

# Package ‘Inventorymodel’

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**Title** Inventory Models

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**Description**

Determination of the optimal policy in inventory problems from a game-theoretic perspective.

**License** GPL-2

**LazyLoad** yes

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coalitions	<i>Coalitions</i>
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### Description

Possible coalitions with n players.

### Usage

```
coalitions(n)
```

### Arguments

n	Number of players
---	-------------------

### Value

This function gives the coalitions in a binary mode and usual way.

### Examples

```
coalitions(3)
#$Binary
#      [,1] [,2] [,3]
#[1,]  0   0   0
#[2,]  1   0   0
#[3,]  0   1   0
#[4,]  0   0   1
#[5,]  1   1   0
#[6,]  1   0   1
#[7,]  0   1   1
#[8,]  1   1   1
#
#$Classic
#[1] "0"  "'{ 1 }'" "'{ 2 }'" "'{ 3 }'" "'{ 1,2 }'" "'{ 1,3 }'" "'{ 2,3 }'"
#[8] "'{ 1,2,3 }'"
```

---

 EOQ

---

 EOQ
 

---

**Description**

This function obtains the optimal orders and the associated cost in the EOQ model.

**Usage**

EOQ(n = NA, a = NA, d = NA, h = NA, m = NA)

**Arguments**

n	Number of agents in the inventory model.
a	The fixed cost per order.
d	Vector. Deterministic demands per time unit to each agent.
h	Vector. Holding costs to each agent.
m	Vector. Number of orders to each agent (optional).

**Value**

This function calculates two vectors. The first shows the optimal order for each agent. The second vector indicates the associated cost to these orders.

**Examples**

```
EOQ(n=3, a=600, d=c(500, 300, 400), h=c(9.6, 11, 10))
```

```
#EOQ model
#"$Optimal order"
#[1] 250.0000 180.9068 219.0890
#
#"$Order costs"
#[1] 2400.000 1989.975 2190.890
```

---

 EOQcoo

---

 EOQcoo
 

---

**Description**

This function obtains the optimal orders and the associated cost when agents are cooperating in the EOQ model.

**Usage**

EOQcoo(n = NA, a = NA, d = NA, h = NA, m = NA)

**Arguments**

n	Number of agents in the inventory model.
a	The fixed cost per order.
d	Vector. Deterministic demands per time unit to each agent.
h	Vector. Holding costs to each agent.
m	Vector. Number of orders to each agent (optional).

**Value**

A list with the following components:

- Optimal order If  $n$  is lesser than  $\theta$ , a matrix with all possible coalitions in the first column. The next  $n$  columns contain the associated cost to each agent in the coalition. Last column indicates the global cost of the optimal order. Otherwise, this matrix contains the individual costs and the associated values for  $N$ .

**Examples**

```
EQCoo(n=3,a=600,d=c(500,300,400),h=c(9.6,11,10))

#EQC model
#Cooperative case
#Optimal order
#   Coalition      1      2      3 Coalitional costs
#1      0      0.0000  0.0000  0.0000      0.000
#2     '{ 1 }' 250.0000  0.0000  0.0000      2400.000
#3     '{ 2 }'  0.0000 180.9068  0.0000      1989.975
#4     '{ 3 }'  0.0000  0.0000 219.0890      2190.890
#5     '{ 1,2 }' 192.4501 115.4701  0.0000      3117.691
#6     '{ 1,3 }' 184.6372  0.0000 147.7098      3249.615
#7     '{ 2,3 }'  0.0000 121.6327 162.1770      2959.730
#8     '{ 1,2,3 }' 157.4592  94.4755 125.9673      3810.512
```

---

 EPQ

 EPQ
 

---

**Description**

This function obtains the optimal orders and the associated cost in the EPQ model.

**Usage**

```
EPQ(n = NA, a = NA, d = NA, h = NA, m = NA, r = NA, b = NA)
```

**Arguments**

n	Number of agents in the inventory model.
a	The fixed cost per order.
d	Vector. Deterministic demands per time unit to each agent.
h	Vector. Holding costs to each agent.
m	Vector. Number of orders to each agent (optional).
r	Vector. Replacement rate to each agent. In general, $r > d$ .
b	Vector. Cost of a shortage to each agent.

**Value**

This function calculates two vectors. The first one shows the optimal order for each agent. The second vector indicates the associated cost to these orders.

