Why is financial market volatility so high?

Downside risk and long-term investing

Prof. Robert F. Engle, 2003 Nobel Laureate for Economics

A risk is a bad event that might occur sometime in the future. But of course many risks are worth taking because the possible benefit exceeds the possible costs. Even crossing the road we take a risk, but we do that all the time for good reason. Finance is a field which investigates the question of which risks are worth taking and this is a particularly important issue for us to examine today.

This question has been studied for many years and has already received several Nobel prizes. Markowitz (1952) and Sharpe (1964) and Tobin (1958) received Nobel awards in 1990 and 1981 for associating risk with the variance of financial returns. Black and Scholes (1972) and Merton (1973) received the prize in 1997 for option pricing which, again, recognizes that a key measure of risk is variance returns.

In this lecture I would like to address the question of why we refer to variance when typically we are only concerned about the downside. We are only concerned if our portfolio goes down a lot, not if it goes up a lot. There is also a question about whether we miss anything important by looking at only the downside risk.

In effect, we typically measure risk in the financial industry using a downside measure. We talk about the Value at Risk as being the number of dollars or euros that we can be 99% sure we may lose, at worst, in the next 10 days. This measure has been very useful for financial practice. It essentially says, given the predictive distribution of portfolio gains, what is the 1% quantile of this distribution where we can be 99% sure that the outcome is not going to be as bad as that.

A more interesting version of this is multivariate downside risk: What is the probability that a collection of assets will all decline in value at the same time? This depends partly on correlations, but it is also linked to the tails of the distribution. Portfolio managers may well ask, “Where are my correlations when I need them?” I think a lot of people probably said that this summer. They thought they had a diversified portfolio, but everything was going down together.

When country equity markets decline together more than would be expected from the normal correlation pattern, it is called contagion. And it turns out that volatilities and correlations appear to move together, so that high volatilities and high correlations are

often associated. There is a statistical measure that is useful in describing this kind of extreme tail movement. It can be voiced as the question, what is the probability that one asset will have a very bad return if another asset has a very bad return? *Tail dependence* (lower tail dependence) is defined as the limit as this probability goes to zero. What is the probability that one asset has an extreme down move when another has an extreme down move? We can actually measure this and one particularly useful way to do this is by using default correlations.

When we think about defaults of bonds or mortgages or sub-prime mortgages, what we must consider is the correlation between one random event and others. A default is a random event. And it is a random event that we will have two defaults or many defaults. The question of how correlated these defaults are, is really a question of whether when one default occurs, it is likely that we will have two and when we have two whether it is likely we will have three and so on. Obviously, this is extremely important when we talk about the performance of a portfolio of loans such as the kind of securities we have been reading about recently and perhaps investing in. It turns out that for extremes, the default correlation is essentially the same as the tail dependence of a joint distribution.

When practitioners try to implement these models—the capital asset pricing model, the value at risk model, the default correlation models—they realize that the parameters are changing over time. They therefore require methods to compute variances and covariances, volatilities, value at risk and default correlations. And it makes a lot of difference how you measure them. Estimates differ for different time periods. Volatility is apparently varying over time. This raises further questions. What is its value now? What is it likely to be in the future? How can we forecast something we never observe? How can we get advanced notice that we have rising default correlations or rising value at risk?

Volatility history

To provide some answers to these questions I want to begin by looking at what I call the volatility history of the US. Figure 1 shows a historic volatility chart for the S&P500 from the 1950's through to recent years. The blue curve plots the daily closing values for the index over a 50-year period. The red curve across the top of the chart represents volatility, the rate of change of the index on a daily basis. The greater the amplitude of the red curve, the higher the volatility.

