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A note on effects of fiscal sentiment on interest rates

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Preliminary Draft

Abstract

This study analyzes the relationship between long-term interest rates and a fiscal sentiment index originally developed by conducting textual analysis of newspaper articles from January 1, 1980, to March 24, 2017—a total of 134,742 articles. Daily frequency regression shows that the fiscal sentiment has significant effects on long-term interest rates as suggested by the conventional wisdom. Considering the literature which employs lower frequency data and concludes that fiscal conditions have statistically insignificant effects on interest rates or raises them by a statistically significant but economically modest amount, our method and results are quite novel.

JEL Classification: E62, H62, H63
Keywords: Budget Deficit, Government Debt, Interest Rate, Fiscal Sentiment, Textual Analysis.

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1. Introduction

During and after the European currency crisis, many research studies confirmed that fiscal deterioration increased long-term interest rates in the Euro area. To the best of our knowledge, no study denies this relationship.[1] However, countries such as Japan, whose public debt is more than 250% of GDP, did not encounter any increase in their long-term interest rates. Also, as summarized in Laubach (2011), previous literature following Plosser's (1982) seminal study documents that an increase in government deficits or debt either has statistically insignificant effects on interest rates or raises them by a statistically significant but economically modest amount. In short, the relationship between fiscal deterioration and long-term interest rates is still controversial.

The following three factors make identifying this relationship challenging. First, financial markets have a forward-looking nature. Any data including fiscal information only contains past information prior to its release. Thus, no statistical analysis using released fiscal data captures rational market participants' forward-looking behavior. The second reason is endogeneity. It is possible that a shock that decreases interest rates worsens fiscal conditions within the same period, which leads an endogeneity problem. The third reason is the low frequency of fiscal data. Under an efficient financial market, interest rates change momentarily to reflect changes in expectations about various factors, including fiscal variables. On the other hand, the frequency of fiscal data is quarterly at most. Thus, any statistical analysis using this low-frequency data is not sufficient to discuss the relationship between interest rates and fiscal conditions.

A possible answer for this cumbersome question would be an event study. For example, Wachtel and Young's (1987) seminal event study in this literature regresses the difference between expectations by, say, the Congressional Budget Office (CBO), and budget deficits release on the daily difference of interest rates assuming market efficiency. Also, Quigley and Porter-Hudak (1994) exploited Box and Tiao's (1975) intervention analysis through which the relationship can be confirmed when the dummy variables are statistically significant. Since only an unexpected change

[1] Some studies emphasize the role of global risk factors although they appreciate the effects of fiscal deterioration on interest rates. See Longstaff et al. (2011), Cimadomo et al. (2016).

among market participants moves asset prices in efficient markets, these methods seem to be sufficient to resolve the three problems mentioned above.

However, the unexpected changes of fiscal conditions among market participants do not convey solely CBO forecasts. Other forecast releases, such as the IMF's and private experts' forecasts, could be considered as unexpected changes. Thus, it is preferable to count all fiscal conditions forecast releases and regard all these releases as an "event" reflected a dummy variable in the analysis. However, as is easily imagined, this is impossible because of the degree of freedom in the statistical analysis.

This study proposes a new method employing a sentiment index that is often utilized in stock market studies. Although several methods are proposed to capture market sentiment, we compute it by counting the number of newspaper article releases on a given day which contain one or a few specific words, similar to a study conducted by Baker et al. (2016). Therefore, a regression of interest rates on this index can be seen as a simple extension of event studies in which each of the releases is regarded as a separate event. Based on this idea, we evaluate in this paper the fiscal policy effects on interest rates.

