CEIC Math Functions

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FUNCTIONS

CEIC provides a number of mathematical functions that can be applied to the series in CEIC databases. You can then use the transformed series to create charts or download to Excel for further analysis.

Functions can be accessed in the following ways:

- "Apply functions" pop-up
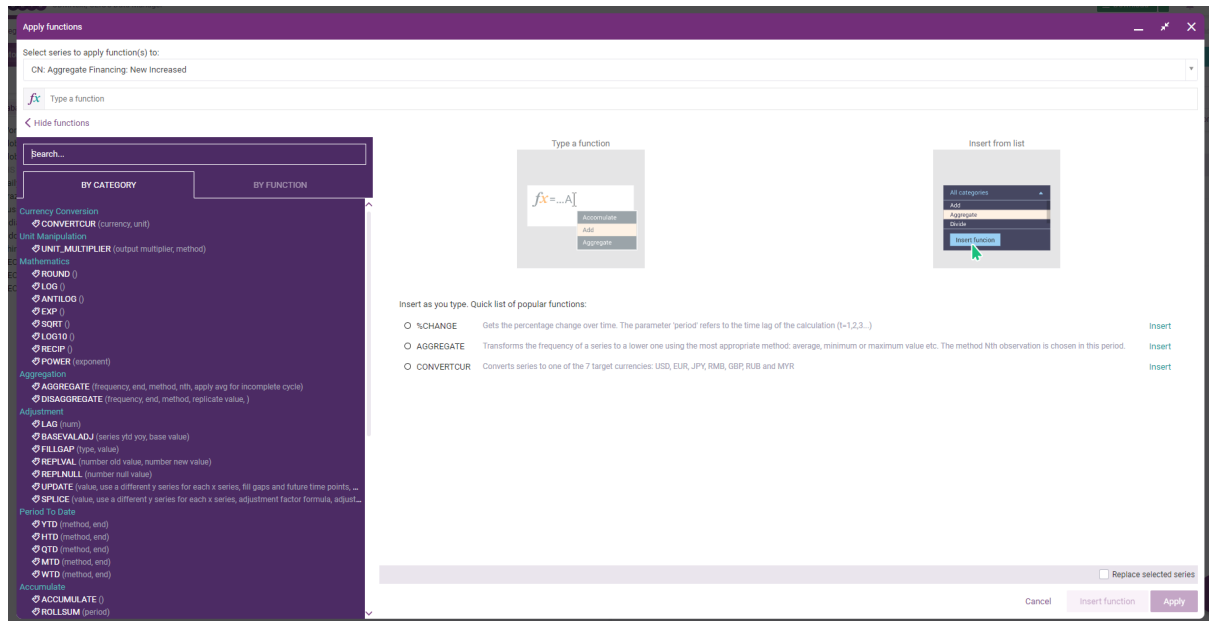
- "Type a function" panel

- "Apply function" menu

ACCUMULATE

The "Accumulate" function is used to calculate the cumulative sum-to-date of a selected series. The result is a series equal to the sum of data points over an interval defined by the number of periods, P.

Syntax of the function:

Function	Formula
Accumulate	$f(x_n) = \begin{cases} \textbf{Null} & \text{if } X_n \text{ is null} \\ \textbf{Null} & \text{if any preceding elements } (X_1, X_2, X_3, \dots X_n) \text{ is / are missing} \\ \sum_{i=1}^{n} X_i & \text{if all } (X_1, X_2, X_3, \dots X_n) \text{ are not missing} \end{cases}$

Example:

	X0	X1
1Q2013	580	580
2Q2013	900	1480
3Q2013	120	1600
4Q2013	390	1990
1Q2014	150	2140
2Q2014	600	2740
3Q2014	450	3190
4Q2014	230	3420
1Q2015	810	4230
2Q2015	700	4930
3Q2015	680	5610
4Q2015	400	6010

ADD

This function adds a constant value or a selected series to operate with.

Syntax of the function:

X1(t)=X0(t)+const
or
X1(t)=X0(t)+Y(t)

Apply functions

Select series to apply function(s) to:

CN: Aggregate Financing: New Increased

fx   Type a function

‹ Hide functions

Search...

BY CATEGORY	BY FUNCTION

- %CHANGE (period, obs. num, annualized)
- ACCUMULATE ()
- ADD (type, value)
- AGGREGATE (frequency, end, method, nth, apply avg for incomplete cycle)
- ANTILOG ()
- BASEVALADJ (series ytd yoy, base value)
- CONVERTCUR (currency, unit)
- CROSSSEC (method, extend to longest, ignore missed)

ADD

Add a constant value or a selected series to operate with

SYNTAX

ADD (type, value)

ARGUMENTS

Type   ⦿ Constant   ◯ Series

Value   1

HELP ON THIS FUNCTION ⌄

Example:

Constant=100

	X0	X1
1Q2013	580	680
2Q2013	900	1000
3Q2013	120	220
4Q2013	390	490
1Q2014	150	250
2Q2014	600	700
3Q2014	450	550
4Q2014	230	330
1Q2015	810	910
2Q2015	700	800
3Q2015	680	780

Series=Y

	X0	Y	X1
1Q2013	580	22	602
2Q2013	900	22	922
3Q2013	120	36	156
4Q2013	390	35	425
1Q2014	150	37	187
2Q2014	600	39	639
3Q2014	450	45	495
4Q2014	230	10	240
1Q2015	810	82	892
2Q2015	700	20	720
3Q2015	680	34	714

AGGREGATE

This function is used to generate an aggregate figure of a selected series from its original frequency to a new frequency. It transforms the frequency of a series to a lower one using the most appropriate method: average, minimum or maximum value etc. You can apply a frequency that is either higher or lower than that of the original series.
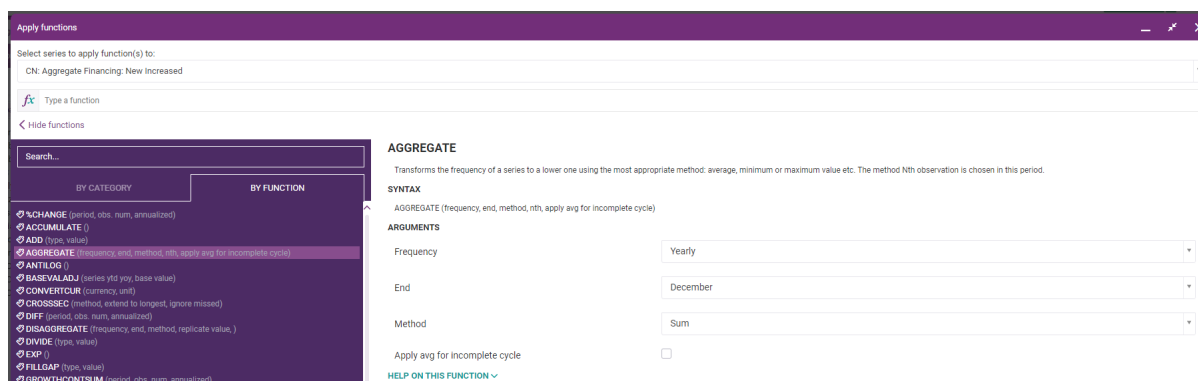
Syntax of this function:

Method	Formula
I Sum	$Y_m = f(X_{mn}) \begin{cases} \mathbf{Null} & \text{if one of the observation } (X_{m1}, X_{m2}, \dots, X_{mj}) \text{ is missing.} \\ \sum\limits_{j=1}^{P} X_{mj} & \text{if all components are not missing} \end{cases}$
Average	$Y_m = f(X_{mn}) \begin{cases} \mathbf{Null} & \text{if one of the observation } (X_{m1}, X_{m2}, \dots, X_{mj}) \text{ is missing.} \\ \sum\limits_{j=1}^{P} X_{mj} / P & \text{if all components are not missing} \end{cases}$
Max	$Y_m = Max \{X_{m1}, X_{m2}, X_{m3}, \dots, X_{mN}\}$
Min	$Y_m = Min \{X_{m1}, X_{m2}, X_{m3}, \dots, X_{mN}\}$
First	$Y_m = \begin{cases} \mathbf{Null} & \text{if } X_{m1} \text{ is missing} \\ X_{m1+i} & \text{where } X_{m1+i} \text{ is the closest non-null element, if } X_{m1}, X_{m1+1}, X_{m1+2}\dots \text{ is null.} \\ X_{m1} & \text{if } X_{m1} \text{ is not null} \end{cases}$
Last	$Y_m = \begin{cases} \mathbf{Null} & \text{if } X_{mP} \text{ is missing} \\ X_{mP-i} & \text{where } X_{mP-i} \text{ is the closest non-null element, if } X_{mP}, X_{mP-1}, X_{mP-2}\dots \text{ is null.} \\ X_{mP} & \text{if } X_{mP} \text{ is not null nor missing} \end{cases}$
Nth	$Y_m = \begin{cases} \mathbf{Null} & \text{if } X_{mN} \text{ is missing} \\ X_{mN+i} & \text{where } X_{mN+i} \text{ is the closest non-null element, if } X_{mN}, X_{mN+1}, X_{mN+2}\dots \text{ is null} \\ X_{mN} & \text{if } X_{mN} \text{ is not null nor missing} \end{cases}$

where M is the Method and P is the Period End

Example:
Method=Sum, Frequency=Yearly

Dates	Dates	Base series	Result
1Q2013		580	
2Q2013		900	
3Q2013		120	
4Q2013	2013	390	1990
1Q2014		150	
2Q2014		600	
3Q2014		450	
4Q2014	2014	230	1430
1Q2015		810	
2Q2015		700	

Method=Avg, Frequency=Yearly

Dates	Dates	Base series	Result
1Q2013		580	
2Q2013		900	
3Q2013		120	
4Q2013	2013	390	497,5
1Q2014		150	
2Q2014		600	
3Q2014		450	
4Q2014	2014	230	357,5
1Q2015		810	
2Q2015		700	

Method=Nth observation=3, Frequency=Yearly

Dates	Dates	Base series	Result
1Q2013		580	
2Q2013		900	
3Q2013		120	
4Q2013	2013	390	120
1Q2014		150	
2Q2014		600	
3Q2014		450	
4Q2014	2014	230	450
1Q2015		810	
2Q2015		700	

ANTILOG

This function applies the inverse of the logarithm with base 10.

Selecting Anti-Log the inverse of the Logarithm with base 10, will be applied, that is we will return the value X such the 10x equal the input with the resultant have the same date as the input value.

Apply functions

Select series to apply function(s) to:

CN: Aggregate Financing: New Increased

fx Type a function

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| BY CATEGORY | BY FUNCTION |

Currency Conversion
CONVERTCUR (currency, unit)
Unit Manipulation
UNIT_MULTIPLIER (output multiplier, method)
Mathematics
ROUND ()

ANTILOG

Applies the inverse of the logarithm with base 10

SYNTAX

ANTILOG ()

ARGUMENTS

HELP ON THIS FUNCTION ∨

Syntax of the function:
X1(t)=10^X0(t)

Example:

	X0	X1
1Q2013	2,2	158,49
2Q2013	2	100
3Q2013	3,3	1 995,26
4Q2013	1	10
1Q2014	3,4	2 511,89
2Q2014	1	10
3Q2014	1,9	79,43
4Q2014	2	100
1Q2015	1,5	31,62
2Q2015	2	100
3Q2015	1	10
4Q2015	4	10000

Treatment of Null elements: if any of the elements of the source series is Null then the corresponding element of the resultant series will also be Null.

BASEVALADJ

This series calculates monthly values from monthly YoY and YoY ytd series taking the predefined base value as the value for 12 months of the first observed year.
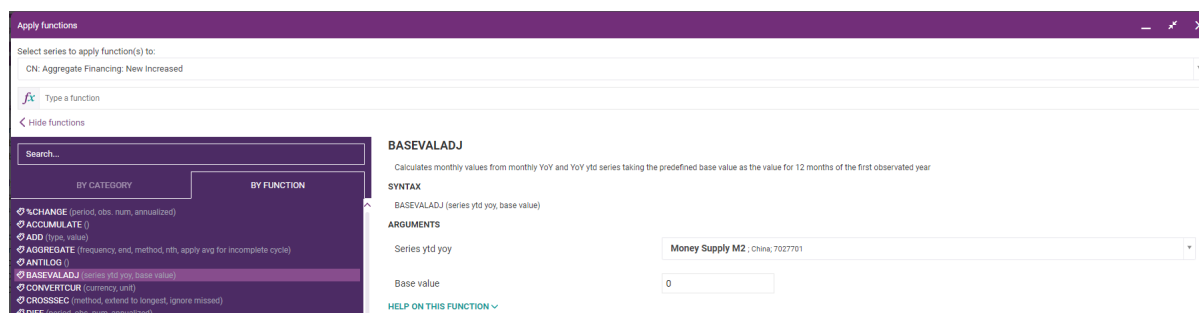
Syntax of the function:

*Assuming Jan=Feb and YoY & YTD-YoY are available.

1. Output[(Jan-Feb).Y2] = Output[Feb.Y1] * (1 + YTD-YoY [Feb.Y2] / 100)
2. Output[(Mar-Dec).Y2] = Output[(Mar-Dec).Y1] * (1 + YoY [(Mar-Dec).Y2]/100]

Example:

Period		YoY	YTD-YoY	Output
Y1	1.2005	1.8		100
	2.2005	9.5		100
	3.2005	9		100
	4.2005	7.2		100
	5.2005	8		100
	6.2005	7.9		100
	7.2005	7.6	7.8	100
	8.2005	7.9	7.8	100
	9.2005	10.2	8	100
	10.2005	10.6	8.2	100
	11.2005	11	8.5	100
	12.2005	11.5	8.8	100
Y2	1.2006	17.9	17.9	110.6

	2.2006	2.1	10.6	110.6
	3.2006	9	10.1	109
	4.2006	9.1	9.7	109.1
	5.2006	8.9	9.5	108.9
	6.2006	9.1	9.4	109.1
	7.2006	9.3	9.4	109.3
	8.2006	9.5	9.4	109.5
	9.2006	8.2	9.3	108.2
	10.2006	7	9.1	107
	11.2006	7.6	9	107.6
	12.2006	7.4	8.9	107.4
	1.2007	15	17.9	122.3
	2.2007	14.5	10.6	122.3
	3.2007	12	10.1	122.1
	4.2007	11.5	9.7	121.6
	5.2007	13	9.5	123.1
	6.2007	13.2	9.4	123.5
Y3	7.2007	10	9.4	120.2
	8.2007	11.8	9.4	122.4
	9.2007	9	9.3	117.9
	10.2007	8.9	9.1	116.5
	11.2007	9.1	9	117.4
	12.2007	8.4	8.9	116.4

CHANGE

This function is used to calculate the percentage changes, absolute difference or logarithmic difference (exponential growth) of a selected series over a period of time or over a year earlier.

