Rodrigo: **00:06**

Hello everyone and welcome to ReSolve's 12 Days of Investment Wisdom mini-series, where Michael Philbrick, Adam Butler, Jason Russell, and myself, Rodrigo Gordillo, will explore timeless evergreen principles that will help you and your clients achieve long-term investment success. From the importance of asset allocation, thoughtful portfolio construction, and maximum diversification, our aim is to offer you a comprehensive framework for a more thoughtful investment approach that may change the way you view the complex arena of investing altogether. We hope that you enjoy the series as much as we enjoyed putting it together.

Disclaimer: **00:42**

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Mike: **01:10**

Welcome back, hot off the back testing and ensemble methods and nuance differences in those areas. Make for interesting differences in strategies. We now head to today's all about "The Optimization Machine …", one of our recent research papers that has also attracted a tremendous amount of attention and so today we're going to ah, be chatting about that.

Rodrigo: **01:40**

No, that's exactly right. And what we want to talk about today is really shine a light on the fact that the weighting scheme is just as important, if not more important than the strategies that you put in place. You can't simply use an equal weight methodology without understanding that, that is a very active decision that is affecting the Sharpe ratio that you're going to get in your portfolio, the return per unit of risk that you're going to get in a new portfolio.

And so today we're gonna kind of walk you through some of the more common ways of weighting that many people use because they're easy, and then see if we can test the assumptions by which we came to those weighting schemes and then try to improve on them by looking at real empirical data and what it says to us to see if we can do a better job at that very, very important part of the equation. So why don't we, uh, let our CIO take over from here and walk us through a little bit of the paper and some of those weighting schemes.

Adam: **02:30**

This is going to be a lot of fun today. We're going to really sacrifice some sacred cows. By habit or convention, the reality is most investors default to just a handful of heuristic methods for portfolio construction. You kind of have market cap weighting, maybe equal weighting. You've got convention weighting, right? Which is kind of, well this is what everybody else does, so this is what I'm going to do too. Think about your kind of 60, 40 portfolio for example. And then you've got conviction weighting, which is a lot of conventional active managers, mutual fund managers, you know, they've got a list of stocks that they like, they liked certain stocks more than others, the stocks you'd like to get more weight in the portfolio and vice versa. Right?

So there really are four different traditional weighting methods and, and what we're going to challenge today is the assumption that any of those weighting methods really hold water most of the time. And I think a natural place to start is by looking at some of the assumptions that we make about what investors would prefer in terms of the character of their portfolio and their investment experience. And so I think we should, we should start by laying a few ground rules. Number one, that investors, when they're asked in a calm state, when they're being thoughtful and reflecting on what they want from their financial future and their objectives, will say that they would prefer to have higher returns.

So a higher mean expected return while minimizing risk or minimizing the distribution of terminal wealth or you know, the, the money that they have at the end or that they use to fund whatever their financial liabilities are. And so financial professionals, they call that set of preferences Mean Variance Optimization, right? You're trying to maximize your mean expected return while minimizing your expected risk, your volatility, which then leads, volatility directly impacts the dispersion of terminal outcomes. Right? So this is Mean Variance Optimization, and we're going to actually make, another assumption as well.

And that is that typically the reason why investors default to these heuristic methods of portfolio construction is because they want to avoid having to make active views about the investments under consideration in their portfolio, right? They, they sort of intuitively understand or have been taught to believe, that it's really hard to estimate relative returns. It's hard to estimate risks, hard to estimate correlations, and so they want to construct portfolios in ways that they think obviate that necessity to express those active views. Right?

So, so two basic assumptions. Number one, people are mean variance optimizers, they want maximum return for minimum risk and secondly they want to minimize the degree to which they've got to calculate or be precise about the active relative views on returns or risks or correlations in the portfolio. So if we can kinda start at that baseline then I think there's a really neat arc of conversation that builds on that.

Mike: **05:51** Is the market cap, is part of market cap the function of the wisdom of crowds to some extent. How does that play into the use of market cap?

Adam: **06:00** It is for sure. I mean that's a really good point. So I think it's helpful to go back and revisit the foundations of the CAPM, the capital asset pricing model, which is the model that leads to the conclusion that the market cap weighted portfolio is mean variance optimal. That it will produce ex ante is expected to produce the maximum amount of return per unit of risk, and the CAPM goes back to the 1960s, you've got Sharpe and Trainer and Markowitz and all the, the grandfathers of financial theory, all producing these papers and all thinking about this concept of market efficiency and they decided that the market was efficient when it expresses the views of all market participants.

