LONG-TERM INVESTING: AN OPTIMAL STRATEGY IN SHORT-TERM ORIENTED MARKETS

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http://cgt.columbia.edu/conferences/long-term_investing/

Keynote Address

SOME PROS AND CONS OF LONG-TERM INVESTING*

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Grantham, Mayo, Van Otterloo (GMO)

Introduction: Paul Woolley

Senior Fellow
London School of Economics

PAUL WOOLLEY: I'm here to introduce Jeremy, which is difficult because he needs no introduction. The first time I met Jeremy was in 1979. GMO then managed $250 million of U.S. equities. The firm was two years old, and had, I think, eight or ten staff, plus partners. At the time, I was with the International Monetary Fund (IMF), and my colleagues and I were looking to appoint a U.S. equity manager to manage part of the IMF pension plan.

The room we met Jeremy in was not a particularly attractive one, made less attractive by a dead rubber plant, and a yellow copy of a Wall Street Journal. The conference table collapsed during the meeting. But Jeremy spoke for two hours in a way that I never heard anybody speak—remember this is 1979—because it straddled the academic and the practitioner. He was absolutely fascinating, and we ended up deciding quite quickly that we would fund his new product, which was one of the first active quant funds.

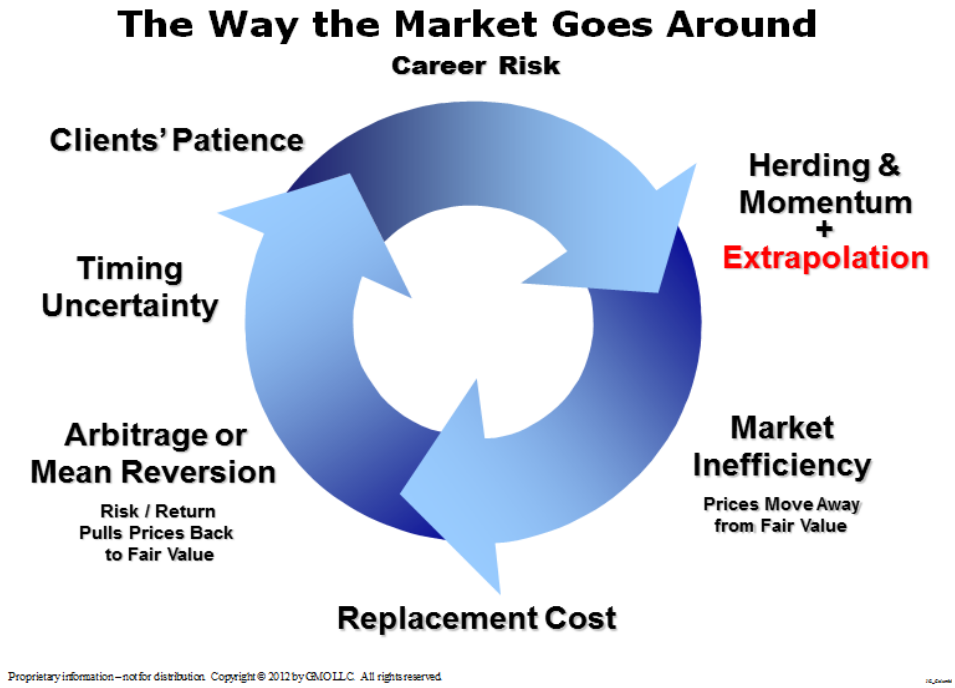
The story of the next 30 years is really now in the public domain. GMO thrived. Jeremy started his quarterly letters about 14 years ago, and they have become widely read, particularly by non-investment people, around the world. Now he has had a second parallel incarnation as a climate change activist, with his Grantham Institute for Climate Change, at Imperial College London, which focuses on the hard sciences. The other one is the Grantham Research Institute on Climate Change and the Environment at the London School of Economics, which addresses the social science of climate change.

* *Remarks have been edited for clarity.*

Jeremy recently was a bit jet-lagged when he introduced me as his partner and former friend. I'm deeply jet-lagged but I am trying to shoot right by introducing Jeremy as my former partner and great friend. Thank you.

JEREMY GRANTHAM: I'm a Brit and I'm extremely cheerful. I have some very dire forecasts outstanding, which has made me very cheerful. I quite enjoy making dire forecasts. I have a few thoughts on long-term and short-term investing. One thing about long-term investing is that I was lucky enough to have a Norman French ancestor who, 577 years ago, had a chance to invest in a nice start-up milling enterprise, with one gold franc. He also had recently read a book by a distant ancestor of Jeremy Siegel, and in this particular rare case his ancestor got it right. He did 6% a year real return on his gold franc, 577 years ago. So how much do I have now in my inheritance? Would anyone care to guess what that would do for you, at the Jeremy Siegel rate times the longest-lived company we heard of this morning? It's $250 trillion per dollar invested. That's not bad.

The first exhibit is something I use to explain how the market works to potential clients or students. Of course, like my friend Paul Woolley, it is based on career risk. The thing that really matters in life in the institutional business is protecting your job. The ultimate job description is to keep it. John Maynard Keynes, my hero, described exactly how this works. You must never, ever be wrong on your own. Even being right on your own was a little dangerous. They patted you on the head while you were in the room, but they described you as a dangerous eccentric when you had left. Being wrong on your own, Keynes said, you would not receive much mercy.



We ran an experiment in 1998-1999. We declaimed greatly about the coming bubble breaking, and that it was on the edge of fiduciary irresponsibility. Clients celebrated our accuracy by shooting us. The asset allocation division, which I was already in, lost 60% of its book of business in two and a half years—a faster rate of firing than anything that I have ever discovered in our business where there was no actual cheating involved. We did not cheat; all we did was talk. It was said that a large foundation in this city banned me from their building, because I was dangerously persuasive and totally wrong, so they kept their huge investment in growth stocks. Anyway, Keynes's point was if you want to make money, just look around and see what everyone else is doing and beat them on the draw. Just be a little quicker and slicker, and if you do that, it will create herding and momentum. He also got into extrapolation, and how you deal with making a forecast. Making a forecast about the future is incredibly dangerous, full of career risk. He said the convention we adopt to deal with an uncertain future is to assume that the past will continue—extrapolation—even though we know from personal experience that that is not the case. In my opinion, this is the major inefficiency in the stock market. There are many inefficiencies, perhaps hundreds. It is a very inefficient enterprise, but by far the biggest inefficiency is momentum. It exists in every asset class that we can study or have ever studied.

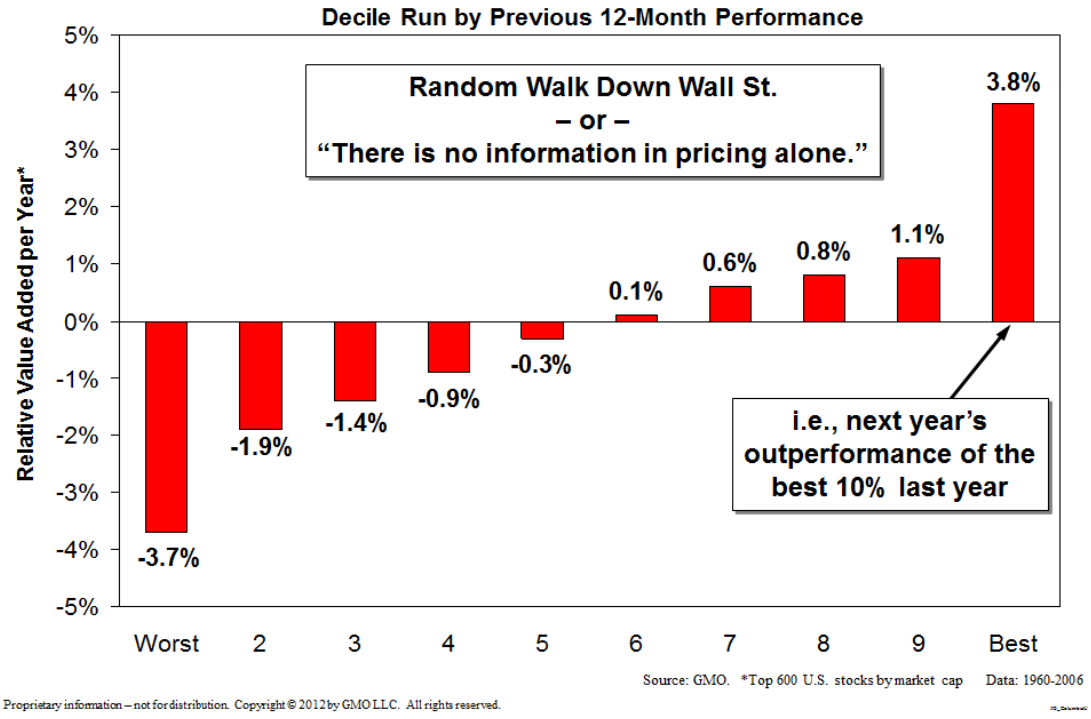
The good news, in real life, is that eventually reality speaks. The reality is that the fair value of any tangible asset is its accurate replacement cost. Sometimes, that is not easy to work out, but if you could work it out, we can agree that it is fair value. Very gradually, things work their way back to fair value. People used to say to me, how can you be so certain of some uncertain long-term future, when you're not certain about the short term? It bamboozled me for quite a few years, until I came up with the analogy of standing on a high building in Florida with a bag of feathers in a hurricane, throwing the feathers up in the air. One of them would hit a block away in a minute, and another one would go to Maine in seven or eight days, the way some poor unfortunate canaries actually do get swept along. You know one thing about all those feathers: that at some uncertain time horizon, every single one of them will hit the ground. That is really the analogy with value. You are not sure of the time horizon, but it is like a gravitational pull; eventually it will hit fair value or replacement cost.

