**2/15/12 CDIAC Webinar Transcript: Investment Analysis- Duration Calculation**

**Introduction Slides 1-5**

Good morning this is Mark Campbell Executive Director of CDIAC, and I want to welcome you to today's webinar Investment Analysis: Duration Calculation-What Does it Mean to You?

Since the later part of last year CDIAC has taken the opportunity to utilize a webinar format to provide a more detailed study on a variety of topics. Today's topic is Duration Calculation and what we will cover such things as the difference between interest rates and duration, portfolio risk and duration strategies and to utilize the Bloomberg system for demonstrating the applications of duration calculations.

I now want to take a moment to go over some of the housekeeping features in case you are having technical difficulties. You will see on this screen that we have our phone number that you can call if you are experiencing difficulties. In addition, on the top bar to the right hand side of your screen you will see a feedback function and by changing the color coding there, you can indicate to us whether you are having problems or if we are moving too quickly through the presentation. Finally, on the left-hand side there is a Q&A drop-down box that allows you to write questions to the presenters which we can respond to directly in writing during the course of the presentation or will wait until the end.

So, with that I'm going to quickly introduce our speakers. Tony Garcia, Vice President & Sales Representative with the Fixed Income Sales Group at Wells Fargo Securities. Tony has represented the fixed income market here in Sacramento, and has been in the industry for over 30 years. He has focused on fixed income sales, public funding and corporate clients. Tony is registered with the Financial Industry Regulatory Authority (FINRA) as a registered general securities representative. He received his Chartered Financial Analyst (CFA) designation in 1998, and Tony has been a frequent speaker at both CMTA and CDIAC Seminars.

With him is Ray Johnson, a Fixed Income Specialist with Bloomberg Analytics based out of the San Francisco office. Ray is responsible for client training on a wide variety of advanced fixed income products and has a working knowledge of government agency and corporate municipal mortgage derivatives, and money market securities. Prior to joining Bloomberg, Ray was the Vice President of Bank of America Securities and Security Pacific Bank in similar roles. In addition, he worked on the trading floor and gained a working knowledge on a wide variety of fixed income products.

So with that I will turn it over to Tony to begin with his presentation.

**Slide 1, 2 & 3**

Mark, thank you as Ray and I really appreciate the opportunity to be here.

First I wanted to go over some of the topics we will be covering today about duration and some of the other concepts that fall into this same category. Essentially we are going to spend our time talking about interest rate risk in the context of Macauley Modified and Effective Duration. We are also going to cover duration and its most important forms, discuss convexity and how it is related to duration, and then go over a couple of things that really don't get a lot of play time in most duration discussions, which is a discussion about dollar or price duration and credit duration.

In addition, I do want to see if at any time any of you have a question, please send it in. You know if the concept isn't clear as we are going through our presentation materials, then let us know and we can try and explain the topic in more detail, because I suspect if it's unclear to any of you it may well be unclear to others. So we want to make sure that we cover the concept thoroughly because a lot of the concepts we introduce are built on the Macauley Duration which moves into modify duration, so if at any point it is unclear make sure we get your questions.

**Slide 4**

The concept duration has really gone through a lot of iterations over the last seven years. Though it has changed a little bit from its original introduction in 1938, by Dr. Frederick Macauley there really has been significant improvements to the concept and because of that, it made it one of the more enduring and effective tools towards measuring portfolio risks that we have in today's market.

Today we are going to discuss the uses and limitations provided by each of the revolutionary changes that have occurred since Professor Macauley first introduced the concept. The Macauley duration is simply the weighted average maturity of the bonds average cash flows, and as we plan to go into a little more detail later in our presentation however, this concept is a pretty significant leap forward for portfolio managers (at the time), that gave them a tool for comparing securities with different coupons and maturities although it does have its limitations.

One sidebar note that is important is that even though the Macauley duration was first introduced in 1938, it really did come into common usage until you got to the 1970's. It was in the 1970's, and I suspect having to do with the availability of better computing power, that you actually saw it come into vogue. Shortly after that, the concept of modified duration was developed, and allowed the ability to get an approximation of how much a fixed income security, or portfolio securities, would wind up moving in price, based upon a given change in yield. Although we typically use a change of + or -1%, or 100 basis points to see what the associated price changes, modified duration works very well but its usefulness begins to break down as bonds with embedded options are considered. As Ray will demonstrate a little bit later, you have to have a rule of thumb, or some type of criteria as to how you apply modified duration to either a callable, or putable security, or essentially any security with optionality.