When calculating a "Over a year" change, CDM automatically sets the time lag to the number of periods within a year for the frequency of the selected series.

"Over period" is to calculate a period-on-period change with user defined time lag. The annualized growth of the defined period can be obtained by checking the "Annualize" checkbox.

Syntax of the function:
100*(X(i)-X(i-t))/X(i-t)

Annualized formula:
100*((X(i)/X(i-t))^(N/t)-1)

Description:

Series Frequency	Number of period within a year (N)
Annual / Yearly	1
Semiannual	2
Quarterly	4
Monthly	12
Weekly	52
Weekday	260
Everyday	365

When in the parameter "period" the variant "Year" is chosen, t in the formula refers to the N in the table above. When "N last observation is chosen", t refers to the N typed by the user.

For the annualised formula N refers to the table above and t is the time lag.

Example:
Period=Over year

	X0	X1
1Q2013	580	
2Q2013	900	
3Q2013	120	
4Q2013	390	
1Q2014	150	-74,14
2Q2014	600	-33,33
3Q2014	450	275,00
4Q2014	230	-41,03
1Q2015	810	440,00
2Q2015	700	16,67
3Q2015	680	51,11
4Q2015	400	73,91

Period=Over period=1

	X0	X1
1Q2013	580	
2Q2013	900	55,17
3Q2013	120	-86,67
4Q2013	390	225,00
1Q2014	150	-61,54
2Q2014	600	300,00
3Q2014	450	-25,00
4Q2014	230	-48,89
1Q2015	810	252,17
2Q2015	700	-13,58
3Q2015	680	-2,86
4Q2015	400	-41,18

CONVERTCUR

This function converts series to one of the 7 target currencies: USD, EUR, JPY, RMB, GBP, RUB and MYR.
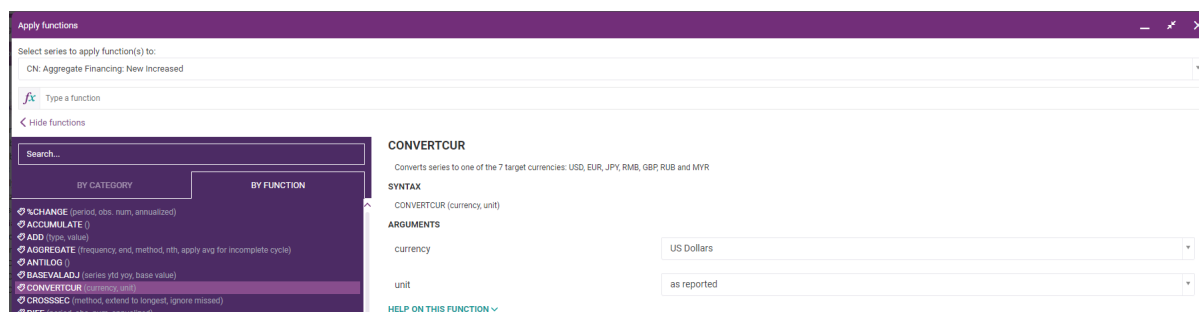
Syntax of the function:
X1=X0*Ex_rate

If a unit is not selected, the new series is calculated with the unit same as the original series (e.g. from EUR billion to USD billion).
Only time-points for which contemporary exchange rates are available are converted.

Example:

	X0 (Unit=Euro)	X1 (Unit=USD)
1Q2013	693.610	915.493
2Q2013	697.210	911.092
3Q2013	682.280	904.310
4Q2013	694.500	945.519
1Q2014	700.390	959.750
2Q2014	694.980	953.101
3Q2014	677.130	896.535
4Q2014	703.910	879.280
1Q2015	702.950	790.924
2Q2015	700.660	775.544
3Q2015	693.570	771.239
4Q2015	712.020	779.238

CROSSSEC

This function returns new series as a result of the applied method over the individual periods for all selected series.
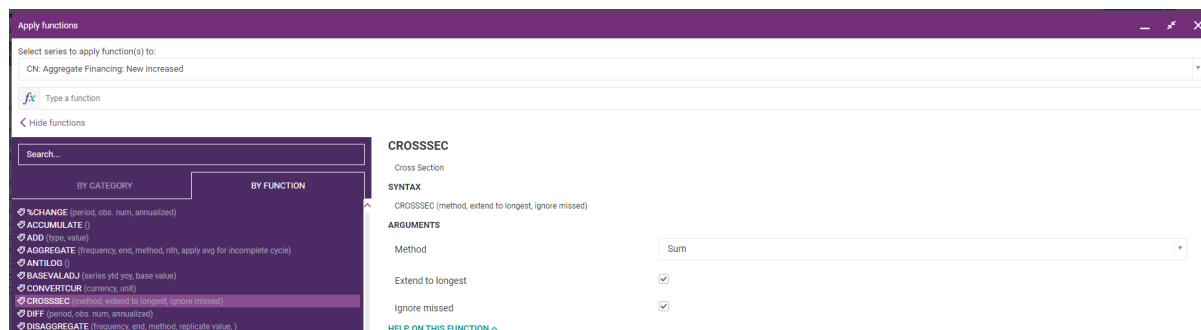
Syntax of the function:
$X(t)=Y(t)+Z(t)$
or
$X(t)=(Y(t)+Z(t))/2$
or
$X(t)=Y(t)*Z(t)$

Example:
Sum

	Y	Z	X
1Q2013	250	25	275
2Q2013	400	75	475
3Q2013	70	15	85
4Q2013	190	105	295
1Q2014	20	35	55
2Q2014	380	95	475
3Q2014	220	35	255
4Q2014	150	145	295
1Q2015	640	95	735
2Q2015	520	65	585
3Q2015	410	55	465
4Q2015	350	45	395

Median/Average

	Y	Z	X
1Q2013	250	25	137.5
2Q2013	400	75	237.5
3Q2013	70	15	42.5
4Q2013	190	105	147.5

1Q2014	20	35	27.5
2Q2014	380	95	237.5
3Q2014	220	35	127.5
4Q2014	150	145	147.5
1Q2015	640	95	367.5
2Q2015	520	65	292.5
3Q2015	410	55	232.5
4Q2015	350	45	197.5

Product

	Y	Z	X
1Q2013	250	25	6250
2Q2013	400	75	30000
3Q2013	70	15	1050
4Q2013	190	105	19950
1Q2014	20	35	700
2Q2014	380	95	36100
3Q2014	220	35	7700
4Q2014	150	145	21750
1Q2015	640	95	60800
2Q2015	520	65	33800
3Q2015	410	55	22550
4Q2015	350	45	15750

DIFF

This function Gets the absolute differences of the series over time. The parameter 'period' refers to the time lag of the calculation (t=1,2,3...).

Syntax of the function:
X(i)-X(i-t)
Annualized formula:
(X(i)-X(i-t))*N/t

Description:

Series Frequency	Number of period within a year (N)
Annual / Yearly	1
Semiannual	2
Quarterly	4
Monthly	12
Weekly	52
Weekday	260
Everyday	365

When in the parameter "period" the variant "Year" is chosen, t in the formula refers to the N in the table above. When "N last observation is chosen", t refers to the N typed by the user.
For the annualised formula N refers to the table above and t is the time lag.

Example:
Over Year

	X0	X1
1Q2013	580	
2Q2013	900	
3Q2013	120	
4Q2013	390	
1Q2014	150	-430,00
2Q2014	600	-300,00
3Q2014	450	330,00
4Q2014	230	-160,00
1Q2015	810	660,00
2Q2015	700	100,00
3Q2015	680	230,00
4Q2015	400	170,00

Over Period=1

	X0	X1
1Q2013	580	
2Q2013	900	320,00
3Q2013	120	-780,00
4Q2013	390	270,00
1Q2014	150	-240,00

2Q2014	600	450,00
3Q2014	450	-150,00
4Q2014	230	-220,00
1Q2015	810	580,00
2Q2015	700	-110,00
3Q2015	680	-20,00
4Q2015	400	-280,00

DISAGGREGATE

This function transforms the frequency of a series to a higher one using the most appropriate method: distributing, replicating etc.
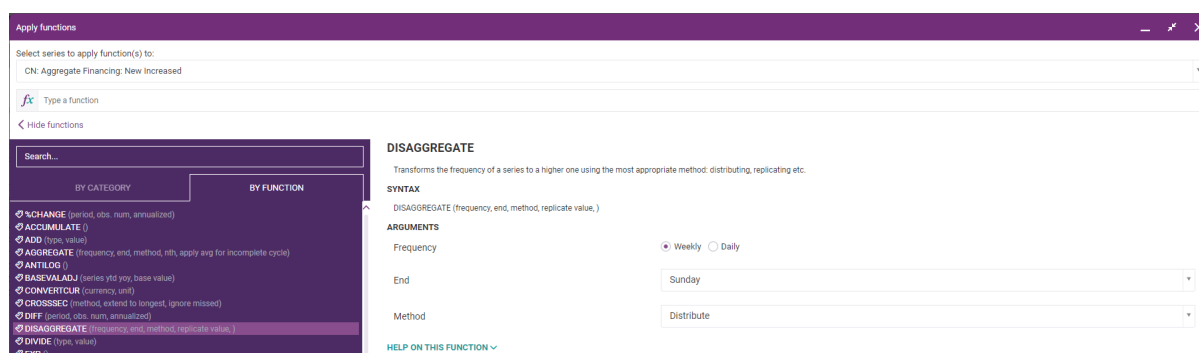
Description:
- ○ Distribution

populates all the elements within a period of the source series by subdividing the value equal between to resultant elements. Maps a series to a higher frequency by populating all the elements within a period of the source series by subdividing the value equal between to resultant elements.

Distribution would be applied when the source series represents a rate of change such as price level change and this data was required to be described in terms of a higher frequency series

- ○ Replication

populates all the elements within a period of the source series with its single value. Maps to a series of a higher frequency by populating all the elements within a period of the source series with its single value.

Distribution would be applied when the source series represents a price level where his data was required to be described in terms of a higher frequency series.

- ○ Linear interpolation

populates sub-period observations with the linearly interpolated observations of the source series. Maps a series to a higher frequency series by populating sub-period observations with the linearly interpolated observations of the source series.

Linear interpolation ensures that the (additive) difference between an interpolated element and next/preceding elements is constant. As such this approach is appropriate for example when the series represents the number of some entity rather than a derivative of a natural phenomenon such as a growth rate.

Formerly, if we have series X(t), then the Linear Interpolation of this series f(X(t)) is:

f(X(t)) = X(q) + { { (X(p) − X(q)) / (p-q) } * (t-q) } where:

- X(q) is the previous known observation excluding NA and missing observations.
- X(p) is the next known observation excluding NA and missing observations.
- t, p, q are the relative positions of the observations within the series.

    ○ Cubic spline interpolation

populates sub-period observations with the (natural) Cubic Spline Interpolation of each observation of the source series. Maps a series to a higher frequency series by populating sub-period observations with the (natural) Cubic Spline Interpolation of each observation of the source series. The interpolated series has the qualitative property of being 'smooth' at the interpolation points, in the sense that a cubic polynomial (i.e. a smooth function) can be fitted over 3 adjacent elements. As such the Cubic Spline Interpolation would be applied for example when the user expects the rate of change of the series to vary in a continuous fashion.

The formal formulae are derived from the fact that the Cubic Spline Interpolation points are uniquely determined by requiring that the series elements value(s) between two known points lie of a cubic polynomial and at these points its second derivative is zero.

Example:
Replication

		X0 (yearly)	X1, transformed (quarterly)
	1Q2013		580
	2Q2013		580
	3Q2013		580
2013	4Q2013	580	580
	1Q2014		100
	2Q2014		100
	3Q2014		100
2014	4Q2014	100	100

Linear interpolation

		X0 (yearly)	X1, transformed (quarterly)
	1Q2013		
	2Q2013		
	3Q2013		
2013	4Q2013	580	580
	1Q2014		460
	2Q2014		340
	3Q2014		220
2014	4Q2014	100	100

Cubic spline interpolation

		X0 (yearly)	X1, transformed (quarterly)
	Jan		7.2777...
	Feb		8.2222...
1Q2013	Mar	9	9
	Apr		9.7777...
	May		10.7222...
2Q2013	Jun	12	12
	Jul		13.7222...
	Aug		15.7777...
3Q2013	Sep	18	18

Divide

This function divides a constant value or a selected series to operate with.

