INTERPOLATION SELECTION FOR USD SOFR

SUMMIT TRICKS AND TRAPS

SERIES - 1 / ARTICLE - 8

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1. Introduction

The purpose of this document is to analyze the performance of different candidate interpolation methods in Summit to find the best interpolation method to build a smooth USD SOFR zero curve. This is used as a benchmark for comparison purposes.

A lot of interpolation methods for curve bootstrap exist in Summit.

In this section, we will focus on studying the selected candidates bootstrapping methodologies in Summit:

- Raw and Continuous
- Raw and Hermite
- Par and Continuous
- Par and Hermite

And Bloomberg Smooth Forwards interpolation methodology will be used as the benchmark approach.

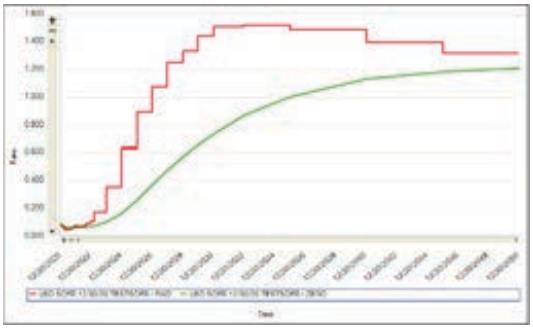
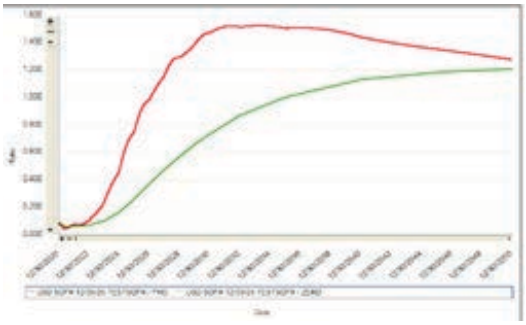
2. USD SOFR – Curve Definition

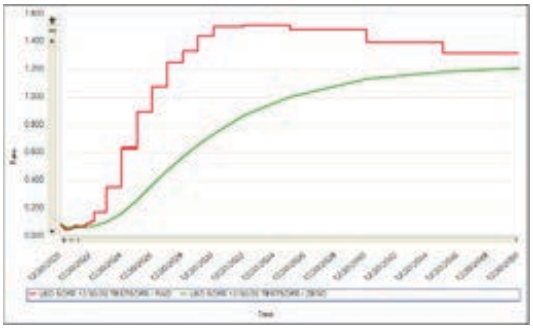
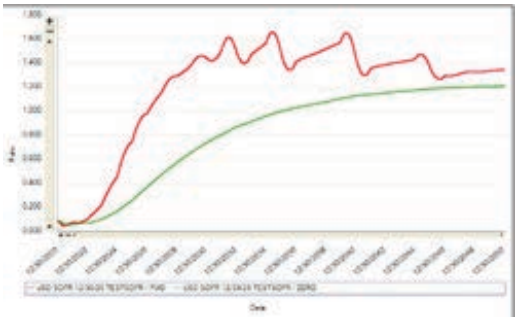
To compare apples with apples, the only variable would be the interpolation method, and the zero curve will be constructed with the same instrument. For USD SOFR, the money market 1D point, serial 1 1M-SOFR Futures Contract, Serial 1~8 3M-SOFR Futures Contract, and SOFR Swap after 2Y will be used.

Summit Segment	Tenor	Bloomberg Ticker
MM	1D	SOFRRATE
FUT 1M	Jan21	SERF1
FUT 3M	Dec21	SFRZ1
	Mar21	SFRH1
	Jun21	SFRM1
	Sep21	SFRU1
	Dec21	SFRZ1
	Mar22	SFRH2
	Jun22	SFRM2
	Sep22	SFRU2
AVA	2Y	USOSFR2
	4Y	USOSFR4
	5Y	USOSFR5
	6Y	USOSFR6
	7Y	USOSFR7
	8Y	USOSFR8
	9Y	USOSFR9
	10Y	USOSFR10
	12Y	USOSFR12
	15Y	USOSFR15
	20Y	USOSFR20
	25Y	USOSFR25
	30Y	USOSFR30

