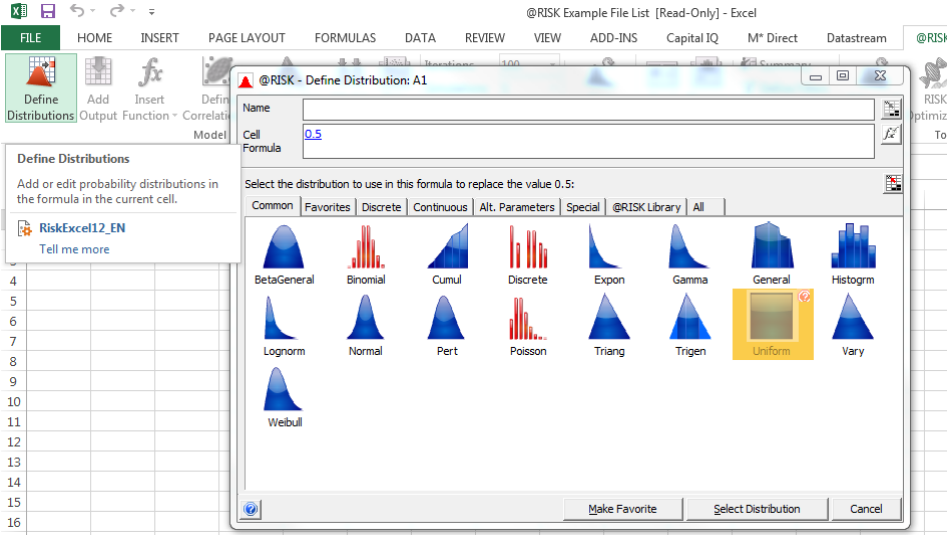


COPULAS

Definind variables for copulas

Select cell, click Define Distribution

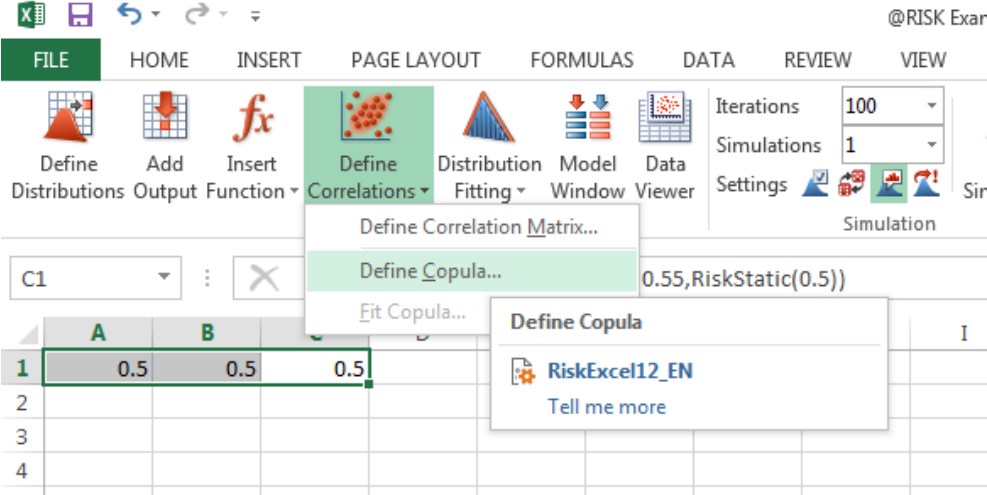


Equivalent of typing this formula in the cell:

