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panel data

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**The Friday the Thirteenth Effect in Stock Prices:  
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# **The Friday the Thirteenth Effect in Stock Prices: International Evidence using Panel Data**

It is a medical fact that “*Friday 13th is unlucky for some*”.

(Scanlon *et al.*, 1993, p. 1584)

## **ABSTRACT**

This examination of the Friday the 13th effect, in 62 international stock indices for the period 2000 to 2008, characterises the degree that the effect is influenced by: (i) the GDP of the economy and (ii) the sign of the return on the prior day. These effects are assessed by the use of an EGLS panel regression model incorporating panel corrected standard errors. The turn of the month effect on Fridays is also examined. Three important results relating to the Friday the 13th effect are observed. First, the depressed Friday the 13th effect is present when the return on the prior day is negative. Second, when the return on the prior day is positive, the depressed Friday the 13th effect is absent. Third, the depressed Friday the 13th effect is independent of the GDP of the country when the returns on control Fridays are used as the yardstick.

JEL: G14, G15

Keywords: Friday the 13th effect, turn of the month effect, international, stock indices, between-country

# **The Friday the Thirteenth Effect in Stock Prices: International Evidence using Panel Data**

## **1. INTRODUCTION**

Twenty years ago, Kolb & Rodriguez (1987, p. 1387) reported the “*frightening ‘Friday the Thirteenth’ effect*” in stock prices. Focusing on Fridays, they show that the returns on Fridays the 13th are depressed. Their evidence is based on the daily returns of the CRSP value-weighted and equally-weighted indices, with and without adjustments for dividends, during the period 1962 to 1985. The returns on Fridays that do not fall on the 13th day of the month are used as the controls by which to assess the Friday the 13th effect. Since then, researchers have failed, in a statistical sense, to reproduce their results.

A replication of their study (Dyl & Maberly, 1988) fails to isolate the Friday the 13th effect in the daily returns of all Fridays for the Standard and Poor’s 500 stock index during the period 1940 to 1987. Similarly, Maberly (1988) fails to find the effect for the Standard and Poor’s 500 futures contracts for the period 1982 to 1988. In the context of the Kolb & Rodriguez (1987) study, Maberly (1988, p. 723) offers the insight that “... *what has been documented is actually a ‘Friday the 13th BEAR market’ effect*”. To date, this insight has not received further attention in the literature.

A further replication (Chamberlain *et al.*, 1991) also uses the Standard and Poor's 500 stock index, but for a longer period (1930 to 1985). This study uses 0,1 dummy variables for each day of the month to examine the effect. In response to the rhetorical question 'Is there a Friday the thirteenth effect?' they respond that "... *the answer is no*" (Chamberlain *et al.*, 1991, p. 113). However, the results of this study raise two important issues. First, it shows that Fridays at the turn of the month exhibit the enhanced turn of the month effect (e.g., Ariel, 1987). All other studies include this effect in their control Fridays, i.e., no separate allowance is made for a turn of the month effect. Second, the intercept of their regression model captures the mean return on Fridays the 13th. This coefficient is negative ( $\hat{\alpha}_{13} = -0.612$ ) and, at first sight, of some magnitude. They do not offer comment on this (see Lucey, 2000, p. 295). Replications with UK indices (Mills & Coutts, 1995; Coutts, 1999) and an Irish index (Dowling & Lucey, 2005) fail to isolate the Friday the 13th effect.

Notwithstanding this evidence, a better assessment of the Friday the 13th effect can be obtained from multi-country studies. *Ceteris paribus*, this approach has the potential to increase the sample size of Fridays the 13th. There are, on average, only 1.72 Fridays the 13th each year (Battersby, 1998). There are two international studies into the Friday the 13th effect.

Agrawal & Tandon (1994) examine 18 non-US stock indices and two US stock indices for the period 1971 to 1987. Their unreported statistical tests, presumably on a country-by-country basis, fail to find the effect. However, inspection of their Figure 5 (Agrawal & Tandon, 1994,

p. 101) reveals three interesting points. First, nine of their 18 non-US indices reveal a lower mean return on Fridays the 13th compared to other Fridays. Second, a similar result is observed for the New York Stock Exchange's value-weighted index but not for the Standard and Poor's 500 index. This could indicate that the Friday the 13th effect is lurking beneath the surface. Third, they point out the presence of a prior day effect on Mondays (Agrawal & Tandon, 1994, p. 93).

Lucey (2000) examines 19 international stock indices for the period January 1988 to May 2000 – a period which immediately follows that studied by Agrawal & Tandon (1994). As per prior research, this study focuses on Fridays on a country-by-country basis. It fails to find the effect – indeed, the mean return on Fridays the 13th is higher than the mean return on the other Fridays for 18 of the countries. In only one country, South Africa, is the mean return on Fridays the 13th lower than the mean return on other Fridays. This leads Lucey (2000, p. 299) to rightly comment “... *there is a Friday the 13th anomaly. Returns on that day are higher than returns on other Fridays*”.

This present examination of the Friday the 13th effect in international stock indices seeks to determine whether Lucey's (2000) unequivocal results still pertain for the period June 2000 to August 2008. This is a period that immediately follows on from that investigated by Lucey (2000). A primary motivation for the study is found in Keef, Khaled & Zhu (2009) who examine the international Monday effect. There are two implications in their Monday results that may be germane to the Friday the 13<sup>th</sup> effect. They show that a depressed Monday return

is not observed when the return on the prior Friday is positive. However, a depressed Monday return is observed when the return on the prior Friday is negative. The implication is that these two effects offset each other – thus the overall Monday return of either sign is not unusual. There is a possibility that a similar situation is present with the Friday the 13<sup>th</sup> effect. This is to say, the depressed Friday the 13<sup>th</sup> effect might only occur when the return on the prior Thursday is negative – it might not occur when the return on the prior Thursday is positive.

