

US Market Stressed Period Review

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Abstract

In this paper, we review typical rates and currency when market stressed. We start with a definition of market stressed period followed by historical review of US equity movements, gold price movements, US swap rates movements, basis spread movements and major currency movements. Specifically, for each stressed period, we measured US swap rate maturity 2Y, 10Y, 20Y, 30Y, spreads on 20Y-2Y, 20Y-10Y, 30Y-20Y, US OIS 5Y basis spread and currency JPY against USD. After each review section we would provide a summary table with key quantitative measurements. In the end of this review, we will examine all hedges with different periods and arrive a rank for each hedging method. Also, one step further, we will provide some possible hedging combinations and their performance.

Keywords: Market Stressed, Rates, Basis, Currency, Commodity

1. Market Stressed Period

1.1 Motivation and Overview

As a manager in tail risk hedging business, one of the important risk contributions comes from large liquidity squeeze. Financial market is built from four cornerstones: Stock market, Commodity market, Bond market and Currency market. As squeeze happened, money flow within-or-out the financial system which caused large movements of all financial products. As a starting point we are trying to narrow the subject to focus only on US equity, swap rates, OIS spread and JPYUSD price. Interest rates set the backbone of the whole system since it represents the cost of borrowing money and the opportunity cost of being lazy. To have a better understanding of rates movements provides us with deep knowledge of how to make correct and profitable strategies.

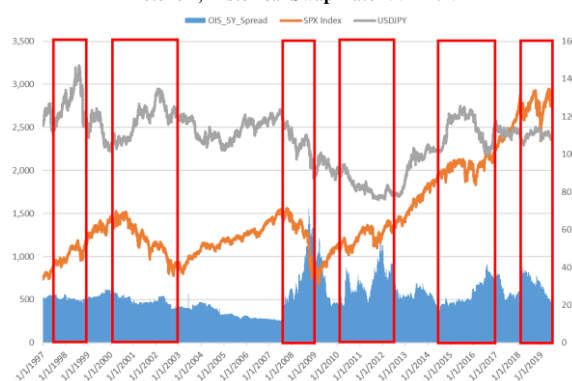
In this paper, we premierly focus on US market and try to demisfy classes of assets movements when there is a liquidity squeeze or market shock. To have a basic understanding and a well known effect that all rates starts to fall badly when there is a huge demand for liquidity in a short time. We should expect to see a large drop in all interests rates across the board, equity drops a lot, OIS spread may or may not be change a lot (that depends on the reason for a perticular shock) and JPY should appreciate a lot since they are the currency in haven.

In this section we will look back starting from 1995, and gave a general outlook of all historical liquidity shocks. (See pictures below).

***Because Dollar start from 2004, here use USDJPY as market sentiment measurement.**



Picture 1, Historical Swap Rate 1997-2019



Picture 2, Historical SP500, USDJPY and 5Y OIS Spread(bars) 1997-2019

- Period One, from the middle of 1997 to the end of 1998: Asian financial crisis(1997) and Russian financial crisis(1998).
- Period Two, from the end of 1999 to the middle of 2003: Dot-com bubble(2000-2002).
- Period Three, from the middle of 2007 to the end of 2008: World Wide Financial Crisis(2007-2009).
- Period Four, from the end of 2009 to the middle of 2012: European debt crisis(2010-2012).
- Period Five, from the end of 2013 to the middle of 2016: Russian financial crisis(2014) and Brazilian economic crisis(2014-2016).
- Period Six, from the end of 2018: Turkish currency and debt crisis(2018).

Basically there are five separated time window when the US market get liquidity squeeze and all of them closely related to market huge event(all types of crisis). In the next section we will review all these market crisis event and get a basic lead of when, how and why they are happening and key market movements during these squeezed period.

1.2 Review of market crisis events

In this section we will take a closer look on those market squzzed time and look into when, how and why they are happening and key market movements during these squeezed period. As following, listed in chronological order.

- 1997, Asian financial crisis and effects: The 1997–98 Asian financial crisis began in July 1997, Thailand and then quickly spread to neighbouring economies. It began as a currency crisis when Bangkok unpegged the Thai baht from the U.S. dollar, setting off a series of currency devaluations and massive flights of capital. In the first six months, the value of the Indonesian rupiah was down by 80 percent, the Thai baht by more than 50 percent, the South Korean won by nearly 50 percent, and the Malaysian ringgit by 45 percent. Collectively, the economies most affected saw a drop in capital inflows of more than \$100 billion in the first year of the crisis. Significant in terms of both its magnitude and its scope, the Asian financial crisis became a global crisis when it spread to the Russian and Brazilian economies.
- 1998, Russian financial crisis: The Russian financial crisis (also called Ruble crisis or the Russian Flu) hit Russia on 17 August 1998. It resulted in the Russian government and the Russian Central Bank devaluing the ruble and defaulting on its debt. The crisis caused by declining productivity, a high fixed exchange rate between the ruble and foreign currencies to avoid public turmoil, and a chronic fiscal deficit were the reasons that led to the crisis. The economic cost of the first war in Chechnya, estimated at \$5.5 billion (not including the rebuilding of the ruined Chechen economy), also contributed to the crisis. In the first half of 1997, the Russian economy showed some signs of improvement. However, soon after this, the problems began to gradually intensify. Two external shocks, the Asian financial crisis that had begun in 1997 and the following declines in demand for (and thus price of) crude oil and nonferrous metals, severely impacted Russian foreign exchange reserves. A political crisis came to a head in March when Russian president Boris Yeltsin suddenly dismissed Prime Minister Viktor Chernomyrdin and his entire cabinet on 23 March 1998. Yeltsin named Energy Minister Sergei Kiriyenko, then 35 years old, as acting prime minister.
- 2000—2002, Dot-com bubble: The dot-com bubble (also known as the dot-com boom, the tech bubble, and the Internet bubble) was a historic speculative bubble and period of excessive speculation mainly in the United States that occurred roughly from 1994 to 2000, a period of extreme growth in the use and adoption of the Internet. The Nasdaq Composite stock market index, which included many Internet-based companies, peaked in value on March 10, 2000, before crashing. The burst of the bubble, known as the dot-com crash, lasted from March 11, 2000, to October 9, 2004. During the crash, many online shopping companies, such as Pets.com, Webvan, and Boo.com, as well as communication companies, such as Worldcom, NorthPoint Communications and Global Crossing, failed and shut down. Others, such as Cisco, whose stock declined by 86%, and Qualcomm, lost a large portion of their market capitalization but survived, and some companies, such as eBay and Amazon.com, declined in value but recovered quickly.
- 2007—2009, World Wide Financial Crisis: The financial crisis of 2007–2008, also known as the global financial crisis and the 2008 financial crisis, is considered by many economists to have been the most serious financial crisis since the Great Depression of the 1930s. It began in 2007 with a crisis in the subprime mortgage market in the United States, and developed into a full-blown international banking crisis with the collapse of the investment bank Lehman Brothers on September 15, 2008. Excessive risk-taking by banks such as Lehman Brothers helped to magnify the financial impact globally. Massive bail-outs of financial institutions and other palliative monetary and fiscal policies were employed to prevent a possible collapse of the world financial system. The crisis was nonetheless followed by a global economic downturn, the Great Recession. The Asian markets (China, Hong Kong, Japan, India, etc.) immediately impacted and volatilized after the U.S. sub-prime crisis. The European debt crisis, a crisis in the banking system of the European countries using the euro, followed later.
- 2010-2012, European debt crisis: The European debt crisis (often also referred to as the eurozone crisis or the European sovereign debt crisis) is a multi-year debt crisis that has been taking place in the European Union since the end of 2009. Several eurozone member states (Greece, Portugal, Ireland, Spain and Cyprus) were unable to repay or refinance their government debt or to bail out over-indebted banks under their national supervision without the assistance of third parties like other eurozone countries, the European Central Bank (ECB), or the International Monetary Fund (IMF). As concerns intensified in early 2010 and thereafter, leading European nations implemented a series of financial support measures such as the European