Apply functions

Select series to apply function(s) to:

CN: Aggregate Financing: New Increased

fx Type a function

‹ Hide functions

Search...	
BY CATEGORY	BY FUNCTION

- ⚘ **%CHANGE** (period, obs. num, annualized)
- ⚘ **ACCUMULATE** ()
- ⚘ **ADD** (type, value)
- ⚘ **AGGREGATE** (frequency, end, method, nth, apply avg for incomplete cycle)
- ⚘ **ANTILOG** ()
- ⚘ **BASEVALADJ** (series ytd yoy, base value)
- ⚘ **CONVERTCUR** (currency, unit)
- ⚘ **CROSSSEC** (method, extend to longest, ignore missed)
- ⚘ **DIFF** (period, obs. num, annualized)

DIVIDE

Divides a constant value or a selected series to operate with

SYNTAX

DIVIDE (type, value)

ARGUMENTS

Type   ● Constant ○ Series

Value | 1 |

HELP ON THIS FUNCTION ⌄

Syntax of the function:
X1(t)=X0(t)/const
or
X1(t)=X0(t)/Y(t)

Example:
Constant=100

	X0	X1
1Q2013	580	5,8
2Q2013	900	9
3Q2013	120	1,2
4Q2013	390	3,9
1Q2014	150	1,5
2Q2014	600	6
3Q2014	450	4,5
4Q2014	230	2,3
1Q2015	810	8,1
2Q2015	700	7
3Q2015	680	6,8
4Q2015	400	4

Series=Y

	X0	Y	X1
1Q2013	580	22	26,36
2Q2013	900	22	40,91
3Q2013	120	36	3,33
4Q2013	390	35	11,14
1Q2014	150	37	4,05
2Q2014	600	39	15,38
3Q2014	450	45	10
4Q2014	230	10	23
1Q2015	810	82	9,88
2Q2015	700	20	35
3Q2015	680	34	20
4Q2015	400	42	9,52

EXP

This function applies each value with its exponential. Selecting Exponential and applying each numerical value of the source series will be mapped to its exponential and assigned to the resultant series with the same date.

Syntax of the function:
X1(t)=e^X0(t)

Example

	X0	X1
1Q2013	2,2	9,03
2Q2013	2	7,39
3Q2013	3,3	27,11
4Q2013	1	2,72
1Q2014	3,4	29,96
2Q2014	1	2,72
3Q2014	1,9	6,69
4Q2014	2	7,39
1Q2015	1,5	4,48
2Q2015	2	7,39
3Q2015	1	2,72
4Q2015	4	54,60

FILLGAP

This function fills missed observations using different methods.
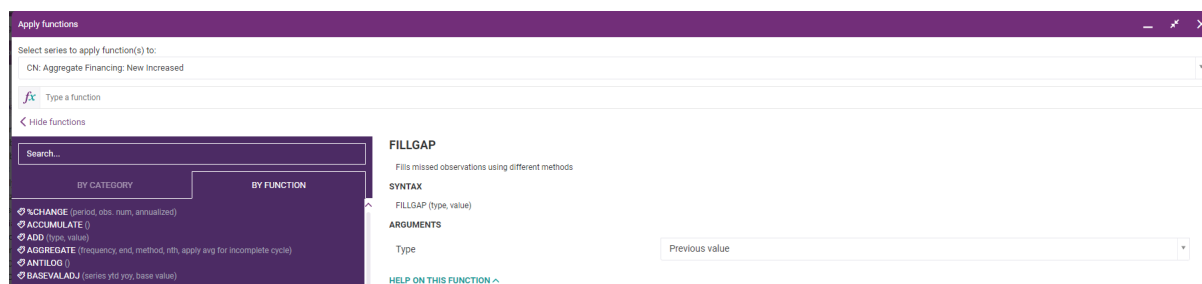
Syntax of the function:
Linear interpolation formula:
$$f(X(t))=X(q)+[\{(X(p)-X(q))/(p-q)\}*(t-q)]$$

where
$X(q)$ is the previous last known observation excluding NA and missing observations
$X(p)$ is the next known observation excluding NA and missing observations
t,p,q are the relative positions of the observations within the series

Description:
Linear interpolation fills in any missing values (excluding first, last elements) by drawing a line from the previous to next known values to the series.

Exponential interpolation fills in any missing values (excluding first, last elements) by using exponential interpolation, which intuitively assumes the rate of change between the previous to next known values to be constant and fills in the intermediate values accordingly.

Cubic spline interpolation fills in any missing elements (excluding first and last) by applying (natural) cubic spline interpolation.

Example:
Linear extrapolation

	X0	X1
01.09.2016	2448,62	2448,62
01.10.2016	2830,91	2830,91
01.11.2016		3114,001
01.12.2016		3397,092

Exponential interpolation

	X0	X1
1Q2014	10	10
2Q2014		13.572088...
3Q2014		18.420157...
4Q2014	25	25

Cubic spline interpolation

	X0	X1
4Q2013	53700	53700
1Q2014	51600	51600
2Q2014		52577.961
3Q2014		58963.558
4Q2014	69800	69800
1Q2015		83473.956
2Q2015		95745.95
3Q2015		101719.969
4Q2015	96500	96500

GROWTHCONTSUM

This function gets the contribution of the sum of the selected series (Y) to the growth of the base series (X) as an additive decomposition of the percentage change in the aggregate series

Syntax of the function:
$100*(X(i)-X(i-t)/Y(i-t))$

Description:

Series Frequency	Number of period within a year (N)
Annual / Yearly	1
Semiannual	2
Quarterly	4
Monthly	12
Weekly	52
Weekday	260
Everyday	365

When in the parameter "period" the variant "Year" is chosen, t in the formula refers to the N in the table above. When "N last observation is chosen", t refers to the N typed by the user.
As the base series (X) the first series from the selected is chosen.
Y is calculated as the sum of all series selected.

Example:
Over Year

	X0 (quarterly)	Y (sum)	X1
1Q2013	580	1452	
2Q2013	900	4986	
3Q2013	120	1595	
4Q2013	390	2789	
1Q2014	150	1268	-29,61
2Q2014	600	3948	-6,02
3Q2014	450	1985	20,69
4Q2014	230	2544	-5,74
1Q2015	810	4282	52,05
2Q2015	700	3498	2,53
3Q2015	680	2495	11,59
4Q2015	400	1963	6,68

Over Period=1

	X0 (quarterly)	Y (sum)	X1
1Q2013	580	1452	
2Q2013	900	4986	22,04
3Q2013	120	1595	-15,64
4Q2013	390	2789	16,93
1Q2014	150	1268	-8,61
2Q2014	600	3948	35,49
3Q2014	450	1985	-3,80
4Q2014	230	2544	-11,08
1Q2015	810	4282	22,80

2Q2015	700	3498	-2,57
3Q2015	680	2495	-0,57
4Q2015	400	1963	-11,22

GROWTHCONTVAL

This function gets the contribution of the selected series (Y, parameter 'value') to the growth of the base series (X) as an additive decomposition of the percentage change in the aggregate series

Syntax of the function:
100*(X(i)-X(i-t)/Y(i-t))

Description:

Series Frequency	Number of period within a year (N)
Annual / Yearly	1
Semiannual	2
Quarterly	4
Monthly	12
Weekly	52
Weekday	260
Everyday	365

When in the parameter "period" the variant "Year" is chosen, t in the formula refers to the N in the table above. When "N last observations is chosen", t refers to the N typed by the user.
As the base series (X) the first series from the selected is chosen.
Y is calculated as the sum of all series selected.

Example:
Over Year

	X0 (quarterly)	Y	X1
1Q2013	580	1274	
2Q2013	900	965	
3Q2013	120	756	
4Q2013	390	1096	
1Q2014	150	608	-33,75
2Q2014	600	1258	-31,09
3Q2014	450	1007	43,65
4Q2014	230	921	-14,60
1Q2015	810	2000	108,55
2Q2015	700	876	7,95
3Q2015	680	1085	22,84
4Q2015	400	1963	18,46

Over Period=1

	X0 (quarterly)	Y	X1
1Q2013	580	1274	
2Q2013	900	965	25,12
3Q2013	120	756	-80,83
4Q2013	390	1096	35,71
1Q2014	150	608	-21,90
2Q2014	600	1258	74,01
3Q2014	450	1007	-11,92
4Q2014	230	921	-21,85
1Q2015	810	2000	62,98
2Q2015	700	876	-5,50
3Q2015	680	1085	-2,28
4Q2015	400	1963	-25,81

GROWTHRATE

This function gets the exponential growth of the series over time. The parameter 'period' refers to the time lag of the calculation (t=1,2,3...)

Syntax of the function:
$100*Ln(X(i)/X(i-t))$

Annualized formula:
$100*Ln(X(i)/X(i-t))*(N/t)$

Description:

Series Frequency	Number of period within a year (N)
Annual / Yearly	1
Semiannual	2
Quarterly	4
Monthly	12
Weekly	52
Weekday	260
Everyday	365

When in the parameter "period" the variant "Year" is chosen, t in the formula refers to the N in the table above. When "N last observation is chosen", t refers to the N typed by the user.
For the annualized formula N refers to the table above and t is the time lag.

Example:
Over Year

	X0	X1
1Q2013	580	
2Q2013	900	
3Q2013	120	
4Q2013	390	

1Q2014	150	-540,96
2Q2014	600	-162,19
3Q2014	450	528,70
4Q2014	230	-211,23
1Q2015	810	674,56
2Q2015	700	61,66
3Q2015	680	165,14
4Q2015	400	221,35

Over Period=1

	X0	X1
1Q2013	580	
2Q2013	900	43,94
3Q2013	120	-201,49
4Q2013	390	117,87
1Q2014	150	-95,55
2Q2014	600	138,63
3Q2014	450	-28,77
4Q2014	230	-67,12
1Q2015	810	125,90
2Q2015	700	-14,60
3Q2015	680	-2,90
4Q2015	400	-53,06

HPFILTER

This function applies the Hodrick-Prescott filter to the series which returns the long-term trend component of the series. 'Smooth' returns the smoothed (in other words the trend line) series. 'Cycle' returns the original series subtracted by smoothed.

Syntax of the function:
X0(t)=X1(Cycle)(t)+X1(Trend)(t)

Description:
The Hodrick-Prescott Filter provides an estimation of the long-term trend component of a series, decomposing the series into "smoothed" and "cycle" components.
The lambda smoothing parameter values used in CDMNext are:
- Daily, "everyday" = 1.10762e+11
- Daily = 2.88323e+10
- Weekly = 46132800
- Monthly = 129120
- Quarterly = 1600
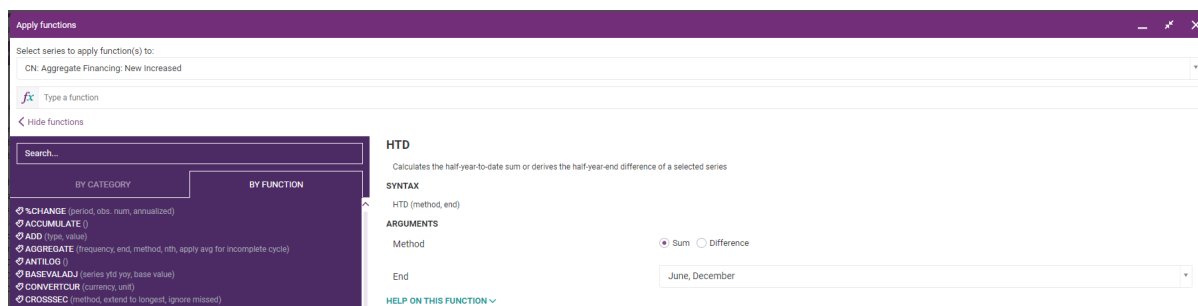- Semiannual = 101.262
- Annual = 6.65545

The Hodrick-Prescott function can be applied to a series of: any frequencies without gaps and/or missing elements.

Example:

	X0	X1 (Cycle)	X1 (Trend)
1Q2013	2,85	0,15	2,70
2Q2013	-1,13	-4,07	2,94
3Q2013	-1,89	-5,07	3,18
4Q2013	-0,39	-3,81	3,42
1Q2014	2,23	-1,44	3,67
2Q2014	5,40	1,48	3,92
3Q2014	6,93	2,77	4,15
4Q2014	7,53	3,16	4,37
1Q2015	6,95	2,38	4,58
2Q2015	3,56	-1,20	4,76
3Q2015	6,94	2,02	4,91
4Q2015	7,30	2,25	5,05

HTD

This function calculates the half-year-to-date sum or derives the half-year-end difference of a selected series.

Syntax of the function:

X_{mj} indicates the value of the jth observation in mth period, e.g. X_{21} is the first observation in the 2nd half-year period.

Example:
Method=Sum

	X0	X1 (End=June, December)
01.01.2015	-3,55	-3,55
01.02.2015	0,18	-3,36
01.03.2015	-1,28	-4,64
01.04.2015	-2,47	-7,11
01.05.2015	-1,59	-8,70
01.06.2015	-1,56	-10,25
01.07.2015	-3,33	-3,33
01.08.2015	0,09	-3,24

01.09.2015	2,33	-0,91
01.10.2015	2,35	1,44
01.11.2015	-0,09	1,35
01.12.2015	-2,09	-0,74

Method=Diff

	X0	X1 (End=June, December)
01.01.2015	0,83	0,83
01.02.2015	0,64	-0,18
01.03.2015	3,65	3,01
01.04.2015	6,27	2,62
01.05.2015	5,71	-0,56
01.06.2015	7,67	1,96
01.07.2015	3,93	3,93
01.08.2015	2,46	-1,47
01.09.2015	3,21	0,75
01.10.2015	0,47	-2,75
01.11.2015	-1,47	-1,93
01.12.2015	-2,01	-0,54

INDEX

This function converts a series into an index number by defining a base period and a specified value.

Syntax of the function:
If both 'Start' and 'End' dates are defined, the formula of this function is:

$$I_i = V * \{X_i * P/ (X_b + X_{b+1} + \ldots + X_{b+P-2} + X_e)\} \text{ where } X_i \text{ is not null nor missing}$$

where
Start (b) is the start date of the base period.
End (e) is the end date of the base period. If it is omitted, the system assumes Base period equal 1, and takes the base begin date as the only base date.
Base period (P) is the number of period between the Start & End date.
Value (V) is the value amount the observation within the base period. It must a positive integer in the range 1-1000 with default value is 100.

If only "Start" is defined, that means the indexing is calculated by single base date, the formula will simplify as:

$$I_i = V * \{X_i / X_b\}$$

where
Start (b) is the start date of the base period.
Value (V) is the value amount the observation within the base period. It must a positive integer in the range 1-1000 with default value is 100.