The advantage of this method is that it includes events we have missed so far. However, the method suffers from problems: (1) we do not distinguish between positive and negative articles' effects on interest rates; and (2) we implicitly assume every event impacts interest rates by the same magnitude. Thus, in the paper, we deal with these problems by (1) dividing the articles into positive, negative, and irrelevant using the textual analysis technique; and (2) weighting the articles by the number of characters and/or an inverse of each article's number of pages. Additionally, (3) we compute a sub-index, such as the macro-policy cluster sub-index and fiscal cluster sub-index, based on the combination of words before and after the specific word using the cluster analysis. By using these sub-indices we can see what fiscal policy factors affect interest rates the most.

We focus on the Japanese government bond (JGB) markets in this study. The reasons are as follows. First, the market is considered as ideal to find fiscal deterioration's effects on interest rates. It is well known that the Japanese fiscal situation is the worst among the OECD countries. Second, long time series data is available for this market. In fact, we utilize daily time series from June 13, 1989 to March 24, 2017. Such a long series is not available in Europe owing to the introduction of the currency union. Finally, foreigners hold a small share of JGB. At the end of 2017, this share was only 6.1%. This means that we can almost ignore exchange rates and country risks. Furthermore, the market is resistant to shocks seen in other countries that propagate through international diversified investments. This aspect is more relevant to our purpose than to analysis of more open markets such as the U.S.

The remainder of this paper consists four sections. In section 2 we describe the data and how we compute the sentiment index. Section 3 presents our empirical results. In section 4, we

outline the paper's main conclusions.

2. Empirical Methodology

2.1. Fiscal Sentiment Index

The fiscal sentiment index's computation methodology is outlined below. Pre-processed data is collected from the Nikkei — a popular newspaper in Japan comparable with the Wall Street Journal and the Financial Times. We use their database Nikkei Telecon 21 and search both the morning and the evening editions for the key word "zaisei" meaning "fiscal," "public finance," or "(government) budget." We retrieve 134,742 articles covering the period from January 1 in 1980 to March 24 in 2017 although we discard them within the first three years because of its imperfect uploading. Then we classify these articles into positive, negative or irrelevant. To do this, we first try applying a commercial-based textual analytics engine ("Nazuki" produced by NTT DATA Corporation), especially in order to ensure objectivity. However, criticisms has arisen such that, for example, news about new tax hike can be classified either as positive (fiscal soundness view) or as negative (tax payer's view). Therefore, we here adopt the standard procedure of the textual analysis as follows. First, we pick up 1000 articles randomly and classify them into the three categories explained above based on the author's decision. Second, we construct a codebook and then built the naive Bayes classifier. By using this, we classify all of the articles and compute the fiscal sentiment index explained below. It should be noted that some may consider this procedure is too subjective. However, as far as we use the textual analysis, to construct the codebook is essential and inevitable. We should note as well that this procedure is better than what we had done to perform the traditional event study.

In order to compute the fiscal sentiment index, we first employ the number of positive and negative articles for each day. Then, we define the fiscal sentiment index as their difference:

$$\begin{aligned} POS_t &= The\ number\ of\ positive\ ariticles \\ NEG_t &= The\ number\ of\ negative\ ariticles \\ Fiscal\ sentiment\ index(IDX)_t &= POS_t - NEG_t \end{aligned} \tag{1}$$

Computing these, we assume the index affect financial markets on the same trading day. It should be noted that the evening edition contains information released before approximately 2 p.m. Therefore, it is reasonable to consider the articles in the evening edition can affect the closing yield on the same day. As for the day after non-business day of Sundays and holidays, we calculate the index as an daily average of the number of articles among the day and the non-business days.

As mentioned in Section 1, this index per se is computed assuming that the magnitude of

impact for any article is the same. However, it would be standard to assume that each impact is different depending on the size and the page it prints on. Thus, the following three indices are calculated as well: (1) an index based on the number of characters in each article, (2) an index based on the inverse of the page the article is printed on in the newspaper, and (3) an index based on the previous two figures.