Financial Stability Facility (EFSF) and European Stability Mechanism (ESM). The ECB also contributed to solve the crisis by lowering interest rates and providing cheap loans of more than one trillion euro in order to maintain money flows between European banks. On 6 September 2012, the ECB calmed financial markets by announcing free unlimited support for all eurozone countries involved in a sovereign state bailout/precautionary programme from EFSF/ESM, through some yield lowering Outright Monetary Transactions (OMT).

- 2014, The financial crisis in Russia in 2014–2015 was the result of the sharp devaluation of the Russian ruble beginning in the second half of 2014. A decline in confidence in the Russian economy caused investors to sell off their Russian assets, which led to a decline in the value of the Russian ruble and sparked fears of a Russian financial crisis. The lack of confidence in the Russian economy stemmed from at least two major sources. The first is the fall in the price of oil in 2014. Crude oil, a major export of Russia, declined in price by nearly 50% between its yearly high in June 2014 and 16 December 2014. The second is the result of international economic sanctions imposed on Russia following Russia's annexation of Crimea and the Russian military intervention in Ukraine.
- 2014–2016, Brazilian economic crisis: From mid 2014 to 2016, Brazil experienced a severe economic crisis. The economic crisis became coupled with a political crisis in Brazil that resulted in the impeachment of president Dilma Rousseff and in widespread dissatisfaction with the political system. In 2015, Brazil's gross domestic product (GDP) fell by 3.9% due to a drop in salaries, restrictions on credit and a rise in the basic interest rate. In 2016, Brazil's GDP fell by 3.6% with reductions across all sectors of the economy. It was the first time since 1931 that the GDP had fallen in two consecutive years.
- 2018–2019, Turkish currency and debt crisis: The Turkish currency and debt crisis of 2018 (Turkish: Türkiye döviz ve borç krizi) was a financial and economic crisis in Turkey. It was characterized by the Turkish lira (TRY) plunging in value, high inflation, rising borrowing costs, and correspondingly rising loan defaults. The crisis was caused by the Turkish economy's excessive current account deficit and large amounts of private foreign-currency denominated debt, in combination with President Recep Tayyip Erdoğan's increasing authoritarianism and his unorthodox ideas about interest rate policy.

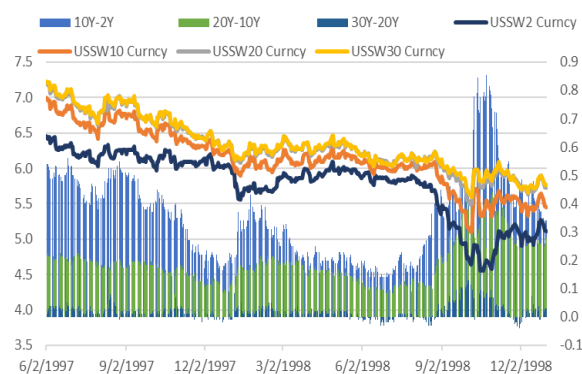
In this section, we provide several key market measurements to quantify market performance during squeezed period. We separate financial market into 4 different sectors; currency, bond(rates), equity and commodity. Different measure are applied ontop of these market as following with a focusing on US and US-related market:

- Currency market: USD currency index taken from Bloomberg (Ticker:BBDXY) , Individual currency against USD value taken from Bloomberg. USDJPY currency value taken from Bloomberg (Ticker:USDJPY)
- Equity market: S&P 500 index value taken from Bloomberg (Ticker:SPX index).
- Rates market: US swap rates with maturity 2,5,10,20,30 year taken from Bloomberg (Ticker:USSWX Curncy) and calculate spread by N swap rate – M swap rate. 5 year OIS basis spread taken from Bloomberg (Ticker:USBG5 Curncy).
- Commodity market: Gold price index taken from Bloomberg (Ticker:XAU Curncy).

The reason for these market instrument selection is simple: as the market gets a shock and the shock propagates to different market sectors and regions, investors general will flight-to-quality and flight-to-liquidity. The combined of the consequence would be a raise in USD, a drop in equity, a drop in rates plus narrow in rate spread and a raise in gold price and some effects in other assets price which can be derived from those basic asset movements. In the following are movement summaries listed in chronological order:

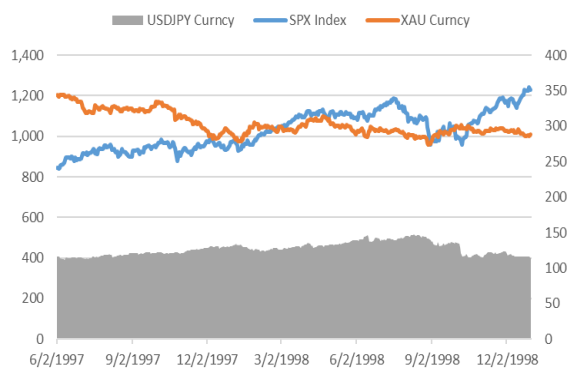
2.1 Period One, 1997-1998: Asian financial crisis and Russian financial crisis

*Time window for this period selected as Jun-1997 to Dec-1998.



Picture 3, Historical Swap Rate and Spread Rate 1997-1998

2. Quant-preview of Market During Squeezed Period



Picture 4, Historical Equity Index, Gold Price and FX 1997-1998

As shown in the above graph, during Asian financial crisis and Russian financial crisis the overall equity market stays calm ends up in the record high for US SP500(+45%). And gold price drops over 16%. However, JPY appreciated against USD over 2% in the same time. This really tells us the US market is actually seeing the Asian financial crisis as a regional event and market priced in the condition it will not propagate to US market. Investor increase their equity holdings may because the strong economic at that time. But as the currency market shown, FX investor indeed get nervous as the JPY, currency in the haven, appreciated against USD over 2%.

