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Full Length Article

The day of the week effect and interest rates

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Abstract

The day of the week effect is one of the regularities observed in financial markets which suggests that Friday returns are higher than Monday returns. One of the possible reasons for this regularity is that the date of trade in equity markets is not always the same as the date that payment is made, or the settlement date. The number of days that investors have to wait for payment is higher when that trade is realized on Fridays rather than on Mondays (due to the weekend holidays). Thus, investors have a few more days to use the money in alternative markets when the trade has been realized on Fridays and until the trade is settled on the settlement date. This paper provides empirical evidence that as the return in alternative markets (overnight interest rates) decreases, the day of the week effect decreases. Thus, there should be a positive relationship between the expected relative returns on Friday to Monday and overnight interest rates.

JEL classification: G14; G11; C51

Keywords: Day of the week effect; Monday effect; Weekend effect; Settlement date; Interest rates

1. Introduction

The *day of the week effect* suggests that returns are predictable based on the day of the week on which the trade is realized in financial markets. It suggests that Friday returns are higher than Monday returns in equity markets (see, for example, Cross, 1973; French, 1980; Gibbons & Hess, 1981; Jaffe & Westerfield, 1985). On the other hand, the efficient market hypothesis suggests that agents make use of all of the available information to form their expectations and that these anomalies should not occur. However, various arguments support the existence of the day of the week effect.

The day of the week effect has been investigated for various financial markets. Kohers and Patel (1996) examine the day of the week effect for the junk bonds, finding that Friday returns are all positive and the highest of any day of the week. Aydoğan and Booth (2003), Yamori and Mourdoukoutas (2003), Yamori and Kurihara (2004) and Berument, Coskun, and Sahin (2007) are among the studies that show the day of the week effect on exchange rates. These studies have different results. For example, Aydoğan and Booth (2003) find that the exchange rate changes on Tuesday and Wednesday is higher than other days; Yamori and Mourdoukoutas (2003) find more negative returns on Tuesday than other days of week; Yamori and Kurihara (2004) find negative Wednesday returns and positive Friday returns; Berument et al. (2007) show that Thursday has higher and Monday has lower depreciation rates when compared to Wednesday. Moreover, the day of the week effect is investigated within gold and silver markets (Kohli, 2012) and in stock market futures (Cornell, 1985; Gay & Kim, 1987). Kohli (2012) finds the day of the week effect in both gold and silver markets. Cornell (1985) does not find the

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Monday effect in SP500 futures market. However, Gay and Kim (1987) find high returns on Friday and Wednesdays in the Commodity Research Bureau future index. Lee and Ou (2010) use the interest rate in their GARCH (the generalized autoregressive conditional heteroskedasticity) model for determining the day of the week effect on mortgage real estate investment trusts (MREITs) and find that MREITs have positive returns on Tuesday and Friday. Bildik (1998) examines the day of the week effect in overnight interest rates in the Turkish Interbank Money Market and Istanbul Stock Exchange Repo Market and finds the day of the week effect in both the overnight interest rate and ISE daily returns. Interest rates fall significantly on Wednesdays and increase on Mondays relative to the previous days, and stock market returns are significantly higher on Fridays (in the one-day settlement and full periods) and Thursdays (in the two-day settlements) than on other days of the week. Bildik (2001) studies the day of the week effect in ISE returns, and his findings are similar to Bildik (1998)'s results. In recent years, studies on the day of the week effect in the cryptocurrency market have become popular. Caporale and Plastun (2018) find evidence of an excess positive return on Mondays in the case of BitCoin.

The day of the week effect has also been studied for various emerging markets. Recent literature allows for time-varying volatility that uses ARCH-type (autoregressive conditional heteroskedasticity) models. Georgantopoulos, Kenourgios, and Tsamis (2011) study the day of the week effect in Emerging Balkan equity markets for the 2000–2008 period. They find that the day of the week effect exists in the Greek and Turkish equity market returns. Moreover, they also report the day of the week effect for the return volatility of the Bulgarian equity market. Dicle and Levendis (2012) examine the day of the week effect for the 51 stock markets in 33 countries for the 2000–2007 period with GJR-GARCH(1,1) (Glosten-Jagannathan-Runkle-GARCH). They find that, even if the day of the week effect does not exist in the stock markets of some countries, it is present in individual stocks. Rodriguez (2012) finds that returns are higher on Fridays and lower on Mondays compared to other days of the week for all the stock markets in Latin America for the 1993–2007 period using GARCH(1,1) models. Alrabadi and AL-Qudah (2012) use least square and GARCH(1,1) models to study the day of the week effect in the Amman Stock Exchange for the 2002–2011 period. They determine that Sunday (the first trading day) and Thursday returns are higher than the other days of the week and Monday returns are significantly negative. Osarumwense (2015) finds evidence of the day of the week effect in the Nigerian Stock exchange in returns and volatility. Gouider, Kaddour, and Hmaid (2015) find a positive, high, and statistically significant coefficient for Friday for the full and pre-revolutionary Tunisian data. Caporale and Zakirova (2017) investigate the day of the week effect in the Russian stock market for the 1997–2016 period and show that the day of the week effect exists in the mean equation for stock market returns, but disappears when returns are adjusted with transaction costs. Zhang, Lai, and Lin (2017) study the presence of the day of the week effect in 28 markets from 25 countries using the rolling sample test and the GARCH(1,1) model and find the day of the week effect differs according to country.

