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Financial crisis and yield curve

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Abstract
The study examines the impact of two major international financial crises: the dot-com bubble in 2001 (i.e., crashing of internet companies) and the Global Financial Crisis (GFC) of 2008 on the short, medium, and long-term government securities (G-Secs) yield & curvature, level, and slope of the yield curve (YC) in the Indian G-Secs market. Data of G-Secs yield is downloaded from the Reserve Bank of India (RBI) database on the Indian economy. F-test and t-test are used for data analysis. The results indicate that average short, medium, and long-term G-Secs' yields and level of YC have decreased while the curvature has increased significantly after the Dot-com bubble of 2001. Further, results also indicate that the Dot-com bubble of 2001 has no significant impact on volatility in the Indian G-Secs market. Regarding the impact of GFC of 2008, the results show that after the average medium and the long-term yield, and level and slope of the YC have increased while average curvature has decreased significantly. Further, F-test also shows that the standard deviation has increased significantly after the GFC of 2008 for short-term yield, slope, and curvature. Therefore, two international financial crises show mixed results that warn the Investors investing in the Indian fixed income market during the global financial crisis. It is difficult to predict the direction of the change in yield and shape of YC in the Indian G-Secs market during the global financial crisis.

Keywords: Yield curve, curvature, level, and slope, international financial crisis, debt market, government securities

Introduction
With the globalization and integration of the world economies, changes in the global economic environment profoundly impact financial markets, including the government securities (G-Secs) market and curvature, level, and slope of the yield curve (YC). Financial markets around the globe keep on fluctuating due to changes in the economic, political, and business environment but, sometimes bubbles and crashes also hit the financial markets. In the last two decades, a financial crisis such as the Global Financial Crisis (GFC) of 2008, the Asian financial crisis of 1997, or the dot-com bubble of 2001, has impacted the globe's economies. This is primarily because liberalization of financial markets, economic globalization, and information technology-savvy environment have entangled effect in the global market, i.e., any financial crisis at a global level affects the domestic financial markets as well, including macroeconomic variables such as GDP growth, international trade, capital flows, exchange rate, fluctuations in the financial markets, inflation, employment, interest rates, etc. (Kumar and Vashisht, 2009; Walia, 2012 and Naudé 2009) [7, 15, 10]. Because of changes in the international financial environment, macroeconomic variables fluctuate, impacting the yield on G-Secs and slope, curvature, and level of the YC. However, their intensity depends upon the nature of the crisis and the level of integration. The Economist (n.d.) essay titled "The Slumps that Shape the Modern Finance," during the great depression from 1929 to 1933, around 1100 banks failed, the unemployment rate increased to 25 percent, and the money supply in the world dropped to over 30 percent. Further, Jones and Ocampo (2009) put forward that remittances, capital flows, and trade play critical roles in spreading the effect of the financial crisis on the developing world. Hence, based on the backdrop described above, the purpose of this paper is to examine the impact of the two international financial crises, i.e., the dot-com bubble of 2001 and the GFC of 2008, on short, medium, and long-term G-secs yield and curvature, level, and slope of YC in the Indian G-Secs market. Due to the non-availability of data before 1997, the Asian financial crisis of

1997 is not selected for the study.

Literature review

Numbers of studies, such as Baig and Golfajn (1998) [1], Lim *et al.* (2008) [8], Kumar and Vashisht (2009) [7], and Walia (2012) [15], are conducted to examine the impact of financial crises, namely Asian financial crises and GFC of 2008 on the Asian financial markets. Studies such as Baig and Golfajn (1998) [1] and Lim *et al.* (2008) [8], while exploring the impact of the Asian financial crisis of 1997 on Thailand, Malaysia, Indonesia, Korea, and the Philippines markets, stated that cross-country correlations in the currency and equity markets were significant during the crisis due to financial panic. Lim *et al.* (2008) [8] further added that the Asian financial crisis of 1997 adversely affected the efficiency of Asian stock markets due to the chaotic economic environment during the crisis. They observed that the efficiency of the Hong Kong stock market was most adversely affected, followed by the Philippines, Malaysia, Singapore, Thailand, and Korea. Similarly, Kumar and Vashisht (2009) [7] and Walia (2012) [15] examined the financial impact on the Indian economy. Kumar and Vashisht (2009) [7] established the effect of the GFC of 2008 on the Indian economy through the exchange rate, financial markets, and trade flows. Specifically, the impact has resulted in decreased export demand, the reversal of capital inflows, and a decline in GDP by more than two percentage points in 2008-2009. Whereas, Walia (2012) [15] found that the impact on foreign portfolio investment, the balance of payment, and export and imports are significant.