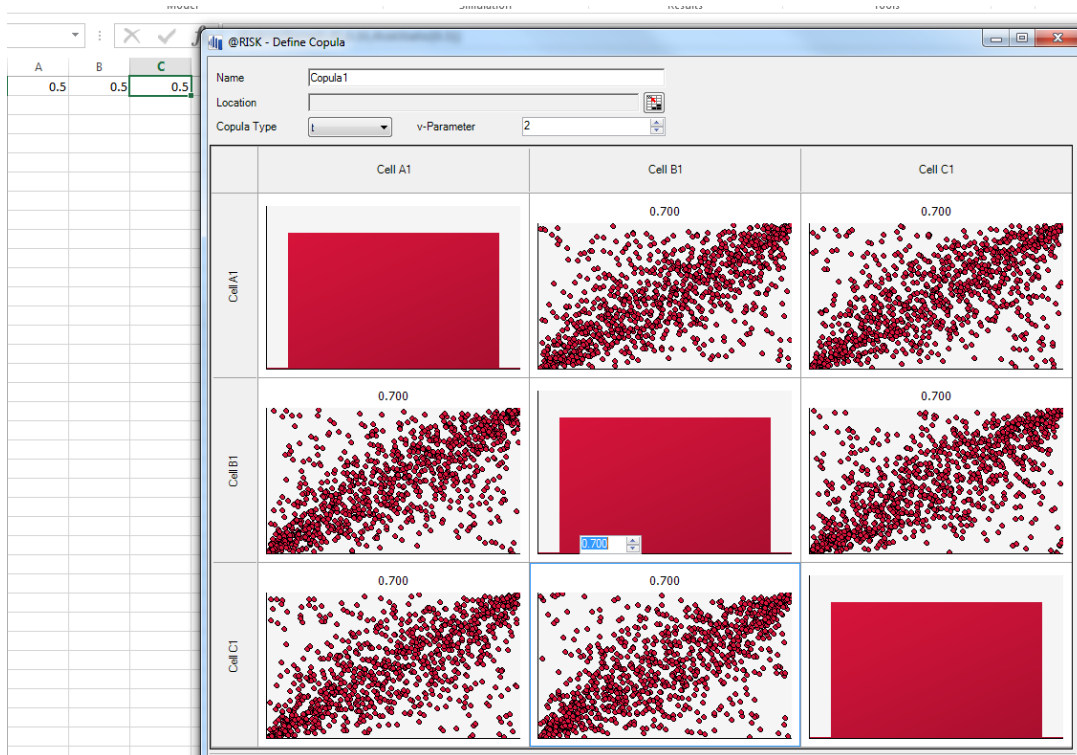
=RiskUniform(0.45,0.55,RiskStatic(0.5))

Drag distribution to other cells

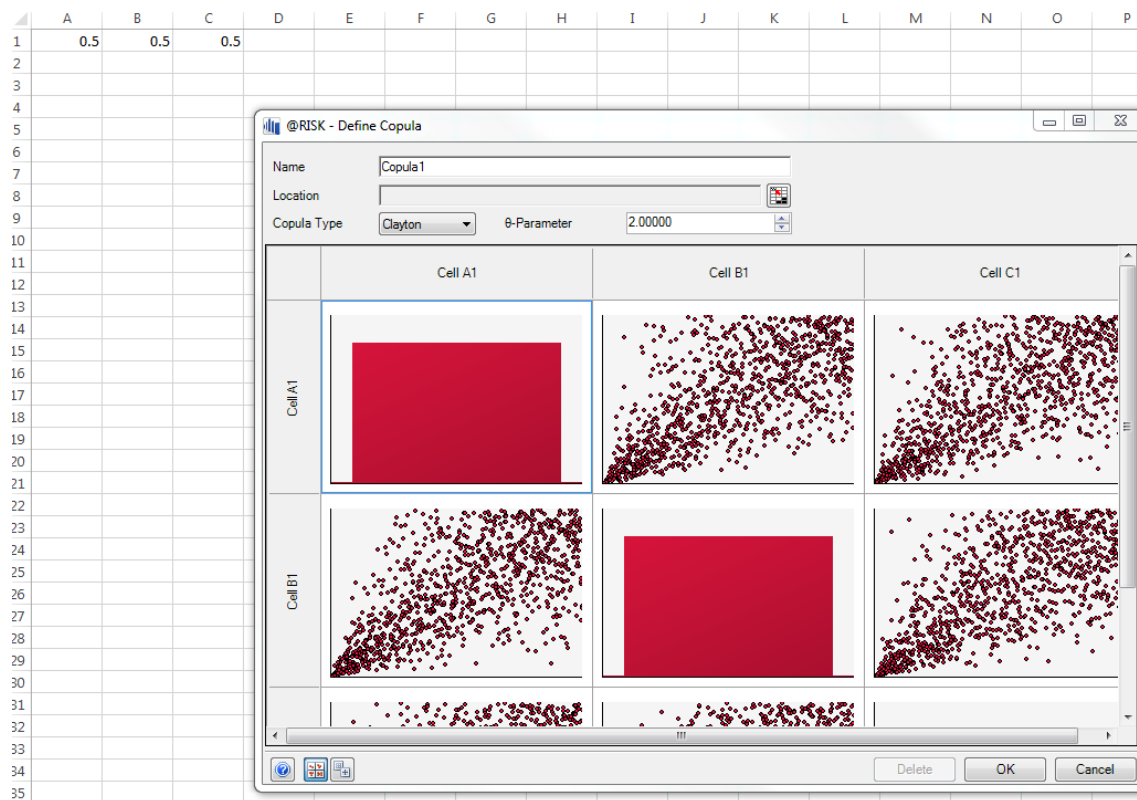
Select the 3 cells containing the variables, then click define copulas