In the meantime, US fixed income market shows a sharp and large drop during the whole period, overall swap rate, including the OIS spread rate, drops around 140 bps across the board and rates spread 10Y-2Y narrowed by 20bps while the longer end spread widen by 2-7 bps.

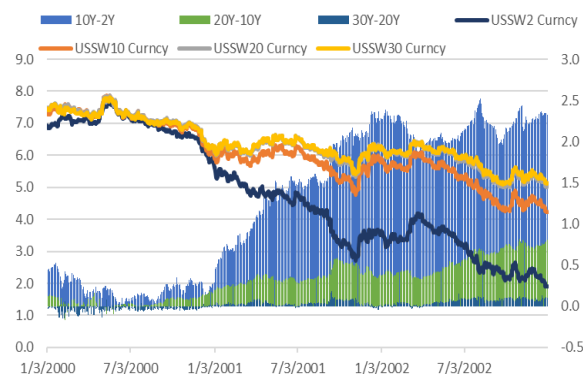
Asset Type	Changes	Std	Return/Std.	Max-Min	Return Skewness
SP500	45.2%	7.6%	5.9	402	-0.55
Dollar	---	---	---	---	---
USDJPY	-2.6%	8.0%	-0.3	36	-1.30
GOLD	-16.3%	5.7%	-2.9	70	-0.11
OIS Spread(BPS)	-2	1	-1.5	5	0.25
Swap 2Y(BPS)	-135	45	-3.0	191	-0.19
Swap 10Y(BPS)	-155	42	-3.7	190	0.46
Swap 20Y(BPS)	-148	38	-3.8	172	0.20
Swap 30Y(BPS)	-146	38	-3.8	163	0.18
10Y-2Y(BPS)	-20	15	-1.3	77	0.47
20Y-10Y(BPS)	7	7	0.9	44	-0.70
30Y-20Y(BPS)	2	3	0.7	22	0.01

Table 1, Summary of major assets class performance 1997-1998

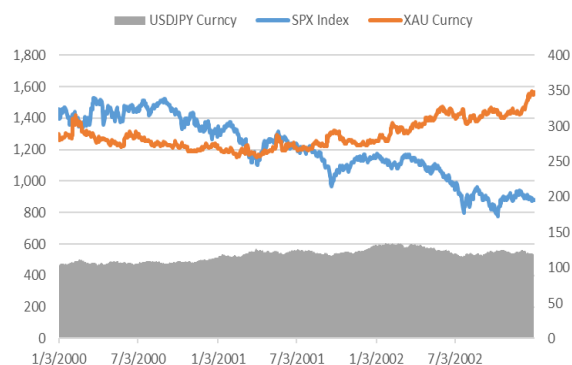
As shown in the summary table above, we take a look in the skewness, the last column, the largest two skewness in absolute value are USDJPY and 20Y-10Y spread, meaning during the stressed period their return distribution are pretty asymmetric and can be used as potential hedging instruments.

2.2 Period Two, 2000-2002: Dot-com bubble

*Time window for this period selected as Jan-2000 to Dec-2002.



Picture 5, Historical Swap Rate and Spread Rate 2000-2002



Picture 6, Historical Equity Index, Gold Price and FX 2000-2002

As shown in the above graph, during Dot-Com crisis the overall equity market drops a lot for US SP500(-39%). And gold price rose over by 20%. However JPY depreciated against USD over 17% in the same time. This tells us as equity market get nervous gold price rose a lot in the same time which could be a good hedge to that but the JPY currency is not responding to this market shock. In other words, FX market is pricing in the expectation that this Dot-Com crisis is a US regional event will not propagate to a world-wide range. In the meantime, US fixed income market shows a sharp and large drop during the whole period, overall swap rate, including the OIS spread rate, drops around 200-500 bps across the board and rates spread 10Y-2Y widen by 189bps while the longer end spread widen by 10-70 bps.

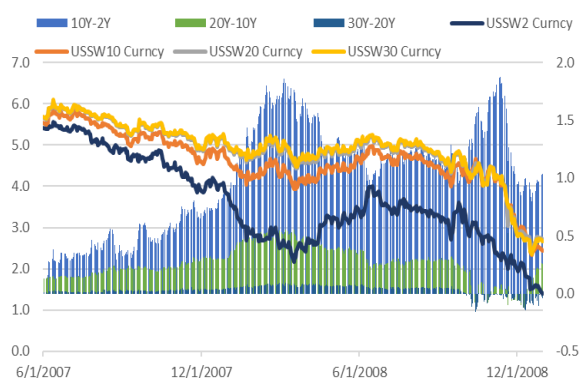
Asset Type	Changes	Std	Return/Std.	Max-Min	Return Skewness
SP500	-39.5%	22.4%	-1.8	751	0.26
Dollar	---	---	---	---	---
USDJPY	17.1%	7.1%	2.4	33	-0.15
GOLD	20.4%	5.8%	3.5	94	1.49
OIS Spread(BPS)	-6	2	-2.6	9	-0.77
Swap 2Y(BPS)	-503	175	-2.9	577	0.09
Swap 10Y(BPS)	-314	94	-3.3	365	0.39
Swap 20Y(BPS)	-243	71	-3.4	286	0.37
Swap 30Y(BPS)	-230	67	-3.4	272	0.53
10Y-2Y(BPS)	189	87	2.2	252	0.07
20Y-10Y(BPS)	70	24	3.0	98	0.23
30Y-20Y(BPS)	13	5	2.5	33	0.50

Table 2, Summary of major assets class performance 2000-2002

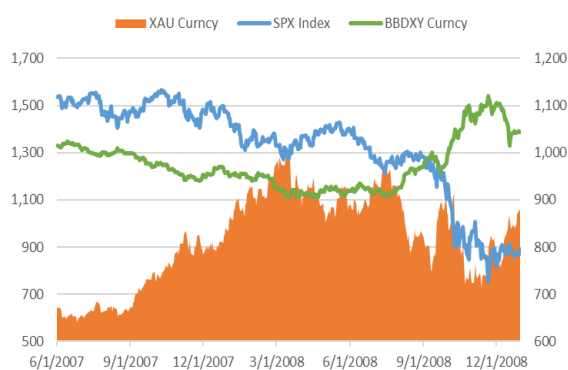
As shown in the summary table above, we take a look in the skewness, the last column, Gold price returns has a very large positive skewness meaning its return distribution shows some very large gain during the stressed period and can be used as potential hedging instruments.