Figure 1 to 4 shows the computed results. Figure 1 shows the POS_t and its smoothed one during 31 days. The noticeable feature of this index is to successfully capture the two eras of fiscal consolidation in Japan: Prime Minister Hashimoto era (1/11/1996 to 7/30/1998) and Prime Minister Koizumi era (4/27/2001 to 9/26/2006). The former PM put his heart on the administrative reform and its final report is disclosed in public on 12/4/1997. We can see the spike expressing this event in the figure. However, before and after this disclosure, the recession caused by the financial crisis in Japan disturbs this consolidation movement and he abandons his administrative and fiscal reform. POS_t reflects this movement very clearly, thereby we can considered this POS_t as reliable. Also, this index traces well the second movement by Prime Minister Koizumi. His predecessors, Mr. Obuchi and Mr. Mori, are notorious as a big spender thus the index is low during their eras (7/31/1998 to 4/26/2001). However, the index starts to increase after the appointment of Mr. Koizumi and records the highest on June 22 in 2001 when he declares his first economic plan. Thereafter, the index keeps higher than that in the other administration, so the index capture Mr. Koizumi's fiscal reform well.

NEG_t depicted in Figure 2 shows the mirror image of Figure 1. For example, during the administration of Prime Minister Obuchi and Mori, we can see an increase in NEG_t. Figure 3 is the (plain) fiscal sentiment index, which is simply calculated as the difference between the positive index and the negative one. We can see that this index explains the above stories well. Finally, Figure 4 shows the 4 types of fiscal sentiment index explained above. Since indices weighted by the number of letters in each article has a big number, we prepare for the right axis in the figure. As is easily understand, the indices move around almost together, thus their effects on long-term interest rates are expected as the same.

2.2. Estimation Equation

In order to investigate how the change in fiscal sentiment affects long-term interest rates, we estimate the following equation:

$$y_t = \alpha + \beta \sum_0^t Index_k + \sum \theta_i CNTL_{it} + \varepsilon_t \qquad (2)$$

where y_t is the 10-year JGB closing yield, $Index_t$ is the fiscal sentiment index, and ε_t is a disturbance term. It should be noted that we should use the accumulation of the number of articles to

accommodate our estimation to the efficient market hypothesis. $CNTL_{it}$ is a vector of control variables that drives yield changes. It includes: (1) the uncollateralized overnight call rate as a proxy for short-term interest rates that explains effects of monetary policy, (2) a level of seasonally-adjusted base money that controls the effects of the zero interest rate policy by the Bank of Japan from 2/12/1999 to 8/11/2000, (3) the average Nikkei stock volatility index that captures a change in market participants' risk attitude, which is suggested to be included in previous research (Beber et al., 2009, Lauback, 2011; Kilponenn et al., 2015), (4) the US 10-year treasury yield in the previous business day. In spite that the sentiment index is computed from January 1 in 1983, the sample period starts from June 13 in 1989 when the volatility index becomes available and ends on March 18 in 2001, the previous day when the Bank of Japan started their unconventional monetary policy including quantitative easing by purchasing the JGB. Holidays including Saturday and Sunday are excluded from our sample.

The uncollateralized overnight call rate is a policy, thereby exogenous variable, and the US 10-year treasury yield is predetermined because the New York market has been closed when Tokyo market opens. In contrast, the volatility index is an endogenous one, therefore we have to care about the endogeneity problem. Also, independent variables but the volatility are integrated of order one, I(1), based on the DF-GLS test (unshown). In order to deal with these two problems, we adopt the fully-modified instrumental variable method (FM-IV) developed Hansen and Phillips (1990). By using this FM-IV, we can obtain consistent estimators and unbiased standard normal distribution of I(1) independent variables under the assumption that the independent variables are not cointegrated, although the coefficient of I(0) variable may be inconsistent when the instruments are invalid.

3. Estimation Results

As shown in Table 1, the index have significant negative effects on long-term interest rates, therefore, we can say that fiscal conditions do affects long-term interest rates as suggested by conventional wisdom. This is our main result. Also, the index is significant regardless of the type (Column 2 to 4). Thus, the weights for the indices — the number of letters and the page number of the articles — are considered not to have important role. Moreover, these results are invariant when we control the temporary overshooting effects (Column 5 to 8).

