**Political Uncertainty Risk in Government Bond Yield**

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Abstract

This paper analyzes the link between political uncertainty risk and government bond yield in 9 developed economies between 2000-2017, constructing jump diffusion models as well as using stochastic volatility model with dummy variables as a complement. We also extend the models to China and find similar conclusions for emerging economy. Within our definition of political uncertainty, we find that, on a country level, peripheral countries in Europe present high jump risk in yields during uncertainty events, and there’s overt increase in jump risk during financial crisis. There’re also statically significant heterogenous effects in the influence of political uncertainty, where the left tail impacts yield in a larger magnitude both in mean and volatility process.

1. Introduction

Political uncertainty has become one of the main drivers of government bond yields in recent years. Europe, exempli gratia, has seen a year of intense political, social and economic tensions through the year of 2016 to present. Italian 10-year yield has spiked over 60bp in the past year and reached 2.5% in mid-March while the whole country is still awaiting an agreement on new electoral law. Dutch and French elections have gone in a market-friendly result yet the process was quite volatile. France 10-year yield rose to 1.12% in late March with the pervasive panicking market sentiments, but dropped significantly after first round showed results favoring Macron.

Large quantities of studies center around the influence of political uncertainty on asset pricing, both in fixed income and equity scope. Theoretically, Lubos Pastor and Pietro Veronesi (2013) construct a general equilibrium solving optimal government policy choice where stock prices react to certain policy. Empirically, Jürgen von Hagen, Ludger Schknecht, Guido Wolswijk (2010), Param Silvapulle, Jean Pierre Frenech, Alice Thomas and Rob Brooks (2016) and Carlo Altavilla, Domenico Giannone, Michele Modagno (2017) testify a structural increase in political uncertainty’s influence, investigate contagion effects among neighboring countries and quantify macroeconomic releases’ impacts at lower frequency.

The principal contribution of this paper is to generalize several patterns of the aforementioned influence through empirical research on 25 political events in Europe and North America through jump diffusion model, as well as extending to China’s government bond market, as a representative of emerging market. It also utilizes stochastic volatility model with dummy variables to construct parameters depicting heterogenous effects of political risk and further classifying different political risks, which solves several drawbacks in jump diffusion model. Combining results from both two models we could get a clear picture of how political uncertainty influences government bond yield and its volatility through different channels.

The remainder of the paper is organized as follows. Section 2 presents literature review on two strands, macroeconomic determinants of government bond yield and political uncertainty’s influence on asset pricing. Section 3 formally defines political uncertainty and constructs jump diffusion model and stochastic volatility model with dummy variables with further discussion and hypotheses. Section 4 shows empirical results verifying the above two models. Section 5 concludes the whole paper with model comparison and suggestions on improving model reliability.

1. Literature Review

Two strands of literature are relevant to our study. The first strand focuses on finding macroeconomic determinants of government bond yield in general, which could be divided into validating effects of these indicators with different countries, testing whether there’s a structural change in such influence after financial crisis and evaluating contagion effects among different countries. The second strand typically deals with influence of political uncertainty on asset pricing. On both theoretical and empirical level we could find profound research on different channels of influence from political risk to different assets. With internationalization of emerging markets, both strands incorporate increasing numbers of literature discussing China’s foreign exchange and government bond market.

* 1. **Determinants of government bond yield**

[Marta Gómez-Puig, Simón Sosvilla-Rivero and María del Carmen Ramos-Herrera (2014)](#Gomez) use market data of a sample of both central and peripheral European countries to investigate the determinants of EMU sovereign bond yield spreads and assess whether there were significant changes after the outbreak of the euro area debt crisis using panel data techniques. This has been a very exhaustive compilations of variables divided into local/ regional/ global market sentiment, local/ regional macrofundamentals and financial linkages. The marginal effects of sovereign spread drivers (specifically, the variables that measure global market sentiment) increased during the crisis compared to the pre-crisis period, especially in peripheral countries.

[Jürgen von Hagen, Ludger Schknecht, Guido Wolswijk (2010)](#Von) use government bond yield spreads data of European central governments until May 2009, distinguishing two crisis phase – market turmoil between August 2007 and August 2008, and acute crisis after collapse of Lehman Brothers. Debt-to-GDP ratio and ratio of central government budget surplus to GDP, as measurement of probability of default and size of debt issue, as measurement of liquidity premium are selected as key determinants. They also add a “turmoil” and a “crisis” dummy to test the change of fiscal variables during two crisis phase. Results indicate that markets penalize fiscal imbalances much more strongly than before only after Lehman default in September 2008, though market valuation of sovereign risk remains largely invariant after the crisis.

[Param Silvapulle, Jean Pierre Frenech, Alice Thomas and Rob Brooks (2016)](#Silvapulle) investigate the contagion effects in bond yield spreads of five peripheral EU countries including Portugal, Italy, Ireland, Greece and Spain, by employing a robust semiparametric corpula method. Results show an overwhelming evidence of financial contagion effects among peripheral countries. The two large countries Spain and Italy appear to be operating independent of each other, whereas Ireland, Greece and Portugal are found to be the exporters of contagion.

[Carlo Altavilla, Domenico Giannone, Michele Modagno (2017)](#Alta) use market data to identify impact of macroeconomic releases and to quantify the effects at lower frequencies using two-step regression strategy. While macroeconomic surprises explain only one tenth of the daily variation in bond yields, their explanatory power improves substantially at lower frequencies, accounting for one third of quarterly variations.

[H. Löchel N. Packham and F. Walisch (2015)](#Loechel) use VAR model where yield curves are represented by Nelson-Siegel latent factors to discuss market determinants and spillover effects of onshore and offshore Chinese government yield curves on a historical context of Renminbi internationalization. Exchange rate expectations turn out to be the main driving variable for both the onshore and the offshore market, with a significantly stronger impact on the latter. Weak spillover effects from the onshore government bond yield curve to the offshore yield curve are observed, but no spillover effects the other way round are present.