2.3 Period Three, 2007-2009: World wide financial crisis

*Time window for this period selected as Jun-2007 to Dec-2008.



Picture 7, Historical Swap Rate and Spread Rate 2007-2008



Picture 8, Historical Equity Index, Gold Price and FX 2007-2008

As shown in the above graph, during World wide financial crisis the overall equity market drops a lot for US SP500(-42%). And gold price rose over by 30%. And US dollar index rose by 2.7% in the ending time. This tells us as equity market get nervous gold price rose a lot in the same time. And in the end time of this crisis, US dollar gets stronger again as investor flight to US again. In other words, when the crisis starts to happen, equity market reponces quickly and intensely along with gold price raising and rates dropping in the same time. Until the end of the crisis, FX market is not reflecting as the dollar index stays calm. But eventually to the ending time of the crisis, dollar index raise huge to reflect the flight-to-quality movements.

In the meantime, US finxed income market shows a sharp and large drop during the whole period, overall swap rate, including the OIS spread rate, drops around 300 bps across the

board and rates spread 10Y-2Y widen by 91bps, 20Y-10Y widen by 13bps while the 30Y-20Y narrowed by 5bps.

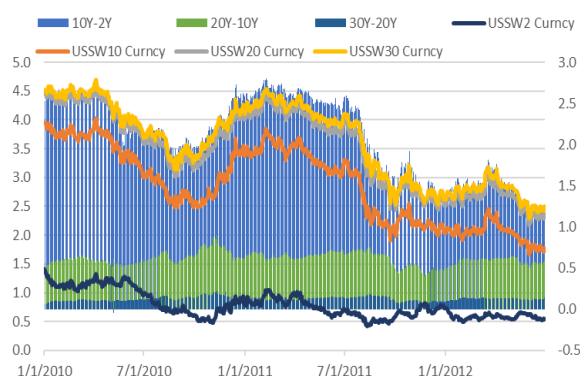
Asset Type	Changes	Std	Return/Std.	Max-Min	Return Skewness
SP500	-42.0%	22.7%	-1.8	813	0.14
Dollar	2.7%	5.0%	0.5	215	-0.32
USDJPY	-26.0%	8.9%	-2.9	37	0.24
GOLD	30.1%	11.1%	2.7	362	0.30
OIS Spread(BPS)	29	15	2.0	59	0.01
Swap 2Y(BPS)	-399	103	-3.9	414	-0.10
Swap 10Y(BPS)	-309	69	-4.5	360	-0.38
Swap 20Y(BPS)	-296	71	-4.2	364	-0.53
Swap 30Y(BPS)	-301	73	-4.1	374	-0.28
10Y-2Y(BPS)	91	45	2.0	177	-0.87
20Y-10Y(BPS)	13	15	0.8	67	-0.67
30Y-20Y(BPS)	-5	5	-1.0	69	1.61

Table 3, Summary of major assets class performance 2007-2009

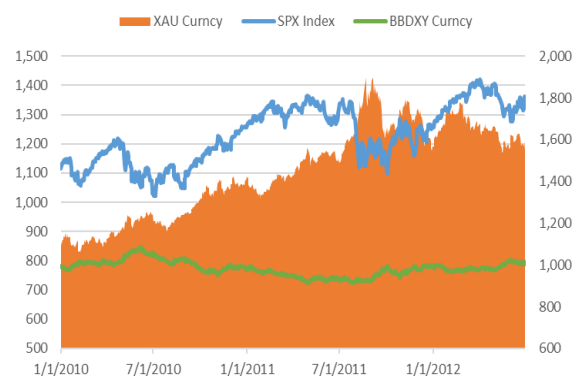
As shown in the summary table above, we take a look in the skewness, the last column, the 30Y-20Y spread, 20Y-10Y and 10Y-2Y spread all have large skewness in absolute value, we look into *Picture 7, the bottom bar plot (very small to see) is the actual 30Y-20Y spread and in the ending time this spread is actually goes into negative but it indeed shows a few days with quiet large positive spreads value and that feature gives us the large positive skewness. They can be considered as hedging instruments in this case.

2.4 Period Four, 2010-2012: European debt crisis

*Time window for this period selected as Jan-2010 to Jun-2012.



Picture 9, Historical Swap Rate and Spread Rate 2010-2012



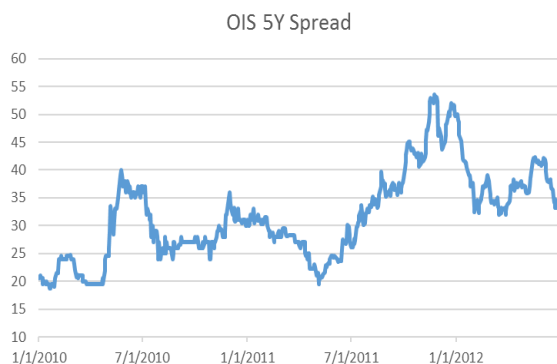
Picture 10, Historical Equity Index, Gold Price and FX 2010-2012

As shown in the above graph, during European debt crisis the overall equity market even rose by 22% for US SP500. And gold price rose over by 45%. And US dollar index stays calm by only increase 1%. This really tells us the US market is actually seeing the European debt crisis as a regional event and market priced in the condition it will not propagate to US market. Investor increase their equity holdings may because the strong economic at that time. The overall dollar stay relative the same value also indicate that this crisis should be a region event. In this case, the gold still rose in price because investor in Euro pushing up the demand a lot.

In the meantime, US fixed income market shows a sharp and large drop during the whole period, overall swap rate, drops around 100-200 bps across the board and rates spread 10Y-2Y narrowed by 131bps, 20Y-10Y widen by 9bps while the 30Y-20Y widen by 8bps. This crisis really drives the attention on OIS spread which can be seen from here it is widen by 13bps. As the summary table and actual OIS spread plot below.

