S									
28-Sep-75														F									
5-Oct-75																			F				
19-Oct-75												F											
26-Oct-75		F		F																		S	S
7-Mar-76																						F	F
21-Mar-76				S																			
28-Mar-76										S									S				
18-Apr-76												S											
25-Apr-76		S	S																				
30-May-76														S									
26-Sep-76										F				F					F				
17-Oct-76												F											
24-Oct-76				F																			S
31-Oct-76		F	F																			S	
6-Mar-77																						F	F
20-Mar-77				S																			
3-Apr-77										S									S				
17-Apr-77												S											
24-Apr-77		S	S																				
22-May-77														S									
25-Sep-77										F				F					F				
16-Oct-77												F											
23-Oct-77				F																			
30-Oct-77		F	F																			S	S

(Continued)

APPENDIX B. Continued.

		Countries in KKL				Additional Countries in Our Study																	
						Northern																Southern	
Date	Non-Sunday	United States	Canada	United Kingdom	Germany	Austria	Belgium	Denmark	Finland	France	Greece	Hong Kong	Ireland	Italy	Luxembourg	Netherlands	Norway	Portugal	Spain	Sweden	Switzerland	Australia	New Zealand
5-Mar-78																						F	F
19-Mar-78				S																			
2-Apr-78										S									S				
30-Apr-78		S	S																				
28-May-78														S									
1-Oct-78										F				F					F				
29-Oct-78		F	F	F																		S	S
4-Mar-79																						F	F
18-Mar-79				S																			
1-Apr-79										S									S				
29-Apr-79		S	S																				
13-May-79												S											
27-May-79														S									
30-Sep-79										F				F					F				
21-Oct-79												F											
28-Oct-79		F	F	F																		S	S
2-Mar-80																						F	F
16-Mar-80				S																			
6-Apr-80					S	S		S		S				S		S			S	S			
27-Apr-80		S	S																				
11-May-80												S											
28-Sep-80					F	F		F		F				F		F			F	F			
19-Oct-80												F											
26-Oct-80		F	F	F																		S	S
1-Mar-81																						F	F
29-Mar-81				S	S	S		S		S				S		S			S	S	S		
26-Apr-81		S	S																				
27-Sep-81					F	F		F		F				F		F			F	F	F		
25-Oct-81		F	F	F																		S	S

(Continued)

APPENDIX B. Continued.

		Countries in KKL				Additional Countries in Our Study: Northern																Additional Countries in Our Study: Southern	
Date	Non-Sunday	United States	Canada	United Kingdom	Germany	Austria	Belgium	Denmark	Finland	France	Greece	Hong Kong	Ireland	Italy	Luxembourg	Netherlands	Norway	Portugal	Spain	Sweden	Switzerland	Australia	New Zealand
7-Mar-82																							F
28-Mar-82				S	S	S		S		S				S		S			S	S	S		
4-Apr-82																						F	
25-Apr-82		S	S																				
26-Sep-82					F	F		F		F				F		F			F	F	F		
24-Oct-82				F																			
31-Oct-82		F	F																			S	S
6-Mar-83																						F	F
27-Mar-83				S	S	S		S		S				S		S	S		S	S	S		
24-Apr-83		S	S																				
25-Sep-83					F	F		F		F				F		F	F		F	F	F		
23-Oct-83				F																			
30-Oct-83		F	F																			S	S
4-Mar-84																						F	F
25-Mar-84				S	S	S		S		S				S		S	S		S	S	S		
29-Apr-84		S	S																				
30-Sep-84					F	F		F		F				F		F	F		F	F	F		
28-Oct-84		F	F	F																		S	S
3-Mar-85																						F	F
31-Mar-85				S	S	S	S	S		S				S	S	S	S		S	S	S		
28-Apr-85		S	S																				
29-Sep-85					F	F	F	F		F				F	F	F	F		F	F	F		
27-Oct-85		F	F	F																		S	S
2-Mar-86																							F
16-Mar-86																						F	
30-Mar-86				S	S	S	S	S		S				S	S	S	S	S	S	S	S		
27-Apr-86		S	S																				
28-Sep-86					F	F	F	F		F				F	F	F	F	F	F	F	F		
19-Oct-86																						S	S
26-Oct-86		F	F	F																			

(Continued)

APPENDIX B. Continued.

		Countries in KKL				Additional Countries in Our Study																	
						Northern																Southern	
Date	Non-Sunday	United States	Canada	United Kingdom	Germany	Austria	Belgium	Denmark	Finland	France	Greece	Hong Kong	Ireland	Italy	Luxembourg	Netherlands	Norway	Portugal	Spain	Sweden	Switzerland	Australia	New Zealand
1-Mar-87																							F
15-Mar-87																						F	
29-Mar-87				S	S	S	S	S	S	S			S	S	S	S	S	S	S	S	S		
5-Apr-87		S	S																				
27-Sep-87					F	F	F	F	F	F				F	F	F	F	F	F	F	F		
25-Oct-87		F	F	F									F									S	S
6-Mar-88																							F
20-Mar-88																						F	
27-Mar-88				S	S	S	S	S	S	S			S	S	S	S	S	S	S	S	S		
3-Apr-88		S	S																				
25-Sep-88					F	F	F	F	F	F				F	F	F	F	F	F	F	F		
23-Oct-88				F									F										
30-Oct-88		F	F																			S	S
5-Mar-89																							F
19-Mar-89																						F	
26-Mar-89				S	S	S	S	S	S	S			S	S	S	S	S	S	S	S	S		
2-Apr-89		S	S																				
24-Sep-89					F	F	F	F	F	F	F			F	F	F	F	F	F	F	F		
8-Oct-89																							S
29-Oct-89		F	F	F									F									S	
18-Mar-90																						F	F
25-Mar-90				S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S		
1-Apr-90		S	S																				
30-Sep-90					F	F	F	F	F	F	F			F	F	F	F	F	F	F	F		
7-Oct-90																							S
28-Oct-90		F	F	F									F									S	
17-Mar-91																						F	F
31-Mar-91				S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S		
7-Apr-91		S	S																				
29-Sep-91					F	F	F	F	F	F	F			F	F	F	F	F	F	F	F		
6-Oct-91																							S
27-Oct-91		F	F	F									F									S	

