Advanced Algorithmic Trading And Portfolio Management

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Lecture- 16

In this video, we will learn how to initiate a simple portfolio object. So we will initiate and interpret a simple portfolio object. For example, I can simply create a simple portfolio object with default specifications, let us call it default spec by just writing this portfolio spec function. I can nicely print the contents of this default spec object by just typing default spec and printed it in the console, I can print the output. The function portfolio spec here allows us to define the specification settings from scratch. The default setting as we can see here MB mean variance, the default settings are for a mean variance portfolio.

We can easily see the arguments for this function by printing the summary as we can, as we have already done here. It's a very easy to read summary with all the formal. First and foremost, we have the model slot that covers all the settings to specify a model portfolio. This includes the type of portfolio that is mean variance portfolio, the objective function to be optimized, which is risk minimization, min risk.

The estimators for mean and covariance here we are by default using covariance co estimator and then some other optional parameters are there. One can easily modify the type of model portfolio that is to be constructed. For example, you can use this get type function, you can use this get type function and apply it to your default portfolio, default spec and you can extract mean variance portfolio spec MB. You can change it for example, let's say you want to change it to C bar type. So you can use this set type argument, put your default spec and assign it a specification of C bar and now your specification are changed.

Notice along with that your solver is also changed, we will discuss more about the solver, but the idea here is that solver is changed to the relevant optimization portfolio. Now if you want to print this default spec, you can simply print it, you can print it and you can notice that now your type is C bar. So we just change the specification from a mean variance portfolio to a mean C bar or conditional value at risk portfolio. For more discussion at C bar, refer to the video topic on C bar. Also notice that this model list entry provides the objective to be optimized, which is minimize risk, min risk.

This list entry optimize in the model slot describes which objective function should be optimized. For example, one choice which is default is min risk which minimizes the risk for a given target return, then you have max return which maximizes the risk return for a given target risk and then you have objective risk function which you can define a particular objective function. To put simply, the first two options that is minimize risk or maximize return are the most common choices. These are either minimizing the portfolio's risk for a given target return or maximizing the portfolio's return for a given target risk. In the default case of the mean variance portfolio, the target risk is calculated from the sample covariance.

The target return is computed by the sample mean of the assets if not otherwise specified. The third option leaves the user or somebody using the programming with the possibility to define any other portfolio objective function. For example, one can maximize the Sharpey ratio. So for example, if you want to change the setting to optimize, you can type get optimize function. You can use this get optimize function and provide the argument of default spec.

Let us see. This currently it is set to min risk. Now you can change it by putting it set optimize set optimize and you can provide the default spec object and you can change it to max return. You can run this and now if I print my default spec object, notice now it is maximize return. Also please notice the estimator slot in the model list.

In Harry Markowitz mean variance portfolio model the type MV, the default estimator is COV covariance estimator is employed, which computes the sample column means and the sample covariance matrix of the multivariate data series such as we have been dealing in this lesson. There are number of alternative estimators that will be discussed and also provided for by F portfolio functions such as candles and Spearman's rank based covariance estimators, various robust estimators, a shrinkage and a bagged estimator as well. We will apply them wherever as may be required. Notice the portfolio slot. In the portfolio list slot, we have all the settings to specify the parameters for a portfolio.

For example, you have target weights, target return and risk, risk free rate, number of frontier points and the status of the solver. So number of for example, here you can see the solver is Solve RGLPK. So you can use the extractor functions to retrieve the current settings in the portfolio slot and change those settings as we did earlier for the model slot. Three important arguments here are weights, which is a numeric vector of weight, target return, which is a numeric value of target return and target risk, which is a numeric value of target risk. Now, for example, if the weights of a portfolio are given, then the target return and target risk are determined.

They are no longer free. As a consequence, if you set the weights to a new value, then the target return and target risk are also changed to a new value. Similarly, if you change the values of target return and risk, the other two values are set to NA or they are determined. If all the three values are set to null, then it is assumed as an equal weight portfolio. In summary, if one only one of the three values is different from null, then the following procedure will be started.

For example, if the weights are specified, then it is assumed that a feasible portfolio should be considered. If the target return is specified, then it is assumed that the efficient portfolio with minimal risk should be considered. And if it is risk is fixed, then the return should be maximized. Let's see this with one example. Currently, as we can see in the portfolio list, all the three arguments target, weight, return, risk are set to null.

Now, let's set one of the one of them, let's set weights, set weights of this default spec, default spec object. Since we have seven objects, we can set it C from 1 to, so we have sequence of 1 to 1 and we will specify the length of 7. Let's have this sequence of 1 to 1 and we will divide it by 7, we will divide the sequence by 7. So we will set the weights, we have the sequence, let's print this inside this object we have 1 and we will divide it by 7 to have equal weighted object 7. So now it has assigned equal weighted object, I can print this default spec.

So it has equal weights. Notice that the target return, target risk are set to NA because we have specified the weights. So the target return and risk objects are now fixed to NA. So basically, we are telling portfolio to optimization to create a feasible portfolio with these equal weights. So the target return risk objects are fixed and they are set to NA, they will be determined in the optimization process.

Similarly, if I set my target return, if I set my target return and let me set the target return of this default spec object to let's say 0.025 and let me print this default spec. Now that I have given the default returns, notice the other two objects weights and target risk are set to NA. So it will given this return, it will minimize the risk and automatically the weights are automatically computed in the optimization process. Similarly, we can set the risk and then other two parameters return and weights are also determined in the process, they are no longer variable, they are fixed by the optimization process.

Next, you have risk-free rate, you can determine the risk-free rate using the extractor function, you can see the current risk-free rate and change the settings. You can also check the number of default frontier points. Currently, the risk-free rate is set to 0 and number of frontier points to 50. These are often employed. Risk-free rate will be employed if you are constructing the tangency portfolio and computing Sharpe ratio.

Number of frontier points will be required when you are constructing the efficient frontier. Lastly, you have Optim slot or Optim list where you have the solver settings. The name of the solver to be used currently is set to Solve RGL-PK. Again, you have the extractor functions to see the current solver information or change it to some other solver. The name of the default solver used for the optimization of the mean variance Markowitz portfolio which is the default portfolio is the quadratic programming solver which is named to Solve R-Quad programming.

Since we changed it to C-bar setting, we are seeing this as Solve RGL-PK. Let me again show it to you. If I change the set type of default spec to mean variance portfolio, it will be changed back. Notice the solver is changed back to Solve quad programming again. A number of solvers are available with different parameters and different attributes depending upon the objective function, risk and return.

To summarize in this video, we initiated a simple portfolio object. We discussed in great detail the parameters including model list which contain type of the portfolio function, the objective to be optimized, the estimator. We also discussed the portfolio list slot where we discussed the weight, target return, target risk, rest rate and number of frontier points. And lastly, we discussed the optimum slot where we discussed the solver properties. In this video, we will discuss how to set the portfolio constraints.

Let's start with the simple portfolio specification object. Let's call it spec-s-p-e-c. We can use the portfolio spec function to initiate this object. Once this object is initiated, let's start with the simple constraints which is long constraints. Let's call them constraints, long only.

Now many times we use only long constraints that means we have all the long positions, no short positions. So let's define our default constraints as portfolio. Now we will use portfolio constraints function to specify our constraints. This is our return object that we are using and we have initialized a portfolio spec, simple portfolio object with spec default configuration. And then we will use our constraints which are long only.

Let's assign this object and let's print the constraints. Notice in the constraints, notice when I run this default constraint object, notice the output, there is a lower value of 0 and upper value of 1. This is because the long only constraints assign lower and upper bounds for each asset between 0 and 1, 1 indicates 100 percent. So all the weights are allowed to vary between 0 and 1. One can also define short constraints.

So instead of using long only constraints, I can use very similar setting and define my constraints as short only. Let's put it as short. And if I do that, so now I will assign the short constraint and I will run my default constraint object. Let me run this. So now if I run my default constraint object, notice now instead of 0 to 1, we have minus infinite to plus infinite that is there are no bounds because we have allowed unlimited short sale.

So one can take any position on the negative or positive side in each of the assets individually. Next we will discuss the box constraints. However, to make our portfolio object more appropriate, let me assign a target return to this and we will most of the time we will use long only conditions. So I am running this long only condition and in addition to that, I am setting the target return set target return as equal to set target return for this spec object equal to mean of final return. So the final rate object, mean of this object will be my final return and this is my, these are my default constraints.

So if I print my default constraint object, it will appear like this. Now we will set a very interesting box constraint. Let's say I want my first box constraint to be that the minimum amount in each of the assets, the minimum weight in each of the assets from 1 to 3, asset number 1, 2 and 3 should be equal to minus 0.1. So this is the minimum weight that I want each of the set to have.

Then the second box constraint I want from asset 4 to 7, asset number 4 to 7, the minimum amount I want is minus 0.2. Next, the maximum amount, let me specify the remaining two conditions. So I will use the box dot 3 third constraint which is the maximum weight in asset 1 to 3 should be equal to 0.

So, it should not exceed by 0.5. Similarly, I am assigning the last and final box constraint that my maximum weight, max weight should not exceed 0.8 from asset 4 to 7. So this is my box constraint that I have specified. Now let's set up my box constraint object, aggregate all these constraint conditions, that's my box constraint object which is a combination of box dot 1, box dot 2, box dot 3 and box dot 4.

So this is my combined box object. You can print it also, I can just print it separately. If I run it, I get all the box conditions. Now let me have my consolidated constraint object printed. So I will use this portfolio constraint and I will specify that I want my return object to be final rate. This is my return object that we have already discussed in previous set of videos on introduction and initiation of portfolio object, then specification spec object which is already there and box constraint.

Now if I print this object, notice the following interesting things. First and foremost, the lower limit which is specified as for a set 1 to 3 minus 0.1, for a set 4 to 7, here notice for a set 4 to 7 minus 0.

2 and the upper limit as 0.5 for a set 1 to 3 and 0.8 for a set 4 to 7. So these are our box constraints that we have specified. Next we will move to group constraint where we can assign a condition which applies to a group of assets. How do we do that? So let us start with our first group constraint group dot 1 equal to equi sum W and I specify that asset number 1 and 3 should have a weight which is equal to 0.

So 1 plus 3 should be equal to 0.6, this is my first constraint. Let us decide the second constraint group dot 2 which is equal to min sum W equal to, now I am specifying that a set let us say 2 to 4 should have a minimum sum of 0.2, so 2 to 4 should have a minimum sum of 0.2 and group 3 that maximum sum for a set let us say 5 to 7 should be equal to 0.

So this is my last constraint. Let me combine all these constraints. So I can use this group constraints object and I can assign all the group constraint group 1, group 2, group 3. So all these group constraints are assigned in this group constraint object. I can print this as well.

So all three constraints are there. Now again I can use the same portfolio constraint object, portfolio constraint object where I need to specify my returns, asset having returns, then my portfolio object which I have already initialized which is spec. Similarly I will provide my group constraint and let us print this. So let us run all these commands and let me print this object. Notice what happens, so first since this was a long object, so we have minimum and maximum limits 0 to 1, but now we have put group constraints.

So let us interpret them. So first we specified the equal sum weight which is 0.6 for security 1 and 3. So notice this equal sum 0.6 which is for security 1 NFTY and security 3 CAC.

Similarly we have minimum sum constraint as 0.2 which we can see lower matrix constraints here 0.2 for security number 2 to 4. So 2, 3, 4, SNP, CAC and DAX. Lastly we have maximum sum constraint which is 0.

8 which is applicable to security 5, 6 and 7. So these are our group constraints. Next we will also talk about risk budget constraints. So to assign budget constraints let us have a look at simple example I can have budget dot 1 which is my first budget constraint and when I say budget constraint this means risk budget constraint. So what is the contribution of each security to the risk of portfolio. So let us put first the minimum budget constraint and I will put 1 to N assets which is my number of assets in this case it is 7.

So this N assets and I specify the minimum as minus maybe minus 2 and the maximum this obviously pertains to on the lower side budget 2 which I specify as max the maximum risk contribution to the risk of the portfolio max B and I specify this as C1. So first asset and then 2 to N assets that means I want some combination for asset 1 and some combination for assets 2 and I specify this as C0.5 this will be assigned to asset number 1 so 0.5 for asset number 1 and then I will repeat from 0.6 instead of repeat I will just use a sequence I will use a sequence from 0.

4 to 1 by 0.1 so it will assign interesting sequence and here instead of 1 I will use just 1 to N assets. So all the assets will be assigned a sequence of 0.05 but since there are 7 assets I will use it as 0.4 and then I will close the entire thing so this is my risk budget constraint. Let me print this also so let us decide or define rather complete object as budget constraints which is equal to C budget dot 1 comma budget dot 2 so these are my risk budgets for individual assets.