And then they realized that the portfolio that that expresses these views in equilibrium is, is the market cap weighted portfolio because it allows all investors to invest in all assets and whatever value they place on those assets. The relative of those values is the market cap weighted portfolio.

Mike: **07:07** Right.

And it's, its portfolio everyone could hold?

Adam: **07:09** It's the portfolio everybody by definition does hold.

Mike: **07:10** Sure.

Adam: **07:13** And therefore obviously the portfolio that everybody can hold. Exactly. And so it has a very large amount of capacity, in fact the maximum amount of capacity of any portfolio, and so going back and sort of revisiting some of the mathematical assumptions for CAPM, and so yes, it, it assumes market efficiency in so far as individual investors have priced all global assets at equilibrium, but it also, in order for it to be mean variance optimal, it also assumes that every investment will produce returns in proportion to the non-diversifiable risk relative to the market portfolio, and so if you sort of, if you think about CAPM the way that most people think about CAPM these days, which is in the context of a stock portfolio and specifically let's just use U.S. stocks as, as a sandbox for discussion.

Then what it says is that the, the CAPM says that an individual stock should produce returns broadly commensurate with that stock's beta to the market, and so in order for just to just, just to close the loop on this, if CAPM is true and therefore if a market cap portfolio is truly mean variance optimal, then we should expect to see empirically that assets have historically had a return that is a linear function of that the stocks beta.

Rodrigo: **08:48** The higher the beta the higher the return.

Adam: **08:50** Higher beta equals higher return. That's what we need to see in order for CAPM to be legitimate and in order for the market cap weighted portfolio to be mean variance optimal.

Rodrigo: **09:02** The pervasive meme of investing across the planet, if I take more risk, I'm going to get better return in my equity selection.

Mike: **09:10** And then of course you have the low vol phenomena that just absolutely stands…

Adam: **09:18** Exactly. And that provides the first clue I think.

It's sort of the next phase of understanding in our portfolio optimization framework because, and this is not a new concept, it goes all the way back. Of course, Hogan produced research in the 80s that showed that stocks do not produce returns

commensurate with their volatility. If anything, the relationship is inverted on a multi period model, but the seminal research from Fama and French 1992, The Cross Section of Stock Returns, table one in that paper shows, returns of stocks historically sorted on beta and size, and so what they did is they divided stocks every month into buckets based on the stock's beta.

So 10 buckets. You've got very low Beta stocks in bucket one, very high Beta stocks in bucket 10 and what they, what they showed is that after controlling for size, that the arithmetic returns to stocks in beta decile one, so low beta stocks are exactly the same, or at least statistically indistinguishable from the returns to stocks in the highest beta decile, and it's basically true across all deciles. All deciles sorted on beta ended up having the same return. In other words, what they showed was that there is no relationship between beta risk and stock returns, which guess what, totally invalidates the CAPM and therefore leads to the conclusion that the market cap weighted portfolio is profoundly mean variance sub optimal. You can get better returns for any unit of risk by investing in a portfolio that is different from the cap weighted portfolio.

Mike: **11:08** Let me summarize that. So if the market cap portfolio is mean variance optimal, that would mean if that were the result, that would mean that stocks would have returns that are, that are proportional to their market beta. So the higher the beta, the higher the return. What we observed through time and what has become very popular low vol investing recently as an example of this standing in the face of that, is that the return per unit of beta is the same across the different betas.

Adam: **11:40** Exactly.

Mike: **11:42** And so now we have this challenge where we have portfolios that, I mean obviously the largest allocation to equity portfolios probably globally and in any geographic region is a market cap weighted portfolio. We'd probably look up some data on that. Probably next is equal weight and then maybe you might get low vol or min vol type portfolios creeping onto the radar, but they would be a very, very small percentage of …

Rodrigo: **12:05** Maximum diversification.

Adam: **12:06** Do you think? I mean I would, I would think that the after market cap weight, probably the next most prevalent weighting scheme would be conviction weight. You still have all of these discretionary active mutual funds out there that are still forming portfolios in the classic way of saying my discretionary call is that stock A is more attractive than stock B and therefore I'm going to give it a higher weighting in the portfolio. Basically ignoring any information about relative volatilities, or the correlation of that asset with or that investment with other securities in the portfolio.