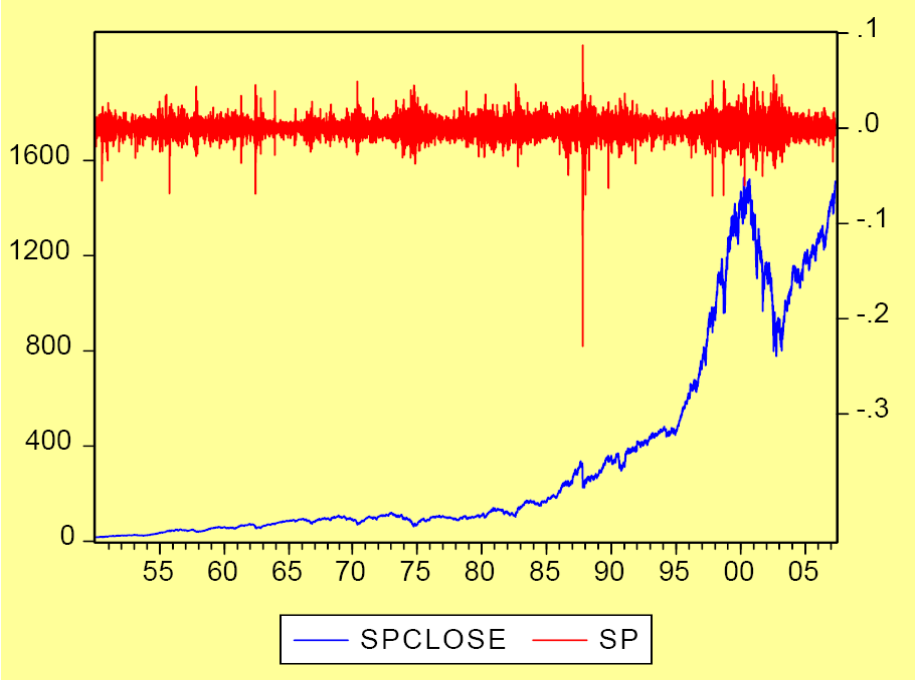

Figure 1: Historical volatility for the S&P500 – 1950's to today

What is immediately clear is that this value is continually changing over time. If we narrow our focus to the early period (Figure 2), we see dramatic evidence of the time varying amplitude of returns and consequently the time varying risk. Another thing we notice is that the periods when amplitude is highest corresponds to the periods when the market is going down. And in fact it is very common for high volatility to be associated with a bear market.

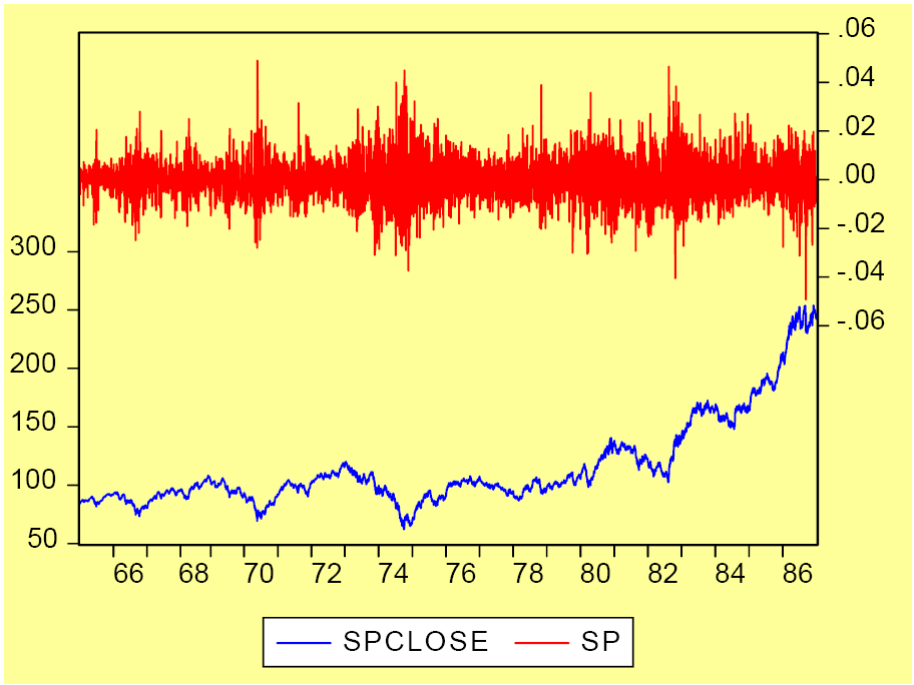

Figure 2: S&P500 volatility – 1963-1987

A second prominent feature of the data is seen in the mid 1990's when volatility was extremely low (Figure 3).