The problem is that sometimes the feather lands quickly and sometimes slowly. You have a great deal of uncertainty about how long it will take to mean revert, and that is the rub. But the client's patience is well known. It is 3.00 years. Those of you who are clients will know that to be very precise and quite accurate. If you underperform for more than three years, you will be shot. Sometimes the timing of uncertainty is longer than three years, sometimes the mean reversion is longer than three years and you meet the fate that we basically met in 1999 and 2000.

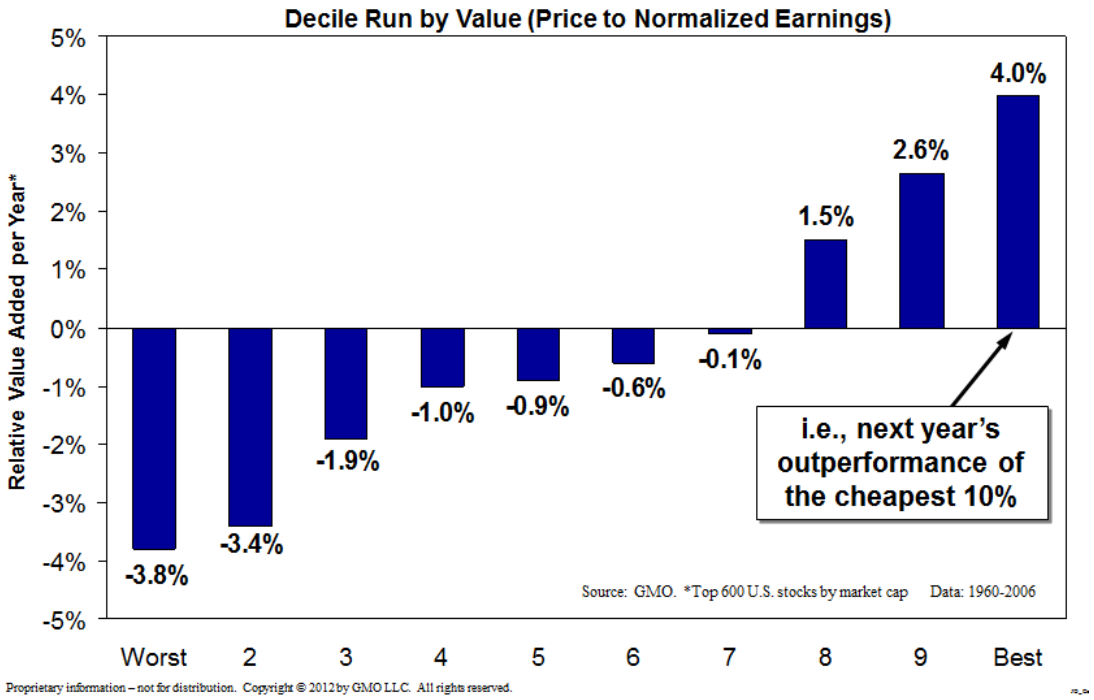
That was a very good experiment. However, we did survive, so I think we have challenged Keynes's famous attribution that the market can stay irrational longer than the client and the investor can stay solvent. We are solvent, and we have stayed in business. We did tough it out, and I think that we have established that it is painful to

remain disciplined, but survivable. The more you can structure your business to be able to stay the course, and the more education you can give to the client, the better off you will be. When you get it right—if you get it right—the more bragging you do about having gotten it right, the better it will be in the future. That is my excuse for bragging when we get it right.

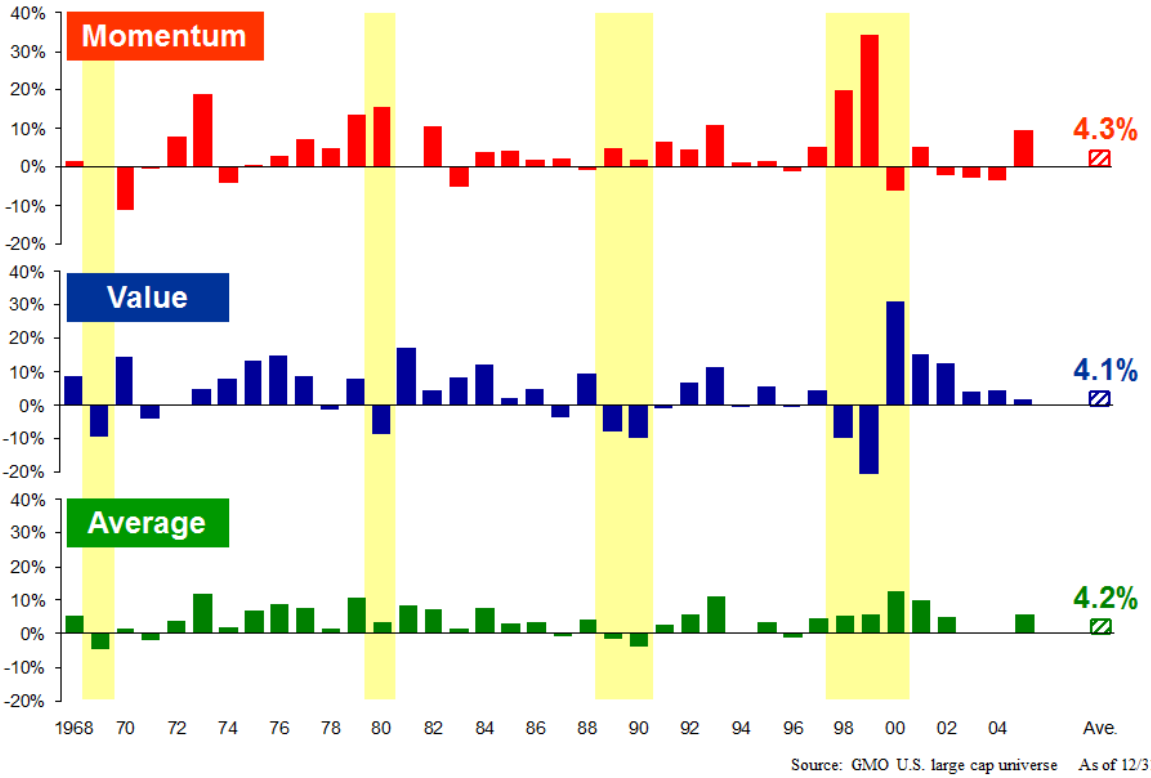
The exhibit below shows momentum in a simple decile run. We have been modeling momentum and value as two key variables for 33 years, so this is pretty old hat. This is really a nice antique exhibit. To make this slide as deliberately primitive as it can be, the stocks that went up the most last year went up 3.8% the following year, and the stocks that went down the most went down 3.7%.



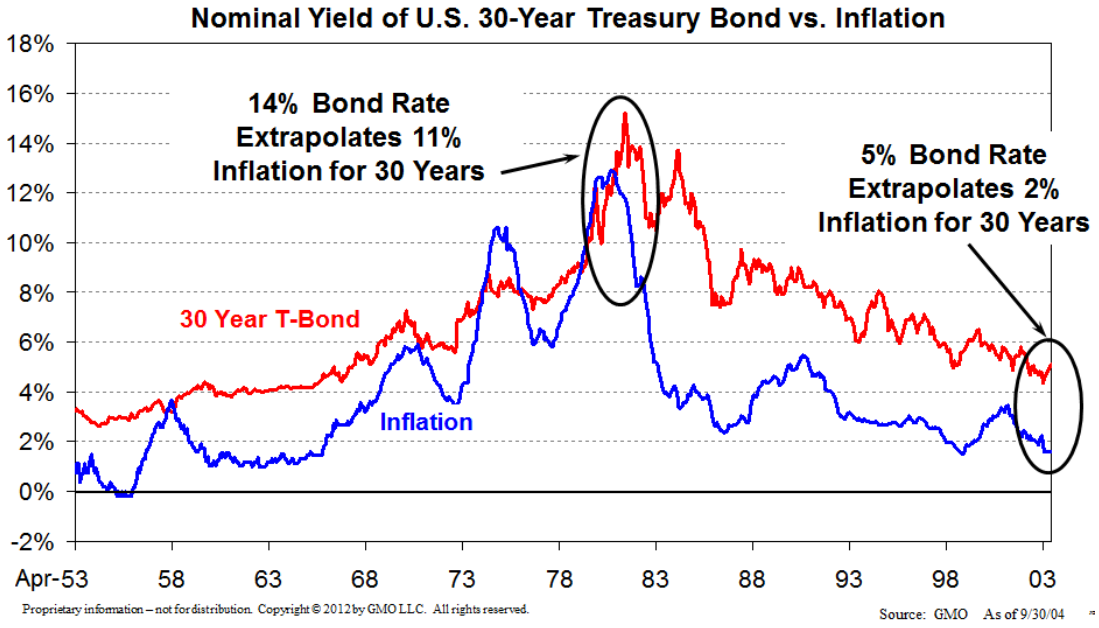
The next exhibit is the *ying* to momentum's *yang*: value held for a year. This is a rolling-average Shiller price-to-earnings ratio (P/E), again as simple as could be, with very similar power and a beautifully smooth decile run.