* 1. **Influence of political uncertainty on asset pricing**

[Lubos Pastor and Pietro Veronesi (2013)](#Pastor) approach political uncertainty’s influence theoretically, developing a general equilibrium model of government policy choice in which stock prices respond to political news. In this model, firm profitability follows a stochastic process whose mean is affected by the prevailing government policy. Government and investors learn about the impact in a Bayesian fashion by observing realized profitability. The equilibrium is reached by government finding a balance between maximizing investors’ welfare and minimizing political costs. There are several political implications a priori – 1) government effectively provides put protection to the market when economy is weak, and a larger risk premium is required in a weaker economy; 2) Stocks are more volatile and correlated with political uncertainty influence; 3) Heterogeneity in potential new government policies increase risk premia, volatilities and correlations of stock returns. The model also allows further extensions in different signal precisions and policy-unrelated business cycles.

[Tao Huang, Fei Wu, Jing Yu and Bohui Zhang (2013)](#Huang) empirically investigate the impact of international political risk on government bond yields in 34 debtor countries using a comprehensive database of 109 international political crises from 1988 through 2007. They attempt to overcome endogeneity of political risk with economic fundamentals by using international political crises that occur outside a country as proxy. Results show heterogeneity across government bonds when bond investors move their capital away from high-risk investments and toward less risky investments, such as U.S. Treasury bonds when uncertainty is high. Spillover effects among neighboring countries is also statistically significant.

[Johan Duyvesteyn, Martin Martens and Patrick Verwijmeren (2015)](#Duyv) use European Monetary Union (EMU) bond index and the Emerging Market Bond Index (EMBI+) of J.P.Morgan for bond data and political risk ratings by the Political Risk Services (PRS) group. At the end of each month they select four countries with highest improvements and deteriorations in political risk respectively to calculate portfolio returns in subsequent month. Result implies a positive expected premium required for political risk. This change in political risk premium cannot be explained by the risk factors default premium, term premium, and liquidity, or by momentum, changes in credit ratings, economic risk or financial risk. The risk-adjusted performance is 7.6% per annum for emerging bond markets and 0.8% per annum for euro government bonds.

[Qingfu Liu and Deye Zhou (2012)](#Qingfu) focuses on China’s equity market, employs Bayesian MCMC algorithm to build a sample based on stochastic volatility model to analyze influence of economic policy announcements on Chinese real estate equity index. It also incorporates heterogeneous policy effects by using two dummies for positive and negative policies respectively. Results indicate that heterogeneity exists in money rate policy. Rate hike and rate cut impose a different magnitude of influence on real estate equity.

1. Theoretical Model
   1. **Definition of political uncertainty**

The first step of our study is to present a precise definition of political uncertainty as a standard for selecting political uncertainty event samples. With regards to previous literature, we define political uncertainty as a political event which could lead to increase in investors’ preference in the relevant country’s financial asset, namely government bond in this paper. Examples of such events include presidential and parliament elections, referendum, global meetings and etc. For simplicity yet without loss of generality, we select presidential election as the primary source of political uncertainty in advanced economies in this literature. As for China, when applying the stochastic volatility models with heterogeneous policy, we use a different approach, categorizing political uncertainty events into international political risks, non-macroeconomic related policy and national political events, and macroeconomic policy.

Such definition of political uncertainty effectively avoids the endogeneity implied in the influence of both political risks and change of macro fundamentals. Global investors view political uncertainty events as an independent factor influencing future asset price. The expected price change is an equilibrium reached by investors’ long or short investments when exposed to information about political uncertainty. Such price change is an exclusive consequence of information digestion.

* 1. **Modelling political uncertainty with jump risk**

In this model, we assume that the logarithm of government bond yield follows a stochastic process with mean reversion and jump risk, as well as seasonal macroeconomic impact. Political uncertainty is incorporated into the jump risk parameter.

A priori, we consider that the logarithm of government bond yield follows the process

where represents the seasonal fluctuations influenced by macroeconomic fundamentals and business cycles, which is illustrated in a group of sinusoidal wave

where are constants.

And follows the stochastic – jump diffusion process

where and are mean reversion factors implying that government bond yields generally fluctuate around the natural clearing yield. is a constant depicting stochastic element determined by non-political uncertainty related factors. follows a Poisson process with intensity of λ, which demonstrates the instantaneous jump caused by the announcement of political uncertainty results. The magnitude of such jump also follows a normal distribution with mean of and standard deviation of

The rationale behind using jump diffusion model in asset pricing has been well elaborated in previous literature. [Merton (1978)](#Merton) is the first to derive a more-general case of asset pricing when the underlying asset follows both continuous and jump processes. As mentioned in earlier literature, the critical assumptions in the Black-Scholes derivation is that trading takes place continuously in time and that the price dynamics of the stock have a continuous sample path with probability one. However, the validity of B-S formula depends on whether underlying asset price satisfies a kind of “local” Markov property. In jump diffusion model, it allows for a positive probability of a pricy change of extraordinary magnitude within a small time interval.

Jump risk is a reasonable proxy of impacts of political uncertainty in that the signals of uncertainty are released in a discontinuous manner by news, poll results and etc., such that investors also digest the information and display an investing behavior discontinuously, causing a jump in yields.

In order to proceed forward with the analysis using bond yield data, we have to discretize the aforementioned stochastic process

where

and follows a probability density function conditional on

where

We could get the parameters by solving the minimum of the equation

**Implication 1** stands for the probability of a jump occurring in averaged across the observed dates. When , it’s highly likely that there will be a jump in yield.

In a standard Poisson process, is the intensity of occurrence of an incident, whereby here we model it as the probability of occurring a jump in yield during an infinitesimal period . When is sufficiently small, we could assume that the probability of occurring two jumps in is almost zero, id est working as a probability measure in the model. We choose in empirical research.

**Implication 2** depicts the magnitude of jumps, where we’re more concerned about the magnitude of , which shows the direction and expected size of jumps.

