# test\_cases\_summary

#### **Test Case 1**

The motivation for this test case was to study interactions between resource rich, resource medium, and resource poor countries. The goal was to study how cooperation between countries functioned when there is a balance between rich, medium and poor countries for rich and poor countries to trade with.

#### Initial state:

Country	R1	R2	R3	R20	R21	R22	R23	R24
self	35	40	15	40	20	15	40	10
Brobdingnag	40	45	20	30	15	15	45	20
Carpania	10	20	11	5	9	7	16	6
Dinotopia	10	15	11	7	5	9	8	8
Erewhon	8	11	15	2	2	1	1	1
Foremz	30	10	3	2	1	0	3	4

# Parameter settings:

Your\_country\_name: 'self'

Resources\_filename: 'data/resource\_data.xslx' Initial\_state\_filename: 'data/test\_case\_1.xslx'

Output\_schedule\_filename: 'data/output\_data1.xslx'

Num\_output\_schedules: 5

depth\_bound: 10 frontier\_max\_size: 10

# Constant settings within a run:

x\_0: 0 k: 5

Gamma: 0.99

Failure cost, C: -0.5

#### Outcomes:

A	8	C	D	1		G	Н	1	1	K	L
	Expected Utility of Schedule	Depth 1	Depth 2	Depth 3	Depth 4	Depth 5	Depth 6	Depth 7	Depth 8	Depth 9	Depth 10
Schedule 1	Expected Utility: 5.67283802686 (TRANSFO		(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)( (OUTPUTS (Population 1) (MetallicAlloys 1)	(MetallicElements 3) (MetallicAlloys 2))(OUTPUTS (Population 5) (Electronics 2)	3) (MetallicAlloys 2))(OUTPUTS	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (DUTPUTS (Population 1)		(TRANSFORM self (NPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1))) EU:	(Population 1) (MetallicElements 2)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (CUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1))( EU: - 0.09043820750088012
Schedule 2	Expected Utility: 5.53718071561: (TRANSFO		(TRANSFORM self (INPUTS (Population 1) (MetallicElements 28) (OUTPUTS (Population 1)			(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2))	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2))	(TRANSFORM self (NPUTS (Population 1) [MetallicElements 2)) (OUTPUTS (Population 1) [MetallicAlloys 1)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements	(TRANSFORM self (INPUTS (Population 1) (Timber 3) (Housing 1)) (OUTPUTS (Population 1) (Food 2) (Housing 1) (FoodWaste 1)() EU: -0.2260955187522011
Schedule 3	Expected Utility: 5.53718071561: (TRANSFO		(TRANSFORM self (INPUTS Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1)	[TRANSFORM self (INPUTS (Population 5)   MetallicElements 3) (MetallicAlloys 20)(OUTPUTS (Population 5) (Electronics 2)   (ElectronicsWaste 10) EU:	(TRANSFORM self (INPUTS (Popula	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)		[TRANSFORM self (NPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1)) EU:	(Population 1) (MetallicElements 2)	(TRANSFORM self (INPUTS (Population 1) (Timber 3) (Housing 1) (OUTPUTS	[TRANSFORM self    NPUTS   Population 1]   MetallicElements 2)    (OUTPUTS    Population 1)   (MetallicAlloys 1)   (MetallicAlloysWaste 1)    EU:   0.1415054725503718
Schedule 4	Expected Utility: 5.53718071561: (TRANSFO		(TRANSFORM self (INPUTS	(TRANSFORM self (INPUTS (Population 5)	[TRANSFORM self (INPUTS (Popula	(TRANSFORM self (INPUTS		(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS		(TRANSFORM self (INPUTS (Population	(TRANSFORM self (INPUTS (Population 1)
Schedule 5	Expected Utility: 5.53718071561: (TRANSFO		(TRANSFORM self (INPUTS (Population 1) (MetallicElements	(TRANSFORM self (INPUTS (Population 5)	(TRANSFORM self (INPUTS (Population 5) (MetallicElements	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2))	, , , , , , , , , , , , , , , , , , ,	(TRANSFORM self (INPUTS (Population		(TRANSFORM self (INPUTS (Population 1) (MetallicElements	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)
Schedule 6	Expected Utility: 5.47211613444 (TRANSFO		(TRANSFORM self (INPUTS (Population 1) (MetallicElements	(TRANSFORM self (INPUTS (Population 5)	(TRANSFORM self (INPUTS	(TRANSFORM self (INPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS	(TRANSFORM self (INPUTS (Population 1)	(TRANSFORM self (INPUTS (Population	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2))(OUTPUTS
	Expected Utility: 5.47211613444 (TRANSFO		(TRANSFORM self (INPUTS (Population 1) (MetallicElements			(TRANSFORM self (INPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS	(TRANSFORM self (INPUTS (Population 1)	(TRANSFORM self (INPUTS (Population	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)( (OUTPUTS (Population 1)
Schedule 8	Expected Utility: 5.47211613444 (TRANSFO		(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)			(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2))	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2))	(TRANSFORM self (NPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1)	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1))) EU:
Schedule 9	Expected Utility: 5.34296865663 (TRANSFO		(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 20)(OUTPUTS (Population 5) (Electronics 2)	(Population 5) (MetallicElements	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2))	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2))	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2))	(TRANSFER self Foremz ((Timber 1)) EU: 0.0	(TRANSFER self Foremz ((Electronics 1)) EU: - 0.057523822012224654
Schedule 10	Expected Utility: 5.21822888677 (TRANSFO	į.	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2))(OUTPUTS (Population 5) (Electronics 2)	(Population 5) (MetallicElements	(TRANSFORM self (INPUTS (Population 1) (Metallic(Liements 2))	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2))	(TRANSFORM self (NPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1)		(TRANSFORM self (INPLITS (Population 1) (MetallicElements	(TRANSFER self Foremz (Timber 1)) EU: 0.0