On the other hand, Naudé (2009) [10] established the impact of the 2008 financial crisis on banking failure, reductions in export earnings, reductions in domestic lending, and reductions in financial flows to the developing countries. Ghosh and Chandrasekha (2009) [6] and Fidrmuc and Korhonen (2010) [5] also found that international financial crises have significantly affected economic development in emerging Asian economies. Further, besides studying after the crisis effect, a few studies such as Chionis *et al.* (2014) [2] have also examined before and after the financial crisis impact. For instance, Chionis *et al.* (2014) [2] studied the influence of macroeconomic variables such as debt to GDP ratio, inflation, deficit, and unemployment on ten-year Greek G-Secs before and after the GFC of 2008. The scholars revealed that before the Greek crisis, both inflation and unemployment have significantly impacted the yield. Still, immediately after the crisis, fiscal deficit significantly affected yield while growth rate had no significant impact on the bond yield. Previously Dua and Sinha (2007) [4] and Dholakia (1998) [3] found that the effect of the Asian financial crisis of 1997 on India is not substantive. They suggested that this might be because of the relatively stringent policies of India, such as tightening of monetary policy, restrictions on capital flow, and the RBI's intervention in foreign exchange. Although the researchers studied the impact of the different international financial crises on the Indian economy (Dua and Sinha, 2007 and Dholakia, 1998) [3, 4], but very meagre research is found on the impact of the dot-com bubble in the year 2001 and GFC of 2008 on short, medium, and long-term G-secs yield and YC.

Based on the aforesaid backdrop, it is hypothesized that

H1a: International financial crises significantly influence the short-term Indian G-Secs yield.

H1b: International financial crises significantly influence the medium-term Indian G-Secs yield.

H1c: International financial crises significantly influence the long-term Indian G-Secs yield.

H2a: International financial crises significantly influence the slope of the YC.

H2b: International financial crises significantly influence the level of the YC.

H2c: International financial crises significantly influence the curvature of the YC.

Methodology

The study examines the impact of two major international financial crises that include the dot-com bubble in 2001 and the 2008 financial crisis, which is also called a subprime crisis (The Economist n. d.). Accordingly, respective two different data set are used to determine the impact of the dot-com and financial crisis. In both crises, the data are divided into two distinct phases, i.e., before and after the crisis. January 2002 to November 2008 data before the financial crisis, which represents a complete business cycle and expansion phase in the economies all over the world, and December 2008 to July 2010 data after the financial crisis, are used to study the impact of the GFC of 2008 on the G-Secs yield and YC. Further, Mandal and Bhattacharjee (2012) [9], while exploring the effects of the financial crisis, found that after the crisis, the impact remained up to July 2010.

For the dot-com bubble of 2001, data before the crisis from January 1998 to February 2001 and after the crisis from March 2001 to November 2001 (Ofek & Richardson, 2003) [11] is considered. Data after November 2001 is not used in the study, as after November 2001 impact of the dot-com bubble reduced, and expansion started (Mandal and Bhattacharjee, 2012) [9]. Further, yield data is downloaded from RBI's database on the Indian economy (RBI, n. d.). The t-test is used for data analysis to study the differences before and after the crisis. In the literature studies, Sahar (2011) [13] and Mandal and Bhattacharjee (2012) [9] have used t-test to study the 2008 financial crisis's impact on the Egyptian stock market and Sensex's. Besides, F-test is also used to study the significant difference between the variances, i.e., the volatility of yields and shape of the YC before and after the crisis.