**Examples**

```
EPQ(n=3, a=600, d=c(500, 300, 400), h=c(9.6, 11, 10), m=NA, r=rep(600, 3), b=c(100, 150, 200))
#EPQ model
#"$Optimal order"
#[1] 641.0928 265.0557 388.8444
#
#"$Optimal shortages"
#[1] 9.359019 9.054699 6.172134
#
#"$Order costs"
#[1] 935.9019 1358.2049 1234.4268
```

---

EPQ<sub>coo</sub>
*EPQ<sub>coo</sub>*


---

**Description**

This function obtains the optimal orders and the associated cost when agents are cooperating in the EPQ model.

**Usage**

```
EPQcoo(n = NA, a = NA, d = NA, h = NA, m = NA, r = NA, b = NA)
```

**Arguments**

n	Number of agents in the inventory model.
a	The fixed cost per order.
d	Vector. Deterministic demands per time unit to each agent.
h	Vector. Holding costs to each agent.

m	Vector. Number of orders to each agent (optional).
r	Vector. Replacement rate to each agent. In general, $r > d$ .
b	Vector. Cost of a shortage to each agent.

### Value

A list with the following components:

- Optimal order If  $n$  is lesser than  $\theta$ , a matrix with all possible coalitions in the first column. The next  $n$  columns contain the associated cost to each agent in the coalition. Last column indicates the global cost of the optimal order. Otherwise, this matrix contains the individual costs and the associated values for  $N$ .
- Optimal shortages A matrix, for each coalition (row), contains in the column  $i$  the allowed optimal shortages.

### Examples

EPQcoo( $n=3, a=600, d=c(500, 300, 400), h=c(9.6, 11, 10), r=rep(600, 3), b=c(100, 150, 200)$ )

```
#EPQ model
#Cooperative case
#$$Optimal order
#      1      2      3      Costs
# 0.0000  0.0000  0.0000  0.0000
# 641.0928 0.0000  0.0000  935.9019
# 0.0000 265.0557  0.0000 1358.2049
# 0.0000  0.0000 388.8444 1234.4268
# 363.7611 218.2567  0.0000 1649.4341
# 387.3208  0.0000 309.8566 1549.1036
# 0.0000 196.1473 261.5297 1835.3556
# 291.2332 174.7399 232.9866 2060.2045
#
#$$Optimal shortages`
#      1      2      3
# 0.000000 0.000000 0.000000
# 9.359019 0.000000 0.000000
# 0.000000 9.054699 0.000000
# 0.000000 0.000000 6.172134
# 5.310381 7.455973 0.000000
# 5.654318 0.000000 4.918359
# 0.000000 6.700683 4.151265
# 4.251580 5.969377 3.698200
```

## Description

This package allows the determination of the optimal policy in terms of the number of orders to apply in the most common inventory problems. Moreover, game-theoretic procedures to share the costs of these situations have been considered by proposing allocations for the involved agents.

## Details

Package: Inventorymodel  
 Type: Package  
 Version: 1.0  
 Date: 2017-04-05  
 License: –

This package incorporates the functions `EOQ` and `EOQcoo`, which compute the optimal policy in an EOQ model. For studying the optimal orders and costs in an EPQ model, functions `EPQ` and `EPQcoo` can be used. The package includes the function `SOC` for the SOC allocation rule. For the inventory transportation system (STI), the functions `STI`, `STIcoo` and `reglalineacoalitional` implement the associated games to these situations and their allocation rule (line rule). The function `mfoc` calculates the optimal order and its associated cost to model with fixed order cost (MFOC). Shapley value can be obtained for this class of games with the function `shapley\_mfoc`. The basic EOQ system without holding costs and with transportation cost (MCT) can be studied with the functions `mct` and `twolines` (allocation rule). This package includes the function `mwhc` for models without holding costs (MWHC), the function `mwhc2c` when two suppliers are considered with different costs of the product and the function `mwhcct` when the transportation costs are considered (MWHCCT).

## Author(s)

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---

inventorygames

*Inventorygames*

---

### Description

Generic function to show the associated cost game to a EOQ or EPQ model.