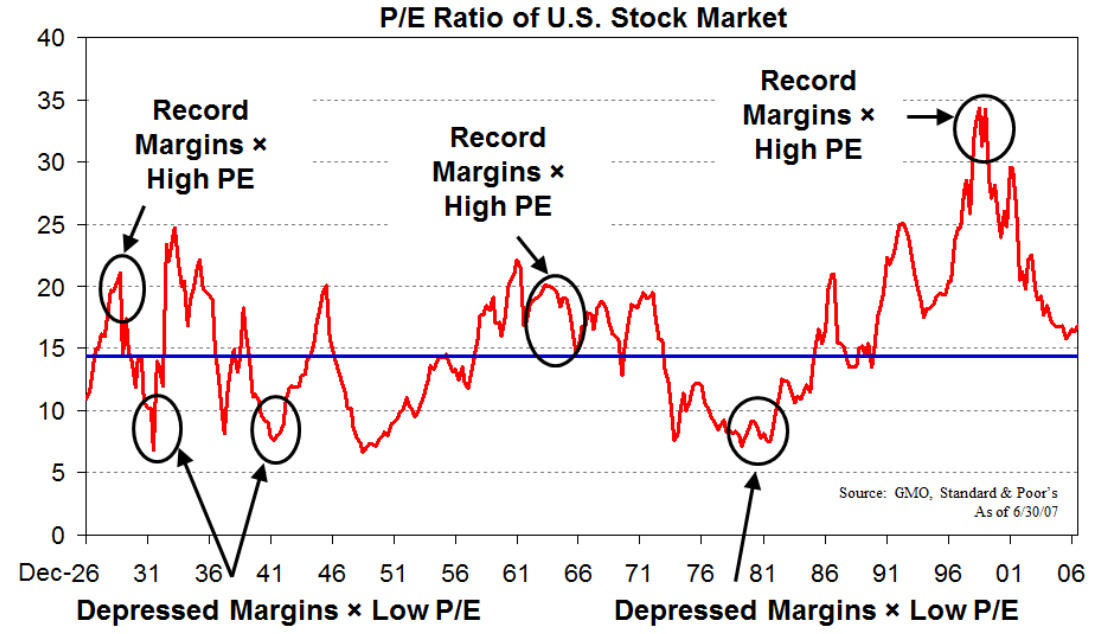
If you add them together you will notice very quickly in the exhibit below, particularly on the right-hand side at the great spike in the red, that when momentum was heroic, value was dreadful. They move in opposite directions, particularly at extremes. If you add them together in a very clearly worked out mix, 50/50, you will see the bottom row: 4.2% a year, precast, but almost no down years. Life should be so simple. We spent 30 years improving on this model, racking our brains, working with top PhDs in particle physics, and at the end of that, we did not do as well as the bottom row model. The moral of that story has never been made clear to me. Sometimes, you do better keeping it really simple and almost antique. We never made a change that did not make sense.



Just a word on extrapolation. In red below, you have the bond market—the yield—and in blue, you have inflation. In 1982, the 30-year bond market peaked for a day at 16%, and inflation peaked for a day at 13%. The 30-year bond was saying that an inflation rate of 13%, which had been reached for one afternoon, would stay for 30 years. That, ladies and gentlemen, is extrapolation. It is just an amazing story. Back when this exhibit was done in 2002-2003, inflation was 3% and the long bond was 6%. Those were the good old days. How time flies! They took the same 3% rate of inflation and extrapolated it for 30 years. This is what we do today; we assume a negligible rate of inflation, because that's what we have now, and extrapolate it for 30 years. But of course, these are the "bondos." We know that they are pretty primitive people, and they extrapolate.



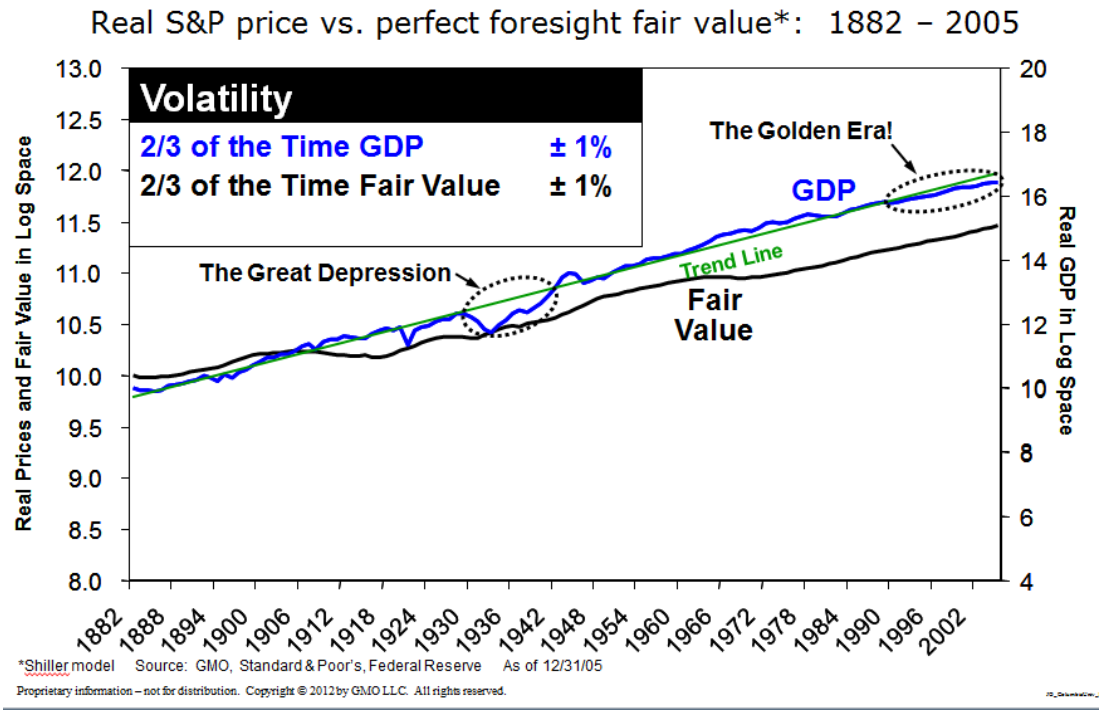
But what about the stock market? The next exhibit is a look at the rolling average Shiller P/E.



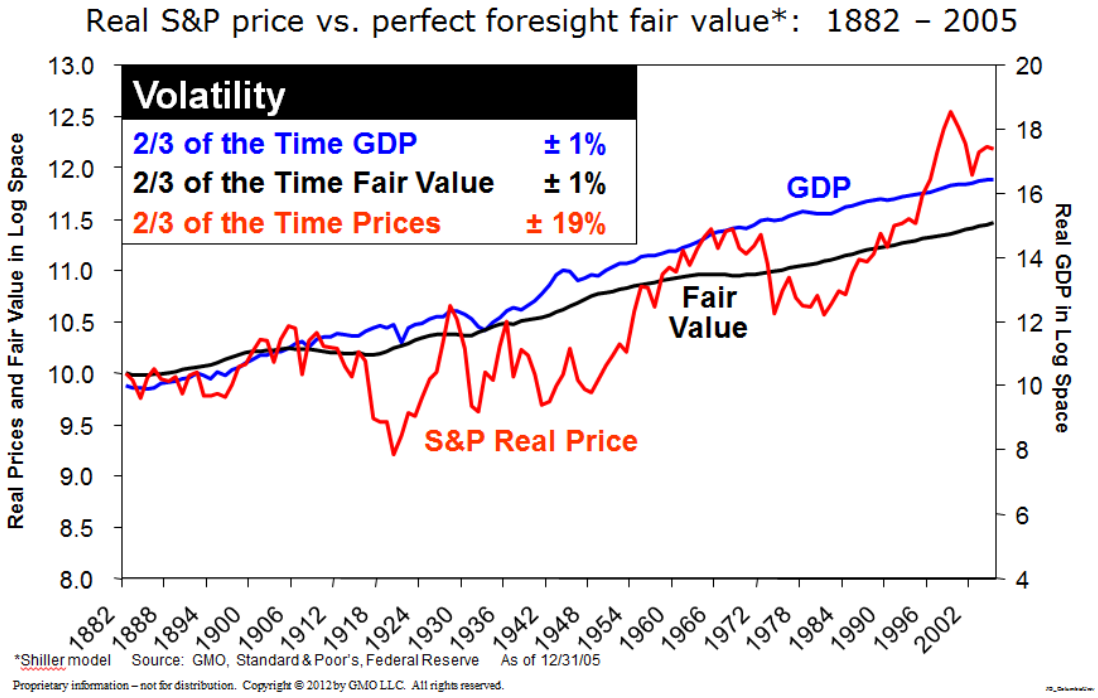
I just want to pick out a few spots. At that time, 1929 had the highest profit margins ever recorded. If you are going to equal replacement cost, then the higher the profit margins are above average, and the lower the P/E must be to equal replacement cost. You must have high profit margins times low P/E equals replacement cost; and low profit margins times high P/E equals replacement cost. And the market will be boringly stable, with a correlation of -1. Looking at the correlation here, the market cannot even get the sign right. The correlation is +.32, but it is higher than that at the peaks and the troughs. We have record profit margins in 1929; no profits at all in 1932 and 1937; record profit margins again in 1965, with the highest P/E equal to 21 times earnings on an annualized basis. Then, in 1974, profit margins were almost half normal, times an 8 or 7 P/E, half normal. If you do twice normal profits times twice the P/E, you have four times replacement cost; and if you do have the P/E on depressed profit margins, you will get a quarter or a third of replacement cost.

