Package ‘LDPD’

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Title Probability of Default Calibration

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Description Implementation of most popular approaches to PD (probability of default) calibration: Quasi Moment Matching algorithm (D. Tasche), algorithm proposed by M. van der Burgt, K. Pluto and D. Tasche's most prudent estimation methodology.

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LDPD-package *Probability of Default Calibration*

Description

Implementation of most popular approaches to PD (probability of default) calibration: Quasi Moment Matching approach, M.van der Burgt algorithm, K.Pluto and D.Tasche's most prudent estimate methodology.

Details

Package:	LDPD
Type:	Package
Version:	1.0.2
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The package implements three most popular among practitioners approaches to PD calibration:

1. Quasi Moment Matching approach proposed by D.Tasche (see `QMMRecalibrate`).
2. M. van der Burgt algorithm based on CAP curve smoothing (see `VDBCalibratePD`).
3. K.Pluto and D.Tasche "most prudent" estimate methodology (see `PTOnePeriodPD`,`PTMultiPeriodPD`).

Author(s)

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References

Pluto, K. and Tasche, D. (2005) Thinking Positively. Risk, August, 72-78.
Van der Burgt, M. (2008) Calibrating low-default portfolios, using the cumulative accuracy profile. Journal of Risk Model Validation, 1(4):17-33.
Tasche, D. (2009) Estimating discriminatory power and PD curves when the number of defaults is small. Working paper, Lloyds Banking Group.
Tasche, D. (2013) The art of probability-of-default curve calibration. Journal of Credit Risk, 9:63-103.

See Also

`QMMRecalibrate` `VDBCalibratePD` `PTOnePeriodPD` `PTMultiPeriodPD` `somers2`

Examples

```
# PD calibration using Multi-period Pluto and Tasche approach
portfolio <- c(10,20,30,40,10)
defaults <- c(1,2,0,0,0)
PTMultiPeriodPD(portfolio, defaults, 0.3, cor.St = 0.3, kT = 5, kNS = 1000, conf.interval = 0.5)

# PD Calibration using M. van der Burgt algorithm,
# portfolio distribution is given by rating classes.
portf.rating <- c(20,50,60,70,10,5)
VDBCalibratePD(portf.rating, 0.1, 0.15, 0.5, rating.type = 'RATING')
# PD Calibration using M. van der Burgt algorithm,
# portfolio distribution is given by scores.
portf.scores <- seq_len(1000)
VDBCalibratePD(portf.scores, 0.1, 0.15, 0.5, rating.type = 'SCORE')

# PD calibration using QMM algorithm,
# portfolio distribution is given by rating classes.
pd <- c(0.2, 0.1, 0.005, 0.001, 0.001)
porfolio <- c(100, 200, 200, 200, 100)
qmm <- QMMRecalibrate(0.05, pd, porfolio, rating.type = 'RATING')
# Plot results of PD calibration.
QMMPlot(qmm)
```

ARestimate *Accuracy Ratio estimation*

Description

Estimate AR (Accuracy Ratio) and mean portfolio PD (probability of default) based on conditional PDs and portfolio unconditional distribution.

Usage

```
ARestimate(pd.cond, portf.uncond, rating.type = "RATING")
```

Arguments

`pd.cond`	Conditional PD distribution (should be sorted from the worst to the best credit quality).
`portf.uncond`	Unconditional portfolio distribution (should be sorted from lowest credit quality to higher one).
`rating.type`	In case 'RATING', each item in the portf.uncond should contain number of companies in each rating class. In case 'SCORE', each item in the portf.uncond is an exact score.

Details

Approach to AR estimation is consistent with the algorithm proposed by D.Tasche in the paper: Estimating discriminatory power and PD curves when the number of defaults is small. Working paper, Lloyds Banking Group, 2009.
Mean portfolio PD (also known as Central Tendency of the portfolio) is estimated using unconditional portfolio distribution.

Value

AR	Estimated accuracy ratio
CT	Mean PD in the portfolio

Note

The algorithm is using conditional PDs as an input. In case one needs to estimate AR from actual default statistic (BAD/GOOD data), one can use, for example, somers2.

Author(s)

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References

Tasche, D. (2009) Estimating discriminatory power and PD curves when the number of defaults is small. Working paper, Lloyds Banking Group.
Tasche, D. (2013) The art of probability-of-default curve calibration. Journal of Credit Risk, 9:63-103.

See Also

QMMRecalibrate somers2

Examples

```
pd.cond <- c(0.1, 0.05, 0.025, 0.01, 0.001)  # PD for given rating class
portf.uncond <- c(10, 20, 30, 50, 10)  # Number of borrowers in each rating class
ARestimate(pd.cond, portf.uncond, rating.type = "RATING")
```

PTMultiPeriodPD — *Multi-period Pluto and Tasche Model*

Description

Estimates probability of default (PD) according to Multi-period Pluto & Tasche model.