Our model specification takes into account the following points. First, the Friday the 13<sup>th</sup> effect applies only to Fridays. Thus, as adopted in all prior studies, we focus on the daily returns on Fridays. The returns on non-Fridays are not explicitly included in the analysis.

Second, it is clear that the presence of the turn of the month effect on Fridays (Chamberlain *et al.*, 1991) has to be taken into account. One choice is to delete the returns at the turn of the month. The other choice is to add a dummy variable for these days. We adopt the latter since it allows a convenient contrast of the controversial Friday the 13<sup>th</sup> effect with the well established turn of the month effect. In a temporal sense, these two anomalies are orthogonal. Fridays that do not fall at the turn of the month or on the 13<sup>th</sup> day of the month are used as controls in the assessment of the two anomalies.

Third, as discussed by Keef, Khaled & Zhu (2009) and Agrawal & Tandon (1994, p. 93), there is evidence that returns on Mondays are correlated with the returns on the prior Friday



(e.g., Cross, 1973; Bessembinder & Hertz, 1993; Abraham & Ikenberry, 1994; Wang *et al.*, 1997). Keef, Khaled & Zhu (2009), who call this ‘the prior day effect’, together with Tong (2000) show that this prior day effect is also present on non-Mondays in several international stock indices (see also Brusa *et al.*, 2003). The prior day effect is assessed by the use of a dummy variable based on the sign of the return on the prior day. The essence of this dummy variable is that it captures the influences of one-day serial correlation. In an allied vein, Maberly (1988) argues that the Friday the 13<sup>th</sup> effect observed by Kolb and Rodriguez (1987) predominantly occurs in bear markets, i.e., a period where days with negative returns dominate days with positive returns. He shows that the effect is not present in a bull market, i.e., a period where days with positive returns dominate days with negative returns. The prior day effect is the short term market counterpart of the long term market bear versus bull effect. The prior day evidence raises the question of the degree that the effect is associated with the Friday the 13<sup>th</sup> effect and with the turn of the month effect on Fridays. Furthermore, there is the question of the degree that the prior day effect differs between these two anomalies.

Fourth, prior research into the international evidence of the Friday the 13<sup>th</sup> effect has essentially examined the results for each stock exchange individually, i.e., on a country-by-country basis. That is to say, between-country differences in the anomaly are examined in a descriptive, rather than a systematic statistical, approach. Similar comments apply to the international turn of the month literature (e.g., Cadsby & Ratner, 1992; Kunkel *et al.*, 2003; McConnell & Xu, 2008). Keef, Khaled & Zhu (2009) address this issue in the context of the international Monday effect. They use a factor, derived from four measures of economic

development, as a between country covariate. They state that similar results are obtained from the use of per capita GDP as the explanatory covariate.

Thus we use per capita gross domestic product as a between-country explanatory variable.

The goal is to determine how the magnitudes of the two anomalies systematically differ between the countries where the stock exchanges are located. We examine the effects using a panel model. This permits controls for heteroscedasticity, serial correlation and contemporaneous correlation. These controls generate estimated standard errors that are more robust compared to those obtained from the statistical methodology commonly adopted in most of the prior research. The prior studies have not capitalised on the increase in the sample size of Fridays the 13<sup>th</sup> that is possible by using a panel design.

Fifth, the data immediately follows on from that of Lucey (2000). This decision constrains the time period we study. We compensate for this unavoidable constraint by an increase in the number of countries examined. We investigate the Friday the 13th effect, together with the turn of the month effect, in 62 countries. This is a three-fold increase compared to the 19 countries studied by Agrawal & Tandon (1994) and Lucey (2000).

We find a depressed Friday the 13th effect is present when the return on the prior Thursday the 12th is negative. However, a depressed Friday the 13th effect is not observed when the return on the prior Thursday the 12th is positive. The depressed Friday the 13th effect is independent of per capita gross domestic product of the country after the prior day effect is

taken into account. The implication is that the Friday the 13th effect is caused by the negative prior day effect. There is an enhanced turn of the month effect on Fridays. This effect is independent of the sign of the return on the prior Thursday when the corresponding prior day effects on control days are taken into account. These relatively enhanced turn of the month effects on Fridays are independent of the gross domestic product of the country.

The remainder of the paper is structured as follows. Section 2 outlines the methodology. Section 3 presents the results and their discussion. Section 4 concludes the study.

## 2. METHODOLOGY

The time series of daily stock index prices for the 62 countries are obtained from Datastream. Table 1 presents the countries and the indices used in the analysis. The choice of the stock index is constrained by the data available from Datastream. Where available, we selected their proprietary “DS market index”. In the absence of this index and a choice was available, we used our judgement to pick the index we perceived to be the most efficient in terms of pricing. The period covered is 1st June 2000 to 31st August 2008. Daily returns  $R_{i,t}$  for day  $t$  of country  $i$  are calculated as percentages in the conventional fashion using the model

$$R_{i,t} = \ln\left(\frac{I_{i,t}}{I_{i,t-1}}\right) \times 100 \quad , \quad (1)$$

where  $I_{i,t}$  represents the closing value of the index on day  $t$  for country  $i$ . In terms of the theoretical sample size, there are: (i) 26,722 Fridays -- 431 per country, (ii) 11,694 (44%) bad

Thursdays (iii) 3,595 (13.5%) turn of the month days and (iv) 868 (0.03%) Fridays the 13th.