Now if you want to print the complete thing you again will follow the same procedure budget constraints I need to specify the return object then the portfolio specification object that I have initialized already and then budget constraints that we have already defined. So one small issue although it is just a warning but we need to have only 0.4 here and I can remove this so now this will work out fine. Now once I run this command notice the budget constraints so for example the minimum constraint is minus 2 as we can see here for all the assets as I specified here and the maximum budget constraints start from 0.

4 up to 1 for all the assets with an increment by 0.1 so this is my budget constraint. Now as a final thing you would like to set up a very complex object which contains all these budget group and individual box constraints, asset constraints so let us see how it is done. So first I will specify my constraints as a combination of box constraints then group constraints and lastly my budget constraints. This is my complete object. Finally I will again use the same set of portfolio constraint function to create this object with very complex constraints which are constraints and if I print this the complex object is produced for example these are the set of individual box constraints that are applied for each assets maximum and minimum.

Then you have group constraints for example equal sum constraint that we discussed already here you have lower group constraint and upper group constraint that we have already discussed and then you have risk budget bounds that we have discussed individually minus 2 and then 0.421 so this is a very complex kind of object with very complex budget constraints for box group and risk budget. To summarize this video we introduced budget constraints and how to implement them in portfolio. We started with long and short portfolios where individual securities can be in the long or short which is minus infinity to plus infinite unlimited short sale.

Then we introduced the individual asset constraints with box constraints. Next we introduced group constraints for a group of assets and lastly we introduced budget constraints for risk budgets and finally we created a very complex portfolio object with complex constraints which are a combination of box group and budget constraints. Recall our discussion about feasible portfolios in the video topic portfolio optimization. We noted that there is a range of portfolios that are called feasible portfolios that represent all the possible combinations of risk and return. In this video we will compute one such feasible portfolio which is also an equal weighted portfolio. A feasible portfolio is an existing portfolio described by the setting of portfolio specification that is expected return and risk.

Existing here means that the portfolio was specified as parameters in a manner that risk versus return plot of the portfolio has a solution and it is part of that feasible set including the efficient frontier. The generic way to define a feasible portfolio is to define the portfolio weights. For example the equal weights portfolio is also one such a portfolio. So here we will compute one such equal weight feasible portfolio.

So here we will compute one such equal weight feasible portfolio. For ease of plotting and computations let us use our return object as we computed earlier and we will multiply it with 100 to make it easy for plotting another aesthetic purposes. Now as a first step I need to define equal weighted spec EW spec object and initiate with our portfolio specification with portfolio spec function. So with this portfolio spec function we have initiated the object but we need to do a number of things starting with let us design this n assets object which will contain the number of assets that is n call finalRib. So basically it will contain the number of assets that is 7 in our case.

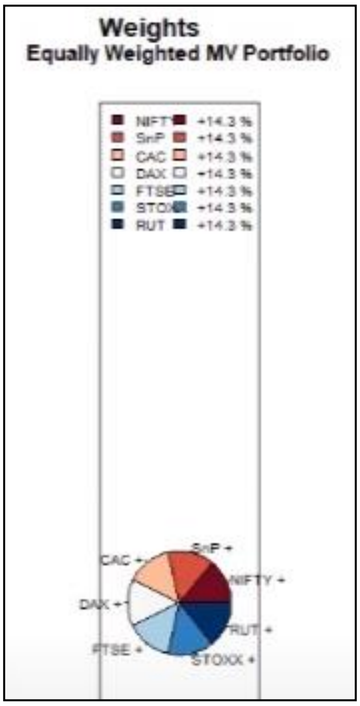
You can check that by printing this so there are 7 assets. Now we need to specify the weight of each asset in the portfolio which is equal so we will use this set weights command and we will use our EW spec object and we will assign equal weight. How to do that? Very easy. We can use this rep command. We can use this repeat or rep command where 1 upon n assets that means 1 by 7 in this case and we will repeat it 7 times.

So in a way we are assigning equal weights to all the 7 assets. Let us print this object and see if it is done actually. So let us print this EW spec and notice 7 equal weights are created in this portfolio weight slot. Now we have created this EW spec object. We have initiated the portfolio specification object. We have also assigned equal weights to all the 7 assets and now we will define our feasible portfolio.

Let us name this object as equal weight portfolio and using this feasible portfolio, feasible portfolio command, we will use our final return data here and we will specify the specification object which is EW spec. We also need to specify the constraints as we have done earlier. We will use long only constraints. Most of the times you rely on long portfolios. Generally short positions are not very desirable so in order to define this equal weighted feasible portfolio, we will use long only constraints.

Now let us print this object. Let us see what we have created here. So let us print this. We can simply run this and print and see the value that we have. So it is the estimator, the solver, minimum risk, long only object.

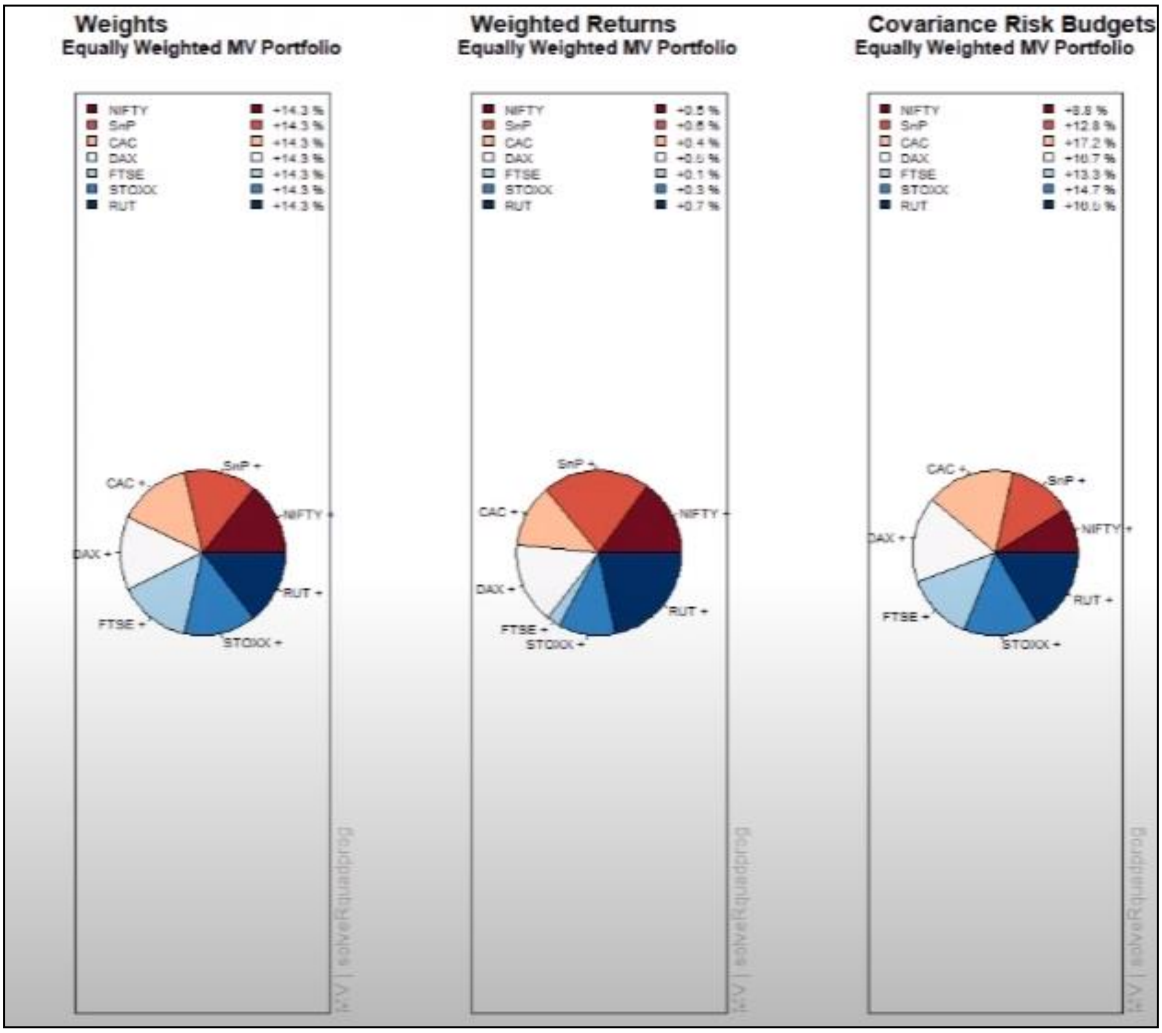
You can see the weights. All the weights are equal here. Also the covariance risk budgets are computed. The target returns and risk covariance are often called here standard deviation also and C bar and bar are represented. Notice here covariance risk for the portfolio in this particular functional terminology is same as the standard deviation of the portfolio. So the standard deviation or variance of the portfolio is measured or represented by this COV covariance object.



C bar risks, bar risks are computed along with the mean return of the portfolio. Now let us print this equal weighted object and first we will define an interesting color palette. In R, there are lot of interesting commands to create colors. So we will use this tip palette command in app portfolio and here we need to specify the number of colors to be generated which we will generate using ncol final return which is 7 assets. So we will generate 7 colors. With this command, we will specify that 7 colors are needed and we will specify that the palette has to be in the red-blue format.

So this is the symbol red-blue which tells R that red-blue palette color combination is to be created. Now we have the colors. Also we will specify 3 windows. So using this par, mfro equal to C 1,3.

We will specify that 3 objects will be printed now and these 3 objects. First we will specify the weights pi object, the proportion of individual asset weights in the portfolio. This is pi. In the weight pi object, we will specify our portfolio object which is ew portfolio.



Also we will specify the radius. Let's take a radius of 0.7. Based on my past experience of coding these kind of figures, I find this 0.7 to be useful. I specify the color as col.

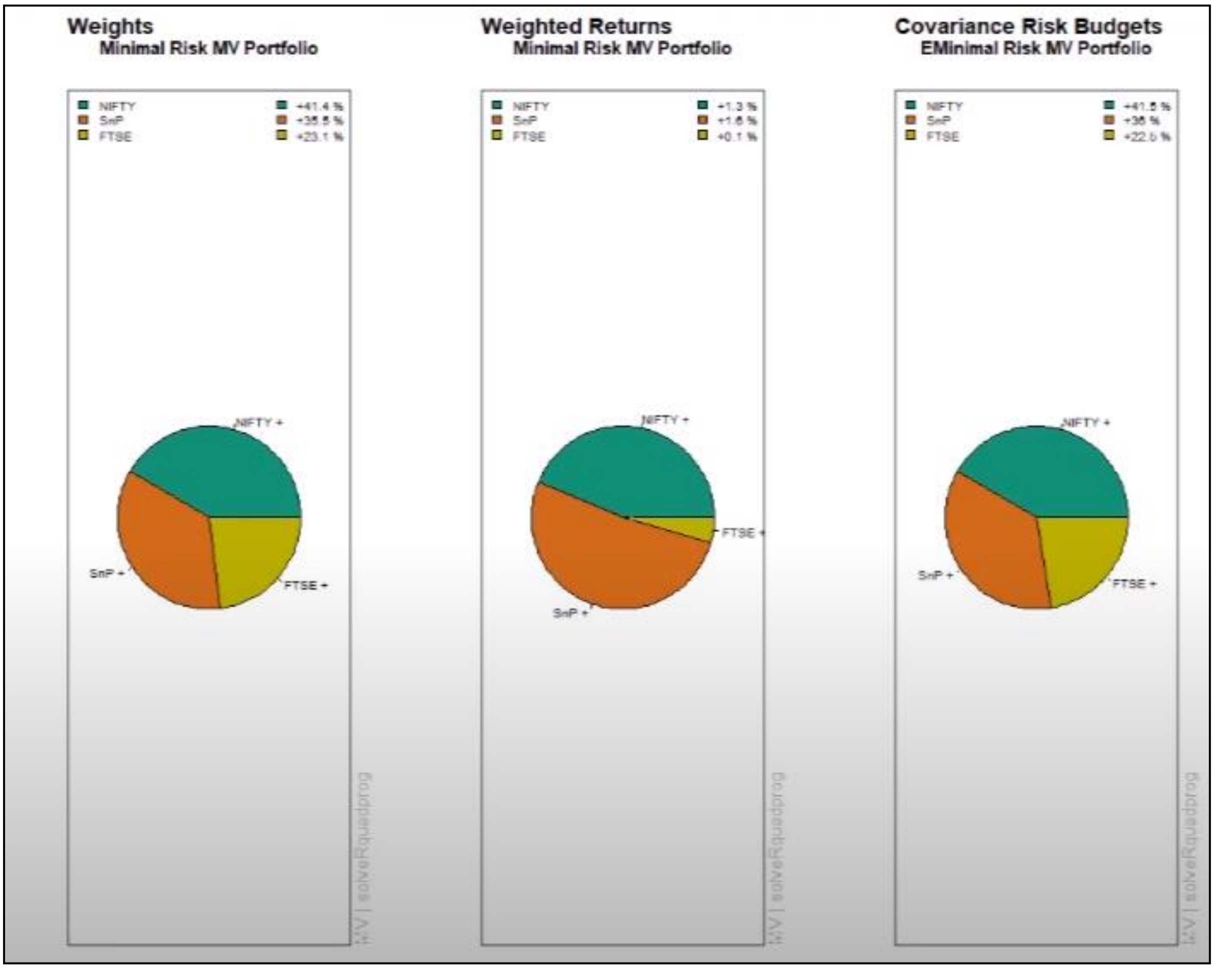
I specify the color as col which we have created. Also some headings are needed here. So mtext command text. The text is equally weighted minimum variance portfolio.

