

# Package ‘Rcess’

December 16, 2016

**Type** Package

**Title** Rcess: An R package for calculating estimates of costs and economies of scale and scope

**Version** 0.1.0

**Description** This package utilizes the theory of economies of scale and scope (developed by Baumol, Panzar, & Willig (1982)) to calculate the average output costs, economies of scale, and economies of scope for different types of multi-output production industries. So far, this package can reproduce the estimates using FFCQ-M cost function (see Zhang, Worthington, and Hu (in press) for details). This package is currently hosted on Github. Please click this link (<https://github.com/LiangCZhang/Rcess>) for how to use and install it

**License** MIT License

**Encoding** UTF-8

**URL** <https://github.com/LiangCZhang/Rcess>

**BugReports** <https://github.com/LiangCZhang/Rcess/issues>

**LazyData** true

**RoxygenNote** 5.0.1

**Imports** minpack.lm, sandwich, lmtest, car

**Suggests** knitr, rmarkdown, testthat

**VignetteBuilder** knitr

**NeedsCompilation** no

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|------|---|
| cess | <i>Calculate estimates of costs and economies of scale and scope from 25 to 200 % levels at means</i> |
|------|---|

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## Description

Calculate estimates of costs and economies of scale and scope from 25 to 200 % levels at means

## Usage

```
cess(data, outputName, priceName, controlName, model,
      vcovCL = clusterEst(model = model, cluster = unidat$unicode)$vcovCL)
```

## Arguments

|             |   |
|-------------|---|
| data        | The data used for calculating the estimates.                                    |
| outputName  | A vector of strings containing the names of the independent (output) variables. |
| priceName   | A vector of strings containing the names of the independent (price) variables.  |
| controlName | A vector of strings containing the names of the control variables.              |
| model       | The estimated model(nls class object).  |
| vcovCL      | A variance matrix provided by clusterEst function                               |
| form        | A cost function character.  |

## Value

Estimates of scale and scope economies including their standard errors (SE), lower interval(Lo) and upper interval(Hi)

## Author(s)

Liang-Cheng Zhang

## References

Zhang, L.-C., Worthington, A. C., & Hu, M. (in press). Cost economies in the provision of higher education for international students: Australian evidence. Higher Education. doi: [10.1007/s10734-016-0078-9](https://doi.org/10.1007/s10734-016-0078-9)

Zhang, L.-C., & Worthington, A. C. (2015). Evaluating the accuracy of scope economies: comparisons among delta method, bootstrap, and Bayesian approach. Paper presented at Australian Conference of Economists PhD Colloquium. Retrieved from <http://www98.griffith.edu.au/dspace/handle/10072/69409>

## Examples

```
##Reproduce results of Zhang et al. (in press)
data(unidat)
data = unidat
library(minpack.lm)
model <- nlsLM(costFunction(costName = colnames(unidat)[3], outputName = colnames(unidat)[7:11],
priceName = colnames(unidat)[4:6], controlName = colnames(unidat)[12:24],
form = "FFCQ-M"), start = list(b0 = 600, b1 = 0, b2 = 0,
```

```

      b3 = 0, b4 = 0, b5 = 0, b11 = 0, b22 = 0, b33 = 0, b44 = 0,
      b55 = 0, b12 = 0, b13 = 0, b14 = 0, b15 = 0, b23 = 0, b24 = 0,
      b25 = 0, b34 = 0, b35 = 0, b45 = 0, bp2 = 0, bp3 = 0, bz1 = 0,
      bz2 = 0, bz3 = 0, bz4 = 0, bz5 = 0, bz6 = 0, bz7 = 0, bz8 = 0,
      bz9 = 0, bz10 = 0, bz11 = 0, bz12 = 0, bz13 = 0), data = unidat,
      trace = F)
vcovCL <- clusterEst(model = model , cluster = unidat$unicode)$vcovCL
cess(data=data, outputName = colnames(unidat)[7:11],priceName = colnames(unidat)[4:6],
controlName = colnames(unidat)[12:24], model=model, vcovCL=vcovCL)

```

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|            |  |
|------------|--|
| clusterEst | <i>Calculate coefficients and covariance with clustering standard deviations</i> |
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## Description

Calculate coefficients and covariance with clustering standard deviations

## Usage

```
clusterEst(model, dfcw = 1, cluster)
```

## Arguments

|         |   |
|---------|---|
| model   | The estimated model(nls class object).  |
| cluster | A vector, matrix, or data.frame of cluster variables, where each column is a separate variable. |

## Value

An list of estimation results and clustering variance

## Author(s)

Liang-Cheng Zhang

## References

Arai, M. (2015). Cluster-robust standard errors using R.  
Retrieved from [http://www.ne.su.se/polopoly\\_fs/1.216115.1426234213!/menu/standard/file/clustering1.pdf](http://www.ne.su.se/polopoly_fs/1.216115.1426234213!/menu/standard/file/clustering1.pdf)

Petersen, M. A. (2009). Estimating standard errors in finance panel data sets: Comparing approaches. *Review of Financial Studies*, 22(1), 435-480.