Select t copula and type in 0.7 (correlations)



Alternatively, select Clayton Copula



	A	B	C	D	E	F	G	H	I
1	0.5	0.5	0.5				@RISK Copula: Copula1		
2							Type	GumbelR	
3							Dimension	3	
4							Parameter	2.000	
5									
6									
7									

Then when you click on the cells, they are linked with the copula by their formula

A1: =RiskUniform(0.45,0.55,RiskStatic(0.5),RiskCopula(Copula1,1))

=RiskUniform(0.45,0.55,RiskStatic(0.5),RiskCopula(Copula1,2))

=RiskUniform(0.45,0.55,RiskStatic(0.5),RiskCopula(Copula1,3))

Set # iterations to 5000 then start simulation

Reverse engineer correlations if given results

Click Excel reports / Simulation data inputs: Shows you input data

The screenshot shows the Excel Risk Solver Studio interface. The 'Fit' dialog box is open, showing the 'Fit' button and the 'RiskExcel12_EN' option. Below the dialog, the '@RISK Input Data' report is visible, showing the input data for the simulation.

Name	RiskUniform(0.45,0.55; RiskUniform(0.45,0.55; RiskUniform(0.45,0.55,RiskStatic(0.5),RiskCopula(Copula1,3))		
Description	SAS1	SBS1	SCS1
Iteration / Cell			
1	0.523940688	0.54541077	0.546978829
2	0.538176714	0.546746982	0.532025839
3	0.508073235	0.540775351	0.521681319
4	0.535883581	0.521726422	0.488145771
5	0.528207972	0.514806403	0.481488884
6	0.480172355	0.471915826	0.470473693
7	0.484488909	0.45664034	0.494334564
8	0.484053155	0.47149556	0.458937383
9	0.471922468	0.47754231	0.50638331
10	0.504068215	0.488949021	0.507445888
11	0.46240074	0.466022802	0.468792669
12	0.534967192	0.485014765	0.507062089
13	0.486298885	0.467562227	0.503195779

Tells you best fit is uniform distribution (which is what was originally inputted into the variable) Fit then write to cell

Select second column/Distribution fitting

Could also fit copula:

Define Distributions Output Function

Define Correlations

Distribution Fitting

Model Window Viewer

Iterations: 5000

Simulations: 1

Settings

Simulation

Start Simulation

Excel Reports

Browse Results

Summary

Define Filters

Results

D4977

B	C	E	F	G	H	I	J	K
---	---	---	---	---	---	---	---	---

4955	4948	0.548296691		
4956	4949	0.487139406		
4957	4950	0.516922367		
4958	4951	0.466454397		
4959	4952	0.519251225	0.488754383	0.49614343
4960	4953	0.470274405	0.500927372	0.475564727
4961	4954	0.497083431	0.545184126	0.545320648
4962	4955	0.48538866	0.458484246	0.467370206
4963	4956	0.460340786	0.451500949	0.463724031
4964	4957	0.507820427	0.507772731	0.51068444
4965	4958	0.527405849	0.503531673	0.50378744
4966	4959	0.482426138	0.483091629	0.502655303
4967	4960	0.526493455	0.480531927	0.487077414
4968	4961	0.515281103	0.497300711	0.545285781
4969	4962	0.495022616	0.535167368	0.492342712
4970	4963	0.473981633	0.467016086	0.468965211
4971	4964	0.482465019	0.519930314	0.493948599
4972	4965	0.487341592	0.485901812	0.497963522
4973	4966	0.545776341	0.537932584	0.500142918
4974	4967	0.451492721	0.473375428	0.464178407
4975	4968	0.4852447	0.481779886	0.462941739
4976	4969	0.53342751	0.521517275	0.538808936
4977	4970	0.456276715	0.457332601	0.4554051
4978	4971	0.532764113	0.534840368	0.535174639
4979	4972	0.517616696	0.515357309	0.485059518
4980	4973	0.464968975	0.45675923	0.469128321
4981	4974	0.494881666	0.511556347	0.500646488
4982	4975	0.485815584	0.457765879	0.486539635
4983	4976	0.518064826	0.537631673	0.539673019
4984	4977	0.495240564	0.490069133	0.509412049