Asset Type	Changes	Std	Return/Std.	Max-Min	Return Skewness
SP500	22.2%	7.3%	3.0	396	-0.35
Dollar	1.0%	3.6%	0.3	172	0.36
USDJPY	-14.2%	6.3%	-2.3	19	0.36
GOLD	45.6%	13.6%	3.3	837	-0.45
OIS Spread(BPS)	13	8	1.6	35	-0.33
Swap 2Y(BPS)	-86	23	-3.8	98	0.09
Swap 10Y(BPS)	-218	66	-3.3	235	0.18
Swap 20Y(BPS)	-209	68	-3.1	241	0.01
Swap 30Y(BPS)	-201	68	-3.0	241	-0.07
10Y-2Y(BPS)	-131	49	-2.7	176	0.12
20Y-10Y(BPS)	9	8	1.1	49	-0.63
30Y-20Y(BPS)	8	3	2.8	26	-0.83

Table 4, Summary of major assets class performance 2010-2012

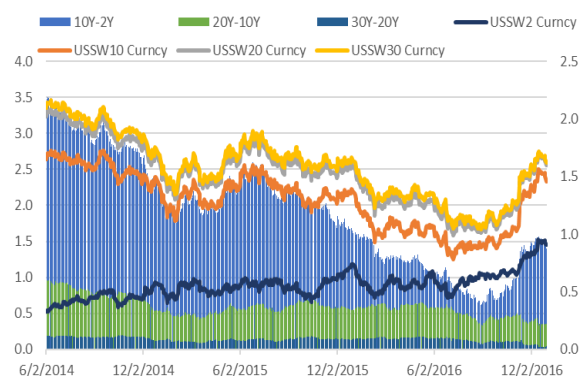


Picture 11, Historical OIS 5Y Spread 2010-2012

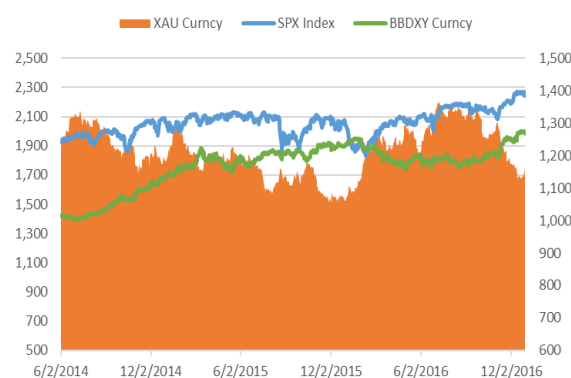
As shown in the summary table above, we take a look in the skewness, the last column, the return skewness for 20Y-10Y and 30Y-20Y spread are relatively large and they can be considered as potential hedging instruments.

2.5 Period Five, 2014-2016: Russian financial crisis(2014) and Brazilian economic crisis(2014-2016).

*Time window for this period selected as Jun-2014 to Dec-2016.



Picture 12, Historical Swap Rate and Spread Rate 2014-2016



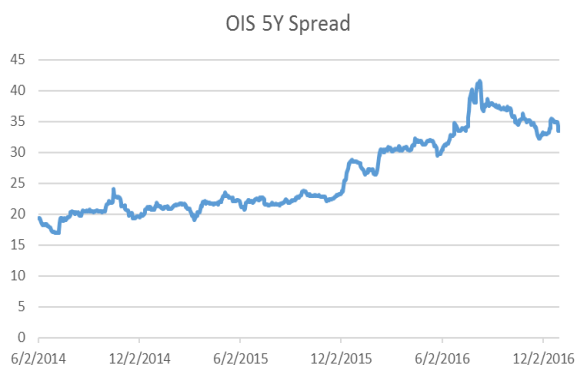
Picture 13, Historical Equity Index, Gold Price and FX 2014-2016

As shown in the above graph, during Russian and Brazil crisis the overall US equity market even rose by 16% for US SP500. And gold price dropped over 7%. And US dollar index increased a lot over 24%. This really tells us the US market is actually seeing the Russian and Brazil crisis as a regional event and market priced in the condition it will not propagate to US market. Investor increase their equity holdings may because the strong economic at that time. Also some investor from offshore invest in US equity and bond market which drives the rates down all across the board.

In the meantime, US fixed income market shows a sharp and large drop in the long end and a raise in short end, overall swap rate, raises 93 bps in short end and drops around 30-70 bps starting from 10 years and rates spread 10Y-2Y narrowed by 123bps, 20Y-10Y widen by 37bps while the 30Y-20Y widen by 9bps. This crisis really drives the attention on OIS spread which can be seen from here it is widen by 14bps. As the summary table and actual OIS spread plot below.

Asset Type	Changes	Std	Return/Std.	Max-Min	Return Skewness
SP500	16.3%	3.9%	4.2	443	-0.25
Dollar	24.9%	5.4%	4.6	274	-0.23
USDJPY	14.2%	6.7%	2.1	26	-0.54
GOLD	-7.8%	6.6%	-1.2	315	0.41
OIS Spread(BPS)	14	6	2.3	25	0.79
Swap 2Y(BPS)	93	17	5.3	100	-0.42
Swap 10Y(BPS)	-30	39	-0.8	151	0.14
Swap 20Y(BPS)	-67	44	-1.5	176	0.24
Swap 30Y(BPS)	-76	45	-1.7	179	0.27
10Y-2Y(BPS)	-123	47	-2.6	180	0.38
20Y-10Y(BPS)	-37	9	-4.4	40	-0.16
30Y-20Y(BPS)	-9	2	-4.4	10	-0.39

Table 5, Summary of major assets class performance 2014-2016

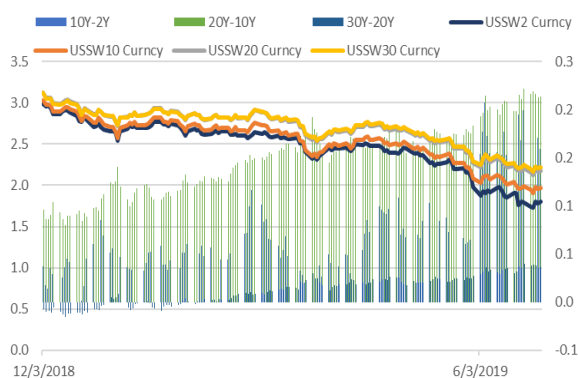


Picture 14, Historical OIS 5Y Spread 2014-2016

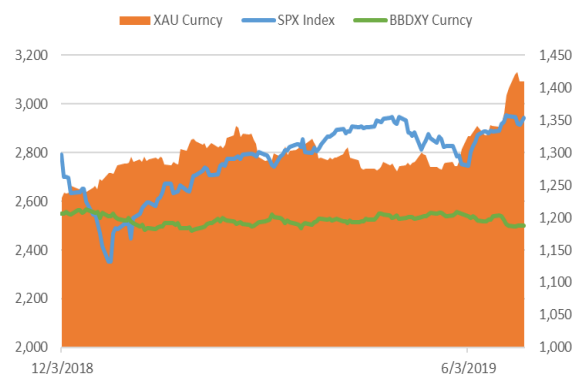
As shown in the summary table above, we take a look in the skewness, the last column, there is no large positive skewness during this period but the max-min is large for this period meaning the market is in a directional move as the rates continued dropped and OIS spread widen.

2.6 Period Six, 2018-now: Turkish currency and debt crisis(2018).

*Time window for this period selected as Dec-2018 to June-2019.