The day of the week effect in Borsa Istanbul (formerly known as the Istanbul Stock Exchange-ISE) has been studied in the literature as well. Most of these studies find that Friday returns are higher than the returns of other days. Muradoğlu and Oktay (1993) find that Tuesday returns are negative and Friday returns are positive. Balaban (1995) finds statistically insignificant low Tuesday returns, but higher Friday returns. Özmen (1997) states that Friday returns are the highest. He also finds that Wednesday has the second highest return. Bildik (2000) points out that Tuesday returns are negative and Friday returns are positive. Aktaş and Kozanoğlu (2007) use a GARCH(1,1) specification to investigate the day of the week effect in the ISE National-30, ISE National-100, ISE National-Bank, ISE National-Industry, ISE National-Financial, and ISE National-Services indexes for the period of 2001–2007. They find statistically significant and positive coefficients for Thursdays and Fridays in the mean equation for all the indexes they consider. Ergül, Dumanoğlu, and Akel (2008) investigate the day of the week effect in the ISE for the 1988–2007 period. They use the analysis of variance (ANOVA) for each year and observe the day of the week effect in some years.[1] Hepsen (2012) uses an ordinary least squares method to investigate the day of the week effect. He finds that the daily returns of Tuesdays, Wednesdays, Thursdays, and Fridays are higher than the returns on Mondays. Konak and Kendirli (2014) study the day of the week effect for the period before, during, and after the 2008 Global Financial Crisis. Their results show that the ISE has the day of the week effect, and that this effect was lower during the crisis period. Aksoy and Ulusoy (2015) examine the day of the week effect for the return and volatility behavior of the Borsa Istanbul REITs Index and the BIST 100 Index by using GARCH and EGARCH (Exponential GARCH) models for the period of 2000–2014. They find the day of the week effect for return and volatility in both the REITs index and BIST index.

There are various reasons for the day of the week effect. Behavioral finance literature suggests that firms release bad news that is likely to affect equity prices on the weekends but release good news immediately. Thus, Monday returns are likely to be negative (Damodaran, 1989; French, 1980). French (1980) points out that "if firms fear panic selling when bad news is announced, they may delay the announcement until the weekend". Due to this strategy, firms give investors more time to digest bad news in order to prevent them from acting suddenly. Damodaran (1989) also notes that firms usually report bad news closer to the weekend, and especially after the close of trading on Friday. This bad news affects the returns of the following trading day, which is usually Monday. Recent technological changes that allow electronic trades as well as developments in the management of a risk-warrant

[1] The years that the day of the week effect could be found are 1988, 1992, 1995, 1996, 2000, 2001, 2002, 2004 and 2006.

system may not allow the relative importance of the day of the week effect exist but may still persist. Another reason for the day of the week effect is *the settlement date*. If the settlement date of an equity purchase is not the day of purchase, then there is room to explore profit-maximizing agents. Thus, the possibility of an excess return exists if the settlement date is not the same day of the trading. If the settlement date is two days hence, then an equity purchased on Monday will be realized on Wednesday (2 days later), but if it is purchased on Friday, the settlement will usually be on Tuesday (4 days later) due to the weekend holiday. French (1980) reports negative stock returns on Mondays. This could be due to the trading time view, which expects stock returns to be equal on different days, whereas the calendar time view expects higher returns on settlement dates due to a longer holding period. He argues that this may be because of the delay between trading and settlement dates. As stated by Lakonishok and Levi (1982), in terms of the Friday effect, investors who sell stocks on Fridays will expect higher returns because they will be paid extra two days later. As for buyers, they are also willing to pay more as they will receive two days interest. Firms may offer higher prices on Fridays than on Mondays; thus, one should expect higher returns on Fridays than on Mondays. Moreover, there are several studies that focus on settlement procedures being likely, rational explanations for the day of the week effect (see, Board & Sutcliffe, 1988; Crouhy & Galai, 1992; Clare, Ibrahim, & Thomas, 1998; Keef & McGuinness, 2001; Draper & Paudyal, 2002; Patel & Mallikarjun, 2014). These studies investigate the effects of changes in the security settlement date cycle to the day of the week effect in stock markets. Usually, in such studies, the data set is divided into several sub-periods based on different settlement day procedures. For example, Patel and Mallikarjun (2014) divide their data set into two periods: before and after the T+2 settlement day. The Indian stock market had an accounting period settlement cycle, T+5 and T+3 settlement day procedures (which were longer than two business days) before a T+2 settlement day procedure was implemented. They estimate their models for the two sub-periods and show that the coefficient of Friday returns relative to Monday in an after T+2 settlement period decreases when compared to a before T+2 settlement period. As the settlement period decreases, the day of the week effect also decreases. Among these studies, Draper and Paudyal (2002) use the interest variable in the regression to allow for the number of days of credit available before settlement. Their estimates show that the stock returns have a day of the week effect with negative Monday returns.

