R topics documented:

br.bdh br.bulk.csv br.bulk.desc br.bulk.idx br.bulk.tiks br.desc br.md2pdf br.rmd2html br.rmd2slides br.rmd2pdf br.rmd2bothbr.sample Deprecated functions Internal BloomR functions Manage connections Misc functions Beta functionalities title: "BloomR Main Functions" author: "Antonio Fasano" date: "Jan 28, 2024"

# BloomR main functions

# br.bdh

Historical data

## Description

Download historical Bloomberg data

# Usage

```
br.bdh(con, securities, fields="PX_LAST", start.date, end.date = NULL,
option.names = NULL, option.values = NULL,
always.display.tickers = FALSE, dates.as.row.names = (length(securities) == 1),
include.non.trading.days = NULL
)
```

# Arguments

```
con the connection token returned from br.open()
securities character vector of the tickers queried for data
```

field case insensitive character vector of the Bloomberg field queried. Defaults to "PX" LAST".

start.date Time series start date as a Date object or an ISO string without separators (YYYYMMDD). Time series will actually begin at start.date if there is data available; otherwise it will start at the first significant date.

end.date Time series end date as a Date object or an ISO string without separators (YYYYMMDD). If NULL or missing, it defaults to the last available date.

option.names, option.values See details

always.display.tickers Displays tickers in first column even if a single one is requested. Defaults to FALSE dates.as.row.names Displays dates also as row names. Defaults to TRUE for single ticker query, FALSE otherwise.

include.non.trading.days If TRUE, rows are returned for all requested dates, even when markets no data is available. It defaults to FALSE for a single security or and TRUE for multiple securities. In the latter case, use na.omit or na.exclude to remove these rows.

#### **Details**

For multi-ticker queries you might consider to use br.bulk.tiks which features also a simulated mode.

option.names and option.values are options vectors affecting the returned data. Options are set pairwise, for example to set opt1 and opt2 respectively to val1 and val2, you would pass the arguments:

option.names=c("opt1", "opt2"), option.values=c("val1", "val2")

Here is a list of options:

- periodicityAdjustment Determine the frequency and calendar type of the output. To be used in conjunction with periodicitySelection. If ACTUAL, it reverts to the actual date from today (if the end date is left blank) or from the End Date. If CALENDAR, (for pricing fields), it reverts to the last business day of the specified calendar period. Calendar Quarterly (CQ), Calendar Semi-Annually (CS), or Calendar Yearly (CY). If FISCAL, it reverts to the fiscal period end for the company Fiscal Quarterly (FQ), Fiscal Semi-Annually (FS) and Fiscal Yearly (FY) only.
- **periodicitySelection** Determine the frequency of the output. To be used in conjunction with periodicityAdjustment. if DAILY, WEEKLY, MONTHLY, QUARTERLY, SEMI ANNUALLY, YEARLY.
- **currency** Amends the value from local to desired currency. The value is a 3 letter ISO code string, e.g. USD, GBP. View WCV<GO> on the Bloomberg terminal for the full list.
- **overrideOption** Indicates whether to use the average or the closing price in quote calculation. Values can be OVERRIDE\_OPTION\_CLOSE for using the closing price or OVERRIDE\_OPTION\_GPA for the average price.
- pricingOption Sets quote to Price or Yield for a debt instrument whose default value is quoted in yield (depending on pricing source). PRICING\_OPTION\_PRICE sets quote to price; PRICING\_OPTION\_YIELD sets quote to yield.
- nonTradingDayFillOption Sets to include/exclude non trading days where no data was generated. NON\_TRADING\_WEEKDAYS includes all weekdays (Monday to Friday); ALL\_CALENDAR\_DAYS includes all days of the calendar; ACTIVE\_DAYS\_ONLY includes only the days where the instrument and field pair were updated.
- nonTradingDayFillMethod If data is to be displayed for non trading days what is the data to be returned.
  PREVIOUS\_VALUE searches back and retrieve the previous value available for this security field pair. The search back period is up to one month. NIL\_VALUE returns blank for the "value" value within the data element for this field.
- maxDataPoints the maximum number of data points to return. If the original data set is larger, the response will be a subset, containing only the last maxDataPoints data points.
- returnEids returns the entitlement identifiers associated with security. If TRUE, populates data with an extra element containing a name and value for the EID date.
- returnRelativeDate returns data with a relative date. If TRUE, populates data with an extra element containing a name and value for the relative date. For example RELATIVE\_DATE = 2002 Q2
- adjustmentNormal Adjust for "change on day". If TRUE, adjusts historical pricing to reflect: Regular Cash, Interim, 1st Interim, 2nd Interim, 3rd Interim, 4th Interim, 5th Interim, Income, Estimated, Partnership Distribution, Final, Interest on Capital, Distribution, Prorated.
- adjustmentAbnormal Adjusts for Anormal Cash Dividends. If TRUE, adjusts historical pricing to reflect: Special Cash, Liquidation, Capital Gains, Long-Term Capital Gains, Short-Term Capital Gains, Memorial, Return of Capital, Rights Redemption, Miscellaneous, Return Premium, Preferred Rights Redemption, Proceeds/Rights, Proceeds/Shares, Proceeds/Warrants.