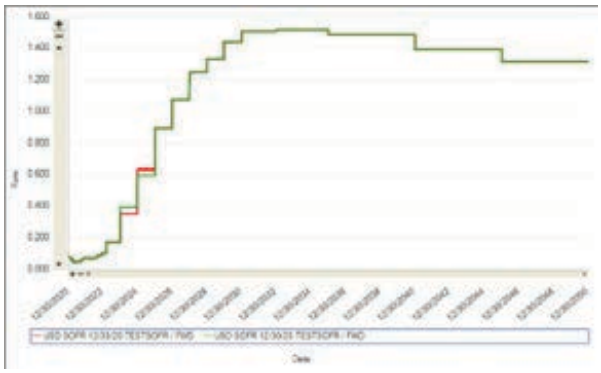
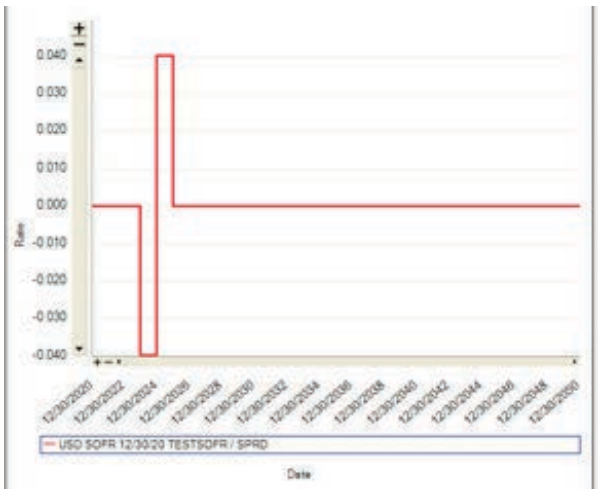
As for the comparison measurement, Hagan's criteria and instrument recalibration will be used.

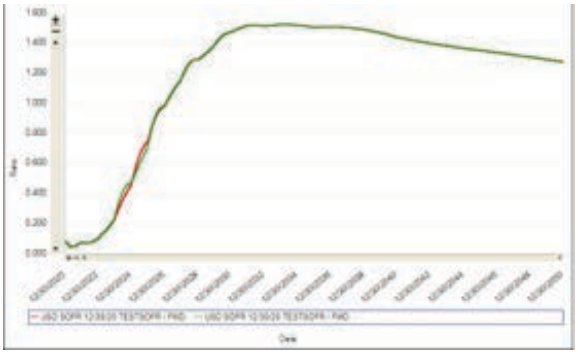
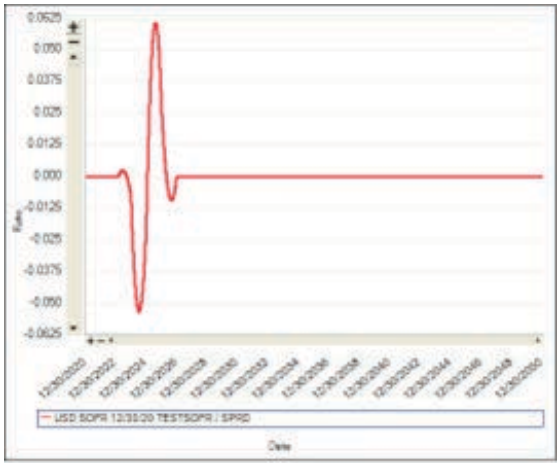
2.1 Hagan's Criteria - Forward Curve Shape