A missing index value occurs on days when the stock exchange is closed. These days are occasioned by predictable holidays and unexpected closures. Thus, if one of the index values in equation (1) is missing, then the daily return for day  $t$  is also missing (see Chamberlain *et al.*, 1991). The theoretical sample size of Fridays is 26,722 -- 431 per country. Missing returns on Fridays, or the prior Thursdays, reduce the empirical sample size to 25,102 -- a 6.1% loss. The number of missing values on Fridays the 13th (8.5%) and turn of the month Fridays (7.6%) is similar but a little higher than the number missing on control Fridays (5.7%). Although explanations for these latter results are not directly obvious, it would appear that Fridays the 13th and turn of the month Fridays can be perceived as unlucky days in this regard.

Since the statistical analysis focuses only on Fridays, hereafter day  $t$  refers to the  $t^{\text{th}}$  Friday in the time series. The Friday the 13th effect is captured by dummy variable  $F13_t$ , which takes on a value of 1 if Friday  $t$  is the 13th day of the month, otherwise zero. As is the convention in the literature (e.g., Lakonishok & Smidt, 1988; Kunkel *et al.*, 2003; McConnell & Xu, 2008), the turn of the month is defined as the last calendar day of the prior month and the first three calendar days of the new month. If Friday  $t$  falls within this period, then dummy variable  $TOM_t$  takes on a value of 1, otherwise zero. These two dummy variables are orthogonal. Therefore, their interaction is redundant in a regression model. Fridays that do not fall within the turn of the month period or do not fall on the 13th day are called 'control Fridays'. The prior day effect, on a country-by-country basis, is captured by dummy variable

$B_{i,t}$  which takes on a value of 1 on Friday  $t$  for country  $i$  if the return on the prior Thursday in country  $i$  is negative, otherwise zero. Dummy variable  $B_{i,t}$  captures the influences of one-day serial correlation. When  $B_{i,t} = 0$ , Friday  $t$  is said to be a ‘good Friday’ since a positive return is to be expected. When  $B_{i,t} = 1$ , Friday  $t$  is said to be a ‘bad Friday’ since a negative return is to be expected.

In an ideal world, we would use an international superstition index to assess between-country differences. Alas, we are not able to discover such an index that covers the countries we study. It is fair to comment that the historical reasons for Friday the 13th being a day of superstition, or a day of foreboding, are shrouded in uncertainty (Emery, 2008). Although there are a variety of explanations, none of which is entirely satisfactory in its own right, a common theme is that the superstition finds its roots in European history. European countries, and their colonies settled by Europeans, can be distinguished from other countries in terms of their higher economic development (Acemoglu, Johnson & Robinson, 2001). This leads us to the tentative hypothesis that the depressed Friday the 13th effect is more pronounced in developed economies compared to less developed economies. Thus, we use a measure of economic development to differentiate between the countries. Any unobserved country differences are treated as random cross-country variations as explained later.

Gross domestic product is the market value of all goods and services produced within an economy. We use the year 2004 estimates (the mid point of our data) of per capita gross domestic product based on market exchange rates in US\$10,000. The data are obtained from

Heston, Summers & Aten (2006). Year 2004 estimates are not available for a few countries -- in these cases we use year 2003 estimates. To aid the interpretation of the results, this between-country variable is standardised to a mean of zero and hereafter is termed  $GDP_i$ . Thus, the intercepts in the regression model capture the scenario for the average country ( $GDP_i = 0$ ). In our sample of countries,  $GDP_i$  ranges from  $-17.3$  to  $+35.7$ .

A full permutation of the four theoretically relevant variables results in the panel regression model

$$\begin{aligned}
R_{i,t} = & \alpha_0 + \alpha_{GDP} GDP_i \\
& + \beta_B B_{i,t} + \beta_{B \times GDP} (B_{i,t} \times GDP_i) \\
& + \phi_{F13} F13_t + \phi_{F13 \times GDP} (F13_t \times GDP_i) \\
& + \varphi_{F13 \times B} (F13_t \times B_{i,t}) + \varphi_{F13 \times B \times GDP} (F13_t \times B_{i,t} \times GDP_i) \quad (2) \\
& + \gamma_{TOM} TOM_t + \gamma_{TOM \times GDP} (TOM_t \times GDP_i) \\
& + \eta_{TOM \times B} (TOM_t \times B_{i,t}) + \eta_{TOM \times B \times GDP} (TOM_t \times B_{i,t} \times GDP_i) \\
& + \delta_i + \varepsilon_{i,t} ,
\end{aligned}$$

where the variables containing the  $F13_t \times TOM_t$  interaction term are omitted since they are always zero. The time-invariant error component  $\delta_i$  represents the unexplained random variation between countries. The remaining random variation is captured by the error component  $\varepsilon_{i,t}$ . Such an error structure results in errors correlated over time for any given cross-sectional unit. Hence, the coefficients are estimated by the panel EGLS method. Further controls are made for undesirable properties in the time-varying error component by the application of panel corrected standard errors that are robust to time-wise heteroscedasticity and autocorrelation.

### 3. RESULTS

#### 3.1. Preliminary Analysis

The first step in the analysis is to use the conventional approach to determine the magnitude of the international Friday the 13th effect. The model

$$R_{i,t} = a_0 + a_1 F13_t + \delta_i + \varepsilon_{i,t} \quad , \quad (3)$$

or a cognate variant of it, is used in all prior research on a country-by-country basis, with the exception of Chamberlain *et al.* (1991). We apply the model

$$\underline{\underline{R_{i,t} = a_0 + a_1 F13_t + \beta_0 GDP_i + \beta_1 (F13_t \times GDP_i) + \delta_i + \varepsilon_{i,t} \quad (3')}} \quad \underline{\underline{\quad}}$$

to the pooled data for the 62 countries using the panel regression approach outlined earlier.