A further look at Model 1 renders us identify several setbacks in using jump diffusion model in that the parameters we’re concerned about could not fully depict influence of political uncertainty in several aspects. 1) jump probability in the model, is an averaged probability across a specified time period (here we choose 9 months). Its value depends on the length of period we choose. In empirical research, we’ve tested the model with 6, 9, and 12 months and concluded that 9 months generates the most convincing result. Yet further concern exists that conclusions might only be valid with 9-month time period and different time periods might lead to different empirical conclusions. 2) The model considers influence of political uncertainty as a whole without distinguishing heterogenous effects of political events or further categorizing listed political events into different classes. Therefore, we’ve utilized another model as a comparison to complement our conclusions.

* 1. **Modelling political uncertainty with stochastic volatility with dummy variables**

Stochastic volatility method has been well documented in modelling asset pricing. [Tsiakas (2008)](#Tsiakas) used a stochastic volatility, which conditions on lagged overnight information, allowing for an asymmetric leverage effect on the impact of overnight news to study relationship between overnight information and stochastic volatility. Bayesian methods are implemented to find the parameters.

In a plain vanilla stochastic volatility model, government bond yield is assumed to follow a univariate discrete-time AR(1) process and are driven by Gaussian innovations:

The persistence of the conditional volatility is captured by the dynamics of the Gaussian stochastic log-variance process

The plain vanilla SV model works as model comparison for the following model adding political uncertainty factors. We first create three dummy variables representing three different types of political uncertainty events – international political risks, non-macroeconomic policy and macroeconomic policy. The adjusted SV model tests whether these types of events incur a statistically significant influence on yield process. In adjusted SV model, government bond yield is assumed to follow a standard SV model with additional variables

For model calibration, the MCMC (Monte Carlo Markov Chain) algorithm must provide estimates of three sets of parameters - in modeling influence of political uncertainty on mean return, in modeling stochastic volatility and in modeling influence on yield volatility. The Bayesian MCMC algorithm is utilized to estimate high-dimensional parameter vector in this model. An efficient sampling of yield volatility is achieved by Gibbs step sampling. is drawn conditionally on the sampled log-variances using a precision-weighted average of prior information and the conditional likelihood.

To account for asymmetric effects of political uncertainty, we need one more step adding additional dummy variables distinguishing positive and negative policy influence. Here, stand for positive policy (policy that yields a positive influence on government bond price), whereby stand for negative ones. The adjusted SV model with asymmetric policy effect is as follows.

where parameters estimation method is the same as above.

With additional dummy variables, we could formally test the following three hypotheses regarding heterogenous effect and different effects from different categories of events.

**Hypothesis 1** Political uncertainty has no predictive influence on both yields and volatility of yields:

**Hypothesis 2** There is no asymmetric leverage effect on the impact of political uncertainty on both yields and volatility of yields:

**Hypothesis 3** There is no difference in the influence of different types of political uncertainty events on both yields and volatility of yields:

1. Empirical Research
   1. **Descriptive statistics and event study**

For the first model, we’ve listed 50 presidential and parliament elections since 2000 in 9 countries – Australia, France, Germany, Greece, Italy, Portugal, Spain, United Kingdom and United States. 25 out of 50 of the aforementioned events could be classified as political uncertainty events. By visualizing the path of government bond yield in 1-month period before and after the events, we’ve selected the events that display an overt extraordinary magnitude of “jump” as defined in Merton’s model. Further categorizing these events, we could describe the characteristics with a 2 by 2 matrix. In table 1, the upper-right box shows an instantaneous jump on the election date whose influence lasts for less than 2 days. The bottom-left box shows an instant jump as well but with longer posterior effects and potentially a structural change in yield level. The bottom right shows a steady directional change with greater volatility in a period longer than 10 days before election date with a jump shortly after the election. There’s no political uncertainty risk in the upper-left box. Such difference could resort to investors’ reaction towards information about election and the election result. “1” stands for greater uncertainty displayed in information about election and the occurrence of “black swan” event in election results. The matrix shows a visualization of yield path and number of samples of different circumstances.

[[TABLE 1]](#T1)

We’ve listed the descriptive statistics of yields in these 25 samples including highest, lowest, mean yields, starting and end date and a description of event type in table 2 Several general conclusions could be drawn out through a look at the data. Investors’ ability to digest political uncertainty information has developed, which is indicated by a shorter length in the influence of political uncertainty and earlier price-in of uncertainty in asset price. Countries with greater liquidity in government bond market shows a shorter length of influence which is a direct result of larger population of investors that reduces the probability of jumps occurring. To carry on our research in a more rigorous manner, we’ve fitted these samples in the following two models.

[[TABLE 2]](#T2)

* 1. **Empirical results of jump diffusion model**

We’ve validated the model on 25 political uncertainty events identified in the previous section. The major parameters we’re concerned about is are . We’ve tested the model on 6-month, 9-month and 12-month scope respectively, using MLE method to get the solution of equation (2) for each event. The rationale behind choosing 6, 9 and 12 months is that 2 months is the minimum period for identifying a valid political uncertainty event, and any time period longer than 12 months will result in an overlap of two or more political uncertainty events.

Table 3, 4 and 5 present a list of all parameters for each time period. For 6, 9 and 12 months, we could get the optimal solution for 18, 18 and 15 out of 25 events respectively. 9 months generates the best results in our model with the following reasons: 1) Standard deviation of probability (= λ/n) is 0.3265, 0.2333 and 0.2417 for 12, 9 and 6 months, and for , the standard deviation is 0.0523, 0.0326 and 0.0322. With lower variation the model generates more stable results in this time period. 2) Since numerous countries have put forward quantitative easing, leading to significantly low and even negative interest rates, taking logarithm of interest rates is either impossible or generates large numbers, rendering the model unreliable. Out of 25 events, only 18, 18 and 15 events could present realistic results as in table 6.