adjustmentSplit Capital Changes Defaults. If TRUE, adjusts historical pricing and/or volume to reflect: Spin-Offs, Stock Splits/Consolidations, Stock Dividend/Bonus, Rights Offerings/Entitlement.

adjustmentFollowDPDF If TRUE (defaults) Follow the Bloomberg function as from DPDF<GO>.

CalendarCodeOverride Returns the data based on the calendar of the specified country, exchange, or religion. Value is a two character calendar code as from CDR<GO>. This will cause the data to be aligned according to the calendar and including calendar holidays. Only applies only to DAILY requests.

calendarOverridesInfo (Experimental, not tested) Returns data based on the calendar code of multiple countries, exchanges, or religious calendars as from CDR<GO>. This will cause the data to be aligned according to the set calendar(s) including their calendar holidays and only applies to DAILY requests. Requires calendarOverrides, which is a character vector of two-character calendar codes as from CDR<GO>; calendareOverridesOperation, which can be CDR\_AND returning the intersection of trading days among multiple calendars or CDR\_OR returning the union of trading days. That is, a data point is returned if a date is a valid trading day for any of the calendar codes specified in the request.

Overrides (Experimental, not tested) Append overrides to modify the calculation. fieldID specifies a field mnemonic or alpha-numeric, such as PR092 or PRICING\_SOURCE. Review FLDS for list of possible overrides. value sets the desired override value

#### Value

A data frame with historical data. If tickers are displayed, the first column shows tickers, the second one the time series dates and the following ones the values of the queried fields; otherwise the columns start with dates. Dates will also be shown as rows if dates.as.row.names=TRUE. If multiple tickers are queried, they are vertically stacked respecting the order in securities vector.

# br.bulk.csv

Historical data from grouped tickers in a CSV files

Reads a CSV file containing a group of tickers in each column and returns the historical data in xts or list format. The CSV file is assumed to have headers denoting group labels.

#### Usage

```
br.bulk.csv(con, file, start = Sys.Date() - 5, field = "PX_LAST",
    cols = NULL, addtype = FALSE, showtype = FALSE, use.xts = TRUE,
    comma = TRUE,
    price=TRUE, nrow=5, same.dates=FALSE, no.na=FALSE, empty.sec=0
)
```

### Arguments

**con** the connection token returned from br.open(). If NULL simulated values are generated. **file** path to CSV file.

**start** start date. Can be a Date object or an ISO string without separators (YYYYMMDD). Defaults to 5 days before current date.

field case insensitive string denoting the Bloomberg field queried. Defaults to "PX\_LAST". If the field is wrong or not accessible, data will be empty but no error will be raised.

cols Logical or integer vector for selecting CSV columns (ticker groups). Defaults to all columns.

addtype If a string denoting the security type, it will be added to all tickers; if TRUE "Equity", will be added; if FALSE (the default), nothing will be added.

**showtype** if TRUE, security types will be removed from names of list or xts output. It defaults to FALSE. **use.xts** if TRUE (the default) each group will be formatted as an xts object else as a list.

comma to be set to FALSE for (non-English) CSV, using semicolon as separator.

**nrow** maximum number of simulated rows (actual is random). Ignored if con!=NULL, it defaults to 5. empty.sec ratio of securities returning no data. Ignored if con!=NULL, it defaults to 0.

## **Details**

Empty CSV cells or cells interpreted as NAs will be ignored.