#### **Test Case 2**

The motivation for this test case was to study interactions between resource rich and medium-level resource countries. The goal was to study how cooperation occurs when rich countries cannot take advantage of poor countries for trade, and what occurs when all countries have enough resources to perform transforms instead of relying on transfers.

#### Initial state:

Country	R1	R2	R3	R21	R22	R23	R24
self	35	40	15	20	15	40	10
Brobdingnag	40	45	20	15	15	45	20
Carpania	10	20	11	9	7	16	6
Dinotopia	10	15	11	5	9	8	8

# Parameter settings:

Your\_country\_name: 'self'

Resources\_filename: 'data/resource\_data.xslx' Initial\_state\_filename: 'data/test\_case\_2.xslx'

Output\_schedule\_filename: 'data/output\_data2.xslx'

Num\_output\_schedules: 5

Depth\_bound: 10 frontier\_max\_size: 10

Constant settings within a run:

x\_0: 0 k: 5

Gamma: 0.99

Failure cost, C: -0.5

#### Outcomes:

	В	C	D	E	F	G	Н	l l	1	K	L
	Expected Utility of Schedule	Depth 1	Depth 2	Depth 3	Depth 4	Depth 5	Depth 6	Depth 7	Depth 8	Depth 9	Depth 10
ie 1	Expected Utility: 5.6728380268 (	TRANSFORM self (INPUTS (Population S) (Metall	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2))	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3)	(INPUTS (Population 5)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2))	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (CUTPUTS (Population 1) (MetallicAlloys 1)			(TRANSFORM self (INPUTS Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1 (MetallicAlloys 1) (MetallicAlloysWaste 1))) EU
ie 2	Expected Utility: 5.5371807156	TRANSFORM self (INPUTS (Population 5) (Metall	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2) (OUTPUTS (Population 1) (MetallicAlloys 1)	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2))(OUTPUTS (Population	(INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys	(Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 1) MetallicElements 2() (OUTFUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1) (EU: 0.19123637508547925		(MetallicElements 2)) (OUTPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1)) EU: 0.14293482076805233	(TRANSFORM self (INPUTS (Population 1) (Timber 3) (Housing 1)) (OUTPUTS (Population 1) (Food 2) (Housing 1) (FoodWaste 1)) EU: - 0.2260955187527011
le 3	Expected Utility: 5.5371807156	TRANSFORM self (INPUTS (Population S) (Metall	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2))	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3)		(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2))	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (DUTPUTS (Population 1)		(TRANSFORM self (INPUTS (Population 1) (Timber 3) (Housing 1)) (OUTPUTS (Population 1) (Food 2) (Housing 1)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population (MetallicAlloys 1) (MetallicAlloysWaste 1)) E
e 4	Expected Utility: \$.5371807156	TRANSFORM self (INPUTS (Population S) (Metall	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1)()	(MetallicAlloys		(TRANSFORM self (INPUTS (Population 1) (Metallici lements 2() (OUTPUTS (Population 1) (MetallicAlloys Waste 1() EU: (MetallicAlloys Waste 1() EU:	(MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1))) EU:	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1)(EU: 0.17317034961701883	(TRANSFORM self (INPUTS (Population 1) (Timber 3) (Housing 1)) (OUTPUTS (Population 1) (Food 2) (Housing 1) (FoodWaste 1))(EU: - 0.23068617360698002	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1)(EU: 0.1560497102119172	[TRANSFORM self [INFUTS [Population 1] [MetallicElements 2]] (OUTPUTS [Population [MetallicAlloys 1] [MetallicAlloysWaste 1])) E 0.1415034725603718