This paper argues that since the payment to be made for any transaction in the equity market is not usually the very same day (i.e., settlement date); as interest rates decrease, the opportunity cost of holding money for settling any transaction decreases, so the day of the week effect decreases. Therefore, the purpose of this paper is to provide empirical evidence that as the return of the alternative use of money in equity market changes during the settlement period, the day of the week effect changes. To be specific, as the money market overnight interest rate decreases, the extra return that Friday offers relative to Monday (the day of the week effect) decreases. The Kalman filter allows the parameters to change such that their changes are systematic and stochastic variations. Furthermore, the Kalman filter specification can handle any type of parameter variation (Rausser, Mindlak, & Johnson, 1982). Therefore, in order to see the effects of time-varying choices on the day of the week effect, we use state space models based on the Kalman filter. There are various reasons for using Turkish data in this study. First, Turkish overnight interest rates fluctuate within a wide margin. The mean, standard deviation, and coefficient of variation of the overnight interest rates are 41.17%, 70.42%, and 17.1% respectively for the sample that we consider from 04 January 1988 to 12 October 2017. The overnight rate fluctuates between 1.5% and 4018% (the sample minimum and maximum). Thus, the evidence gathered from Turkey is not subject to *Type II* error — not rejecting the null when it is false. Second, Borsa Istanbul is ranked as number three among world equity markets in terms of share turnover velocity (192.3%) for the year 2016. It is also the seventh largest in traded value in equities (419 billion USD) among the emerging markets. Equity portfolio holdings by international investors are 56.2 billion USD. Its free float capitalization is 62.5%, and its total market capitalization is 237.6 billion USD. It has a 1.73 billion USD daily average trading value. The total trading value is 431.3 billion USD.

The rest of the paper is organized as follows: Section 2 introduces the Kalman filtering method, which is used to capture the effect of interest rate on the day of the week effect. Section 3 reports the empirical evidence that we gathered. The last section concludes the paper.

2. Methodology

One can use the Kalman filter method for estimating unobservable state variables using observed data. A general state space model is given as follows:

$$\xi_{t+1} = \mu + F\xi_t + Bz_{t+1} + v_{t+1} \tag{1}$$

$$y_t = A'x_t + H'\xi_t + w_t \tag{2}$$

$$E\left(v_t v_k'\right) = \begin{cases} Q, & \text{if } t = k \\ 0, & \text{otherwise} \end{cases}$$

$$E\left(w_t w_k'\right) = \begin{cases} D, & \text{if } t = k \\ 0, & \text{otherwise} \end{cases}$$

Equations (1) and (2) are known as state and signal equations, respectively. The state equation captures how the coefficients in the observation equation change over time. F, B, Q, A, H, and D matrices are called system matrices. The error terms $\{v_t, w_t\}_{t=1}^{T}$ have Gaussian with mean zero and non-zero covariance matrices of Q and D. The Kalman filter needs initial values which are $\xi_{1|0} \sim N(\widehat{\xi}_{1|0}, P_{1|0})$ for an estimation;

typically, these are given by $\widehat{\xi}_{1|0}=0$ and $vec(P_{1|0})=[I-(F\otimes F)]^{-1}vec(Q)$ (Hamilton, 1994). Following Harvey (1990) and Hamilton (1994), the Kalman filter recursive algorithm starts with obtaining the Kalman Gain matrix by

$$K_t=P_{t|t-1}H(H'P_{t|t-1}H+D)^{-1}$$

in the second step, the covariance of ξ_t is updated by

$$P_{t|t}=[I-K_tH']P_{t|t-1}$$

then projected to t of ξ_t and its covariance can be calculated

$$\widehat{\xi}_{t|t-1}=F\widehat{\xi}_{t-1|t-1}$$

$$P_{t|t-1}=FP_{t-1|t-1}F'+Q$$

Finally, the estimations are updated by

$$\widehat{\xi}_{t|t}=\widehat{\xi}_{t|t-1}+K_t(y_t-A'x_t-H'\xi_{t|t-1})$$

In this paper, we try to determine if the day of the week effect, specifically the Friday return, decreases relative to the Monday return as the interest rates (the funding cost of borrowing before the weekend and paying back after the weekend) decrease. In order to estimate this time-varying relationship, we describe the state space model as follows:

$$\alpha_{F,t}=\beta_0+\beta_1\alpha_{F,t-1}+\beta_m overnight_{t-1}+v_t \quad v_t\sim N(0,Q) \tag{3}$$

$$R_t=\alpha_0+\alpha_U TU_t+\alpha_W WE_t+\alpha_H TH_t+\alpha_{F,t}FR_t + \sum_{i=1}^{p}\alpha_i R_{t-i}+w_t \quad w_t\sim N(0,D), \tag{4}$$

