Key risk factors for equities

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1.Introduction

For investors, finding the key risk factors of the equities is critical for their investment choices. One of the important parts of the analysis is studying the macro economic environment and its impact on the key risk factors driving most asset returns. Then the optimal portfolio can be determined by these factors. Besides the influence of world market, sector effect and regional effect are often taken into account while determining the key factors. This project mainly focuses on this top-bottom process of equity market analysis.

Research question

What is the role of sectors, and what is the role of regions, in this risk decomposition? Which matters more in the return of the equity market?

It is acknowledged that the equity markets are highly related to their countries or regions because they are affected by the common currency and fiscal policies of those countries or regions. However, companies in certain industries can also be affected by global trends of their industries, no matter where they are registered. For instance, industries such as technology, energy, and commodities are far more globalized than banks, utilities, and retail. Therefore, some discussions are required to figure out whether the regional effect or the sector effect dominates as the componient of equities' risk factor. This is the problem I want to solve in this project.

Data and method

The project will use three linear regression models to determine the extent to which regional markets and industry markets affect the excess returns of securities. Model 1 only analyze the relationship between the excess return of the world market as a whole and of a certain industry in a certain region. Model 2 is divided into two parts in order to discuss

the effect of sector market and region market seperately. In Model 2a, the excess return of a certain sector market is added to Model 1 as one of the independent variables. In Model 2b, the excess return of the regional market is added to Model 1 as one of the independent variables. Both sector factor and regional factor are added to Model 1 in Model 3. Each model runs 66 times (see the data collection part below) because there are 66 pairs of data for each sector in each region.

The project checks the average of r-squared of the regression results in each regression models group by different sectors and regions to figure out which model fits better and then the effect of two factors.

2.Dataset and variables

Data collection

The regressions use the excess returns on the MSCI family of indices.

The world equity index is represented by the MSCI ACWI Index. The 10 sectors we consider are the following GICS Level 1 sectors: consumer durables, consumer staples, energy, finance, health care, industrials, information technology (IT), materials, telecom services, utilities. The seven regions we consider are North America, Europe (except United Kingdom), United Kingdom (UK), Japan as developed market and Emerging Markets (EM) Asia, Emerging Markets (EM) Latin America, and Emerging Markets (EM) Europe as emerging market. Thus, there are 70 region-sector pairs in all. However, 4 pairs are excluded from them because of irregular data availability, so the regressions include 66 region-sector pairs in total. The excluded pairs are EM Latin America Information Technology, EM Latin America Health Care, EM Europe Information Technology, and

EM Europe Health Care. All excess returns are measured monthly and in US dollars. The US dollar short-term riskless rate represents for the short-term riskless rate. The sample period is Feb.1999–Oct.2018. All the data are collected from bloomberg terminal.

Variables

Dependent variables:

The excess returns of MSCI indexes of a certain sector in a certain region in the 66 pairs. The returns of the MSCI indexes are calculated by the natural logarithm and the excess returns can be got by the difference between the return of index and the last period of non-risk return. The price of the index - P; the excess return of the index - R; the non-risk return - r.

$$R_t = ln(\frac{P_t}{P_{t-1}}) * 100 - r_{t-1}$$

excess_return represents for R_t in the R chunk.

Independent variables:

Model 1: the excess return of MSCI ACWI Index. World equity market factor - *WD_market*

Model 2a: the excess return of MSCI ACWI Index and of the MSCI index of a certain sector. *WD_market* and broad sector factor - *sector_market*

Model 2b: the excess return of MSCI ACWI Index and of the MSCI index of a certain region. *WD_market* and regional factor - *region_market*

Model 3: the excess return of MSCI ACWI Index, of the MSCI index of a certain sector and of the MSCI index of a certain region. *WD_market*, *region_market* and *sector_market*.

The calculation methods of each excess return are as below:

$$R_{wd(t)} = ln(\frac{P_{wd(t)}}{P_{wd(t-1)}}) * 100 - r_{t-1}$$

$$R_{sector(t)} = ln(\frac{P_{sector(t)}}{P_{sector(t-1)}}) * 100 - R_{wd(t)}$$

$$R_{region(t)} = ln(\frac{P_{region(t)}}{P_{region(t-1)}}) * 100 - R_{wd(t)}$$

The price of the index - P; the excess return of the index - R; the non-risk return - r.

3.Descriptive statistics

Table 1 provides the mean of excess return of global market and the non-risk return through the time. The non-risk return is about 1.94% and the mean of excess return of global market is about -1.72%. The results indicate that though the return of global MSCI index can be positive through 20 years, the average excess return of the equity market compared to non-risk return from 1999 to 2018 is negative.