5		TRANSFORM self IINPUTS (Population 5) IMetal	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2) (OUTPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2000xTPUTS (Population	(INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys	(Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1)() EU: 0.19123637508547925	(TRANSFORM self (INPUTS (Population 1) (Timber 3) (Housing 1)( (OUTPUTS (Population 1) (Food 2) (Housing 1) (FoodWaste 1)() EU: - 0.23301633697674748	(MetallicElements 2)) (OUTPUTS (Population 1)	[TRANSFORM self [INPUTS [Population 1]] (MetaillicElements 20) (OUTPUTS [Population 1) (MetallicAlloys 1) (MetaillicAlloysWaste 10) EU: 0.15560467102119172	[TRANSFORM self (INPUTS (Population I) (MetalliticTlements 2)) (DUTPUTS (Population (MetalliticAlloys I) (InetalliticAlloysWaste I)() 0.1415054725603718
e 6		TRANSFORM self (INPUTS (Population S) (Metall	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1)()	(TRANSFORM self (NPUTS (Population 5) (Metallici lements 3) (MetalliciAlloys 2)(WUTPUTS (Population 5) (Electronics 2) (Electronics 2)	[TRANSFORM self [INPUTS (Population 5) [Metallist liements 3] [MetallistAlloys 2)((CUTPUTS (Population 5) (Electronics 2) [Electronics 4]	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2I) (OUTPUTS (Population 1) (MetallicKloys 1)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1)	(TRANSFORM self (INPUTS	(TRANSFORM self (INPUTS (Population 1) (Metaillellements 2)) (OUTPUTS (Population 1) (Metaillellioys 1)	(TRANSFORM self (INPUTS (Population 1)) (Metallickineness 2)) (OUTPUTS (Population 1)) (Metallickiness) (Metallickiness) (Metallickiness) 1)(EU: 0.14295482078805233)	(TRANSFORM self (NPUTS (Population 5) (Metalliclinements 3) (Metallickleys (2000TPUTS (Population 5) (Hiertonics 2) (HiertonicsWaste 1)) EU- 0.2911600999206
		TRANSFERM WHINFILT (Provide on S.) Metallos	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1)(I	(MetallicAlloys 2)(OUTPUTS (Population 5) (Electronics 2) (ElectonicsWaste 1)[] EU:	(INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2)((OUTPUTS (Population 5) (Electronics 2) (ElectronicsWaste 1)() EU:		[TRANSFORM self (INPUTS (Population 1) (Metallicillements 2)) (OUTPUTS (Population 1) (Metallicklings 1) (MetallicklingsWaste 1)) (EU: 0.1912/3637306279)5	(TRANSFORM self IMPLITS Population 1) (Metallicificments 2); (BUTFUTS (Population 1) (Metallicification) (	(OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1))) EU:	(TRANSFORM self (INPUTS Population 5) (Retallicklements 3) (Metallickloys 2)(OUTPUTS (Population 5) (Flectrorics 2) (ElectroicsWeste 1)(EUL:	[TRANSFORM self (NPUTS (Population 1) (MetallicElements 2)] (OUTPUTS (Population (MetallicEleys 1) (MetallicAlloys 1) (Metallic

#### **Test Case 3**

The motivation for this test case was to study interactions between resource rich and resource poor countries. The goal was to study how cooperation and competition function when countries are dependent on other countries (power imbalance) for transfers and have low resources to transform.