If con=NULL, values are simulated by means of br.sample(). This function is used with default values, except for nrow, start, same.dates, no.na, empty.sec, which can be explicitly passed as arguments, and sec.names depending on tickers found in the CSV file. These arguments are ignored if con!=NULL. See br.sample() help for more.

#### Value

a list where each element is the historical data of a CSV group.

If use.xts=TRUE, elements are xts object, where each column is the historical data of a security.

If use.xts=FALSE, elements are sub-list, where each element is the historical data of a security.

If there is only one group, the first (and unique) element of the list will be returned.

#### Demonstration

A sample CSV with Bloomberg tickers will look like follows:

```
read.csv("mybloomr/tickers.csv")
## This file is part of BloomR and anyway available here:
## https://github.com/AntonioFasano/BloomR/blob/master/res/tickers.csv
```

## Note:

- CSV group headers are mandatory;
- Group headers need not to be the same length.

We can now download data:

```
con=NULL #Simulated mode: replace with con=br.open() on terminal

data=br.bulk.csv(con, "mybloomr/tickers.csv")

## Processing Financial ...

##

## Attaching package: 'zoo'

## The following objects are masked from 'package:base':

##

## as.Date, as.Date.numeric

## Loading 3988 HK Equity

## Loading C US Equity

## Loading 601288 CH Equity

## Loading BAC US Equity

## Loading HSBA LN Equity

## Processing Technology ...
```

```
## Loading QCOM US Equity
## Loading CSCO US Equity
## Loading 700 HK Equity
## Loading IBM US Equity
## Loading INTC US Equity
## Processing Indices ...
## Loading DJI Index
## Loading DJUSFN Index
## Loading W1TEC Index
```

Above you see some info about data being processed that we will not show anymore in the following.

If you want to have detailed ticker descriptions, see br.bulk.desc Example. Downloaded data look like follows: data

```
## $Financial
##
              3988 HK
                        C US 601288 CH BAC US HSBA LN
## 2024-01-23
              10.064 10.481
                                     NA
                                            NA
                                               10.622
## 2024-01-24
                9.831 11.874
                                     NA 11.179
                                                11.233
                                10.219 10.005
               10.020 11.018
## 2024-01-25
                                                 9.853
## 2024-01-26
               10.524 9.776
                                     NA
                                            NA
                                                 9.575
## 2024-01-27
                9.624
                          NA
                                     NA 10.311
                                               10.234
##
## $Technology
              QCOM US CSCO US 700 HK IBM US INTC US
##
## 2024-01-23
                   NA
                        7.331
                                   NA
                                          NA
                                               8.542
## 2024-01-24
                8.773
                           NA
                                   NA
                                          NA
                                              10.857
## 2024-01-25
                   NA
                        9.159
                               8.401
                                       9.943
                                               8.915
## 2024-01-26
                   NA
                       10.453
                               8.781
                                          NA
                                                  NA
## 2024-01-27
                   NA
                       11.339 10.646 10.706
                                               8.839
##
## $Indices
##
                 DJI DJUSFN
                             W1TEC
## 2024-01-23 10.110
                             9.817
## 2024-01-24 9.100 11.221 10.739
## 2024-01-25
               7.399 11.000
## 2024-01-26 10.213 9.710 10.731
## 2024-01-27
                         NA 11.899
                  NA
```

#### Note:

- The name of the securities tickers is stored without the security type: "Equity", "Index", etc. If this piece of info is significant for you, pass showtype = TRUE.
- Time series start date defaults to 5 days before current date, unless you set start to: an R Date object (start=as.Date("2014/9/30")) or to a more friendly ISO string (start="20140930")).

Data are stored as a list of xts objects, each representing one group of tickers in the CSV file.