Variables

Following variables are used for the analysis

1. Short-term G-Secs yield represented by 15-91 days treasury bills yield (15-91TB) and one-year G-Secs yield (1YGSY).
2. Medium-term G-Secs yield represented by five-year G-Secs yield (5YGSY).
3. Long-term G-Secs yield represented by ten-year G-Secs yield (10YGSY).
4. **Slope:** Difference between the ten year and one-year yields
5. **Level:** The average of the one, five, and ten-year yields
6. **Curvature:** Sum of one-year and ten-year minus two

times the five-year yield.

Data analysis and Results

Impact of Dot-com Bubble of 2001

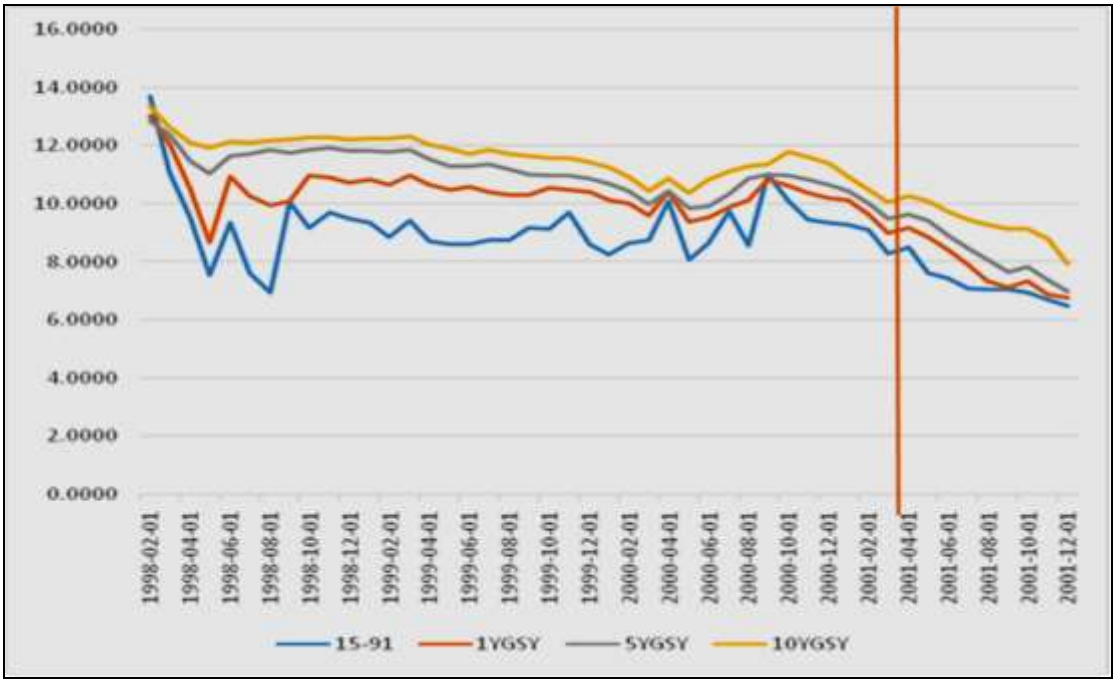
The impact of the Dot-com bubble of 2001 on the G-Secs yield of different maturities and shapes of the YC is found to be mixed (Table 1). The results indicate that average short (represented by 15-91 days' maturity treasury bill yield and one-year G-Secs yield), medium, and long-term G-Secs' yields and level have significantly decreased, from 9.18 %, 10.37%, 11.12%, 11.64%, and 11.04% to 7.19%, 7.74%, 8.25%, 9.31%, and 8.43% respectively. This decrease is found to be significant, as demonstrated by the p-values of the t-test. On the other hand, the average increases for slope and curvature, but this increase is significant only for the curvature and not for the slope. Further, results also indicate that risk represented by standard deviation has increased for one, five, and ten-year G-Secs' yield and level and decreased for very treasury bills yield, slope, and curvature. However, this increase/decrease in standard deviation is not significant, as shown by the F-test values, both one and two-tail, for all the variables, which indicates that the Dot-com bubble of 2001 has no significant impact on the risk of investment in G-Secs market in India. Further, Figure 1 illustrates a decrease in G-Secs yield after the dot-com bubble. Pre- and post-crisis data is divided by the red line in the graph.