Side equal to 3, line equal to 0.5. These are some of the parameters font equal to 2, 6 equal to 0.7, adjustment equal to 0. So this is first object. So let's see if we have correctly created. Yes, so this is correctly created.

At the end of it, I will format it properly but before that we will create these objects. Next object is weighted returns pi. So weighted returns pi. So we will use this weighted returns pi function. I will specify the portfolio spec which is ew portfolio.

Again the same set of objects radius equal to 0.7, col is col. Again I will use the same mtext heading as earlier. I will just copy paste. Lastly I will also specify the covariance risk budgets. We will explain these things in detail shortly. Here also I will specify the same parameters that is the portfolio, equilibrated portfolio, radius and color remains the same.

And now I will again give the heading mtext. Now let me plot them in one go. First I will specify the color object which col and then par telling are that three plots are to be created. First weight pack, name it. Then returns, weighted returns, named covariance risk object and name it. Let me zoom the plot and explain it in detail.



So as you notice the first plot is equally weighted and minimum variance portfolio. Since it is equally weighted portfolio, notice all the weights are 14.3% for all the securities. The next weight is weighted returns which indicates the contribution to overall returns by individual assets. As we can see here, the color coding represents the contribution to return by individual objects clearly. The last one is covariance risk budget which indicates the contribution of individual securities to overall risk of the portfolio.

As we can see here for example, if we have 8.8% contributions, S&P 500, S 12.8% and this will sum up to 100%. So these are contribution to the risk of the portfolio by individual securities. To summarize, in this video, we created a feasible portfolio with equal weight specification. Subsequently, we visualize the portfolio with the respective weights of the individual assets, their contribution to returns in the form of weighted returns and their contribution to the overall risk of the portfolio through covariance risk budget plot. In the previous video, we computed a feasible equal weighted asset portfolio. In this video, we will try to compute minimum variance portfolio and we will try to visualize various aspects of this portfolio.

Now for a minimum variance portfolio, for every return, there is one portfolio which has the minimum variance or minimum risk and therefore in this particular portfolio, we will try to initiate this mini risk, let us call it mini or min risk spec and we will initiate this with portfolio spec object through a portfolio spec function. Like we noted earlier, we need to specify a particular return for which we will compute the minimum variance portfolio. So let us set the target return equal to, let us set the target return of this min risk spec as mean of final return. So the mean of all the securities will be considered as the target return for which we will compute the minimum risk portfolio.

Now that we have assigned target return, let us specify this minimum risk portfolio object. Let us call it min risk portfolio and for this min risk portfolio, a very simple command is to use is efficient portfolio because this will be part of our efficient frontier and we need to specify the data. Like we noted earlier, once the target return is specified, other parameters that is weight and risk are automatically computed as part of the efficient portfolio. That means we have identified a particular portfolio on the efficient frontier once we specify either the risk or return.

So this is our data final return object. We need to specify that specifications are min risk. So min risk spec and lastly, since we are working with long only constraints, we will specify the constraints as long only. So with this, we will start with our min risk portfolio object. In fact, we can very well print this min risk object like this. We can see the printed object, it has portfolio weights are given, the resulting portfolio weights.

We can see the only three assets have been used NIFTY, FTSE and S&P. The covariance risk budgets are also provided along with target returns and the risk covariance or variance risk C bar var. Now let us do a little bit of visualization as we did earlier. So I will not write the command again, I will simply just copy paste the commands. Although this time around we will use a different color palette, let us call this color palette while visualizing instead of div palette, we will use QALY palette and here the color specified is let us use dark 2 theme.

So with this theme and also this is not the feasible portfolio but min risk portfolio. So we need to specify that this is not equal weight portfolio, this is min risk portfolio that we are using and this we need to highlight in the heading also, so minimum risk MB portfolio. So this is minimal risk MB portfolio. This is minimum risk MB portfolio, so we will specify likewise.

This is the minimal risk portfolio. Instead of equal weight specification, this is the minimum risk. So now let us run the visualization. So again we will specify the color, 3 windows to be plotted, first, second and third. Now because in this case as a part of efficient frontier only 3 assets were utilized. So let us have a look at this diagram.

As we can see here, you have Nifty, S&P and FTSE and their corresponding weights are provided 41%, 35.5 and 23%. We can also notice the minimal risk portfolio weighted returns, the contribution of 2 returns from all these 3 assets Nifty, S&P and FTSE and we can also see their covariance risk budgets as a part of visualization exercise. So in this video, we created a efficient portfolio. The target return was mean return of all the 7 assets, the mean returns as target and corresponding portfolio with minimum risk which is corresponding to this given return. Obviously, that portfolio will lie on the efficient frontier that portfolio has been identified with long wholly constraints.

So no short constraints, only long positions are considered and then we subsequently visualize the portfolio its 3 properties. First the weights of individual assets, we found that only 3 assets have been utilized to create this portfolio. We also visualize the weighted returns and the covariance risk budgets. In the previous video, we computed minimum risk portfolio while for every portfolio with a given expected return or a target expected return, one efficient portfolio with the minimum risk can be identified on efficient frontier. However, there is one particular portfolio for which the risk is minimum across the entire efficient frontier and this is called global minimum variance portfolio.

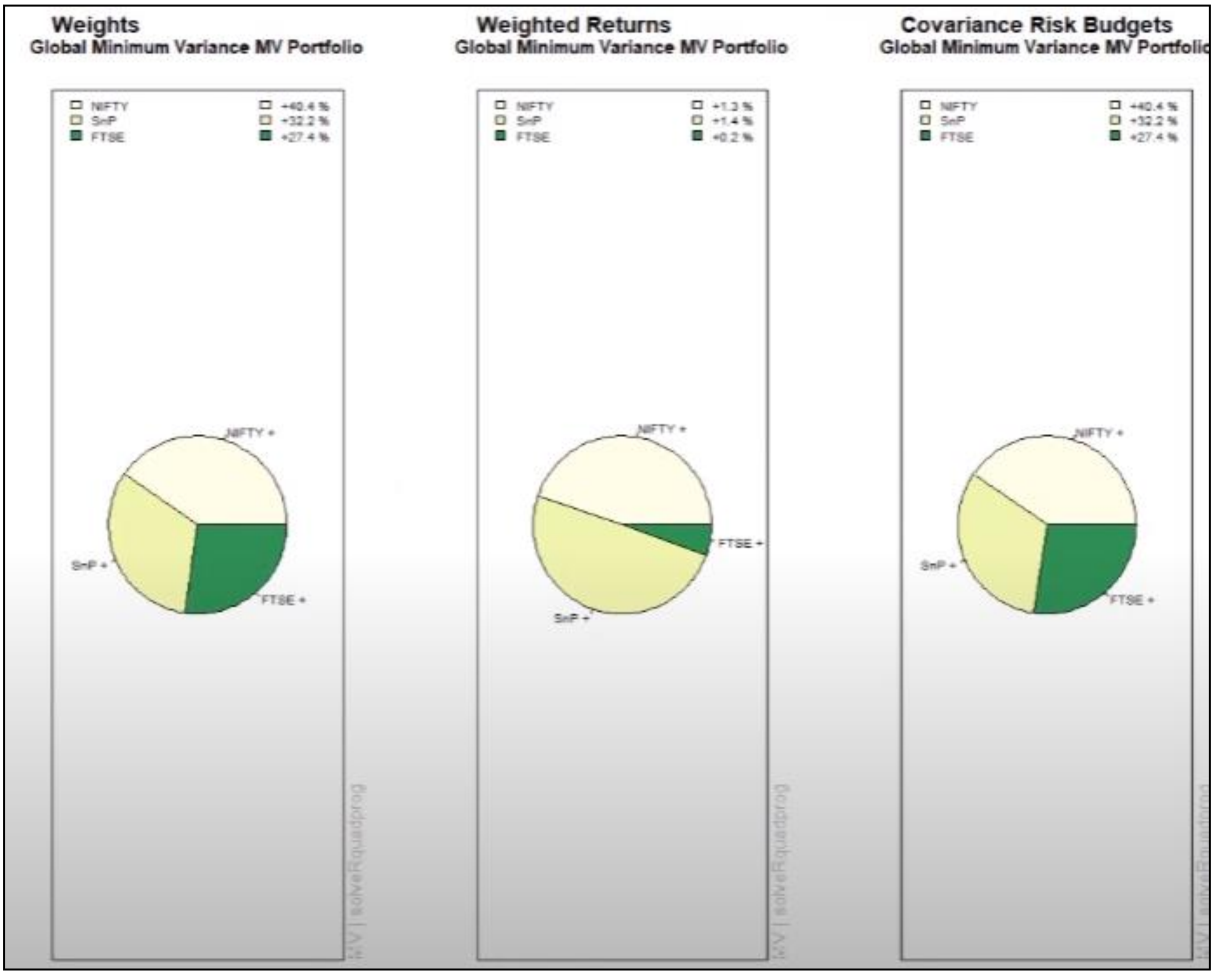
In this video, we will try to identify this global minimum variance portfolio. Let us name it global min spec, global min spec and this is portfolio spec. Let us name it global min spec specification. Let us initialize this as we have been doing in the previous videos. Now for this portfolio, let us start with global, let us call it global min portfolio and let us initialize it with the command.

The command that is used is called minimum variance portfolio. Now here we specify the data which is final return. We also need to provide the spec which is global min spec. Next we need to provide the constraints and as we did earlier, we will use the long only constraints, long only. So we will initiate our portfolio object which is global minimum variance portfolio.

Let us print this. So for this portfolio, as we can see in the printed object, this portfolio employs NFTY, S&P and FTSE. We can see the respective contribution of these assets to the portfolio risk in the covariance risk budgets, 40 percent contribution to risk by NFTY, 27.9 by FTSE and 32.2 percent risk contribution by S&P. We can also see the mean value of the return, risk measure that is covariance risk of the portfolio essentially which is the variance of this portfolio C bar and bar.

So three risk measures. In this terminology, this covariance is same as the variance of the portfolio along with the C bar and bar. Now let us visualize this and again, we will use the same set of commands for visualization. So I am just copy pasting them from previous video and here we need to just change a few parameters. So this is global min portfolio. So instead of this min risk portfolio object, we will replace it with the global min portfolio.

Also in the nomenclature, the headache, we will call it global min. Instead of minimum risk, we will call it global minimum variance MB portfolio. So we will call it global minimum variance MB portfolio. And we will define a slightly interesting another color palette.



This is called Siqui palette. And here again, we will define a new color scheme, yellow green. So we use this YLGN, YLGN for yellow green. And let us run it. I will enlarge my plotting window a little bit so that graphs are clean, global minimum variance and all the three plots are here. Let us visualize them a little bit.

So we have global minimum variance MB portfolio, we can see Nifty 40%, S&P 30, those we already saw and this is in the form of pie chart.

We also have weighted returns. So that is contribution to overall returns from each asset which is Nifty 1.3, S&P 1.4 and 4C 0.2. Lastly, we have contribution to the portfolio risk around 40% from Nifty, 32% from S&P, and 27% from FTSE. So this is the risk contribution. To summarize this video, we created a global minimum variance portfolio object with long constraints. Then we visualize the portfolio, we visualize in pie chart format, we visualize the weights of different assets, we found that only three assets are employed out of the given seven assets in the minimum risk variance, global minimum risk or global minimum variance portfolio.

We also computed the weighted returns plot indicating the contribution to overall returns from different assets. Again, the three assets were employed. And then we also saw the covariance risk budget pie plots where we saw the contribution of individual assets to overall portfolio risk. Recall our discussion on video topic portfolio optimization. We noted that in the presence of risk-free lending and borrowing, there is one particular portfolio that is best among all and that portfolio was identified through a tangent line from the free rate to the efficient frontier.