#### length(data)

### ## [1] 3

```
names (data)
## [1] "Financial" "Technology" "Indices"
class(data$Financial)
## [1] "xts" "zoo"
If you prefer you may get time series as data frames, and precisely as a list representing the ticker groups,
where each group is in turn a list containing a data frame for each security:
data=br.bulk.csv(con, "mybloomr/tickers.csv", use.xts=FALSE)
length(data)
## [1] 3
names (data)
## [1] "Financial" "Technology" "Indices"
class(data$Financial)
## [1] "list"
length(data$Financial)
## [1] 5
names(data$Financial)
## [1] "3988 HK"
                    "C US"
                                 "601288 CH" "BAC US"
                                                          "HSBA LN"
class(data$Financial$`BAC US`)
## [1] "data.frame"
By defaults time series list values from the Bloomberg "PX_LAST" field. To change the default field use:
data=br.bulk.csv(con, "mybloomr/tickers.csv", field = "PX_OPEN")
You can choose to import only some of the CSV groups
## Processing Financial ...
## Loading 3988 HK Equity
## Loading C US Equity
## Loading 601288 CH Equity
## Loading BAC US Equity
## Loading HSBA LN Equity
## Processing Indices ...
## Loading DJI Index
## Loading DJUSFN Index
## Loading W1TEC Index
data=br.bulk.csv(con, "mybloomr/tickers.csv", cols=c(1,3))
## or equivalently:
data=br.bulk.csv(con, "mybloomr/tickers.csv", cols=c(TRUE, FALSE, TRUE))
```

```
mames(data)
## [1] "Financial" "Indices"
In the CSV file, if your tickers represent all equities, you can omit the type.
Consider this CSV:
read.csv("mybloomr/tickers.eqt.csv")
## This file is part of BloomR and anyway available here:
## https://github.com/AntonioFasano/BloomR/blob/master/res/tickers.eqt.csv
```

Note how the "Equity" type is missing! But you can use this CSV file with addtype:

```
data=br.bulk.csv(con, "mybloomr/tickers.eqt.csv", addtype=TRUE)
```

Before going home, don't forget to:

```
br.close(con)
```

# br.bulk.desc

# Description

Get security descriptions for a vector of tickers.

## Usage

```
br.bulk.desc(con, tiks)
```

# Arguments

```
con the connection token returned from br.open()tiks character vector of the tickers queried for data
```

#### Value

A list of data frames, each representing the description of a security. For the format of data frames see the function br.desc.

# Example

```
con=br.open()
data=read.csv("mybloomr/tickers.csv", as.is=TRUE)
br.bulk.desc(con, as.vector(as.matrix(data[1:2,])))
br.close(con)
```

# br.bulk.idx

# Description

Returns the historical data for the constituents of an index in xts or list format.

# Usage

# Arguments

con the connection token returned from br.open(). If NULL simulated values are generated.
index string denoting the index ticker with or without the final security type label ('Index')
include.idx if TRUE (default) returns also historical data for the index.
nsec number of simulated index constituents. Ignored if con!=NULL, it defaults to 10.
sec.names character vector with names of sampled index constituents. Ignored if con!=NULL. By default security names are like 'memb1', 'memb2', etc.

For other arguments see the function br.bulk.csv

## **Details**

If con=NULL, values are simulated by means of br.sample(). This function is used with default values, except for nrow, nsec1, price, start, same.dates, no.na, empty.sec, sec.names.

#### Value

If use.xts=TRUE, an xts object, where each column is the historical data of a constituent. If use.xts=FALSE, a list, where each element is the historical data of a constituent. If include.idx=TRUE, the last column or element will be the historical data of the index.

# br.bulk.tiks

Bulk historical data

Returns the historical data for a vector of tickers in xts or list format

# Usage

```
br.bulk.tiks(con, tiks, start=Sys.Date()-5, field="PX_LAST",
    addtype=FALSE, showtype=FALSE, use.xts=TRUE,
    price=TRUE, nrow=5, same.dates=FALSE, no.na=FALSE, empty.sec=0)
```

## Arguments

tiks character vector of the tickers queried for data

For other arguments see the function br.bulk.csv

## **Details**

If an element of tiks is NA or empty ("") it is ignored. This is intended to avoid errors when the character vector are read from a CSV file with empty cells.

If con=NULL, values are simulated by means of br.sample(). Sampled values are based on default values of br.sample(), but it is possible to set explicitly start, same.dates, no.na, empty.sec; sec.names depends on tiks argument. These arguments are ignored if con!=NULL. See br.sample() help for more.

#### Value

If use.xts=TRUE, an xts object, where each column is the historical data of a security. If use.xts=FALSE, a list, where each element is the historical data of a security.