Table 1

mean(WD_market)	mean(non_risk)
-1.718161	1.940225

Table 2 provides the mean of excess return of each region. The average excess return of equity market in emerging regions is higher than developed market. Europe, Japan and UK even have the negative excess return on average, while all the emerging market listed in the table are with a positive excess returns. Emerging Latin America is the region with

the highest excess return of MSCI index from 1999 to 2018, which is a high 0.37%. This statistic is reasonable because the economy of emerging regions has been developing rapidly in the recent 20 years, showing a high excess return on equity market as a whole.

Table 2

area	mean(region_market)
EM.Asia	0.2486148
EM.Europe	0.0643466
EM.Latin	0.3715150
Europe	-0.1116934
Japan	-0.0919008
North.America	0.0738356
UK	-0.2697497

Table 3 provides the mean of excess return of each sector. For most of the sectors, there is not much difference between the excess return, ranging from 0.1-0.2%, positive. It indicates that the development of most sectors market did not vary too much. However, in the industry of finance, telecommunication and utility, the excess returns are negative. Telecommunication industry even gets a -0.46% which is the lowest excess return among all the sectors.

Table 3

sector	mean(sector_market)
Consumer durable	0.1574065
Consumer staple	0.1183257
Energy	0.1613900
Finance	-0.1555241
Health care	0.1640017
Industrial	0.1708838
IT	0.1115833
Material	0.1913954
Telecom	-0.4608515

Utility	-0.1227039

4.Models

Model 1

The model with the world equity market factor alone is the following:

$$R(i,j)_t = \alpha(i,j) + \beta_1(i,j)R_{wd(t)} + \epsilon(i,j)$$

$$1 \le i \le N_s(j), 1 \le i \le N_r, t = 1,2,\dots,T-1$$

where $R(i,j)_t$ denotes the total excess return at the end of month t on the index of firms in sector i and region j, $N_S(j)$ denotes the number of sectors in the sample for region j, and N_r denotes the number of regions in the sample. Moreover, $\alpha(i,j)$ is the intercept of the regression; $\beta_1(i,j)$ is the world equity market beta; and $\epsilon(i,j)$ is the error term that is assumed to satisfy the usual conditions.

Take the North.America_industrial as an example, the regression results are as Table 4:

Table 4

	Estimate	**Std. Error**	**t value**	**Pr(>|t|)**
(Intercept)	-3.1592939	0.2223771	-14.20692	0
WD_market	0.8088887	0.0419701	19.27297	0

The result indicates that with one percent increase of world market's excess return, the excess return of North.America_industrial increases about 0.81% on average and the result is statistically significant. The adjusted R-squared is 61.25%, suggesting that we can explain 61.25 percent of the variation in excess return of North.America_industrial with excess return of world market. The regression model run 66 times as there are 66 pairs of regions and sectors. The r-squared and β_1 are extracted from the results, counted the average by sectors and regions seperately. The results of r-squared are as below (Table5

and Table6). All the average will be put into a single table after getting the results from all the models.

Table 5

The average of r-squared in Model 1 by regions

region	r_sq
world market	0.48
emerging market	0.49
developed market	0.47
EM.Asia	0.51
EM.Europe	0.45
EM.Latin	0.50
Europe	0.64
Japan	0.34
North.America	0.41
UK	0.51

Table 6

The average of r-squared in Model 1 by sectors

sector	r_sq_1
consumer.durable	0.61
consumer.staple	0.42
energy	0.42
finance	0.55
health.care	0.33
industrial	0.61
IT	0.55
material	0.54
telecom	0.42
utility	0.32

In Model 1, the full sample average r-squared is 48%, the average r-squared for all developed markets regressions is 47%, and the average r-squared for all of the emerging market indices is 49%. Thus, world equity market beta explains less than half of the

changes in the returns of region-sector portfolios. In developed region, Europe has the highest proportion explained by the world market factor, followed by UK. The average r-squared in Japan is only 34%, which means other effects may take a stronger explanation to the excess return of equity market in Japan. Among sectors, health care and utilities exhibit a poorer fit than others, suggesting that other effects may play a prominent role in explaining variations in their returns.

Model 2a

The model with a world market factor and broad sector factors is as follows:

$$R(i,j)_t = \alpha(i,j) + \beta_1(i,j)R_{wd(t)} + \beta_{2a}(i,j)R(i)_{sector(t)} + \epsilon(i,j)$$

$\beta_{2a}(i,j)$ is the sector coefficient of the portfolio of equities in the equity index for sector i and region j; and $R(i)_{sector(t)}$ is excess return on the index of the ith global sector. All other variables are as defined for Model 1.