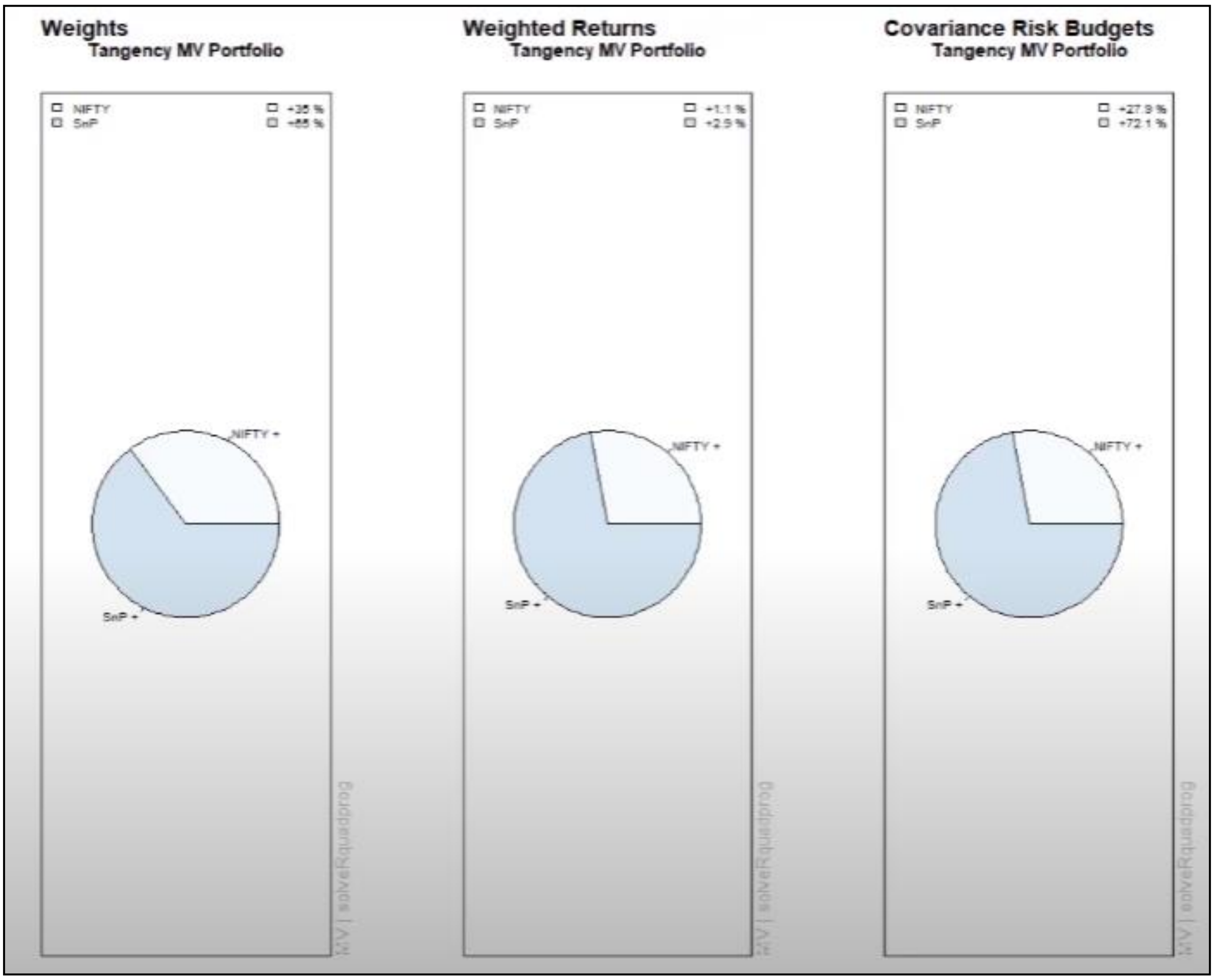
So in this video, we will try to plot visualize and construct that tangency portfolio or the best portfolio across all the portfolios. Let's call it and initialize this portfolio with TG spec. As we have done in the previous videos, we will initially initiate the object with portfolio spec, portfolio spec function, the object is initiated.

However, this object will need risk-free rate. So we will set the risk-free rate for this TG spec object. Let's have a 0% rate. So we will assign it a 0 value. One can assign depending upon the market and security, one can assign a suitable and appropriate value. Now let's call this portfolio a TG portfolio, tangency portfolio and we need the function tangency portfolio to create this object. The data employed is again final rate, which contains the seven security returns that we have selected earlier.

We need to provide the specifications which we have initiated the object TG spec object that we have initiated earlier. And we are using long only constraints later on we will also employ short constraints, but for now we are using long only constraints. So long only and this is our portfolio.

Now let's print this portfolio object. Let's see what are the contents. So for this portfolio, we have the portfolio weights. Notice only two assets are employed here. It seems these two assets, the combination of these two assets provide the best among all, Nifty, S&P, their risk budgets 27% and 72% for Nifty and S&P respectively. Their mean, the risk of the portfolio, covariance, C-bar and bar risks are provided.

Let's try to visualize this portfolio as we have been doing. And again, we will copy paste the same visualization command. Now we will use another palette, let's blue purple kind of palette with sequential. We will use this blue purple, BU, BU, blue purple. And again, this is TG portfolio object. So we will change the name from global minimum portfolio to TG portfolio, which is our tangency portfolio.



The best efficient portfolio identified through tangent line from risk free rate to this. So I need to copy paste it properly, TG portfolio instead of global minimum portfolio. Also the name has to be changed. So I have written global minimum variance MB, so I will call it tangency, tangency MB portfolio.

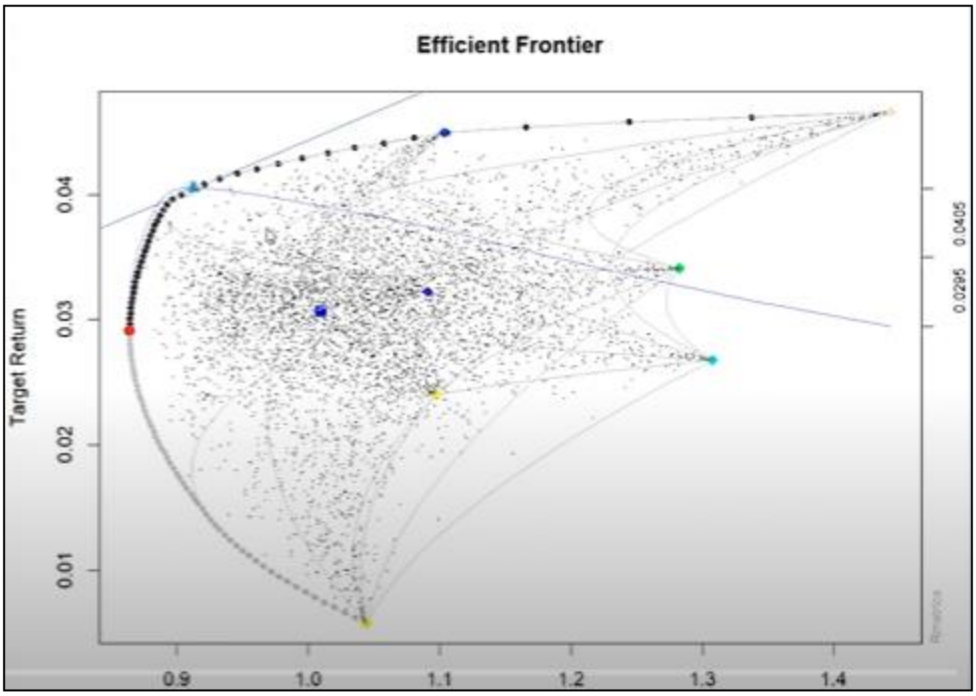
So this is the best efficient portfolio. We will visualize it. So I have created a color scheme. Let me plot this and let us zoom and visualize the object properly. So in this object, only two assets are employed, SNP and NFTY and as we saw 35 percent contribution, 35 percent wait for NFTY and 65 percent for recent weighted returns, the contribution to return 1.

1 percent from NFTY and 2.9 percent from SNP. Also let us look at the contribution to risk, the covariance risk budgets which indicate the contribution to risk. So NFTY has 27.9 percent while SNP has 72 percent contribution to risk, which also reflects the higher weight assigned to SNP. To summarize in this video, we computed the tangency portfolio with the risk free rate of 0 percent and long only constraints.

We also tried to visualize the portfolio. We visualize the respective weights. We found that only two assets NFTY and SNP 500 were utilized in construction of this portfolio with weights of 35 percent and 65 percent. We also found the weighted returns, the contribution to returns from these two assets in this portfolio, tangency portfolio and we also computed the contribution to the overall risk from NFTY and SNP to this tangency portfolio which works around 27.9 percent contribution from NFTY and 72.1 percent contribution from SNP as we can see in the charts. Thank you.

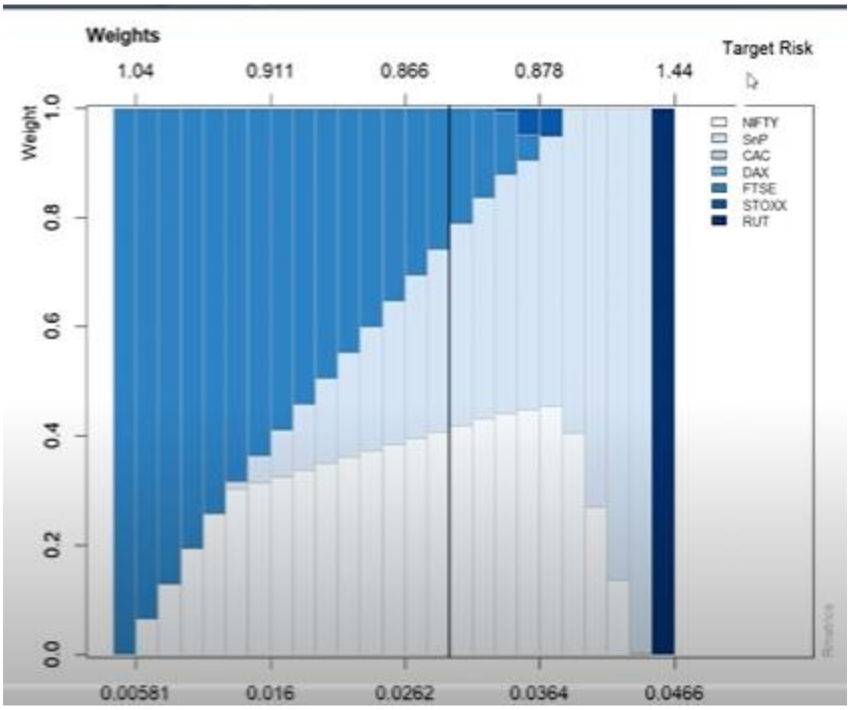
In this video, we will learn how to interactively plot mean variance frontiers. So we will interactively plot mean variance portfolio frontiers. As a starting point, let us initiate our mean variance portfolio object. Let us name it MBP spec and as we have been doing, we will use this portfolio spec function to initiate this object. First we need to specify the number of frontier points. These frontier points will be used to specify how many frontier points are required and we will use this MB spec object, MBP spec object and we will assign 100 frontier points.

Now finally, we will create our frontier objects because we are using long only constraint, we will name it long frontier. Let us name it long frontier and we will use portfolio frontier function. First we will specify the data object which is final underscore return and we need to provide our minimum variance portfolio spec. Now that we have created this long frontier object, let us print it and see what is inside this object.



So, we can see that it has basic portfolio slot with estimator, solver, optimization, long only constraint and notice out of 100, there are total 100 points, out of those 100 will be giving us 5 points to as a brief summary. So notice portfolio weights, point number 1, 25, 50. So we have every 25 interval, we have the details of weights, we have covariance risk budgets for each of these 100 points, but here for presentation purposes only 5 points are printed. We also have target, the target returns and various risk, covariance C bar bar risk printed for 5 points out of 100. So let us start.

So let me enlarge the plotting window and we wanted to plot it interactively. So we will plot this long frontier object. Let us plot it and once I click control enter and so I press control enter, 8 options are provided. So in the first option, it will plot the frontier object. Notice the frontier object is created.



Then we will add the minimum risk portfolio with selection 2. That red point is the minimum risk portfolio, it is added here. With number 3, we will add this tangency line. So this is the tangency line and this is tangency portfolio. Also with point number 4, we will specify the risk return of individual assets.

So all the 7 assets are there printed. So here we can see individual assets being printed. With next selection, we will add equal weights portfolio. With selection 5, we will add equal weight portfolio. This is the square solid blue point here, which is the equal weighted portfolio.