# Example

```
con=NULL # Open simulated connection and load some data
br.bulk.tiks(con, c("MSFT US", "AMZN US"), addtype=TRUE)
## Loading MSFT US Equity
## Loading AMZN US Equity
              MSFT US AMZN US
##
## 2024-01-23
                8.996
                        8.684
## 2024-01-24
                   NA
                      10.024
## 2024-01-25
                   NA 11.051
## 2024-01-26
                   NA 11.347
               9.312 11.241
## 2024-01-27
br.close(con) # Use the token to release the connection
```

# See Also

br.bulk.csv

#### br.desc

# Description

Get security descriptions.

### Usage

br.desc(con, tik)

### Arguments

con the connection token returned from br.open()tik string denoting the ticker queried for data

#### Value

A data frame containing the value of the Bloomberg fields form ds001 to ds009 and the long field CIE\_DES\_BULK.

# br.md2pdf

# Description

Make a markdown file into a PDF It assumes that you have installed the proper BloomR version.

# Usage

br.md2pdf(md.file, pdf.file)

## **Arguments**

md.file path to the markdown file to be converted.

pdf.file path to the PDF file to be generated. If missing, change extension of rmd.file to pdf.

quiet FALSE to show the system PATH variable.

#### **Details**

The function will stop with an error if you have not installed proper BloomR version.

#### Value

If there are no errors, it returns zero invisibly, otherwise it prints an error message and returns the related error code.

## br.rmd2html

# Description

Make an R markdown file into a HTML.

# Usage

br.rmd2html(rmd.file, html.file, quiet=TRUE)

## Arguments

**rmd.file** path to the R markdown file to be converted.

html.file path to the HTML file to be generated. If missing, change extension of rmd.file to html. quiet FALSE to show the system PATH variable and intermediate files.

#### **Details**

You need BloomR LaTeX addons or the proper BloomR version.

## Value

If there are no errors, it returns invisibly the absolute path of the output file.

## br.rmd2slides

# Description

br.rmd2slides.html() makes an R Markdown file into a Google Slides self-contained HTML file. br.rmd2slides.pdf() makes an R Markdown file into a Beamer PDF.

br.rmd2slides() makes both a self-contained HTML file and a Beamer PDF. highlight.styles() print the list of available syntax highlight styles.

# Usage

```
br.rmd2slides(rmd.file, theme = "AnnArbor", highlight = "tango", quiet = TRUE)
br.rmd2slides.html(rmd.file, html.file, quiet=TRUE)
br.rmd2slides.pdf(rmd.file, pdf.file, theme = "AnnArbor", highlight = "tango", quiet = TRUE){
highlight.styles()
```

## Arguments

rmd.file path to the R markdown file to be converted.

theme A Beamer theme

highlight A syntax highlight style. Use highlight.styles() to list them.

html.file path to the HTML file to be generated. If missing, we change the extension of rmd.file to ".html". pdf.file path to the PDF file to be generated. If missing, we change the extension of rmd.file to ".pdf". quiet FALSE to show the system PATH variable and intermediate files.

#### **Details**

You need the proper BloomR edition. The output filename for br.rmd2slides() is automatically generated by changing the rmd.file file extension.

To represent the slide structure in an Rmd, you use the following pattern:

```
title: "Your Presentation Title"
author: "Your Name"
date: "A date description"
---

## Slide 1

This is the content for slide 1.

## Slide 2

This is the content for slide 2.
```

Then you can proceed as usual to add R code chunks.

#### Value

If there are no errors, it returns invisibly the absolute path of the output file.

# br.rmd2pdf

# Description

Make an R markdown file into a PDF.

# Usage

br.rmd2pdf(rmd.file, pdf.file, quiet=TRUE)

## Arguments

rmd.file path to the R markdown file to be converted.

pdf.file path to the PDF file to be generated. If missing, change extension of rmd.file to pdf.

quiet FALSE to show the system PATH variable and intermediate files.

#### **Details**

You need BloomR LaTeX addons or the proper BloomR version.

#### Value

If there are no errors, it returns invisibly the absolute path of the output file.

# br.rmd2both

# Description

Make an R Markdown file into a PDF and an HTML self-contained file

## Usage

br.rmd2both(rmd.file, out.dir, quiet=TRUE)

#### Arguments

rmd.file path to the R markdown file to be converted.

out.dir directory of the output files. If missing, use dirname(rmd.file).

quiet FALSE to show the system PATH variable and intermediate files.