Description:
The selected dates should fall between the first and the last observation dates of the series.

Example:
Start=01/01/2016, End=01/31/2016, Value=100

	X0	X1
01.01.2015	475,88	97,91
01.02.2015	478,39	98,43
01.03.2015	477,65	98,27
01.04.2015	474,07	97,54
01.05.2015	480,25	98,81
01.06.2015	475,12	97,75
01.07.2015	477,33	98,21
01.08.2015	479,78	98,71
01.09.2015	481,07	98,98
01.10.2015	472,55	97,22
01.11.2015	480,15	98,79
01.12.2015	482,93	99,36
01.01.2016	486,04	100

LAG

This function shifts series by specified number of periods, forwards for the positive number and backwards for the negative number.

Syntax of the function:
f(X(t)) = X(t-Num)
where
Num is defined by a user and can be either positive or negative

Description:
Returns a series where each observation of the resultant series takes the value of the selected series on the lagged date where by lagged we refer to the date shifted by the integer number of periods given. Intuitively the elements are just shifted forward or backwards by a given number of periods.

Remark: Though we use the term lag, if the period given happens to be a negative integer then the series will be mapped to later periods and as such the resultant series will be leading the series selected (rather than lagging it).

The lag function can be applied to a series of any frequency, which may have gaps and/or missing elements.

Example:
Num=1

	X0	X1
1Q2013	580	
2Q2013	900	580
3Q2013	120	900
4Q2013	390	120
1Q2014	150	390

2Q2014	600	150
3Q2014	450	600
4Q2014	230	450
1Q2015	810	230
2Q2015	700	810
3Q2015	680	700
4Q2015	400	680

Num=-2

	X0	X1
1Q2013	580	120
2Q2013	900	390
3Q2013	120	150
4Q2013	390	600
1Q2014	150	450
2Q2014	600	230
3Q2014	450	810
4Q2014	230	700
1Q2015	810	680
2Q2015	700	400
3Q2015	680	
4Q2015	400	

LOG

This function applies each value to its logarithm with natural base.

Syntax
X1(t)=ln(X0(t))
where
ln is the logarithm with natural base

Example:

	X0	X1
1Q2013	580	6,36
2Q2013	900	6,80
3Q2013	120	4,79
4Q2013	390	5,97
1Q2014	150	5,01
2Q2014	600	6,40
3Q2014	450	6,11
4Q2014	230	5,44
1Q2015	810	6,70
2Q2015	700	6,55
3Q2015	680	6,52
4Q2015	400	5,99

LOG10

This function applies the value to its logarithm with base 10.

Syntax of the function:
X1(t)=Lg(X0(t)),
where
lg is the logarithm with base 10

Example:

	X0	X1
1Q2013	580	2,76
2Q2013	900	2,95
3Q2013	120	2,08
4Q2013	390	2,59
1Q2014	150	2,18
2Q2014	600	2,78
3Q2014	450	2,65
4Q2014	230	2,36
1Q2015	810	2,91
2Q2015	700	2,85
3Q2015	680	2,83
4Q2015	400	2,60

MOVAV

This function is used to calculate moving average.
There are 5 methods available:
- Exponentially weighted
- Geometric
- Simple
- Linearly weighted
- Centered

Syntax of the function:

Function	Formula	
Simple Moving Average (SMA)	$f(x_n, P) = \begin{cases} \text{Null} \\ \sum x_i / P \end{cases}$	if (1) x_n is null / missing OR (2) any observation within the specified interval is missing OR (3) n < P Arithmetic mean of x_n over P non-null periods, given that all observations are not missing.
Exponentially Weighted Moving Average (EWMA)	$f(x_n, c, P) = \begin{cases} \text{Null} \\ SMA_n \\ c*P + (1-c)*f(x_{n-1}, c, P) \end{cases}$	if (1) x_n is null OR (2) x_n or x_{n-1} is missing OR (3) n < P where n = P where n > P
Geometric Moving Average (GMA)	$f(x_n, P) = \begin{cases} \text{Null} \\ \sqrt[P]{\prod x_i} \end{cases}$	if (1) x_n is null / missing OR (2) any observation within the specified interval is missing OR (3) n < P Geometric mean of x_n over P^{th} non-null periods, given that all observations are not missing.
Linearly Weighted Moving Average (LWMA)	$f(x_n, P) = \begin{cases} \text{Null} \\ \sum x_i * t_i / \sum t_i \end{cases}$	if (1) x_n is null / missing OR (2) any observation within the specified interval is missing OR (3) n < P where t_i = 1,2,……, P

where
P is the Number of Period
c is the Number Factor (for Exponentially weighted)

The Centered Moving Average evaluates the arithmetic average centered about each element of the source series over a given number of periods (P>0). Depending on whether P is even or odd the numeric differ slightly. For a source series X(t) when P is an odd integer the elements of the resultant series are given by:
f(X(t), P) = {X(t+n) + ... + X(t) + ... + X(t-n)} / P

where
n=(P-1)/2

If any of X(t-n),…, X(t+n) are Null or missing than the resultant element is Null or missing.

When P is even for a source series X(t) the elements of the resultant series are given by:
f(X(t), P) = { [X(t+n)* 0.5] + ... + X(t) + ... + [X(t-n)*0.5] } / P
where
n=P/2

If any of X(t-n), …, X(t+n) are Null or missing than the resultant element is Null or missing.
Note: in the simplest case if P =1, this function reduces to the identical mapping.

Example:
Simple, Period=2

	X0	X1
1Q2013	3 166,23	
2Q2013	3 374,77	3 270,50
3Q2013	3 406,34	3 390,55
4Q2013	2 994,99	3 200,67
1Q2014	2 896,58	2 945,78
2Q2014	3 052,56	2 974,57
3Q2014	3 139,80	3 096,18
4Q2014	3 007,60	3 073,70
1Q2015	2 985,46	2 996,53
2Q2015	2 866,23	2 925,85
3Q2015	2 977,37	2 921,80
4Q2015	3 114,95	3 046,16

Exponentially weighted, Period=2, Factor=0,3

	X0	X1
1Q2013	3 166,23	
2Q2013	3 374,77	3 270,50
3Q2013	3 406,34	3 311,25
4Q2013	2 994,99	3 216,37
1Q2014	2 896,58	3 120,43
2Q2014	3 052,56	3 100,07
3Q2014	3 139,80	3 111,99
4Q2014	3 007,60	3 080,67
1Q2015	2 985,46	3 052,11
2Q2015	2 866,23	2 996,35
3Q2015	2 977,37	2 990,65
4Q2015	3 114,95	3 027,94

Centered, Period=2

	X0	X1
1Q2013	3 166,23	
2Q2013	3 374,77	3 330,53
3Q2013	3 406,34	3 295,61
4Q2013	2 994,99	3 073,23
1Q2014	2 896,58	2 960,18
2Q2014	3 052,56	3 035,37
3Q2014	3 139,80	3 084,94
4Q2014	3 007,60	3 035,12
1Q2015	2 985,46	2 961,19
2Q2015	2 866,23	2 923,82
3Q2015	2 977,37	2 983,98
4Q2015	3 114,95	3 102,49

MTD

This function calculates the month-to-date sum or derives the month-end difference of a selected series.

Syntax of the function:

Function	Formula
Sum Period-end ➡ Period-to-date	$f(x_{mn}) = \begin{cases} \text{Null} & x_{mn} \text{ is Null.} \\ \text{Null} & \text{if any elements } (x_{m1}, x_{m2}, \dots, x_{mn-1}) \text{ is / are missing} \\ \sum_{j=1}^{n} x_{mj} & \text{if all components are not missing} \end{cases}$
Difference Period-end ⬅ Period-to-date	$f(x_{mn}) = \begin{cases} \text{Null} & \text{if either } x_{mn} \text{ or } x_{m(n-1)} \text{ is null or missing} \\ x_{m1+i} & \text{where } x_{m1+i} \text{ is the closest non-null element, if } x_{m1}, x_{m1+1}, x_{m1+2}\dots \text{ is null.} \\ x_{mn} - x_{m(n-1)} & \text{if } n > 1 \end{cases}$

Xmj indicates the value of the jth observation in mth period, e.g. X21 is the first observation in the 2nd half-year period.

Example:
Method=Sum

	X0	X1 (End=Last day of month)
Week1, 2015	-3,55	-3,55
Week2, 2015	0,18	-3,37
Week3, 2015	-1,28	-4,65

Week4, 2015	-2,47	-2,47
Week5, 2015	-1,59	-1,59
Week6, 2015	-1,56	-3,15
Week7, 2015	-3,33	-6,48
Week8, 2015	0,09	0,09
Week9, 2015	2,33	2,33
Week10, 2015	2,35	4,68
Week11, 2015	-0,09	4,59
Week12, 2015	-2,09	-2,09

Method=Diff

	X0	X1 (End=Last day of month)
Week1, 2015	0,83	0,83
Week2, 2015	0,64	-0,19
Week3, 2015	3,65	3,01
Week4, 2015	6,27	6,27
Week5, 2015	5,71	5,71
Week6, 2015	7,67	1,96
Week7, 2015	3,93	-3,74
Week8, 2015	2,46	2,46
Week9, 2015	3,21	3,21
Week10, 2015	0,47	-2,74
Week11, 2015	-1,47	-1,94
Week12, 2015	-2,01	-2,01

MULTIPLY

This function multiplies by a constant value or a selected series to operate with.

Syntax of the function:
X1(t)=X0(t)*const
or
X1(t)=X0(t)*Y(t)

Example:
Constant=1.5

	X0	X1
1Q2013	580	870
2Q2013	900	1350
3Q2013	120	180
4Q2013	390	585
1Q2014	150	225
2Q2014	600	900
3Q2014	450	675
4Q2014	230	345
1Q2015	810	1215
2Q2015	700	1050
3Q2015	680	1020
4Q2015	400	600

Series=Y

	X0	Y	X1
1Q2013	580	1,4	812

2Q2013	900	1,7	1530
3Q2013	120	2	240
4Q2013	390	1	390
1Q2014	150	2,3	345
2Q2014	600	1,2	720
3Q2014	450	1,6	720
4Q2014	230	1,5	345
1Q2015	810	0,8	648
2Q2015	700	1,3	910
3Q2015	680	1,4	952
4Q2015	400	2	800

POWER

This function assigns a value raised to the power.

Syntax of the function:
X1(t)=X0(t)^Exponent

Example:
Exponent=2

	X0	X1
1Q2013	3	9
2Q2013	21	441
3Q2013	4	16
4Q2013	11	121
1Q2014	9	81
2Q2014	23	529

3Q2014	7	49
4Q2014	8	64
1Q2015	16	256
2Q2015	22	484
3Q2015	19	361
4Q2015	10	100

QTD

This series calculates the quarter-to-date sum or derives the quarter-end difference of a selected series.

Syntax of the function:

Xmj indicates the value of the jth observation in mth period, e.g. X21 is the first observation in the 2nd half-year period.

Example:
Method=Sum

	X0	X1 (End=March, June, September, December)
01.01.2015	-3,55	-3,55
01.02.2015	0,18	-3,37
01.03.2015	-1,28	-4,65
01.04.2015	-2,47	-2,47
01.05.2015	-1,59	-4,06
01.06.2015	-1,56	-5,62
01.07.2015	-3,33	-3,33
01.08.2015	0,09	-3,24
01.09.2015	2,33	-0,91
01.10.2015	2,35	2,35
01.11.2015	-0,09	2,26
01.12.2015	-2,09	0,17

Method=Diff

	X0	X1 (End=March, June, September, December)
01.01.2015	0,83	0,83
01.02.2015	0,64	-0,19
01.03.2015	3,65	3,01
01.04.2015	6,27	6,27
01.05.2015	5,71	-0,56
01.06.2015	7,67	1,96
01.07.2015	3,93	3,93
01.08.2015	2,46	-1,47
01.09.2015	3,21	0,75
01.10.2015	0,47	0,47
01.11.2015	-1,47	-1,94
01.12.2015	-2,01	-0,54

RECIP

This function takes values of X and return values of 1/X with the same date assigned.

Syntax of the function:
X1(t)=1/X0(t)

Example

	X0	X1
1Q2013	0,5	2
2Q2013	0,2	5
3Q2013	0,1	10
4Q2013	0,4	2,5
1Q2014	0,8	1,25
2Q2014	2	0,5
3Q2014	1	1
4Q2014	0,2	5
1Q2015	2,5	0,4
2Q2015	0,5	2
3Q2015	1,25	0,8
4Q2015	5	0,2

REPLNULL

This function fills missed observations with specified values. Null value is the value which should replace NA observations.

Syntax of the function:

X1(t)=Number null value, if X0(t)=NA

Example:

Number null value=300

	X0	X1
1Q2013	580	580
2Q2013	900	900
3Q2013	NA	300
4Q2013	390	390
1Q2014	NA	300
2Q2014	600	600
3Q2014	450	450
4Q2014	NA	300
1Q2015	810	810
2Q2015	700	700
3Q2015	680	680
4Q2015	NA	300

REPLVAL

This function replaces observations with specified values. Old value is the value to replace, new value is the replacement value.

Syntax of the function:
X1(t)=Number new value, if X0(t)=Number old value

Example:
Number old value=150, Number new value=180

	X0	X1
1Q2013	580	580
2Q2013	900	900
3Q2013	150	180
4Q2013	390	390
1Q2014	150	180
2Q2014	600	600
3Q2014	450	450
4Q2014	150	180
1Q2015	810	810
2Q2015	700	700
3Q2015	680	680
4Q2015	150	180

ROLLSUM

This function returns a series with the values equal to the sum over a given number of previous observations.

Syntax of the function:
f(X(t)) = {X(t) + X(t-1) + ... + X(t-P+1)}

where
f(X(t)) is the numerical value of the t-th element of the resultant series
X(t) is the value of the latest date of the source series
X(t-1) is the numerical value of the previous element of so on.