The express purpose of the  $GDP_i$  variable is to ensure that estimated coefficient  $\hat{a}_0$  measures

the average (i.e., when  $GDP_i = 0$ ) of the intercepts for the 62 countries when they are

individually applied to equation (3). Similar sentiments apply to the  $F13_t \times GDP_i$  variable

and estimated coefficient  $\hat{a}_1$ . The results, listed in Table 2: Panel A, show the presence of a

depressed Friday the 13th effect ( $\hat{a}_1 = -0.1030$ ,  $p = 0.009$ ) compared to the other Fridays.

As we show below, these results are biased towards finding a significant Friday the 13th effect since the returns on the implied control Fridays are enhanced by the turn of the month effect.

Following upon the insight of Chamberlain *et al.* (1991), the addition of the turn of the month dummy variable  $TOM_t$  gives the model

$$\begin{aligned}
 R_{i,t} = & a'_0 + a'_1 F13_t + a'_2 TOM_t \\
 & + \beta'_0 GDP_i + \beta'_1 (F13_t \times GDP_i) + \beta'_2 (TOM_t \times GDP_i) , \\
 & + \delta'_i + \varepsilon'_{i,t}
 \end{aligned} \tag{4}$$

where the three variables containing the  $GDP_i$  term are added for the reasons explained earlier. There is clearly a turn of the month effect on Fridays ( $\hat{a}'_2 = 0.2825, p < 0.001$ ) when referenced against control Fridays (Table 2: Panel B). This is consistent with the international turn of the month evidence reported in the literature (e.g., Kunkel *et al.*, 2003; McConnell & Xu, 2008). Thus, it is not unexpected that the addition of the dummy variable  $TOM_t$  to the regression model reduces the relative magnitude of the Friday the 13th effect ( $\hat{a}'_1 = -0.0639, p = 0.10$ ). However, there is still evidence, albeit at the margin of statistical significance, of a depressed Friday the 13th effect for the average country. The pressing issues we address relate to: (i) the degree that this effect is attributable to the good day effect and how much is attributable to the bad day effect and (ii) the degree that these results are influenced by per capita gross domestic product.

### 3.2. Panel Regression Model

The results of regression model (2), based on the full permutation of the independent variables, are presented in Table 3. The next step in the analysis is to eliminate the redundant variables. The logic is as follows. Consider, as an illustration, coefficients  $\alpha_0$  and  $\phi_{F13}$  which relate to the situation where  $GDP_i = 0$ . Coefficient  $\alpha_0$  captures the mean return on



good control Fridays. Estimated coefficient  $\hat{\phi}_{F13}$  ( $p = 0.85$ ) argues that the mean return on good Fridays the 13th does not statistically differ from the mean return on good control Fridays  $\hat{\alpha}_0$ . If this hypothesis is true, then a more efficient estimate of the mean return on these two good days (i.e., good Fridays the 13th together with good control Fridays) is given by coefficient  $\alpha'_0$ , see equation (5) below, which is obtained when variable  $F13_t$  is omitted from the regression.

As a conservative approach to variable selection, we eliminate the six variables with  $p \geq 0.20$ . These are: (i) variable  $F13_t$  ( $\hat{\phi}_{F13} = -0.0099$ ,  $p = 0.85$ ), (ii) variable  $F13_t \times GDP_i$  ( $\hat{\phi}_{F13 \times GDP} = -0.0012$ ,  $p = 0.80$ ), (iii) variable  $F13_t \times B_{i,t} \times GDP_i$  ( $\hat{\phi}'_{F13 \times B \times GDP} = -0.0092$ ,  $p = 0.22$ ), (iv) variable  $TOM_t \times GDP_i$  ( $\hat{\gamma}_{TOM \times GDP} = -0.0028$ ,  $p = 0.36$ ), (v) variable  $TOM_t \times B_{i,t}$  ( $\hat{\eta}_{TOM \times B} = 0.0505$ ,  $p = 0.33$ ), and (vi) variable  $TOM_t \times B_{i,t} \times GDP_i$  ( $\hat{\eta}_{TOM \times B \times GDP} = 0.0009$ ,  $p = 0.84$ ). These estimated coefficients are clearly not statistically different from zero. To check whether it is appropriate to delete the variables outlined above, we conduct a Wald chi-square test of the hypothesis that these six estimated coefficients are jointly zero, that is,

$$\phi_{F13} = 0, \phi_{F13 \times GDP} = 0, \phi_{F13 \times B \times GDP} = 0, \gamma_{TOM \times GDP} = 0, \eta_{TOM \times B} = 0, \eta_{TOM \times B \times GDP} = 0.$$

There is compelling evidence ( $\hat{\chi}^2_{6 \text{ df}} = 6.21$ ,  $p = 0.40$ ) to support the decision to delete these six variables.

Thus, the reduced panel regression model is

$$\begin{aligned}
R_{i,t} = & \alpha'_0 + \alpha'_{GDP} GDP_i \\
& + \beta'_B B_{i,t} + \beta'_{B \times GDP} (B_{i,t} \times GDP_i) \\
& + \varphi'_{F13 \times B} (F13_t \times B_{i,t}) \\
& + \gamma'_{TOM} TOM_t \\
& + \delta'_i + \varepsilon'_{i,t} ,
\end{aligned} \tag{5}$$

where primes are used to denote the re-estimated coefficients. The results, see Table 4, are used to generate the mean return versus standardised *GDP* profiles presented in Figure 1.