Rodrigo: **12:42** Right. But I mean, the reason it's just if you're building a multi billion dollar firm, then you want market cap weight to be the most optimal portfolio because that's where you can fit the most amount of money in.

Mike: **12:53** Well of course this …

Rodrigo: **12:55** This is this, this is why that dominates. And, and this is why. If everybody believes in which a lot of people still do, then it's going to dominate the zeitgeist and the vast swaths of money will want to be in it.

Mike: **13:10** Who has the most money to market these various things? The largest companies, what are they going to produce? Are they going to produce highly focused portfolios or are they're going to use sort of broader rules that allow for a lot of capacity?

Rodrigo: **13:23** Exactly.

Capacity rules here in the business.

Adam: **13:25** It's true, but. But when you think about the fact that the margins on these cap weighted products are essentially going to zero, then the revenue for these asset management firms has got to come from models that are different than market cap weight because there's basically, there's no margin anymore in market cap weighted, market cap weighted products. The good news is that there are lots of very good theoretical and empirical reasons to deviate from market cap weight as we've, as we just touched on. Right, but I mean, just, just to close the loop on this, like, like Rodrigo said, if you're CalPERS, if you're CalPERS, and you are the market, then you are seeking the most liquid, most high capacity access point for exposure to whatever the risk premia is you're seeking, whether it's U.S. stocks or global stocks or global bonds.

It needs to be market cap weighted. It has to be. That's the only way you can get the capacity you need. If you don't have portfolio agility, if you don't have mandate flexibility, then you're constrained to market cap weighting. Fortunately, most of the people that we talked to, the advisors, the individual investors, the small, the medium sized institutions don't have those constraints and therefore they have an opportunity to produce, we think very substantially more efficient exposures to the global sources of return that everybody's after.

Mike: **14:45** Oh yeah. Let's dive into that because that that is a, a lot of where this paper really digs in deep, and you know, I think, I think the reality is that, that the views, that you are expressing views about the various volatilities, correlations and expected returns of the individual holdings in your portfolio, you are expressing those views whether you're aware of that or not. They are being expressed, and I think what this, this paper helps to uncover, shed light on is the fact that here is what the assumptions that you're making in your portfolio.

So an equal weight assumption for example means that you kind of know nothing, right? I, I don't know volatilities, I don't know, correlations, I don't know, expected returns and as such I'm going to buy an equal weight portfolio. And in certain circumstances that's actually a really good idea. Like if you are buying a sector ETF where you have a very

small sector of whatever, telecom, technology, these are going to have very similar reactions to news that comes into the sector and so.

Rodrigo: **15:53** Highly correlated.

Mike: **15:55** And they're highly correlated. So assuming you knew nothing about correlations is, is not. It doesn't hurt you. The volatility, probably going to be somewhat similar, what the expected return might be going forward from the smallest companies in a particular, um sector to the largest, you know, you're, you're going to actually benefit from, from having more small company exposure. So it's interesting that in that context that, that's not a bad assumption, but could you do it better? Probably. And so, yeah. Let's, let's, let's jump off from there.

Adam: **16:20** Yeah, great, great point. I mean it's, it's absolutely worthwhile spending one more moment on equal weighting because as you say, equal weighting expresses no views, but it also sort of expresses, it does express a very strong set of views as well, because it expresses the view that all assets have or all investments have the same expected return.

Mike: **16:43** Yeah.

Adam: **16:44** It expresses the view they all have the same risk, that they all have the same correlations.

Mike: **16:48** Right. Right. So no view is, is a view, right?

Adam: **16:52** Exactly.

Mike: **16:54** Like it's a very strong view.

Adam: **16:55** Its a very strong view.

Mike: **16:56** Yeah. No, agreed. And I did. Yeah. That's, that's a very crucial point. That no view is a very strong view.

Rodrigo: **17:01** It's an inadvertent view, right?

Mike: **17:03** Yeah.

Rodrigo: **17:03** A lot of people think, well, I don't know if I'm not going to do anything.

Mike: **17:05** Right.

Rodrigo: **17:06** You actually do it, there is no doing anything.

