

Intra-portfolio correlation (IPC)

FINANCE TOYS

Intra-portfolio correlation allows us to understand how good our portfolio is diversified

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The intra-portfolio correlation coefficient (IPC) can be from -1 to +1. The closer it is to -1 the more diversified your portfolio is. The closer IPC is to +1 the less diversified your portfolio is.

So let's create a portfolio of 5 stocks and find its IPC

STEP 1 CREATING A PORTFOLIO

Traditionally, let's take Apple, Citi, General Electric, Exxon Mobil and Alcoa and upload their weekly market prices for 2010

You should take price intervals (weekly, monthly, quarterly, annually) similar to for what period of time you are planning to create your portfolio

And let's just randomly insert number of shares in our portfolio

Company	Ticker	Last price (end of 2010), \$	Number of shares	Position \$	Share in portfolio
Apple	AAPL	322.56	2	645	21.5%
Citi	C	4.73	150	710	23.6%
General Electric	GE	18.29	20	366	12.2%
Exxon Mobil	XOM	73.12	7	512	17.1%
Alcoa	AA	15.39	50	770	25.6%
Portfolio				3 002	100.0%

STEP 2 CALCULATING IPC

The formula for intra-portfolio correlation coefficient (IPC) is:

$$Q = \sum_i \sum_j X_i X_j P_{ij}$$

where X_i and X_j are the weights of the assets in the portfolio
 p - is the correlation coefficient between the assets in the portfolio

We will draw 4 matrices to calculate IPC of our portfolio

First, we need the correlation matrix

Use CORREL function in excel to calculate correlation between the assets

Correlation matrix

	AAPL	C	GE	XOM	AA
AAPL	1.000	0.477	0.566	0.587	0.631
C	0.477	1.000	0.665	0.566	0.488
GE	0.566	0.665	1.000	0.700	0.697
XOM	0.587	0.566	0.700	1.000	0.741
AA	0.631	0.488	0.697	0.741	1.000

Now we need a simple matrix with the weights of assets in our portfolio

Weights matrix

	AAPL	C	GE	XOM	AA
21.5%	23.6%	12.2%	17.1%	25.6%	
21.5%	23.6%	12.2%	17.1%	25.6%	
21.5%	23.6%	12.2%	17.1%	25.6%	
21.5%	23.6%	12.2%	17.1%	25.6%	
21.5%	23.6%	12.2%	17.1%	25.6%	

After that we need to multiply the weights of all the assets in our portfolio (like in the formula for IPC)

Weights multiplication matrix

	AAPL	C	GE	XOM	AA
AAPL	0.046	0.051	0.026	0.037	0.055
C	0.051	0.056	0.029	0.040	0.061
GE	0.026	0.029	0.015	0.021	0.031
XOM	0.037	0.040	0.021	0.029	0.044
AA	0.055	0.061	0.031	0.044	0.066

And the last matrix we need is the multiplication of the weights multiplication matrix and correlation matrix

Final matrix

	AAPL	C	GE	XOM	AA
AAPL	0.0462	0.0242	0.0148	0.0215	0.0348
C	0.0242	0.0559	0.0192	0.0228	0.0296
GE	0.0148	0.0192	0.0149	0.0145	0.0218
XOM	0.0215	0.0228	0.0145	0.0291	0.0324
AA	0.0348	0.0296	0.0218	0.0324	0.0657

By the way I multiply matrices step by step but if you want you can use MMULT function in excel

Now to find IPC we just need to sum up all the values in the final matrix

IPC = 0.6828

Now we need to know which percentage of diversifiable risk we removed.

It is simple

Risk removed = $-0.5 \times \text{IPC} + 0.5 = 15.9\%$

Using the diversification of our portfolio we removed 15.9% of non-systematic risk

That's it. Change the number of shares in your portfolio to experiment with this coefficient

Remember: the lower the correlation between the assets in your portfolio - the better diversified it is.