Once again, in 2000, we thought we were looking at the highest profit margins ever recorded times 35 times earnings. This is the most barbaric double counting. The investment industry is not adjusting for profit margins, which are the most provably mean reverting series in the whole of finance. If profit margins do not mean revert, then capitalism is broken.

The next exhibit shows the battleship GDP, 3.4% a year for 100 years ending in about 1985. Two thirds of the time, it is one standard deviation, +/- 2.5%, from trend; that is incredibly stable.



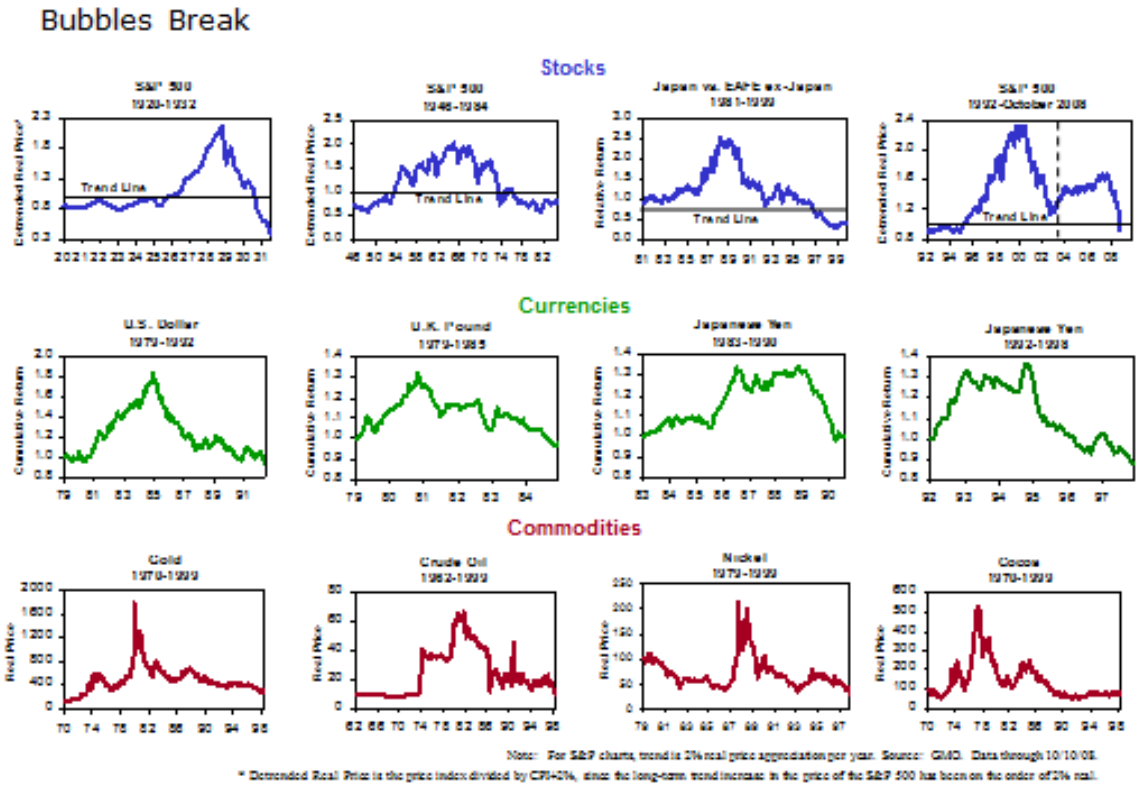
The great depression bounced off, the golden era began to sag a bit, but this is Shiller's fair value. The idea is that when you stand there in 1906, you know the future completely; you know all the flight paths of dividends and earnings, and you can work out the fair price in 1906 or 1929, and so on. You can see that, since fair value is a long-term stream of future dividends, it is an incredibly stable series. If the underlying GDP is stable and you have a smooth long-term discounted rate, you are going to be very stable. Two thirds of the time, it is within 1% of its trend line value. In other words, the



true discounted value of the market does not change much and this is what we have done to it.

By dint of double counting and overstating good times and understating bad times, we are 19 times more volatile than the clairvoyant series—19 times more volatile than is justified by the underlying stable data to a long-term holder. This is not impressive. This is not efficient. I have spent 30 years being extremely irritated listening to the intellectual torturing of logic to explain that it is in fact a rational market.

We are great students of bubbles especially when our livelihood depends on it, which it did in 1998-1999. We had elegant data. We went through every great bubble, and we laid it on the table in front of our committees, who ignored it. At the time, we found 27 important bubbles of which these are the famous twelve in three different categories. On the top left, we have 1929. Then 1965, the so-called Nifty 50, and then Japan—the mother and father of all great stock bubbles. Then the S&P, the grandmother of all U.S. bubbles. As you can see, they are fairly nice-looking bubbles, fairly symmetrical. 1929 goes up in three years, down in three years. 1965 goes up in six or seven years and down in six or seven years. Japan's bubbles are up and down in three or four years; and the recent bubble in 2000 was up and down in three or four years.

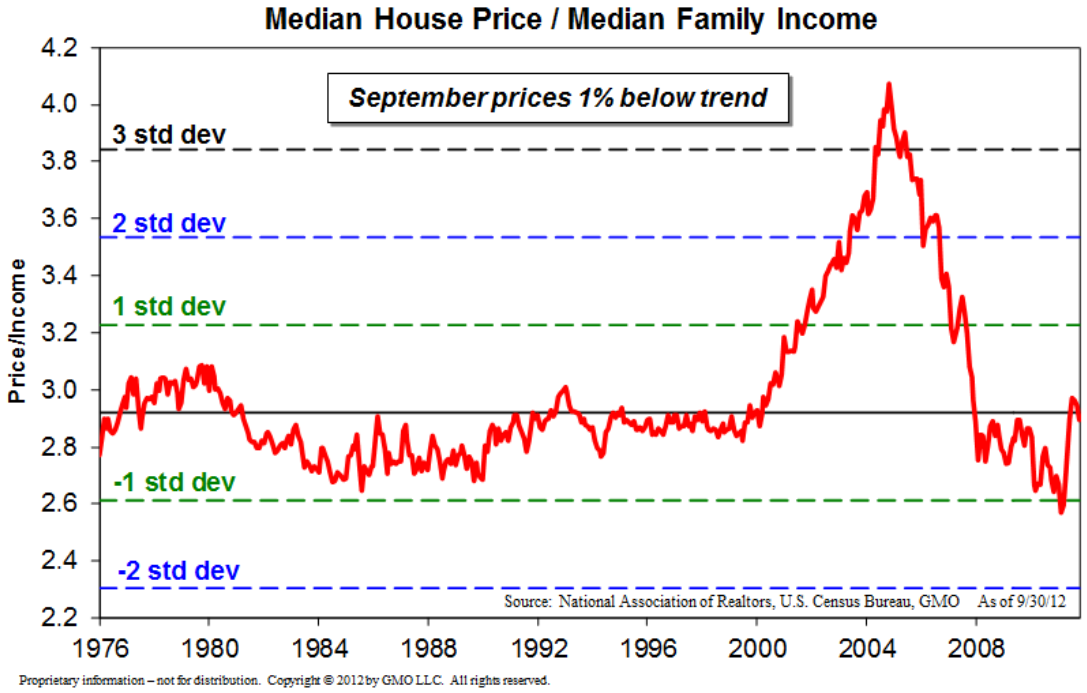


The only difference is the earlier three all crashed through fair value and stayed there for a long time, 10 or 15 years. We broke their hearts, and they had to put their hearts back together slowly. Greenspan would not allow our hearts to be broken. In 2002 he came back in with such an amazingly powerful cavalry, armed to the teeth with

money, that we could not even reach trend in 2002. It was completely unlike any other experience. He managed to double the market, in his usual way, and then finally, in 2008, it completed itself—the 29th bubble. But it's not a bad record, 29 out of 29.