Picture 15, Historical Swap Rate and Spread Rate 2018-2019



Picture 16, Historical Equity Index, Gold Price and FX 2018-2019

As shown in the above graph, during Russian and Brazil crisis the overall US equity market even rose by 5% for US SP500. And gold price rose over 14%. And US dollar index dropped over 1%. As the Turkish crisis happened, US market first gave it a sharp drop and corrects itself in a few weeks and eventually ends up highest level(+5%). Dollar performed pretty stable during crisis time but gold went up a lot by +14%. The reason behind this would be a geo-crisis pushed up short-term gold demand but not propagate enough to influence US market. Quant-driven investors seems to hedge their long gold positions by shorting some dollar and that gave a slightly down movements.

In the meantime, US fixed income market shows a stable down movement all across the board about 100bps and rates spread 10Y-2Y widen by 12bps, 20Y-10Y widen by 12bps while the 30Y-20Y widen by 4bps. Since this type of region crisis is not effecting US bank system, so OIS rate is calm during this period eventually end up 10bps narrower.

Asset Type	Changes	Std	Return/Std.	Max-Min	Return Skewness
SP500	5.4%	4.8%	1.1	603	0.25
Dollar	-1.6%	0.6%	-2.5	32	-0.21
USDJPY	-5.1%	1.4%	-3.6	6	-0.51
GOLD	14.5%	2.5%	5.8	193	0.29
OIS Spread(BPS)	-10	3	-3.0	11	-0.13
Swap 2Y(BPS)	-119	30	-3.9	126	-0.56
Swap 10Y(BPS)	-106	27	-4.0	112	0.24
Swap 20Y(BPS)	-95	24	-4.0	100	0.24
Swap 30Y(BPS)	-90	22	-4.1	95	0.25
10Y-2Y(BPS)	12	4	2.8	21	0.64
20Y-10Y(BPS)	12	4	3.3	14	-0.01
30Y-20Y(BPS)	4	1	3.0	5	-0.01

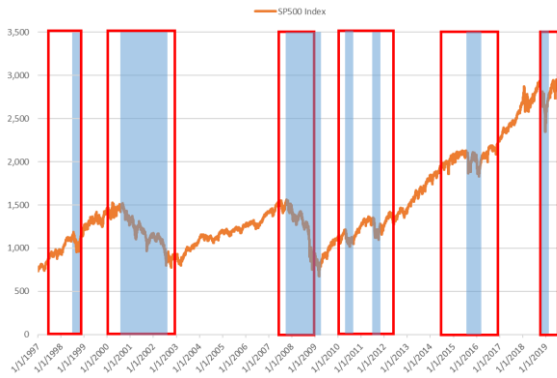
Table 6, Summary of major assets class performance 2018-2019

As shown in the summary table above, we take a look in the skewness, the last column, the 10Y-2Y returns has a relatively large skewness meaning during the stressed period this spread has asymmetric distribution and can be used as hedging instruments.

3. Summary and Conclusion

3.1 Summary of major assets class performance

In this section we began with a summary of previous review and with a focus on equity market downside risk we also quantified the largest six equity drop periods and compare with market crisis periods.

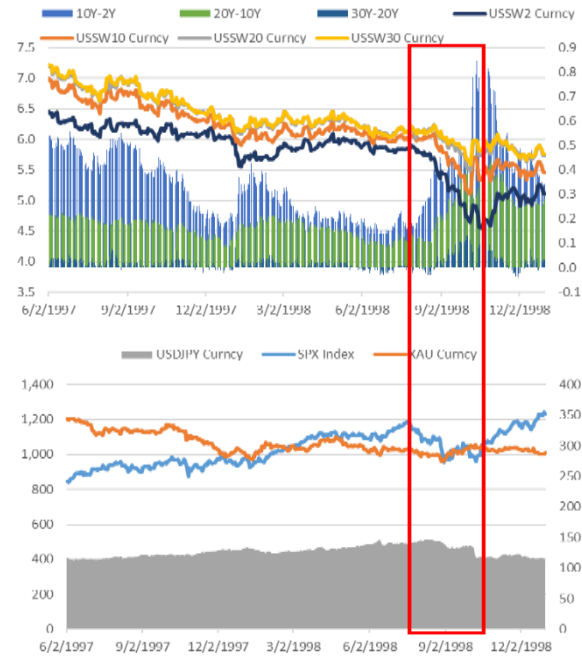


Picture 17, Historical Equity Drop & Stressed Period Compare

Period	Event	Equity Crash Period	Possible Hedge
Jun-1997 to Dec-1998	Asian and Russian financial crisis	Aug-1998 to Oct-1998	10Y-2Y/USDJPY
Jan-2000 to Dec-2002	Dot-com bubble	Jun-2000 to Oct-2002	10Y-2Y/GOLD
Jun-2007 to Dec-2008	World wide financial crisis	Oct-2007 to Jan-2009	10Y-2Y/GOLD
Jan-2010 to Jun-2012	European debt crisis	May-2010 & Aug-2011	GOLD
Jun-2014 to Dec-2016	Russian and Brazilian financial crisis	Jul-2015 & Jan-2016	DOLLAR
Dec-2018 to June-2019	Turkish currency and debt crisis	Dec-2018 to Jan-2019	10Y-2Y/USDJPY

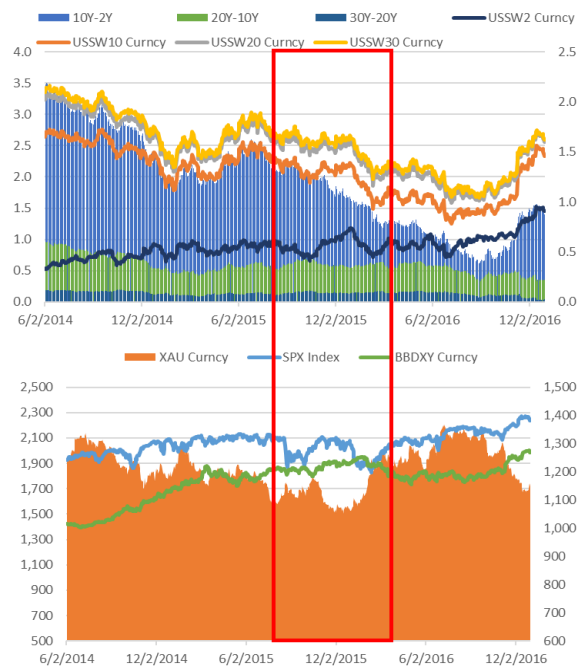
Table 7, Summary of historical equity Drop & stressed period compare

Our selection for possible hedges based on the following basic conditions: When the market gets a shock, investors will do flight-to-quality trades and that generally is a combination of equity sell-off, short-term bond over-buy, long-term bond over-sell, currency in haven over-buy, gold over-buy and some geo-political currency directional move. So, we assume our portfolio is pre-hedged with the above movemens and take a quick look of how they performed during stressed period. The best one here is selected as possible hedge. Even when the overall equity ends up at highest level for a given period, we still can find a possible hedge for its volatility, for example, see the first stressed period 1997-1998: Asian financial crisis and Russian financial crisis. During that time US SP500 ends up a 45% gain however, in the lower half of the period, it had a sharp a quick correction.(see picture 4) And in the same time, the overall rates market drops a lot combined with a widen in the rate spreads. (See below picture)



Picture 18, Equity correction and rates market compare

Also, for period 2014-2016, the equity market ends up +16%. But during the period, it has two large and fast corrections (See below pictures). Here, rate spreads get narrower but gold price indeed response to these corrections.