Table 2 shows the results when we divide the index into the positive and negative ones. As expected, the coefficient of the negative and positive indices are positive and negative, respectively. This outcome is unchanged even if we control the temporary effects similar to Table 1 (Column 5 to 8). Finally, the case where 5-year yields are employed as the independent variable is presented in Table 3. The results is almost the same as those for 10-year yields, but the significance level of the indices is low more or less. However, this result would be reasonable because the default risk should be reflected more to longer maturity bonds under apparently stable bond markets.

4. Concluding Remarks

This study analyzes the relationship between long-term interest rates and a fiscal sentiment index originally developed by conducting textual analysis of newspaper articles. Daily frequency regression shows that the fiscal sentiment has significant effects on long-term interest rates as suggested by the conventional wisdom.

Many points remain to be considered. First, we could obtain more fruitful outcome if we can divide movements of long-term interest rates into crowding-out component and default risk component. Second, we should perform regression analyses in separated sample periods utilizing the sufficient length of our time series data. Although we could find interesting points furthermore, they are reserved for future studies.

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Table 1: Effects of the fiscal sentiment index on the 10-year JGB yields.

	Weight				Weight			
	None	Inv. Page	Num. letters	Both	None	Inv. Page	Num. letters	Both
Constant	77.1359 ***	74.9116 ***	61.1998 ***	66.8799 ***	77.1007 ***	74.8679 ***	61.1520 ***	66.8156 ***
	(7.937)	(7.439)	(12.344)	(9.715)	(7.933)	(7.432)	(12.302)	(9.689)
US 10-year note yield	0.4353 ***	0.4285 ***	0.4247 ***	0.4176 ***	0.4349 ***	0.4283 ***	0.4254 ***	0.4179 ***
	(11.306)	(11.081)	(11.045)	(10.788)	(11.139)	(10.957)	(10.924)	(10.666)
Call rate, O/N	0.4383 ***	0.4221 ***	0.4385 ***	0.4299 ***	0.4381 ***	0.4219 ***	0.4384 ***	0.4297 ***
	(11.540)	(11.546)	(11.685)	(11.586)	(11.535)	(11.543)	(11.677)	(11.578)
Nikkei stock volatility index	-0.0020	-0.0023	-0.0010	-0.0015	-0.0020	-0.0023	-0.0010	-0.0015
	(-0.517)	(-0.601)	(-0.266)	(-0.378)	(-0.516)	(-0.601)	(-0.269)	(-0.382)
Level of base money, seasonally adjusted	-6.0019 ***	-5.8132 ***	-4.7548 ***	-5.1869 ***	-5.9986 ***	-5.8094 ***	-4.7515 ***	-5.1819 ***
	(-7.708)	(-7.232)	(-11.899)	(-9.402)	(-7.704)	(-7.227)	(-11.869)	(-9.381)
Dummy for the first day after holidays	-0.0041	-0.0040	-0.0047	-0.0044	-0.0050	-0.0046	-0.0045	-0.0044
	(-0.075)	(-0.074)	(-0.087)	(-0.081)	(-0.091)	(-0.083)	(-0.083)	(-0.081)
Accumulated fiscal sentiment index	-0.0008 ***	-0.0015 ***	-0.0001 ***	-0.0002 ***	-0.0008 ***	-0.0015 ***	-0.0001 ***	-0.0002 ***
	(3.049)	(2.704)	(3.146)	(2.901)	(3.042)	(2.699)	(3.143)	(2.894)
Fiscal sentiment index on the day					-0.0026	-0.0041	0.0002	-0.0001
					(-0.256)	(-0.203)	(0.192)	(-0.059)

Note) *** means significant at the 0.01 level, ** means significant at the 0.05 level, and * means significant at the 0.10 level. t-values are shown below the coefficients. Sample period is from 6/13/1989 to 3/18/2001 (n=2611).