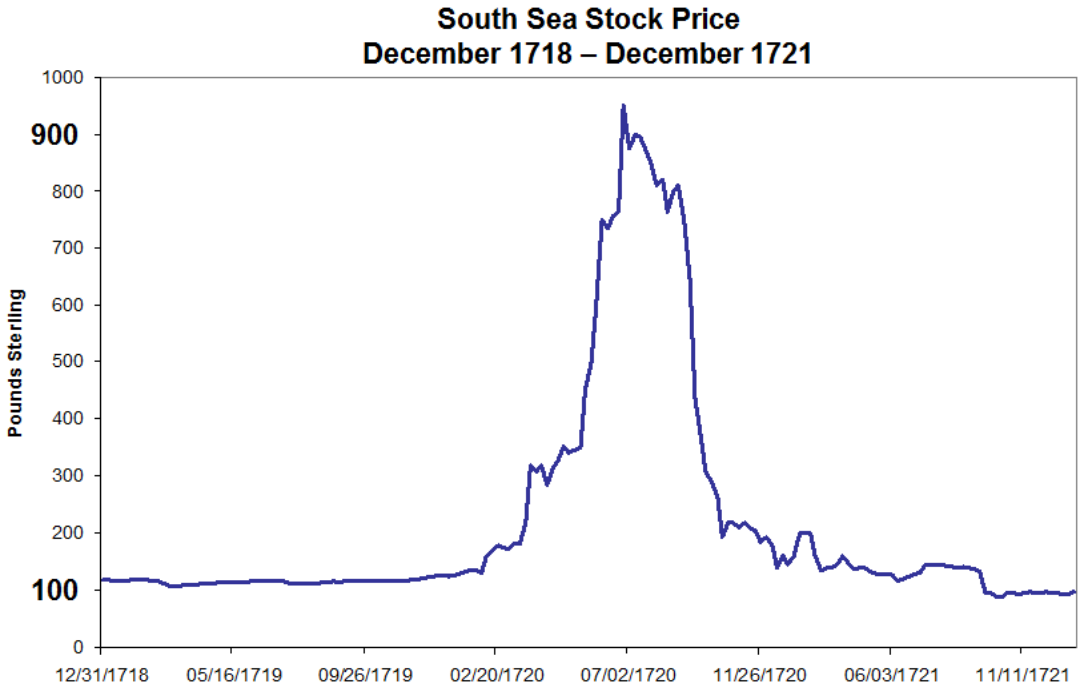
Nothing we could find ever indicated that there was a new paradigm. We have now completed studying 330 analyses, and there are some very strange looking minor bubbles, which are worth looking at.

The housing bubble in the next exhibit caused all the fuss. We called this perfectly. We shouted and screamed all the way up to the top half. We said, "Look, it's a three sigma event, a one-in-1,200 year event, if it were a normal distribution." Now, for all of our bubbles, they occur every 30 years, and we define them as two sigma events. You have to define what a bubble is. You've got the data and the volatility, so you can look through and find what looks like a two sigma bubble. A two sigma event should occur every 44 years, but, as it turns out, in the real world they occur every 30 years. They are much closer together than people think. Yes, they have a fat tail, but it is not ludicrously fat. Every 30 years is pretty close.



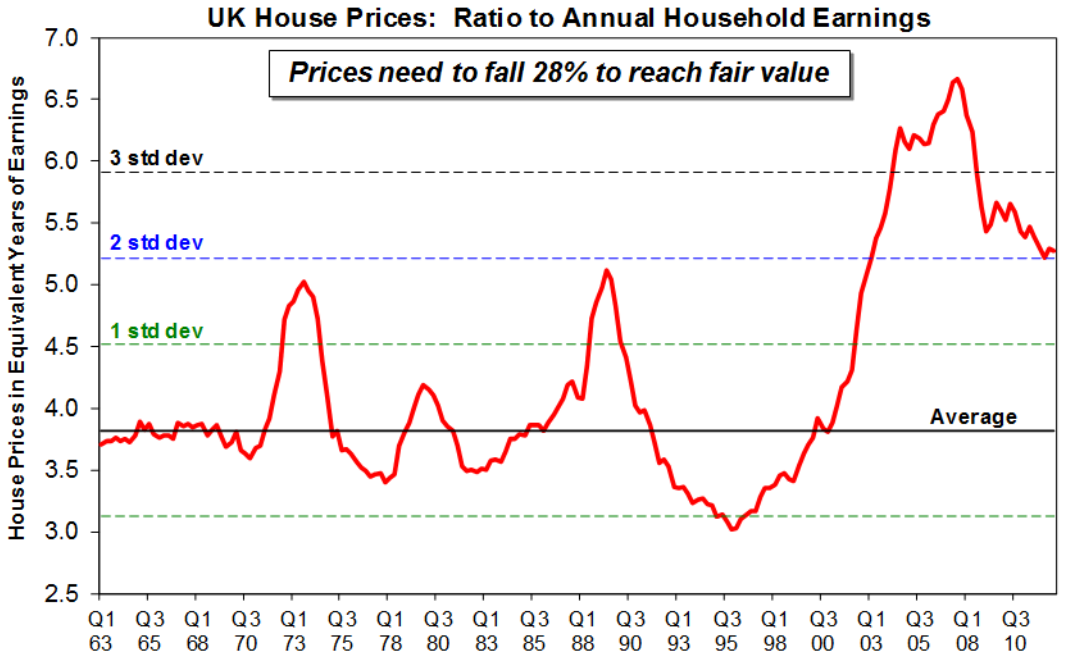
The housing bubble was a perfect bubble, and Ben Bernanke could not see it. He said the U.S. housing market largely reflects a strong U.S. economy, and the U.S. housing market has never declined, meaning it never would. Here was a guy surrounded by statisticians, who could not see a three sigma bubble in a housing market that had never bubbled before in American history, because of the diversification between Chicago, California, and Florida. This was amazing. He is a dangerous guy, who must be watched.

Next is the South Sea bubble, which predates any institutional activity. It looks devastatingly similar to several of the indices and the NASDAQ in 2002. GMO forecasted in the April 2000 issue of the *Economist Magazine* that the NASDAQ would drop 75%; it dropped 82%.



Source: Marc Faber, Editor and Publisher of "The Gloom, Boom & Doom Report"

This is the U.K. housing market. The Australian housing market looks the same. It is a pain in the bottom to a purist like me, because it just will not break in the classic way. The reason is that they do not build houses in Australia or the U.K. One part of



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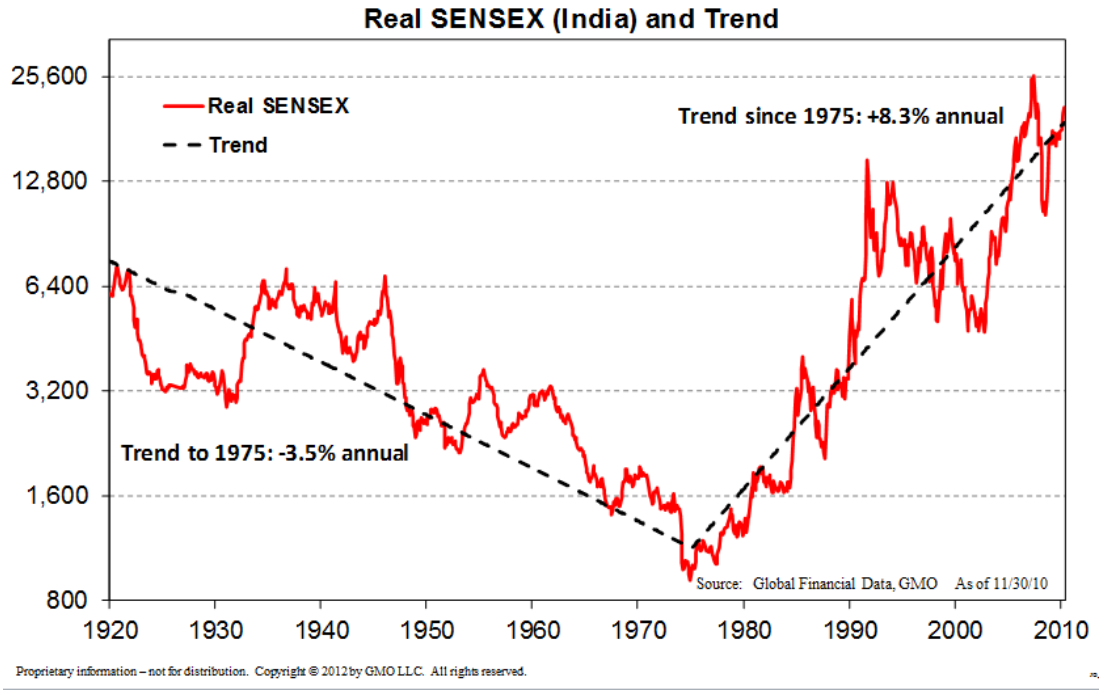
Source: Datastream, UK ONS As of 9/30/12

the government allows in lots of immigrants, and the other part of the government will not zone any land for house building. You get this ludicrous state of affairs, where people cannot afford for their children to live in Sydney, because they know they will never be able to afford a house there. The same will apply to Vancouver any minute. There, half of your income has to go to pay a mortgage, if you are the average person buying the average house. It is completely ridiculous. The markets that built houses—capitalist systems, like Ireland, Spain, and the U.S.—all broke perfectly. The ones that did not allow housing did not.