Picture 19, Equity correction and rates market compare

On another perspective, let's look into the summary of all assets returns with different stressed periods.

Asset Class	Jun-1997 to Dec-1998	Jan-2000 to Dec-2002	Jun-2007 to Dec-2008	Jan-2010 to Jun-2012	Jun-2014 to Dec-2016	Dec-2018 to Jun-2019
SP500	45.24%	-39.54%	-42.03%	22.16%	16.30%	5.43%
Dollar	---	---	2.75%	0.96%	24.89%	-1.61%
USDJPY	-2.60%	17.09%	-26.01%	-14.24%	14.24%	-5.11%
GOLD	-16.32%	20.43%	30.07%	45.57%	-7.75%	14.54%
OIS Spread(BPS)	-1.5	-5.8	29.0	13.0	14.1	-9.6
10Y-2Y(BPS)	-20.0	189.0	90.7	-131.1	-123.2	12.2
20Y-10Y(BPS)	6.5	70.3	12.5	8.6	-37.3	11.7
30Y-20Y(BPS)	2.0	13.0	-4.8	7.6	-9.1	4.4

Table 8, Summary of assets performance with different stressed periods

On another perspective, let's look into the summary of all assets returns with different stressed periods. There are totally 6 times of market stressed periods, and gold price response to 4 out of them. (The only two remaining ones when equity goes up instead of down.) So if we only look into a good hedge to equity, gold price should be on the list definitely. Now, let's look into the spread movements during stressed periods. For 6 stressed periods, 10Y-2Y rates widened 3 times with average around 97bps, and it narrowed 3 times with average around -91bps. As shown in the above summary table see row 6. 20Y-10Y widened 5 times with average around 22bps, and narrowed 1 times with -37bps. And 30Y-20Y widened 4 times with average around 7bps and narrowed 2 times with average around -7bps. Gold price up 4 periods with average around 27% and down for 2 periods average around -12%. USDJPY currency up 4 periods with average around 12% and down 2 periods with average around -16%. (See the summary table below)

Asset Class	Up Ratio	Average Up Returns	Down Ratio	Average Down Returns
USDJPY	67%	12%	33%	-16%
GOLD	67%	27%	33%	-12%
OIS Spread(BPS)	50%	19	50%	-6
10Y-2Y(BPS)	50%	97	50%	-91
20Y-10Y(BPS)	83%	22	17%	-37
30Y-20Y(BPS)	67%	7	33%	-7

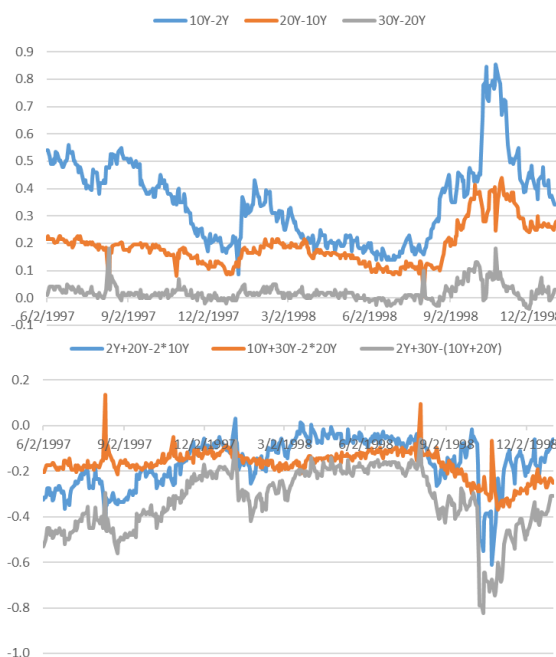
Table 9, Summary of assets performance Capture Ratios and Returns

Conclusion, for equity hedge gold price performed the best given its high capture ratio and high average positive response and low average negative response. If we use either 10Y-2Y, 20Y-10Y or 30Y-20Y hedge the capture ratio is not bad especially for 30Y-20Y but the average positive response is almost the same as average negative response meaning longing the spread will give some small gain and possible large loss in the stressed period. But if one just simply reverse the direction for the spread trade, the average capture rate will be too low in order for the trade to be considered as a down side hedge. Probably a combination of spread trades will work both showing a high capture ratio and large average positive response and small average negative response.

3.2 Dig into rates curvature: Slope&Convexity

In this section we look more closely into interest rate curvature: slope and convexity. We will examine slope as the following: 10Y-2Y, 20Y-10Y, 30Y-20Y. Convexity defined as the following: $2Y+20Y-2*10Y$, $10Y+30Y-2*20Y$, $2Y+30Y-(10Y+20Y)$. In the following we will present historical movements graph with key feature summary.

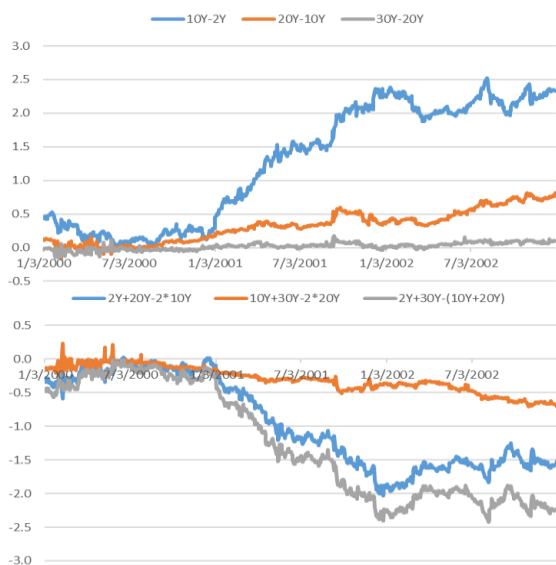
➤ Period One, 1997-1998: Asian financial crisis and Russian financial crisis



Picture 20, Period One Curvature Plot

In the first period, the curve first goes flat in the beginning, as measured by short end spread like 10Y-2Y goes from 50bps to only 15bps in the middle of 1998. However, the middle term and longer term seems to be stable. After the middle part of 1998, starting about Sep. 1998, the curve starts to go steepening as measured by both 10Y-2Y and 20Y-10Y. The 10Y-2Y spread hit record high at about Oct. 1998 with 80bps. Also as we see in the 20Y-10Y spread, it is stable in the beginning of the crisis however, suddenly becomes steepening in the lower half of 1998 from 10bps all the way goes to 40bps. In terms of convexity, the curve first flattens when the shock happens, and at around the same time it goes very convex in the lower half of 1998. But the curvature feature comes quickly and goes away quickly. The pick of both steepening and convexity lasts only a few weeks and suddenly goes away.