Here, Equation (3) is the state equation and Equation (4) is the signal equation. These equations describe the relationships among daily returns, unobserved time-varying excess Friday returns, and interest rates. In order to write equations (3) and (4) as a general state space model (as given in equations (1) and (2)), system matrices are described as $x_t=[1\ TU_t\ WE_t\ TH_t\ R_{t-1}\dots R_{t-p}]'$, $A'=[\alpha_0\ \alpha_U\ \alpha_W\ \alpha_H\ \alpha_1\ ...\ \alpha_p]$, $\xi_t=[\alpha_{F,t}]$, $H'=[FR_t]$, $B=[overnight_{t-1}]$ $Q=[\sigma_v^2]$, $D=[\sigma_w^2]$. Where R_t is the return at time t, $overnight_t$ is the overnight interest rates and TU_t, WE_t, TH_t, FR_t are the dummy variables for Tuesday, Wednesday, Thursday, and Friday. We did not include a dummy variable for Monday to avoid the dummy variable trap and thus, the coefficient FR_t captures the relative return of Friday to Monday returns. The lag values of returns are included to account for the persistence. In equation (3), $\alpha_{F,t}$ indicates the time varying in the day of the week effect that is captured with the Kalman Filter. Including explanatory variables to time-varying estimated parameters is common, especially in the Marketing literature (see, for example, Chavas, 1983; Osinga, Leeflang, Srinivasan, & Wieringa, 2011; Pauwels & Hanssens, 2007; Sriram, Chintagunta, & Neelamegham, 2006). A positive coefficient for FR_t suggests that Friday returns are higher than Monday returns. If this coefficient changes with the overnight interest rate, then β_m is expected to be positive with a statistically significant coefficient; this suggests that the lower return on Friday (relative to Monday) is due to the decrease in the funding cost.

3. Empirical evidence

To investigate the day of the week effect, we use the daily data of the market interest rate and Borsa Istanbul 100 indexes (formerly known as the Istanbul Stock Exchange-ISE) for the period from 02 January 1990 to 12 October 2017 (6931 observations in total). This period is dictated by the specific characteristics and historical development of Turkey's financial markets. Even though the ISE was established in 1985, we did not use data from the 1985–1987 period. Although there were daily stock market transactions at the beginning, there were no daily calculations of index numbers until October 1987. In addition, there was only a limited number of listed companies between 1986 and 1987. Thus, any unusual price change in a small number of firm equities could change the stock market index significantly (Muradoğlu, Berument, & Metin, 1999). Since the BIST is thin during the beginning period and the interest rate data was not available until January 1990, our data begins from the latter date. We obtained the Borsa Istanbul closing prices from the Electronic Data Delivery System (EDDS) of the Central Bank of the Republic of Turkey (CBRT), and the Interbank Overnight Average Rate is obtained from Datastream, which is used as a proxy for the market interest rate. One may also see the supplementary material available online.

In order to provide visual support for the relationship between the day of the week effect and overnight interest rates, we plot the time-varying Friday coefficients with the $\pm 2RMSE$ confidence band on the left axis and overnight interest rate on the right axis in Fig. 1. We calculate the Friday ($\alpha_{F,t}$) coefficient using a common and conventional random walk specification for the state specification, in which we assume $\beta_0=0$, $\beta_1=1$ and $\beta_m=0$ in equation (3). In order to get a better visual effect, we did not report the overnight interest rate when it was above 2057%. Fig. 1 clearly suggests that, overall, the day of the week effect and overnight interest rates have downward trends.

Tables 1 and 2 report the estimated parameters for a set of model specifications and sub-samples. Specification 1 is our benchmark model as stated in equations (3) and (4). In order to address the autocorrelation and persistency of the series, we use the lag order of one (as suggested by the Final Prediction Error [FPE] criteria for return series). Panel A of the tables report the estimated coefficients of the signal (return) specifications. The estimated coefficients for the constant term, Tuesday (TU_t), Wednesday (WE_t), and Thursday (TH_t) are time-invariant; thus, we report these coefficients as they are. Since the estimated parameter for Friday is not constant, we report the final state value for Friday only.[2]

[2] We also use various time varying parameters for α_U, α_W, α_H. We often face a convergence problem. Yet the basic results on the sign of the coefficient for α_F and equation (2) were sensible. Thus, we did not pursue this avenue further.