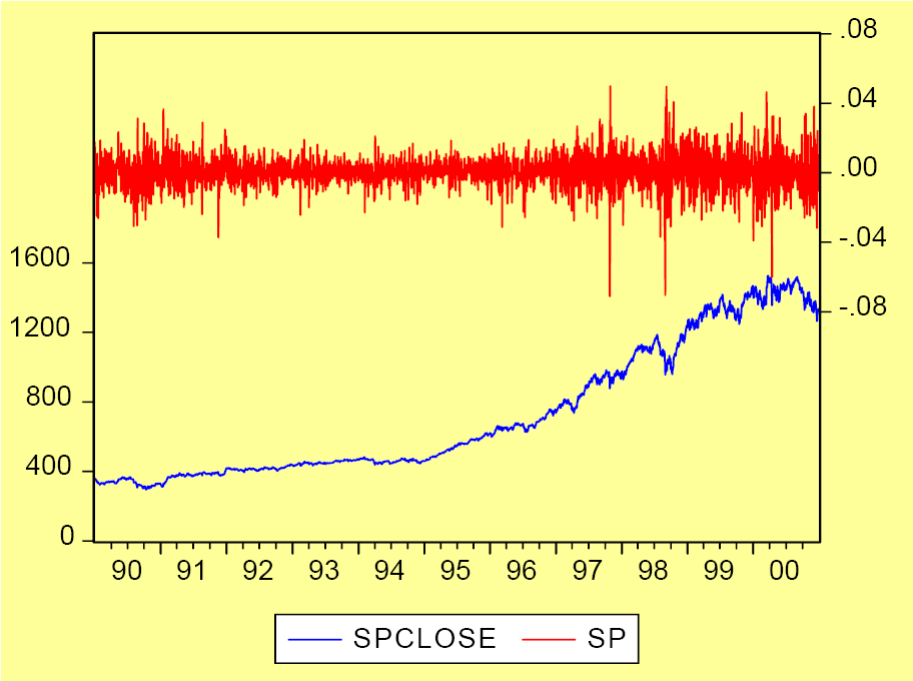

Figure 3: S&P500 volatility – 1990-2000

This is the period when I first went to consult on Wall Street, and the question I was asked was, "Why is volatility so low, and will it stay low?" From my simple knowledge of this market I replied, "Volatility is mean reverting, so that when it is low, it tends to come up, and when it is high, it tends to come down, but I don't know when." In effect, that turned out to be the right answer, and we can see that volatility rose dramatically after 1997 as we approached what we now call the internet bubble, when risk levels in the market were very high.

If we look at the next period (Figure 4), we see that when the bubble broke and the market collapsed, we saw continued high volatility for several years only ending with a fall in volatility in 2003 as the market recovered.