### Usage

```
inventorygames(n = NA, a = NA, d = NA, h = NA, m = NA, r = NA, b = NA,
model = c("EOQ", "EPQ"))
```

### Arguments

n	Number of agents in the inventory model.
a	The fixed cost per order.
d	Vector. Deterministic demands per time unit to each agent.
h	Vector. Holding costs to each agent.
m	Vector. Number of orders to each agent (optional).
r	Vector. Replacement rate to each agent. In general, $r > d$ .
b	Vector. Cost of a shortage to each agent.
model	Model to be selected. EOQ and EPQ models can be considered.

### Value

The characteristic function of the associated cost game is calculated to model EOQ or EPQ.



**Examples**

```

inventorygames(n=3,a=600,d=c(500,300,400),h=c(9.6,11,10),model="EQQ")
#EQQ model
#Cooperative case
#Optimal order
#   Coalition           1           2           3 Coalitional costs
#1      0    0.0000    0.0000    0.0000           0.000
#2    '{ 1 }' 250.0000    0.0000    0.0000           2400.000
#3    '{ 2 }'  0.0000  180.9068    0.0000           1989.975
#4    '{ 3 }'  0.0000    0.0000  219.0890           2190.890
#5    '{ 1,2 }' 192.4501  115.4701    0.0000           3117.691
#6    '{ 1,3 }' 184.6372    0.0000  147.7098           3249.615
#7    '{ 2,3 }'  0.0000  121.6327  162.1770           2959.730
#8    '{ 1,2,3 }' 157.4592  94.4755  125.9673           3810.512

```

---

inventorymodelfunction

*inventorymodelfunction*

---

**Description**

General function in Inventorymodel package for obtaining the optimal policy by selecting any model and its corresponding parameters.

**Usage**

```

inventorymodelfunction(model=c("EQQ", "EPQ", "STI", "FOC", "MCT", "MWHC", "MWHC2", "MWHCCT"),
n=NA, a=NA, av=NA, d=NA, h=NA, m=NA, r=NA, K=NA, b=NA, c1=NA, c2=NA,
cooperation=c(0,1), allocation=c(0,1))

```

**Arguments**

model	Model to be selected. EQQ, EPQ, STI, mfoc, mct, mwhc, mwhc2c or mwhcct models can be considered.
n	Number of agents in the inventory model.
a	The fixed cost per order.
av	Vector. Transportation costs to each agent.
d	Vector. Deterministic demands per time unit to each agent.
h	Vector. Holding costs to each agent.
m	Vector. Number of orders to each agent(optional).
r	Vector. Replacement rate to each agent. In general, $r > d$ .
K	Vector. Warehouse capacity to each agent.
b	Vector. Shortage cost to each agent.
c1	Value. Cost of a product from the first supplier.
c2	Value. Cost of a product from the second supplier.
cooperation	Option to indicate cooperation. If it exists cooperation=1 else cooperation=0.
allocation	Option to indicate the allocation. If it is required allocation=1 else allocation=0.

**See Also**

[EOQ](#), [EOQcoo](#), [EPQ](#), [EPQcoo](#), [STI](#), [STIcoo](#), [mct](#), [mfoc](#), [mwhc](#), [mwhc2c](#) and [mwhcct](#).

**Examples**

```
inventorymodelfunction(model="MCT",n=3,a=400,av=c(300,500,200),d=c(2,2,5),K=c(9,8,7),
cooperation=1,allocation=1)
#MCT model
#Cooperative case
#Two-lines rule
#`Optimal solution`
# 1 2 3 Coalition      Cost
# 0 0 0          0  0.0000
# 1 0 0          1 155.5556
# 0 1 0          2 225.0000
# 0 0 1          3 428.5714
# 1 1 0          12 225.0000
# 1 0 1          13 500.0000
# 0 1 1          23 642.8571
# 1 1 1          123 642.8571
#
#`Allocation two-lines rule`
#[1]  0.0000 219.6429 423.2143
```

---

linerule

*Line rule*

---

**Description**

Line rule for an inventory transportation system when coalition  $N$  is formed.

**Usage**

```
linerule(n=NA,a=NA,av=NA,d=NA,h=NA,m=NA)
```

**Arguments**

n	Agents in the inventory situation.
a	The fixed cost per order.
av	Vector. The transportations cost per order to each agent.
d	Vector. Deterministic demands per time unit to each agent.
h	Vector. Holding cost per time unit to each agent.
m	Vector. Number of orders to each agent (optional).

**Value**

Allocation for each agent if  $N$  was formed.

