

Package ‘jubilee’

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Type Package

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Description A long-term forecast model called “Jubilee-Tectonic model” is implemented to forecast future returns of the U.S. stock market, Treasury yield, and gold price. The five-factor model can forecast the 10-year and 20-year future equity returns with high R-squared above 80 percent. It is based on linear growth and mean reversion characteristics in the U.S. stock market. In addition, this model enhances the CAPE model by introducing the hypothesis that there are fault lines in the historical CAPE, which can be calibrated and corrected through statistical learning.

URL <https://ssrn.com/abstract=3156574>

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'jubilee-package.R' 'jubilee-class.R' 'jubilee-constructor.R'
'jubilee-eqty-ols-method.R' 'jubilee-forward-rtn-method.R'
'jubilee-fred-data-method.R' 'jubilee-locate-file.R'
'jubilee-mcsapply-method.R' 'jubilee-ols-method.R'
'jubilee-predict-method.R' 'jubilee-read-fred-file.R'
'jubilee-repo-class.R' 'jubilee-repo-config.R'

'jubilee-repo-creator.R' 'jubilee-std-fault-line-method.R'
 'tri-wave-class.R' 'tri-wave-creator.R' 'tri-wave-model.R'

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jubilee-package	<i>jubilee: A package to forecast long-term growth of the US stock market.</i>
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Description

The jubilee package provides the core class and functions to forecast long-term growth of the U.S. stock market. A tutorial is provided to demonstrate how to use this package and explain the relation between the mathematical notations and the functions and data columns in this package.

Author(s)

Stephen H-T. Lihn

References

Stephen H.T. Lihn, "Jubilee Tectonic Model: Forecasting Long-Term Growth and Mean Reversion in the U.S. Stock Market." Available at SSRN: <https://ssrn.com/abstract=3156574> or via DOI: <http://dx.doi.org/10.2139/ssrn.3156574>

daily2fraction	<i>Converter from daily Date to fraction</i>
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Description

Utility to convert from daily Date (R's Date object) to fraction.

Usage

```
daily2fraction(d)
```

Arguments

d array of Date object, or string in ISO yyyy-mm-dd format

Value

numeric, year in fraction convention

Author(s)

Stephen H. Lihn

Examples

```
daily2fraction(as.Date("2017-01-15")) # 2017.038  
daily2fraction(as.Date("2017-02-14")) # 2017.122  
daily2fraction(as.Date("2017-07-15")) # 2017.538
```

`fraction2daily` *Converter from fraction to daily Date*

Description

Utility to convert from fraction to daily Date (R's Date object).

Usage

```
fraction2daily(fraction)
```

Arguments

`fraction` numeric, representing year in fraction convention.

Value

array of Date object

Author(s)

Stephen H. Lihn

Examples

```
fraction2daily(2017.038) # 2017-01-15
fraction2daily(2017.125) # 2017-02-15
```

`jubilee` *Constructor of the jubilee class*

Description

Construct an jubilee object which holds raw and derived data, channel regression results, and other derived analytical quantities. This object is the main object to perform various forecasts and analyses.

Usage

```
jubilee(dtb, lookback.channel = 45, fwd.rtn.duration = 20)
```

Arguments

`dtb` data.table from the `jubilee.repo` object, typically it is the `ie` slot. The user is allowed to provide custom data object to research different markets, as long as the column names are compliant.

`lookback.channel` numeric, look-back channel in years to calculate mean-reversion. Default is 45.

`fwd.rtn.duration` numeric, forward return duration in years. Default is 20.

Value

an object of the jubilee class

Author(s)

Stephen H. Lihn

Examples

```
## Not run:
repo <- jubilee.repo(online=FALSE)
ju <- jubilee(repo@ie, 45, 20)

## End(Not run)
```

`jubilee-class`

The jubilee class

Description

This S4 class stores raw and derived data, channel regression settings and results.

Slots

`call` the `match.call` slot.

`lookback.channel` numeric, the look-back channel in years.

`fwd.rtn.duration` numeric, the forward return duration in years.

`reg.dtb` data.table, contains the regression data.

`dtb` data.table, contains the consolidated market data.

`rate.spread.mean` numeric, the mean of the yield spread, used to calculate `rate.spread.norm` column.

`create.time` POSIXct, records the creation time of this object.

`jubilee.adj_fault_line`*Adjust the time series by fault lines*

Description

This utility is used to adjust the time series by the provided fault lines.