With number selection 6, we will add 2 frontiers, 2 asset frontiers, combination or basically combination of 2 assets, large number of 2 asset combinations as they are being created, we can see that line by line, a number of 2 asset combinations are created. Next with point number 7, we will add Monte Carlo simulated portfolios. These dots represent a number of simulated dot Monte Carlo portfolios with different combinations of weights and so on so forth. You can see these small dots representing Monte Carlo simulated portfolios. Lastly, we will add Sharpe ratio of Monte Carlo.

So with point number 8, we will add the Sharpe ratio line. So notice this dotted line here, Sharpe ratio for Markowitz portfolio only. So this is Harry Markowitz portfolio Sharpe ratio. To summarize in this video, we created interactive portfolio of efficient frontier and feasible region plot. In this plot, we started with plotting the efficient frontier, then we added minimum risk portfolio, then tangency portfolio, then we added risk return of single assets, then we added equal weighted portfolio, then we combined all possible 2 asset combinations to create 2 asset frontiers and then we added Monte Carlo portfolios, simulated portfolios.

In this particular video, we are working with long only configuration. So none of the assets are put in short position. In this video, we will again create the long frontier plot, but in a more customized manner. So we will again create the portfolio frontier, but in a more interactive and customized manner. So let us see.

So we will start with our frontier plot object. And here, we use our long frontier object that we created in the previous video. We specify the type, we specify the type as line and we will add line width as 4, which will result in a very solid line in our portfolio. So we will run this command and a very large efficient plot appears, then we will add the you can say CML point or tangency point. Again, we will specify the long frontier object.

We will provide color as red and we will add PCH 19 kind of figure for plotting and line width of 3, LWD of 3. So notice this solid red circle has appeared as the tangency point, CML point or you can call it tangency point or best portfolio. Then I would like to plot equal weight points, points with equal weight portfolio. So equal weight points. Again same objects are supplied only that we change color to probably brown and maybe PCH as 20 this time to change it a little bit.

So this brown circle is supplied here, we can see that this is our equal weighted points, point representing equal weighted portfolio, there are certain combinations. Next I also wanted to plot single assets individually. So I will supply single asset points. So I want to identify single asset points as well. So I will provide long frontier, PCH as specified at 20, but this time around I want to plot multiple colors.

So I will use color equal to 1 to 7. So 7 different colors will be employed and 6 equal to 3 indicates large circles. So let me start plotting from here. So when I add this notice a number of colors appear. So these are my 7 assets.

I also wanted to draw 2 asset lines as we did earlier with interactive plot. Here we will do it in more customized manner. So I will draw 2 asset lines, but this time I supplied specific colors. So probably I specified color equal to blue.

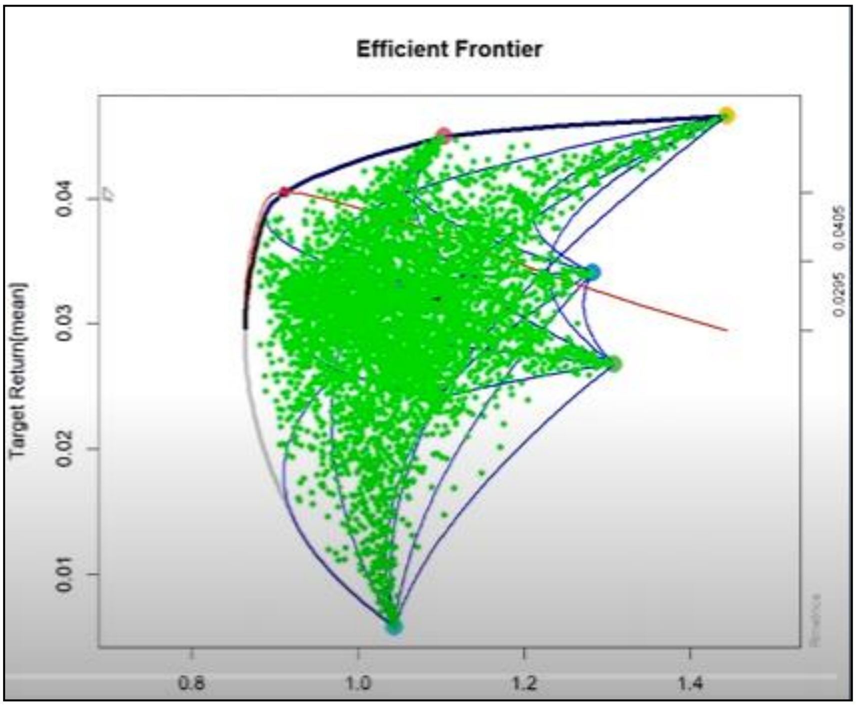
Let me see. So here color equal to blue. So I will run this 2 asset line command, 2 asset lines and I will supply my long frontier object. Let's see if these lines are created. You can see the lines being created. Let's see if we can specify the color also.

So let me give a color of maybe blue. I will empty this chart. So I will again recreate these. Okay so blue color lines are being created and we can see. In fact here if you want you can increase the line width slightly large so that the width of the line can be increased and WD can be specified as 2.

So you can see now again the lines are redrawn with a solid larger width. Also you can add Monte Carlo portfolios or first let's try with Sharpe ratio lines. So if we can plot Sharpe ratio lines with again the long frontier. But this time I will provide color as red for Sharpe ratio line, color as red, line width again will be 2. You can see a very solid line which is sort of going from here is plotted.

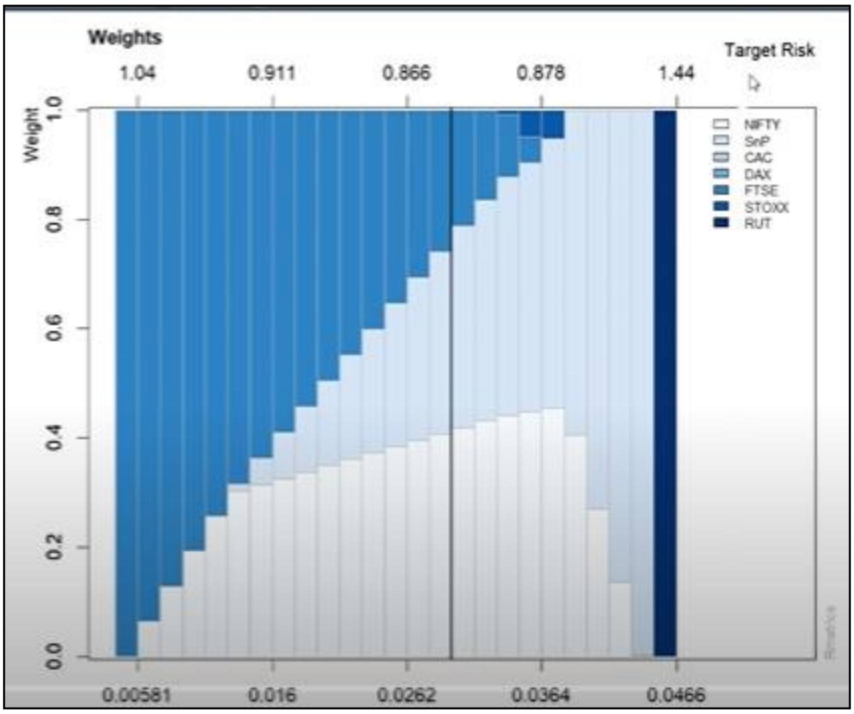
Now let's add Monte Carlo portfolios also. So I will add Monte Carlo portfolios. Monte Carlo points each point represents a combination of securities for a given risk and return. So I will use long frontier. Let's use PCH of 20 and I will use maybe color green.

Let's use green color. It seems less green so we will use green colors to present Monte Carlo points and you can see these filling the feasible region filled with Monte Carlo points. So to summarize this video we created a customized frontier plot where we started with the frontier plot using our long frontier object created in the previous video. Then we added the tangency point with CML points command. Then with equal weighted points command we provided the portfolio with equal weights in all the seven assets. Then we identified the single asset, seven single asset points.



There are seven assets in this portfolio that we are using, seven securities we are using. So with the single asset points command we identified all the points in this region. Then we also created two asset line and a combination of two portfolios. Then we added Sharpe ratio line and then lastly we added Monte Carlo points. In this video we will examine the properties of our frontier point plots.

Most specifically we examine the efficient frontier points and their weights, the weighted return of individual assets and covariance risk budgets. So here we will identify the properties of frontier points. Now initially we started with the object with 100 frontier points. However it would be slightly difficult to visualize 100 points in one graph. So rather what we will do is we will set n frontier points but instead of using very large number of points we will restrict ourselves to maybe 25 points and recall the name of the object in the previous video it was MVP spec.

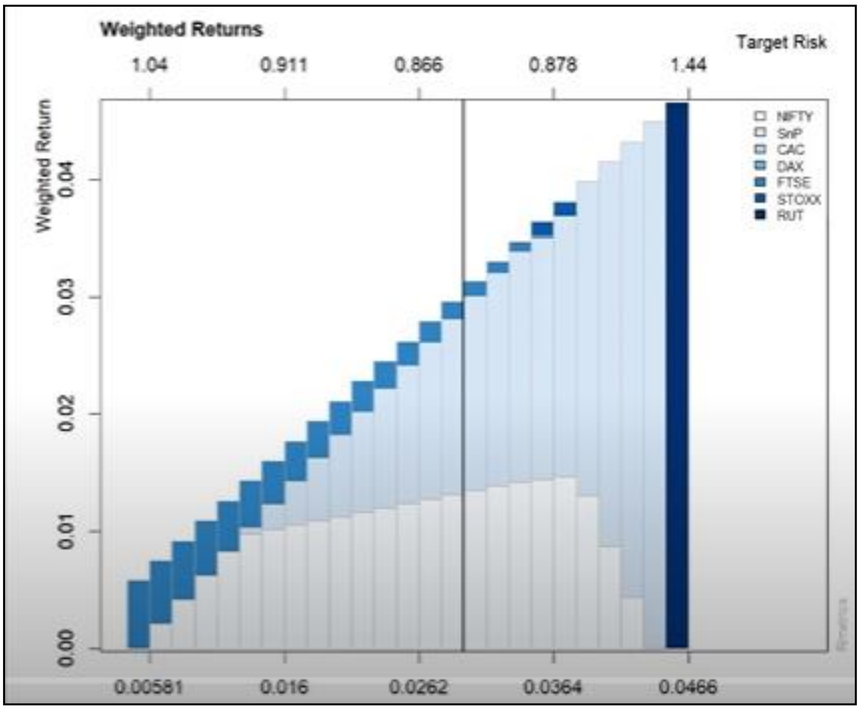


So we will use the same MVP spec object and we will specify that we want to use only 25 points instead of 100. So now the specification is changed. So we will again modify our long frontier object which we have already created but we need to modify it with the new frontier point values. So we will specify our return object, final return which contains the security returns or individual asset returns basically all the seven assets the returns and then we will supply our modified spec object.

So long frontier object is created. Now with this object we will do first we will do the weights plot. So we need to use this weights plot command and we need to supply our long frontier object. Let us run this. So notice in this weights plot command we have weights and on the x axis we have target return on the top of it we have target risk and we have unique combination. So there are 25 points or portfolios for each portfolio we have target risk and target return printed here and their weight out of the total 100 percent or this one represents 100 percent and there is zero.

So their weights. So notice that the first portfolio with the return of 0.00581 here we have completely it is completely it seems DAX and then as we move ahead the proportion of this DAX security goes down and in between we have S&P and NFTY security and last one is seems to be Russell. Last one is Russell. So how the portfolio weight changes can be easily visualized and also we can see the how the movement of risk takes place. So return here we can see return increases and also the risk increases we can see that for all these 25 frontier points that we have specified.