Fit Copula

RiskExcel12_EN

Tell me more

0.5
0.499995

	SBS1	SCS1
3	0.54541077	0.54697
4	0.546746982	0.53202
5	0.540775351	0.52168
1	0.521726422	0.48814
2	0.514806403	0.48148
5	0.471915826	0.47047
9	0.45664034	0.49433
5	0.47149556	0.45893
3	0.47754231	0.50634
5	0.488949021	0.50744
	0.466022802	0.46879
2	0.485014765	0.50706
5	0.467562227	0.50319
1	0.472752389	0.45915
3	0.460190674	0.48114
2	0.462230463	0.48630
9	0.471112874	0.47365
9	0.489390308	0.49777
3	0.456940251	0.47699
	0.465084298	0.452831003
3	0.46030950	0.48190644

@RISK - Fit Copulas to Data

Data Set

Range: c8:E5007

Variable Names in First Row

Data Already Demarginalized

Fitting

Method: Maximum Likelihood Estimation (High Accuracy)

- Gaussian Elliptical copula
- t Elliptical copula
- Clayton Archimedean copula
- ClaytonR ClaytonR copula with all variables reversed
- Frank Archimedean copula
- Gumbel Archimedean copula
- GumbelR GumbelR copula with all variables reversed

Buttons: Load Fit From File, OK, Cancel

Tells you Clayton is the best – retrieved all information that was originally inputted.
 Write to spreadsheet – will write copula on excel

@RISK Copula: Copula1	
Type	Clayton
Dimension	3
Parameter	1.442

Application: Stocks, want to know correlation
 Define Distributions:

@RISK - Define Distribution: H17

Name: 10 / Parameter
 Cell Formula: =RiskNormal(10,30)

Function: Normal(10,30)
 Parameters: Standard

μ: 10
 σ: 30

Statistics for Normal(10,30):
 Cell: Input Data/H17
 Minimum: -∞
 Maximum: +∞
 Mean: 10.00
 Mode: 10.00
 Median: 10.00
 Std Dev: 30.00
 Skewness: 0.0000
 Kurtosis: 3.0000
 Left X: -39.3
 Left P: 5.0%
 Right X: 59.3
 Right P: 95.0%
 Dif. X: 98.69
 Dif. P: 90.0%
 1%: -59.79
 5%: -39.35

Parameter: 1.442

Name	Description	RiskUniform(0.45,0.51 RiskU
Iteration / Cell	SAS1	SBS1
1		0.523940688
2		0.538176714
3		0.508073235
4		0.535883581
5		0.528207972
6		0.480172355
7		0.484488909
8		0.484053165
9		0.471922468
10		0.504068215
11		0.46240074
12		0.534967192
13		0.486298885
14		0.466801101

@RISK - Define Distribution: H18

Name:
 Cell Formula:
 Select the distribution to add to this formula:

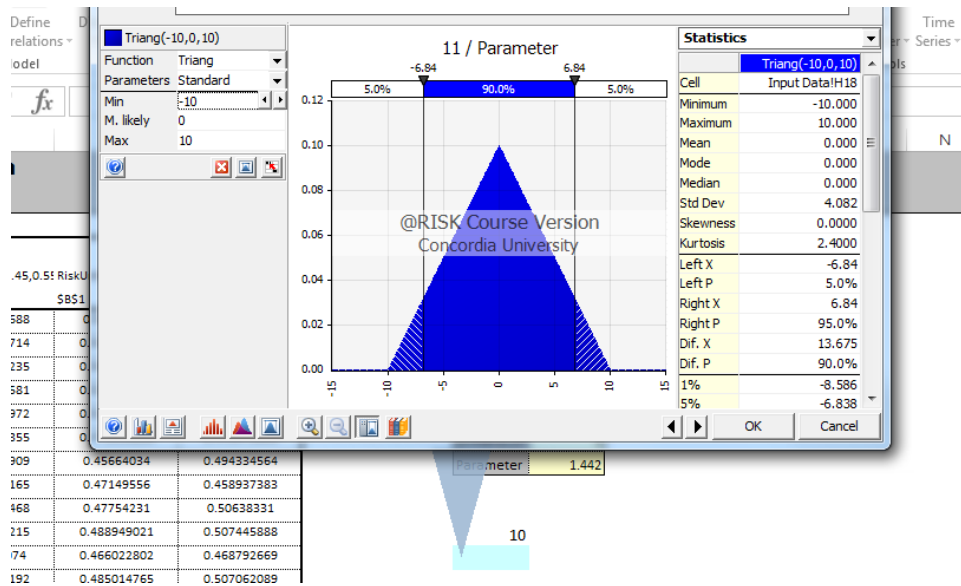
Common | Favorites | Discrete | Continuous | Alt. Parameters | Special | @RISK Library | All

