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14 November 2018

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Stavros Degiannakis[1], George Filis[2] and Stefanos Tsemperlidis[1,*]

[1]Department of Economics and Regional Development, Panteion University of Social and Political Sciences, 136 Syggrou Avenue, 17671, Greece.
[2]Department of Accounting, Finance and Economics, Bournemouth University, 89 Holdenhurst Road, BH8 8EB, Bournemouth, UK.

*Corresponding author's email: steftsemp@panteion.gr

Abstract

The role of information flows for the formation of assets prices remains an open question despite the extensive literature concerning this issue. This is due (i) to the high complexity of markets themselves, (ii) the proliferation of information flows and (iii) the difficulties in determining the effects of information on financial markets. In the current study we identify the announcements that trigger substantial changes in the behavior of the 10-year US Treasury bond market, without using the surprise component and, therefore, expectational data, which are expensive and dubious. To do so, we use a novel model-free approach based on extreme market movements. Our findings corroborate those of previous studies, which were based on expectational data. More importantly, though, we identify two additional announcements (Oil Inventories and the Mortgage Applications), which have not been previously reported. These findings are primarily important to financial analysts and investors.

Key words*: US Treasury market, economic announcements, event studies.*
JEL: G12, G14

1. Introduction

Economic announcements are recognized as major determinants of asset prices formation. However, the differentiation between relevant and irrelevant economic news with regards to a specific asset class, the measurement of the announcements' impact on the market dynamics and the extent to which market movements can be attributed to new information, remain issues under examination for more than three decades (important contributions include, Cuttler *et al.*, 1989; Engle and Victor, 1993; Fleming and Remolona, 1997; Bollerslev *et al.*, 2000; Evans, 2011, Monticini *et al.*, 2011; among others).

A key feature of the aforementioned studies is the use of the *surprise component*, which is defined as the difference between the expected and the actual number released during an announcement. This is theoretically explained by the hypothesis that a market should respond not only to the event itself but to the *unexpected* part of the information released during an event (Fleming and Remolona, 1997; Balduzzi *et al.*, 2001). Various regression models of returns, volatility or volume on surprises have been used for tracing importance, size or speed of impact of announcements on markets.

It is well documented that the US Treasury bond market is considered to react strongly to the US economic releases, although the specific announcements vary among studies and time period. Largely, the most important announcements are associated with real output, employment, prices and monetary policy (see, *inter alia*, Beechey and Wright, 2009; Fleming and Remolona, 1997; Baltuzzi *et al.*, 2001; Kearney, 2001). Recently, though, there is evidence of increasing importance of advance readings of GDP, consumers and investors' sentiment and nowcasting indicators in regard to price variations (Bollerslev *et al.*, 2000).

Although the use of the surprise component is dominant in the relevant literature, there are drawbacks in measuring market expectations. The surprise component is based on expectational data (surveys), which in turn, contain errors due to the lag between expectation data and released data or/and due to poor measurement (Rigobon and Sack, 2008).

Our study, which is based on a rich, tick-by-tick, dataset, shows that it is feasible to identify important announcements for the 10-year Treasury bond without using the surprise component and therefore expectational data which are expensive and dubious. Interestingly enough, our findings confirm those of previous studies, which were based on expectational data; however, we should highlight that two additional announcements (Oil Inventories and the Mortgage Applications), which have not been previously reported, are also identified, demonstrating the validity and added-value of our approach.

The remaining of the paper is structured as follows. Section 2 describes the data, Section 3 details our model-free approach, Section 4 discusses the findings and Section 5 concludes the study.

2. Data

Our dataset includes 120million tick-by-tick observations of prices and volume for the 10-year US T-bond collected from Tickdata (4 January, 2012 - 31 December, 2014: 772 trading days). Based on the tick-by-tick data we construct the following minute-by-minute measures:

1. $r_m = log(c_m/c_{m-1}) \times 100$ is the log-returns per minute, where c_m is the last tick price at minute *m*.
2. v_m : volume of trade per minute.
3. $y_m = (h_m - l_m)$ is a range based volatility of price per minute, where h_m and l_m are the highest and lowest transaction prices during any particular minute.