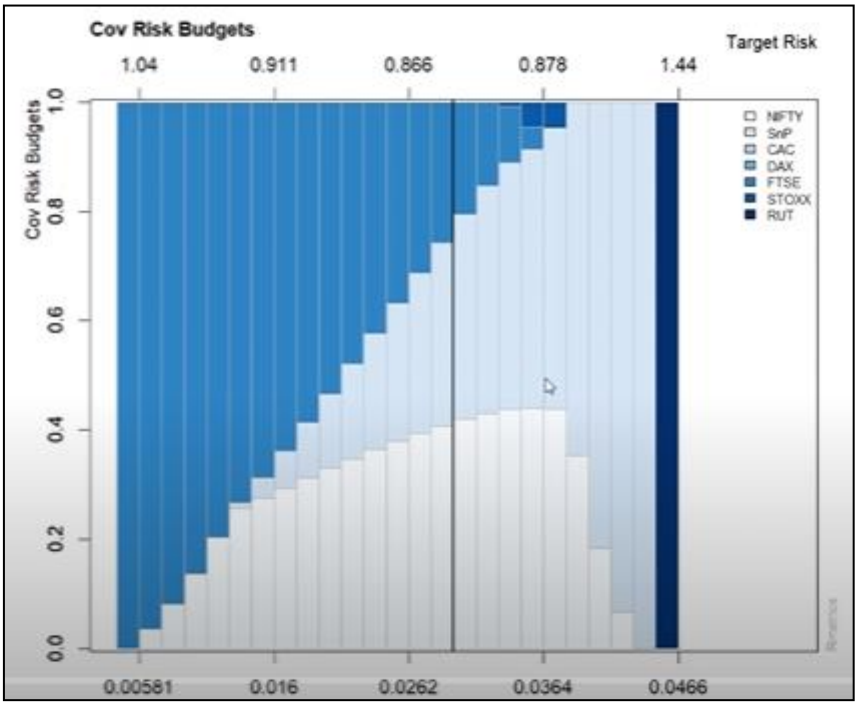
Next we can also plot the weight weighted return plot. So for that we need to add weighted return weighted returns plot and again we use our we will supply this long frontier object to this window and we can see weighted returns that means contribution to overall return by each asset is provided. Again on bottom and top we have target return target risk and we can see initially we have this DAX object and as we move ahead in between we have this NFTY and S&P objects increasing share of in the return as we can see on the weighted return axis and last one is Russell. Finally we also plot our covariance risk budget plot. In the covariance risk budget plot we need to provide again we need to provide our long frontier object and we can see the overall covariance risk budget 100% that is 1.



In the first portfolio as we expected we have the DAX object completely and its return and risk and as we move ahead the risk contribution as we decrease the weight of DAX the risk contribution also decreases in between we have NFTY and S&P significantly contributing to portfolio risk because we are significantly investing in these portfolios or assets. Lastly in the last portfolio we have Russell 2000 dollar. To summarize in this video we visualize our portfolio object with 25 frontier points. We visualize the weights for each of these 25 frontier point portfolios the weights of individual assets for all the 7 assets. We noted that mostly it is DAX, NFTY, S&P and in one portfolio Russell contributing.

We also noted the weighted returns plot we visualize the weighted return plot and lastly we saw the contribution to the risk of overall risk to individual assets through covariance risk budget plot. In fact if you like you can visualize them in one window only for example you can use this powermfro equal to C3,1 and let us see enlarge our plot window let us see. So this entire plot can be visualized in one window itself using powermfro and nicely visualize we can see the movement of weights, weighted returns and covariance risk in a single window with each other. In this video we will initiate a short portfolio object and visualize it. So as a starting point let us initiate a short portfolio object let us call it short.

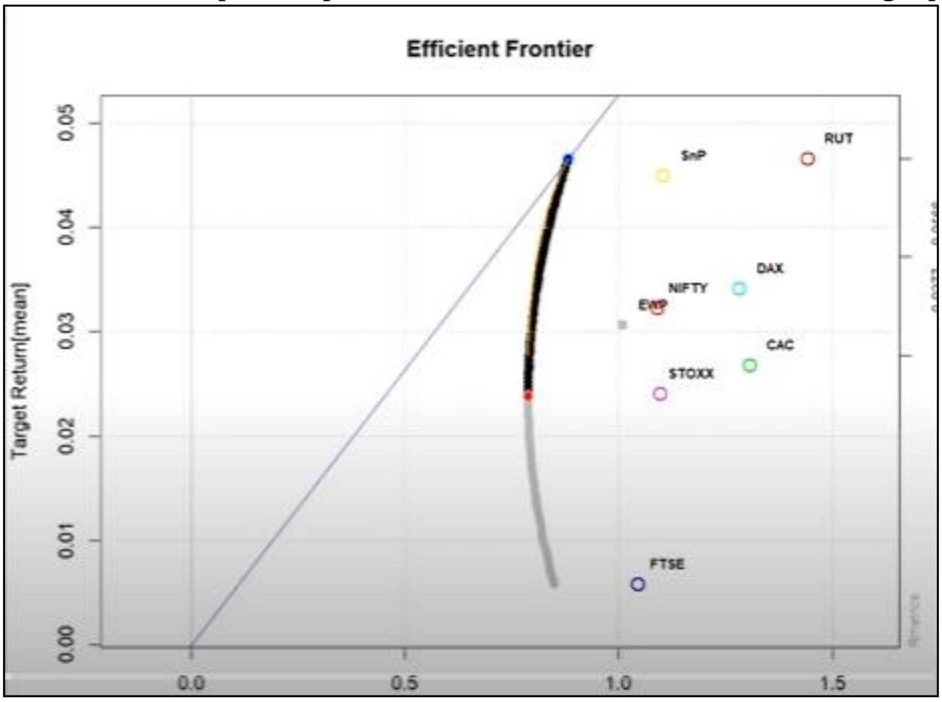
We will initiate and visualize a short portfolio object. So as a first point let us start with this short spec object. Again we will use our portfolio spec command to initiate the object. Once the object is initiated let us assign some frontier points. So first we will assign using this asset and frontier points command as we did earlier.



We will simply put short spec and we will assign we will start with 100 points first and now that we have assigned 100 points also please remember when you are working with short objects where minus infinity to plus infinity all options are on table you need to change the solver also so we will set using this set solver command. If you print the short spec object notice the current solver configuration is SolveQuad program. Now we need to change it and using this set solver we will use short we will change it to short solver we will supply our short spec object and we will supply solver name which is solver short exact. So this is our solver object solver short exact. Now that we have identified the solver we will start with our portfolio object which is short let's name it short frontier and again we will use our portfolio frontier portfolio frontier function.

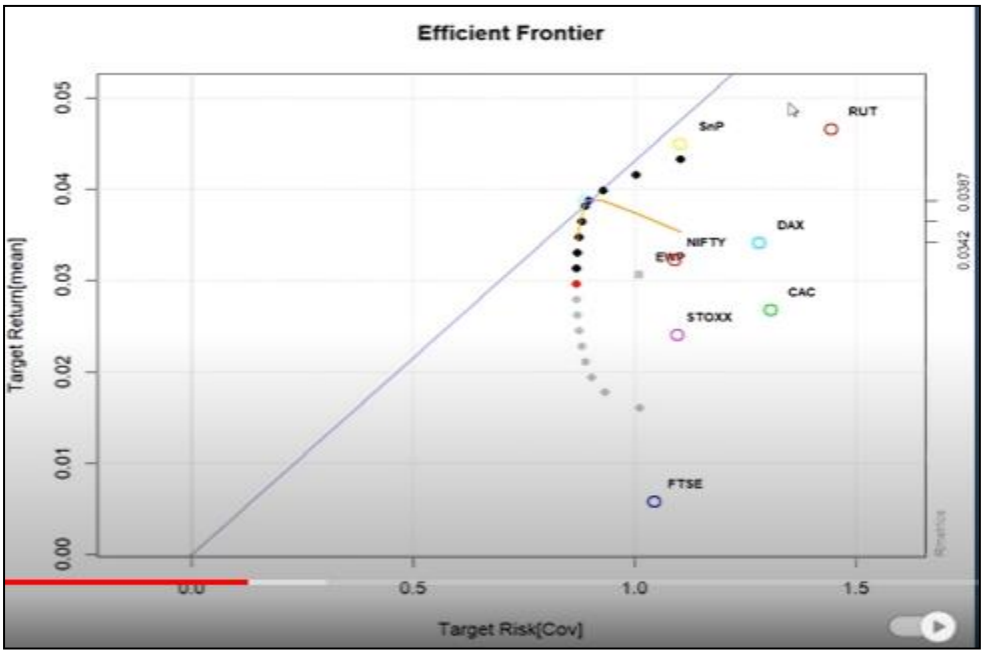
We will provide the return object data data which is final return which contains the return of seven securities that we are using. Then spec which is short spec object that we started and lastly we can now provide constraints as short so we will run this. Now short frontier object is created in fact you can print it to see what are inside so we can see now the portfolio weights we can see some of the weights are negative out of hundred five points are printed as we have seen in the previous video notice the solver solver short exact and you can see some of the portfolios have negative in fact in covariance risk budgets also we can see some negative and target we can see the target returns covariance C bar and bar risk calculated. Now using a very interesting command which is called tailored frontier plot we will try to visualize this short object so we will use this what we call tailored frontier plot which nicely prints a graph or plot of short frontier so we will use the short frontier object that we created. Let's give it a heading M text which is MV portfolio with short constraints short constraints.

Again we will stick to the covariance risk risk equal to COV. Now let's enlarge the plotting window so that graphs turns out nicely and we can see here let's examine the graph so we have a nicely printed frontier along with the tangency line and we have also individual assets plotted here along with the Sharpe ratio line so this is the complete graph through tailored plot command we can also use plotting commands that we use earlier to visualize this. In addition we would also like to have those weighted returns weights and covariance risk budget plots so for that I will again use the same set of commands copy paste them but I will just change this long frontier to short frontier. So I will just change it to long frontier to short frontier and let us plot them I will use this powermpro31 so that all of them are there in the single plot.



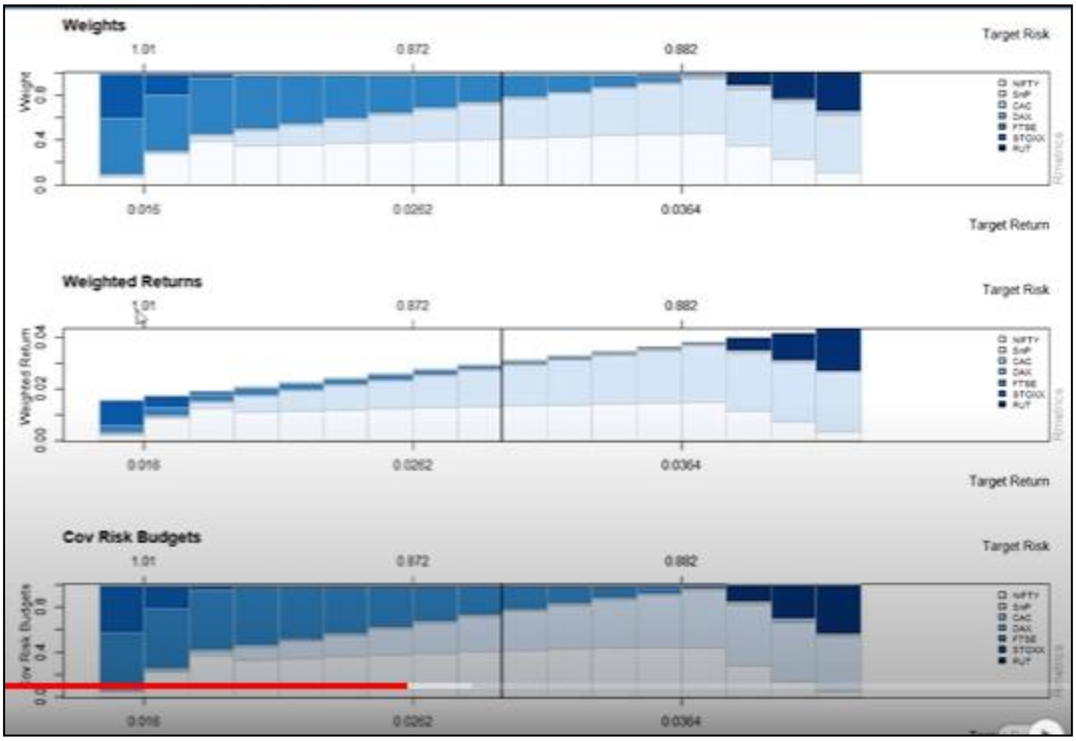
So let me zoom it to visually examine it more carefully. So let us examine this graph more carefully in the first plot we have weights of individual assets and now we can see it varies from 0.005812 to 0.0451 we can also see how the weights are changing now see it is negative minus one we can also see some of the points below minus one and some of them above two which indicates that some of assets have been shorted and the additional well due to shorting is invested in other assets so we can see that. In fact it seems that Russell has been shorted maybe a little bit of FTSE also and on the long side we have probably FTSE and tags on the long side and the pattern moves gradually. On the weighted return plot also we can see the contribution in fact we can see some of the assets contributing negatively particularly the Russell and along with Russell maybe it seems CAC some of them are contributing negatively to the returns along with we can also see along with that target risk and target return.