Typically a securities premium option will be exercised if the bond is going to be called, so if the bond is at a discount it will be assumed that the bond will go to maturity. The problem exists that you then get radically different duration values for a security with optionality when you move even a small price difference away from par. So to deal with that issue, or deal with that problem, effective duration was developed and effective duration effectively smooth's out so to speak, the abrupt transition between premium and discounted price by using rather observable price in yield calculations or combinations.

**Slide 5**

Next, we are going to discuss and break down in terms of first discussing interest rate risk, and outlay a couple of basic concepts, which I'm sure most of you know, and what we plan to discuss is interest rate risk. More specifically interest rate risk is the risk of rising or changing yields and where the yield will ultimately end up, the changing value of the bond, which obviously is the real risk in a rising rate environment, and how that price of the bond is going to fall.
Then we will discuss duration, and how you can quantify how much the price a bond will, or is expected to change, or will change by knowing and being able to generate a duration value. Then once you have that information and you can get an approximate change of the expected value of the bond, we will then finally discuss risk. Generally when we look at Bloomberg and we see risk it is

basically stated in terms of DV- 01, which means the dollar value of a basis point and this is different from duration. It is important to note that this is a different concept in dealing with duration because its importance begins to develop when you start to move away significantly from par.

**Slide 6**

As we begin the discussion of Macauley duration we go back to the fact that it's been around for quite a while and that this was truly the first useful method for beginning to measure the risk inherent in a given security, and allowed portfolio managers the flexibility to apply it to portfolios. Prior to this concept, it was difficult to compare securities with similar maturities with different coupons however; Macauley duration allowed the portfolio manager something another means of measuring which security was superior, other than the yield. Macauley duration simply is the weighted average maturity of the cash flows of the security and is a time measure; therefore it's referred to in terms of years or fractional years. As we are dealing with cash flows it's easily applicable to an entire portfolio as if you have a portfolio of fixed income securities you know what those cash flows are by using the same calculation and extending it to the entire portfolio, therefore you can develop a duration measure.

With Macauley duration, the cash flows are weighted by the time period in which they occur, and then divide by 1+ the yield to maturity giving you the present value of each of those cash flows. The Macauley duration value is then derived with the present values and then divided by the price of the bond. The easiest way to think about it is in terms of this fulcrum that is on this particular slide. Essentially, the Macauley duration is that point where the present value of all those cash flows is balanced. Clearly this is a little bit off just intuitively, but essentially it is the time in years in which you get half of the cash flows that are received, however there are a couple of characteristics that naturally fall out of any discussion of Macauley duration. One of these is when we talk about duration, in that the duration of a zero-coupon bond is equal to its maturity. It's pretty intuitive if you take a look at the fulcrum and then you take a look at the cash flows to the left of the final cash flow, which the only point of balance is going to be that final maturity date. The other thing that comes naturally from this is that the Macauley duration of the bond will be shorter than its maturity because there are cash flows that are going to happen. Another characteristic is that the longer the security is assuming that the coupons are similar, the longer the duration. In addition, you will find that high coupon securities have lower durations relative to lower coupon securities. This is due to the fact that the present values of the coupon portions of high coupon securities are higher than those for lower coupon securities where their durations are going to be correspondingly lower. Furthermore, the duration of a security is also affected by the rate environment that you're in, so duration of the bond will be lower in a high rate environment that it is in a lower rate environment. Again this is affected by the present value calculation and as indicated earlier, as we are dealing with cash flows you have the ability to extend this discussion, or extend this to using it for portfolios.

Now I will turn the presentation over to Tony to show us the Bloomberg screens.

**Slide 7 -Bloomberg Screen**

Now that we are on Bloomberg screens are going to discuss how we really measure risk and duration with bonds in the portfolios. When I am going around talking to customers and training folks on Bloomberg discussing risk characteristics for the market I have noticed that evolution of duration calculations from Macauley to modified to effective have evolved over time. It is interesting that discussions of duration are widely used, but I find a lot of clients, when you talk to them, and ask how is your duration calculated or are you using effective for modified, it is

surprising how many times they look at a reporting system and they never thought to understand exactly how the duration calculations would be delivered. In addition, people find it a useful tool, but sometimes discount it and essentially say we manage duration by managing maturities of our portfolio. So, hopefully if Tony and I do our job well at the end of this presentation you will understand it is a little bit more complicated than that, and there are some tools you can utilize in the market to monitor.