Usage

```
jubilee.adj_fault_line(fraction, ts, fl, months = 1)
```

Arguments

<code>fraction</code>	numeric, representing year in fraction convention.
<code>ts</code>	numeric, time series to be adjusted, typically it is <code>log.cape10</code> or <code>log.cape20</code> .
<code>fl</code>	the fault line matrix. See <code>jubilee.std_fault_line()</code> for more detail. If it is provided as character string, it will be looked up as the name of data set in the standard fault line library. If it is provided as numeric array, it will be converted to a matrix.
<code>months</code>	interval in months to ramp up the fault line. Default is 1.

Value

numeric, ts adjusted by fault lines

Author(s)

Stephen H. Lihn

Examples

```
## Not run:
repo <- jubilee.repo(online=FALSE)
dj <- jubilee(repo@ie, 45, 10)@reg.dtb
dj$log.cape10.adj <- jubilee.adj_fault_line(dj$fraction, dj$log.cape10, "r_nom_f10_5ftr_4fl")

## End(Not run)
```

jubilee.calc_cape *Internal utility to calculate n-year CAPE*

Description

This CAPE calculator replicates the methodology of Shiller, so that one can calculate n-year CAPE, e.g. n=20. This utility has been calibrated by original 10-year CAPE data from Shiller.

Usage

```
jubilee.calc_cape(dtb, period, tol.frac = 1/6)
```

Arguments

dtb	data.table
period	numeric, the backward-looking regression period
tol.frac	numeric, tolerance of missing data in the beginning of the time series, expressed as fraction. Default is 1/6, that is, two months.

Value

numeric, the same length as dtb\$fraction.

Author(s)

Stephen H. Lihn

Examples

```
## Not run:
dtb <- jubilee.repo(online=FALSE)@ie
cape10 <- jubilee.calc_cape(dtb, 10)
cape20 <- jubilee.calc_cape(dtb, 20)

## End(Not run)
```

jubilee.eqty_ols *Internal utility to calculate OLS regression for log total return index*

Description

Calculate the OLS regression for log total return index

Usage

```
jubilee.eqty_ols(dtb, end.frac, lookback.channel, tol.frac = 1/6)
```

Arguments

dtb data.table that contains fraction and log.tri columns.
 end.frac numeric, the ending fraction of regression.
 lookback.channel numeric, the backward-looking regression period
 tol.frac numeric, tolerance of missing data in the beginning, expressed as fraction. Default is 1/6, that is, two months.

Value

two-element array $c(a, R)$ if end.frac is length-one; data.table with end.frac as fraction column if end.frac is an array.

Author(s)

Stephen H. Lihn

Examples

```
## Not run:
dtb <- jubilee.repo(online=FALSE)@ie
jubilee.eqty_ols(dtb, 1970, 50) # c(11.8671626, 0.1008371)

## End(Not run)
```

jubilee.forward_rtn *Internal utility to calculate annualized forward and backward return*

Description

Calculate the annualized forward and backward return on the given time series. The forward return is typically the response variable in a forecast. The backward return is often used as explanatory variable in a regression.

Usage

```
jubilee.forward_rtn(fraction, ts, fwd.rtn.duration, tol.frac = 1/12)

jubilee.backward_rtn(fraction, ts, bwd.rtn.duration, tol.frac = 1/12)
```

Arguments

fraction numeric, the ending fraction of regression
 ts numeric, the time series data
 fwd.rtn.duration numeric, the forward-looking regression period

tol.frac numeric, tolerance of missing data in the beginning, expressed as fraction. Default is 1/12, that is, one month.

bwd.rtn.duration numeric, the backward-looking regression period

Value

numeric, the same length as fraction

Author(s)

Stephen H. Lihn

Examples

```
## Not run:
dtb <- jubilee.repo(online=FALSE)@ie
dtb$fwd.rtn.10 <- jubilee.forward_rtn(dtb$fraction, dtb$log.tri, 10)
dtb$bwd.rtn.10 <- jubilee.backward_rtn(dtb$fraction, dtb$log.tri, 10)
head(subset(dtb, fraction >= 1990),1)$fwd.rtn.10 # 1/1990+10y: 0.16745
tail(subset(dtb, fraction <= 2000+1/12),1)$bwd.rtn.10 # the same as above

## End(Not run)
```

jubilee.fred_data *Internal utility to download time series data from FRED*

Description

This utility downloads time series from FRED. Many time series that this package uses are available on FRED. Therefore, this utility is used to provide daily or monthly updates by concatenating live data to the internal static data.