Usage

```
PTMultiPeriodPD(portf.uncond, portf.def, rho, cor.St, kT, kNS = 1000, conf.interval = 0.9)
```

Arguments

`portf.uncond`	Unconditional portfolio distribution (e.g. number of counterparts by rating classes).
`portf.def`	Number of defaults by rating classes.
`rho`	Correlation with systematic factor.
`cor.St`	Correlation matrix of systematic factor realization through the time. In case constant is given - power matrix is used: Correlation matrix (i, j) = cor.St ^ |s - t|, s = 1..kT, t = 1..kT.
`kT`	Number of periods used in the PD estimation.
`kNS`	Number of simulations for integral estimation (using Monte-Carlo approach).
`conf.interval`	Confidence interval for PD estimation.

Details

Estimates probabilities of default according to multi-period Pluto and Tasche model (additionally captures the inter-temporal correlation effects).

Value

Conditional PDs according to Multi-period Pluto and Tasche model

Note

Portfolio and default data should be sorted by rating classes from lowest credit quality to higher one.

Author(s)

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References

Pluto, K. and Tasche, D., 2005. Thinking Positively. Risk, August, 72-78.

See Also

PTOnePeriodPD

Examples

```
portfolio <- c(10,20,30,40,10)
defaults <- c(1,2,0,0,0)
PTMultiPeriodPD(portfolio, defaults, 0.3, cor.St = 0.3, kT = 5, kNS = 1000, conf.interval = 0.5)
```

PTOnePeriodPD *One-period Pluto and Tasche Model*

Description

Estimates probability of default according to One-period Pluto and Tasche model.

Usage

```
PTOnePeriodPD(portf.uncond, portf.def, conf.interval = 0.9)
```

Arguments

portf.uncond	Unconditional portfolio distribution (e.g. number of counterparts by rating classes).
portf.def	Number of defaults by rating classes.
conf.interval	Confidence interval for PD estimation.

Details

Implementation of simple one-period Pluto and Tasche probability of default (PD) calibration model.

Value

Conditional PDs according to one-period Pluto and Tasche model

Note

Portfolio and default data should be sorted by rating classes from lowest credit quality to higher one.

Author(s)

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References

Pluto, K. and Tasche, D., 2005. Thinking Positively. Risk, August, 72-78.

See Also

PTMultiPeriodPD

Examples

```
portfolio <- c(10,20,30,40,10)
defaults <- c(1,2,0,0,0)
PTOnePeriodPD(portfolio, defaults, conf.interval = 0.5)
```

QMMPlot *Plot Results of Probability of Default Calibration*

Description

Plot detailed results of probability of default calibration using Quasi Moment Matching algorithm.

Usage

```
QMMPlot(x)
```

Arguments

x	Output of QMMRecalibrate function.

Details

Plot contains conditional PD (probability of default) values:

before re-calibration (sample Central Tendency and AR (accuracy ratio));
after re-calibration (target Central Tendency and AR);
upper confidence interval PDs (target Central Tendency and target AR minus one standard deviation of sample AR);
lower confidence interval PDs (target Central Tendency and target AR plus one standard deviation of sample AR).

Value

Plot of conditional PDs.

Note

In case rating.type is 'RATING', PD plot is produced against unconditional cumulative portfolio distribution.
In case rating.type is 'SCORE', PD plot is produced against scores.

Author(s)

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References

Tasche, D. (2009) Estimating discriminatory power and PD curves when the number of defaults is small. Working paper, Lloyds Banking Group.
Tasche, D. (2013) The art of probability-of-default curve calibration. Journal of Credit Risk, 9:63-103.

See Also

QMMRecalibrate

Examples

```
pd <- c(0.2, 0.1, 0.005, 0.001, 0.001)
porfolio <- c(100, 200, 200, 200, 100)
qmm <- QMMRecalibrate(0.05, pd, porfolio, rating.type = 'RATING')
QMMPlot(qmm)
```

`QMMRecalibrate` *Probability of Default Calibration using Quasi Moment Matching Algorithm*

Description

Calibrates conditional probabilities of default (PD) according to Quasi Moment Matching (QMM) algorithm.
Calibration is based on target accuracy ratio (AR) and mean portfolio PD (Central Tendency). For the information purposes, also AR standard deviation is estimated using bootstrap approach.

Usage

```
QMMRecalibrate(pd.uncond.new, pd.cond.old, portf.uncond, portf.condND = NULL,
AR.target = NULL, rating.type = "RATING", calib.curve = "robust.logit")
```

Arguments

`pd.uncond.new`	Target Mean PD (Central Tendency) for the portfolio.
`pd.cond.old`	Conditional PD distribution.
`portf.uncond`	Unconditional portfolio distribution.
`portf.condND`	Conditional on non-default portfolio distribution. If portf.condND is NULL, portf.uncond will be used as a proxy.
`AR.target`	Target accuracy ratio(AR), in case is NULL - implied by pd.cond.old AR is used (`ARestimate` is called for AR estimation purposes).
`rating.type`	In case 'RATING', each item in the portf.uncond contains number of counterparts in a given rating class. In case 'SCORE', each item in the portf.uncond is treated as an exact score of counterparty.