The first illustration we have up there right now is a distinction between duration and maturity. And if you look at the two securities displayed we have a 1 3/8 NAVI- 15, government security that we have 9 1/4 that is roughly 3 months longer of February 16. If you take your eyes to the right-hand corner where we circled the risk characteristics you can see no matter how it is measured both in duration, modified duration or risk in fact the shorter security has a longer duration. This is what Tony was alluding to earlier that illustrates that duration is a risk measure not only affected by maturity, but affected by the coupon. So you see the waiting on 9 1/4 and in early years actually creates a waiting cash flow that will lead to a security being less volatile in terms of price movement than a security that actually has a longer maturity. There is a tendency when we buy securities, and Tony, if you want you can look at the yield curve is we look at maturities and look at higher yields as we go out on the yield curve. So this is an illustration of an instance where you probably passed over a least risky point in terms of duration to a more risky point in a security.

**Slide 8**

Thank you Ray, that was great. The next natural evolutionary thing that occurred once we had Macauley duration was to move to or the creation of modified duration. The problem with Macauley duration is that there's really no natural way to use that to determine a better sense of the risk inherent in a portfolio, except in some relatively superficial level. So, modified duration was developed as a means to bridge that gap and better understand the price risk characteristics that are in a portfolio. Using Macauley duration as a jumping off point we can divide it by 1+ the yield per payment, the function, or the equation is right there on the screen. This calculation allows us to move away from a time-based series to one that is yield based. So this means that modified duration will have a lower value than Macauley duration however, we now have a better ability to understand the security. In addition, when we talk about or say duration, we really just mean modified duration and at this point we are just moving away from the entire concept of Macauley duration in our discussion.

With duration we can now measure the sensitivity of the security and a portfolio to a given change in yield. Note that duration is a negative value due to the inverse relationship between price and yield, and as we all know as price goes up, yields go down and just the opposite. By taking the duration value which is a negative and multiplying it by the expected change in yield we get an expected change in price. We can then add or subtract that value from the current value of the bond and get an expected price. Understand that this is true for relatively small changes in yield because the price yield function is curvilinear in nature however there begins to develop a certain error between the estimated price, and duration calculation suggesting that the actual observed price of a bond. This has to do with that convex nature of the price yield function and each bond or each portfolio will have their own degree of convexity and also their own individual duration. The question is: convexity is a measure of just how curved the price yield function is. We wanted to discuss convexity a little later, but for those of you that might have looked ahead we wanted to at least begin to make that link.

It's also important to note that while two bonds may have the same duration we may not get the same expected price change. Duration represents the expected percent change of a bond and so a par bond will have a different expected price change then a bond of say a dollar price of 90. This

risk characteristic we will address a little bit later when we talk about risk and in dollar terms, or as we refer to as DV- 01. So, here are some more practical explanations of that, and I will turn the presentation over to Ray and his Bloomberg Terminal examples.

**Slide 9- Bloomberg Screen**

Thanks Tony. As we discussed before and going back to the evolution of duration calculations, Macauley duration measures a weighted average cash flows, which is useful, and to reiterate this and as what Tony was stating, modified duration gives a much more useful number in that it gives us a number that is going to represent a percent of loss on a security should interest rates move up or down. So it is an actual measure in terms of a 30-year price of your bond. How much money you're going to make or lose for a given a shift in interest rates. We haven't yet got to effective duration but modified duration and effective duration for non-callable securities, and for bullet securities are essentially identical or very similar as the differences between them are almost insignificant. However, with modified duration when evaluating callable securities has some weaknesses that effective duration doesn't, mainly when you calculate a modified duration the advantage is you don't really need as much data, you don't need an underlying yield curve to shift, you don't need either a government curve for swap curve to base your yield curve calculations you can calculate duration off all the components of the security itself. However the weaknesses to calculating the duration is that you have to make a maturity assumption or call assumption on an individual security and what I wanted to illustrate here is that when looking at solely modified duration for non-bullet securities, small price changes can lead to larger risk swings when looking at a security.