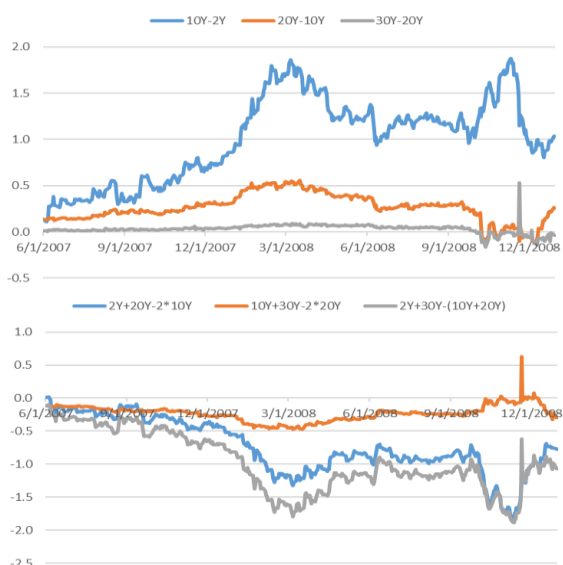
➤ Period Two, 2000-2002: Dot-com bubble



Picture 21, Period Two Curvature Plot

In the second period, curve first goes flat in the beginning, as measured by short end spread like 10Y-2Y goes from 50bps to only 1bps in the middle of 2000. However, the middle term and longer term seems to be stable. After the middle part of 1998, starting about Jan.2001 curve starts to go steeping as measured by both 10Y-2Y and 20Y-10Y. The 10Y-2Y spread hit record high at about Aug. 2002 with 250bps. Also as we see in the 20Y-10Y spread, it is stable in the beginning of the crisis however, suddenly becomes steeping in the lower half of 2000 from 1bps all the way goes to 40bps. In terms of convexity, the curve first linearly when the shock happens, and at around the same time it goes very convex in the lower half of 2001. This time, both the slope and convexity last longer enough until 2003.

➤ Period Three, 2007-2009: World wide financial crisis



Picture 22, Period Three Curvature Plot

In the third period, curves all the way go steeping since middle of 2007, the most trendy one in the short end as measured by 10Y-2Y. The far longer end is quiet stable 30Y-20Y. This time the slope shows steeping quick and reverse parts of it also quick. For the longer end, at the end of 2008 it even goes into invert as shown in the orange and gray lines. In terms of convexity, the curve first linearly when the shock happens, and at around the same time it goes very convex in the lower half of 2008. This time, only the short end slope and convexity last longer enough until 2009.

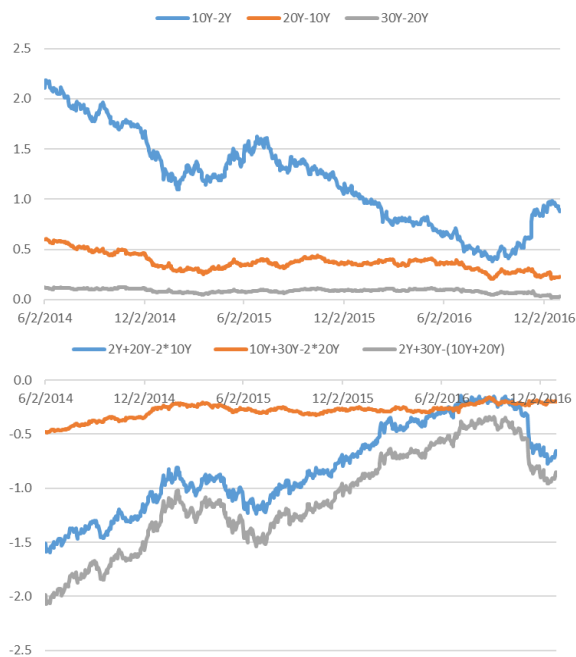
➤ Period Four, 2010-2012: European debt crisis



Picture 23, Period Four Curvature Plot

In the fourth period, curves all the way go flatting since beginning of 2010, the most trendy one in the short end as measured by 10Y-2Y. The far longer end is quiet stable 30Y-20Y. This time the curve goes flatting all the way until 2012. In terms of convexity, the convexity continues to decrease until 2012.

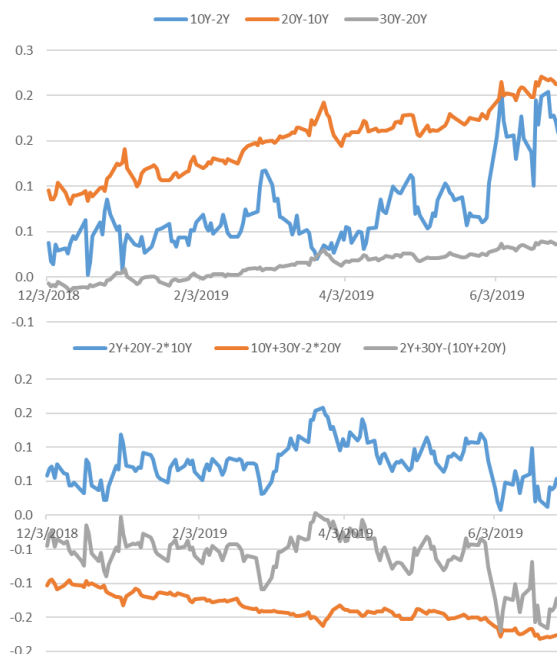
➤ Period Five, 2014-2016: Russian financial crisis(2014) and Brazilian economic crisis(2014-2016)



Picture 24, Period Five Curvature Plot

In the fifth period, curves all the way go flatting since beginning of 2014, the most trendy one in the short end as measured by 10Y-2Y. The far longer end is quiet stable 30Y-20Y. This time the curve goes flatting all the way until 2016. In terms of convexity, the convexity continues to decrease until 2016.

- Period Six, 2018-now: Turkish currency and debt crisis(2018)



Picture 25, Period Six Curvature Plot

In the sixth period, curves go gradually steeping with a huge volatility, the most trendy one in the short end as measured by 20Y-10Y. The far longer end is quiet stable 30Y-20Y. This time the curve goes flatting all the way until 2019. In terms of convexity, the convexity continues to decrease until 2019.