## Initial state:

,,	5	-		_		-	
Country	R1	R2	R3	R21	R22	R23	R24
self	35	40	15	20	15	40	10
Brobdingnag	40	45	20	15	15	45	20
Erewhon	8	11	15	2	1	1	1
Foremz	30	10	3	1	0	3	4

# Parameter settings:

Your\_country\_name: 'self'

Resources\_filename: 'data/resource\_data.xslx' Initial\_state\_filename: 'data/test\_case\_3.xslx'

Output\_schedule\_filename: 'data/output\_data3.xslx'

Num\_output\_schedules: 5

Depth\_bound: 5

frontier\_max\_size: 10

Constant settings within a run:

x\_0: 0 k: 5

Gamma: 0.99

Failure cost, C: -0.5

#### Outcomes:

A	В	c	D	E	F	G
	Expected Utility of Schedule	Depth 1	Depth 2	Depth 3	Depth 4	Depth 5
Schedule 1	Expected Utility: 5.37965031821	(TRANSFORM self (NPUTS (Population 5) (Metallic Elements 3) (MetallicAlloys 2))	(TRANSFORM self (INPUTS (Population 1) [MetallicElements 2]) (OUTPUTS (Population 1) [MetallicAlloys) 1) (MetallicAlloysWaste 1))) EU: 0.1669464178438576	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2))(OUTPUTS (Population 5) (Electronics 2) (Electronics Waste 1))) EU:	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2) (OUTPUTS (Population 5) (Electronics 2) (ElectonicsWaste 1))) EU: 4.655813354059579	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2 (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloys 1) (MetallicAlloys 2) (2.2177845219545496
Schedule 2	Expected Utility: 4.93012435354	(IBANSFORM self (INPUTS (Population 5) (Metallic Elements 3) (Metallicalloys 2))	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1))) EU:	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2)(OUTPUTS (Population 5) (Electronics 2) (ElectonicsWaste 1)))	[TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2))(OUTPUTS (Population 5) (Electronics 2) (ElectronicsWaste 3))) EU: 4.65581335409579	(TRANSFORM self (INPUTS (Population 1) (Timber 3) (Housing 1)) (OUTPUTS (Population 1) (Food 2) (Housing 1) (FoodWaste 1))) EU:- 0.2377475124749998
Schedule 3	Expected Utility: 4.72823669928	(TRANSFORM self (INPUTS (Population 5) (Metallic Elements 3) (MetallicAlloys 2))	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1))) EU: 0.1669464173848876	(IRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2) (MOUTPUTS (Population 5) (Electronics 2) (Electronics 2) (Electronics Waste 1))) EU:  0.1881136373909225	[TRANSFORM self (INPUTS (Population 5) (Metallic Elements 3) (Metallic Elements 3) (Metallic Elements 2) (EUCTURE (Population 5) (Electronics 2) (Electronic Waste 1))) EU: 4.655813334055579	(TRANSFER self Foremz ((Timber 1)) EU: 0: 0
Schedule 4	Expected Utility: 4.68225324084	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2))	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1))) EU: 0. 16694641743408376	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2))(OUTPUTS	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2))(OUTPUTS (Population 5) (Electronics 2) (ElectonicsWaste 1))) EU: 4.655813354059579	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3 (MetallicAlloys 2))(OUTPUTS (Population 5) (Electronics 2) (ElectonicsWaste 1))) EU: -
Schedule 5		(TRANSFORM self (INPUTS (Population S) (MetallicElements 3) (MetallicAllios) 21)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1))) EU:	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2))(OUTPUTS	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2))(OUTPUTS (Population 5) (Electronics 2) (ElectonicsWaste 1))) EU:	

## **Test Case 4**

The motivation for this test case was to study interactions between a rich country, medium-resourced countries, and countries with poor resources. The goal was to study how cooperation and competition looks like when there is a less of power imbalance than only rich countries and poor countries.