Available Distributions: BetaGeneral, Binomial, Cumul, Discrete, Expon, Gamma, General, Histogram, Lognorm, Normal, Pert, Poisson, Triang, **Triang**, Uniform, Vary, Weibull

Parameter: 1.442

10

Name	Description	RiskUniform(0.45,0.51 RiskU
Iteration / Cell	SAS1	SBS1
1		0.523940688
2		0.538176714
3		0.508073235
4		0.535883581
5		0.528207972
6		0.480172355
7		0.484488909
8		0.484053165
9		0.471922468
10		0.504068215
11		0.46240074
12		0.534967192
13		0.486298885



Then select a uniform distribution

iformed By: Kingf00
 Date: April-05-16 7:40:16 PM [Tell me more](#)

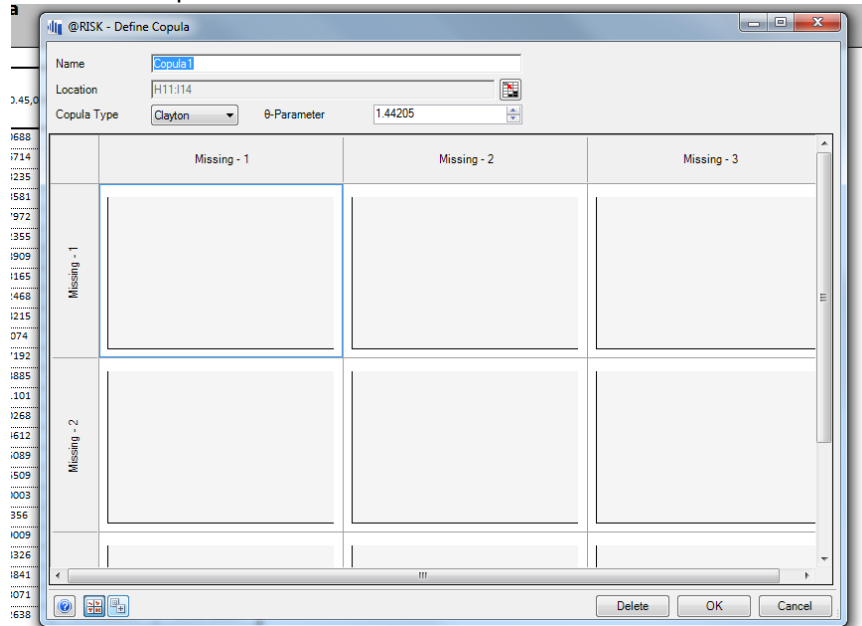
ime	RiskUniform(0.45,0.5) RiskUniform(0.45,0.5) RiskUniform(0.45,0.55,RiskStatic(0.5),RiskCopula(Copula1,3))		
cription	SAS1	SBS1	SCS1
ration / Cell	0.523940688	0.54541077	0.546978829
	0.538176714	0.546746982	0.532025839
	0.508073235	0.540775351	0.521681319
	0.535883581	0.521726422	0.488145771
	0.528207972	0.514806403	0.481488884
	0.480172355	0.471915826	0.470473693
	0.484488909	0.45664034	0.494334564
	0.484053165	0.47149556	0.458937383
	0.471922468	0.47754231	0.50638331
	0.504068215	0.488949021	0.507445888
	0.46240074	0.466022802	0.468792669
	0.534967192	0.485014765	0.507062089
	0.486298885	0.467562227	0.503195779
	0.466801101	0.472752389	0.459155227
	0.505350268	0.460190674	0.481147482
	0.513634612	0.462230463	0.48630067