(Continued)

APPENDIX B. Continued.

		Countries in KKL				Additional Countries in Our Study																	
						Northern																Southern	
Date	Non-Sunday	United States	Canada	United Kingdom	Germany	Austria	Belgium	Denmark	Finland	France	Greece	Hong Kong	Ireland	Italy	Luxembourg	Netherlands	Norway	Portugal	Spain	Sweden	Switzerland	Australia	New Zealand
1-Mar-92																						F	
15-Mar-92																							F
29-Mar-92				S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S		
5-Apr-92		S	S																				
27-Sep-92					F	F	F	F	F	F	F			F	F	F	F		F	F	F		
4-Oct-92																							S
25-Oct-92		F	F	F									F									S	
7-Mar-93																						F	
21-Mar-93																							F
28-Mar-93				S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S		
4-Apr-93		S	S																				
26-Sep-93					F	F	F	F	F	F	F			F	F	F	F	F	F	F	F		
3-Oct-93																							S
24-Oct-93				F									F										
31-Oct-93		F	F																			S	
6-Mar-94																						F	
20-Mar-94																							F
27-Mar-94				S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S		
3-Apr-94		S	S																				
25-Sep-94					F	F	F	F	F	F	F			F	F	F	F	F	F	F	F		
2-Oct-94																							S
23-Oct-94				F									F										
30-Oct-94		F	F																			S	
5-Mar-95																						F	
19-Mar-95																							F
26-Mar-95				S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S		
2-Apr-95		S	S																				
24-Sep-95					F	F	F	F	F	F	F			F	F	F	F	F	F	F	F		
1-Oct-95																							S
22-Oct-95				F									F										
29-Oct-95		F	F																			S	

(Continued)

APPENDIX B. Continued.

						Additional Countries in Our Study																	
		Countries in KKL				Northern																Southern	
Date	Non-Sunday	United States	Canada	United Kingdom	Germany	Austria	Belgium	Denmark	Finland	France	Greece	Hong Kong	Ireland	Italy	Luxembourg	Netherlands	Norway	Portugal	Spain	Sweden	Switzerland	Australia	New Zealand
17-Mar-96																							F
31-Mar-96				S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S	F	
7-Apr-96		S	S																				
6-Oct-96																							S
27-Oct-96		F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	S	
16-Mar-97																							F
30-Mar-97				S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S	F	
6-Apr-97		S	S																				
5-Oct-97																							S
26-Oct-97		F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	S	
15-Mar-98																							F
29-Mar-98				S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S	F	
5-Apr-98		S	S																				
4-Oct-98																							S
25-Oct-98		F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	S	
21-Mar-99																							F
28-Mar-99				S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S	F	
4-Apr-99		S	S																				
3-Oct-99																							S
31-Oct-99		F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	S	
19-Mar-00																							F
26-Mar-00				S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S	F	
2-Apr-00		S	S																				
27-Aug-00																						S	
1-Oct-00																							S
29-Oct-00		F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F		

(Continued)

APPENDIX B. Continued.

		Countries in KKL				Additional Countries in Our Study																	
						Northern																Southern	
Date	Non-Sunday	United States	Canada	United Kingdom	Germany	Austria	Belgium	Denmark	Finland	France	Greece	Hong Kong	Ireland	Italy	Luxembourg	Netherlands	Norway	Portugal	Spain	Sweden	Switzerland	Australia	New Zealand
18-Mar-01																							F
25-Mar-01				S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S	F	
1-Apr-01		S	S																				
7-Oct-01																							S
28-Oct-01		F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	S	
17-Mar-02																							F
31-Mar-02				S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S	F	
7-Apr-02		S	S																				
6-Oct-02																							S
27-Oct-02		F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	S	
16-Mar-03																							F
30-Mar-03				S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S	F	
6-Apr-03		S	S																				
5-Oct-03																							S
26-Oct-03		F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	S	
21-Mar-04																							F
28-Mar-04				S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S	F	
4-Apr-04		S	S																				
3-Oct-04																							S
31-Oct-04		F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	S	
20-Mar-05																							F
27-Mar-05				S	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	S	F	
3-Apr-05		S	S																				
2-Oct-05																							S
30-Oct-05		F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	S	

Note: Only nationally standardized DST changes are recorded. All DST changes occur early Sunday morning (or late Saturday night), except Monday (marked with *). KKL = Kamstra, Kramer, and Levi (2000, 2002); S = DST spring change; F = DST fall change.

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