The transformed dataset includes approximately one million minute-by-minute observations. Table 1 and Figure 1 present the descriptive statistics and the kernel density estimate of the distribution of the variables under investigation, respectively. Evidently, the three measures present large variations and extreme values, which we test if they are associated with economics announcements.

[TABLE 1 HERE]
[FIGURE 1 HERE]

3. Methodology

The proposed model-free approach is based on the identification of extreme values of the three aforementioned measures and how these are linked with economic announcements. Our approach is predicated upon the premise that important announcements should be more frequently associated with abrupt changes in the three measures. Abnormal events such as price volatility jumps or daily excess returns are widely used in event studies to associate assets dynamics with announcements (Fleming and Remolona, 1999; Dungey *et al.,* 2009; Rosa, 2016).

Our approach is as follows:

i. Identify extreme values

For each measure we employ a criterion of extremity. For returns, we follow Fleming and Remolona (1997), with extreme returns (r_m^{ext}) being identified as $r_m > 0.2\%$ or $r_m < -0.2\%$, at any given minute[1]. Extreme volume (v_m^{ext}), i.e. trading activity, is regarded as the maximum daily v_m for every trading week and expresses the 0.0149% upper quantile point of the empirical distribution. Finally, extreme volatility (y_m^{ext}) is regarded the y_m that is greater than or equal 10 times the median of the sample's volatility ($\tilde{y}_m$)[2,3]. We then identify the days and times of extreme values

[1] The $r_m = \pm 0.2\%$ express the 0.0035% lower and upper quantile points of the empirical distribution.
[2] The $10\tilde{y}_m$ expresses the 0.0377% upper quantile point of the empirical distribution.
[3] We have also experimented with other criteria of extremity (e.g. $r_m > 0.1\%$ *or* $r_m < -0.1\%$ and $r_m > 0.3\%$ *or* $r_m < -0.3\%$, the five largest daily v_m for every month and $y_m > 5(15) \times \tilde{y}_m$) and we obtained qualitatively similar results.

occurrence. The period under investigation contains 73 occurrences of r_m^{ext}, 157 of v_m^{ext} and 397 of y_m^{ext} .

ii. Identify announcements

For each day that contains extreme values we trace which announcements (*i*) are released, using the monthly Economic Policy indicators calendar of the years 2012-2014 (US Department of Treasury). During each month there are between 66 and 76 scheduled announcements of weekly, monthly, quarterly or other periodicity (*j*) US economic indicators. The earlier recorded announcement is the Monster Employment Index (monthly) at 6:00 and the latest recorded announcement is the Auto Sales (monthly) at 17:00 (EST time). The 90% of the announcements are released between 7:00-11:00 (EST time).

iii. Identify important announcements

For each of the three measures we calculate the frequency of announcements' occurrence ($f_{i,j}$) found in (*ii*):

$$f_{i,j} = \frac{n_{i,j}}{T}, \quad (1)$$

where $n_{i,j}$ is the number of occurrence of announcement i with periodicity j (weekly, monthly, quarterly or other) in extreme events and T is the total number of extreme events.

We calculate the mean frequency of occurrence (F_j) in extreme events for the different periodicities:

$$F_j = \frac{\Sigma f_{i,j}}{k}, \quad (2)$$

where k is the number of announcements at its particular frequency. So, if $f_{i,j} > F_j$ then the announcement is considered to be important for the formation of the 10-year Treasury bond dynamics.

iv. Identify most important announcements

The above steps provide three sets of announcements. By keeping only the common announcements of these sets we extract a *Most Important Announcements List* for the US bond market.