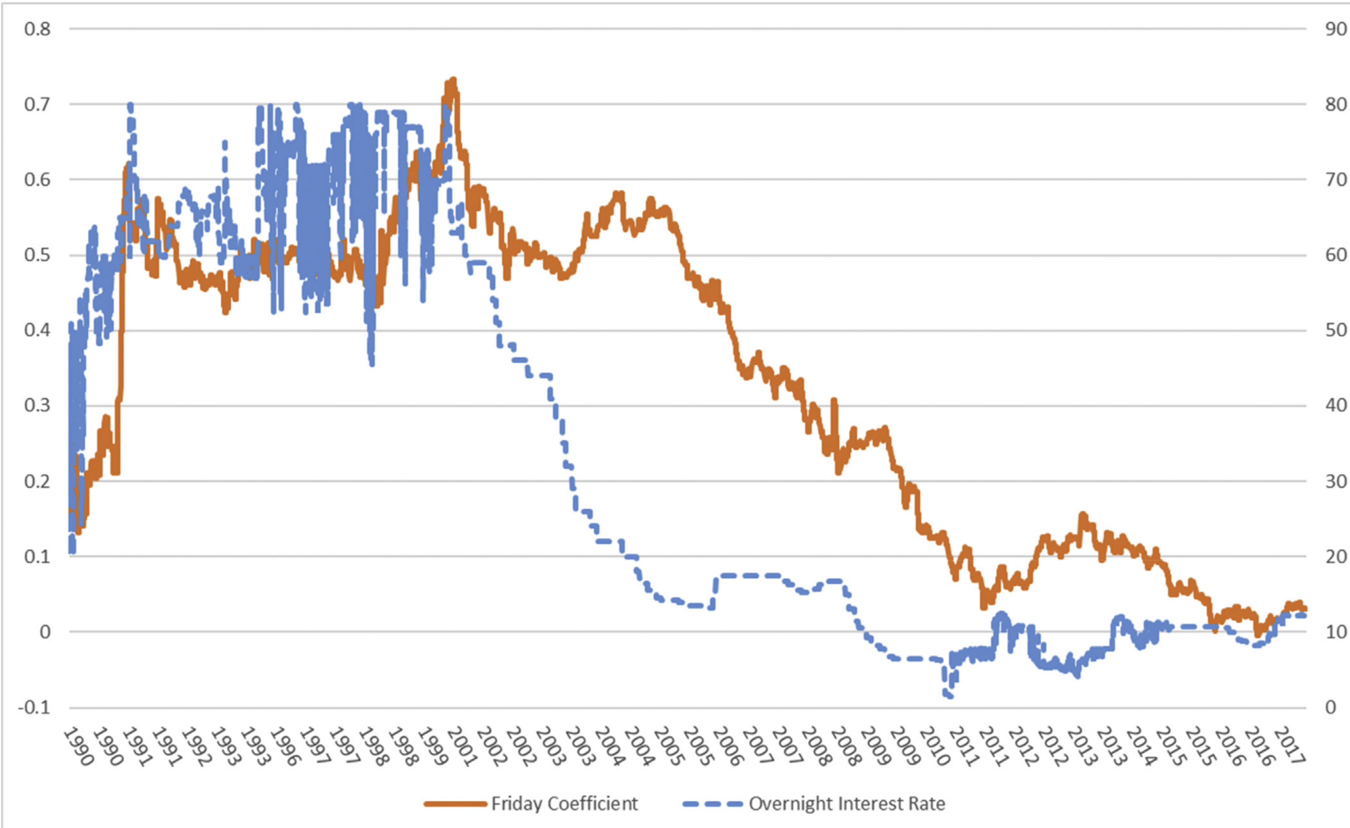

Fig. 1. Time-varying Friday Coefficients (left axis) and Overnight Interest Rates (right axis).

Specification 1 suggests that Friday's final state value is positive (as suggested by the existing literature on the day of the week effect) but not statistically significant (the level of significance is 5% unless otherwise stated). Panel B in Table 1 reports the state equation for the excess return on Fridays. The estimated coefficient of the lagged dependent variable for the state variable ($\alpha_{F,t-1}$) is positive and statistically significant. More importantly, the estimated coefficient for the overnight rate is positive and significant. Thus, the empirical evidence suggests that as the borrowing cost or lending rate decreases, then the day of the week effect decreases. Next, to assess the robustness of our analyses, we estimate a set of specifications that also take into account extreme values. In order to account for this, we consider two types of dummies: In the signal equation, we include a dummy variable for the observations that returns are above or below three standard deviations ($\pm 3\sigma$return) from the mean. In the state equation, we include a dummy variable for the overnight interest rate variable for the observations above and below 3 standard deviations ($\pm 3\sigma$overnight) from the mean. These are the two types of dummy variables considered for different combinations. When we include these dummies, the final prediction error criterion could also suggest that the lag order for the return equation is two from time to time. In order to account for these, we repeat the estimations in Specifications 2–8. We begin by including a dummy variable in Specification 2 to account for the extreme values of high overnight interest rates in the state equation, so that the observed effect of the overnight interest rate on $\alpha_{F,t}$ is not due to a few outliers. Specification 3 includes a dummy variable for excessive returns in the signal equation. Even if the FPE Criteria suggests that the lag order is one for the benchmark specification, we report the exercise with a second lagged dependent variable in Specification 4 as suggested by FPE Criteria for the new specification. Again, the results are robust. A common practice for the state equation is to use a random walk specification: $\beta_0 = 0$ and $\beta_1 = 1$ in equation (3). Specifications 5 to 8 repeat the same exercise with the random walk assumptions. The estimated coefficients of the overnight interest rate in the state equation are consistently positive and statistically significant. This suggests that lower overnight interest rates are associated with lower levels of the day of the week effect; our initial estimates, reported in Specification 1, are robust.

We also repeat the exercise for different sub-samples and report these estimates in Table 2. We consider the data from 02 January 1990 to 31 December 2007 (to avoid 2008 financial crises). This covers the period that the inflation rate (and overnight interest rate) is high and volatile. The mean of return and overnight interest are 0.22358 and 58.5747, respectively. The standard deviation of return and overnight interest are 2.52155 and 82.6052, respectively. Next, we consider the period from 02 January 2009 to 12 October 2017. During this period, Turkey had low and stable inflation and overnight interest rates. The mean of return and overnight interest are

Table 1
Time-varying the day of the week effect estimates.