So, for instance in this example we are looking at a callable home loan security that matures in 17, that has a six-month embedded call option on it and as you can see at the top part of the slide we are running at Bloomberg yield analysis grade, and we are looking at a dollar price of 99 spot 99 which is a yield of 1.102, and as you can see from the modified duration calculations, which are listed under that security column on the right-hand side, the modified duration and risk of the securities is listed at 4 spot 85, which we tend to think of it as almost 5 years, although as we have mentioned it is not really a discussion of years, when we are looking at modified duration. Now please look to the bottom right-hand portion of the slide and a note that I just changed the price from 99 spot 99 to par on the security and the yield changed less than 2/10 of one basis point. So, virtually nothing. However, whether it is a Bloomberg yield analysis grading or any modified duration calculation of any system, you now see that the modified duration is calculating on a yield to worth basis and it's actually calculating a yield to the first call, so it is showing you the risk characteristics of your bonds are less than 1/2 year, or very similar to a six-month security. So as you can see and if you are solely looking at modified duration for callable securities you may be exposed to very large swings in your risk characteristics or your portfolio. This issue has led to portfolios with substantial amounts of callable securities and mortgage securities, as well as callable agencies that are with more sophisticated accounts have moved toward considering effective duration rather than modified duration in order to avoid these swings or unexpected changes in the risk of a portfolio that could result from interest rates going up, in what could be quite marginal levels say, of 25 to 50 basis points. Tony do you have anything to add to this?

The only other thing I might want to add is that there are some issues using modified duration. One of the issues that arise when you are using duration and convexity is that they really are not fixed values, and they change both over time. Certainly when a security gets closer to maturity and as the rate environment itself changes, the duration value really has no durability because as a bond gets closer to maturity obviously the duration value gets smaller. Also as rates change the duration value is going to develop for the security. Again, just think of it in terms of the price yield function. You're going to get a lot more movement in a higher yield environment that you would in a low yield

environment given the change in yield. At any rate that was really the only other thought I had since you already introduced the topic of effective duration. So, let's talk about that.

**Slide 10**

The calculation is right on this slide. The failure with, or the issue with duration and convexity, and where they fail is when you start to look at securities with embedded options. So with that, effective duration essentially is that place, or that calculation that we use to be able to develop a risk profile for a particular security. Securities with optionality begun to populate portfolios and was using duration as a tool for managing risk or determining the risk. It was really pretty much a compromise and that has to do with the fact that the duration model is primarily driven by cash flows. So, any uncertainty about those cash flows is essentially going to make the calculation worthless. So in order to determine what an unexpected percent change in a securities price is going to be we use effective duration.

Effective duration uses the actual observed changes in price for a given parallel shift in interest rates to determine the duration of a bond and again, the calculations on the screen. Effective duration considers how changing rates will change the expected cash flows for given changes in interest rates, and only some future cash flows will change for an embedded bond. In other words for a callable bond in a declining rate environment this will cause the bond to be called, and the future cash flows essentially are eliminated. Since only some of the cash flows will occur, those are the only ones that you can use to discount or to determine the duration, so effectively the duration has shortened, but the duration value has gotten smaller. Another advantage of effective duration is that even in the case of large changes in yields; you are able to capture a reasonable price change generally when using duration as the measure as it becomes less useful for large changes in yield as essentially we move to a binary outcome. If the bond is going to be called say, at the next call date or there is a high probability of doing so, or the bond will go to maturity. Think of it in these terms: Say we have a five-year note that is moved several points away from par; say 90 or 95 dollar price, it will take a very significant decline in rates to cause the bond to be called. The opposite is true given a bond trading say above par, at 105, and then you would have to see the market yield increase substantially for that bond not to be called. That's not to say that rates won't undergo that type of change it's just that the probability will have declined materially. Therefore, the effective duration calculation takes into account these perceptive outcomes to deliver a value that more accurately counts for the effects right around par, and Ray will walk us through some examples.

**Slide 11 –Bloomberg Screen**

Thank you Tony, specifically in terms of effective duration we will stick with the same example that we used previously with the callable security and we will just look at the effects of the price movement. So you can see while the modified duration of the security can fluctuate greatly in terms of just a very minuet dollar movement, effective duration essentially as stays static so, for very small price movements the likelihood of the bond being called or not being called really hasn't substantially changed. As we look at interest rates as variable over time and there are many mathematical models that apply to inverse characteristics we can say over time that roughly the same probability is a minutely lower dollar price than par, so it is reflected in the price movement of the securities and this is more an indicative behavior of callable securities. So, over time it will mitigate any jumps in risk measurement and give you a consistent risk measurement that over wide moves in interest rates it will lengthen or shorten depending on the movement of interest rates. As interest rates go up, callable securities effective durations will lengthen as the likelihood of any call action on the security goes down and the opposite is true if interest rates drop.