4. Results

Tables 2-4 present the three sets of announcements in regard to the three measures and Table 5 presents the merged *Most Important Announcements list*, categorized by their content.

Similarly with other studies, we find that about 40% of the total announcements are associated with extreme trading volume, followed by the 33% which are linked with extreme volatility and 20% with extreme returns.

Our results are highly consistent in comparison to other studies that employ the surprise-depended models (e.g. Fleming and Remolona, 1997; Balduzzi *et al.*, 2001, Andersen *et al.*, 2007), showing that announcements related to advance readings of GDP, consumers' sentiment and employment, among others, trigger extreme movements in all three measures. More importantly, though, we report two additional announcements, *Oil Inventories* and *Mortgage Applications,* as being important for the US bond market. The importance of these announcements has not being previously documented. We maintain that these new findings hold true as (i) the level of inventories are expected to exercise an impact on bond prices, via their effect on oil

price speculation and, in turn, oil prices (see, Fattouh *et al.*, 2013) and (ii) Mortgage Applications is a measure of demand for real estate property, a parameter that affects the demand for fixed-income assets.

[TABLE 2 HERE]
[TABLE 3 HERE]
[TABLE 4 HERE]
[TABLE 5 HERE]

5. Conclusion

In the examination market-information interaction it is vital to evaluate which information affects an asset market. Our model-free approach is capable of identifying the most relevant announcements without using expectational data. We show that an investigation of the relevant announcements based on the extreme market movements, in terms of the first two moments, as well as, the trading activity, may be used to substitute, crosscheck or complement the standard methods based on the surprise component. Our results may be further investigated for other asset markets. These findings have important implications to investors and financial analysts, who do not necessarily have access to the expectational data.

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Figures & Tables

Figure 1. Kernel density graphs of log-returns, range volatility and volume of trade.

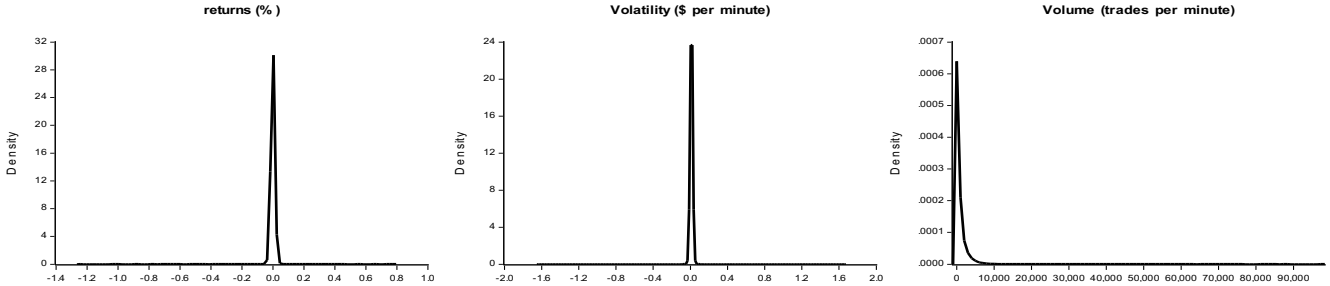

Table 1. Descriptive statistics log-returns, range volatility and volume of trade

	r_m	v_m	y_m
Mean	-0.0001	745.4920	0.0118
Median	0.0000	153.0000	0.0156
Maximum	0.7752	97382.0000	1.5312
Minimum	-1.2445	0.0000	0.0000
Std. Dev.	0.0107	1615.0401	0.0141
Average min-by-min obs per day		1360	
Average tick-by-tick obs per day		155746	

Table 2. Extreme returns: important announcements

Periodicity	Announcement	% appearance
Weekly	Oil inventories	17.8
	Mortgage Applications	24.7
Monthly	NAR PH Sales Index	9.6
	Monster employment index	16.4
	Employment Situation	34.2
	Factory orders	9.6
	Consumer Credit	11.0
	NY Fed Mfg survey	8.2
	Personal income	11.0
	Construction	8.2
	International Trade	8.2
	GDP (estimation)	11.0
Quarterly	Current account	4.1
8 times/year	FOMC	11.0
Twice/month	Consumers Sentiment*	15.1

Note: % appearance denotes $f_{i,j} \times 100$. The average frequencies $F_j \times 100$ are: $F_w = 16.7\%$, $F_m = 6.8\%$, $F_q = 2.7\%$, $F_8 = 8.2\%$, where w=weekly, m=monthly, q=quarterly and 8=8 times per year.