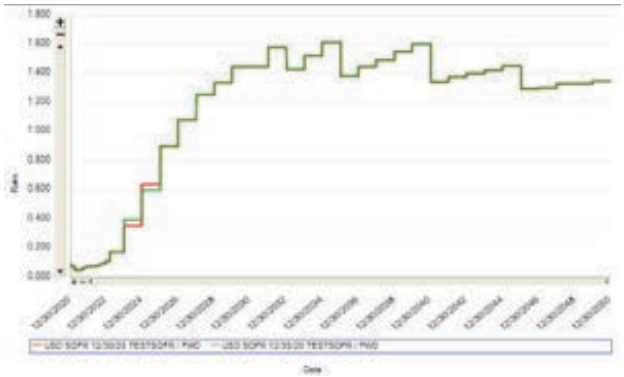
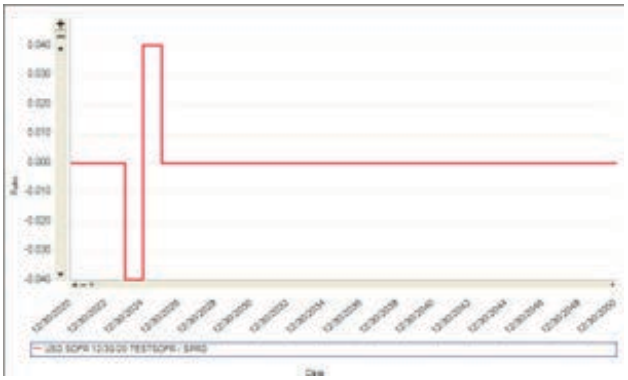
Interpolation Type	Shape of Fwd Curve	Comments
Raw and Continuous		Forward curve is very smooth.
Raw and Hermite		Forward curve is very smooth.

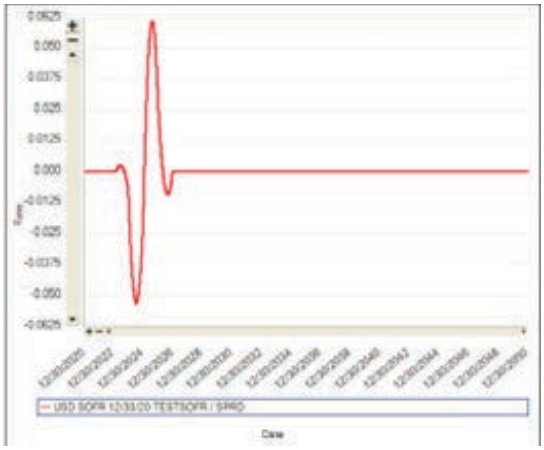
Interpolation Type	Shape of Fwd Curve	Comments
Par and Cont		Forward curve has a saw-tooth structure, with periodical fluctuations from the mid to long end.
Par and Hermite		Forward curve has a saw-tooth structure, with periodical fluctuations from the mid to long end.

2.2 Hagan's Criteria - Locality

Method	Effect of changing 4Y swap by 1bp	Comments
Raw and Continuous	 	Increasing the 4Y swap rate by 1bp does not significantly change the shape of the daily 1D FWD curve, this indicates good locality and stability.

Method	Effect of changing 4Y swap by 1bp	Comments
Raw and Hermite	 	Increasing the 4Y swap rate by 1bp does not significantly change the shape of the daily 1D FWD curve, this indicates good locality and stability.

Method	Effect of changing 4Y swap by 1bp	Comments
Par and Continuous	 	Increasing the 4Y swap rate by 1bp does not significantly change the shape of the daily 1D FWD curve, this indicates good locality and stability.

Method	Effect of changing 4Y swap by 1bp	Comments
Par and Hermite	 	Increasing the 4Y swap rate by 1bp does not significantly change the shape of the daily 1D FWD curve, this indicates good locality and stability.

2.3 Hagan's Criteria – Stability

Increasing the 4Y swap rate by 1bp, the maximum changes in the forward trade from the curve is as follows.

Interpolation Method	Maximum Abs Changes in Forward Rate
Raw and Continuous	4.03321 bps
Raw and Hermite	6.086752 bps
Par and Continuous	4.03321 bps
Par and Hermite	6.086752 bps

All four interpolation methodologies show good stability.

2.4 Instrument Recalibration

- Break-even Rate Comparison

Swap details:
Notional: 10MM.
Pay Leg: X, Annually Payment, USD SOFR Discounting.
Receive Leg: USD SOFR(Compounded), Annually Payment, USD SOFR Discounting.
Solve X to price Swap at Par.

As shown in the below table, Raw and Hermite interpolation gave the best performance.