[[TABLE 3](#T3), [4](#T4), [5](#T5), [6](#T6)]

Low consistency is also observed across different time periods when using this model. As in table 6, only 11 events could generate reliable parameter results, with only 7 of them showing consistency in the most important parameter probability=. This in accordance with our discussion above that this model is strictly constrained to a certain time period and certain country. To generate more general results, we need the stochastic volatility model in the next section.

Further investigation on the descriptive statistics of 6-month results could validate the implications and drawbacks we proposed in section 3. For events with high jump risks, i.e. a larger probability of jump, is positive, some with larger , increasing volatility of interest rates. is skewed upward, with a mean of -0.0002 and a median of 0.0031, which validates our hypothesis that there’re heterogenous effects in positive and negative political risks.

On country level, results generally agree with our consensus of major political uncertainty events in the past decades. Peripheral European countries display higher jump risk, with Italy, Spain, Greece and Portugal topping the list with an average of 11.17%, 30.71%, 21.61% and 21.93% respectively. It’s also worth mentioning that U.S. also produces very high jump risk in 2016 and 2004 presidential election, ruling out the explanation that higher liquidity will smooth the price change. Noted that different election systems might lead to different investors’ behavior on political risk, we’ve listed election systems in table 7. Countries with at least 2 rounds of each presidential election, such as France, enjoy lower jump risk but larger drift terms during political uncertainty events.

[[TABLE 7]](#T7)

When plotting jump probability against time as in figure 1, there’s no determinant trend, either increase or decrease in jump probability. Yet results in all time periods (6, 9 and 12 months) have pointed out a spike in jump probability between 2008-2009 during financial crisis.

[[FIGURE 1]](#F1)

Another potential usage of this model is to predict future yield path with model parameters. We’ve also plotted one-year prediction of all 18 events in figure 2. The model could predict the general trend of interest rates successfully across all events, but for political events without a statistically significant λ parameter, the model fails to predict the level of interest rates. Since parameter results are obtained through historical data, it also could not take into account future political uncertainty jump risk effectively.

[[FIGURE 2]](#F2)

* 1. **Empirical results of stochastic volatility model with dummy variables**

1. Conclusion

References

Altavilla, Carlo, Domenico Giannone, and Michele Modugno. "Low frequency effects of macroeconomic news on government bond yields." Journal of Monetary Economics (2017).

Duyvesteyn, Johan, Martin Martens, and Patrick Verwijmeren. "Political risk and expected government bond returns." Journal of Empirical Finance 38 (2016): 498-512.

Gómez-Puig, Marta, Simón Sosvilla-Rivero, and María del Carmen Ramos-Herrera. "An update on EMU sovereign yield spread drivers in times of crisis: A panel data analysis." The North American Journal of Economics and Finance 30 (2014): 133-153.

Huang, Tao, et al. "International political risk and government bond pricing." Journal of Banking & Finance 55 (2015): 393-405.

Loechel, Horst, Natalie Packham, and Fabian Walisch. "Determinants of the onshore and offshore Chinese Government yield curves." Pacific-Basin Finance Journal 36 (2016): 77-93.

Merton, Robert C. "Option pricing when underlying stock returns are discontinuous." Journal of financial economics 3.1-2 (1976): 125-144.

Pástor, Ľuboš, and Pietro Veronesi. "Political uncertainty and risk premia." Journal of Financial Economics 110.3 (2013): 520-545.

Qingfu Liu, and Deye Zhou. "经济政策对房地产股票指数的影响效应研究——基于公告发布与利率调整的短期效应分析." New Finance 3 (2012): 36-39.

Silvapulle, Param, et al. "Determinants of sovereign bond yield spreads and contagion in the peripheral EU countries." Economic Modelling 58 (2016): 83-92.

Tsiakas, Ilias. "Overnight information and stochastic volatility: A study of European and US stock exchanges." Journal of Banking & Finance 32.2 (2008): 251-268.

Von Hagen, Jürgen, Ludger Schuknecht, and Guido Wolswijk. "Government bond risk premiums in the EU revisited: The impact of the financial crisis." European Journal of Political Economy 27.1 (2011): 36-43.