If any of the observations from X(t) to X(t-P+1) are missing, then f(X(t)) of the resultant series will be a missing observation.

Example:
Period=4

	X0	X1
1Q2013	3166,23	
2Q2013	3374,77	
3Q2013	3406,34	
4Q2013	2994,99	12942,33
1Q2014	2896,58	12672,68
2Q2014	3052,56	12350,47
3Q2014	3139,8	12083,93
4Q2014	3007,6	12096,53
1Q2015	2985,46	12185,42
2Q2015	2866,23	11999,09
3Q2015	2977,37	11836,67
4Q2015	3114,95	11944,02

ROUND

This function rounds the values of a series to the nearest integer.

SMOOTH

This function evaluates the weighted average between the present observation and the previous weighted average with the base of the average of all elements of the series.

Syntax of the function:
- ○ Single Smoothing

Evaluates the weighted average between the present observation and the previous weighted average where the base of this inductive process is the average of all

elements of the series. That is, the evaluation of the weighted averages it given by the inductive relation:

f(X(t)) = a * X(t) + (1- a) * f(X(t-1)),

with base

f(X(0)) ={X(0)+X(1)+….+X(n)} / (n+1)

where

X(0) is the first element of the series.

a is the factor (smoothing constant which lies in the range (0, 1)).

If the series X(t) has a missing observation e.g. X(b), then f(X(t)) will have a missing observation for the elements f(X(b)), f(X(b+1)) of the resultant series.

○ Double Single Smoothing

Function is applicating Single Smoothing to the same series consecutively.

Example:

Single Smoothing, Factor=0,5

	X0	X1
1Q2013	3166,23	3123,47
2Q2013	3374,77	3249,12
3Q2013	3406,34	3327,73
4Q2013	2994,99	3161,36
1Q2014	2896,58	3028,97
2Q2014	3052,56	3040,76
3Q2014	3139,8	3090,28
4Q2014	3007,6	3048,94
1Q2015	2985,46	3017,2
2Q2015	2866,23	2941,72
3Q2015	2977,37	2959,54
4Q2015	3114,95	3037,25

Double Smoothing, Factor=0,5

	X0	X1
1Q2013	3166,23	3128,26
2Q2013	3374,77	3188,69
3Q2013	3406,34	3258,21
4Q2013	2994,99	3209,78
1Q2014	2896,58	3119,38
2Q2014	3052,56	3080,07
3Q2014	3139,8	3085,18
4Q2014	3007,6	3067,06

1Q2015	2985,46	3042,13
2Q2015	2866,23	2991,92
3Q2015	2977,37	2975,73
4Q2015	3114,95	3006,49

SMOOTHEXP

This function evaluates the weighted average between the present observation and the previous weighted average with the base of the first element of the series.

Syntax of the function:
- ○ Single Exponential Smoothing

Evaluates the weighted average between the present observation and the previous weighted average where the base of this inductive process is the first element of the series. The evaluation of the weighted averages it an inductive procedure defined by the relations:

f(X(t)) = a * X(t) + (1- a) * f(X(t-1))

f(X(0)) = X(0)

where
X(0) is the first element of the series.
a is the factor (smoothing constant which lies in the range (0, 1)).

If the series X(t) has a missing observation e.g. X(b), then f(X(t)) will have a missing observation for the elements f(X(b)), f(X(b+1)) of the resultant series.

○ Double Exponential Smoothing

Function is applicating Exponential Smoothing to the same series consecutively.

Example:

Single Smoothing, Factor=0,5

	X0	X1
1Q2013	3166,23	3166,23
2Q2013	3374,77	3270,5
3Q2013	3406,34	3338,42
4Q2013	2994,99	3166,71
1Q2014	2896,58	3031,64
2Q2014	3052,56	3042,1
3Q2014	3139,8	3090,95
4Q2014	3007,6	3049,27
1Q2015	2985,46	3017,37
2Q2015	2866,23	2941,8
3Q2015	2977,37	2959,59
4Q2015	3114,95	3037,27

Double Smoothing, Factor=0,5

	X0	X1
1Q2013	3166,23	3166,23
2Q2013	3374,77	3218,37
3Q2013	3406,34	3278,39
4Q2013	2994,99	3222,55
1Q2014	2896,58	3127,1
2Q2014	3052,56	3084,6
3Q2014	3139,8	3087,77
4Q2014	3007,6	3068,52
1Q2015	2985,46	3042,95
2Q2015	2866,23	2992,37
3Q2015	2977,37	2975,98
4Q2015	3114,95	3006,62

SPLICE

This function returns a series containing all observations from Y together with adjusted observations from X where they do not overlap.
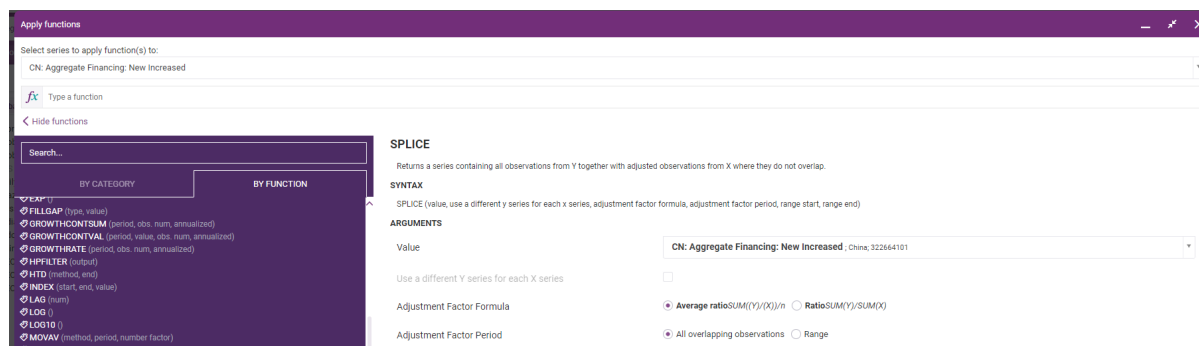
Syntax of the function:

Returns a series containing all observations from Y together with adjusted observations from X where they do not overlap. Series X is adjusted by a constant factor equal to average ratio of the series where series X and Y overlap. In order to be able to apply this function both series X and Y must have the same frequency and overlap.

$$f(X(t), Y(t)) = \begin{cases} Y(t), & \text{where } Y(t) \text{ is not missing} \\ p * X(t), & \text{where } Y(t) \text{ is missing and } X(t) \text{ is not missing} \end{cases}$$

where p is the adjustment factor, calculated as follows:

      ○ Average ratio adjustment factor:

$$adjustment\ factor = \frac{1}{n} \sum \frac{Y_t}{X_t}$$

      ○ Ratio adjustment factor:

$$adjustment\ factor = \frac{\sum Y_t}{\sum X_t}$$

Users can choose the period for which the adjustment factor will be calculated via the "Adjustment Factor Period" range option.

$$\rho = [\mathbf{S} \, (Y(t) / X(t) \,)] / n,$$

Where we sum over all overlapping elements where X(t) is not Null or zero, and n is the number of overlapping series elements where X(t) is not Null or zero. Since the series is required to overlap n = 1, and is referred to as the adjustment factor.

Example:

	Series X	Series Y	Average ratio adjustment factor		Ratio adjustment factor	
			No Range Selected Adj factor: 1.1383838	Range 1/10/2016 -31/11/2016 Adj Factor: 1.1575757	No Range Adj Factor: 1.1445783	Range 1/10/2016 -31/11/2016 Adj Factor: 1.1587301
			Result	Result	Result	Result
1/6/2016	10		11.38384	11.57576	11.44578	11.5873
1/7/2016	15		17.07576	17.36364	17.16867	17.38095
1/8/2016	20	22	22	22	22	22
1/9/2016	25		28.4596	28.93939	28.61446	28.96825
1/10/2016	30	34	34	34	34	34
1/11/2016	33	39	39	39	39	39
1/12/2016		45	45	45	45	45
1/1/2017		51	51	51	51	51
1/2/2017		57	57	57	57	57

CDMNext users can also use the function syntax to type in the SPLICE function directly in the "Type a function" text input. As the user types, a context menu will suggest the available options for the function and each of its arguments. Users will only need to click on the desired option in order to build the function.

SQRT

This function applies to the power with input of 1/2.

Syntax of the function:
X1(t)=X0(t)^(1/2)

Applied the square root to each element of the source series and assigned the same date with the resultant series. Note the square root is just a short cut means to applying the Power function with the input 1/2.

Example:

	X0	X1
1Q2013	256	16
2Q2013	900	30
3Q2013	100	10
4Q2013	9	3
1Q2014	484	22
2Q2014	361	19
3Q2014	729	27
4Q2014	81	9
1Q2015	36	6
2Q2015	289	17
3Q2015	529	23
4Q2015	400	20

SUBTRACT

This function subtracts a constant value or a selected series to operate with.

Syntax of the function:
X1(t)=X0(t)-const
or
X1(t)=X0(t)-Y(t)

Example:
Constant=100

	X0	X1
1Q2013	580	480
2Q2013	900	800
3Q2013	120	20
4Q2013	390	290
1Q2014	150	50
2Q2014	600	500
3Q2014	450	350
4Q2014	230	130
1Q2015	810	710
2Q2015	700	600
3Q2015	680	580
4Q2015	400	300

Series=Y

	X0	Y	X1
1Q2013	580	250	330
2Q2013	900	400	500
3Q2013	120	70	50
4Q2013	390	190	200

1Q2014	150	20	130
2Q2014	600	380	220
3Q2014	450	220	230
4Q2014	230	150	80
1Q2015	810	640	170
2Q2015	700	520	180
3Q2015	680	410	270
4Q2015	400	350	50

SUM

This function returns the sum of all selected series. 'Extend to the longest period' means that the returned sum will have the length of the longest series among the selected. 'Ignore missed observations' means that they are considered as equalling 0.
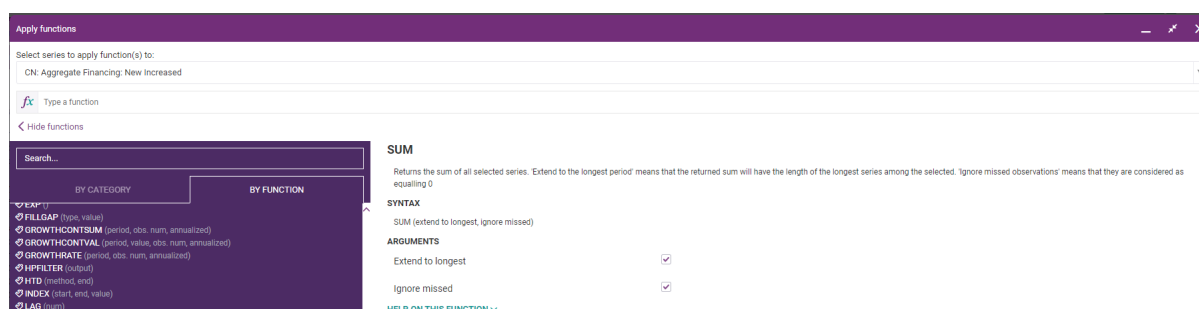
Syntax of the function:
X1(t)=X0(t)=Y(t)+Z(t)

Example:

	X0	Y	Z	X1
1Q2013	580	250	25	855
2Q2013	900	400	75	1375
3Q2013	120	70	15	205
4Q2013	390	190	105	685
1Q2014	150	20	35	205
2Q2014	600	380	95	1075
3Q2014	450	220	35	705
4Q2014	230	150	145	525
1Q2015	810	640	95	1545
2Q2015	700	520	65	1285
3Q2015	680	410	55	1145
4Q2015	400	350	45	795

TRAMOSEATS

This function provides seasonal adjustment, trend and forecasting for the selected series according to the TRAMO/SEATS methodology.
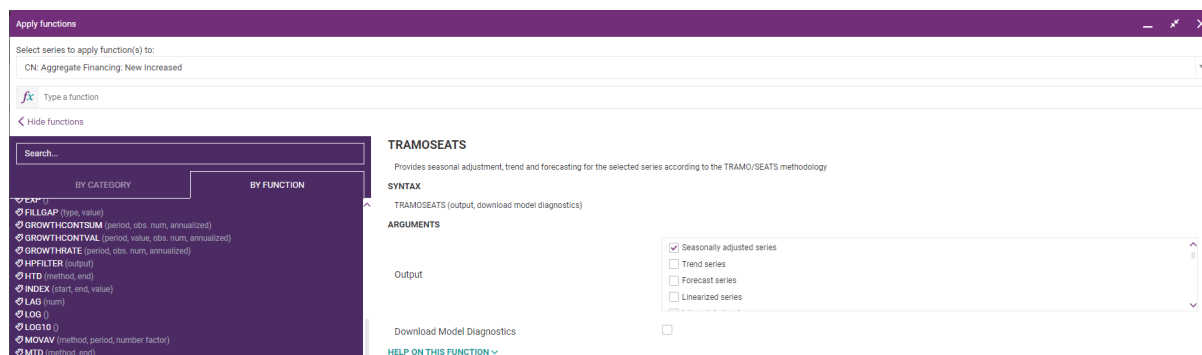
Syntax of the function:

These functions apply techniques for the automated time series analysis of the Seasonal Adjustment, Trend and Forecast, which is broadly in line (in most cases) with the implementation known as TRAMO-SEATS originally developed by Victor Gomez and Agustin Maravall. The term TRAMO stands for "Time series Regression with ARIMA noise, Missing values and Outliers" and SEATS for "Signal Extraction in ARIMA Time Series". Quoting from TSW (Revised Reference Manual) July 2004, by Gianluca Caporello and Agustin Maravall, on page 1, paragraph 2:

"TRAMO ("Time Series Regression with ARIMA Noise, Missing Observations and Outliers") is a program for estimation and forecasting of regression models with possibly non-stationary (ARIMA) errors and any sequence of missing values. The program interpolates these values, identifies and corrects for several types of outliers, and estimates special effects such Trading Day and Easter and, in general, intervention variable type of effects. Fully automatic model identification and outlier correction procedures are available.