Maturity	Interpolation Method	Market Data quo	Break-even Rate with MKT Point	Break-even Rate w/o MKT Point	Diff In bps
3Y	BB – Smooth Fwd	0.0988	0.0988	0.130929	3.21
	Summit – Raw and Cont	0.0988	0.0988	0.13092	3.21
	Summit – Raw and Hermite	0.0988	0.0988	0.10417	0.54
	Summit – Par and Cont	0.0988	0.0988	0.11537	1.66
	Summit – Par and Hermite	0.0988	0.0988	0.11537	1.66
15Y	BB – Smooth Fwd	0.9725	0.9725	0.969542	(0.30)
	Summit – Raw and Cont	0.9725	0.9725	0.96925	(0.33)
	Summit – Raw and Hermite	0.9725	0.9725	0.9721	(0.04)
	Summit – Par and Cont	0.9725	0.9725	0.93808	(3.44)
	Summit – Par and Hermite	0.9725	0.9725	0.93808	(3.44)
30Y	BB – Smooth Fwd	1.17055	1.17055	1.170614	0.01
	Summit – Raw and Cont	1.17055	1.17055	1.15004	(2.05)
	Summit – Raw and Hermite	1.17055	1.17055	1.15004	(2.05)
	Summit – Par and Cont	1.17055	1.17055	1.15004	(2.05)
	Summit – Par and Hermite	1.17055	1.17055	1.15004	(2.05)

- MTM Comparison

Swap details:

Notional: 10MM.

Pay Leg: 10%, Annually Payment, USD SOFR Discounting.

Receive Leg: USD SOFR(Compounded), Annually Payment, USD SOFR Discounting.

As shown in the below table, Raw and Hermite interpolation gave the best performance.

Maturity	Interpolation method	Fixed Rate	Break-even Rate	DV01	MTM w mkt	MTM w/o mkt	Diff	Diff/DV01
3Y	BB – Smooth Fwd	10	0.0988	-3,647.93	-3,006,605.11	(3,001,119.96)	5,485.15	(1.50)
	Summit – Raw and Cont	10	0.0988	3,602.19	(3,006,606.19)	(2,995,874.39)	10,731.80	2.98
	Summit – Raw and Hermite	10	0.0988	3,602.19	(3,006,606.19)	(3,004,807.51)	1,798.68	0.50
	Summit – Par and Cont	10	0.0988	3,602.19	(3,006,606.19)	(3,001,064.22)	5,541.97	1.54
	Summit – Par and Hermite	10	0.0988	3,602.18	(3,006,607.07)	(3,001,065.09)	5,541.98	1.54
15Y	BB – Smooth Fwd	10	0.9725	(24,747.50)	(12,989,395.75)	(13,034,777.78)	(45,382.03)	1.83
	Summit – Raw and Cont	10	0.9725	24,141.19	(12,989,088.94)	(12,994,618.41)	(5,529.47)	(0.23)
	Summit – Raw and Hermite	10	0.9725	24,141.19	(12,989,132.77)	(12,989,910.82)	(778.05)	(0.03)
	Summit – Par and Cont	10	0.9725	24,143.74	(12,991,116.95)	(13,049,248.43)	(58,131.48)	(2.41)
	Summit – Par and Hermite	10	0.9725	24,143.74	(12,991,117.69)	(13,049,249.17)	(58,131.48)	(2.41)
30Y	BB – Smooth Fwd	10	1.17055	(60,412.45)	(23,011,319.00)	(23,104,436.64)	(93,117.64)	1.54
	Summit – Raw and Cont	10	1.17055	58,660.73	(23,008,409.10)	(23,075,991.75)	(67,582.65)	(1.15)
	Summit – Raw and Hermite	10	1.17055	58,654.53	(23,005,531.63)	(23,074,027.97)	(68,496.34)	(1.17)
	Summit – Par and Cont	10	1.17055	58,673.07	(23,016,116.32)	(23,082,683.91)	(66,567.59)	(1.13)
	Summit – Par and Hermite	10	1.17055	58,673.07	(23,016,116.95)	(23,082,684.53)	(66,567.58)	(1.13)

Conclusions

Raw and Hermite is recommended for RFR Curve construction.

Interpolation Method	Smoothness	Locality	Stability	Instrument Recalibration
Raw and Continuous	Good	Good	Good	Good
Raw and Hermite	Good	Okay	Good	Very Good
Par and Continuous	Poor	Good	Good	Good
Par and Hermite	Poor	Okay	Good	Good

The choice of interpolation and bootstrap methodology is essential when building a smooth and stable zero curve in Interest Rate Curve Market Data in the Summit application.