**Examples**

```
linerule(n=3,a=200,av=c(300,300,900),d=c(90,80,20),h=c(0.06,0.06,0.1),m=NA)

#Line rule
#[1] 51.38935 46.10733 66.33250
```

linerulecoalitional     *Line rule (coalitional)*

**Description**

Line rule for an inventory transportation system for each possible coalition.

**Usage**

```
linerulecoalitional(n = NA, a = NA, av = NA, d = NA, h = NA, m = NA)
```

**Arguments**

- n                    Agents in the inventory situation.
- a                    The fixed cost per order.
- av                   Vector. The transportations cost per order to each agent.
- d                    Vector. Deterministic demands per time unit to each agent.
- h                    Vector. Holding cost per time unit to each agent.
- m                    Vector. Number of orders to each agent (optional).

**Value**

Matrix with allocations proposed by Line rule to agents (columns) in each possible coalition *S* (row).

**Examples**

```
linerulecoalitional(n=3,a=200,av=c(300,300,900),d=c(90,80,20),
h=c(0.06,0.06,0.1),m=NA)
```

#	Coalition	1	2	3	Coalitional cost
#1		0.00000	0.00000	0.0000	0.00000
#2	'{ 1 }'	73.48469	0.00000	0.0000	73.48469
#3	'{ 2 }'	0.00000	69.28203	0.0000	69.28203
#4	'{ 3 }'	0.00000	0.00000	66.3325	66.33250
#5	'{ 1,2 }'	52.59885	48.39619	0.0000	100.99505
#6	'{ 1,3 }'	61.26061	0.00000	66.3325	127.59310
#7	'{ 2,3 }'	0.00000	55.97858	66.3325	122.31108
#8	'{ 1,2,3 }'	51.38935	46.10733	66.3325	163.82918

---

marginal\_contribution\_mean  
*fauxiliar*

---

### Description

Intermediate auxiliar function to calculate the mean of the marginal contributions for a set of permutations.

### Usage

```
marginal_contribution_mean(permute, costs)
```

### Arguments

permute	Matrix with $n$ columns. By rows, it contains a order.
costs	Vector with the associated costs to each possible coalition in a set of agents $N$ .

### Value

A vector with  $n$  elements with component  $i$  equal to the mean of the marginal contribution indicated by each order in *permute* for agent  $i$ .

---

mct	<i>MCT</i>
-----	------------

---

### Description

This function obtains the associated costs in a basic EOQ system without holding costs and with transportation cost.

### Usage

```
mct(n = NA, a = NA, av = NA, d = NA, K = NA, cooperation = c(0, 1))
```

### Arguments

n	Agents in the inventory situation.
a	The fixed cost per order.
av	Vector. The transportations cost per order to each agent.
d	Vector. Deterministic demands per time unit to each agent.
K	Vector. Warehouse's capacity to each agent.
cooperation	Option to indicate cooperation. If it exists cooperation=1 else cooperation=0.

**Value**

If  $\text{cooperation}=0$ , a vector with the individual cost to each agent in a MCT. If  $\text{cooperation}=1$  and  $n$  is lesser than  $0$ , a matrix which contains the associated costs for each possible group. Otherwise, this matrix only contains the individual costs and the associated values for  $N$ .

**Examples**

```
mct(n=3,a=400,av=c(300,500,200),d=c(2,2,5),K=c(9,8,7),cooperation=0)

#MCT model
#Individual cost
#[1] 155.5556 225.0000 428.5714
```

mfoc

*MFOC***Description**

This function obtains the associated costs in a fixed order cost model.

**Usage**

```
mfoc(n = NA, a = NA, d = NA, K = NA, cooperation = c(0, 1))
```

**Arguments**

n	Agents in the inventory situation.
a	The fixed cost per order.
d	Vector. Deterministic demands per time unit to each agent.
K	Vector. Warehouse's capacity to each agent.
cooperation	Option to indicate cooperation. If it exists $\text{cooperation}=1$ else $\text{cooperation}=0$ .

**Value**

If  $\text{cooperation}=0$ , a vector with the individual cost to each agent in a MFOC. If  $\text{cooperation}=1$  and  $n$  is lesser than  $0$ , a matrix which contains the associated costs for each possible group. Otherwise, this matrix only contains the individual costs and the associated values for  $N$ .

**Examples**

```
mfoc(n=3,a=200,d=c(1.2,1.4,1.2),K=c(6,10,8),cooperation=0)

#MFOC model
#[1] 40 28 30
```

mwhc

*MWHC***Description**

This function obtains the associated costs in a model without holding costs. Demands and capacities must be introduced in the order indicated by the ratios  $d/K$ . In other case, agents change their position.