Mike: **17:08** Right and now, and now the universe selection, right? So my example was a sector, okay, well that's the universe selection. So that's, that's particularly relevant. If we take another universe, which is 500 stocks and one bond, and we equal weight, that bond is

going to have no opportunity to provide any diversification. Let's call it a government bond. But if we were to say we have 500 stocks and one bond, and we're going to do an equal risk contribution portfolio, that one bond's going to have a pretty massive holding within that 501 security portfolio.

Rodrigo: **17:47** Yeah. So that, that's just saying, uh, so equal weight will, you will get one, one 500th of an allocation to that bond.

Mike: **17:54** Yeah.

Rodrigo: **17:55** When you don't care about the line items, but care about creating balance in the portfolio by understanding the correlations. Assuming you can, you can estimate the correlation is relatively well, then you will have it for from an equal risk contribution perspective of bond that has lower volatility and non correlated, be a dominant position in that portfolio, right? So which is better? If you are trying to create, if your goal is to maximize your return per unit of risk, then there are other weighting schemes that we need to consider, and we have to look at the data in order to come to, to assumptions and conclusions about our assumptions and whether they're real or not, whether the assumption that we can't foresee or estimate correlations correctly is correct.

Whether we can't estimate volatility is correct, and we think that we can do all of those relatively well and if you can do all of those relatively well when the whole plethora of optimization schemes come to fruition that, that we can take advantage of to maximize their potential unit of risk.

Adam: **18:54** Exactly.

Mike: **18:55** And the funny thing is that the mean is the hardest one. Like the expected return is the hardest one to estimate and is often where everyone starts, well, why am I picking this one stock? Because I think the return is going to be the best return, but you should have the lowest confidence.

Rodrigo: **19:14** I love that fact.

The conclusion is that all, all equities provide the same return because then it means I know what I can focus on, and we do see, the evidence does point to the fact that we can do a very good job at estimating correlations. You can do a very good job at estimating volatilities. And so, uh, why don't you walk us through some of the.

Mike: **19:30** Walks us through. Yeah. Walk us through your favorite portfolio Adam.

Adam: **19:34** Just to be clear, this is not my favorite portfolio, but it is a portfolio that I like a lot for equities.

Mike: **19:38** Hold on. Is it not your favorite equity portfolio?

Adam: **19:40** Yes. Unconditionally, you…

Mike: **19:43** You could say no. I thought it was.

Adam: **19:44** It is my favorite equity portfolio.

Rodrigo: **19:45** I thought it was.

Adam: **19:46** If you're just trying to get access to equity beta. But just we got, we wandered all over the place there. So I just want to make sure.

Mike: **19:52** Yeah

Adam: **19:53** Because Mike, you brought up a really good point that I want to, and I think it provides an opportunity for a really good example. You talked about this sort of sector universe, right, where you got a bunch of companies that are very highly correlated, they're reacting to very similar macroeconomic factors, that sort of thing, but it could be that the, the companies in that sector are, have a wide disparity of volatility. Now, if we assume that those companies all have equal expected return and that they all have approximately similar correlations to one another, it doesn't mean that there's not a good optimization that may be better than equal weight.

The inverse variance portfolio that's so, weighting to stocks by one over their variance is the minimum variance portfolio, when you assume that all of the stocks have approximately equal correlations. So that, that inverse variance portfolio is the portfolio that minimizes portfolio volatility for that, for that group of stocks in the sector. Right? So even there you have an opportunity , that may do better on a risk adjusted basis, yeah, than the equal weighted portfolio, right? So that's just one example.

Mike: **21:02** But again, but what you're saying there, what you're saying there is that volatilities are telling you something about the portfolio, the assumption that you've made there is, oh wait a second. You know, the volatility thing is actually a pretty decent indicator and I actually can have, it's probably one of the easiest items to estimate.

Adam: **21:21** Well, yeah, so this is a bit nuanced, right? Um, so I'm glad you mentioned that because people may mistake this. So the inverse vol weighted portfolio and now we're really getting nuance, but the inverse vol weighted portfolio makes the assumption that all assets have the same correlation and that returns are proportional to volatility. The inverse variance portfolio makes the assumption that all correlations are, are equal, but that returns are not at all proportional to risk. So the inverse variance portfolio is a minimum variance portfolio, not a risk parity type portfolio. So it's just a nuance difference there.

Mike: **21:58** You've mentioned the magic word risk parity. So now maybe we can jump into what is an optimal portfolio when the Sharpe ratio across asset classes would be considered equal?