Stay tuned for more such articles on Summit! Also, be sure to visit GreenPoint Summit for more resources on Summit!

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ABOUT GREENPOINT SUMMIT

- GreenPoint Summit is a comprehensive platform encompassing new implementations, version and module upgrades, product and application development, test automation, cloud migration, and system maintenance
- Our quantitative services and platforms include Libor Replacement Simulation Tool (LRST), curve creation, recreation and management, model validation and documentation, and creation of challenger models for regulatory compliance.
- Our summit professionals also provide data porting, migration and management as well as cloud services.
- Over the last year we have completed several projects including full system upgrades, Libor/RFR migration, replacement of valuation frameworks, and custom code creation and testing for large global banks and insurers.

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ABOUT GREENPOINT FINANCIAL

- GreenPoint Financial is a division of GreenPoint Global, which provides software-enabled services, content, process and technology services, to financial institutions and related industry segments.
- GreenPoint is partnering with Finastra across multiple technology and services platforms.
- Founded in 2006, GreenPoint has grown to over 500 employees with a global footprint. Our production and management teams are in the US, India, and Israel with access to subject matter experts.
- GreenPoint has a stable client base that ranges from small and medium-sized organizations to Fortune 1000 companies worldwide. We serve our clients through our deep resource pool of subject matter experts and process specialists across several domains.
- As an ISO certified company by TÜV Nord, GreenPoint rigorously complies with ISO 9001:2015, ISO 27001:2013, and ISO 27701:2019 standards.

Sanjay Sharma, PhD

FOUNDER AND CHAIRMAN

Sanjay provides strategic and tactical guidance to GreenPoint senior management and serves as client ombudsman. His career in the financial services industry spans three decades during which he has held investment banking and C-level risk management positions at Royal Bank of Canada (RBC) Goldman Sachs, Merrill Lynch, Citigroup, Moody's, and Natixis.

Sanjay is the author of "Risk Transparency" (Risk Books, 2013), Data Privacy and GDPR Handbook (Wiley, 2019), and co-author of "The Fundamental Review of Trading Book (or FRTB) - Impact and Implementation" (Risk Books, 2018).

Sanjay was the Founding Director of the RBC/Hass Fellowship Program at the University of California at Berkeley and has served as an advisor and a member of the Board of Directors of UPS Capital (a Division of UPS). He has also served on the Global Board of Directors for Professional Risk International Association (PRMIA).

Sanjay holds a PhD in Finance and International Business from New York University and an MBA from the Wharton School of Business and has undergraduate degrees in Physics and Marine Engineering. As well as being a regular speaker at conferences, Sanjay actively teaches postgraduate level courses in business and quantitative finance at EDHEC (NICE, France), Fordham, and Columbia Universities.

Marcus Cree

MANAGING DIRECTOR AND HEAD OF FINANCIAL PRODUCTS AND SERVICES

Marcus heads GreenPoint Financial Technology and Services and has conceptualized and directed design and management of its Risk Management and Treasury and Capital Markets platforms. These areas encompass lending (including CECL), sustainable finance, and LIBOR/RFR transition for enterprise systems.

Marcus has over two decades of experience in Risk Management, working on both the buy and sell sides of the financial services industry. He has worked on capital markets and lending risk technology and management projects in over 50 countries and brings a unique perspective on the nuances and differences across regulatory regimes around the world.

Before joining GreenPoint, Marcus was a member of the strategic leadership team for risk management at Finastra for several years. Prior to Finastra, Marcus was the US Head of Risk Solutions for FIS. He started his professional career at Deutsche Bank in London as a Quantitative Analyst.

Marcus is a prolific conference speaker, thought leader, and author in risk management spanning market, credit, and liquidity risks. He also publishes papers on sustainability and green finance regularly.

Marcus graduated from Leicester University in the UK, after studying Pure Mathematics, Phycology, and Astronomy. Since graduation, Marcus has continually gained risk-specific qualifications including the FRM (GARP's Financial Risk Manager) and the SCR (GARP's Sustainability and Climate Risk). Marcus's latest academic initiative is creating and teaching a course on Green Finance and Risk Management at New York University's Tandon School of Engineering.

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