**Usage**

```
mwhc(n = NA, a = NA, b = NA, d = NA, K = NA, cooperation = c(0, 1),
allocation = c(0, 1))
```

**Arguments**

n	Agents in the inventory situation.
a	The fixed cost per order.
b	Vector. Shortage cost per unit to each agent.
d	Vector. Deterministic demands per time unit to each agent.
K	Vector. Warehouse's capacity to each agent.
cooperation	Option to indicate cooperation. If it exists cooperation=1 else cooperation=0.
allocation	Option to indicate the allocation. If it is required allocation=1 else allocation=0.

**Value**

A list with the following components:

- "Optimal policies" If  $n$  is lesser than 0, a matrix with all possible coalitions in the first column. The second column contains the optimal order to each coalition. Last column indicates the global cost of this optimal order. Otherwise, this matrix contains the individual costs and the associated values for  $N$ .
- "R-rule" A matrix, for each coalition (row), contains the coalition  $i(S)$  and allocations proposed by R-rule.

**Examples**

```
mwhc(n=4,a=180,b=c(15,15,10,12),d=c(0.45,0.95,1.05,1.2),K=c(5,7.5,8,9),
cooperation=1,allocation=1)
```

```
#MWHC model
#Cooperative case
#"$Optimal policies"
#   Coalitions Optimal orders   Costs
#1      0      0.00000000  0.00000
#2    '{ 1 }'    0.07520921 14.74965
```

```

#3      '{ 2 }'      0.10684954 20.86510
#4      '{ 3 }'      0.10406757 20.89599
#5      '{ 4 }'      0.11094004 21.79985
#6      '{ 1,2 }'    0.10684954 20.86510
#      ..
#
#`R-rule`
# Coalition_SxT      1          2          3          4
#      0 0.00000 0.000000 0.000000 0.000000
#      1 14.74965 0.000000 0.000000 0.000000
#      2 0.00000 20.865100 0.000000 0.000000
#      3 0.00000 0.000000 20.895986 0.000000
#      4 0.00000 0.000000 0.000000 21.79985
#      2 0.00000 20.865100 0.000000 0.000000
#      3 0.00000 0.000000 20.895986 0.000000
#      ..

```

---

mwhc2c

*MWHC2C*


---

### Description

This function obtains the associated costs in a model without holding costs and with two different cost of product. Demands and capacities must be introduced in the order indicated by the ratios  $d/K$ . In other case, agents change their position.

### Usage

```
mwhc2c(n=NA, a=NA, b=NA, d=NA, K=NA, c1=NA, c2=NA, cooperation=c(0,1), allocation=c(0,1))
```

### Arguments

n	Agents in the inventory situation.
a	The fixed cost per order.
b	Vector. Shortage cost per unit to each agent.
d	Vector. Deterministic demands per time unit to each agent.
K	Vector. Warehouse's capacity to each agent.
c1	Value. Cost per unit of product from the first vendor.
c2	Value. Cost per unit of product from the second vendor.
cooperation	Option to indicate cooperation. If it exists cooperation=1 else cooperation=0.
allocation	Option to indicate the allocation. If it is required allocation=1 else allocation=0.

**Value**

A list with the following components:

- "Optimal policies" If  $n$  is lesser than  $\theta$ , a matrix with all possible coalitions in the first column. The second column contains the optimal order to each coalition. Last column indicates the global cost of this optimal order. Otherwise, this matrix contains the individual costs and the associated values for  $N$ .
- "GR-rule" A matrix, for each coalition (row), contains the coalition  $i(S)$  and allocations proposed by GR-rule.