#### Initial state:

Country	R1	R2	R3	R21	R22	R23	R24
self	35	40	15	20	15	40	10
Carpania	10	20	11	9	7	16	6
Dinotopia	10	15	11	5	9	8	8
Erewhon	8	11	15	2	1	1	1
Foremz	30	10	3	1	0	3	4

Parameter settings:

Your\_country\_name: 'self'

Resources\_filename: 'data/resource\_data.xslx' Initial\_state\_filename: 'data/test\_case\_4.xslx'

Output\_schedule\_filename: 'data/output\_data4.xslx'

Num\_output\_schedules: 5

Depth\_bound: 10 frontier\_max\_size: 10

## Constant settings within a run:

x\_0: 0 k: 5

Gamma: 0.99

Failure cost, C: -0.5

#### Outcomes:

В	C	D	E	F	G	H		1	K	L
Expected Utility of Schedule	Depth 1	Depth 2	Depth 3	Depth 4	Depth 5	Depth 6	Depth 7	Depth 8	Depth 9	Depth 10
Expected Utility: 5.672838026867065	(TRANSFORM self (INPUTS (Pop		(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2))(OUTPUTS (Population 5) (Electronics 2)	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)	(Population 1) (MetallicElements 2))	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)	[TRANSFORM self (INPUTS (Population 1) (MetallicElements 2]) (OUTPUTS (Population 1)
Expected Utility: 5.537180715615744			(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3)	(TRANSFORM self (INPUTS (Population 5)	(TRANSFORM self (INPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 1)		(TRANSFORM self (INPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 1) (Timber 3)
Expected Utility: 5.537180715615744		1) (MetallicAlloys 1) (MetallicAlloysWaste 1)()	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2))(OUTPUTS (Population 5) (Electronics 2)	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)	(Population 1) (MetallicElements 2))	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 1) (Timber 3) (Housing 1)) (OUTPUTS (Population 1) (Food 2)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)
Expected Utility: 5.537180715615744		(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1)))	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2)(IOUTPUTS (Population 5) (Electronics 2) (ElectronicsWaste 1) EU: 0.1881136373909225	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2)(OUTPUTS (Population 5) (Electronics 2) (ElectronicsWaste 1))) EU:	(INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1)	(MetallicAlloys 1)	(Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1)() EU:	(TRANSFORM self (INPUTS (Population 1) (Timber 3) (Housing 1)) (OUTPUTS (Population 1) (Food 2) (Housing 1) (FoodWaste 1))) EU: -0.23068617360698002	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1))) EU:	TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1))) EU: 0.1415054725603718
Expected Utility: 5.537180715615744		(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1)))	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2))(OUTPUTS (Population 5) (Electronics 2) (ElectonicsWaste 1))) EU:	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2))(OUTPUTS (Population 5)	(INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1)	(Population 1) (Timber 3) (Housing 1)) (OUTPUTS (Population 1) (Food 2)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2) (OUTPUTS (Population 1) (MetallicAlloys 1)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2) (OUTPUTS (Population 1) (MetallicAlloys 1)
Expected Utility: 5.472116134447312		(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1)))	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2))(OUTPUTS (Population 5) (Electronics 2) (ElectonicsWaste 1))) EU:	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2))(OUTPUTS (Population 5)	(INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)	(Population 1) (MetallicElements 2))	(Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2) (OUTPUTS (Population 1) (MetallicAlloys 1)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1)	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2))(OUTPUTS (Population 5) (Electronics 2)
Expected Utility: 5.472116134447312		(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1)))	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2))(OUTPUTS (Population 5) (Electronics 2) (ElectonicsWaste 1))) EU: 0.1881136373909225	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicElements 3) (MetallicAlloys 2))(OUTPUTS (Population 5) (Electronics 2)	(INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1)	(OUTPUTS (Population 1) (MetallicAlloys 1)	(Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloys Waste 1)) EU:	(Population 5) (MetallicElements 3) (MetallicAlloys 2)((OUTPUTS (Population	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloys 1)

# Test Case 5a

The motivation for this test case was to study a country rich in natural resources, but with low access to manmade resources. This test case used a depth of 1 and our assumption is that the expected utilities will be extremely low with a depth of 1.