		Prices (\$)					Change (%)						
		AAPL	C	GE	XOM	AA	S&P	AAPL	C	GE	XOM	AA	S&P
01.01.2010	210.73	3.31	15.13	68.19	16.12	1122.9							
08.01.2010	211.98	3.59	16.6	69.52	17.02	1148	0.6%	8.5%	9.7%	2.0%	5.6%	2.2%	
15.01.2010	205.93	3.42	16.44	69.11	15.63	1137.6	-2.9%	-4.7%	-1.0%	-0.6%	-8.2%	-0.9%	
22.01.2010	197.75	3.25	16.11	66.1	13.4	1098.7	-4.0%	-5.0%	-2.0%	-4.4%	-14.3%	-3.4%	
29.01.2010	192.06	3.32	16.08	64.43	12.73	1080.2	-2.9%	2.2%	-0.2%	-2.5%	-5.0%	-1.7%	
05.02.2010	195.46	3.22	15.79	64.8	13.18	1064.5	1.8%	-3.0%	-1.8%	0.6%	3.5%	-1.5%	
12.02.2010	200.38	3.18	15.55	64.8	13.28	1081.2	2.5%	-1.2%	-1.5%	0.0%	0.8%	1.6%	
19.02.2010	201.67	3.42	16.17	65.87	13.53	1112.3	0.6%	7.5%	4.0%	1.7%	1.9%	2.9%	
26.02.2010	204.62	3.4	16.06	65	13.3	1109.6	1.5%	-0.6%	-0.7%	-1.3%	-1.7%	-0.2%	
05.03.2010	218.95	3.5	16.35	66.47	13.84	1139.2	7.0%	2.9%	1.8%	2.3%	4.1%	2.7%	
12.03.2010	226.6	3.97	17.04	66.8	13.6	1147.3	3.5%	13.4%	4.2%	0.5%	-1.7%	0.7%	
19.03.2010	222.25	3.9	18.07	67.04	14.26	1153.9	-1.9%	-1.8%	6.0%	0.4%	4.9%	0.6%	
26.03.2010	230.9	4.31	18.34	66.54	14.27	1170.4	3.9%	10.5%	1.5%	-0.7%	0.1%	1.4%	
02.04.2010	235.97	4.18	18.33	67.61	14.7	1179.9	2.2%	-3.0%	-1.0%	1.6%	3.0%	0.8%	
09.04.2010	241.79	4.55	18.52	68.76	14.39	1195.7	2.5%	8.9%	1.0%	1.7%	-2.1%	1.3%	
16.04.2010	247.4	4.56	18.97	67.93	13.91	1189.3	2.3%	0.2%	2.4%	-1.2%	-3.3%	-0.5%	
23.04.2010	270.83	4.86	19.07	69.24	14.11	1216.8	9.5%	6.6%	0.5%	1.9%	1.4%	2.3%	
30.04.2010	261.09	4.37	18.86	67.77	13.43	1191.9	-3.6%	-10.1%	-1.1%	-2.1%	-4.8%	-2.0%	
07.05.2010	235.86	4	16.88	63.7	12	1142.4	-9.7%	-8.5%	-10.5%	-6.0%	-10.6%	-4.2%	
14.05.2010	253.82	3.98	17.64	63.6	12.36	1136.5	7.6%	-0.5%	4.5%	-0.2%	3.0%	-0.5%	
21.05.2010	242.32	3.75	16.42	60.88	11.35	1085	-4.5%	-5.8%	-6.9%	-4.3%	-8.2%	-4.5%	
28.05.2010	256.88	3.96	16.35	60.46	11.64	1085.7	6.0%	5.6%	-0.4%	-0.7%	2.6%	0.1%	
04.06.2010	255.97	3.79	15.71	59.25	10.84	1066.7	-0.4%	-4.3%	-3.9%	-1.5%	-6.9%	-1.8%	
11.06.2010	253.51	3.88	15.56	61.86	11.36	1096	1.0%	2.4%	-1.0%	3.9%	4.8%	2.7%	
18.06.2010	274.07	4.01	15.95	63.1	11.11	1124.5	8.1%	3.4%	2.5%	2.0%	-2.2%	2.6%	
25.06.2010	266.7	3.94	14.91	59.1	11.23	1078.2	-2.7%	-1.7%	-6.5%	-6.3%	1.1%	-4.1%	