This is India. India went down for 50 years. It had a leaky bucket. It was just a flawed capitalist model. The stock market went from 6,400 to about 1,100. It just went down and down, and would have gone on down forever, until finally they got their act together and reformed the system. Since then it has changed. You could argue this is a paradigm shift. You can see the reasons that it might be a paradigm shift in a primitive economy like that, but it was not an important market.



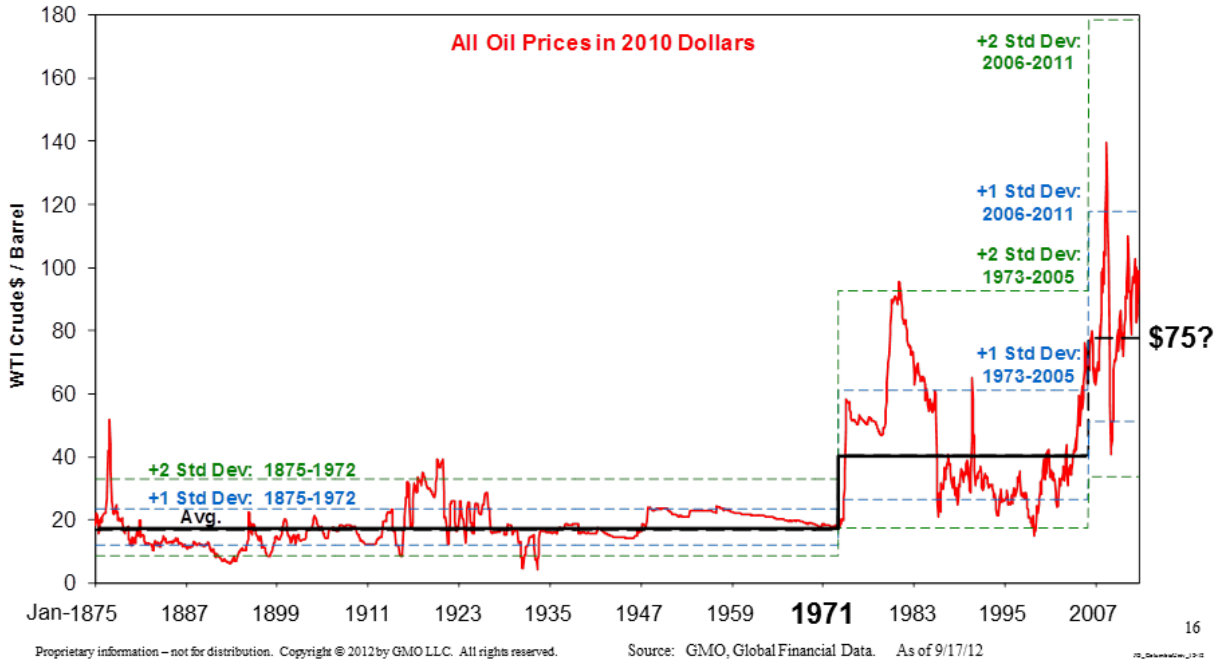
This was ironic, because we have made our living talking about the impossibility of paradigm shifts, and suddenly we had one. I just want to say a word about this whole topic. Economists in general, I feel, are rearranging the deck chairs on the Titanic. The real event is getting very little of their attention. The real events are resource squeeze and climate change. These are the events that are going to bring us to our knees, and, with one or two honorable exceptions, we do not seem to be that interested in them. There is no major economic theory that deals with the finiteness of resources according to the OECD.

There is a chronic and dangerous shortage of phosphorus. I have been going around asking economists and specialists what will happen, and they tend to say, like

most economists, "leave it to the market, it is just a question of price." To which I say, "Oh, I get it, when a quarter of the world starves, because they can't afford it, there will be plenty for the other three quarters—it's just a question of price."

When I hear that, I wonder when economics became the anti-social science. There used to be a time when economics was considered an industry where people attempted to be useful, by solving social problems. I'm developing a slight case of hero worship for Kenneth Boulding. Kenneth Boulding got a paper accepted by Keynes's magazine when he was 22 years old, but by the time he was about 45, he became disillusioned by this very issue. He thought that people were missing the point. Consequently, he has a great quote on resources: "Anyone who believes exponential growth can go on forever in a finite world is either a madman or an economist." He actually has another wonderful anti-economist quote, which has to do with mathematics: "Mathematics brought rigor to economics; unfortunately, it also brought mortis." My view of economics, particularly in finance, is that we have spent our whole time arguing about models and assumptions, not real life and rational expectations, which I consider fit into that category. The view is that real life is merely an irritating special case. I am, however, very attached to real life.

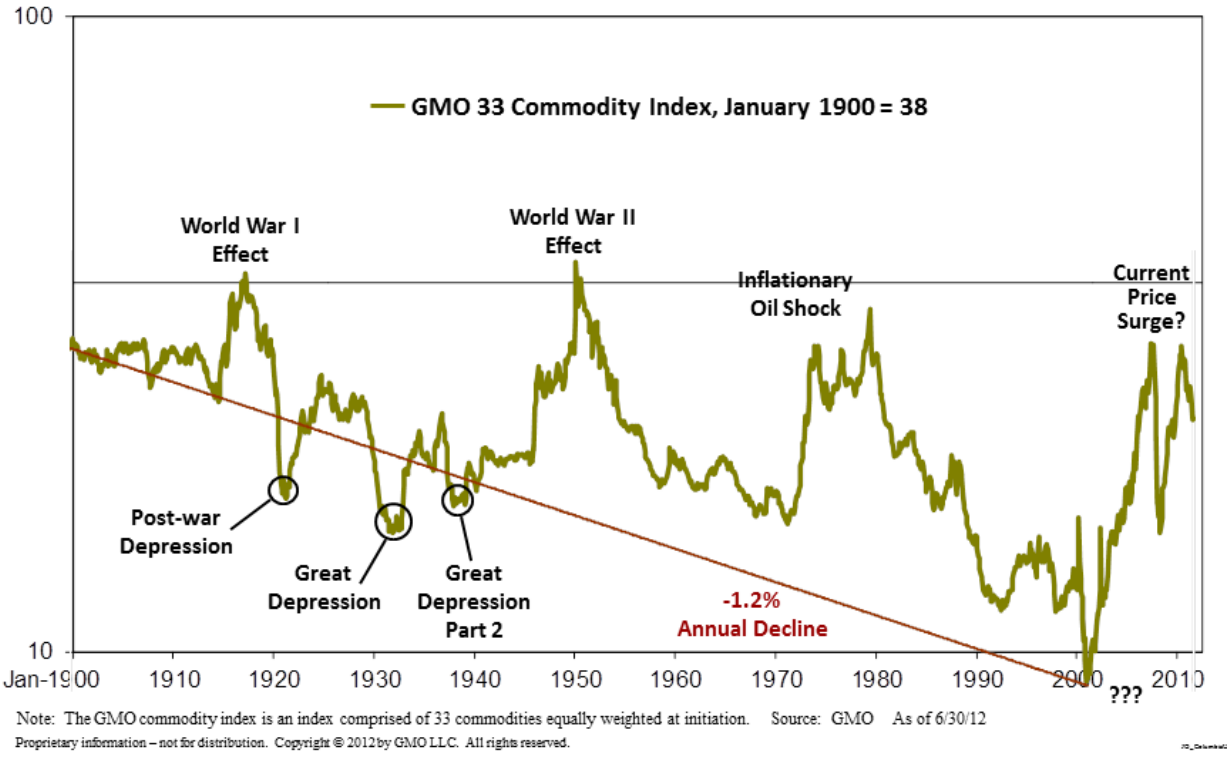
So back to the paradigm shift: the trend in oil was quite surprising to me. It worried me. For 100 years, it was at $16 a barrel, perfectly well-behaved, until it breaks



out to the two sigma line at just about the right number—2½ times, 1½ times. With the establishment of OPEC, the price of oil breaks out and doubles to $35 a barrel for 30 years. Yet you have the same volatility, and still well-behaved around $35. It more than doubles, and it less than halves; that is the volatility of oil. Then, finally it doubles again to $75 a barrel. You can meet with Royal Dutch Shell or BP, they will tell you they

count on about $80 a barrel to find a reasonable quantity of traditional oil. The price is underpinned by cost.

I finally asked myself a couple of years ago why this would only be in oil, and we started to work on it. This is an index of three equally weighted important commodities.