#### Initial State:

Country	R1	R2	R3	R21	R22	R23	R24
self	50	17	50	13	3	3	3
Brobdingnag	40	45	20	15	15	45	20
Carpania	10	20	11	9	7	16	6
Dinotopia	10	15	11	5	9	8	8
Erewhon	8	11	15	7	7	7	7
Foremz	30	10	8	7	7	7	7

## Parameter settings:

Your\_country\_name: 'self'

Resources\_filename: 'data/resource\_data.xslx' Initial\_state\_filename: 'data/test\_case\_5.xslx'

Output\_schedule\_filename: 'data/output\_data5a.xslx'

Num\_output\_schedules: 5

Depth bound: 1

frontier\_max\_size: 10

## Constant settings within a run:

x\_0: k: 5

Gamma: 0.99

Failure cost, C: -0.5

#### Outcomes:

1	Α	В	C	D	E	F	G	Н	- 1	J
1		Expected Utility of Schedule	Depth 1							
2	Schedule 1	Expected Utility: 0.267834462160923	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Populatio	n 1) (Metall	icAlloys 1) (N	∕letallicAlloy	/sWaste 1)))	EU: 0.2678	344621609	2305
3	Schedule 2	Expected Utility: 0.026159580195337	(TRANSFER Brobdingnag self ((Electronics 1)) EU: 0.495							
4	Schedule 3	Expected Utility: 0.000660579980428	(TRANSFER Brobdingnag self ((Housing 1)) EU: 0.029700000000000247							
5	Schedule 4	Expected Utility: -0.005257053372984	(TRANSFER self Foremz ((Timber 1)) EU: 0.0							
6	Schedule 5	Expected Utility: -0.0075	(TRANSFER self Foremz ((MetallicElements 1)) EU: 0.0							
7										

## **Test Case 5b**

Country	R1	R2	R3	R21	R22	R23	R24
self	50	17	50	13	3	3	3
Brobdingnag	40	45	20	15	15	45	20
Carpania	10	20	11	9	7	16	6
Dinotopia	10	15	11	5	9	8	8
Erewhon	8	11	15	7	7	7	7
Foremz	30	10	8	7	7	7	7

The motivation for this test case was to study a country rich in natural resources, but with low access to manmade resources, with a depth of 3. Our expectation is that the expected utilities will be higher than the expected utilities of depth 1.

## Parameter settings:

Your country name: 'self'

Resources\_filename: 'data/resource\_data.xslx' Initial\_state\_filename: 'data/test\_case\_5.xslx'

Output\_schedule\_filename: 'data/output\_data5b.xslx'

Num\_output\_schedules: 5

Depth\_bound: 3

frontier\_max\_size: 10

# Constant settings within a run:

x\_0: 0 k: 5

Gamma: 0.99

Failure cost, C: -0.5

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# Outcomes:

A	В	C	D	E
	Expected Utility of Schedule	Depth 1	Depth 2	Depth 3
Schedule 1	Expected Utility: 0.71627164002	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicA	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1)	(TRANSFORM self (INPUTS (Population 1) (MetallicElement: 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1))) EU: 0.21607841260632032
Schedule 2	Expected Othity. 0.71027104002	(TIXANSFORM Sell (INFO13 (Fopulation 1) (Metallicelenients 2)) (OOTFO13 (Fopulation 1) (Metallice	(Fobulation 1) (WetallicAlloys 1)	(WetalicAlloys Waste 1))) EO. 0.21007841200032032
scriedule 2	Expected Utility: 0.53366444999	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicA	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1)	(TRANSFORM self (INPUTS (Population 5) (MetallicElement: 3) (MetallicAlloys 2))(OUTPUTS (Population 5) (Electronics 2) (Electonics Waste 1))) EU: 0.033471222581490705
Schedule 3			(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys 2))(OUTPUTS (Population 5)	(TRANSFORM self (INPUTS (Population 1) (MetallicElement: 2)) (OUTPUTS (Population 1) (MetallicAlloys 1)
Schedule 4	Expected Utility: 0.53366444999	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicA	(Electronics 2) (ElectonicsWaste 1)))	(MetallicAlloysWaste 1))) EU: 0.29129689606462333
	Expected Utility: 0.43591477544	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicA	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1))) EU: 0.2400895667218065	(TRANSFER self Foremz ((Timber 1)) EU: 0.0
Schedule 5				
	Expected Utility: 0.25761847741	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicA	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1)) EU: 0.240089567218065	(TRANSFORM self (INPUTS (Population 1) (Timber 3) (Housing 1)) (OUTPUTS (Population 1) (Food 2) (Housing 1) (Food Wast 1)) [EU-0.24257475

# **Test Case 5c**

Country	R1	R2	R3	R21	R22	R23	R24
self	50	17	50	13	3	3	3
Brobdingnag	40	45	20	15	15	45	20
Carpania	10	20	11	9	7	16	6
Dinotopia	10	15	11	5	9	8	8
Erewhon	8	11	15	7	7	7	7
Foremz	30	10	8	7	7	7	7

The motivation for this test case was to study a country rich in natural resources, but with low access to manmade resources, with a depth of 5. Our expectation is to see higher expected utilities with a greater depth.

# Parameter settings:

Your\_country\_name: 'self'

Resources\_filename: 'data/resource\_data.xslx' Initial\_state\_filename: 'data/test\_case\_5.xslx'

Output\_schedule\_filename: 'data/output\_data5c.xslx'

Num\_output\_schedules: 5

Depth\_bound: 5 frontier\_max\_size: 10

Constant settings within a run:

x\_0: k: 5

Gamma: 0.99 Failure cost, C: -0.5

Outcomes

	Expected Utility of Schedule	Depth 1	Depth 2	Depth 3	Depth 4	Depth 5	
edule 1		(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)					0.005377569925577382
dule 2			(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1))) EU:		(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2))	[TRANSFER self Foremz ([Timber 1)] EU: - 0.0053775699255773825	
4.4- 2	Expected Utility: 0.6779342938978686	(INVINSPORM Self (INPOTS (Population 1) (Metallicelements 2)) (DOTPOTS (Population	0.2400893067218063	0.0	(OUTPUTS (Population 1	0.0053775099255773825	
edule 3							
ule 4	Expected Utility: 0.6417291398396782		(TRANSFORM self (INPUTS (Population 1) (Metalliclillerments 2)) (OUTPUTS (Population 1) (Metalliclillery) 1 (Metalliclillory) (Metalliclillory) (Metalliclillory) (1) 0.2400895667218065	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1) (MetallicAlloys 1) (MetallicAlloysWaste 1))) EU: 0.21607841260632032		(TRANSFER self Foremz ((MetallicElements 1)) EU: -0.0075	
			(TRANSFORM self (NPUTS Population 1) (Metalliclicements 2) (OUTPUTS Population 1)	[TRANSFER self Forenz ([Timber 1)] EU:	(TRANSFORM self (INPUTS (Population 1) (Metallic Elements) (Metallic Elements) (QUITPUTS (Population 1) (Metallic Elements) (Metallic Elloys) (Metallic Ello	[TRANSFER self Forems	
	Expected Utility: 0.6417291398396782	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)			0.07335541784556646	((MetallicElements 1)) EU: -0.0075	
dule 5	Expected Utility: 0.4842551151315782	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 1) (MetallicElements 2)) (OUTPUTS (Population 1)	(TRANSFORM self (INPUTS (Population 5) (MetallicElements 3) (MetallicAlloys	(TRANSFER self Foremz ((Timber 1)) EU: 0.0	(TRANSFER self Foremz ((Timber 1)) EU: - 0.0053775699255773825	