In the last plot we have covariance risk budgets and again here also some of them are contributing negatively due to their short positions while more specifically the FTSE and DAX are sorry CAC and DAX are contributing FTSE and DAX are contributing positively so they are in the long position niche and the position varies over time. To summarize this video we initiated with the short object with 100 frontier points first we plotted these frontier points along with their frontier then tangency line and individual asset points through tailored frontier plot command here we plotted them and then also we visualize their weights, weighted returns and covariance risk budget plots for this short portfolio object. In the series of next four videos we construct and visualize box, group and covariance budget constraint portfolios and in the final fourth video we will create a complex portfolio object with all four constraints put together. So first we will start with the box constraint portfolio frontier. Please note when you put constraints in the frontier the frontier is slightly restricted not as free as the frontier printed earlier which means that some of the combinations of risk return portfolios may not be available.



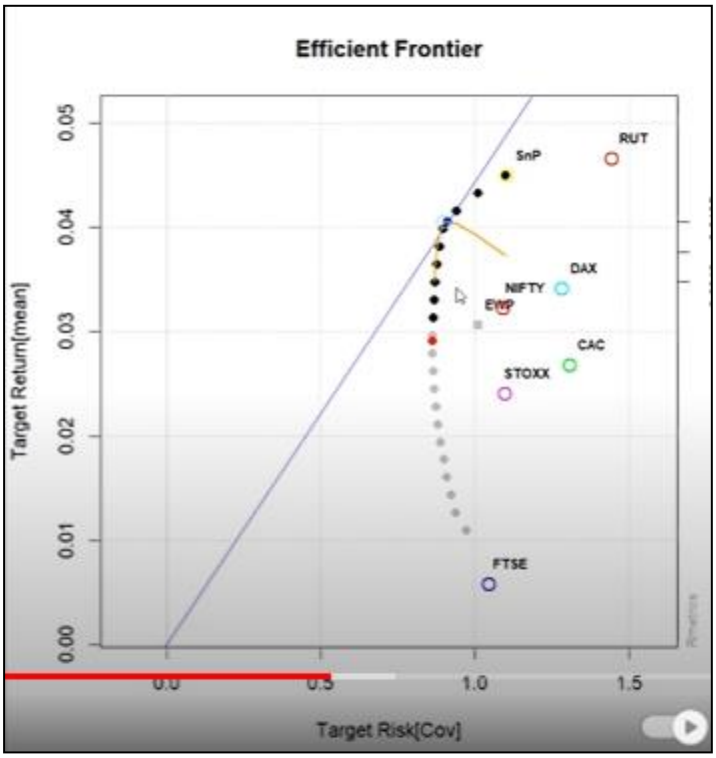
So let's start with this box spec, let's call it box spec and we will again initiate with the portfolio spec object. Let's have it for set n frontier points let's start with 25 points we will start with so we will have this box spec object with 25 points and let's specify the box constraints. Let's have

C first constraint may be minimum weight for portfolio 1 to 7 or let's put it on all the 7 portfolios equal to 0.01 as minimum constraint and let's also put the maximum weight constraint for all the 1 to 7 portfolios equal to 0.

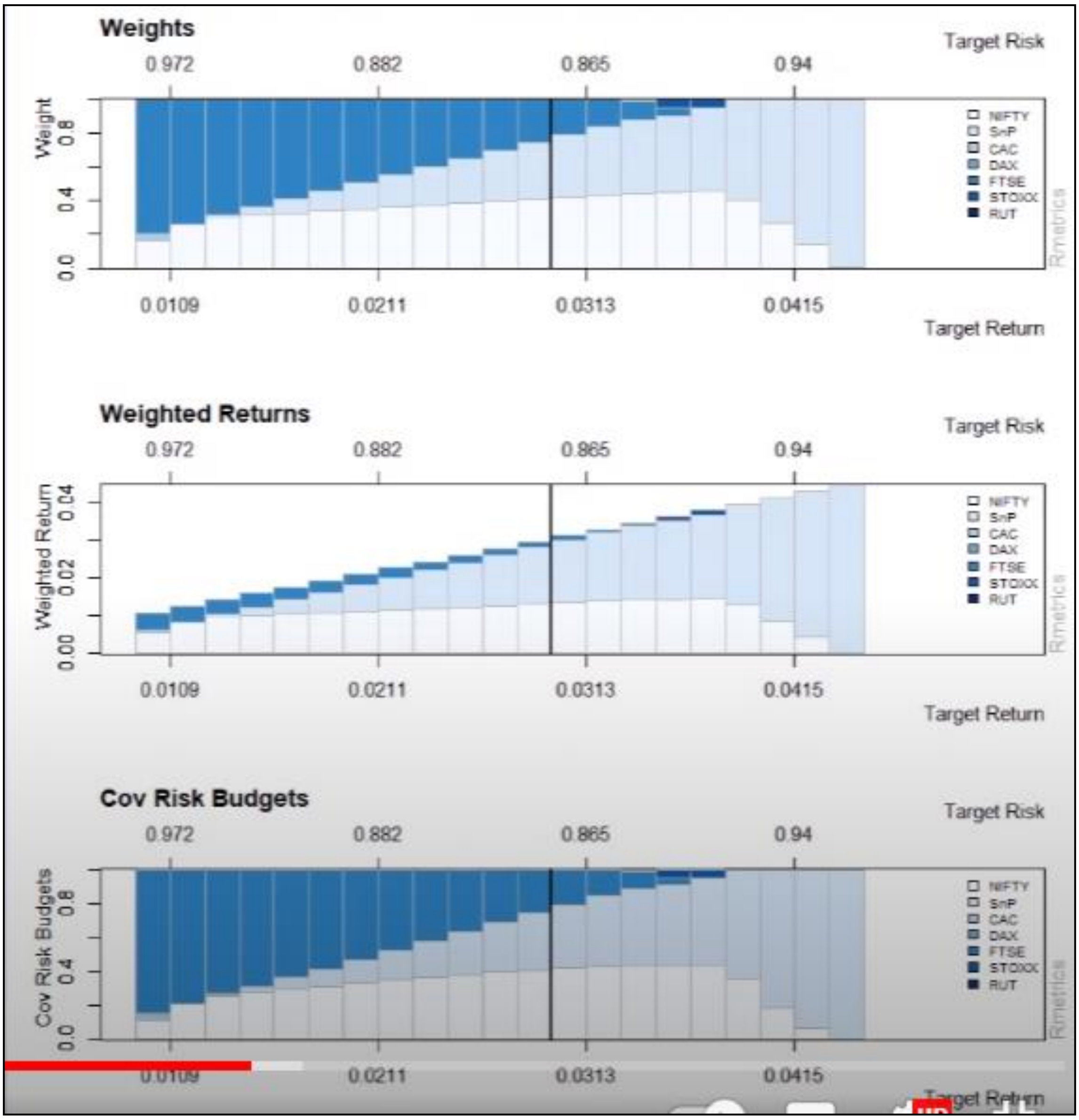


So these are our box constraints. Now let's create this box frontier object and this requires this portfolio frontier function where we specify the data as final underscore rate and we also need to provide the specification of this which we have put a box spec and then constraints. So now that we have specified box constraint we can directly put our box constraints object so we have box frontier. Now as a starting point to visualize this or you can directly print this also you can just print it simply and you will find all the constraints we have already discussed in the constraint video topic on constraints 5 points are printed you can see that their target risk returns are also computed covariance as budgets and portfolio weights are computed. You can see the constraints minimum weight and maximum weight these are box constraints on individual assets. So let's use this tailored frontier plot and let's specify the object our object is box frontier heading is mean variance portfolio with box constraints and again our risk is covariance risk.

So let's plot this so we need to enlarge the window a little bit and you can see the plots nicely printed plot return on the x y axis risk on the x axis covariance risk you have the frontier points 25 points along with individual assets and tangent line sharp ratio line nicely provided here. So this is your visualization also we can also plot the weights weighted plots and other plots that we discussed earlier that is quite easy you simply need to use the same commands here we will just copy paste in the interest of time I will not rewrite them and I just need to change this short frontier here from box frontier because this is our box constraint object box frontier so I will just put box frontier here and again they will be plotted and I will just enlarge the plotting window a little bit and then I will run them. So you can see that all the three plots weights weighted returns and covariance risk budgets are plotted the interpretation remains same as in the previous series of videos where we discussed the interpretation with target return target risk weight contribution of individual assets weighted return contribution of individual assets how they are contributing to overall return and how individual assets are contributing to the overall covariance risk of the portfolio or sort of risk of the portfolio which is measured through standard deviation or variance. In the next video we will plot the group frontier or group constraint frontier. To summarize this video we created a box constraint frontier object and visualize it in the next video we will create a group constraint frontier object.



In this video we will construct and visualize group constraint object or portfolio. So first let us initiate with the group spec and again as we do every time portfolio spec function to initiate the group spec object again I will use the same 25 points here we will just change the group spec notice I am changing box spec to group spec here so basically this will assign 25 frontier points to group spec. Now we will create this group constraints and we will assign a group constraints the following constraints are implied first we will use minimum sum weight that means for assets let us say 1 to 4 I am putting a constraint of sum equal to 0 point let us say maybe 0.05 so sum should not be less than 0.05 minimum sum of assets 1 to 4 that means 1, 2, 3, 4 and let me also put a group constraint of max sum W maximum weight maximum sum I am restricting for a set let us say 4 to 7 to 0.



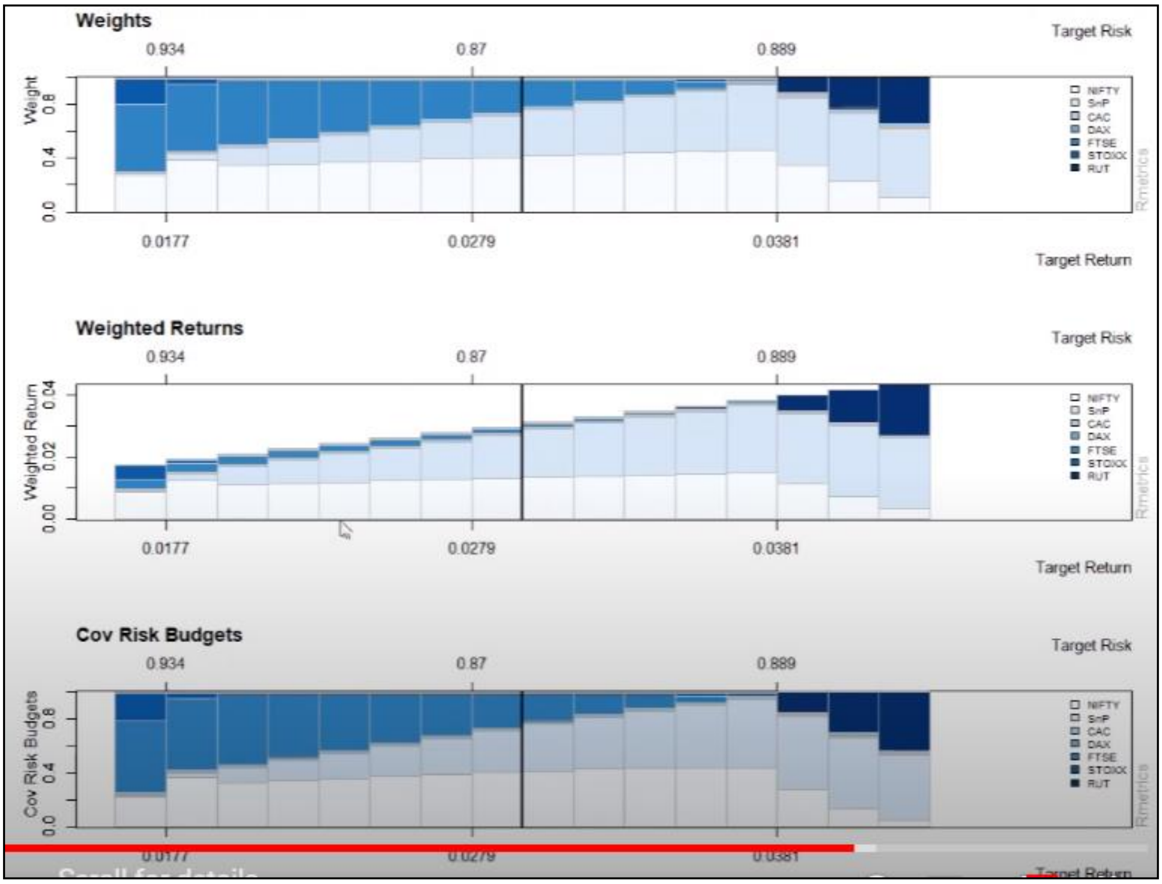
8 so I am restricting the maximum sum and minimum sum for 1 to 4 and 4 to 7 so these are my constraints. Now let me define the group frontier nicely so group frontier and let me assign it through portfolio frontier function as we have already done portfolio frontier function I need to specify the data which is final underscore return then I need to specify the spec which we have created with group spec group spec object and lastly I need to specify the constraints constraints equal to group constraints. Now I will run this command so my group frontier is created you can print it to see the elements inside for example you will find basic portfolio slot with covariance estimator solver optimization function you have nicely printed objects the target return risk and so on so let's visualize them. So I will use again the tailored frontier plot as we used earlier so tailored frontier plot for this we need to provide the object which is group frontier object and then we need to provide the heading temp text equal to MB portfolio with group constraints and we will specify the risk as covariance. Let us run this tailored frontier plot and as we can see the tailored frontier plot here nicely printed please notice some of the

risk return combinations of portfolios may not be available here because of these group constraints as they were in the original plot.