Also, take North.America_industrial as an example for Model 2a. The redults are as Table 7:

Table 7

	Estimate	**Std. Error**	**t value**	**Pr(>|t|)**
(Intercept)	-3.2874858	0.1969505	-16.691937	0
WD_market	0.8068845	0.0370552	21.775199	0
sector_market	0.7300188	0.0888636	8.215046	0

The result indicates that net of sector factor, with one percent increase of world market's excess return, the excess return of North.America_industrial increases about 0.81% on average and the result is statistically significant, which is not too much different from Model 1. As for the sector factor, net of the world market factor, one percent of increase of

the excess return of sector factor make the excess return of North.America_industrial increase by 0.73% on average and the result is also statistically significant. The adjusted R-squared is 69.92%,suggesting that we can explain 69.92 percent of the variation in excess return of North.America_industrial with both the excess return of world market and sector market. It shows that Model 2a increase the fitness of the model slightly.

Model 2b

The model with a world market factor and region factors is as follows:

$$R(i,j)_t = \alpha(i,j) + \beta_1(i,j)R_{wd(t)} + \beta_{2b}(i,j)R(j)_{region(t)} + \epsilon(i,j)$$

$\beta_{2b}(i,j)$ is the region coefficient of the portfolio of equities in the equity index for sector i and region j; and $R(j)_{region(t)}$ is excess return on the index of the jth region. All other variables are as defined for Model 1.

The example of North.America_industrial as Table 8:

Table 8

	Estimate	**Std. Error**	**t value**	**Pr(>|t|)**
(Intercept)	-3.1483124	0.2162676	-14.557488	0.0000000
WD_market	0.8444938	0.0418701	20.169355	0.0000000
region_market	0.6798044	0.1784690	3.809089	0.0001783

The result indicates that net of region factor, with one percent increase of world market's excess return, the excess return of North.America_industrial increases about 0.84% on average and the result is statistically significant, which enhances compared to Model 1. As for the region factor, net of the world market factor, one percent of increase of the excess return of sector factor make the excess return of North.America_industrial increase by 0.68% on average and the result is also statistically significant. This coefficient β_{2b} is less than

β_{2a} in Model 2a. The adjusted R-squared is 63.51%, showing that though it increases compared to Model 1, Model 2b does not increase the fitness of the model as much as Model 2a.

Model 3

The model with a world market factor and region factors is as follows:

$$R(i,j)_t = \alpha(i,j) + \beta_1(i,j)R_{wd(t)} + \beta_2(i,j)R(i)_{region(t)} + \beta_3(i,j)R(j)_{region(t)} + \epsilon(i,j)$$

$\beta_2(i,j)$ is the sector coefficient of the portfolio of equities in the equity index for sector i and region j; $\beta_3(i,j)$ is the region coefficient of the portfolio of equities in the equity index for sector i and region j.

The example of North.America_industrial as Table 9:

Table 9

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-3.2754910	0.1905479	-17.189860	0.00e+00
WD_market	0.8408156	0.0367764	22.862939	0.00e+00
sector_market	0.7212662	0.0859909	8.387703	0.00e+00
region_market	0.6473835	0.1567936	4.128891	5.08e-05

Net of region factor and sector factor, with one percent increase of world market's excess return, the excess return of North.America_industrial increases about 0.84% on average and the result is statistically significant. As for the region factor, net of other factors, one percent of increase of the excess return of sector factor make the excess return of North.America_industrial increase by 0.72% on average and the result is also statistically significant, while 0.65% for the region factor. The adjusted R-squared is about 72%, showing a obvious improvement of fitness of the model.

The average r-squared of world market is listed in Table 10. And the average r-squared by region and sector of all four models are listed in Table 11 and Table 12.

Table 10
Average r-squared of world market.

Model 1	Model 2a	Model 2b	Model 3
0.48	0.6	0.65	0.76

The results show that including sector effects increases the average R2 from 48% to 60% while including regional effects increases the average R2 to 65%. Therefore, in the aspect of global equity market, regional effects take a more important role than sector effects.

Table 11

area	Model 1	Model 2a	Model 2b	Model 3
EM.Asia	0.51	0.54	0.72	0.75
EM.Europe	0.45	0.47	0.67	0.69
EM.Latin	0.50	0.53	0.79	0.81
Europe	0.64	0.78	0.73	0.86
Japan	0.34	0.42	0.60	0.69
North.America	0.41	0.72	0.44	0.74
UK	0.51	0.70	0.60	0.76

Emerging market and Japan market show the same pattern as the global market. However, in some developed region, North.America, UK and Europe ex UK, Model 2a shows a higher average r-squared than Model 2b, which means sector effects are more important than region effects in these areas. Note that developed regions are usually more globalized than emerging region, it may explain the results that regional effects effect the market not as much as sector effects in developed market.