Table 1 Categorization of Different Political Events

|  |  |  |  |
| --- | --- | --- | --- |
|  | | UNCERTAINTY | |
| 0 | 1 |
| BLACK SWAN | 0 | - | 8 |
| 1 | 5 | 12 |

Table 2 Political Uncertainty Event List

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| date | country | type | note | event id | start date | highest point | end date | days | high | low | mean | high-low | pricein type |
| 2012/4/22 | France | Pres | first round | 1 | 2012/4/12 | 2012/4/23 | 2012/5/4 | 22 | 3.0150 | 2.9957 | 2.9957 | 0.64 | 3 |
| 2012/5/6 | France | Pres | second round |  |  |  |  |  |  |  |  |  |  |
| 2007/4/21 | France | Pres | first round | 2 | 2007/4/18 | 2007/4/20 | 2007/4/24 | 6 | 4.2540 | 4.1990 | 4.2260 | 1.31 | 2 |
| 2007/5/5 | France | Pres | second round |  |  |  |  |  |  |  |  |  |  |
| 2007/6/10 | France | Parl |  | 3 | 2007/6/8 | 2007/6/18 | 2007/6/27 | 19 | 4.7090 | 4.5920 | 4.6569 | 2.55 | 4 |
| 2007/6/17 | France | Parl |  |  |  |  |  |  |  |  |  |  |  |
| 2002/6/9 | France | Parl |  |  |  |  |  |  |  |  |  |  |  |
| 2002/6/16 | France | Parl |  |  |  |  |  |  |  |  |  |  |  |
| 2012/6/10 | France | Parl |  | 4 | 2012/6/1 | 2012/6/29 | 2012/7/16 | 45 | 2.7920 | 2.1620 | 2.5123 | 29.14 | 4 |
| 2012/6/17 | France | Parl |  |  |  |  |  |  |  |  |  |  |  |
| 2015/1/29 | Italy | Pres |  | 5 | 2015/1/23 | 2015/2/11 | 2015/2/24 | 32 | 1.6605 | 1.4589 | 1.5827 | 13.82 | 4 |
| 2006/5/2 | Italy | Pres |  | 6 | 2006/4/21 | 2006/5/12 | 2006/5/22 | 31 | 4.3674 | 4.2390 | 4.3085 | 3.03 | 4 |
| 2013/4/18 | Italy | Pres |  |  |  |  |  |  |  |  |  |  |  |
| 2013/2/24 | Italy | Parl |  | 7 | 2013/2/25 | 2013/3/4 | 2013/3/22 | 25 | 4.8429 | 4.3220 | 4.3279 | 12.05 | 3 |
| 2008/4/13 | Italy | Parl |  | 8 | 2008/4/14 | 2008/4/30 | 2008/5/9 | 25 | 4.6953 | 4.4163 | 4.5954 | 6.32 | 3 |
| 2006/4/10 | Italy | Parl |  |  |  |  |  |  |  |  |  |  |  |
| 2015/12/20 | Spain | Parl |  |  |  |  |  |  |  |  |  |  |  |
| 2016/6/26 | Spain | Parl |  |  |  |  |  |  |  |  |  |  |  |
| 2011/11/20 | Spain | Parl |  | 9 | 2011/11/7 | 2011/11/25 | 2011/12/2 | 25 | 6.8390 | 5.5820 | 6.2943 | 22.52 | 4 |
| 2008/3/9 | Spain | Parl |  |  |  |  |  |  |  |  |  |  |  |
| 2004/3/14 | Spain | Parl |  |  |  |  |  |  |  |  |  |  |  |
| 2016/7/2 | Australia | Pres |  |  |  |  |  |  |  |  |  |  |  |
| 2013/9/7 | Australia | Pres |  |  |  |  |  |  |  |  |  |  |  |
| 2010/8/21 | Australia | Pres |  |  |  |  |  |  |  |  |  |  |  |
| 2007/11/24 | Australia | Pres |  |  |  |  |  |  |  |  |  |  |  |
| 2004/10/9 | Australia | Pres |  | 10 | 2004/9/28 | 2004/10/8 | 2004/10/14 | 16 | 5.5500 | 5.3600 | 5.4577 | 3.54 | 2 |
| 2014/12/17 | Greece | Pres | first round | 11 | 2014/12/8 | 2014/12/12 | 2014/12/20 | 12 | 9.2360 | 7.2740 | 8.6883 | 26.97 | 2 |
| 2014/12/29 | Greece | Pres | second round | 12 | 2014/12/27 | 2015/1/7 | 2015/1/14 | 18 | 10.6560 | 6.4750 | 9.4805 | 64.57 | 3 |
| 2005/2/8 | Greece | Pres |  |  |  |  |  |  |  |  |  |  |  |
| 2010/2/3 | Greece | Pres |  | 13 | 2010/1/25 | 2010/1/28 | 2010/2/10 | 16 | 7.1550 | 6.0210 | 6.5932 | 18.83 | 2 |
| 2016/1/24 | Portugal | Pres |  | 14 | 2016/1/30 | 2016/2/14 | 2016/2/18 | 19 | 3.8910 | 2.6580 | 3.2228 | 46.39 | 3 |
| 2011/1/23 | Portugal | Pres |  | 15 | 2011/1/21 | 2011/1/27 | 2011/2/2 | 12 | 7.0870 | 6.7890 | 6.9370 | 4.39 | 4 |
| 2006/1/22 | Portugal | Pres |  | 16 | 2006/1/16 | 2006/2/1 | 2006/2/17 | 32 | 3.6510 | 3.3850 | 3.5579 | 7.86 | 4 |
| 2015/10/4 | Portugal | Parl |  |  |  |  |  |  |  |  |  |  |  |
| 2011/6/5 | Portugal | Parl |  |  |  |  |  |  |  |  |  |  |  |
| 2009/9/27 | Portugal | Parl |  |  |  |  |  |  |  |  |  |  |  |
| 2005/2/20 | Portugal | Parl |  |  |  |  |  |  |  |  |  |  |  |
| 2002/3/17 | Portugal | Parl |  |  |  |  |  |  |  |  |  |  |  |
| 2016/11/8 | US | Pres |  | 17 | 2016/11/9 | 2016/11/14 | 2016/11/15 | 6 | 2.2540 | 2.0680 | 2.1724 | 8.99 | 4 |
| 2012/11/6 | US | Pres |  | 18 | 2012/10/31 | 2012/11/6 | 2012/11/8 | 8 | 1.7510 | 1.6180 | 1.6900 | 8.22 | 4 |
| 2008/11/4 | US | Pres |  | 19 | 2008/10/27 | 2008/10/31 | 2008/11/5 | 9 | 3.9740 | 3.6740 | 3.8340 | 8.17 | 2 |
| 2004/11/2 | US | Pres |  | 20 | 2004/10/29 | 2004/11/10 | 2004/11/17 | 19 | 4.2510 | 4.0220 | 4.1450 | 5.69 | 4 |
| 2015/5/7 | UK | Pres |  | 21 | 2015/4/20 | 2015/5/5 | 2015/5/8 | 18 | 2.0844 | 1.6911 | 1.8868 | 23.26 | 2 |
| 2010/5/6 | UK | Pres |  | 22 | 2010/5/5 | 2010/5/10 | 2010/5/13 | 8 | 3.9600 | 3.8400 | 3.8900 | 3.13 | 4 |
| 2005/5/5 | UK | Pres |  |  |  |  |  |  |  |  |  |  |  |
| 2001/6/7 | UK | Pres |  |  |  |  |  |  |  |  |  |  |  |
| 2013/9/22 | Germany | Federal |  | 23 | 2013/9/19 | 2013/9/23 | 2013/9/24 | 5 | 2.0100 | 1.9300 | 1.9675 | 4.15 | 4 |
| 2009/9/27 | Germany | Federal |  | 24 | 2009/9/14 | 2009/9/22 | 2009/9/28 | 14 | 3.6900 | 3.5200 | 3.5927 | 4.83 | 2 |
| 2005/9/18 | Germany | Federal |  | 25 | 2005/9/12 | 2005/9/13 | 2005/9/22 | 10 | 3.2200 | 3.0700 | 3.1533 | 4.89 | 2 |
| 2002/9/22 | Germany | Federal |  |  |  |  |  |  |  |  |  |  |  |