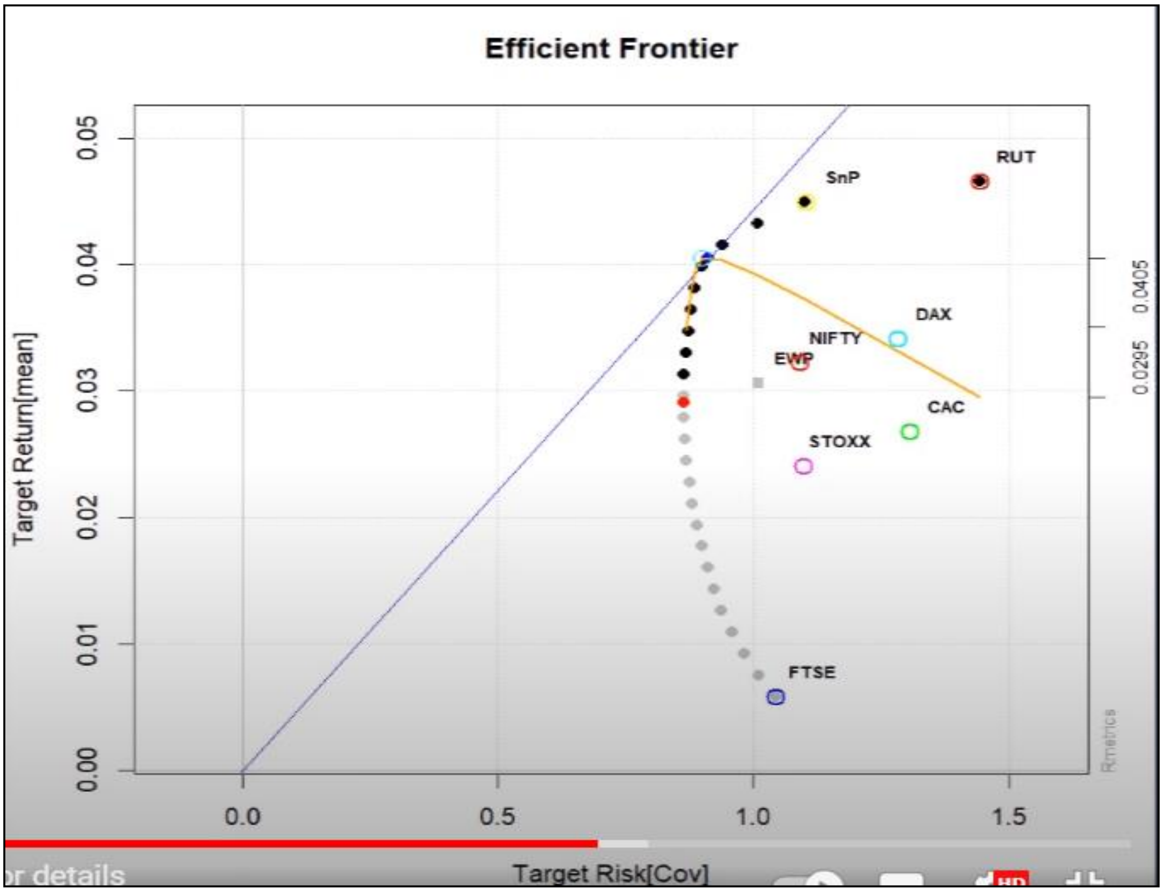
Now we can also add those weighted plots I will simply copy paste these commands I will not rewrite in the interest of time and please notice I will just change the box frontier to group frontier and I will put it here I will just change the box frontier to group frontier as we can see it is being done and then I can print it. Notice all the three weights weighted return and covariance risk budget plots are plotted here the interpretation remains the same we can interpret them in our free time. To summarize this video we started with our group spec object with portfolio spec function we initiated the object and specified 25 frontier points then we provided the group constraints as we can see here with these group constraints we created our portfolio frontier object with group constraints which we visualize with the help of tailored frontier plot and then we visualize three plots weighted plot weighted return plot and covariance risk budget plots. In the next video we will create a covariance risk budget constraint object and visualize it.

In this video we will construct a budget constraint portfolio frontier. So let us initiate this budget spec and again we will use our portfolio spec object again we will set our frontier points to 25 but let us use this budget spec object here replace this with group spec so we have budget spec and then let us specify these budget constraints. So let us start with identifying these budget constraints. Constraint number one let us call it budget dot one and we specify minimum for one to n assets there are seven assets so this n assets means seven and we will put it to minus infinite so this is minus infinite so we are putting no restriction on the downside and let us put object number two maximum budget maximum budget constraint let us put for one to n assets again seven assets we will have a sequence from 0.4 to one and we will set it by 0.1 so these are two constraints that we are going to use and let us define this object as budget let us specify this is budget constraints and we can assign this with both the conditions c budget dot one and budget dot two we can exclude this in fact we can print these this combined budget constraints we can print them you can see here.

Now let us create our frontier plot so for that let us specify our budget budget frontier object for this we need that portfolio frontier function so let us specify the data as final return final return data then spec as we have already specified our budget budget spec object then we need to specify the constraints equal to budget constraints let us run this so we have budget frontier now we will use our tailored plot frontier command here in fact we can copy paste the same set of commands and we just need to replace this budget frontier let us replace this budget frontier and we will call it minimum variance portfolio with budget risk budget constraints risk budget constraints let us plot this this is our risk budget frontier and again please notice a number of points may be not available here for there in the original plot because now we are putting this budget constraints so some of the risk return combinations may not be available with this budget frontier similarly we can also plot the weights plot that we did earlier we can plot this notice with different combination of weights weighted returns and covariances budgets interpretation remains same only that this time around we are putting certain conditions as we can see here so to summarize this video here we initiated a budget specification object with 25 frontier points and we specified certain budget constraints as we can see in these lines we have specified for all the seven assets certain conditions on their minimum and maximum risk budgets then we visualize this risk budget object here we visualize this through Taylor frontier plot command and then we also plotted the great beta return and covariances budget plots and we noted that there was some risk written combinations may not be available because we have put certain budget constraints that means in terms of maximum and minimum risk where it can possibly attain for individual securities in the next video we will create a complex budget object using all these three box group and covariance risk budget constraints and then construct and visualize the portfolio object in this video we will construct a complex constraint object we will employ the group box and budget constraint objects that we developed in the previous videos we will combine them and create a complex budget object and construct a portfolio around it and visualize it so we will create a complex constraint object let's create that so for that let's call it complex spec let's call it complex spec and again we use our portfolios spec function to create this object will as we did earlier we will specify the 25 frontier points but we need to change the object to complex spec object here so we will do that and now we will create our complex constraints and we will assign our box constraints group constraints and budget constraints so this is our complex constraint object now the remaining commands will remain same we need to create a frontier box constraint frontier so we will let's call it box frontier sorry complex frontier so we will call it complex frontier and here instead of normal constraints and specs we need to specify the complex spec object let's call it we will use our complex we will use our spec as complex spec object and constraint as let me enlarge the plot window a little bit complex constraints object so this will be our complex frontier and now while plotting we use this complex frontier object to create the plot we will call it mbportfolio with complex constraints let's plot this a little we need to enlarge it a little bit so this is our complex constraint plot as we can see here so let me plot our complex frontier this is our complex frontier similarly using this complete frontier object I can also plot the weight plots the weighted return plots and the covariance risk budget plot so let me do that as we did earlier so this is our complex constraint object we have weights weighted returns covariance risk budgets interpretation remains identical as we did earlier to summarize in this video we initiated a complex specification object wherein again with 25 frontier points and we combine all the three constraints that is box group and budget constraints combining these we created a complex constraint object and we started with the complex frontier and we visualize the complex frontier with our tailored frontier plot as we can see here this was our tailored frontier plot subsequently we plotted the weight weighted returns and covariance budget plot for this complex constraint plot in this video we will discuss how to initiate a C-var conditional var or expected short form specification portfolio in the interest of time we'll only discuss initiation of portfolio the other functions for generating tangency portfolio minimum risk portfolio global minimum risk equal weighted portfolio and also creation of efficient frontier will remain same so we'll in the interest of time will not cover that they can be replicated simply using the functions that we have discussed already in this lesson so we'll just initiate mean C-var portfolio so earlier we were using standard deviation variance or what we called here as covariance risk earlier we'll replace that with C-var conditional work risk so to initiate that object we'll simply use this C-var spec object and initiate it with portfolio spec function so we have initial so this is our portfolio specification object now notice that while I'm setting the type of this C-var spec I'll use the appropriate C-var risk so that this C-var spec is created now notice that while solver RGLPK has been set but we'll use a different variant of this and we'll call this set solver command and we'll pass on the C-var spec object and specify the solver as solverglpk.cvar so this specific solver will you assign we use this specific solver again the number of assets although this we have already done we will assign the number of assets as n call final return so we specify that there are six assets with this our complete specification is come over now you can create number for example if you want to set weights or perform other functions you can exactly do the same commands that you used earlier so for example you want to set weights to this C-var spec object you can simply assign it with the same command rip 1 upon n assets comma times equal to n asset the same command so basically we are able to initiate our C-var spec object now if you want to compute equal weighted portfolio you want to compute tangency portfolio as an example if you want to compute equal weighted portfolio let me show you that equal weighted portfolio equal to feasible portfolio as we did earlier same command we are using and I'm specifying data is equal to final underscore return here spec is C-var spec also you can use those dynamic interactive frontier construction with the feasible region and everything you can do all that so here I'm specifying long only so if I run this my equal weighted portfolio object feasible portfolio is created if I run this I can print a nicely printed readable summary notice this is C-var object C-var portfolio risk here being C-var and you can see the weights equal weight since it was equal weighted object we can see the equal weights covariance risk budgets target risk covariance C-var and so on so other procedure and implementation remain identical to what we have already seen for example we can construct tangency portfolio we can construct minimum risk or global minimum risk portfolio we can dynamically and in an interactive manner we can construct frontier plot as well so to summarize in this video we initiated a C-var object which was in contrast to our covariance risk object that we created in the previous series of videos in this lesson so just to summarize we created C-var object the other remaining commands to create frontier plots tailored plot and other things remain identical so in the interest of time we will not repeat them we hope with this lesson and with this our implementation we are now comfortable with constructing portfolio of your own choice with your own securities using R to summarize this lesson mean variance framework relies on portfolio variance or standard deviation as a measure of risk more recently tail risk measures such as conditional value at risk which is C-var have been implemented to examine the extreme risk scenarios we augment our mean variance framework with this C-var measure to construct and visualize mean C-var portfolios we start the discussion with introducing these measures next we implement the portfolio concepts using our programming we start by downloading the data from Yahoo Finance subsequently we compute the returns and visualize the data we initiate our portfolio object with simple long only constraints then we construct and visualize portfolios with specific risk return objectives these include equal weighted feasible portfolio minimum risk portfolio global minimum variance portfolio and NC portfolio then we plot efficient frontier in an interactive and customized manner we also initiate a short portfolio object with box group and risk budget constraints and visualize various attributes of this portfolio including weights weighted returns and risk budget composition we also combine these constraints and create a complex constraint object we comprehensively examine this portfolio object with complex constraints lastly we also learn how to initiate a portfolio in mean C-var framework.



Weights
Target Risk
0.934
0.87
0.889
Weight
0.0
0.4
0.8
NIFTY
SnP
CAC
DAX
FTSE
STOXX
RUT
0.0177
0.0279
0.0381
Target Return
Weighted Returns
Target Risk
Weighted Return
0.00
0.02
0.04
Cov Risk Budgets
Target Risk
Cov Risk Budgets
Rmetrics



Efficient Frontier
Target Return[mean]
0.00
0.01
0.02
0.03
0.04
0.05
RUT
SnP
DAX
NIFTY
EWP
CAC
STOXX
FTSE
0.0405
0.0295
Rmetrics
0.0
0.5
1.0
1.5
Target Risk[Cov]