## Examples

```

##Simple example
data(unidat)
m1 = nls(c ~ b0+b1*y1,start=list(b0=1,b1=0), data = unidat)
cluster.vcov(m2, petersen$firmid)

##Reproduce results of Table 4 in Zhang et al. (in press)
data(unidat)

```

```
library(minpack.lm)
model <- nlsLM(costFunction(costName = colnames(unidat)[3], outputName =
colnames(unidat)[7:11], priceName = colnames(unidat)[4:6], controlName =
colnames(unidat)[12:24], form = "FFCQ-M"), start = list(b0 = 600,
b1 = 0, b2 = 0, b3 = 0, b4 = 0, b5 = 0, b11 = 0, b22 = 0, b33 = 0, b44 = 0,
b55 = 0, b12 = 0, b13 = 0, b14 = 0, b15 = 0, b23 = 0, b24 = 0,
b25 = 0, b34 = 0, b35 = 0, b45 = 0, bp2 = 0, bp3 = 0, bz1 = 0,
bz2 = 0, bz3 = 0, bz4 = 0, bz5 = 0, bz6 = 0, bz7 = 0, bz8 = 0,
bz9 = 0, bz10 = 0, bz11 = 0, bz12 = 0, bz13 = 0), data = unidat,
trace = F)
clusterEst(model = model , cluster = unidat$unicode)$model #extract summary results
clusterEst(model = model , cluster = unidat$unicode)$vcovCL #extract covariance
```

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|              |   |
|--------------|---|
| costFunction | <i>Generate the right format of cost function for calculating economies of scale and scope.</i> |
|--------------|---|

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## Description

Generate the right format of cost function for calculating economies of scale and scope.

## Usage

```
costFunction(costName, outputName, priceName, controlName, form = c("FFCQ-M"))
```

## Arguments

|             |   |
|-------------|---|
| costName    | A character string containing the name of the dependent (cost) variable.        |
| outputName  | A vector of strings containing the names of the independent (output) variables. |
| priceName   | A vector of strings containing the names of the independent (price) variables.  |
| controlName | A vector of strings containing the names of the control variables.              |
| form        | A cost function character.  |

## Details

This function returns flexible fixed cost quadratic (FFCQ) function formula based on the classification of Mayo (1984). You can find the applications in Zhang et al. (in press).

## Value

An object of class "formula" consisting of costName, outputName and priceName based on varied functional forms.

## Author(s)

Liang-Cheng Zhang

## References

Mayo, J. W. (1984). Multiproduct monopoly, regulation, and firm costs. *Southern Economic Journal*, 51(1), 208-218. doi:10.2307/1058333

Zhang, L.-C., Worthington, A. C., & Hu, M. (in press). Cost economies in the provision of higher education for international students: Australian evidence. *Higher Education*. doi: [10.1007/s10734-016-0078-9](https://doi.org/10.1007/s10734-016-0078-9)

## Examples

```
##Specify arguments with user-identified names
costFunction(costName="c",outputName = c("y1","y2"))
costFunction(costName="c",outputName = c("y1","y2","y3"),
priceName = c("w1","w2","w3"),controlName = c("z1","z2","z3"),
form="FFCQ-M")

##Specify arguments with data' column names
costFunction(costName=colnames(unidat)[3],outputName =
colnames(unidat)[7:11],priceName = colnames(unidat)[4:6],
controlName = colnames(unidat)[12:24], form="FFCQ-M")
```

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|              |  |
|--------------|--|
| intervalPlot | <i>Generate interval plot for inferring the existence of economies of scale or scope</i> |
|--------------|--|

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## Description

Generate interval plot for inferring the existence of economies of scale or scope

## Usage

```
intervalPlot(intervalData = intervalData, estimates,
meanLevels = intervalData$meanLevels, lowerLevel = intervalData$Lo_GSE,
UpperLevel = intervalData$Hi_GSE, ylab, h, ylim = c(-1, 1))
```

## Arguments

|              |   |
|--------------|---|
| intervalData | The data used for plotting intervals.   |
| estimates    | A vector of estimates which you want to plot with.  |
| meanLevels   | A vector of percentage of output mean.  |
| lowerLevel   | A vector of lower confidence intervals.   |
| ylab         | Y axis label.   |
| h            | A horizontal red line for inferring the existence of economies of scale (=1) or scope (=0). |
| ylim         | Y axis limit.   |
| upperLevel   | A vector of upper confidence intervals.   |

## Details

This function generates a interval plot (Zhang, 2015) to infer the existence of scale and scope economies. If the intervals of point estimates do not include one for scale economies or zero for the scope economies, it suggests that these estimates are significantly different from the thresholds (one and zero, respectively) at the 5% significance level. Thus, there is evidence for the existence of scale and scope economies (if their intervals are higher than the threshold) or diseconomies (if their intervals are lower than the threshold).