*Consumers Sentiment is the only announcement with this periodicity, hence the F_j is the same as its $f_{i,j}$. We include it in our results due to its high frequency of occurrence in extreme events.

Table 3. Extreme volatility: important announcements

Periodicity	Announcement	% appearance
Weekly	Oil inventories	29.47
	Mortgage Applications	40.05
Monthly	CPI	8.31
	Housing Starts	7.30
	Phil. Fed. Survey	5.79
	Monster employment index	12.09
	Employment Situation	19.65
	Factory orders	6.80
	Consumer Credit	8.31
	Import prices	6.05
	NY Fed Mfg survey	8.82
	PPI	11.34
	ADP Employment Index	7.81
	Monthly chain sales	5.54
	Retail sales	11.84
	Business Inventories	11.84
	HelpWant online	6.55
	GDP (est)	8.06
Quarterly	Current account	6.55
8 times/year	FOMC meeting	18.89
Twice/month	Consumers Sentiment*	7.05

Note: % appearance denotes $f_{i,j} \times 100$. The average frequencies $F_j \times 100$ are: $F_w = 22.7\%$, $F_m = 5.23\%$, $F_q = 2.42\%$, $F_8 = 14.11\%$, where w=weekly, m=monthly, q=quarterly and 8=8 times per year.

*Consumers Sentiment is the only announcement with this periodicity, hence the F_j is the same as its $f_{i,j}$. We include it in our results due to its high frequency of occurrence in extreme events.

Table 4. Extreme volume: important announcements

Periodicity	Announcement	% appearance
Weekly	UI claims	26.8
	Consumer Comfort index	26.8
	Oil inventories	28.7
	Mortgage Applications	23.6
Monthly	CPI	6.4
	Housing Starts	8.3
	Phil. Fed. Survey	8.3
	Advance Durable Orders	5.1
	Monster employment index	8.9
	Employment Situation	18.5
	Factory orders	5.7
	Consumer Credit	7.0
	Wholesale trade	7.0
	ISM-Chicago index	6.4
	Import prices	7.0
	NY Fed Mfg survey	5.7
	PPI	6.4
	NAHB Housing index	5.7
	Personal income	7.0
	Retail sales	7.0
	Business Inventories	7.0
	International Trade	7.0
	GDP (estimation)	5.7
Quarterly	Current account	3.8
	ECI	1.3
	Fed FoF	1.3
8 times/year	FOMC meeting	5.7
Twice/month	Consumers Sentiment*	14.0

Note: % appearance denotes $f_{i,j} \times 100$. The average frequencies $F_j \times 100$ are: $F_w = 22.3\%$, $F_m = 4.80\%$, $F_q = 1.12\%$, $F_8 = 4.51\%$, where w=weekly, m=monthly, q=quarterly and 8=8 times per year.
*Consumers Sentiment is the only announcement with this periodicity, hence the F_j is the same as its $f_{i,j}$. We include it in our results due to its high frequency of occurrence in extreme events.

Table 5. Most Important Announcements for the 10y T-Bond

Monetary-Financial	Production-Economic Activity	Expectations-Confidence
Oil inventories	Employment Situation	NY Fed Mfg survey
Mortgage Applications	Factory orders	Consumers Sentiment
Consumer Credit	GDP (estimation)	
FOMC	Monster employment index	