**Examples**

```
mwhc2c(n=3,a=1,b=c(10,10,10),d=c(30,45,46),K=c(30,45,46),c1=3.5,c2=3,cooperation=1,allocation=1)
#MWHC model
#"$`Optimal policies`"
# Coalitions Optimal orders Costs
#1      0      0.0000000 0.0000
#2    '{ 1 }'    0.9505864 105.5947
#3    '{ 2 }'    0.9515422 157.9165
#4    '{ 3 }'    0.9515838 161.4046
#5  '{ 1,2 }'    0.9523090 262.5595
#6  '{ 1,3 }'    0.9523241 266.0476
#7  '{ 2,3 }'    0.9525115 318.3690
#8  '{ 1,2,3 }'  0.9527470 423.0118
#
#"$`GR-rule`"
# Coalition_SxT      1      2      3
#      0  0.0000  0.0000  0.0000
#      1 105.5947  0.0000  0.0000
#      2  0.0000 157.9165  0.0000
#      3  0.0000  0.0000 161.4046
#     12 105.0238 157.5357  0.0000
#     13 105.0188  0.0000 161.0288
#     23  0.0000 157.4352 160.9338
#    123 104.8790 157.3184 160.8144
```

---

mwhcct

---

*MWHCCT*


---

**Description**

This function obtains the associated costs in a basic EOQ system without holding costs and with a general transportation cost.

**Usage**

```
mwhcct(n = NA, a = NA, av = NA, d = NA, K = NA, cooperation = c(0, 1), allocation = c(0, 1))
```



**Arguments**

n	Agents in the inventory situation.
a	The fixed cost per order.
av	Vector. The transportations cost per order to each possible group of agents.
d	Vector. Deterministic demands per time unit to each agent.
K	Vector. Warehouse's capacity to each agent.
cooperation	Option to indicate cooperation. If it exists cooperation=1 else cooperation=0.
allocation	Option to indicate the allocation. If it is required allocation=1 else allocation=0.

**Value**

If  $n$  is lesser than 0, a matrix with all possible coalitions in the first column. The next  $n$  columns contain the associated cost to each agent in the coalition. Last column indicates the global cost of the optimal order. Otherwise, this matrix contains the individual costs and the associated values for  $N$ .

**Examples**

```
mwhcct(n=3,a=10,av=c(0,10,10,10,20,20,20,30),d=c(1,0.95,0.9),K=c(1,1,1),
cooperation=1,allocation = 1)
# MWHC with Transportation Costs model
#Cooperative case
#[1] "Shapley Value"
#"$`Optimal solution`
# 1 2 3 Coalition Cost
#1 0 0 0 0 0.0
#2 1 0 0 '{ 1 }' 20.0
#3 0 1 0 '{ 2 }' 19.0
#4 0 0 1 '{ 3 }' 18.0
#5 1 1 0 '{ 1,2 }' 30.0
#6 1 0 1 '{ 1,3 }' 30.0
#7 0 1 1 '{ 2,3 }' 28.5
#8 1 1 1 '{ 1,2,3 }' 40.0
#
#"$`Allocation R rule`
# 1 2 3
# 13.75 13.25 13
```

shapley\_mfoc

*SMFOC***Description**

Function to calculate the Shapley value for the associated game to a fixed order cost model.

**Usage**

```
shapley_mfoc(n = NA, a = NA, d = NA, K = NA)
```

**Arguments**

n Agents in the inventory situation.  
 a The fixed cost per order.  
 d Vector. Deterministic demands per time unit to each agent.  
 K Vector. Warehouse's capacity to each agent.

**Value**

Shapley value for the associated game to the fixed order cost model.

**Examples**

```
shapley_mfoc(n=5, a=200, d=c(1.2, 1.4, 1.2, 1.3, 0.4), K=c(6, 10, 8, 8, 4))
#Shapley-Value
#MFOC model
#[1] 4.000000 6.000000 6.666667 7.916667 15.416667
```

---

 SOC

---

 SOC
 

---

**Description**

Generic function for showing the allocations proposed by SOC rule under an EOQ or EPQ model.

**Usage**

```
SOC(n = NA, a = NA, d = NA, h = NA, m = NA, r = NA, b = NA,
    model = c("EOQ", "EPQ"))
```

**Arguments**

n Number of agents in the inventory model.  
 a The fixed cost per order.  
 d Vector. Deterministic demands per time unit to each agent.  
 h Vector. Holding costs to each agent.  
 m Vector. Number of orders to each agent(optional).  
 r Vector. Replacement rate to each agent. In general,  $r > d$ .  
 b Vector. Cost of a shortage to each agent.  
 model Model to select. EOQ and EPQ models can be considered.

**Value**

Matrix with number of rows equal to the number of coalitions and  $n$  columns. For each coalition or row, the output shows the cost that SOC rule allocates to each player or column.