**Slide 12**

The next measure we want to introduce is risk management and I will continue with this because it is really not a new concept. We talked about duration, right, in terms of being a measure of sensitivity both in price in a portfolio or a bond. Risk is simply a dollar measure of the same issues. So, risk, while duration measures the percentage gain or loss of a bond, so a risk measures as an absolute dollar amount gained or lost. The reason I mention this topic is as I speak with people there is a lot of confusion and unique distinction between risk and duration.

**Slide 13 –Bloomberg Screen**

Here we are looking at duration as a percentage and risk is a dollar amount. So look through the three separate issues on a five-year government security. The top slide you can identify that at par when the bond has now accrued, you can see modified duration and risk are identical, and it is the same exact number. So, for example 4.88% of par with no accrued interest is going to result in a price movement of 4.88 points. The distinction is when the bond goes to a discount as you see the second slide I used a $97 price for the bond and you can see that duration as a measure is now higher than risk, so for example 4.86% of a $97 price is an absolute dollar movement of 4.719. Then, it follows the other difference is when a bond goes to a premium and I used a 103 dollar price on five-year security which seems five years ago that would have seemed absurd to everybody listening, but it's probably not outside the realm of possibilities in this interest rate environment, but that said, it is just for illustration however, you can see that the modified duration which remains somewhat static in terms of percentage, now results in a higher risk number, that is, the money I risk is actually increased to 5.04, so that is the distinction we see between risk measures and duration measures. It's meant to absolutely give you a dollar amount as opposed to a percentage of the portfolio. Ray would you agree that this becomes useful when you are talking about securities that are either deeply discounted or have a very high premiums? So isn't this where risk becomes really useful.

Tony, exactly it would've been a good illustration to look at the discrepancy between those coupons if we are looking at 9 1/4 versus the 1 3/8 that we were looking at previously right? Because the 9 1/4 was the 135 dollar price, so the 135 dollar price means the duration percentages are going to be roughly 35% higher due to the premium on that bond. So it can have substantial differences between duration calculations.

**Slide 14**

All right, well I think we covered that part of duration pretty well and I see that we have a question, so we want to go take a quick look at that.

**Question:** Why does one of the screens indicate maturity and the other as a work out?

**Answer:** The reason being is if you are not familiar with the yield calculation, reflecting how modified duration is calculated, and any time a dollar price you are calculating on a modified calculation with a security moves higher than the call price of the security the yield reverse will usually be the first call on the security, and there could be a call on where it changes. However, for a par call anytime you are looking at a call at par price or greater the yield price is going to be over the shortest period. In addition, when you change the dollar price to something below the call price, the yield reverse is in this case automatically going to shift to usually maturity, the longest maturity base of the security because that date is what generates the highest yield. This is the industry standard for calculating modified duration and it is the source of the weakness in evaluating risk associated with callable bonds. I hope that answers your question.

Okay now I think we can move onto convexity, and if that did not completely answer the question, then please go ahead and send us back another question and we will deal with that at the end of the session.

The topic we've referred to previously is the idea of convexity, or the actual shape of that price yield curve. And for relatively small changes in the yield, duration does provide a very reasonable estimate of the expected percent change in the price of a bond. However, when you are in the process of stressing a security or portfolio that duration estimate starts to drift away from the actual price you end up getting, this is due to the convexity or the curvilinear nature of the price yield curve and each security and portfolio is going to have their own. Duration is linear in nature. Some people refer to it being the first derivative of the price yield function but it is basically that point of tangency that a particular price yield combination provides along that curve. Convexity represents just how curved it is. So, as you move away from that original value that is defined or provided by duration, then you start to get some error, and the error comes in the form of a separation between what duration provides as your expected price for a given yield, and what you wind up getting is the more complex the curve is, the greater the error. The solution here is basically to add a second factor to the calculation which is convexity and you when you add convexity to duration you end up getting a better estimate. Convexity is typically a positive value and when added to duration, which is a negative value, it gives you a more accurate estimate of the expected price of a bond for a parallel shift in yield. One of the characteristics of convexity is that being a positive value and duration being a negative value it provides a positive skew to prices. In other words, bullet securities, those without embedded options will tend to increase more in value for a given decline in yield that they will go down for an identical increase in yield.