Table 2: Effects of the positive and the negative sentiment index on the 10-year JGB yields.

	Weight				Weight			
	None	Inv. page	Num. letters	Both	None	Inv. page	Num. letters	Both
Constant	34.5085 **	32.0219 **	24.7558	21.8430	33.4450 **	30.9498 *	24.1895	21.4788
	(2.188)	(1.996)	(1.563)	(1.382)	(2.118)	(1.927)	(1.530)	(1.362)
US 5-year note yield	0.3957 ***	0.3898 ***	0.3966 ***	0.3842 ***	0.3970 ***	0.3914 ***	0.3974 ***	0.3850 ***
	(9.782)	(9.598)	(9.980)	(9.732)	(9.690)	(9.542)	(9.910)	(9.662)
Call rate, O/N	0.4067 ***	0.3879 ***	0.3794 ***	0.3729 ***	0.3977 ***	0.3800 ***	0.3720 ***	0.3664 ***
	(11.149)	(11.076)	(9.977)	(10.260)	(10.312)	(10.424)	(9.536)	(9.860)
Nikkei stock volatility index	0.0001	-0.0001	-0.0002	0.0003	-0.0001	-0.0003	-0.0004	0.0001
	(0.023)	(-0.035)	(-0.056)	(0.080)	(-0.032)	(-0.079)	(-0.101)	(0.035)
Level of base money, seasonally adjusted	-2.6444 **	-2.4363 *	-1.8684	-1.6329	-2.5547 **	-2.3469 *	-1.8182	-1.5992
	(-2.120)	(-1.922)	(-1.493)	(-1.309)	(-2.045)	(-1.850)	(-1.456)	(-1.284)
Dummy for the first day after holidays	-0.0048	-0.0047	-0.0054	-0.0052	-0.0148	-0.0172	-0.0113	-0.0133
	(-0.092)	(-0.089)	(-0.102)	(-0.099)	(-0.279)	(-0.322)	(-0.216)	(-0.254)
Accumulated negative index	0.0006 **	0.0010 *	0.0000	0.0001	0.0005 **	0.0009	0.0000	0.0001
	(2.412)	(1.824)	(1.621)	(1.426)	(2.154)	(1.625)	(1.466)	(1.294)
Accumulated positive index	-0.0011 ***	-0.0023 ***	-0.0001 ***	-0.0003 ***	-0.0011 ***	-0.0022 ***	-0.0001 ***	-0.0003 ***
	(-3.640)	(-3.324)	(-3.275)	(-3.504)	(-3.365)	(-3.112)	(-3.113)	(-3.351)
Negative index on the day					-0.0082	-0.0177	-0.0011	-0.0026
					(-0.747)	(-0.817)	(-0.817)	(-0.930)
Positive index on the day					-0.0140	-0.0346	-0.0016	-0.0041
					(-0.807)	(-0.979)	(-1.099)	(-1.085)

Note) *** means significant at the 0.01 level, ** means significant at the 0.05 level, and * means significant at the 0.10 level. t-values are shown below the coefficients. Sample period is from 6/13/1989 to 3/18/2001 (n=2611).

Table 3: Effects of the fiscal sentiment index on the 5-year JGB yields.