	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5	Specification 6	Specification 7	Specification 8
Panel A: Signal Equations-Return Equation ($Return_t = \alpha_0 + \alpha_U Tuesday_t + \alpha_W Wednesday_t + \alpha_H Thursday_t + \alpha_{F,t} Friday_t + \sum_{i=1}^{p} \alpha_i Return_{t-i} + \delta_1(\pm 3\sigma) return_t + w_t$)								
Constant	−0.028794	−0.029164	−0.029232	−0.025093	−0.028668	−0.088669	−0.065549	−0.023980
	(−0.218196)	(−0.221080)	(−0.222046)	(−0.191120)	(−0.213638)	(−0.669286)	(−0.499490)	(−0.181471)
$Tuesday_t$	0.067450	0.067804	0.031375	0.031714	0.067335	0.132477	0.069986	0.031966
	(0.474865)	(0.477532)	(0.219958)	(0.222687)	(0.466404)	(0.927931)	(0.491835)	(0.907316)
$Wednesday_t$	0.221582	0.221882	0.183198	0.179180	0.221453	0.281416**	0.221960	0.178378
	(1.566951)	(1.569649)	(1.288493)	(1.262937)	(1.539961)	(1.980213)	(1.565097)	(1.249228)
$Thursday_t$	0.292998**	0.293091**	0.258604*	0.248039*	0.292819**	0.353062**	0.291281**	0.247369*
	(2.074801)	(2.076186)	(1.777456)	(1.752645)	(2.039284)	(2.487810)	(2.059272)	(1.736789)
$Friday_t$	0.235103	0.288142	0.258604	0.257339	0.043137	0.106733	0.100639	0.052544
(Final State Value)	(0.370409)	(0.451220)	(0.559903)	(0.613761)	(0.284701)	(0.120110)	(0.078007)	(0.902026)
$Return_{t\text{-}1}$	0.091086***	0.092507***	0.092738***	0.094274***	0.091425***	0.093144***	0.091058***	0.093876***
	(14.13785)	(14.25829)	(14.10755)	(13.86047)	(14.39664)	(14.12009)	(14.02098)	(14.14730)
$Return_{t\text{-}2}$				−0.016743**		−0.018794**		−0.02096***
				(−2.251086)		(−2.551862)		(-2.845954)
$(\pm 3\sigma) Return_t$			1.688139***	1.696323***			1.541922***	1.687047***
			(28.51621)	(28.65148)			(25.41900)	(28.79596)
Panel B: State Equations- Friday Specification ($\alpha_{F,t} = \beta_0 + \beta_1 \alpha_{F,t-1} + \beta_m overnight_{t-1} + \delta_2(\pm 3\sigma) overnight_t + v_t$)								
Constant	0.110471	0.473639*	0.440733	0.446462				
	(1.425780)	(1.699997)	(1.553992)	(1.571572)				
$Friday_{t\text{-}1}$	0.64370***	−0.85474***	−0.90409***	−0.91768***	1.000†	1.000†	1.000†	1.000†
	(35.4062)	(−18.04170)	(-25.04591)	(−29.37885)				
$overnight_{t\text{-}1}$	0.1066**	0.3006**	0.28580**	0.27860***	0.00045***	0.01150***	0.05190***	0.00033***
	(1.980528)	(2.388496)	(2.381936)	(2.444239)	(4.4801)	(3.860794)	(8.369768)	(7.651200)
$(\pm 3\sigma) overnight_t$		−1.043873**	−0.568110*	−0.641245**		−0.17214***	−0.544184***	0.007745*
		(-2.038607)	(−1.840244)	(−2.160156)		(−10.24593)	(−14.98869)	(1.890184)
Log likelihood	−15803.33	−15803.02	−15768.26	−15767.25	−15810.98	−15885.18	−15949.29	−15772.42
Akaike criterion	4.411587	4.411778	4.402359	4.402359	4.413163	4.434420	4.452305	4.403241
Schwarz criterion	4.421180	4.422330	4.413871	4.414830	4.420838	4.444014	4.461898	4.413794
Hannan-Quinn criter	4.414888	4.415410	4.406321	4.406651	4.415804	4.437722	4.455607	4.406873
Corrected R^2	0.80	0.80	0.80	0.80	0.80	0.77	0.80	0.80

Note: The values in the parenthesis are **t**-statistics of estimates of corresponding parameters. ***, **, and * indicate the level of the significance at the 1 percent, 5 percent, and 10 percent level, respectively. † coefficient of 1 is imposed due to the random walk assumption.