Usage

```
jubilee.fred_data(symbol, col_out = "Close")
```

Arguments

symbol character, the name of the time series

col_out character, the name of the output closing price column. Default is "Close"

Value

The xts object for the time series

Examples

```
## Not run:  
  jubilee.fred_data("VIXCLS") # VIX  
  
## End(Not run)
```

`jubilee.locate_file` *Internal utility to locate static file*

Description

This utility returns the path to internal file

Usage

```
jubilee.locate_file(local_file, stop = TRUE)
```

Arguments

`local_file` character, the file name of an internal file.
`stop` logical, whether to stop if file can't be located. Default is TRUE.

Value

The path to the file, or else, an empty string

Author(s)

Stephen H. Lihn

Examples

```
jubilee.locate_file("UNRATE.csv")
```

jubilee.mcsapply *Wrapper to calculate sapply using multi-core*

Description

This utility calculates sapply using multi-core capability. It is a simple wrapper on `simplify2array` and `parallel::mclapply`. It is particularly convenient on Linux and Mac when parallelism saves significant amount of computing time.

Usage

```
jubilee.mcsapply(x, FUN, ...)
```

Arguments

x	numeric
FUN	the function to be applied to each element of x
...	optional arguments to FUN

Value

numeric

Author(s)

Stephen H. Lihn

Examples

```
a <- seq(1,100)
jubilee.mcsapply(a, function(x) x^2) # use multi-core!
```

jubilee.ols *Internal utility to calculate OLS regression*

Description

Calculate the OLS regression for a given time series and fraction

Usage

```
jubilee.ols(fraction, ts, lookback.channel, tol.frac = 1/6)
```

Arguments

fraction numeric, the ending fraction of regression
 ts numeric, the time series data
 lookback.channel
 numeric, the backward-looking regression period
 tol.frac numeric, tolerance of missing data in the beginning, expressed as fraction. Default is 1/6, that is, two months.

Value

data.table with columns of fraction, lm.a, lm.y, lm.r

Author(s)

Stephen H. Lihn

References

See Section 2.3 of Stephen H.T. Lihn, "Jubilee Tectonic Model: Forecasting Long-Term Growth and Mean Reversion in the U.S. Stock Market." Available at <http://dx.doi.org/10.2139/ssrn.3156574>

Examples

```
## Not run:
dtb <- jubilee.repo(online=FALSE)@ie
df <- jubilee.ols(dtb$fraction, dtb$log.tri, 50)
subset(df, fraction > 1970 & fraction < 1970.05)
# fraction    lm.a    lm.r    lm.y
# 1970.042 11.86401 0.1007617 0.02103105

## End(Not run)
```

jubilee.predict

Make prediction based on linear regression

Description

Make prediction based on the linear regression of the forward return. Refer to the tutorial for more detail.

Usage

```
jubilee.predict(object, lm, data)
```

```
jubilee.predict_real(object, lm, data)
```

Arguments

object	object of jubilee class
lm	the linear model
data	data used to predict (similar to newdata of stats::predict)

Value

data.table containing the prediction

Author(s)

Stephen H. Lihn

References

See Section 7 of Stephen H.T. Lihn, "Jubilee Tectonic Model: Forecasting Long-Term Growth and Mean Reversion in the U.S. Stock Market." Available at <http://dx.doi.org/10.2139/ssrn.3156574>

jubilee.read_fred_file

Internal utility to read FRED file

Description

This utility reads the internal static file, optionally amends with FRED online data, and returns the values of a given symbol.

Usage

```
jubilee.read_fred_file(fraction, local_file, symbol, online = FALSE,
  daily_symbol = NULL)
```

Arguments

fraction	numeric, the fraction to return the value. The utility will lookup within a month to find value. For debug purpose, set it to NULL, and the intermediate data table will be returned.
local_file	character, the file name of an internal file. For debug purpose, set it to NULL, and the process will initiate the source data from FRED via symbol, instead of a local file.
symbol	character, the FRED symbol.
online	logical, whether to fetch online data from FRED. Default is FALSE.
daily_symbol	character, the FRED symbol to read daily data that supplements the monthly data. Default is NULL.

Value

The values of the symbol, numeric with the same length as fraction.

Author(s)

Stephen H. Lihn

Examples

```
repo <- jubilee.repo(online=FALSE)
a <- jubilee.read_fred_file(repo@ie$fraction, "BAA.csv", "BAA")
tail(a)
```

jubilee.repo

Constructor of jubilee.repo class

Description

Construct a `jubilee.repo` class by combining data from that of Robert Shiller since 1871, historical stock market data from 1802 to 1987 by William Schwert, 3-month Treasury bill rate, gold price, and several other economic time series from FRED. Optionally, this function can fetch more recent data from the website of Robert Shiller and Federal Reserve FRED website if the R session has connection to the internet.