Table 3 Jump Diffusion Model Parameters Results (12 months)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Event id | Event Date | Start Date | End Date | Country | λ | Probability | μj | σj | σ | α | κ |
| 1 | 2012/4/22 | 2011/10/24 | 2012/10/22 | France | 8.5899 | 0.0235 | -0.0703 | 0.0010 | 0.3825 | 0.5932 | 313.2426 |
| 3 | 2007/6/10 | 2006/12/11 | 2007/12/10 | France | 291.9337 | 0.7998 | -0.0037 | 0.0036 | 0.1256 | 1.1600 | 340.0148 |
| 4 | 2012/6/10 | 2011/12/12 | 2012/12/10 | France | 40.3494 | 0.1105 | -0.0037 | 0.0405 | 0.2860 | 0.0793 | 328.6527 |
| 5 | 2015/1/29 | 2014/7/31 | 2015/7/31 | Italy | 150.8972 | 0.4134 | 0.0041 | 0.0364 | 0.3707 | -0.6661 | 327.4604 |
| 6 | 2006/5/2 | 2005/11/1 | 2006/11/1 | Italy | 126.3530 | 0.3462 | -0.0076 | 0.0011 | 0.1143 | 0.9943 | 325.2445 |
| 7 | 2013/2/24 | 2012/8/27 | 2013/8/26 | Italy | 39.1557 | 0.1073 | 0.0056 | 0.0317 | 0.2432 | -0.2717 | 337.2185 |
| 9 | 2011/11/20 | 2011/5/23 | 2012/5/21 | Spain | 87.1674 | 0.2388 | -0.0013 | 0.0410 | 0.2722 | 0.0196 | 333.3861 |
| 10 | 2004/10/9 | 2004/4/13 | 2005/4/11 | Australia | 0.0004 | 0.0000 | -0.0222 | 0.0427 | 0.1484 | -0.0163 | 306.1494 |
| 11 | 2014/12/17 | 2014/6/18 | 2015/6/18 | Greece | 94.4105 | 0.2587 | 0.0081 | 0.0538 | 0.3241 | -0.5613 | 336.3109 |
| 12 | 2014/12/29 | 2014/6/30 | 2015/6/30 | Greece | 81.1423 | 0.2223 | 0.0126 | 0.0665 | 0.3497 | -0.6447 | 331.6720 |
| 13 | 2010/2/3 | 2009/8/5 | 2010/8/5 | Greece | 43.2194 | 0.1184 | 0.0121 | 0.0988 | 0.3251 | -0.5178 | 323.1748 |
| 14 | 2016/1/24 | 2015/7/27 | 2016/7/25 | Portugal | 11.4386 | 0.0313 | 0.0794 | 0.0060 | 0.0794 | -0.9775 | 331.3648 |
| 15 | 2011/1/23 | 2010/7/26 | 2011/7/25 | Portugal | 108.7279 | 0.2979 | -0.0017 | 0.0334 | 0.2283 | -0.0976 | 321.2029 |
| 16 | 2006/1/22 | 2005/7/25 | 2006/7/24 | Portugal | 341.9703 | 0.9369 | -0.0117 | 0.0011 | 0.1949 | 4.0303 | 260.2457 |
| 17 | 2016/11/8 | 2016/5/10 | 2017/5/1 | US | 32.3516 | 0.0886 | -0.0006 | 0.0383 | 0.3653 | 0.0961 | 329.1863 |
| 19 | 2008/11/4 | 2008/5/6 | 2009/5/6 | US | 11.6155 | 0.0318 | -0.0394 | 0.0561 | 0.4847 | 0.9392 | 341.2174 |
| 24 | 2009/9/27 | 2009/3/30 | 2010/3/29 | Germany | 364.9096 | 0.9998 | 0.1913 | 0.0010 | 0.2890 | -69.7854 | 168.2701 |
| 25 | 2005/9/18 | 2005/3/21 | 2006/3/20 | Germany | 308.8698 | 0.8462 | 0.0161 | 0.0108 | 0.0884 | -4.9957 | 323.1954 |
| Mean |  |  |  |  | 119.0612 | 0.3262 | 0.0093 | 0.0313 | 0.2595 | -3.9235 | 315.4005 |
| Median |  |  |  |  | 84.1549 | 0.2306 | -0.0009 | 0.0349 | 0.2791 | -0.0570 | 328.0566 |
| s.d. |  |  |  |  | 119.1721 | 0.3265 | 0.0523 | 0.0267 | 0.1121 | 16.0558 | 39.8408 |