**Slide 15**

Now in this example and one of the things that we can take away from just looking at this graph here is that the more convexity, the better, so convexity is a good characteristic to have. A bond with greater convexity is less affected by interest rates than one that has less convexity. Also as you look at the graph you can see that the bond with greater convexity will have a higher price than any yield with a bond with a lower convexity even though they may have the same duration, you will get better performance out of bond A than you would out of bond B.

**Slide 16**

The discussion so far of convexity really as related to bullet securities or those securities without embedded options. When we begin to examine securities with optionality we begin to see a radical change begin to occur in the price yield function. In a rising rate environment a callable security will tend to perform like a bullet security. There is this smooth decrease in the value of a bond as yields increase which is due to the value of the option essentially moving out of the money. The option held by the issuers is unlikely to be exercised and the bond will go to maturity. However in a declining rate environment as most of us have experienced recently, the performance is anything but equal and opposite as rates decline, the steady increase in value of the bond begins to slow. Ultimately as the bond moves further above and away from par the price appreciation stops. Here the option has moved into the money and it becomes increasingly likely that the issuer will exercise the option to call the security. The price yield function has now gone negatively convexed and that's where we get the term negative convexity and this is a characteristic common to all securities that have a call option embedded in them. As rates decline the duration of a callable bond begins to decline as the value of the security shifts to using the call date as the expected maturity date. Since there is a declining expectation that the cash flows beyond the call date will realized there is no need to include them in the calculation.

I think Ray has got some great examples here.

**Slide 17 –Bloomberg Screen**

When I speak at Bloomberg sales force training events about convexity, and as I listen to Tony discuss convexity I'm glad I cannot see your faces and your response to this subject matter. But to summarize what Tony was saying in detail is when we measure duration and the risk of a security, duration can be good or bad depending on whether interest rates are going up or down. Just ignore how we measure it for the time being. When dealing with convexity the first thing that is important to do is think of a security with a given duration, convexity is always good. The more convex a security, the better it will perform as interest rates change. So it will actually gain more money than a similar duration with a less convex bond. When interest rates go down and it will actually lose less money than the bond when interest rates go up. That is why it's important to not only look at a duration, which I would argue is still by far the most important risk measure, but also convexity, that is how your securities are going to change over time. In addition, it is a difficult task and it really forces investors out of the yield curve and into a callable product in a variety of things however, it is important to understand the risk characteristics you're generating in your portfolio when you are making these decisions.

So let's look at two securities and what I did was take two particular securities; one the Fannie Mae 1.125 June 14 and the Farm Credit 1.27 Jan 17; the Jan 17 bond that I've listed on the top you can see is callable, in a year, January 18 at par. The Fannie Mae with a shorter maturity is a bullet security and non-callable. These are typical examples of two securities of similar durations, one with embedded optionality which we can define as poor convexity.

**Slide 18 –Bloomberg Screen**

If you look at this slide this is what I'm trying to illustrate. If you look at the risk characteristics of these two securities from day one, and you are evaluating them, is that you are evaluating current dollar prices you can see that the effective durations, (which I just argued are the most important measure or the best way to measure risk associated with callable securities) of these two securities are virtually identical. So by simply looking at duration and ignoring any convexity issues you would say these bonds are very similar, however if you look at the top convexity calculations you can see the convexity associated with a callable security is actually a negative number while the convexity associated with the bullet security is a positive number. What does that really mean?

**Slide 19 –Bloomberg Screen**

On this slide we can calculate in Bloomberg total return calculations over a given time frame. So we put in a scenario to calculate the return of my securities in any given scenario. So what I've done is I first loaded in the top screen a callable security out in 17, you can see that an up 50 and up a 75 interest rate scenario for the three-month horizon we put in the time horizon of May 2012 so if interest rates go up 50 basis points I'm going to lose roughly 5% annualized on the security up 75 as it approaches 9% annualized or 1.2% and 2.25% over the three-month period in terms of my total return on the security is. If you look down to the bottom right-hand corner where I ran the identical scenario on the security that originally had the same duration you can see that due to convexity this bond actually performs somewhat better so that the losses are much smaller in each circumstance, so rather than 1.28% 2.25% losses in the three-month time period, you have less than 1% and 1.4%, and this reflects that the fact that more convexity of the bond allows a security that originally had the same effective duration to perform better over time.