### 3.3 Control Friday Effects

The *GDP* profile for good control Fridays (i.e.,  $B_{i,t} = 0$ ,  $TOM_t = 0$  and  $F13_t = 0$ ) is represented by the solid line in Figure 1. For the average country (i.e.,  $GDP_i = 0$ ), there is an enhanced return on these days ( $\hat{\alpha}'_0 = 0.1921$ ,  $p < 0.001$ ). This enhanced return is negatively related to *GDP* ( $\hat{\alpha}'_{GDP} = -0.0042$ ,  $p = 0.004$ ). That is to say, the enhanced effect is smaller for developed economies. The *GDP* profile for bad control Fridays (i.e.,  $B_{i,t} = 1$ ,  $TOM_t = 0$  and  $F13_t = 0$ ) is represented by the dash-dash-dash line in Figure 1. For the average country (i.e.,  $GDP_i = 0$ ), there is a depressed return on these days ( $\hat{\beta}'_B = -0.2473$ ,  $p < 0.001$ ) using good control Fridays as the yardstick. In a similar vein, the slope of the line for bad control Fridays is significantly different from the slope on good control Fridays ( $\hat{\beta}'_{B \times GDP} = 0.0051$ ,  $p = 0.03$ ). The positive slope shows that the depressed bad control Friday effect is weaker for developed economies.

Similar results are reported for non-Mondays by Keef, Khaled & Zhu (2009), who suggest that the most plausible explanation for these *GDP* effects is found in considerations of market

efficiency. Our conjecture is that the magnitude of the prior day effect, defined as the difference in the mean return on good days compared to the mean return on bad days, is a reflection of market inefficiency. In a properly functioning market, such predictable differences should be absent. The stock markets of large developed economies are more efficient, in an information sense, than their counterparts in small less developed economies. This is illustrated by the convergence, on control Fridays, presented in Figure 1. The difference between the good prior day effect (solid line) and the bad prior day effect (dash-dash-dash line) is essentially absent for the more wealthy countries on control Fridays. In contrast, the gap is considerably larger for less developed countries.

### 3.4 Turn of the Month Effects

The *GDP* profile for good turn of the month Fridays (i.e.,  $B_{i,t} = 0$  and  $TOM_t = 1$ ) is represented by the dot-dot-dot line in Figure 1. This line is parallel to the profile for good control Fridays ( $\hat{\gamma}_{TOM \times GDP} = -0.0028$ ,  $p = 0.36$  -- see Table 3), but lies above it ( $\hat{\gamma}'_{TOM} = 0.2560$ ,  $p < 0.001$ ). That is to say, the returns on good turn of the month Fridays are consistently greater than the returns on good control Fridays across the 62 countries.

The *GDP* profile for bad turn of the month Fridays (i.e.,  $B_{i,t} = 1$  and  $TOM_t = 1$ ) is represented by the dash-dot-dot-dash line in Figure 1. This profile is parallel to the bad control Friday line ( $\hat{\eta}_{TOM \times B \times GDP} = 0.0009$ ,  $p = 0.84$  -- see Table 3), but lies above it ( $\hat{\gamma}'_{TOM} = 0.2560$ ,  $p < 0.001$ ). That is to say, the returns on bad turn of the month Fridays are consistently greater than the returns on bad control Fridays across the 62 countries.

As noted earlier, control Fridays exhibit a convergence in terms of the *GDP* prior day profiles. Turn of the month Fridays exhibit a similar picture in terms of the degree of convergence -- the only difference being the two turn of the month profiles 'are spatially higher on the graph'. Alternatively put, turn of the month Fridays exhibit a relatively enhanced mean return on good days and on bad days.

### 3.5 Friday the 13th Effects

The *GDP* profile for good Fridays the 13th (i.e.,  $B_{i,t} = 0$  and  $F13_t = 1$ ) is represented by the solid line in Figure 1. That is to say, the mean return on good Fridays the 13th is indistinguishable from the mean return on good control Fridays across the 62 countries ( $\hat{\phi}_{F13} = -0.0099, p = 0.85$  and  $\hat{\phi}_{F13 \times GDP} = -0.0012, p = 0.80$  -- see Table 3). Thus, good Fridays the 13th are not exceptional -- there is not a depressed Friday the 13th effect on these days.

The *GDP* profile for bad Fridays the 13th (i.e.,  $B_{i,t} = 1$  and  $F13_t = 1$ ) is represented by the dash-dot-dash line in Figure 1. This line is parallel to the profile for bad control Fridays ( $\hat{\phi}_{F13 \times B \times GDP} = -0.0092, p = 0.22$  -- see Table 3) but lies below it ( $\hat{\phi}'_{F13 \times B} = -0.1531, p = 0.01$ ). That is to say, the mean return on bad Fridays the 13th is consistently lower than the mean return on bad control Fridays across the 62 countries. The implications are clear. The depressed Friday the 13th effect is caused by the bad day effect. The parallelism shows that the effect is independent of the country, as identified by its GDP per capita, when the bad control Friday effect is taken into account.

### 3.6 Sensitivity Analysis

It has been suggested to us that Asian economies are less superstitious than non-Asian economies. This hypothesis is tested using a dummy variable which takes on a value of 1 if the country is Asian, otherwise 0. We assess 18 of our countries as being Asian – these are coded with an asterisk in Table 1. Our original full permutation model (equation 2) contains 12 independent variables. The Kronecker product of these variables with the Asian dummy variable creates another 12 independent variables. The estimated coefficients of these new Asian variables have probabilities of being zero which range from  $p = 0.25$  to  $p = 0.80$ . A Wald test is used to assess the degree that these 12 estimated Asian coefficients are jointly zero. The test statistic ( $\hat{\chi}_{12}^2 = 12.93, p = 0.37$ ) indicates that the inclusion of Asian dummy variable does not contribute to the explanation of systematic variation in the daily returns.