**Table 4 Jump Diffusion Model Parameters Results (9 months)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Event id | Event Date | Start Date | End Date | Country | λ | Probability | μj | σj | σ | α | κ | |
| 1 | 2012/4/22 | 2011/12/9 | 2012/9/4 | France | 30.2419 | 0.1120 | -0.0109 | 0.0437 | 0.2560 | 0.3240 | 233.4854 | |
| 3 | 2007/6/10 | 2007/1/26 | 2007/10/23 | France | 6.3523 | 0.0235 | -0.0188 | 0.0010 | 0.1320 | 0.2254 | 163.1490 | |
| 4 | 2012/6/10 | 2012/1/27 | 2012/10/23 | France | 42.9583 | 0.1591 | -0.0043 | 0.0401 | 0.2355 | 0.2205 | 242.9102 | |
| 5 | 2015/1/29 | 2014/9/16 | 2015/6/15 | Italy | 76.2291 | 0.2823 | 0.0045 | 0.0440 | 0.3431 | -0.4279 | 212.5567 | |
| 7 | 2013/2/24 | 2012/10/12 | 2013/7/9 | Italy | 8.8789 | 0.0329 | 0.0357 | 0.0328 | 0.0357 | -0.5136 | 245.5194 | |
| 8 | 2008/4/13 | 2007/11/30 | 2008/8/26 | Italy | 5.3496 | 0.0198 | 0.0187 | 0.0010 | 0.1378 | -0.0463 | 233.9704 | |
| 9 | 2011/11/20 | 2011/7/8 | 2012/4/3 | Spain | 82.9083 | 0.3071 | -0.0033 | 0.0416 | 0.2207 | 0.3948 | 240.8354 | |
| 11 | 2014/12/17 | 2014/8/4 | 2015/5/4 | Greece | 75.0190 | 0.2778 | 0.0097 | 0.0570 | 0.2858 | -0.8063 | 239.0835 | |
| 12 | 2014/12/29 | 2014/8/16 | 2015/5/13 | Greece | 71.3411 | 0.2642 | 0.0111 | 0.0579 | 0.2957 | -0.9017 | 235.1414 | |
| 13 | 2010/2/3 | 2009/9/21 | 2010/6/18 | Greece | 28.6791 | 0.1062 | 0.0102 | 0.1171 | 0.3540 | -0.0855 | 236.3225 | |
| 14 | 2016/1/24 | 2015/9/11 | 2016/6/7 | Portugal | 10.0107 | 0.0371 | 0.0798 | 0.0081 | 0.3161 | -0.8426 | 246.4305 | |
| 15 | 2011/1/23 | 2010/9/10 | 2011/6/7 | Portugal | 130.3329 | 0.4827 | -0.0016 | 0.0249 | 0.1643 | 0.3271 | 237.7779 | |
| 16 | 2006/1/22 | 2005/9/9 | 2006/6/6 | Portugal | 37.3030 | 0.1382 | 0.0135 | 0.0010 | 0.1373 | -0.5001 | 222.6541 | |
| 17 | 2016/11/8 | 2016/6/27 | 2017/3/23 | US | 176.2953 | 0.6529 | -0.0224 | 0.0014 | 0.3122 | 3.9264 | 208.4170 | |
| 19 | 2008/11/4 | 2008/6/23 | 2009/3/19 | US | 13.9609 | 0.0517 | -0.0577 | 0.0565 | 0.4567 | 0.6954 | 246.9260 | |
| 20 | 2004/11/2 | 2004/6/21 | 2005/3/17 | US | 201.5670 | 0.7465 | 0.0016 | 0.0109 | 0.0893 | -0.3687 | 220.5355 | |
| 21 | 2015/5/7 | 2014/12/23 | 2015/9/18 | UK | 2.0194 | 0.0075 | -0.0787 | 0.0010 | 0.4398 | 0.0103 | 237.7210 | |
| 24 | 2009/9/27 | 2009/5/15 | 2010/2/9 | Germany | 174.4810 | 0.6462 | 0.0096 | 0.0094 | 0.1213 | -1.6181 | 221.3197 | |
| Mean |  |  |  |  | 65.2182 | 0.2415 | -0.0002 | 0.0305 | 0.2407 | 0.0007 | 229.1531 |
| Median |  |  |  |  | 40.1307 | 0.1486 | 0.0031 | 0.0289 | 0.2458 | -0.0659 | 235.7320 | |
| s.d. |  |  |  |  | 62.9820 | 0.2333 | 0.0326 | 0.0297 | 0.1165 | 1.1056 | 19.4700 | |

Table 5 Jump Diffusion Model Parameters Results (6 months)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Event id | Event Date | Start Date | End Date | Country | λ | Probability | μj | σj | σ | α | κ |
| 1 | 2012/4/22 | 2012/1/23 | 2012/7/23 | France | 4.5740 | 0.0251 | -0.0872 | 0.0010 | 0.2361 | 0.4827 | 149.9255 |
| 4 | 2012/6/10 | 2012/3/12 | 2012/9/10 | France | 4.7043 | 0.0258 | -0.0057 | 0.0010 | 0.2621 | 0.3481 | 148.1044 |
| 9 | 2011/11/20 | 2011/8/22 | 2012/2/20 | Spain | 63.0552 | 0.3465 | -0.0033 | 0.0377 | 0.1798 | 0.1805 | 161.6138 |
| 11 | 2014/12/17 | 2014/9/17 | 2015/3/18 | Greece | 55.9222 | 0.3073 | 0.0123 | 0.0590 | 0.2532 | 0.7224 | 152.0756 |
| 12 | 2014/12/29 | 2014/9/29 | 2015/3/30 | Greece | 61.0811 | 0.3356 | 0.0136 | 0.0573 | 0.2512 | -0.9873 | 149.7162 |
| 13 | 2010/2/3 | 2009/11/4 | 2010/5/5 | Greece | 42.1761 | 0.2317 | -0.0036 | 0.0383 | 0.2926 | 0.1427 | 131.5953 |
| 14 | 2016/1/24 | 2015/7/27 | 2016/7/25 | Portugal | 44.2107 | 0.2429 | 0.0068 | 0.0451 | 0.1969 | -0.3768 | 165.7871 |
| 15 | 2011/1/23 | 2010/7/26 | 2011/7/25 | Portugal | 76.2401 | 0.4189 | -0.0045 | 0.0256 | 0.1181 | 0.3180 | 145.1809 |
| 17 | 2016/11/8 | 2016/8/9 | 2017/2/7 | US | 93.2454 | 0.5123 | -0.0316 | 0.0010 | 0.2040 | 2.7524 | 101.0465 |
| 19 | 2008/11/4 | 2008/8/5 | 2009/2/3 | US | 13.9609 | 0.0767 | -0.0577 | 0.0565 | 0.4567 | 0.6954 | 246.9260 |
| 20 | 2004/11/2 | 2004/8/3 | 2005/2/1 | US | 16.8969 | 0.0928 | -0.0633 | 0.0010 | 0.3502 | 1.0391 | 142.5608 |
| 22 | 2010/5/6 | 2010/2/4 | 2010/8/5 | UK | 163.3767 | 0.8977 | 0.0136 | 0.0083 | 0.0858 | -2.2116 | 142.4232 |
| 23 | 2013/9/22 | 2013/3/25 | 2014/3/24 | Germany | 45.4861 | 0.2499 | 0.0078 | 0.0084 | 0.2443 | -0.3117 | 135.0828 |
| 24 | 2009/9/27 | 2009/3/30 | 2010/3/29 | Germany | 137.9691 | 0.7581 | 0.0161 | 0.0092 | 0.0607 | -2.2338 | 142.9616 |
| 25 | 2005/9/18 | 2005/3/21 | 2006/3/20 | Germany | 58.3794 | 0.3208 | 0.0209 | 0.0010 | 0.1095 | -1.2682 | 122.5086 |
| Mean |  |  |  |  | 58.7519 | 0.3228 | -0.0111 | 0.0234 | 0.2201 | -0.0472 | 149.1672 |
| Median |  |  |  |  | 55.9222 | 0.3073 | -0.0033 | 0.0092 | 0.2361 | 0.1805 | 145.1809 |
| s.d. |  |  |  |  | 43.9895 | 0.2417 | 0.0322 | 0.0225 | 0.1004 | 1.2339 | 30.1942 |