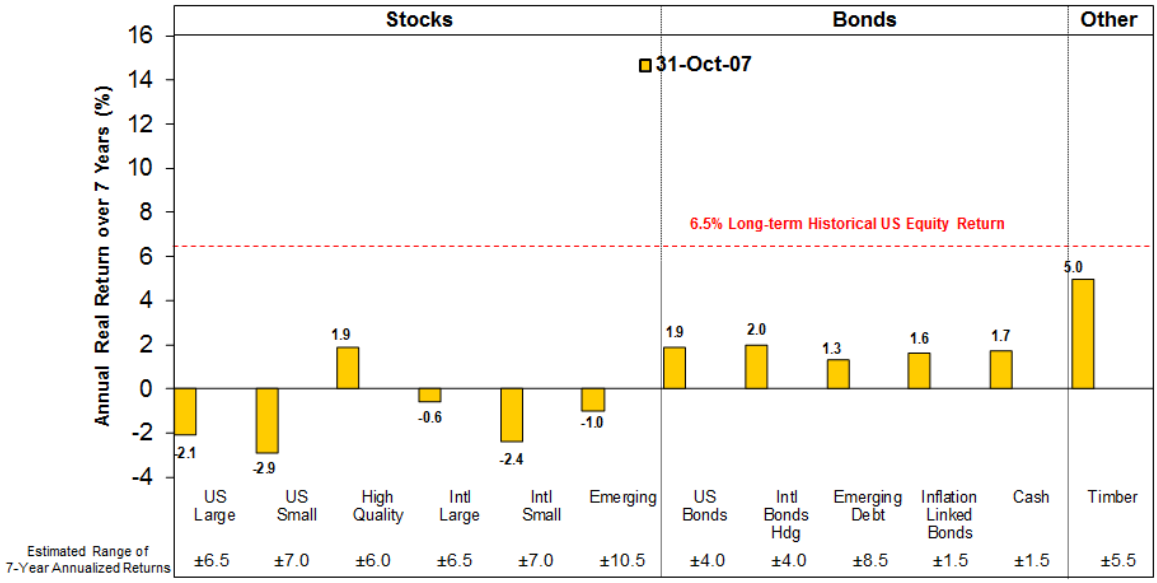


They declined in price forever, by 70% over 100 years, at 1.3% a year. Then, bang, they went back in 6 years. Now, you will notice when they spiked before, it was during World War I, World War II, and the great oil shocks of 1974 and 1979. What we're lacking on the far right side of the graph is World War III. There is no World War III. Without any defined event, without any real screaming or shouting, everything tripled. Phosphate quadrupled, nickel tripled, and oil quadrupled. Everything went up, and no one really complained.

But oil is a different game. It is squeezing the real economy. If it keeps growing, at 7%, in 20 years it will chew up all of the growth of the entire system in the U.S.—the energy, the steel, the brains, and the money to get the resources you need to grow the system. If it were to accelerate to 9% a year, we would have 11 years; if it declines to 5% a year, we have 31 years to get our act together. Getting our act together means we have got to change the energy system above all. We also have to change the food system to be sustainable, and we have to start recycling everything as if our lives depend on it, because they do.

Going back to investments, we do a 7-year forecast. We have done it for 17 years and we've completed 38 of them now (it used to be a 10-year forecast, but we moved to 7 years). We finished 38 forecasts and we have beaten random 38 times, every single time, with some of the forecasts having been very good.

GMO 7-year asset class return forecasts* as of October 31, 2007

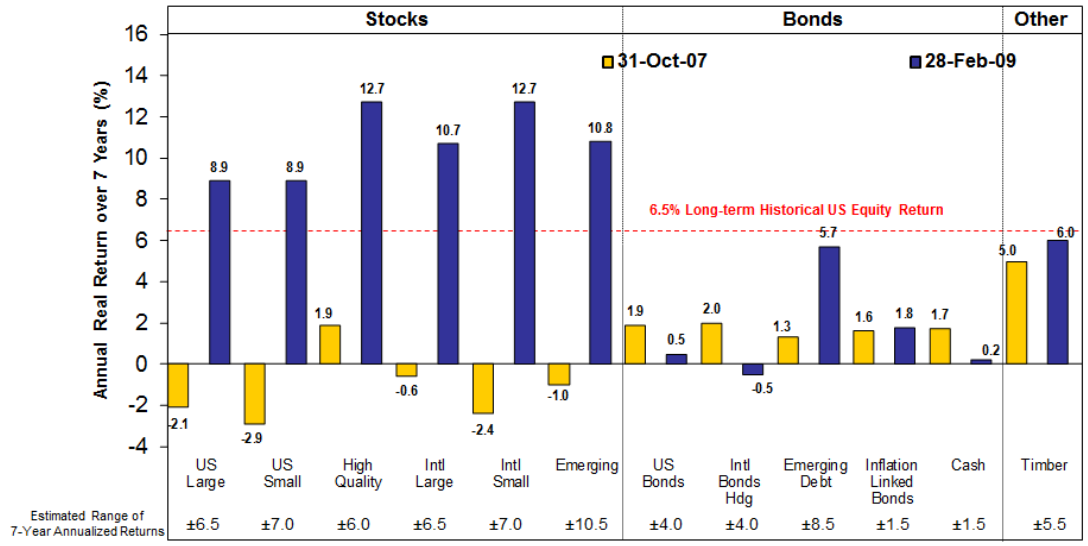


*The chart represents real return forecasts for several asset classes and not for any GMO fund or strategy. These forecasts are forward-looking statements based upon the reasonable beliefs of GMO and are not a guarantee of future performance. Forward-looking statements speak only as of the date they are made, and GMO assumes no duty to and does not undertake to update forward-looking statements. Forward-looking statements are subject to numerous assumptions, risks, and uncertainties, which change over time. Actual results may differ materially from those anticipated in forward-looking statements. US inflation is assumed to mean revert to long-term inflation of 2.2% over 15 years.

Source: GMO 18

This was the worst forecast we have ever had, in October 2007. We had a 7-year forecast for U.S. Large Cap of -2.1% real. Only high quality made it into the plus column at 1.9%. Bonds were pretty miserable, too. Only my favorite asset class, timber, was 5.0% real. That was the worst forecast.

GMO 7-year asset class return forecasts* as of February 28, 2009



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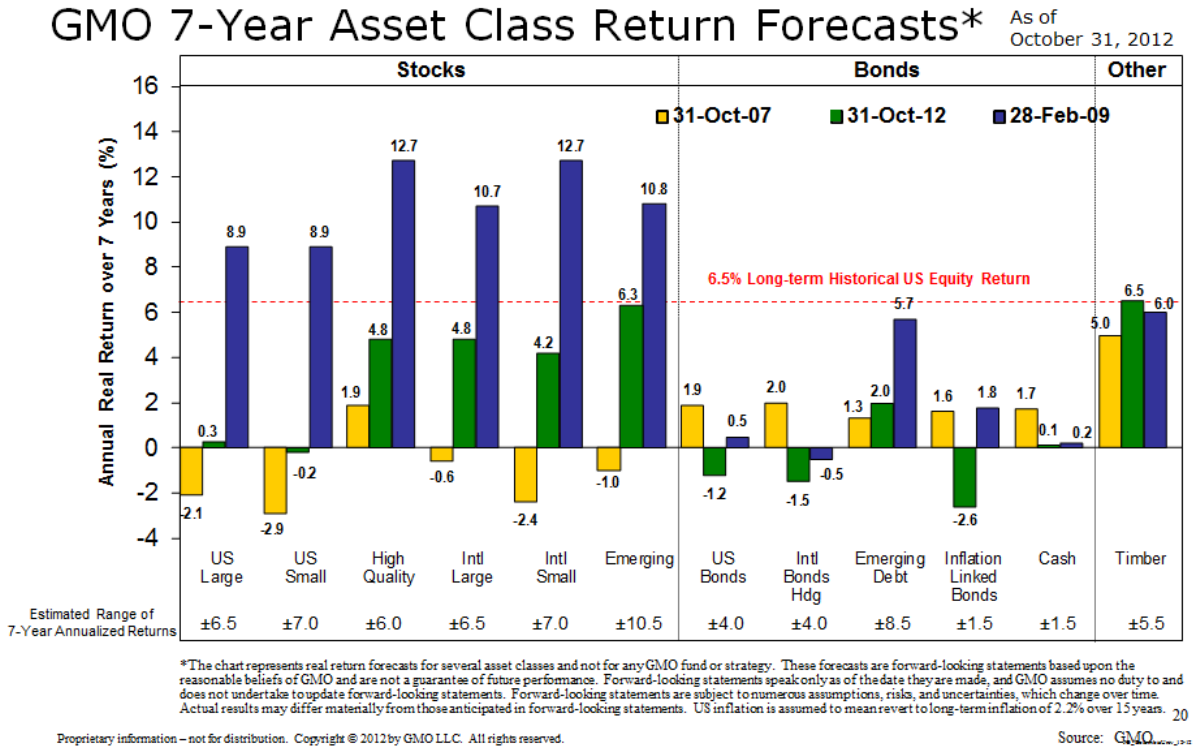
Source: GMO 19

This was the best forecast, and it was only a year and a half later, in February 2009. We had high quality at 12.7% and U.S. Large Cap 8.9% real, which had been over 10% two weeks earlier. Emerging, which was at 10.8%, had been over 12% in October of 2008. Amazing wipeouts create enormous value; that is how the system works.