SEATS ("Signal Extraction in ARIMA Time Series") is a program for estimation of unobserved components in time series following the ARIMA-model-based method. The Trend, Seasonal, Irregular and Transitory components are estimated and forecasted with signal extraction techniques applied to ARIMA models. The standard errors of the estimates and forecasts are obtained and the model-based structure is exploited to answer questions of interest in short-term analysis of the data."

For more details on the methodology, motivation and justification of the TRAMO-SEATS techniques please go to the Bank of Spain Statistics and Econometrics Software website.

Description:
TRAMO-SEASTS implementation has been adopted with assistance of Gianluca Caporello for CEIC infrastructure and performance requirements, and provides the key functionality of Seasonal Adjustment, Trend and Forecast using the default suggested automatic model calibration procedure. Note that the Bank of Spain's TWS 197 desktop application available from http://www.bde.es/servicio/software/programase.htm, when the automatic default model calibration is set will reproduce the results of our offering on the one hand, and also allow a seamless means by which users can apply additional TRAMO-SEATS analysis using a broad range of model calibration and options.

In CDMNext the following options are available:

○ Seasonally Adjusted:

The series selected is seasonally adjusted by the application of the Bank of Spain's SEATS ("Signal Extraction in ARIMA Time Series") algorithm. Intuitively this algorithm removes the effect of irregular observations (i.e. outliers) and factors out the cyclical behavior of the series.

○ Trend:

For the series selected the trend function applies the Bank of Spain's algorithm which intuitively returns the underlying series netting out the seasonal cyclical effects and irregular outlier elements (i.e. 'the trend').

○ Forecast:

Used to predict additional elements of the given series by estimating its intrinsic (constant) growth rate. The additional elements are simply the last element iteratively increased by the growth rate for each subsequent period. The number of additional elements returned is twenty four for monthly series and eight for all other frequencies.

○ Remark on maximum number of observations:

The maximum number of observations the functions will work with is 600. In the case of a series with more than 600 observations the seasonal adjustment will only consider the first 600 values.

○ Seasonal Adjustment additional outputs:

View various other metrics and model parameters of the Seasonal Adjustment algorithm. To request these additional outputs select the 'Model calibration, metrics and statistics' tick box and/or click the Additional outputs button, as shown below:

When the 'Model' tick box is selected in addition to one of the main algorithms, after one (or more) of the primary algorithms has been run and the output series returned, you can view both the model calibration, and the various qualitative metrics and statistics of the output series. This data can be viewed either when the output series is downloaded to Excel or by viewing the output series within a CDMNext data-table (i.e. right click on output series and select View as Table').

The additional outputs selected are returned as series and displayed within the CDMNext workspace with a corresponding label.

Remark: If more than one object series is selected then all the additional outputs selected will be calculated for all the object series.

Requirements of Seasonal Adjustment, Trend and Forecast functions
The TRAMO-SEATS functionality requires that the selected series satisfies the following requirements:
a) Minimum Number of Different Observations: The Seasonal Adjustment, Trend and Forecast functions can only be applied to series of frequency yearly, semi-annual, quarter or monthly. Moreover, for each of these frequencies the series are required to have the following number of (non-null) different observations:
- Yearly: Minimum of 12 observations with different values.
- Semi-annual: Minimum of 12 observations with different values.
- Quarterly: Minimum of 16 observations with different values.
- Monthly: Minimum of 36 fobservations with different values.

For example: The two yearly series with numerical values:
      i) {100, 101, 100.5, 103, 104, 102, 105, 102.5, 108, 109, 107, 115}
      ii) {100, 101, 100.5, 103, 104, 108, 105, 102.5, 108, 109, 107, 115}

Both series (i), (ii) each have 12 elements satisfying the (implicit) minimum number of elements requirement, however only series (i) has 12 different numerical values since series (ii) has two identical values, namely 108 and hence only has 11 different numerical values.

b)   Too Many Identical Observations and/or Gaps: The algorithm may trigger exceptions if the series selected has many identical values or gaps. In such instances of series with too many gaps we advise the users to apply the fill gap function provided and/or populate/clean the data with your preferred technique

Automated Default Calibration of TRAMO-SEATS
The TRAMO-SEATS functions offered here use an automated model calibration procedure. Below we provide explicit details of this calibration and compare this selection to the options available within the TWS 197 TRAMO-SEATS desktop application.
The core component of the TRAMO-SEATS set of procedures is known as the ARIMA algorithms (in particular, regular auto-regressive order, regular difference order, regular moving average order, seasonal auto-regressive order, seasonal difference order and Seasonal moving average order) and are defined within the Bank of Spain documentation. These techniques calibrate (or set) the model parameters automatically through analysis of the values of the series given. That is, Seasonal Adjustment is in fact a class of algorithms where the algorithm is selected by the qualitative properties of the series on which Seasonal Adjustment is

performed. We also refer the reader to the follow document which below we will refer to as the PROGRAM Document for additional information.

Instructions for the User

Programs TRAMO (Time Series Regression with ARIMA Noise, Missing Observations, and Outliers) and SEATS (Signal Extraction in ARIMA Time Series) (Beta Version: November 1997) by Víctor Gómez and Agustín Maravall

Download Link:
 http://www.bde.es/f/webbde/SES/servicio/software/tramo/guide.pdf

Below we provide an overview of how the implementation provided of TRAMO-SEATS has been calibrated:

1. Automatic Procedure Selected - Quoting from the TWS 197 TRAMO-SEATS documentation

"The program tests for the log/level specification, interpolates missing observations (if any), and performs automatic model identification and outlier detection. Three types of outliers are considered: additive outliers, transitory changes and level shifts; the level of significance is set by the program and depends on the length of the series. The full model is estimated by exact maximum likelihood, and forecasts of the series up to a two-year horizon are computed. The model is decomposed and optimal estimators and forecasts of the components are obtained, as well as their mean squared error. These components are the trend-cycle, seasonal, irregular and (perhaps) transitory component. If the model does not accept an admissible decomposition, it is replaced by a decomposable one.

Note on the Automatic procedure:

The automatic configurations associated with the RSA parameter can be modified: after setting the RSA parameter, enter the modified parameters (if the value desired is the default one, you still have to re-enter the parameter)."

Remark:

Within the TWS 197 application you are able to set the automate model calibrated to be performed by the same means by setting the parameter RSA =3.

2. ARIMA Model Calibration

Within the implementation offer the following default ARIMA Polynomials which we document using standard ARIMA notation. Within brackets we also specify how this calibration can be set up within the TWS 197 application.

- ○ ARIMA Polynomials:

a) P the order of regular autoregressive polynomial is zero (i.e. P = 0 in TWS 197)

b) Q the order of regular moving average polynomial is one (i.e. Q = 1 in TWS 197)

c) D the order of regular differences is one (i.e. D = 1 in TWS 197)

d) BP the order of seasonal autoregressive polynomial is zero (i.e. BP = 0 in TWS 197)

e) BQ the order of seasonal moving average polynomial is one (i.e. BQ = 1 in TWS 197)

f) BD the order of the seasonal differences is one (i.e. BD = 1 in TWS 197)

    ○ ARIMA Model Parameters:

a) All unknown ARIMA parameters will be estimated and the starting values from which estimates searches will start is computed by the program. That is, they are not fixed or given as inputs. (In TWS 197 this option is specified by setting INIT = 0.). In the following section 'Additional ARIMA Parameters' we provide more details of how the ARIMA parameters are estimated.

b) Mean correction is applied as defined in the PROGRAM Document which is used in the correction of outliers. (In TWS 197 this is set with IMEAN = 1.)

c) Source data is not transformed by the application of logs or program tests using log-level specification as detailed on page 15 with section 1.3.4 of the PROGRAM Documentation. (In TWS 197 this is set with LAM = 1.)

d) The real value which controls the bias in the log/level pre-test has been set to 1; this notion is detailed in section 2.5.4 of the PROGRAM Document. (In TWS 197 this is set with FCT = 1.)

e) Applies the Exact Maximum Likelihood algorithm (rather than Least Squares technique) to set the parameters for (i) the detection and control and outliers, (ii) compute optimal forecasts for the series. Further details and references are provided on page 2 of the product documentation. (In TWS 197 this is set with TYPE = 1.)

    ○ Additional ARIMA Parameters:

There we detail the additional ARIMA parameters which are automatically estimated by the default implementation we provide. Note in TWS 197 this corresponds to setting INIT = 0, where the alternative settings with TWS 197 are:

a) INIT = 1: Corresponding to allowing users to specify the starting point from where ARIMA polynomials parameters will be searched from by TRAMO-SEATS program.

b) INIT = 2: Corresponding to allowing users to give the ARIMA polynomials parameters which will be used by TRAMO-SEATS with no additional parameter estimation done.

For further details see Section 1.3 of the PRODUCT documentation. Here we detail the additional ARIMA parameters automatically estimated by TRAMO-SEATS within our offering:

a) The following parameters of the Regular, Regular Moving, Seasonal and Seasonal Moving Autoregressive ARIMA polynomials are estimates by TRAMO-SEATS (referred to as the 'ARIMA fixed Parameters' in TWS 197):

i. JPR (1), JPR (2), JPR (3): Are the parameters of the regular autoregressive polynomial.

ii. JQR (1), JQR (2), JQR (3): Are the parameters of the regular moving average polynomial.

iii. JPS (1): The parameter of the seasonal autoregressive polynomial.

iv. JQS (1): The parameter of the seasonal moving average polynomial.

b) The following starting points from which the Regular, Regular Moving, Seasonal and Seasonal Moving Autoregressive ARIMA polynomials parameters are estimated by TRAMO-SEATS (referred to as the 'ARIMA Parameters' in TWS 197):

i. PHI(1), PHI(2), PHI(3): Initial estimates of regular autoregressive polynomial parameters from where the program will estimate the parameters JPR (1), JPR (2), JPR (3).

ii. TH(1), TH(2), TH(3): Initial estimates of regular moving average polynomial parameters from where the program will estimate the parameters JQR(1), JQR(2), JQR(3).

iii. BPHI(1): Initial estimate of seasonal autoregressive polynomial parameter from where the program will estimate the parameter JPS(1).

iv. BTH(1): Initial estimate of seasonal moving average polynomial parameter from where the program will estimate the parameter JQS(1).

Note: The above notionally devices are standard ARIMA terminology and in particularly consistent with TWS 197.

3. Calendar Effects

Calendar effects such as trading day/holiday and Easter effects are not taken into account. However, in TWS 197 these effects can be taken into account and conclude the possibility to specify:

a) Easter effect by setting IEAST = 1. To replicate the behaviour in our offering you will need to set IEAST = 0 in TSW 197.

b) The trading day effect by setting ITRAD = ±1, ±2, ±6 or ±7. To replicate the behaviour in our offering you will need to set ITRAD = 0 in TSW 197.

c) The duration given as a number of integer days of the period affected by Easter. To replication the behaviour of our offering you will need to set IDUR = 0.

d) In the instance when trading days are taken into account the trading day regression variable can be set, allowing multiply resulting models (or day count conventions) for the selection of days of the weeks of each month. To replication the behavior of our offering set SMPDAY = 0 in TSW 197.

4. Outliers

The general methodology and approach to the treatment of outlier is detailed within: Gomez, V. and Maravall, A. (1994), Estimation, Prediction and Interpolation for Nonstationary Series with the Kalman Filter", Journal of the American Statistical Association 89, 611 624.

With the default calibration for outlier detection and correction procedures applied here being as follows:

a) There is no automatic detection and correction for outliers. In TWS 197 this behaviour is set with the parameter IATP = 0.

b) However, additive outliers, transitory changes and level shifts are considered, corresponding to the behaviour in TWS 197 of setting AIO = 2.

c) Rather than the maximum likelihood estimation technique the fast method of Hannan-Rissanen is applied for intermediate automation detection and correction of outliers. Note in TWS 197 is can be set with the parameter IMVX = 0.

d) The critical value used for outlier detection (VA) depends on number of observations in a series which we denote be N, and is given by:

1. VA = 3.0, if N <= 50,

2. VA = 3.0 + 0.0025*(N-50), if 50 < N < 450,

3. VA = 4.0, otherwise.

In TWS 197 this parameter though can be given is evaluated using these relations by default.

Remark: By default the outlier are search over the entire series given however the range over which outlier are consider can be restriction with the TWS 197 application which would increase performance.

5. Automatic Model Identification

We refer to the reader to section 1.3.5 of the PRODUCT documentation and limit ourselves here and just detailed the setting of the default TRAMO-SEATS offered here.

These setting are:

a) No automatic model identification is performed for the stationary model (i.e. INIC = 0 in TSW 197), and no searches for regular polynomials up to order 3 or seasonal polynomials up to order 1 (stationary model) are made.

b) No automatic model identification for non-stationary roots (i.e. IDIF = 0 in TSW 197), and no search for regular differences up to order 2 or seasonal differences up to order 1 are made.

c) The level of 0.97 for which "if one of the roots in the "AR(2) x ARs(1) plus mean" estimation in the first step of the automatic identification of the differencing polynomial is larger that, in modulus", will be set to unity. In TWS 197 this behaviour is set with UB1 = 0.97.

d) The level of 0.88 for which "if one of the roots in the "ARMA(1, 1) x ARMAs(1, 1) plus mean" estimation in the second step if the automatic model identification is larger, in modulus", will be set to unity. In TWS 197 this behaviour is set with UB2 = 0.88.

e) The level of the significance used within the Ljung-Box Q-test is 95% and used in automatic model identification. In TWS 197 this would be set with PCR = 0.95.

f) The percentage by which the critical value used for outlier detection (VA, described above) is reduced by 12% in the second round. In TWS 197 this is set with PC = 0.12, and only applies in cases when IATIP =1, i.e. no automatic model for stationary model as is the case here.

g) The minimum for the significant mean is set to 1 (i.e. TSIG = 1 in TSW 197).