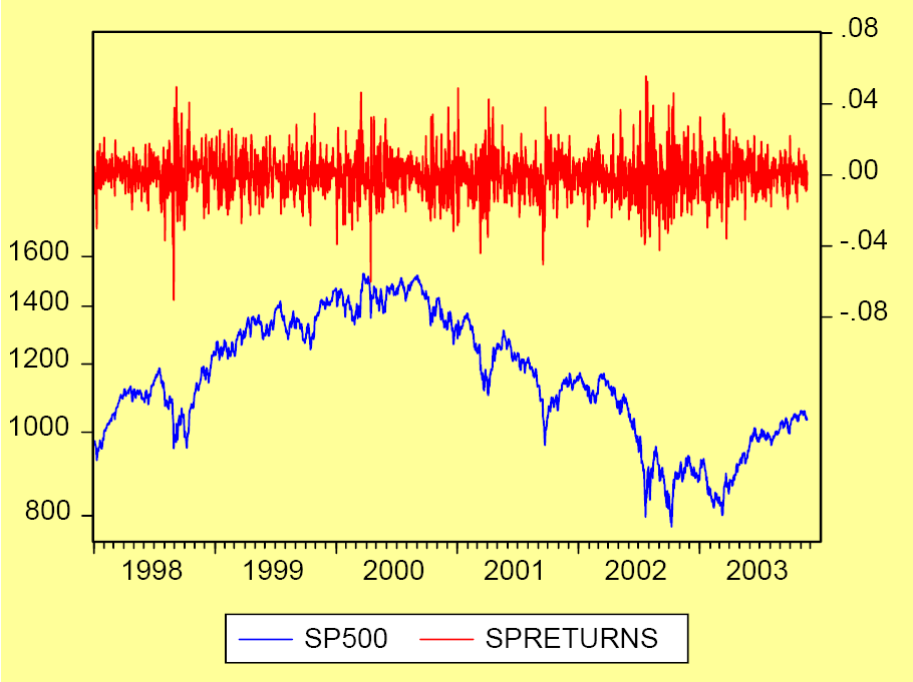

Figure 4: S&P500 volatility – 1998-2003

So, in response to the question how do we measure and forecast volatility in this kind of environment, the answer that I give is the Arch Model, which is designed exactly for this purpose. Essentially, it uses a weighted average of the volatility over a long period with higher weights on the recent past and small but non-zero weights on the distant past. The weights are carefully chosen to represent the length of periods that we typically see: clusters of high volatility and periods of low volatility. By using a weighted average of returns we can optimally measure what volatility is today and forecast what it is going to be in the future.

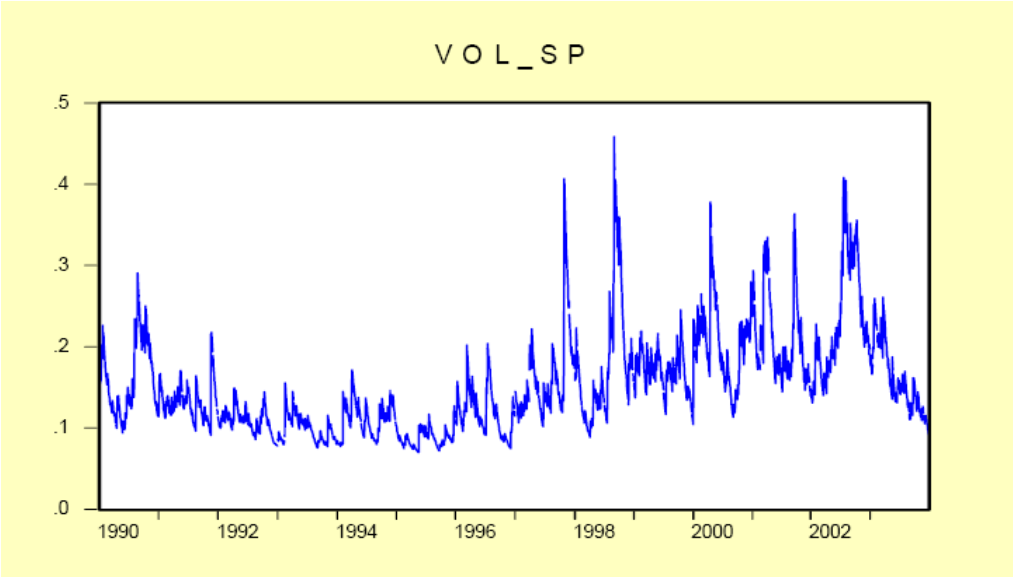

Figure 5: ARCH/GARCH volatilities – 1990-2003

Figure 5 shows what the volatility looks like according to the Arch model since 1990, and it is actually very close to the options data, for example the VIX chart. We can see the low volatility period in the 1990's, the high volatility period up to 2002 and the dramatic decline in volatility by 2003.