*The chart represents real return forecasts for several asset classes and not for any GMO fund or strategy. These forecasts are forward-looking statements based upon the reasonable beliefs of GMO and are not a guarantee of future performance. Forward-looking statements speak only as of the date they are made, and GMO assumes no duty to and does not undertake to update forward-looking statements. Forward-looking statements are subject to numerous assumptions, risks, and uncertainties, which change over time. Actual results may differ materially from those anticipated in forward-looking statements. US inflation is assumed to mean revert to long-term inflation of 2.2% over 15 years. 20

Source: GMO

This is what it looks like today. Ho-bloody-hum, as we say in England. These are really boring returns. If you took all our forecasts and you put the forecast on one axis and the return on the other, you will see that it has been remarkably accurate. We live in a mean-reverting world.

10-Year Forecasts from September 30, 2002 vs. actual as of September 30, 2012

Asset Class	Estimated Rank	GMO 10-Year Forecast Sep-2002	10-Year Real Return Sep-2012	Actual Rank
Emerging Market Equities	1	10.9%	15.1%	1
EAFE Small Cap	2	10.6%	8.5%	4
EAFE	3	9.5%	5.6%	6
US REITs	4	9.4%	8.6%	3
Emerging Market Bonds	5	6.8%	9.8%	2
Russell 2500	6	4.8%	8.2%	5
Foreign Bonds	7	4.1%	4.9%	8
US TIPS	8	2.4%	4.0%	9
S&P 500	9.5	1.9%	5.4%	7
US Government Bonds	9.5	1.9%	2.2%	10
US T-Bills	11	1.8%	-0.7%	11
Correlation of rank order: 85%				

The accuracy of these forecasts does not guarantee that current or future predictions will be accurate either with respect to the ranking of those asset classes over a 10-year period, the absolute levels of real return, or results over shorter periods. The accuracy of forecasted rankings in the asset class forecasts generally varies from period to period. 22

*Average error ±1.1% Source: GMO

This is the last of our 10-year-forecasts—which expired September 30 of 2012, because we moved to a 7-year forecast 10 years ago. Emerging equity was forecast at 10.9% and the S&P 500 at 1.9%. That is 9 points of difference; 9 points of difference compounded for 10 years will triple your money. And it did better than that; it came in at 9.7%. These have a correlation of 0.65. That tells you all you need to know about my view of the significance of correlation. Correlation, which is so important in the way most of you build your portfolios, is a complete red herring to long-term investors. What could demonstrate it better than this? If you back up a year, the S&P 500 goes to the bottom of our asset class rank, emerging is the top of the list. Twelve asset classes, where two highly correlated assets are forecast to be top and bottom, actually came in top and bottom.

FURTHER DISCUSSION

AUDIENCE MEMBER: What does fracking do for your projections of U.S. energy needs and the way that returns would be affected by it?

GRANTHAM: I have a long report on my website about long-term growth, based on the simple data and problems with resources, which I think is far less than Bernanke and the IMF. I do think fracking is a great help, and I've given it a 0.2% for 18 years, predicting up to 2030. It will peak out at about 0.5%, which is just huge, but it peaks fairly fast. You probably know that fracked gas and even fracked oil flows far faster than normal. The main impetus has already passed. Over the last five years, we have started to drill thousands of wells; we will never drill as many wells as we drilled this year. The actual economic impetus first derivative of people and metal and drilling has passed its peak; therefore the future will not help growth as much as it has. It is already in the numbers, and that is the problem with going forward.

A second derivative is how long do we benefit from a cheaper energy asset than anyone else for chemical, feedstock, and so on? That goes on quite a bit longer, but the faster we respond, the bigger effect it has for the economy, and the faster it pushes the price back up. The faster it pushes the price back up, the less impetus it has on that front. It is not nearly as big as some people think, but it is pretty huge, at 0.5%, and then tailing off fairly rapidly for a very considerable 0.2% over 18 years. In a world where I think productivity is 1.1% prior to a deduction for a resource squeeze of 0.4%, 0.2% is a big number.

AUDIENCE MEMBER: I have a question on your outlook and recommendations for how the financial community should more quickly respond to the challenges around climate change. Your perspective would be welcome on the U.S. dynamic and how

that's changed post-election, with Hurricane Sandy and other events catapulting climate change back onto the agenda.

GRANTHAM: Sandy was incredibly convenient and helped several really bad, climate change denier-type congressmen to get zapped. We had on our agenda the Flat-Earth Five and we managed to take care of four of them. Some very decent senators in tight races got elected against flat-earthers too, in seven out of eight races we concentrated on. That's huge.

Obama was a no-show. He has been a bitter disappointment on this front. He chose to use his energies in other areas. He talked a good game, and when he came in, he forgot about it. His scientists, including John Holdren, just went missing in action, which was fairly tragic. They didn't even have the nerve to resign with dignity. Finally, they were considered great guys, but the test of a great guy is how you behave in adversity. When you come in under the promises of great action by a President who doesn't deliver, you should resign. They were chickens.

Where do we go from here? He is going to be a lame duck. The environmentalist may have a good mid-term, who knows, and that would change a lot. There is going to be slow steady progress, but I don't think we'll make it. I think we will pay a very, very high price. I don't think it's in our gene pool. If they spoke a more sensible language in Scandinavia, I'd immigrate.

AUDIENCE MEMBER: What can finance do about that?

GRANTHAM: Everyone has to do what little they can, and all our attempts to get some accounting for sustainability, for good and green behavior—the clock is ticking. It is a long uphill struggle. Bill McKibben is going around in a bus lobbying school kids to get colleges to divest oil, and it's a sad waste of terrific resources and a great guy. I think it is just almost a non-starter, but I hope he disproves my thesis.

AUDIENCE MEMBER: We talk about global warming and carbon dioxide, but why does no one talk about methane, which is seven times more potent as a greenhouse gas than carbon dioxide?

GRANTHAM: They do talk about it. In the environmental circle, people have been talking about everything forever. The question is why don't people listen to them? There is no listening going on, but there is plenty of talking. You can calculate methane as 100 times more potent in the short-term, but it just breaks down a lot faster than carbon dioxide, which is there for about 100,000 years. Once carbon dioxide is up there,

it stays there. With methane, we are potentially on the cusp of a couple of dreadful reinforcing cycles.

The tundra and, worse yet, the methane clathrates, which are frozen methane under the ocean beds of the northern oceans, are said to contain two to three times the total carbon dioxide of all hydrocarbons added together. If they start to go into the atmosphere, we could stop all industrial activity the next day, and they might keep going. In other words, we are playing well far and away the most dangerous games that we have ever played as a species, and we are behaving so badly that a Martian would say that we deserve to be roasted. It is a great test of *homo sapiens*. Can we deal with just learning gratification? Can we deal with grappling with the bosses of Exxon, who support all those formerly think tanks, now propaganda tanks, designed to do nothing but obfuscate actual scientific data? As I keep asking, have they no grandchildren? How do they feel when they go home after a good day confusing the public on an issue that may boil their grandchildren along with ours? They did the same in the tobacco industry. Don't trust capitalism to have a heart; capitalism given half the chance is a real bastard that needs regulation.

AUDIENCE MEMBER: Could you shed some light on why, without World War III, the commodity prices went up so quickly?

GRANTHAM: It's you. It is China. Population had been a steadily increasing factor, but the main determinant of when it happened was China. It is not just that China was growing at 10%; it is that people forget that mass is increasing so rapidly. Ten years ago, 10% was 50 units, but now 10% at twice the size is 100 units. Even if growth drops to 5% in fourteen years, it's 200 units. It is growing so fast that even a slowing growth rate means more units on finite reserves. At today's growth rate, it would take China 13 years to run through every ton of coal that they reckon they have in Australia. China is 45% of the world's total use of coal and cement.

AUDIENCE MEMBER: Is that because China is in a stage of industrialization?

GRANTHAM: Right. China will go from 50% capital spending to 30%, if they're lucky, smoothly over 20 years. If they do and the growth rate goes from 10% to 5%, they will still be using more coal when they are growing at 5% than they do today.

AUDIENCE MEMBER: So implicit in what you've said is that you support a global carbon tax?

GRANTHAM: Damn right, yes. Of course. Everyone should support a global carbon tax or a U.S. carbon tax or an Australian carbon tax. When I was in Australia a few years ago, I got bushwhacked by a question in a press conference—I've only done two in my life. Someone asked, "we've just introduce a carbon tax discussion into parliament, why should we do it when the U.S. and China won't?" I said, imagine you're in a life boat. It's leaking, you're far from land and the two big guys refuse to bail on principle. What are you going to do, sit there and sulk? Or get the hell on your knees and bail like mad, and hope that one of them is going to join in sooner or later?