Adam: **22:11**

Yeah. So Yep. So, so jumping from the stock specific realm, right? Where we've sort of, I think concluded again, just to close the loop that if, if all stocks have about the same expected return, regardless of their risk, whether you measure risk by beta or volatility, then the only objective should be to minimize portfolio volatility and the optimization that minimizes portfolio volatility when you can estimate volatility and correlations, is the minimum variance optimization.

And that is the portfolio that is at the very far tip of that mean variance efficient frontier bullet, right? So just to close the loop on that, given all of the, the empirical evidence on relationships between risk and return and an equity universe, it does look like the minimum variance portfolio is mean variance optimal. And if you go and look at our papers, you'll see that we ran a bunch of tests on industry universes, sector universes, etc. that all confirmed this with a very high level of statistical significance. So all that said, moving on to the asset allocation problem, well now you've got a situation where the relationship between risk and returns empirically has been very different than what we observe in the stock only universe.

As you said, across asset classes we see that returns have historically been highly proportional to volatility. So stocks have say, twice the long-term volatility of bonds and they produced about twice the long-term excess return. And so as you say, that means that they all have approximately the same expected Sharpe ratio and the objective when all assets have approximately the same Sharpe ratio should be to equalize the risk contribution across all the different asset classes. The, the method of doing that is called risk parity and there are actually a couple of different ways that you can achieve risk parity depending on what you think you can estimate.

Can you estimate correlations for example, and the type of risk that you think is rewarded in markets, are markets rewarding volatility, idiosyncratic risk, marginal risk to the market portfolio, etc. But regardless, risk parity sort of encompasses all of those different optimization methods. And the risk parity portfolio is mean variance optimal if we believe that assets have the same Sharpe ratio or they all have the same expected return relative to risk.

Rodrigo: **24:50**

Right? So all those optimizations are trying to answer the same question in different ways. This idea of creating balance in the portfolio and max and if everybody has the same Sharpe ratio, then there are different ways of estimating uh, how you define risk and then how you estimate correlations. So we like to use them all generally in our optimizations, a handful of them, because we, we can't say for certain than any one is going to be the best over the next five years. They're all reasonably sound, so we want to minimize the chances of being specifically wrong.

We want to be broadly correct, we use them all. Now we have a portfolio that is balanced, that is providing the best return per unit of risk, theoretically. Does that necessarily mean that we're going to get the best absolute return for our, for our portfolios, for our clients?

Adam: **25:35**

Well, no. I mean, obviously there are ways that we can systematically tilt portfolios to investments that have a higher expected return. We've been through some of those systematic factors, uh, in, in previous episodes of this series, talking about momentum, value, trend, carry, low beta, etc. So there's absolutely ways to, to tilt portfolios towards characteristics that are likely to predict higher future returns. The point is that if you don't have any active views on returns, then these, these risk efficient optimizations, minimum variance optimization in the equity space, risk parity optimization, in the asset allocation space, are likely ex ante to produce mean variance optimal outcomes. So you're going to get the highest long term expected return per unit of risk. All things equal.

Mike: **26:33**

I love it. So it is, it is the, the, the questions we should be asking ourselves is, is what can we estimate and what risks are being rewarded. And if we can, if we can answer those questions honestly and accurately, they can lead to better optimizations. And there's a decision tree in the Portfolio Optimization Machine paper that helps you walk through that. Now what I want to do is just, we're running a little bit long so I do want to kind of wrap this up, but I do, we, we do want to leave you with some of the dangers of, um you know some of the out of the box solutions or some of the things that you'll run across if you start to dig down this rabbit hole.

And uh, we don't want you to be surprised by them or give up on some of the challenges because you know, small differences in assumptions can sometimes lead to some large swings in allocations. And maybe Adam, can you address that as, as sort of our final point as we, as we wrap, uh this session up?

Adam: **27:32**

Absolutely. So Chopra and Ziemba in a paper in the 1990s showed that errors in returns are about 50 times more dangerous in terms of portfolio outcomes than errors in estimates of volatility and correlation. So the real danger here is in, is in misestimating returns and, and you know, even a small error in the estimate of returns can have a very substantial impact on, uh the holdings of the portfolio. And also the long-term outcome of that portfolio, I just think it's worth giving a short example. Consider ah, a portfolio you're trying to allocate between U.S. S&P 500, Nasdaq, and small cap stocks and Barclay's Aggregate for bonds.