Usage

```
jubilee.repo(online = TRUE)
```

Arguments

`online` logical, indicating whether to fetch data from online resource or not. Default is TRUE.

Value

An object of `jubilee.repo` class

Author(s)

Stephen H. Lihn

Examples

```
repo <- jubilee.repo(online=FALSE)
dtb <- repo@ie
tail(dtb,1)
```

`jubilee.repo-class` *The jubilee repository class*

Description

This S4 class stores the raw data for the jubilee package

Slots

`call` The match.call slot

`ie` data.table, contains the combined data from `ie.raw` , `ws` , and `inflation` .

`yield.inversion` numeric, the fractions of yield curve inversion

`raw.ie` data.table, contains the data from `ie_data.xls` of Robert Shiller

`ws` data.table, contains the historical market return data from William Schwert

`inflation` data.table, contains the historical inflation data from Minneapolis FED

`comm.int` data.table, contains the historical commercial interest rate

`tb3ms` data.table, contains the historical 3-month Treasury bill rate

`gold` data.table, contains the historical monthly gold prices

`gold2` data.table, contains the historical annual gold prices

`create.time` POSIXct, records the creation time of this object.

`jubilee.repo.config` *Configuration of jubilee's data repository*

Description

This utility stores the data configuration for the jubilee's data repository. This is used internally to provide proper abstraction to the data sources, such as file name, URL, FRED symbol, column name, decimal format, etc.

Usage

```
 jubilee.repo.config()
```

Value

The list of data elements and their attributes.

Author(s)

Stephen H. Lihn

Examples

```
c <- jubilee.repo.config()
c$ie$url
```

jubilee.std_fault_line

Standard fault line data sets

Description

This method defines a collection of standard fault line data sets that have been analyzed and optimized in the research. It is intended for end users to produce standard regressions, forecasts, and charts quickly.

Usage

```
jubilee.std_fault_line(name)
```

Arguments

name	character, the name of the collection. If "list" is supplied, the list of names will be returned. If a numeric array is supplied, it will be converted to a matrix format.
------	--

Value

numeric, pairs of fault lines, each is `c(year, delta)`

Author(s)

Stephen H. Lihn

Examples

```
jubilee.std_fault_line("r_nom_f10_5ftr_4fl")
jubilee.std_fault_line("r_nom_f20_5ftr_2fl")
jubilee.std_fault_line("r_nom_f20_5ftr_2fl_ramp5y")
```

tri.wave	<i>Constructor of tri.wave class</i>
----------	--------------------------------------

Description

Construct an `tri.wave` object to simulate the triangular wave model.

Usage

```
tri.wave()
```

Value

an object of `tri.wave` class

Author(s)

Stephen H. Lihn

Examples

```
w <- tri.wave()
```

tri.wave class	<i>The triangular wave model class</i>
----------------	--

Description

This S4 class defines the parameters in the triangular wave model.

Slots

`call` the `match.call` slot.

`a.t` numeric, the look-back channel in years

`a0` numeric, the look-back channel in years

`s1` numeric, the forward return duration in years

`s2` numeric, the start fraction of in-sample training period

`y.mean` numeric, the end fraction of in-sample training period

`y.amp` numeric, the end fraction of in-sample training period

`y.t` numeric, the end fraction of in-sample training period

`y.p` numeric, the end fraction of in-sample training period

References

See Section 4 of Stephen H.T. Lihn, "Jubilee Tectonic Model: Forecasting Long-Term Growth and Mean Reversion in the U.S. Stock Market." Available at <http://dx.doi.org/10.2139/ssrn.3156574>

triangle

Methods of triangular wave model

Description

Methods of triangular wave model

Usage

```
triangle(t, p)
tri.wave.s(object, t)
tri.wave.a(object, t)
tri.wave.y(object, t)
tri.wave.x(object, t)
tri.wave.logr.y(object, t, p)
tri.wave.logr(object, t, p)
tri.wave.logr.semi(object, t)
tri.wave.logr.quarter(object, t)
```

Arguments

t	the time vector in fraction
p	the period of the triangle wave
object	the object of tri.wave class

Value

numeric

Author(s)

Stephen H. Lihn

References

See Section 4 of Stephen H.T. Lihn, "Jubilee Tectonic Model: Forecasting Long-Term Growth and Mean Reversion in the U.S. Stock Market." Available at <http://dx.doi.org/10.2139/ssrn.3156574>

Examples

```
w <- tri.wave()
t <- seq(1900, 2000, by=1)
tri.wave.y(w, t)
```

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