**Slide 20 –Bloomberg Screen**

On this last slide what I am trying to illustrate is why this is the case and the reason this is the case. As interest rates go up the likelihood of the callable security being called decreases substantially. So the effective duration calculations and as you can see here, the security begins to behave much more like a security to its final maturity. So if I took a snapshot and I put in a settlement date for each of the securities for our horizon date which was May 13, 2012, and I put in the yield associated with the bonds given those dates and the shifts in interest rates and you can see the effective durations of the callable security. Now it is substantially longer than the effective duration of the bullet security. So in fact the bullet security moved down the yield curve it's in fact three months shorter and is going to behave more like a three month instrument that is three months shorter than it was on day one however, the callable security not only did it underperform it's now adding more interest-rate risk to your portfolio than it did before, because it is behaving more like a five-year security. These are all the factors that illustrate what poor convexity really means with a portfolio.

Tony did you have anything to add?

No, I think that covers it beautifully. I think we can move on to credit risk.

**Slide 21**

No we want to illustrate the primary risks that usually affect municipality's portfolios in terms of interest-rate risk and hopefully you found those examples useful but we didn't want to just leave it there, we wanted to discuss other risks such as credit risk. We have the concept of interest rate duration, there's also the concept of credit spread duration. We can look at impacts of credit spreads on returns on securities, very similar to how we look at returns of interest-rate movements, and the effects of interest-rate movements on returns in terms of securities. More specifically, I wanted to relate to corporate securities (and we know that they carry greater risks because they are not a government-sponsored entity) as most municipalities when they look to evaluate credit risk what they are really evaluating is the default risk and what portions of the security could impact and result in losses of the portfolio. Those are all pretty straightforward and all pretty much the same whether they are fixed-rate securities or floating rate securities. However with floating rate securities there are some characteristics we want to look at in terms of how floating rate securities are going to behave over time.

**Slide 22 –Bloomberg Screen**

What I have done to illustrate his kind of risk and what we term as credit duration or credit risk associated with a floating rate security and I am looking at a specific example of a September 14 General Electric floating-rate bond which I would imagine is still one of the few AA rated securities out there, which fits the investment criteria of many municipalities that you may actually consider buying. It is a senior piece of debt; it floats quarterly and is libor +26 basis points. The attractiveness of floating rates instruments is that they are not tremendously impacted by interest-rate shifts. So if we look at this bond, if interest rates go up, some time frame less than 90 days from now I'm going to get a reset in my interest rates and hopefully by interest-rate will reflect where libor rates move to, current interest rates and my securities going to reset with a coupon that reflects that in stays current with the current level of interest rates which was all positive.

**Slide 23 –Bloomberg Screen**

Now as I page forward however, when looking at the risk characteristics of the bond, please go to the portion of it I actually circled in red, where we look at duration calculation and at the left-hand

side the duration calculation to March 15 2012, which March reflects the minimal interest-rate exposure we have with the bond. However when we look at the OAS and it's not displayed well on this screen, but this OAS calculation from our yield calculator is calculating the option adjusted spread of a movement in credit spreads. So, while interest rates are not going to affect the value of the bond, a movement in credit spreads can have a substantial impact on the value of a security even if it doesn't default. So while a floating-rate bond has very minimal interest-rate exposure it can have substantial exposure to a movement in credit spreads. If we look historically, we can see movements of hundreds of high investment grades by up to 100 basis point movement can be identified so, know that this can have an impact, so when you buy floating-rate corporate bonds if it's a period where credit rate interest spreads are very tight, perhaps you might want to hold off until credit spreads are wiped out a little bit and you can evaluate at that point.

**Slide 24 –Bloomberg Screen**

What I illustrate on this slide is to show you, is to quantify the value in terms of movement. So the top screen we are looking at the yield calculator that shows that GE bond is at par where we are earning the discount margin which is the effective credit spread for the security over the remaining life of the security so you can see at par it is roughly 26 basis points. The illustration on the bottom right I simply changed the discount margin which is a measure of the credit spread and say some adverse impact moves earnings on GE that has less of an appetite for that corporate debt now the credit spreads have widened out by 100 basis points which is not inconceivable. You can see the effect of the dollar price of the bond, so if we were forced to evaluate this bond at 126 DM as opposed to 26 DM you can see roughly the bond decreases in dollar price by 2 1/2 points, which looking down to the, bottom right-hand circle where you have credit spread duration. It is reflected their exactly how the security is going to perform. So it largely gets ignored in thinking of credit spread durations and credit risk because for bullet securities it is identical to interest-rate duration. It doesn't really matter whether underlying interest rates move a couple basis points or where underlying credit spread is, the risks associated with those securities are virtually going to be identical however, when evaluating floating rate securities there is a substantial difference between interest rate risk and credit spread risk associated with those and I just wanted to make sure that we pointed that out because I don't think it is often discussed in terms of portfolio management.