It has also been suggested to us that the examination of the influence of a full permutation of the four primary independent variables is mechanical and that a prune criterion of  $p > 0.20$  is too arbitrary. As an alternative, we examine a model based on the four primary variables and their two-way interactions. There are ten independent variables including the constant. We then add the ten concomitant Asian dummy interactions. The Wald test statistic ( $\hat{\chi}_{10}^2 = 11.89, p = 0.29$ ) indicates that these ten Asian variables do not make a statistically significant contribution to the explanation of systematic variation in the returns of the stock indices – a similar result is reported before. The application of a pruning criterion of  $p > 0.05$  to this

model with 20 independent variables results in the reduced model reported earlier (equation 5).

#### **4. CONCLUDING REMARKS**

There are three major conclusions arising from this study. First, the enhanced good prior day effect and the depressed bad prior day effect observed on control Fridays are a function of *GDP* (Figure 1). These effects, which are also reported by Keef, Khaled & Zhu (2009), are attributed to differences in market efficiency. Cognate *GDP* influences are observed on Fridays the 13th and turn of the month Fridays. These effects are also attributed to differences in market efficiency. Second, on Fridays there is an enhanced turn of the month effect. It occurs on good days and bad days. When the prior day control Friday effect is taken into account, this enhanced turn of the month effect on Fridays is uniform across the 62 countries. Third, there is a depressed Friday the Thirteenth effect. It occurs when the return on Thursday the Twelfth is negative. It is not present when the return on Thursday the Twelfth is positive. When the bad control Friday effect is taken into account, this depressed effect is uniform across the 62 countries.

It is not an easy task to adequately explain why our results are dramatically different from those of Lucey (2000) -- he shows compelling evidence of an enhanced Friday the 13th effect. We tentatively suggest that the earlier results of Agrawal & Tandon (1994) are more equivocal. We suspect that one explanation might lie in the influences of the prior day effect.

Prior research focuses on returns without acknowledgement of the prior day effect – these are termed the ‘overall’ returns. The mean overall return is a weighted average of the good day effect and the bad day effect. The degree that the mean overall return is negative, or positive, will depend upon the relative magnitude and relative frequency of the good day versus bad day effects – see Maberly’s (1988) conjecture relating to bull versus bear markets.

This study raises the following issues for researchers to consider. First, one country differs from another country in any number of dimensions. Would the same results emerge if alternative between-country explanatory variables are used? Second, a potential criticism of this study is that the microstructure characteristics of the stock indices, in terms of thin trading, non-synchronous trading and index construction etc., may not be uniform. A challenge for future research is to control for the potential influences of these differences. Third, does the turn of the month Friday effect we observe also hold on non-Fridays? Our conjecture, which remains to be properly tested, is that the turn of the month effect on non-Fridays is similarly influenced by the prior day effect. Fourth, the prior day effect plays a vital role in the Friday the 13th effect and the turn of the month effect on Fridays. The prior day effect is not symmetrical. With turn of the month Fridays, the returns on bad days and good days are relatively enhanced to the same degree. With Fridays the 13th, the bad day is relatively depressed but the good day is typical of good control Fridays. These observations raise the question of the way that the prior day effect impinges on other stock market anomalies.

Finally, is it necessary to reconsider the explanations for the Friday the 13th effect in light of the prior day effect? On good days, the returns on Friday the 13th are unremarkable -- they do not differ from good control Fridays. It is only on bad Fridays the 13th that the frightening effect is observed. Why is Friday the 13th not frightening when the return on the prior Thursday is positive? On these days, the stock markets around the world consistently assess Friday the 13th just like the other Fridays. The reasons for this asymmetry remain to be discovered. Succinctly put, our systematic worldwide results are as enigmatic as those observed by Kolb & Rodriguez (1987).



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Table 1  
The 62 Countries and the Index Names<sup>(a,b)</sup>

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|                                    |                                  |
|------------------------------------|----------------------------------|
| Argentina, DS Market               | Australia, DS Market             |
| Austria, ATX - Austrian Traded     | *Bangladesh, SE All Share        |
| Belgium, DS Market                 | Brazil, Bovespa                  |
| Bulgaria, BSE SOFIX                | Canada, S&P/TSX Composite        |
| Chile, General (IGPA)              | *China, DS Market                |
| Czech Republic, PX Global          | Denmark, DS Market               |
| Egypt, EFG                         | Estonia, ARIPA EV                |
| Finland, DS Market                 | France, CAC 40 DS-Calc           |
| Germany, DAX 30 DS-Calc            | Greece, DS Market                |
| *Hong Kong, Hang Seng              | Hungary DS Market                |
| Iceland, OMX Iceland All Share     | *India, BSE National 200         |
| Ireland, DS Market                 | *Israel, Tel Aviv SE General     |
| Italy, DS Market                   | *Japan, Nikkei 225 Stock Average |
| *Jordan, Amman SE Financial Market | Kenya, Nairobi SE                |
| *Kuwait, SE Kuwait Companies       | Luxembourg, DS Market            |
| *Malaysia, KLCI Composite          | Malta, SE MSE                    |
| Mexico, DS Market                  | Morocco, SE CFG 25               |
| Netherlands, DS Market             | New Zealand, DS Market           |
| Norway, Oslo SE OBX                | *Oman, Muscat Securities Mkt.    |
| *Pakistan, Karachi SE 100          | Peru, Lima SE General (IGBL)     |
| *Philippines, DS Market            | Poland, Warsaw General           |
| Portugal, PSI General              | *Qatar, DS Market                |
| Romania. BET                       | Russia, RSF EE MT                |
| *Singapore, DS Market              | Slovakia, SAX 16                 |
| Slovenia, SBI                      | South Africa, FTSE/JSE All Share |
| Spain, DS Market                   | *Sri Lanka, SE All Share         |
| Sweden, DS Market                  | Switzerland, DS Market           |
| *Taiwan, DS Market                 | *Thailand, DS Market             |
| Tunisia, Tunindex                  | *Turkey, DS Market               |
| UK, FTSE 250                       | Ukraine, KP-Dragon               |
| USA, DS Market                     | Venezuela, DS Market             |