Table 1: Impact of Dot-Com Bubble 2001

Calculations	Pre/Post	15-91TB	1YGSY	5YGSY	10YGSY	Level	Slope	Curvature
Average	Pre (%)	9.18	10.37	11.12	11.64	11.04	1.28	-0.22
	Post (%)	7.19	7.74	8.25	9.31	8.43	1.57	0.55
Standard Deviation	Pre (%)	1.13	0.75	0.75	0.70	0.69	0.51	0.53
	Post (%)	0.60	0.88	0.91	0.70	0.82	0.37	0.32
F-test (Two-tail)	p-value	0.06	0.47	0.40	0.87	0.45	0.33	0.13
F-test (One-tail)	p-value	0.03	0.23	0.20	0.44	0.22	0.17	0.06
t-test* (Two-tail)		0	0	0	0	0	0.07	0
t-test **(Two-tail)		0	0	0	0	0	0.12	0
t-test* (One-tail)		0	0	0	0	0	0.03	0
t-test **(One-tail)		0	0	0	0	0	0.06	0

Source: Authors' Calculations

Note: t-test*(p-value): unequal variance; t-test** (p-value): equal variance; TB15_91 (15-91 days' maturity treasury bill yield), 1YGSY (one-year G-Secs yield) 5YGSY (five-year G-Secs yield), 10YGSY (ten-year G-Secs yield), NDA (National Democratic Alliance), UPA (United Progressive Alliance)



Source: Authors' Calculations

Fig 1: Impact of the Dot-com Bubble

Impact of GFC of 2008

Table 2 shows the impact of the GFC of 2008 on the short, medium, and long-term G-Secs yield and shape of the YC. The p-values of the t-test in the table show that after the crisis, the average percentage of the medium and the long-term yield and level and slope of the YC increased significantly while average curvature decreased significantly. However, the average percentage change in the short-term yield is not significant. P-values of the F-test also show that the standard deviation has increased

significantly after the crisis for short-term yield, slope, and curvature. The results are the same for both equal/unequal variance and one/two-tail t-test.