## Value

A interval plot

## Author(s)

Liang-Cheng Zhang

## References

Zhang, L.-C., Worthington, A. C., & Hu, M. (in press). Cost economies in the provision of higher education for international students: Australian evidence. Higher Education. doi: [10.1007/s10734-016-0078-9](https://doi.org/10.1007/s10734-016-0078-9)

Zhang, L.-C. (2015). Inferring (dis)economies of scope with a proper procedure: using an interval plot as an alternative solution. Paper presented at the 2015 AFE PhD Research Symposium in Economics, Economics and Business Statistics Discipline, Griffith Business School, Griffith University. [PDF Link](#)

## Examples

```
#interval plot for GSE
data(unidat)
data = unidat
library(minpack.lm)
model <- nlsLM(costFunction(costName = colnames(unidat)[3], outputName = colnames(unidat)[7:11],
priceName = colnames(unidat)[4:6], controlName = colnames(unidat)[12:24],
form = "FFCQ-M"), start = list(b0 = 600, b1 = 0, b2 = 0,
                                b3 = 0, b4 = 0, b5 = 0, b11 = 0, b22 = 0, b33 = 0, b44 = 0,
                                b55 = 0, b12 = 0, b13 = 0, b14 = 0, b15 = 0, b23 = 0, b24 = 0,
                                b25 = 0, b34 = 0, b35 = 0, b45 = 0, bp2 = 0, bp3 = 0, bz1 = 0,
                                bz2 = 0, bz3 = 0, bz4 = 0, bz5 = 0, bz6 = 0, bz7 = 0, bz8 = 0,
                                bz9 = 0, bz10 = 0, bz11 = 0, bz12 = 0, bz13 = 0), data = unidat,
                                trace = F)
vcovCL <- clusterEst(model = model , cluster = unidat$unicode)$vcovCL
##interval plot for GSE
intervalPlot(intervalData = intervalData, estimates = intervalData$GSE,
meanLevels = intervalData$meanLevels, lowerLevel = intervalData$Lo_GSE,
UpperLevel = intervalData$Hi_GSE, ylab = "Degree of economies of scope",
h = 0,ylim = c(-1,1))

##interval plot for SRAY
intervalPlot(intervalData = intervalData, estimates = intervalData$SRAY,
meanLevels = intervalData$meanLevels, lowerLevel = intervalData$Lo_SRAY,
UpperLevel = intervalData$Hi_SRAY, ylab = "Degree of economies of scale",
h = 1,ylim = c(min(intervalData$Lo_SRAY,1),max(intervalData$Hi_SRAY)))
```

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unidat

*Data of 37 Australian public universities*

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## Description

A panel data containing the cost, outputs, and prices of 37 Australian public universities over the period from 2003 to 2012

## Usage

unidat

## Format

A data frame with 370 rows and 24 variables:

**year** Data collection time point

**unicode** Index of Australian universities

**c** Total operating expenditure, in thousands of AUD (2003 = 100)

**w1** Price of academic labour, in thousands of AUD (2003 = 100)

**w2** Price of non-academic labour, in thousands of AUD (2003 = 100)

**w3** Price of non-labour, in thousands of AUD (2003 = 100)

**y1** Domestic science completions

**y2** Domestic non-science completions

**y3** Overseas science completions

**y4** Overseas non-science completions

**y5** Number of publications

**q** Attrition rate, in percentages

**z1** One for ATN institutions, otherwise zero

**z2** One for Go8 institutions, otherwise zero

**z3** One for IRU institutions, otherwise zero

**z4** One for RUN institutions, otherwise zero

**g1** One for Institutions located in NSW, otherwise zero

**g2** One for Institutions located in VIC, otherwise zero

**g3** One for Institutions located in QLD, otherwise zero

**g4** One for Institutions located in WA, otherwise zero

**g5** One for Institutions located in SA, otherwise zero

**g6** One for Institutions located in ACT, otherwise zero

**g7** One for Institutions located in TAS, otherwise zero

**g8** One for Institutions located in NT, otherwise zero

**Details**

This data is formatted based on Zhang et al. (in press) and collected from multiple sources. For outputs and control variables (y, q, z, and g), they are from Australian Government Department of Education and Training (n.d.-b) For Total operating expenditure and price variables (c and w), they are from Australian Government Department of Education and Training (n.d.-a). Please see the data copyright here

**Source**

Australian Government Department of Education and Training. (n.d.-a). Higher education publications: Finance publication. Retrieved from <https://www.education.gov.au/finance-publication>

Australian Government Department of Education and Training. (n.d.-b). uCube - Higher education statistics. Retrieved from <http://highereducationstatistics.education.gov.au/Default.aspx>

Zhang, L.-C., Worthington, A. C., & Hu, M. (in press). Cost economies in the provision of higher education for international students: Australian evidence. Higher Education. doi: [10.1007/s10734-016-0078-9](https://doi.org/10.1007/s10734-016-0078-9)



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