02.07.2010	246.94	3.79	13.88	56.57	10	1030.2	-7.4%	-3.8%	-6.9%	-4.3%	-11.0%	-4.5%	
09.07.2010	259.62	4.04	14.95	58.78	10.94	1076.7	5.1%	6.6%	7.7%	3.9%	9.4%	4.5%	
16.07.2010	249.9	3.9	14.55	57.96	10.41	1067.5	-3.7%	-3.5%	-2.7%	-1.4%	-4.8%	-0.9%	
23.07.2010	259.94	4.02	15.71	59.72	11.05	1103.6	4.0%	3.1%	8.0%	3.0%	6.1%	3.4%	
30.07.2010	257.25	4.1	16.12	59.68	11.17	1108.7	-1.0%	2.0%	2.6%	-0.1%	1.1%	0.5%	
06.08.2010	260.09	4.06	16.45	61.97	11.59	1123.6	1.1%	-1.0%	2.0%	3.8%	3.8%	1.3%	
13.08.2010	249.1	3.88	15.38	59.91	10.64	1077.5	-4.2%	-4.4%	-6.5%	-3.3%	-8.2%	-4.1%	
20.08.2010	249.64	3.75	15.03	58.89	10.57	1074.2	0.2%	-3.4%	-2.3%	-1.7%	-0.7%	-0.3%	
27.08.2010	241.62	3.76	14.71	59.8	10.32	1061.3	-3.2%	0.3%	-2.1%	1.5%	-2.4%	-1.2%	
03.09.2010	258.77	3.91	15.393	61.32	10.88	1101.7	7.1%	4.0%	4.6%	2.5%	5.4%	3.8%	
10.09.2010	263.41	3.91	15.98	61.2	11.17	1113.4	1.8%	0.0%	3.8%	-0.2%	2.7%	1.1%	
17.09.2010	275.37	3.95	16.29	60.78	11.172	1127	4.5%	1.0%	1.9%	-0.7%	0.0%	1.2%	
24.09.2010	292.32	3.904	16.66	61.75	12.2	1148.6	6.2%	-1.2%	2.3%	1.6%	9.2%	1.9%	
01.10.2010	282.52	4.09	16.36	62.54	12.23	1144.6	-3.4%	4.8%	-1.8%	1.3%	0.2%	-0.4%	
08.10.2010	294.07	4.19	17.12	64.38	12.89	1165.9	4.1%	2.4%	4.6%	2.9%	5.4%	1.9%	
15.10.2010	314.74	3.95	16.3	65.19	13.13	1176.8	7.0%	-5.7%	-4.8%	1.3%	1.9%	0.9%	
22.10.2010	307.47	4.11	16.055	66.34	12.72	1186.6	-2.3%	4.1%	-1.5%	1.8%	-3.1%	0.8%	
29.10.2010	300.98	4.17	16.02	66.49	13.14	1187	-2.1%	1.5%	-0.2%	0.2%	3.3%	0.0%	
05.11.2010	317.13	4.49	16.73	70	14	1222.6	5.4%	7.7%	4.4%	5.3%	6.5%	3.0%	
12.11.2010	308.03	4.29	16.25	70.99	13.49	1202.4	-2.9%	-4.5%	-2.9%	1.4%	-3.6%	-1.7%	
19.11.2010	306.73	4.268	16.22	70.54	13.38	1195.3	-0.4%	-0.5%	-0.2%	-0.6%	-0.8%	-0.6%	
26.11.2010	315.76	4.11	15.8	69.23	13.17	1183.8	2.9%	-3.7%	-2.6%	-1.9%	-1.6%	-1.0%	
03.12.2010	317.44	4.45	16.78	71.19	14.23	1223.5	0.5%	8.3%	6.2%	2.8%	8.0%	3.4%	
10.12.2010	320.56	4.77	17.72	72.18	14.25	1243.4	1.0%	7.2%	5.6%	1.4%	0.1%	1.6%	
17.12.2010	320.61	4.7	17.7	72.17	14.56	1246.5	0.0%	-1.5%	-0.1%	0.0%	2.2%	0.2%	
24.12.2010	323.6	4.68	18.04	73.2	15.34	1253.6	0.9%	-0.4%	1.9%	1.4%	5.4%	0.6%	
31.12.2010	322.56	4.73	18.29	73.12	15.39	1262.9	-0.3%	1.1%	1.4%	-0.1%	0.3%	0.7%	