6. Interpolation and Forecasting

a) Missing observations are treated as additive outlier and interpolated by setting the initial value as the sum of the two adjacent observations. In TWS 197 this is set with INTERP = 2, where the user can also use the skipping interpolation approach of missing observations and possibility to ignore unobserved values.

b) Number of additional period observation returned by the forecast function

i. 24 for series of monthly frequency.

ii. 8 for series of quarterly semi-annually and yearly.

With the TWS 197 application the number of additional observations returned is given by the parameter NPRED.

Remarks: In TWS 197 you are also able to undertake an out-of-sample forecast test, which does not affect the estimation of the model (i.e. reproducing CDMNext implementation results can use NBACK = 0 in TWS 197. These tests offer the ability to model the error estimates of the forecast function, and apply an F-test comparing the sample forecast errors with the in sample residues through back testing where the user can specify the observations omitted from the end of the series.

7. Seats Parameters

This section details (for completeness) the parameters used for application of SEATS (we definition above which is applied after the TRAMO procedures which the so called ARIMA based methods.

a) The modulus of a root passed by TRAMO or estimated in SEATS falls in the range (0.99, 1), it is set equal to 1 if root is in AR polynomial. If root is in MA polynomial, it is set equal to 0.99. Within the TWS 197 application (i.e. XL = 0.99 in TSW 197)

b) When the regular AR polynomial f(B) contains a complex root, this root is allocated to the seasonal if its frequency differs from one of seasonal frequencies by less than 3 (measured in degrees). Otherwise, it goes to the transitory component.

c) The cutting point for the modulus of an AR real root. If modulus < 0.5 it goes to the transitory component; if > 0.5, to the trend-cycle (positive roots) or to the seasonal component (negative roots).

d) When model does not accept an admissible decomposition, no approximation is made and SEATS ends. In TWS 197 this behaviour is set with NOADMISS = 0.

e) The number of autocorrelations used in computing Ljung-Box Q-statistics. The number if autocorrelations used in computing Ljung-Box Q-statictics depends on the frequency of the series considered and is set to 24 for monthly frequency, 12 for quarterly, 8 for semi-annual and yearly frequency.

Note: Within TWS 197 you will also notice that the variable BIAS = 1, however since the source data is not transformed, that is, LAM = 1, this variable will be ignored when reproduced our default implementation. In a similar fashion the variable MAXIBAS in TWS 197 can also be ignored.

Appendix:

CAGR Model comparison with TRAMO Forecast:

Here we consider what it known as the Constant Annual Growth rate (CAGR) metric as a means to illustrate the TRAMO Forecast function which also produces predictive future values by estimating a series future growth rate. CAGR assumes the future growth rate is equal to the average growth rate over the entire series and is given by:

CAGR: = ((End Value/Start Value)^(1/(Periods - 1)) -1

Now with regard to the example corresponding to series ID = 173886402, entitled "Exports: Non CIS: Russia" used to illustrate the TRAMO Forecast functions, we have:

Constant Annual Growth Rate (CAGR) = 85.59%

Which compares with the average growth rate implied from the results of the TRAMO Forecast function of 71.54% That is, the magnitude of the two results are similar, with the TRAMO Forecast differing due to its ability to model the intricate nature of the series, versus rough model of CAGR which only considers the first and last elements.

Example:

	X0	X1 (Seasonally adjusted)	X1 (Trend)	X1 (Forecast)
1Q2013	9512	23822	23768	9 512
2Q2013	19088	23265	23299	19 088
3Q2013	28442	23422	23459	28 442
4Q2013	37203	23766	23662	37 203
1Q2014	9110	22817	22905	9 110
2Q2014	18685	22771	22743	18 685
3Q2014	27940	23009	23012	27 940
4Q2014	36392	23250	23271	36 392
1Q2015	6254	15664	15693	6 254
2Q2015	13768	16777	16708	13 768
3Q2015	20489	16873	16912	20 489
4Q2015				26 926
1Q2016				7 183
2Q2016				15 440
3Q2016				23 894
4Q2016				32 210

UNIT_MULTIPLIER

This function changes the multiplier of the unit of the selected time series and adjusts the values so that they match the new multiplier. Can be used to modify the additional multiplier of the unit (e.g. USD mn) and the multiplier that is part of the unit itself, if any (e.g. 100 ml). Please refer to the help section for this function for details.
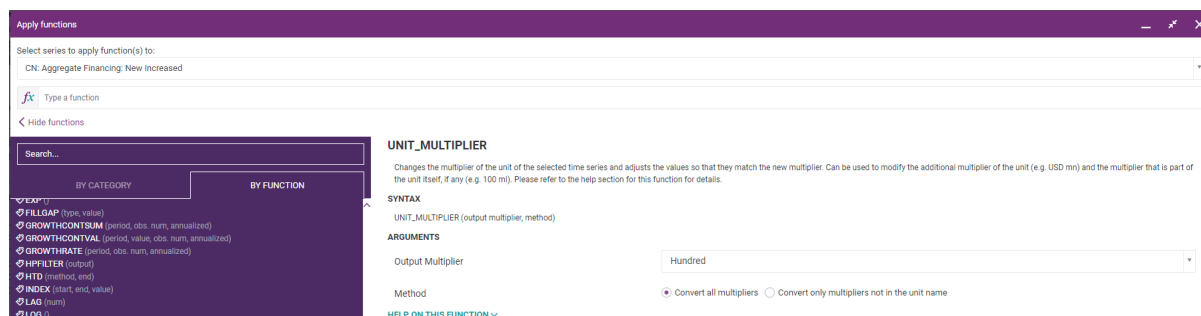
Description:

Use this function to manipulate the unit multiplier (thousands, millions, etc.) of a time series. Users can choose to convert the time series to one of the following unit multipliers:

100 (Hundreds), TH (Thousands), MN (Millions), BN (Billions), TN (Trillions)

Unit multipliers can be of two types – a multiplier that is applied additionally to the series in order to convert it to millions, thousands, etc. units, for reasons of convenience, or a multiplier that is a part of the unit itself as reported, such as dozens of kilograms (12 kg). Multipliers the former will have the multiplier at the end of the unit while the latter will be displayed in the beginning. On CDMNext users can choose to manipulate both or one of these.

Following on the above, users can avail of two settings for this function:
  ○ Convert all multipliers
Converts all multipliers to the multiplier selected by the user.

Examples:

Series Values	Original Unit	Desired Multiplier	Formula Used	New Series	New Unit
10, 20	10 Ton mn	TH	value*((10*1 mn)/1 th)	100 000, 200 000	Ton th
1000, 2000	12 kg	MN	value*((12*1)/1 mn)	0.012, 0.024	kg mn

| 1 000 000 000, 2 000 000 000 | USD th | BN | value*((1*1 th)/1 bn) | 1000, 2000 | USD bn |
| 10 000, 20 000 | lb | TH | value*((1*1)/1 th) | 10, 20 | lb th |

○ Convert only multipliers not in the unit name

Converts the additional multiplier, but leaves intact any multipliers that are part of the unit itself.

Examples:

Series Values	Original Unit	Desired Multiplier	Formula Used	New Series	New Unit
10, 20	10 Ton mn	TH	value*(1 mn/1 th)	10 000, 20 000	10 Ton th
1000, 2000	12 kg	MN	value*(1/1 mn)	0.001, 0.002	12 kg mn
1 000 000 000, 2 000 000 000	USD th	BN	value*(1 th/1 bn)	1000, 2000	USD bn
10 000, 20 000	lb	TH	value*(1/1 th)	10, 20	lb th

The function can be applied only to time series measured in currency or any volume measure (kilograms, cubic meters, barrels, kWh, etc.). It does not support ratios (Ton th/Day) or Indices (2010=100). Users will see a message that the unit is not supported, if this is the case.

UPDATE

This function returns a series containing all observations from the selected series (Y) together with observations from the base series (X) where they do not overlap.
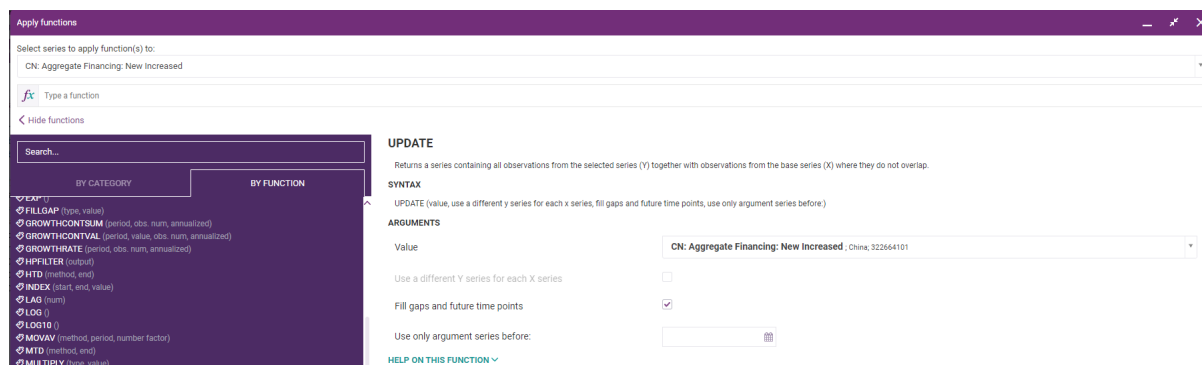
Syntax of the function:

Returns a series containing all observations from Y together with observations from X where they do not overlap. To be able to apply this function the updated source series X and the series from which updates are taken Y must have the same frequency.

Formerly, the resultant series dates will be the union of the dates of X and Y and the corresponding observations are evaluated by the relation:

$$f(X(t), Y(t)) = \begin{cases} Y(t), & \text{where } Y(t) \text{ is not missing} \\ X(t), & \text{where } Y(t) \text{ is missing} \end{cases}$$

Description:

To be able to apply this function the X0 and Y series must have the same frequency.

Example:

	X0	Y	X1
1Q2014	20	22	22
2Q2014	22	NA	22
3Q2014	35	36	36
4Q2014	NA	35	35
1Q2015	35	37	37
2Q2015		39	39
3Q2015		45	45

WTD

This function calculates the week-to-date sum or derives the week-end difference of a selected series.

Syntax of the function:

X_{mj} indicates the value of the jth observation in mth period, e.g. X_{21} is the first observation in the 2nd half-year period.

Example:
Method=Sum

	X0	X1 (End=Saturday)
Jan1, 2015 (Thu)	-3,55	-3,55
Jan2, 2015 (Fri)	0,18	-3,37
Jan3, 2015 (Sat)	-1,28	-4,65
Jan4, 2015 (Sun)	-2,47	-2,47
Jan5, 2015 (Mon)	-1,59	-4,06

Jan6, 2015 (Tue)	-1,56	-5,62
Jan7, 2015 (Wed)	-3,33	-8,95
Jan8, 2015 (Thu)	0,09	-8,86
Jan9, 2015 (Fri)	2,33	-6,53
Jan10, 2015 (Sat)	2,35	-4,18
Jan11, 2015 (Sun)	-0,09	-4,18
Jan12, 2015 (Mon)	-2,09	-6,27

Method=Diff

	X0	X1 (End=Saturday)
Jan1, 2015 (Thu)	0,83	0,83
Jan2, 2015 (Fri)	0,64	-0,19
Jan3, 2015 (Sat)	3,65	3,01
Jan4, 2015 (Sun)	6,27	6,27
Jan5, 2015 (Mon)	5,71	-0,56
Jan6, 2015 (Tue)	7,67	1,96
Jan7, 2015 (Wed)	3,93	-3,74
Jan8, 2015 (Thu)	2,46	-1,47
Jan9, 2015 (Fri)	3,21	0,75
Jan10, 2015 (Sat)	0,47	-2,74
Jan11, 2015 (Sun)	-1,47	-1,47
Jan12, 2015 (Mon)	-2,01	-0,54

X12ARIMA

This function provides seasonal adjustment, trend and forecasting according to the X12ARIMA methodology which can only be applied to Monthly and Quarterly series.
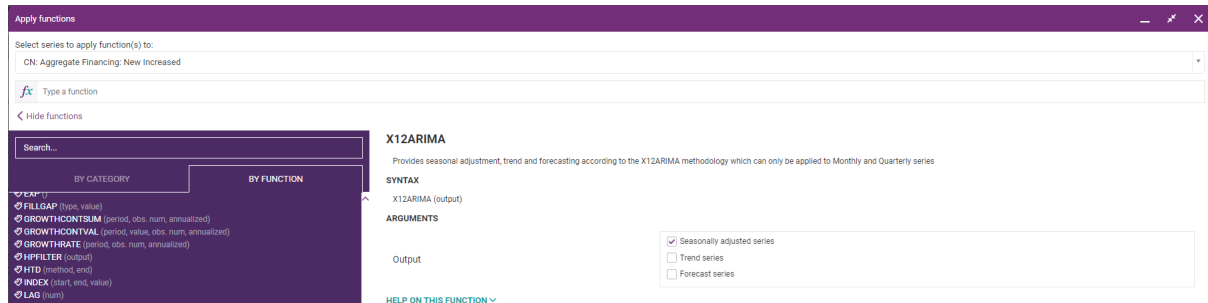
Syntax of the function:
Formulas for calculating X-12 Arima model results are offered by US Census Bureau.

Description:
X-12 Arima is a seasonal ad by US Censdjustment model offereus Bureau available from 'Seasonal Adjustment & Forecasting' menu within CDMNext.
X-12 Arima provides the following functions which can only be applied to Monthly and Quarterly series:
   ○ Seasonally Adjusted: The series selected is seasonally adjusted by the application of the US Census Bureau X-12 Arima algorithm. Intuitively this algorithm removes the effect of irregular observations (i.e. outliers) and factors out the cyclical behavior of the series.
   ○ Trend: For the series selected the trend function applies the X-12 Arima algorithm which intuitively returns the underlying series netting out the seasonal cyclical effects and irregular outlier elements (i.e. 'the trend').
   ○ Forecast: Used to predict additional elements of the given series, which the US Census Bureau refers to as projected seasonal factors.