0.05146 and 8.74449, respectively. The standard deviation of return and overnight interest are 1.27772 and 2.40717, respectively. For the 02 January 1990 to 31 December 2007 sample period, our results are robust. On the other hand, we could not find a statistically significant coefficient for the overnight interest rate in the state equation for the period of 02 January 2009 to 12 October 2017, perhaps due to a *Type-II* error. This makes sense because, during this period, Turkey had low inflation and interest rate volatility. These low rates were one of the various reasons we chose Turkey to test our hypothesis. In order to further validate our estimates, we performed the analysis with two additional sub-samples. The first sub-sample covers the period between 02 January 1990 and 29 December 2000; the second sub-sample covers the period from 02 July 2001 to 31 December 2007. The basic conclusion of our estimates is still robust. Fig. 2 reports the estimated coefficient of Fridays as a measure of the excess return of Friday relative to Monday with ±2 RMSE (Root mean square error) confidence intervals. Since the coefficient of Friday is modeled as a stochastic process, we use RMSE rather than standard errors. (see; Van den Bossche, 2011). Thus, a positive coefficient for Friday suggests that Friday returns are higher than Mondays', and we can reject the null of no extra return of Fridays compared to Mondays (no day of the week effect) until mid-2007. On the other hand, we cannot reject the null after mid-2007. Not rejecting the null might mean that the day of the week effect disappears or that we cannot detect the day of the week effect due to a Type-II error. In both cases, we can safely claim that the extra return on Fridays decreases relative to Mondays (or lowers the day of the week effect) for the periods that Turkey has low and stable inflation as well as interest rates.

Our empirical evidence suggests that the excess returns of Fridays decrease with a lower overnight interest rate. When investors purchase an equity on Friday, the transaction day will be Tuesday. They can use their money for these four days in alternative markets such as overnight money markets. On the other hand, in the case of Monday purchases, the settlement date duration will be two days. Thus, investors prefer to buy an equity on Friday rather than Mondays due to two-days weekend holidays. However, as the opportunity cost of holding money will be lower due to lower interest rates, investors will demand a lower return to purchase an equity on Friday. As mentioned above, several researchers have studied the effect of settlement days. Patel and Mallikarjun (2014) show that when the duration before the settlement day decreases, the day of the week effect also

Table 2
Time-varying the day of the week effect estimates (different sub-samples).

	1990:01–2007:12	2009:01–2017:10	1990:01–2000:12	2001:07 2007:12
Panel A: Signal Equations-Return Equation ($Return_t = \alpha_0 + \alpha_U Tuesday_t + \alpha_W Wednesday_t + \alpha_H Thursday_t + \alpha_{F,t} Friday_t + \sum_{i=1}^{p} \alpha_i Return_{t-i} + w_t$)				
Constant	−0.065132*	−0.00003	−0.083331	−0.063335
	(−1.806800)	(−0.0000001)	(−0.302440)	(−0.254444)
$Tuesday_t$	0.087062*	0.073168	0.064794	0.095625
	(0.491835)	(0.479283)	(0.218355)	(0.359404)
$Wednesday_t$	0.357812***	0.063347	0.513171*	0.168267
	(3.645061)	(0.413173)	(1.728054)	(0.625169)
$Thursday_t$	0.456099***	0.064958	0.454958	0.347379
	(4.671625)	(0.428567)	(1.539838)	(1.316305)
$Friday_t$	0.476531	0.043035	0.600715	0.358854***
(Final State Value)	(0.618499)	(1.496221)	(0.680359)	(3.652421)
$Return_{t-1}$	0.100813***	0.000218	0.118371***	−0.017076
	(4.013521)	(0.011650)	(9.814348)	(−0.783090)
Panel B: State Equations- Friday Specification ($\alpha_{F,t} = \beta_0 + \beta_1 \alpha_{F,t-1} + \beta_m overnight_{t-1} + v_t$)				
Constant	0.800746***	−0.002834	0.512520	0.325801
	(5.019459)	(−0.007949)	(0.196945)	(0.026831)
$Friday_{t-1}$	−0.84258***	−0.336570	0.112304	−0.211482
	(−8.805743)	(−0.008425)	(0.024889)	(−0.004687)
$overnight_{t-1}$	0.2153***	0.4927	0.0593***	0.6917**
	(3.388661)	(0.033116)	(2.556034)	(2.021923)
Log likelihood	−10998.37	−3679.185	−5998.696	−2857.883
Akaike criterion	4.673473	3.343167	4.869284	4.016643
Schwarz criterion	4.687180	3.368991	4.892830	4.053506
Hannan-Quinn criter	4.678292	3.352602	4.877838	4.030409
Corrected R^2	0.85	0.39	0.87	0.70

Note: The values in the parenthesis are **t**-statistics of estimates of corresponding parameters. ***, **, and * indicate the level of the significance at the 1 percent, 5 percent and 10 percent level, respectively.