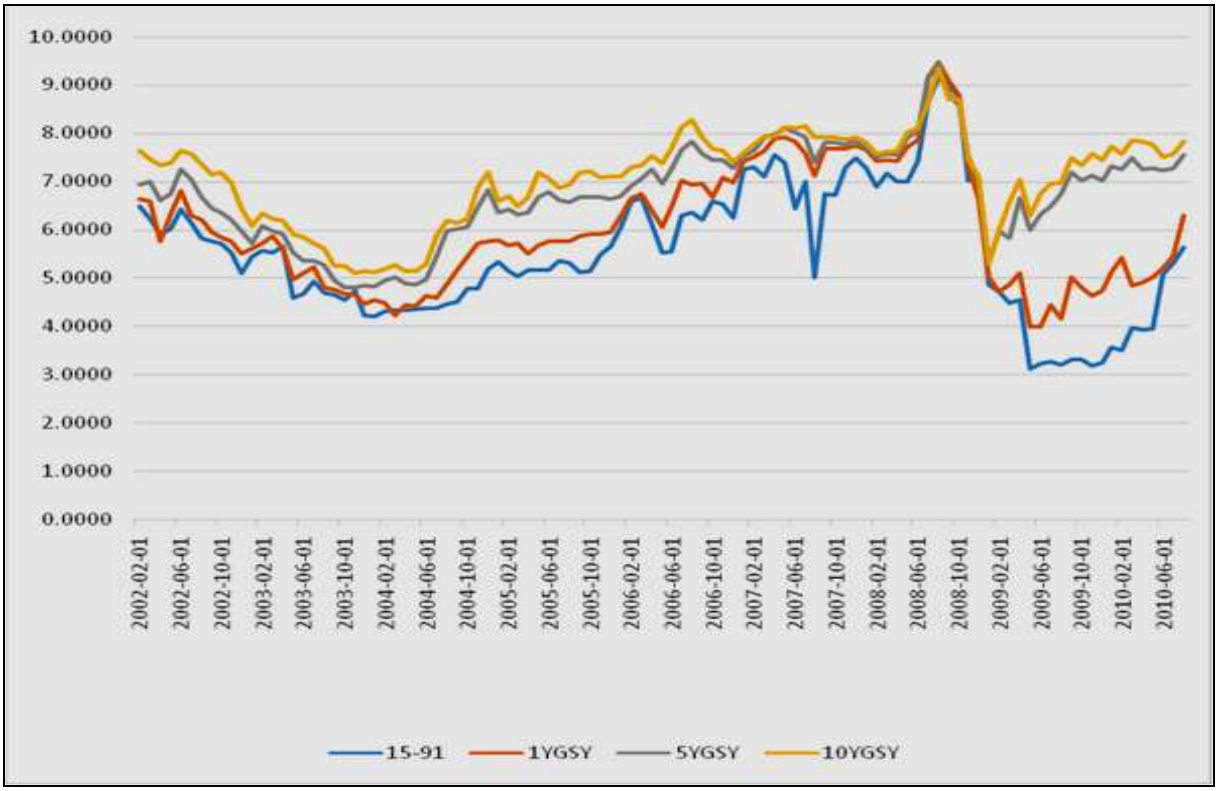
The results are further supported by Figure 2, which shows that the fluctuations have increased after the crisis. Pre and post-crisis are divided by the red line in the figure.

Table 2: Impact of GFC of 2008

Calculations	Pre/Post	15-91TB	1YGSY	5YGSY	10YGSY	Level	Slope	Curvature
Average	Pre (%)	5.63	6.05	6.54	6.88	6.49	0.83	-0.15
	Post (%)	1.17	6.06	7.29	7.51	6.95	1.45	-1.00
Standard Deviation	Pre (%)	0.93	1.02	0.97	0.95	0.96	0.39	0.29
	Post (%)	2.01	1.67	0.91	0.80	1.06	1.22	0.87
F-test (Two-tail)	p-value	0	0	0.71	0.30	0.50	0	0
F-test (One-tail)	p-value	0	0	0.35	0.15	0.25	0	0
t-test* (Two-tail)		0.49	0.96	0	0	0.04	0.01	0
t-test **(Two-tail)		0.38	0.95	0	0	0.03	0	0
t-test* (One-tail)		0.25	0.48	0	0	0.02	0	0
t-test **(One-tail)		0.19	0.48	0	0	0.02	0	0

Source: Authors' Calculations

Note: t-test*(p-value): unequal variance; t-test**(p-value): equal variance; TB15_91 (15-91 days' maturity treasury bill yield), 1YGSY (one-year G-Secs yield) 5YGSY (five-year G-Secs yield), 10YGSY (ten-year G-Secs yield), NDA (National Democratic Alliance), UPA (United Progressive Alliance)



Source: Authors' Calculations

Fig 2: Impact of GFC of 2008

Discussion

Two international financial crises, the dot-com bubble of 2001 and the GFC of 2008, are selected to study the impact on the G-Secs yield of various maturities. It is found that the GFC of 2008 has no significant effect on the short-term G-Secs yield, and the dot-com bubble of 2001 has no significant impact on the slope of the YC. Both the international financial crisis significantly impact all the three maturities of G-Secs yield and parameters of YC. The decrease average yield after the Dot-com bubble may be because of the fact that the economies have contracted after the crisis. Due to contraction, central banks, including the Indian central bank, have reduced the interest rates (RBI n.d.). The decrease in yield may also be because of the decline in inflation during the slowdown after the dot-com bubble. Average yields and volatility of yields in India increased after the GFC of 2008, which is opposite to the impact of dot-com bubble of 2001 in which average yields decreased and volatility increased. Although the change in average yields is significant in both the financial crisis, the direction of change is different.