@RISK Copula: Copula1	
Type	Clayton
Dimension	3
Parameter	1.442

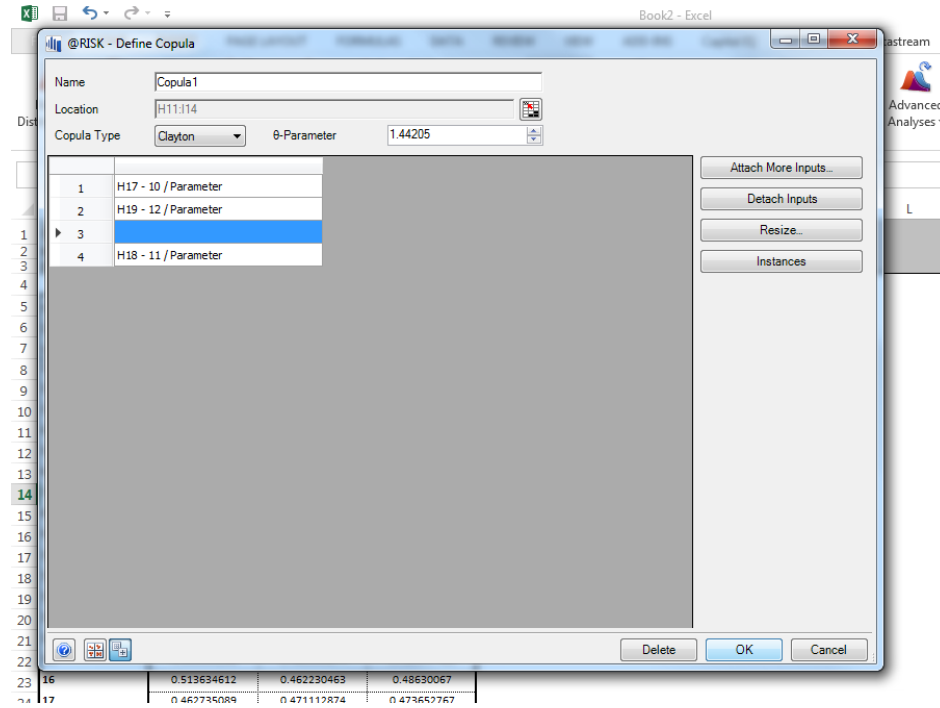
10
 0
 -25

Now link them using the copula we just built.