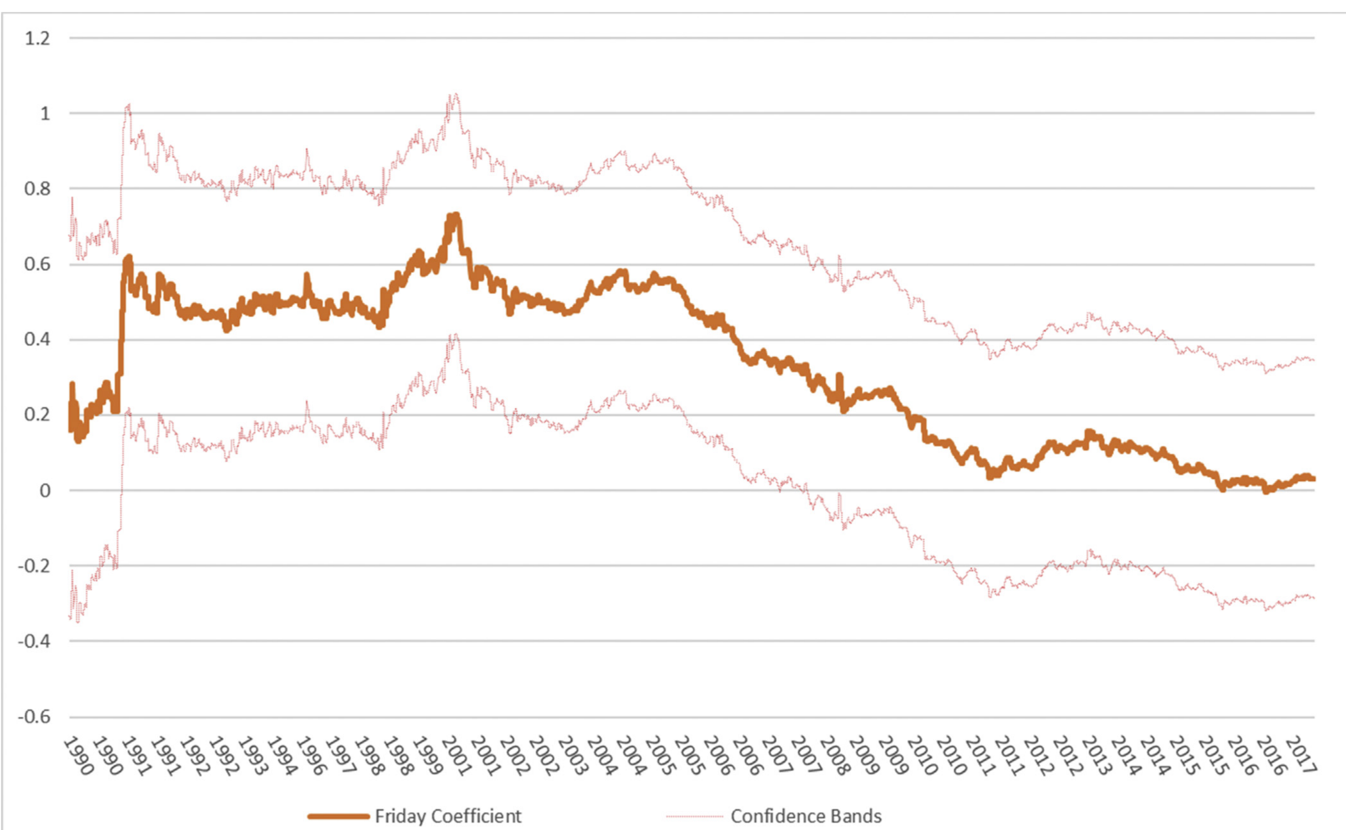

Fig. 2. Time-varying Friday Coefficients with ±2*RMSE* confidence band (left axis).

decreases. Clare et al. (1998) estimate two separate samples (pre-1990 and post-1990) to test for the influence of change in a settlement arrangement. They find that in the pre-1990 sample period (when the settlement duration was longer than the post-1990 settlement date procedure), Thursdays have a statistically significant positive return, but this effect disappears in the post-1990 sample period. However, although the interest rate is an important factor in the opportunity cost of holding money, none of the studies took interest rates into account when looking at the relationship between the settlement duration and the day of the week effect.

3.1. Caveats

We only introduce time-varying parameters for the coefficient of the Friday dummy variable. However, since the settlement date is two for Turkey, it is possible that the time-varying coefficients may also be studied for Thursdays or the other days. We also allow that the coefficients of the Thursday and Friday dummy variables be time-varying. Even if we have 6931 observations, the system either fails to converge or settles with a local maximum. When we set the convergence criteria too high, the estimated coefficients have confidence bands that are too wide. Thus, we did not pursue this avenue further.

4. Conclusion and further research

One of the important reasons for the day of the week effect is the settlement date. If this date is two days later, then due to the weekend, it will take four days for a transaction realized on Friday to be settled. Thus, investors have an extra two days to use their money in alternative markets (such as investing in money markets and gathering extra returns). This paper provides empirical evidence from Turkey that the day of the week effect indicates that the return of Friday relative to Monday decreases as the overnight interest rates decrease (as captured with a decreasing estimated coefficient for the Friday dummy variable with lower overnight interest rates). However, this effect is not statistically significant for the period that Turkey had low and stable inflation and low overnight interest rates. This further supports our selection of a country to assess the effect of overnight interest rates on relative returns of Friday to Monday because Turkey has high and volatile overnight interest rates. Otherwise, we could have a *Type-II* error (not rejecting the null when it is false). This paper successfully shows that the day of the week effect is not entirely a market anomaly. If the intent is to decrease this 'anomaly', then it may be necessary to consider decreasing the settlement date from two to one or zero. We may claim that the stance of monetary policy and regulations, which affects short term-risk free interest rates, should alter the patterns in the day of the week effect.

One might also carry out a further set of studies by analyzing the effects of the technological innovations that allow algorithm trading as more observations will be available over time. Recent technological changes that allow sophisticated electronic transactions and developments in managing risk-warrant systems might reduce the relative significance of the day-of-the-week effect.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bir.2019.07.010.

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