Based on the data analysis discussed above, table 3 shows the results of hypothesis testing. Barring two hypotheses relating to the GFC of 2008 (H1a) and the dot-com bubble crisis 2001 (H2a) all hypotheses are accepted.

Table 3: Hypothesis testing results of impact of international financial crisis

S. No.	Hypothesis	Crisis	Result
1.	H1a: International financial crisis significantly influences the short-term Indian G-Secs yield.	Dot-Com Bubble 2001	Accepted
		GFC of 2008	Rejected
2.	H1b: International financial crisis significantly influences the medium-term Indian G-Secs yield.	Dot-Com Bubble 2001	Accepted
		GFC of 2008	Accepted
3.	H1c: International financial crisis significantly influences the long-term Indian G-Secs yield.	Dot-Com Bubble 2001	Accepted
		GFC of 2008	Accepted
4.	H2a: International financial crisis significantly influences the slope of the yield curve.	Dot-Com Bubble 2001	Rejected
		GFC of 2008	Accepted
5.	H2b: International financial crisis significantly influences the level of the yield curve.	Dot-Com Bubble 2001	Accepted
		GFC of 2008	Accepted
6.	H2c: International financial crisis significantly influences the curvature of the yield curve.	Dot-Com Bubble 2001	Accepted
		GFC of 2008	Accepted

Source: Authors' Calculations

Thus, study results indicate that investors should be careful in the international financial crisis as the direction of the change in yield and shape of YC is not clear after the crisis. In other words, investors should avoid investing in G-Secs during the financial crisis. Investors should wait, watch, and then invest at the time of the international financial crisis.

Conclusion

This paper aims to study the impact of the international financial crises on the Indian G-Secs yield of different maturities and the curvature, level, and slope of YC. The t-test and F-test are used to study the significant differences in yield and standard deviation (risk), respectively. The study considered two financial crises, i.e., the dot-com bubble of 2001 and the GFC of 2008. The study discovered that the international financial crisis significantly impacted the G-Secs yield and shape of the YC, except the GFC of 2008, which has no significant effect on the short-term G-Secs yield, and the Dot-com bubble of 2001, which has no significant impact on the slope of the YC. The findings indicate that average short, medium, and long-term G-Secs yield and level have significantly decreased after the dot-com bubble of 2001. Also, the average has increased for slope and curvature, but the increase is significant for curvature and not for the slope. Further, the fluctuations represented by the standard deviation have increased for one, five, and ten-year G-Secs' yield and level but decreased for treasury bills yield, slope, and curvature. This increase/decrease in standard deviation is not significant, as shown by the F-test values. The GFC of 2008 has no significant impact on the average short-term yield, whereas the average medium and long-term yield increased significantly after the GFC of 2008. However, the curvature of the YC decreased, and fluctuations in short-term yield, slope, and curvature of YC increased significantly after the financial crisis. These results warn the investors to invest carefully in the Indian G-Secs market during and after the fluctuations in the international economic environment. Investors should wait, watch, and then invest at the time of the international financial crisis. The study has measured the impact of two global financial crises, namely the dot-com bubble of 2001 and the GFC of 2008, on the G-Secs yield and shape of the YC. The impact of other political and economic crises in the world, such as the Asian financial crisis of 1997, the European sovereign debt crisis of 2010, the Covid-19 pandemic, etc., can be studied in future research.

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