## **Details**

You need BloomR LaTeX addons or the proper BloomR version.

### Value

If there are no errors, it returns invisibly the absolute path of the output file.

# br.sample

## Description

Return simulated historical data for n securities in xts or df format.

#### Usage

```
br.sample(nrow, nsec=1, price=TRUE, start=Sys.Date(),
mean=ifelse(price, 10, 0.1), sd=1, jitter=0, same.dates=FALSE, no.na=FALSE,
empty.sec=0, df=FALSE, sec.names=NULL)
```

# Arguments

**nrow** number of simulated data points for each security; if same.dates=FALSE, the number of rows for each sampled security will be a random number not exceeding nrow, else it will be nrow for all securities.

**nsec** number of simulated securities (defaults to 1).

price if TRUE (default), simulated values are non-negative.

start start date. Can be a Date object or an ISO string without separators (YYYYMMDD). Defaults to current date.

mean mean of security generated values. If price=TRUE, default to 10 else defaults to 0.1.

sd sd of security generated values. It defaults to 1.

**jitter** modifies each security mean by adding adding a random value in [-jitter, jitter]. Defaults to 0.

same.dates if TRUE, all sampled securities will refer to the same dates and for each security the number will equal nrow. If FALSE (default), date values and number will randomly differ. For each security the random number will not exceed nrow.

no.na if same.dates=FALSE, when merging sampled security data NAs are likely to be produced. If no.na=FALSE (default) they will be left, otherwise they will be removed using R na.omit

df if FALSE (default), the output will be an xts object, else the output will be a data frame with the first column containing the dates of the sampled data.

sec.names character vector for column names. If df=FALSE the length of the vector should be equal to
nsec, else to nsec + 1 (because of the first column containing dates). By default security names are
like 'sample1', 'sample2', etc. and the date column is named 'date'.

empty.sec ratio of securities returning no data (defaults to 0). The result is rounded without decimal places.

#### Value

If df=TRUE, a data frame object, where the first column is the vector with all generated dates merged and each subsequent column contains the sampled data of a security. If df=FALSE, an xts object, where each element is the sampled data of a security, while the dates will be part of the xts time object. In both cases if same.dates=FALSE and/or empty.sec!=0 generated data points will have different length and the the date gaps will be filled with NAs, except if no.na=TRUE. If the generated values are only NAs the output will be converted to a 0-rows xts or data frame, containing only security labels accessible with dimnames(\*)[[2]].

# Deprecated functions

#### Description

Functions not used anymore generating an informative error

# Usage

bbg.open()
bbg.close(con)

#### Arguments

**con** the connection token returned from br.open()

# Example

```
con=bbg.open()
## Sorry 'bbg.open' is now deprecated. Please use br.open().
```

# Internal BloomR functions

# **Description:**

Internal functions not to be used by the end user

# Usage:

```
.br.is.con(con)
.br.types
.br.check.type(type)
.br.cuttype(type)
.br.jar()
```

# **Arguments:**

con the connection token returned from br.open()type a string representing the security type

#### Details

.br.is.con checks for the validity of a connection token. .br.types is a character vector with security types suitable as an argument for br.bulk\* functions. .br.check.type checks if a type matches .br.types. .br.cuttype cuts trailing security type from character vector. .br.jar() returns the path to the blpapi\*.jar

# Manage connections

# Description

Open and close the connection to the Bloomberg service.

## Usage

```
br.open()
br.close(con)
```

## Arguments

con the connection token returned from br.open()

## **Details**

br.open returns the connection token needed by the BloomR function downloading data. When you finish you session, you pass it to br.close. If you are using simulated data and so your connection token is NULL, closing the connection is optional. Anyway running br.close(con), even if con==NULL avoids adding this line when you switch to a actual data download.

# Example

```
con=br.open() # Open the connection and get the token and load some data
br.bulk.tiks(con, c("MSFT US", "AMZN US"), addtype=TRUE)
br.close(con) # Use the token to release the connection
```

# Misc functions

# Description

<code>rm.all</code> deletes all objects (variables and functions) from memory, including invisible objects (those starting with a dot). <code>rm.var</code> deletes non-function objects from memory.

# Usage

rm.all()
rm.var()

# Beta functionalities

# Description

Activate beta functionalities, if available for this release.

# Usage

br.beta()