	Weight				Weight			
	None	Inv. page	Num. letters	Both	None	Inv. page	Num. letters	Both
Constant	67.0588 ***	64.9617 ***	49.3853 ***	55.3202 ***	66.9902 ***	64.8476 ***	49.2816 ***	55.1686 ***
	(6.333)	(5.939)	(9.251)	(7.433)	(6.327)	(5.928)	(9.219)	(7.405)
US 5-year note yield	0.3727 ***	0.3660 ***	0.3654 ***	0.3571 ***	0.3732 ***	0.3665 ***	0.3670 ***	0.3582 ***
	(10.642)	(10.404)	(10.331)	(10.049)	(10.525)	(10.321)	(10.251)	(9.968)
Call rate, O/N	0.6223 ***	0.6066 ***	0.6082 ***	0.6067 ***	0.6222 ***	0.6063 ***	0.6077 ***	0.6061 ***
	(15.101)	(15.344)	(14.854)	(15.021)	(15.096)	(15.339)	(14.842)	(15.008)
Nikkei stock volatility index	-0.0013	-0.0016	-0.0009	-0.0011	-0.0013	-0.0016	-0.0009	-0.0011
	(-0.311)	(-0.376)	(-0.212)	(-0.249)	(-0.316)	(-0.383)	(-0.220)	(-0.260)
Level of base money, seasonally adjusted	-5.2685 ***	-5.0906 ***	-3.8789 ***	-4.3352 ***	-5.2635 ***	-5.0818 ***	-3.8716 ***	-4.3237 ***
	(-6.208)	(-5.826)	(-8.963)	(-7.246)	(-6.202)	(-5.816)	(-8.938)	(-7.221)
Dummy for the first day after holidays	-0.0032	-0.0032	-0.0039	-0.0037	-0.0027	-0.0028	-0.0033	-0.0034
	(-0.054)	(-0.053)	(-0.066)	(-0.062)	(-0.046)	(-0.048)	(-0.056)	(-0.056)
Accumulated fiscal sentiment index	-0.0008 ***	-0.0015 **	-0.0001 **	-0.0002 **	-0.0008 ***	-0.0015 **	-0.0001 **	-0.0002 **
	(2.773)	(2.473)	(2.449)	(2.420)	(2.768)	(2.465)	(2.441)	(2.405)
Fiscal sentiment index on the day					0.0012	0.0017	0.0006	0.0006
					(0.107)	(0.076)	(0.507)	(0.222)

Note) *** means significant at the 0.01 level, ** means significant at the 0.05 level, and * means significant at the 0.10 level. t-values are shown below the coefficients. Sample period is from 6/13/1989 to 3/18/2001 (n=2611).

Table 4: Effects of the positive and the negative sentiment index on the 5-year JGB yields.

	Weight				Weight			
	None	Inv. page	Num. letters	Both	None	Inv. page	Num. letters	Both
Constant	49.7426 ***	48.0846 ***	44.0864 ***	42.3429 **	48.4098 ***	46.8246 ***	43.4177 ***	41.8191 **
	(2.967)	(2.810)	(2.631)	(2.507)	(2.886)	(2.735)	(2.596)	(2.481)
US 5-year note yield	0.4751 ***	0.4671 ***	0.4707 ***	0.4566 ***	0.4785 ***	0.4702 ***	0.4731 ***	0.4591 ***
	(11.047)	(10.786)	(11.194)	(10.821)	(10.992)	(10.754)	(11.154)	(10.782)
Call rate, O/N	0.5764 ***	0.5588 ***	0.5686 ***	0.5602 ***	0.5660 ***	0.5502 ***	0.5614 ***	0.5531 ***
	(14.861)	(14.963)	(14.131)	(14.419)	(13.814)	(14.158)	(13.603)	(13.928)
Nikkei stock volatility index	-0.0007	-0.0011	-0.0006	-0.0006	-0.0010	-0.0014	-0.0008	-0.0008
	(-0.170)	(-0.281)	(-0.152)	(-0.148)	(-0.240)	(-0.338)	(-0.201)	(-0.204)
Level of base money, seasonally adjusted	-3.9782 ***	-3.8321 ***	-3.5297 ***	-3.3805 **	-3.8680 ***	-3.7286 ***	-3.4730 ***	-3.3350 **
	(-3.00)	(-2.835)	(-2.666)	(-2.535)	(-2.915)	(-2.757)	(-2.628)	(-2.506)
Dummy for the first day after holidays	-0.0052	-0.0051	-0.0056	-0.0055	-0.0148	-0.0176	-0.0108	-0.0138
	(-0.093)	(-0.092)	(-0.101)	(-0.099)	(-0.262)	(-0.309)	(-0.195)	(-0.246)
Accumulated negative index	0.0007 ***	0.0013 **	0.0000 **	0.0000 **	0.0006 **	0.0012 **	0.0000 **	0.0000 **
	(2.631)	(2.200)	(2.352)	(2.179)	(2.355)	(1.991)	(2.202)	(2.038)
Accumulated positive index	-0.0008 **	-0.0015 **	0.0000 **	0.0000 **	-0.0007 **	-0.0014 *	0.0000 **	0.0000 **
	(-2.308)	(-1.977)	(-2.133)	(-2.126)	(-2.062)	(-1.788)	(-1.996)	(-1.984)
Negative index on the day					-0.0031	-0.0085	0.0000	0.0000
					(-0.268)	(-0.368)	(-0.345)	(-0.514)
Positive index on the day					-0.0234	-0.0502	0.0000	-0.0001
					(-1.270)	(-1.332)	(-1.405)	(-1.417)