`calib.curve`	In case 'logit', simple logit calibration curve is used (is applicable only for rating.type = 'SCORE'). In case 'robust.logit', robust logit function is used (see Tasche D. (2013) for details).

Details

PD curve is fitted using robust logit function proposed by D. Tasche.
For the information purposes output of the function also contains PD fitted using target CT and AR plus/minus one standard deviation.

Value

`alpha`	Itercept parameter of the calibration curve.
`beta`	Slope parameter of the calibration curve.
`CT.ac`	Mean PD after calibration, e.g. target CT.
`AR.ac`	AR after calibration, e.g. target AR.
`CT.bc`	Mean PD before calibration, as implied by conditional PDs and portfolio unconditional distribution.
`AR.bc`	AR before calibration estimated from conditional PDs.
`AR.sdev`	AR standard deviation (based on sample data).
`condPD.ac`	Conditional PDs after QMM calibration.
`condPD.bc`	Conditional PDs before calibration.
`condPD.ac.upper`	Conditional PDs given AR as initial AR plus one standard deviation and target CT.
`condPD.ac.lower`	Conditional PDs given AR as initial AR minus one standard deviation and target CT.
`portf.cumdist`	Cumulative portfolio distribution needed to estimate logit PDs (conditional on non-default portfolio distribution if such data is given).
`portf.uncond`	Unconditional portfolio distribution from the worst to the best credit quality.
`rating.type`	In case 'RATING', each item in the portf.uncond contains number of counterparts in a given rating class. In case 'SCORE', each item in the portf.uncond is treated as an exact score of counterparty.

Note

Portfolio and default data should be sorted by rating classes from lowest credit quality to higher one.

Author(s)

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References

Tasche, D. (2009) Estimating discriminatory power and PD curves when the number of defaults is small. Working paper, Lloyds Banking Group.
Tasche, D. (2013) The art of probability-of-default curve calibration. Journal of Credit Risk, 9:63-103.

See Also

QMMPlot

Examples

```
pd <- c(0.2, 0.1, 0.005, 0.001, 0.001)
porfolio <- c(100, 200, 200, 200, 100)
qmm <- QMMRecalibrate(0.05, pd, porfolio, rating.type = 'RATING')
QMMPlot(qmm)
```

`VDBCalibratePD` *Probability of Default Calibration using M. Van Der Burgt Algorithm*

Description

Calibrates conditional probabilities of default (PD) according to algorithm proposed by M. van der Burgt.
Decomposition of PDs by rating classes is based on smoothed Cumulative Accuracy Profile (CAP) curve and target mean portfolio PD (Central Tendency - CT).

Usage

```
VDBCalibratePD(portf.uncond, pd.uncond.old, pd.uncond.new, AR, rating.type)
```

Arguments

`portf.uncond`	Unconditional portfolio distribution.
`pd.uncond.old`	Unconditional PD of the sample on which AR had been estimated (in case is zero, approximation AR = 2*AUC - 1 is used for parameters estimation).
`pd.uncond.new`	Target Mean PD (Central Tendency) for the portfolio.
`AR`	Accuracy ration (AR) of the ranking model.
`rating.type`	In case 'RATING', each item in the portf.uncond contains number of counterparts in a given rating class. In case 'SCORE', each item in the portf.uncond is treated as an exact score of counterparty.

Details

One parameter approximation of CAP curve is used. Parameter is fitted in the way that the AUC (Cumulative Accuracy Profile) implied by the provided AR should be equal to the area under the approximation curve.

Value

`lambda`	Convexity parameter of the calibration curve.
`pd.cond`	Conditional PDs after calibration.
`portf.cumdist`	Cumulative portfolio distribution needed to estimate logit PDs (conditional on non-default if such data is given).
`portf.uncond`	Unconditional portfolio distribution from the worst to the best credit quality.
`rating.type`	In case 'RATING', each item in the portf.uncond contains number of counterparts in a given rating class. In case 'SCORE', each item in the portf.uncond is treated as an exact score of counterparty.

Note

Portfolio and default data should be sorted by rating classes from lowest credit quality to higher one.

Author(s)

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References

Van der Burgt, M. (2008) Calibrating low-default portfolios, using the cumulative accuracy profile. Journal of Risk Model Validation, 1(4):17-33.

See Also

`ARestimate`

Examples

```
portf.rating <- c(20,50,60,70,10,5)
portf.scores <- seq_len(1000)
VDBCalibratePD(portf.scores, 0.1, 0.15, 0.5, rating.type = 'SCORE')
VDBCalibratePD(portf.rating, 0.1, 0.15, 0.5, rating.type = 'RATING')
```

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