Table 12

sector	Model 1	Model 2a	Model 2b	Model 3
Consumer durable	0.61	0.63	0.76	0.79

Consumer staple	0.42	0.59	0.58	0.73
Energy	0.42	0.61	0.61	0.76
Finance	0.55	0.63	0.80	0.88
Health care	0.33	0.52	0.43	0.62
Industrial	0.61	0.62	0.77	0.78
IT	0.55	0.68	0.66	0.79
Material	0.54	0.68	0.72	0.83
Telecom	0.42	0.56	0.56	0.71
Utility	0.32	0.47	0.51	0.64

The sectors where regional effects are much less important are IT and health care. This result is intuitive as these sectors tend to be dominated by highly global companies. Regional and sector factors have little difference in impact for some industries. The finance, consumer durable, material, utility and industrial sectors turn out to be sectors which region factor makes an obvious greater contribution to. These sectors are highly influenced by the common currency and fiscal policies regionally.

Coefficient

According to the regression results, all of the coefficients of world_market factors and most of the coefficients of other factors in Model 3 are statistically significant. However, here are some exclusion.

In north America with the sectors of health care, IT, energy and consumer staple, sector factors are not statistically significant, which indicates that developed region as North American are not strongly affected by region factor. As what have been mentioned above, industries such as energy and consumer staple are usually with a higher level of globalization (usually happens in more developed regions). Thus, it makes sense that some of the industries in developed region do not have a statistically significant relationship with region market factor. On the contrary to developed country, some sectors in emerging

region do not show a statistically significant relationship with the sectorfactor because region markets matter more in these less globalized region. Also, sectors such as utility and industrial are more likely to be influenced by the common currency and fiscal policies or some other change of economy of the region they belong to. In this project, they are utility and industrial sector in emerging europe market and health care sector in emerging Asia market.

Regardless of the statistical significance, Table 13 shows the all the coefficients of three factors in Model 3 and the average of coefficients above it.

Table 13

World average:

b1	b2	b3
0.9846388	0.5841283	0.8255908

By area

area	b1	b2	b3
EM.Asia	0.9467853	0.4047417	0.8867917
EM.Europe	1.0344707	0.3243918	0.8818609
EM.Latin	1.0251928	0.3473672	0.9416764
Europe	1.0508667	0.7066388	0.9046811
Japan	0.9835966	0.5870824	0.9607170
North.America	0.7828575	0.9002710	0.4388094
UK	1.0687018	0.8184052	0.7645989

The results of coefficients show that average world market β_1 is 0.98. Theoretically, the average β_1 is expected to be 1, but it does not have to be an exact 1.0 because the 66 market betas are equal-weighted but not market-weighted due to the size of the market. In the whole world perspective, region market takes a larger explanation of the excess return of the equities compared with the sector market. Basically, the results of the coefficient

and r-squared draw a similar conclusion that region effect is more significant than sector effect in equity market

Sector betas β_2 are smaller in Japan, Europe ex UK and emerging regions because their regional effects particularly matter more. On the contrary, North American and UK are regions that are more influenced by global sector market because they have higher sector betas β_2 than region betas β_3.

5.final models

No matter according to which sectors, regions or the whole world market, Model 3 stand outs with a higher r-squared among all the models in the discussion.

$$R(i,j)_t = \alpha(i,j) + \beta_1(i,j)R_{wd(t)} + \beta_2(i,j)R(i)_{region(t)} + \beta_3(i,j)R(j)_{region(t)} + \epsilon(i,j)$$

6.conclusion

The above results indicate that the representative of the influencing factors of the stock market can start with the world stock index and then include a small number of regional and global sector factors. This approach is able to account for about 76% of the return on equity of the regional sector portfolio (the average r-squared of Model 3). It should be noted, however, that we cannot ignore the factors other than world market portfolios, global sectors effects and regional effects in analyzing stock returns. Additionally, the r-squared results are probably overestimated because the excess returns calculated in the model already derive from portfolio index as our dependent variables instead of excess returns on individual stocks. Recall also that region effect tends to be overestimated because all

returns are measured in US dollars, so the currency factor in equity market is somehow included.

While discussing the global equity market, region effects explain the return of equity better no matter compare the r-squared of different model or the betas in Model 3. However, an overall conclusion is vital, but not that practical when analyzing. The differences between region and sector need to be taken into account. It is evident that regional factors are more influential for emerging markets since those markets are not that globalized to be affected by the variation of sector market, while sector factors affect developed market more. The categorized discussion also works for sector dimension. Some industries, such as energy and consumer staple, are more likely to fluctuate with changes in international markets, so sector factors are more explainable in their return.