So you've got your estimated returns for the different stock indices and the bond index, and you've got estimates of correlations and volatilities. What you discover of course, is that the equity indices are highly correlated to one another. Maybe they're expected correlation is around 90 or .95, and so when you run it through the optimizer, oftentimes what you find, even if the expected difference in returns is really small, because those markets are so highly correlated, the optimizer will just say, "well, you should own 100% of your equity exposure in one of those indices and ignore the other two completely."

So you've just got an allocation to say S&P 500 and Barclays Ag. Right? But then if you, if you change your expected returns just very slightly, it will go completely the opposite way. maybe it'll say you want ah, ah total allocation to US small caps and zero allocation S&P 500 and along with the Barclays Ag, and so this, this can cause a lot of trouble

because of course as we talked about, the returns over or five or even 10 years for small caps could be very substantially higher or lower than to the Nasdaq or to the S&P, etc.

So I mean ideally you want to have a robust portfolio that contains some exposure to all three of them and it, and it's not that hard, especially with this small portfolio to conceive of a way to do that. So imagine we know that the equity indexes are all broadly exposed to the same risk factors, the same macro economic exposures. They're highly correlated to one another. They're kind of like one cluster. So why don't we form portfolios by doing this: we take the S&P and Barclays Ag, we form the mean variance optimal portfolio of those two.

Then we choose small caps and Barclays Ag, form the optimal portfolio. Then separately Nasdaq and Ag, form the optimal portfolio. Now you've got three optimal portfolios and then just take the average of all of those three portfolios as your final portfolio and now you've got a robust, mean variance optimal portfolio that accounts for the fragility of our return estimates, and that's just an example.

Rodrigo: **30:30** Yeah, so the - what this means is that if your estimate, you return estimate for the Nasdaq for example, changes then what won't happen is you won't then. So let's say you're, you're, you're bringing it down in the first example, your Nasdaq position will go to zero and something else will replace it. Right? And the example that Adam just described, what will happen is if your estimate changes, your return estimate changes, the weighting between the Ag Bond and the Nasdaq will change, but it will not take away. It will be part of the portfolio, it won't be replaced by something else.

Adam: **31:03** Yeah, it will have a lower weight.

Rodrigo: **31:06** **It'll be less susceptible to drastic changes in portfolio construction. Right? So what you** want to avoid when you're doing an optimization, is you don't want things that are highly correlated to each other that are part of the same economic risk bucket to meet in the same optimization. You want to separate those, right? So if you could go into the futures space, the same thing can be said about Kansas City wheat and Manitoba wheat. You put them in the same optimization and you'll be in and out of those things back and forth because it's a wheat product, there's just a direct way, it's the same thing.

You take them outside, you make sure that they're never in the same, never the twain shall meet, and you will have inclusion of those asset classes without the fragility risk. Right? So that is a key thing that we need to address because of course everybody knows that mean variance optimization is an error maximizing equation. That's what everybody quotes and that's why it's so difficult to use and because it's so fragile, people avoid it. Well, there are ways to mitigate against that and you just have to make sure that you're clustering your, your asset classes appropriately.

Mike: **32:05** Awesome. Well gentlemen, that was a little over, uh our normal, ah podcast time, but at the same time this is ah, a kind of complicated topic and also, uh, was one of ah, our

most popular posts, so next we're going to jump to one of our favorites. The trend, trend is your friend. We're going to talk about trend.

Rodrigo: **32:26** The most hated of all factors

Mike: **32:28** Yeah.

Rodrigo: **32:29** Gotta talk about it.

Adam: **32:29** At the moment.

Rodrigo: **32:30** That's for sure. At the moment. And we'll, uh, we'll see you then.

Rodrigo: **32:34** Thank you for listening to our 12 days of Investment Wisdom mini-series. You will find all the information we highlighted in this episode in the show notes @investresolve.com/12 days. You can also learn more about ReSolve's approach to investing by going to our website and research blog at investresolve.com, where you will find over 200 articles that cover a wide array of important topics in the area of investing. We also encourage you to engage with the whole team on Twitter by searching the handle @investresolve and following Adam, Mike and myself. If you're really enjoying this series, please take the time to share us with your friends through email, social media, and if you really learned something new and believe that our series would be helpful to others, we would be incredibly grateful if you could leave us a review on iTunes. Thanks again and see you next time.