Note) *** means significant at the 0.01 level, ** means significant at the 0.05 level, and * means significant at the 0.10 level. t-values are shown below the coefficients. Sample period is from 6/13/1989 to 3/18/2001 (n=2611).

Figure 1: The number of positive articles

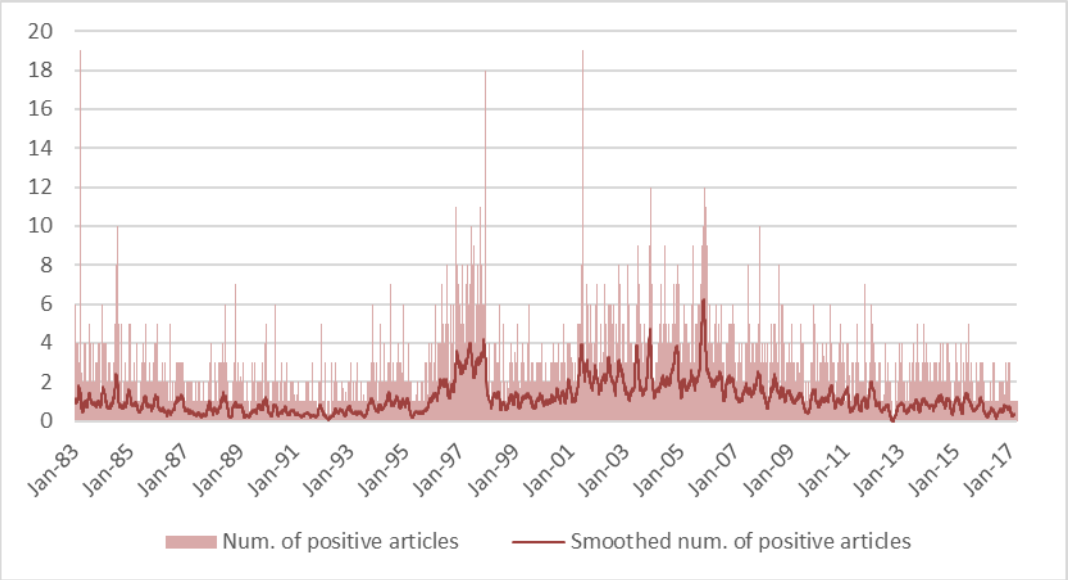

Figure 2: The number of negative articles

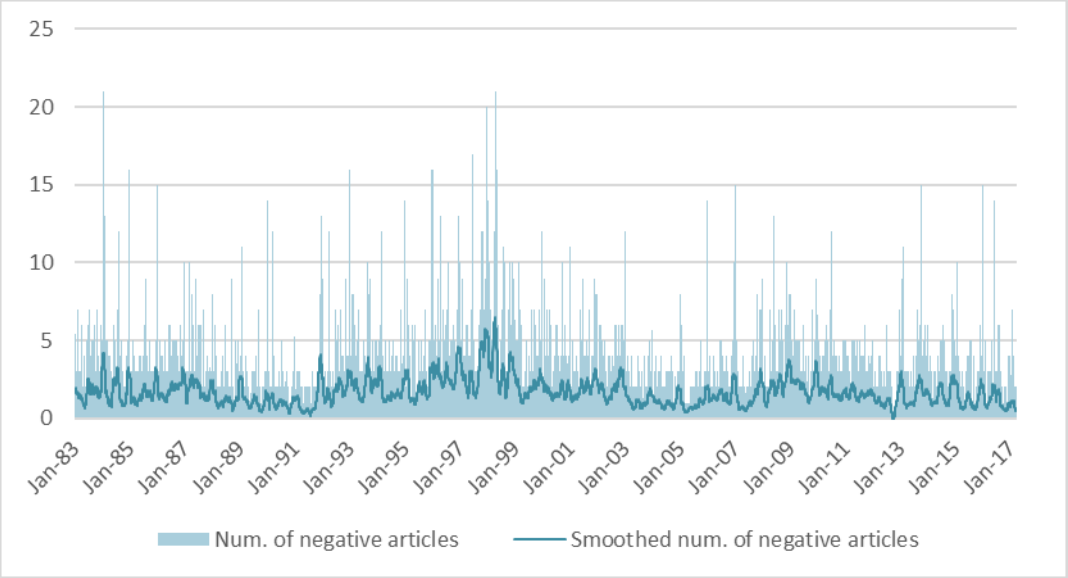

Figure 3: Fiscal sentiment index

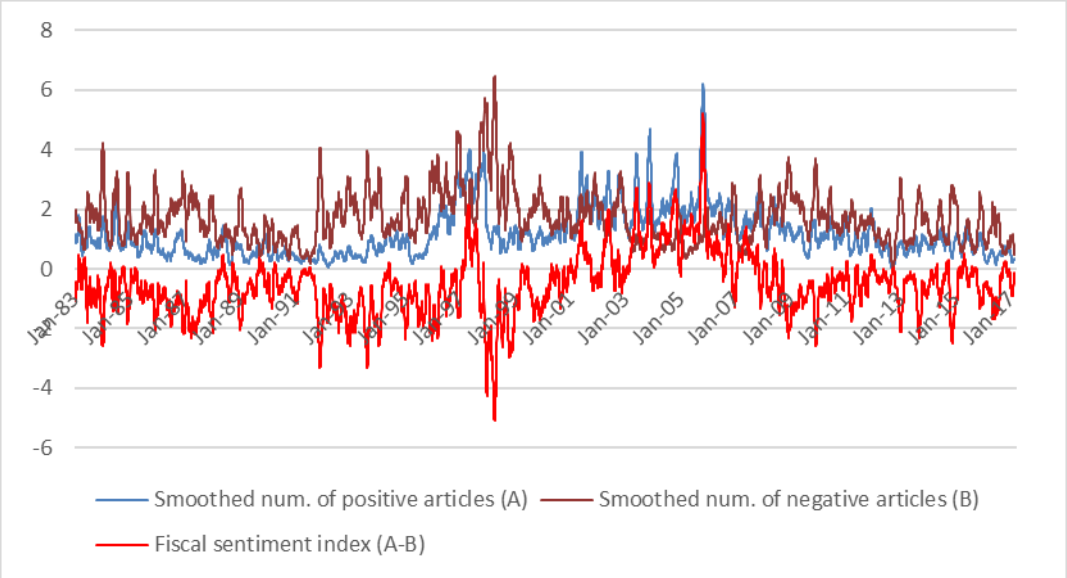

Figure 4: Comparison among 4 types of fiscal sentiment indices