**Slide 25**

That really ends our prepared remarks and I see that we have a few questions.

**Question:** Can diversification of bonds smooth out the convexity of the overall portfolio?

**Answer:** It doesn’t smooth out. How convexity calculates, in our illustration of the callable security with negative convexity in the instance where interest rates went up and the effective duration began to migrate toward duration for maturity, what you would see over time is that as that duration lengthens the convexity of your bond will actually improve. So as the damage is already done so to speak in terms of you've already experienced higher interest rates having your duration effectively lengthened on that security, your convexity on that security will actually improve somewhat. In contrast that can be undone as interest rates rally.

**Question:** Does a portfolio of securities with negative convexity apply a portfolio approach and make it less important, or the portfolio as a whole less negatively convex is that fair?

Ray, I think the specific question was can diversification I guess of the portfolio kind of smooth out any convexity issues.

Tony, I assume, what I was trying to get out is it does not really smooth it out. A portfolio is really going to be a combination of the convexity of the individual bonds. The only way that will changes over a fundamental movement of interest rates. Buying two separate bonds that both have poor convexity is not going to mitigate, make it any better for the entire portfolio that it will be the individual securities. What will mitigate it is basically a time and movement in interest rates that, when interest rates rise is, your duration lengthens and you're convexity will improve as a result.

Yes, it is essentially a portfolio of callable securities in a declining rate environment. You have no diversification effect.

Hopefully that answers that question.

The previous question talked about work out and maturity. I think that the question had to do with when you are referring to maturity you are really talking about a bullet security and when you talking about work out that typically is going to be what you use when you are talking about a callable security. Is that fair? It's really a terminology question, essentially when you're talking about work out in a bullet security it's always going to be to maturity, right?

Exactly, I was kind of confused in terms of the question. What we use is yield to work out. Yield to work out at least in Bloomberg's analytics is generally yield to work to out. So if the bond is trading at a call price above the dollar price yield prices usually going to be to the first call. When it is trading below the call price yield to work out will be to the maturity of the security. It is a yield to worst euphemism that the workout defaults in our yield analytics are always on a yield to works basis.

Okay I think those are the questions we have so far and if anyone else has questions we have time and we would be happy to respond to them. So, please send any in as we have time.

Tony, it actually it just occurred to me that there may be one another kind of concept to add to this presentation. We talked at length, hopefully not too much length, about the difference between modified duration and effective duration. More to the point, I want to illustrate what I have been talking about when discussing convexity. As interest rates increase for instance, effective duration is going to migrate toward duration into maturity because the probability, the vetted analytics that Bloomberg runs to determine the probability of that security being called, that optionality is now way out of the money for the issuer. They are not going to affect it in overtime. You will not see the substantial movements over small interest rate levels, but over large interest rate levels you will see the same migration in terms of reported risk and duration on the security.

Thank you, Tony and Ray for an outstanding presentation on duration. This is a perfect example of how CDIAC has tried to use the webinar format to deliver relatively complex topics in a condensed period of time. The disadvantage here is that we don't have the face-to-face interaction that can encourage questions, and a deeper analysis of the subject matter. So I would suggest to you that if you do have remaining questions that you e-mail them to the CDIAC Education email. We will pass those on to Tony and Ray and we will try and make sure we get answers to you, or you can certainly take the opportunity to follow up directly with Ray and Tony.

I would like to mention one of our Debt Essentials upcoming classroom seminars being held in Pomona, California, March 13 through 15th. The course is on the fundamentals of debt issuance and administration. We also have a Municipal Market Disclosure seminar May 3rd here in Sacramento and we have another webinar coming up on March 28th at 10 AM to 11:30, focusing on Investment Structures and Risk Management of public investment portfolios.

So, with that I think we can close the seminar, the webinar and I thank you for your participation today.