Note of Restrictions: X-12 Arima can only be applied to monthly series of at least (non-null) 36 (non-null) elements and quarterly series of at least 12 (not null) elements.

For more information please refer to the following link: https://www.census.gov/ts/x12a/v03/x12adocV03.pdf

Example:

	X0	X1 (Seasonally adjusted)	X1 (Trend)	X1 (Forecast)
1Q2013	9512	24 747	25 434	9 512
2Q2013	19088	23 802	23 603	19 088
3Q2013	28442	23 337	23 327	28 442
4Q2013	37203	23 308	23 429	37 203
1Q2014	9110	23 804	23 599	9 110
2Q2014	18685	23 271	23 492	18 685
3Q2014	27940	22 953	22 760	27 940
4Q2014	36392	22 773	21 012	36 392
1Q2015	6254	16 395	18 676	6 254
2Q2015	13768	17 152	17 177	13 768
3Q2015	20489	16 842	16 853	20 489
4Q2015				27 475
1Q2016				6 637
2Q2016				14 272
3Q2016				22 137
4Q2016				29 925

X13ARIMA

This function provides seasonal adjustment, trend and forecasting for Monthly and Quarterly series.

Description:

X-13 Arima is a seasonal adjustment model offered by US Census Bureau and made available on CEIC platforms via the X13 ARIMA CEIC function. X-13 Arima provides filtering for seasonal effects and cycle component, as well as an option to produce forecasts. X-13 ARIMA can only be applied to Monthly and Quarterly series with at least 3 years of data.

Instructions

Output:

X-13 ARIMA offers 3 possible outputs for series:

- Seasonally Adjusted: The series selected is seasonally adjusted by the application of the US Census Bureau X-13 Arima algorithm. Intuitively this algorithm removes the effect of irregular observations (i.e. outliers) and factors out the cyclical behavior of the series.
- Trend: For the series selected the trend function applies the X-13 Arima algorithm which intuitively returns the underlying series netting out the seasonal cyclical effects and irregular outlier elements (i.e. 'the trend').
- Forecast: Used to predict additional elements of the given series, which the US Census Bureau refers to as projected seasonal factors. 12 months of forecast are provided for monthly data and 8 quarters – for quarterly.

You can apply the function to more than one series, but the settings, which will be applied, will be the same for all selected series. Therefore, you can expect better results if the selected series are from the same economic sector and are expected to share similar seasonal effects.

Additionally, users can select "Download Model Diagnostics" option. This will make the following diagnostics available upon downloading the output series in Excel:

Diagnostic	Description
Transformation	Informs whether a pre-adjustment logarithmic transformation was performed
AICC	Displays the likelihood test results (F-adjusted Akaike's Information Criterion is used)
ARIMA Model	The ARIMA model selected automatically by X-13-ARIMA-SEATS procedure
Identifiable Seasonality	Informs whether identifiable seasonality was detected. (1 – Yes, 0 – No)
M7	The amount of moving seasonality present relative to the amount of stable seasonality
I/C Ratio	Shows the irregular/trend ratio

QS Original Series, EV adj. (p-value)	p-value for the QS statistic (test of the hypothesis of no seasonality) of the original series adjusted for extreme values
QS Original Series (p-value)	p-value for the QS (test of the hypothesis of no seasonality) statistic of the original series
QS Residuals (p-value)	p-value for the QS statistic (test of the hypothesis of no seasonality) of the residuals
F-statistic, Assuming stability	F-statistic of test for seasonality, assuming stability
Q (avg. M1-M11)	A weighted average of M1-M11*
User Regressor (holiday, chi-sq, p-value)	Provides the chi-squared and p-value of the chi-squared test of the selected Chinese holiday regression variables

*M1 to M11 represent different quality control statistics

Chinese Holidays Adjustment

CDMNext and CDMNext add-in users can select 1 or more Lunar calendar holidays, as observed in China, to improve seasonal adjustment of Chinese data. This will include a custom proportionality regression variable for the holiday(s). Users can avail from a set of default holiday effect values, which can be applied in 1 click, or specify their own parameters:

- Use CEIC Defaults: With just 1 click from the "Data Series" menu, users can choose among a selection of available default values for a number of economic sectors/indicators – select the sector closes to your data series. Each selection will populate the default values for holiday effects of the selected holiday. Default values were selected through testing relevant series from each sector for all possible combinations for the 3 holiday effects periods (Before, During and/or After)*. Tests covered a range for each affected period of 1-20 days for Lunar New Year and 1-10 for the rest of the holidays. The result that scored the lowest on the AICC likelihood test (F-adjusted Akaike's Information Criterion) was selected.*
- Use own holiday effects values: Users can populate any value for the holiday effect periods (Before, During and/or After)** of each holiday by choosing "Custom" from the "Data Series" menu. Acceptable range is as follows: 0-42 for Before and 0-49 for the combined value of During and After. Inputting 0 will mean no holiday effect for the selected period. Users must enter a positive number for at least 1 period. If the users have made an input for Before and After, they must also set the During period to at least 1.

* Please note that the list provided includes the most relevant sectors/indicators for each holiday and that some sectors/indicators might not be available for a certain holiday due to little relevance. (For example, requesting a custom regression variable for the Lunar New Year Effects for a Quarterly GDP series has no effect as

the holiday is always within the same quarter. Users should execute X13-ARIMA without this custom regression variable and control only the rest of the options and custom holiday regressors)

**"Before" signifies the number of affected days before the holiday, "During signifies the number of days from the day of the holiday, including that day, "After" signifies the number of affected days after the During period.

Note: Users can select 1, all or none of the Chinese holidays offered. If they choose to adjust for one of the holidays they must supply values for at least 1 of the affected periods or choose 1 of the default options from the "Data Series" menu.

Regression variables are calculated as proportionality repressors, where their value in any month is the proportion of the days of the specified interval that belong to the month over the total number of days in the interval.

Default values might be missing for quarterly data and for some data categories, due to unsatisfactory results during testing. Default values are maintained continuously, so such values can be expected in the future, if new data allows for better results.

Gregorian calendar holidays adjustment
X-13 ARIMA function offers additional parameters for 3 other holidays:
- Easter: Specify an Easter holiday regression variable (as based on the Gregorian calendar) for monthly flow data, which assumes the level of daily activity changes in the 10 days before Easter;
- Thanksgiving: Specify a Thanksgiving holiday regression variable for monthly flow data, which assumes the level of daily activity changes in the 10 days before Thanksgiving
- Labour Day: Specify a Labour Day holiday regression variable for monthly flow data, which assumes the level of daily activity changes in the 10 days before Thanksgiving

Using Advanced Options
Prior Adjustments:
Users can further control X-13 ARIMA parameters as follows:
- Model Span: Allows users to select a sub-set of the data. Only that subset will be included in the modeling of the output series. Leaving the Start or End fields empty, signifies to use all data from the start or the end of the series, respectively. For quarterly data, users are required to enter the end-month of the quarter. To specify the start or the end of the series, simply leave the date

field blank. The output series will include only the span specified. If one of the selected dates falls outside of the data range of the series, they will be automatically moved to the start or end of the series during calculation.The default value is from January 2000 until the end of the series (i.e. leaving the End field blank).

- ○ Regression variables: Users can choose whether to include trading day effects to their adjustment (adjust for different day-of-week compositions of the same month in different years). The trading day variable comprises 6 contrast variables obtained from the difference between the numbers of each day of the week in the month and the number of Sundays in the month and 1 length-of-the-month variable. It also includes adjustment for leap years. Trading Day is switched on by default.

- ○ Transformation: Specifies whether X-13 ARIMA will automatically chose whether to apply logarithmic transformation to adjust the series prior to estimating, or turn off prior adjustment altogether. Default value is 'Auto'.

- ○ To return to any of the default values: you can restore each setting to the default values mentioned under each description above. Also, if you are applying the function to the series for the first time or have not previously changed the default settings under Advanced Options, you can simply disregard any input you just made to Advanced Options by closing the pop-up or clicking "Cancel", instead of accepting the changes by clicking "OK".

Chinese holidays regression variables settings

Please note, that these settings will have effect only if a Chinese holiday is selected on the main screen.

- ○ Calculation of the Means Start/End: Users can input two 4-digit dates between 1900 and 2100 to specify the first and last years used in the calculation of the means of the holiday repressors. By default this is left blank (displaying Beginning or End), which signifies to calculate the means for all holiday occurrences.

- ○ Zero Regression before/After: users can specify a period before or/and after which the holiday regression variable used will be equal to 0. Please note that the period left to be non-zero must overlap with the series data range, or the range selected in the span argument, by at least 2 years in order to avoid a singular matrix scenario. The default value is None, which means that all holiday occurrences will be included in the regressor.

- ○ Centre: users can choose between Calendar, Mean and no centering of the regressors. The centering is done to keep the yearly totals of the series, obtained by removing the estimated holiday effects, approximately equal to the yearly totals of the unadjusted data. If centering is not done, these two totals will differ by approximately the same amount each year, and user will conclude that combined seasonal and holiday adjustment is producing a

biased estimate of the level of the observed series. (The bias is a crude estimate of what the data would be like if there were no holiday.)Calendar centering is appropriate for holidays like Easter or the Chinese New Year whose regressors are always zero in some calendar months because the holiday can occur only in a few calendar months. This method is selected by default.

○ To return to any of the default values: if you have not accepted the changes to Advanced Options, by clicking "OK", please simply close the pop-up or click "Cancel". If you have accepted the changed values, you can restore each setting to the default values mentioned under each description above.

Remarks

CDMNext users can also avail of the function syntax to type in the X13ARIMA() function directly in the "Type a function" text input. As the user types, a context menu will suggest the available options for the function and each of its arguments. Users will only need to click on the desired option in order to build the function.

X-13 ARIMA function always includes a trend constant regression variable to allow for a nonzero overall mean for the differenced data series.

CEIC methodology for Chinese holiday adjustment and estimating holiday occurrences is verified against academic work, such as:

Lytras, Demetra P. et al, "Determining Seasonality: A Comparison of Diagnostics From X-12-ARIMA", U.S. Census Bureau

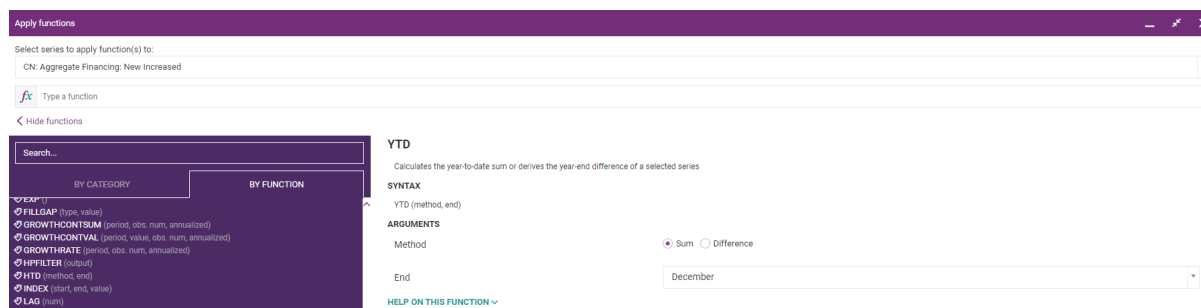Roberts, Ivan, Graham White, "Seasonal Adjustment of Chinese Economic Statistics", 2015

Lin, Jin-Lung, Tian-Syh Liu, "Modeling Lunar Calendar Holiday Effects in Taiwan", 2002

Aslaksen, Helmer, "When is Chinese New Year?", 2005

Aretz, Tilman, "The Chinese Lunar Calendar 1900–2100", 2010

YTD

this function calculates the year-to-date sum or derives the year-end difference of a selected series.

Syntax of the function:

Function	Formula
Sum Period-end ➡ Period-to-date	$f(X_{mn}) = \begin{cases} \text{Null} & X_{mn} \text{ is Null.} \\ \text{Null} & \text{if any elements } (X_{m1}, X_{m2}, \dots, X_{mn-1}) \text{ is / are missing.} \\ \sum_{j=1}^{n} X_{mj} & \text{if all components are not missing} \end{cases}$
Difference Period-end ⬅ Period-to-date	$f(X_{mn}) = \begin{cases} \text{Null} & \text{if either } X_{mn} \text{ or } X_{m(n-1)} \text{ is null or missing} \\ X_{m1+i} & \text{where } X_{m1+i} \text{ is the closest non-null element, if } X_{m1}, X_{m1+1}, X_{m1+2}\dots \text{ is null.} \\ X_{mn} - X_{m(n-1)} & \text{if } n > 1 \end{cases}$

Xmj indicates the value of the jth observation in mth period, e.g. X21 is the first observation in the 2nd year period.

Example:
Method=Sum

	X0	X1 (End=December)
1Q2013	-3,55	-3,55
2Q2013	0,18	-3,37
3Q2013	-1,28	-4,65
4Q2013	-2,47	-7,12
1Q2014	-1,59	-7,12
2Q2014	-1,56	-8,68
3Q2014	-3,33	-12,01
4Q2014	0,09	-11,92

1Q2015	2,33	-9,59
2Q2015	2,35	-7,24
3Q2015	-0,09	-7,33
4Q2015	-2,09	-9,42

Method=Diff

	X0	X1 (End=December)
1Q2013	0,83	0,83
2Q2013	0,64	-0,19
3Q2013	3,65	3,01
4Q2013	6,27	2,62
1Q2014	5,71	5,71
2Q2014	7,67	1,96
3Q2014	3,93	-3,74
4Q2014	2,46	-1,47
1Q2015	3,21	3,21
2Q2015	0,47	-2,74
3Q2015	-1,47	-1,94
4Q2015	-2,01	-0,54