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Notes:

- (a) Name used by Datastream.
- (b) Asterisk represents Asian countries.

Table 2  
Friday the 13th and Turn of the Month Effects for the Average Country <sup>(a, b)</sup>

| Independent Variable | Name of Coefficient | Estimated Coefficient | Standard Error | <i>t</i> | <i>p</i> |
|----------------------|---------------------|-----------------------|----------------|----------|----------|
| Panel A              |                     |                       |                |          |          |
| <i>Constant</i>      | $a_0$               | 0.1163                | 0.0111         | 10.44    | < 0.001  |
| $F13_t$              | $a_1$               | -0.1030               | 0.0393         | -2.62    | 0.009    |
| $GDP_i$              | $\beta_0$           | -0.0019               | 0.0010         | -1.93    | 0.05     |
| $F13_t \times GDP_i$ | $\beta_1$           | -0.0055               | 0.0034         | -1.60    | 0.11     |
| Panel B              |                     |                       |                |          |          |
| <i>Constant</i>      | $a'_0$              | 0.0773                | 0.0105         | 7.33     | < 0.001  |
| $F13_t$              | $a'_1$              | -0.0639               | 0.0384         | -1.67    | 0.10     |
| $TOM_t$              | $a'_2$              | 0.2825                | 0.0289         | 9.85     | < 0.001  |
| $GDP_i$              | $\beta'_0$          | -0.0015               | 0.0009         | -1.67    | 0.09     |
| $F13_t \times GDP_i$ | $\beta'_1$          | -0.0058               | 0.0033         | -1.73    | 0.08     |
| $TOM_t \times GDP_i$ | $\beta'_2$          | -0.0026               | 0.0025         | -1.03    | 0.30     |

Notes:

- (a) Sample size = 25,490.  
(b) Variable  $GDP_i$  has a mean of zero.

Table 3  
Full Model: Equation (2) <sup>(a)</sup>

| Independent Variable   | Name of Coefficient              | Estimated Coefficient | Standard Error | <i>t</i> | <i>p</i> |
|--|----------------------------------|-----------------------|----------------|----------|----------|
| Panel A: Good control Fridays ( $F13_t = 0$ , $TOM_t = 0$ and $B_{i,t} = 0$ )  |                                  |                       |                |          |          |
| <i>Constant</i>  | $\alpha_0$                       | 0.1953                | 0.0169         | 11.55    | < 0.001  |
| $GDP_i$  | $\alpha_{GDP}$                   | -0.0038               | 0.0015         | -2.52    | 0.01     |
| Panel B: Bad control Fridays ( $F13_t = 0$ , $TOM_t = 0$ and $B_{i,t} = 1$ )   |                                  |                       |                |          |          |
| $B_{i,t}$  | $\beta_B$                        | -0.2544               | 0.0272         | -9.37    | < 0.001  |
| $B_{i,t} \times GDP_i$   | $\beta_{B \times GDP}$           | 0.0051                | 0.0024         | 2.12     | 0.03     |
| Panel C: Good Fridays the 13th ( $F13_t = 1$ , $TOM_t = 0$ and $B_{i,t} = 0$ ) |                                  |                       |                |          |          |
| $F13_t$  | $\phi_{F13}$                     | -0.0099               | 0.0531         | -0.19    | 0.85     |
| $F13_t \times GDP_i$   | $\phi_{F13 \times GDP}$          | -0.0012               | 0.0046         | -0.25    | 0.80     |
| Panel D: Bad Fridays the 13th ( $F13_t = 1$ , $TOM_t = 0$ and $B_{i,t} = 1$ )  |                                  |                       |                |          |          |
| $F13_t \times B_{i,t}$   | $\phi_{F13 \times B}$            | -0.1333               | 0.0833         | -1.60    | 0.11     |
| $F13_t \times B_{i,t} \times GDP_i$  | $\phi_{F13 \times B \times GDP}$ | -0.0092               | 0.0074         | -1.24    | 0.22     |
| Panel E: Good TOM Fridays ( $F13_t = 0$ , $TOM_t = 1$ and $B_{i,t} = 0$ )      |                                  |                       |                |          |          |
| $TOM_t$  | $\gamma_{TOM}$                   | 0.2365                | 0.0357         | 6.63     | < 0.001  |
| $TOM_t \times GDP_i$   | $\gamma_{TOM \times GDP}$        | -0.0028               | 0.0031         | -0.91    | 0.36     |
| Panel F: Bad TOM Fridays ( $F13_t = 0$ , $TOM_t = 1$ and $B_{i,t} = 1$ )       |                                  |                       |                |          |          |
| $TOM_t \times B_{i,t}$   | $\eta_{TOM \times B}$            | 0.0505                | 0.0522         | 0.97     | 0.33     |
| $TOM_t \times B_{i,t} \times GDP_i$  | $\eta_{TOM \times B \times GDP}$ | 0.0009                | 0.0046         | 0.20     | 0.84     |

Note:

(a) Sample size = 25,102.