**Examples**

```
SOC(n=3,a=600,d=c(500,300,400),h=c(9.6,11,10),m=NA,r=NA,b=NA,model="EQ")
```

```
#EQ model
#`Share the ordering costs rule (individually)`
#[1] 2400.000 1989.975 2190.890
```

```
SOC(n=3,a=600,d=c(500,300,400),h=c(9.6,11,10),m=NA,r=NA,b=NA,model="EQ")
```

```
#EQ model
#`Share the ordering costs rule (individually)`
#      1      2      3
#  0.000  0.000  0.000
# 2400.000  0.000  0.000
#   0.000 1989.975  0.000
#   0.000  0.000 2190.890
# 1847.521 1270.171  0.000
# 1772.517  0.000 1477.098
#   0.000 1337.960 1621.770
# 1511.608 1039.230 1259.673
```

---

 STI

---

 STI
 

---

**Description**

This function obtains the optimal orders and the associated cost when agents are cooperating in the inventory transportation system.

**Usage**

```
STI(n = NA, a = NA, av = NA, d = NA, h = NA, m = NA)
```

**Arguments**

<code>n</code>	Agents in the inventory situation.
<code>a</code>	The fixed cost per order.
<code>av</code>	Vector. The transportations cost per order to each agent.
<code>d</code>	Vector. Deterministic demands per time unit to each agent.
<code>h</code>	Vector. Holding cost per time unit to each agent.
<code>m</code>	Vector. Number of orders to each agent (optional).

**Value**

This function calculates two vectors. The first one shows the optimal order for each agent. The second vector indicates the associated cost to these orders.

**Examples**

```
STI(n=3, a=200, av=c(300, 300, 900), d=c(90, 80, 20), h=c(0.06, 0.06, 0.1), m=NA)
#STI model
#"$Optimal order"
#[1] 1224.745 1154.701 663.325
#
#"$Order cost"
#[1] 73.48469 69.28203 66.33250
```

---

STIcoo

*STIcoo*


---

**Description**

This function obtains the optimal orders and the associated cost when agents are cooperating in the inventory transportation system when agents are cooperating.

**Usage**

```
STIcoo(n = NA, a = NA, av = NA, d = NA, h = NA, m = NA)
```

**Arguments**

n	Agents in the inventory situation.
a	The fixed cost per order.
av	Vector. The transportations cost per order to each agent.
d	Vector. Deterministic demands per time unit to each agent.
h	Vector. Holding cost per time unit to each agent.
m	Vector. Number of orders to each agent (optional).

**Value**

A list with the following components:

- Optimal order If  $n$  is lesser than 0, a matrix with all possible coalitions in the first column. The next  $n$  columns contain the associated cost to each agent in the coalition. Last column indicates the global cost of the optimal order. Otherwise, this matrix contains the individual costs and the associated values for  $N$ .

**Examples**

```
STIcoo(n=3,a=200,av=c(300,300,900),d=c(90,80,20),h=c(0.06,0.06,0.1),m=NA)
```

```
#$`Optimal order`
#      1      2      3  Coalition Order cost
#1  0.0000  0.000  0.0000      0  0.00000
#2 1224.7449  0.000  0.0000    '{ 1 }'  73.48469
#3   0.0000 1154.701  0.0000    '{ 2 }'  69.28203
#4   0.0000  0.000 663.3250    '{ 3 }'  66.33250
#5  891.1328 792.118  0.0000   '{ 1,2 }' 100.99505
#6 1551.8080  0.000 344.8462   '{ 1,3 }' 127.59310
#7   0.0000 1438.954 359.7385   '{ 2,3 }' 122.31108
#8 1208.5759 1074.290 268.5724 '{ 1,2,3 }' 163.82918
```

---

twolines

*Two-lines rule*


---

**Description**

Two-lines rule for a basic EOQ system without holding costs and with transportation cost.

**Usage**

```
twolines(n = NA, a = NA, av = NA, d = NA, K = NA)
```

**Arguments**

n	Agents in the inventory situation.
a	The fixed cost per order.
av	Vector. The transportations cost per order to each agent.
d	Vector. Deterministic demands per time unit to each agent.
K	Vector. Capacities of agents' warehouse to each agent.

**Value**

The output is a vector who contains the allocation to each player.

**Examples**

```
twolines(n=3,a=400,av=c(300,500,200),d=c(2,2,5),K=c(9,8,7))
#MCT model
#Cooperative case
#Two-lines rule
#[1] 0.0000 219.6429 423.2143
```

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