Click in the copula

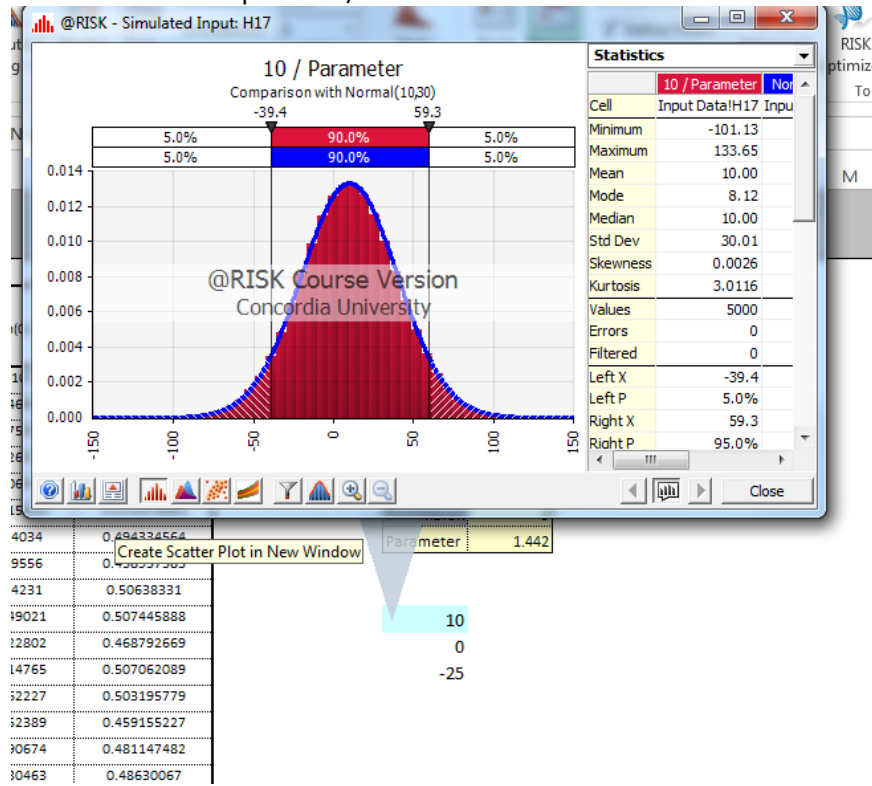


Edit copula, then attachment editor

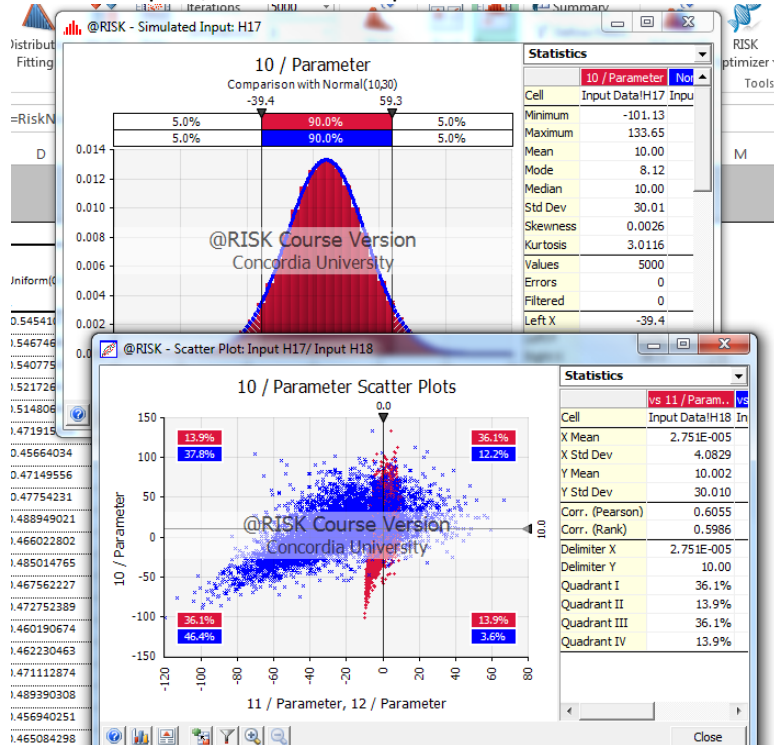


Attach inputs – add cells just created

Select one of the input cells / Start simulation.



lick Scatter plot / Select all 3 input cells:



Have 3 stocks.

	Stock 1	Stock 2	Stock 3
Mean Growth Rate	12%	18%	25%
Volatility	25%	35%	50%
Initial Stock Price	\$ 20	\$ 30	\$ 40
# Shares Bought	1000	750	500
Initial Portfolio Value	\$ 62,500		

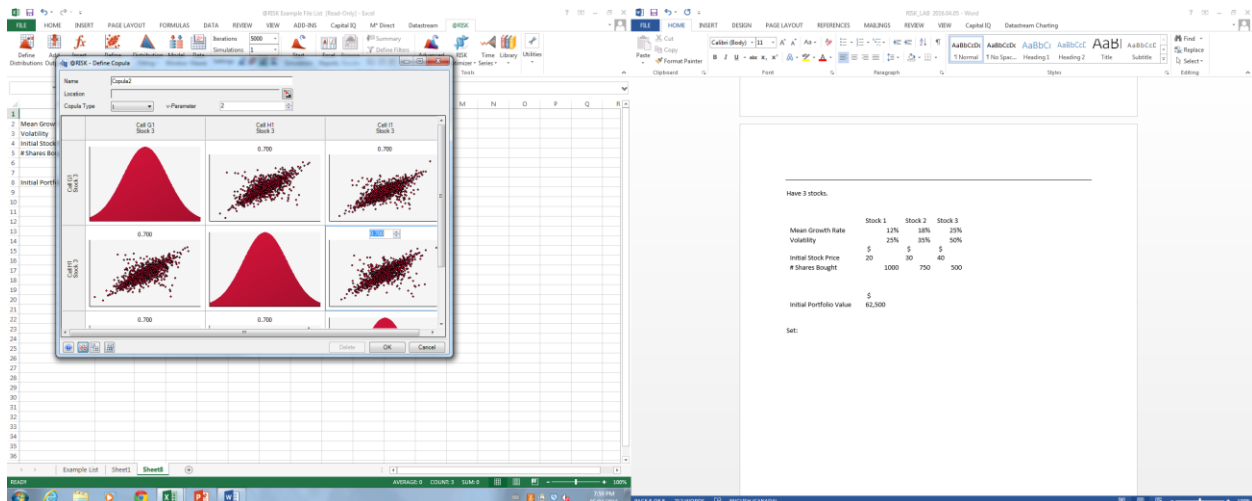
Set:

G1=RiskNormal(0,1)

H1= RiskNormal(0,1)

I1= RiskNormal(0,1)