Table 4  
 Reduced Model: Equation (5) <sup>(a)</sup>

| Independent Variable  | Name of Coefficient     | Estimated Coefficient | Standard Error | <i>t</i> | <i>p</i> |
|---|-------------------------|-----------------------|----------------|----------|----------|
| Panel A: Good control Fridays ( $F13_t = 0$ , $TOM_t = 0$ and $B_{i,t} = 0$ ) |                         |                       |                |          |          |
| <i>Constant</i>   | $\alpha'_0$             | 0.1921                | 0.0164         | 11.68    | < 0.001  |
| $GDP_i$   | $\alpha'_{GDP}$         | -0.0042               | 0.0015         | -2.86    | 0.004    |
| Panel B: Bad control Fridays ( $F13_t = 0$ , $TOM_t = 0$ and $B_{i,t} = 1$ )  |                         |                       |                |          |          |
| $B_{i,t}$   | $\beta'_B$              | -0.2473               | 0.0267         | -9.27    | < 0.001  |
| $B_{i,t} \times GDP_i$  | $\beta'_{B \times GDP}$ | 0.0051                | 0.0024         | 2.12     | 0.03     |
| Panel C: Bad Fridays the 13th ( $F13_t = 1$ , $TOM_t = 0$ and $B_{i,t} = 1$ ) |                         |                       |                |          |          |
| $F13_t \times B_{i,t}$  | $\phi'_{F13 \times B}$  | -0.1531               | 0.0608         | -2.52    | 0.01     |
| Panel D: Good TOM Fridays ( $F13_t = 0$ , $TOM_t = 1$ and $B_{i,t} = 0$ )     |                         |                       |                |          |          |
| $TOM_t$   | $\gamma'_{TOM}$         | 0.2560                | 0.0289         | 8.87     | < 0.001  |

Note:

(a) Sample size = 25,102.

Figure 1  
Influence of GDP on the Effects

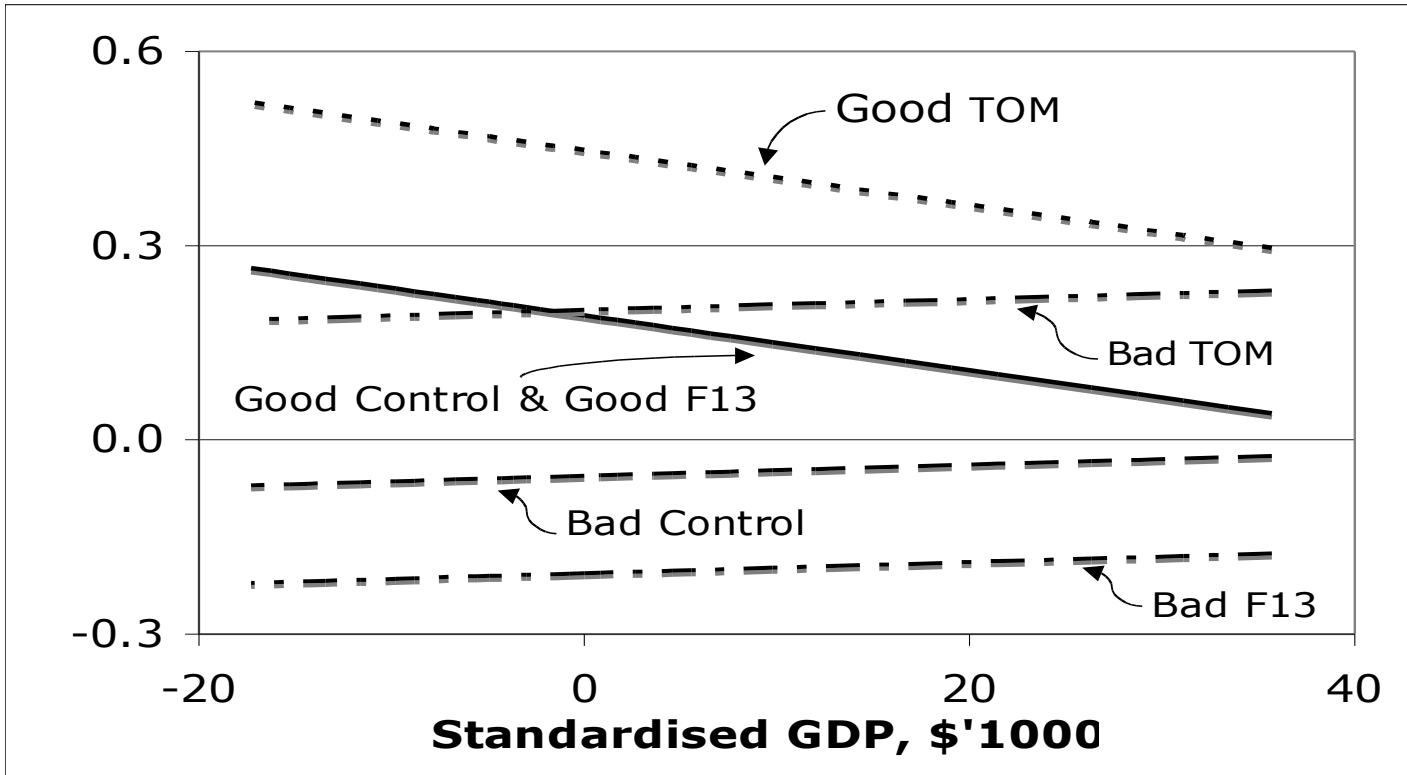


Figure 1