Figure 1 Jump Risk Against Time

Table 6 Comparison of Different Time Periods

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Event id | Event Date | Start Date | End Date | Country | 12 months | 9 months | 6 months | Consistency |
| 1 | 2012/4/22 | 2011/10/24 | 2012/10/22 | France | 0.0235 | 0.1120 | 0.0251 |  |
| 3 | 2007/6/10 | 2006/12/11 | 2007/12/10 | France | 0.7998 | 0.0235 | - |  |
| 4 | 2012/6/10 | 2011/12/12 | 2012/12/10 | France | 0.1105 | 0.1591 | 0.0258 |  |
| 5 | 2015/1/29 | 2014/7/31 | 2015/7/31 | Italy | 0.4134 | 0.2823 | - |  |
| 6 | 2006/5/2 | 2005/11/1 | 2006/11/1 | Italy | 0.3462 | - | - |  |
| 7 | 2013/2/24 | 2012/8/27 | 2013/8/26 | Italy | 0.1073 | 0.0329 | - |  |
| 9 | 2011/11/20 | 2011/5/23 | 2012/5/21 | Spain | 0.2388 | 0.3071 | 0.3465 | Y |
| 10 | 2004/10/9 | 2004/4/13 | 2005/4/11 | Australia | 0.0000 | - | - |  |
| 11 | 2014/12/17 | 2014/6/18 | 2015/6/18 | Greece | 0.2587 | 0.2778 | 0.3073 | Y |
| 12 | 2014/12/29 | 2014/6/30 | 2015/6/30 | Greece | 0.2223 | 0.2642 | 0.3356 | Y |
| 13 | 2010/2/3 | 2009/8/5 | 2010/8/5 | Greece | 0.1184 | 0.1062 | 0.2317 | Y |
| 14 | 2016/1/24 | 2015/7/27 | 2016/7/25 | Portugal | 0.0313 | 0.0371 | 0.2429 | Y |
| 15 | 2011/1/23 | 2010/7/26 | 2011/7/25 | Portugal | 0.2979 | 0.4827 | 0.4189 |  |
| 16 | 2006/1/22 | 2005/7/25 | 2006/7/24 | Portugal | 0.9369 | 0.1382 | - |  |
| 17 | 2016/11/8 | 2016/5/10 | 2017/5/1 | US | 0.0886 | 0.6529 | 0.5123 | Y |
| 19 | 2008/11/4 | 2008/5/6 | 2009/5/6 | US | 0.0318 | 0.0517 | 0.0767 | Y |
| 24 | 2009/9/27 | 2009/3/30 | 2010/3/29 | Germany | 0.9998 | 0.6462 | 0.7581 |  |
| 25 | 2005/9/18 | 2005/3/21 | 2006/3/20 | Germany | 0.8462 | - | 0.3208 |  |

Table 7 Electoral Systems Comparison

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Country | Sample | G7 | Electoral System | Duration of Election |
| Australia | 1 |  | two-party | 51 |
| France | 4 | Y | multi-party,  two-round | 47 |
| Germany | 3 | Y | multi-party,  two votes | 2 |
| Greece | 3 |  | multi-party,  reinforced proportionality | 40 |
| Italy | 4 | Y | multi-party | 27 |
| Portugal | 3 |  | multi-party,  two-round | 24 |
| Spain | 1 |  | multi-party,  party list proportional  representation | 20 |
| UK | 2 | Y | two-party,  first past the post | 42 |
| US | 4 | Y | two-party,  first past the post | 46 |

Figure 2 Prediction of Interest Rate Path

|  |  |  |
| --- | --- | --- |
| France 2012 President Election (first round) | France 2007 Parliament Election | France 2012 Election (second round) |
| Germany 2009 Federal Election | Greece 2014 President Election (first round) | Greece 2014 Election (second round) |

|  |  |  |
| --- | --- | --- |
| Greece 2010 President Election | Italy 2015 President Election | Italy 2013 Parliament Election |
| Italy 2008 Parliament Election | Portugal 2016 President Election | Portugal 2011 President Election |

|  |  |  |
| --- | --- | --- |
| Portugal 2006 President Election | Spain 2011 Parliament Election | UK 2015 President Election |
| US 2016 President Election | US 2008 President Election | US 2004 President Election |