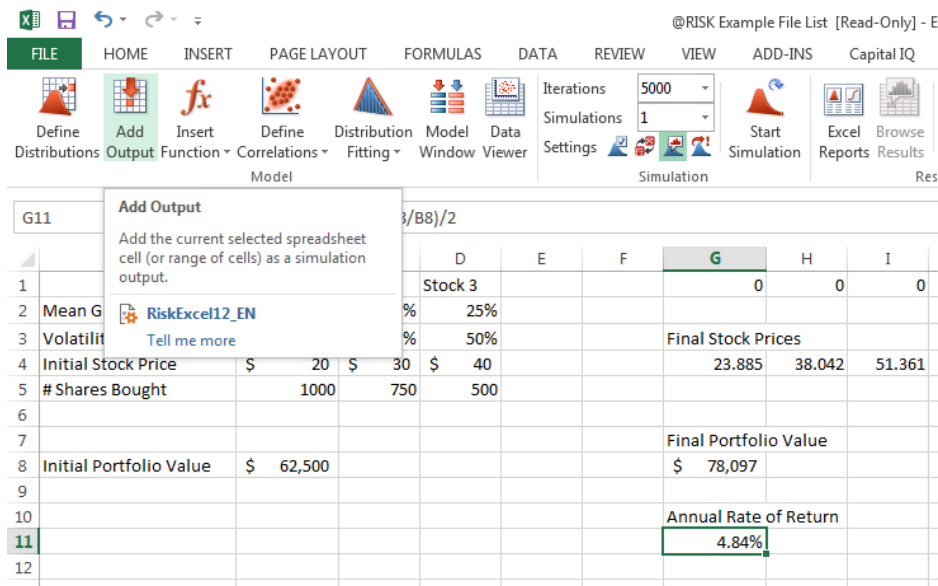
Select cells / define copulas



Set final stock price = $[START_STOCK_PRICE] * \exp((GROWTH - 0.5 * [VOLATILITY]^2) * [TIME] + [VOLATILITY] * \text{sqrt}(TIME) * 0.5 * RISK_NORMAL)$

Calculate ARR

Add output to the cell containing ARR:



Start simulation

What is the probability to make a loss?

Probability of a loss

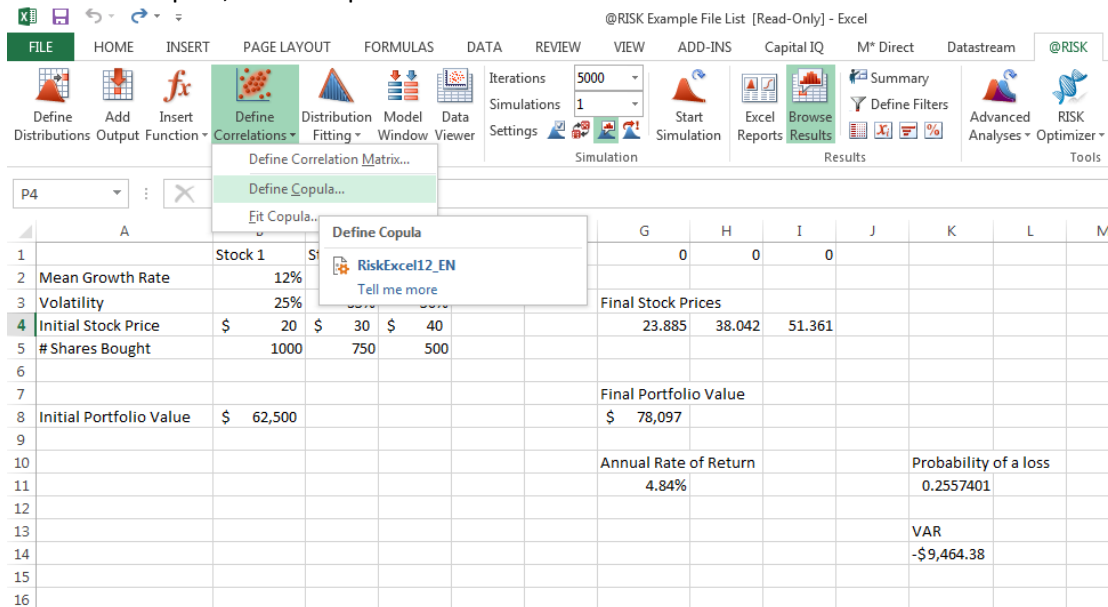
=RiskTarget(G11,0)

Value at Risk for 99%

=RiskPercentile(ARR, 0.01)*INITIAL_PORTFOLIO_VALUE

Change copula to Gaussian Copula. Chances of losing should be lower.

Click in the copula, define copula



Change to Gaussian Copula

T and Gaussian copulas should be fairly similar in terms of probability of default. But looking at the tails (99% VAR), should be more of a difference; Gaussian copula is more conservative (but t copula is a more accurate description of stock market).