Perhaps a better way to think about this is in terms of confidence intervals (Figure 6). Every day we could plot a confidence interval for what the volatility is going to be the next day, what the returns are going to be tomorrow. The blue line is the upper tail, the probability that returns will exceed expectations might be only 1%, while the probability that they fall below the green curve might be 1%. In this way we can get an idea of what to expect the following day.

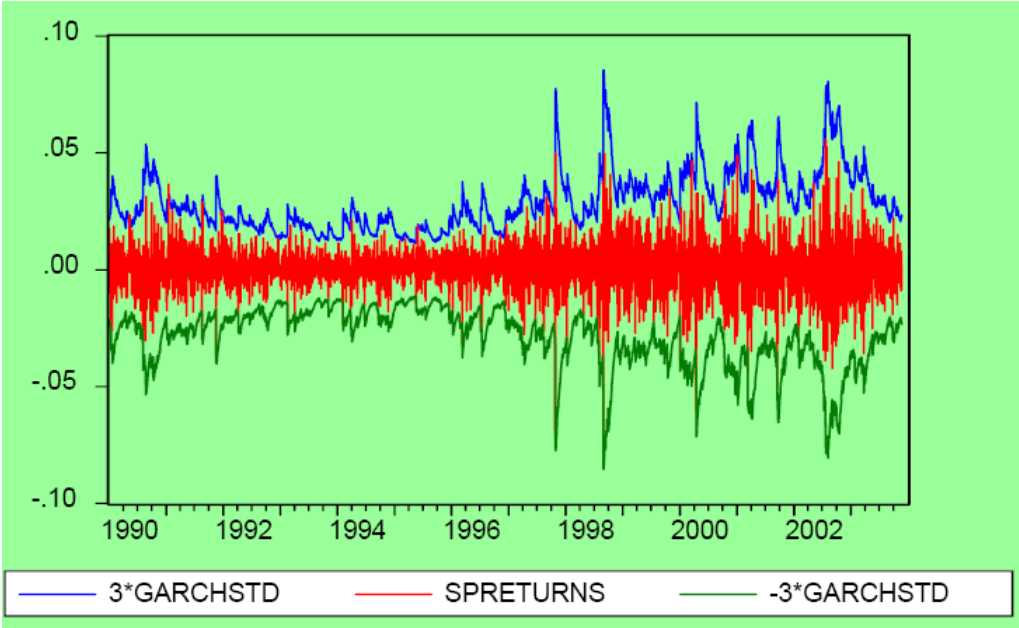

Figure 6: Confidence intervals – 1990-2003

The bottom curve is essentially the value at risk, the downside risk measured in a time varying way using, in this case, the GARCH model. This kind of approach is used by investment banks all over the world to measure the volatility of their portfolios.

What about the economics of volatility?

The GARCH model is not an economic model. It was not even designed to be a finance model, it just turned out that it was ideally suited to modeling some key features of financial data. But if it fits all kinds of financial data surprisingly well, we need to ask ourselves, why does the same sort of model fit so many different series so well?

It might have something to do with the random way the data is created. However, I actually think a better answer is that it has to do with news. Economic news on future values and risks is the main thing that moves financial markets. Volatility is the natural response to new information. Every day we try to figure out which companies are going to outperform, which countries are going to outperform, what the risks are going to be in the future, and we put all of these into a complicated calculation and choose our portfolios and our stocks.

Maybe our pension funds can move from one option back to the default or whatever, but how do we manage this kind of process? If we look every day, we see different prices every day. So, the Arch model seems to be successful, because the news also arrives in clusters. We have a lot of news for a while and then not so much news for a time and that is a natural outcome of an efficient market responding to new information. It is clear from the chart that there have been many episodes of high and low volatility over this 50-year period. But what determines these episodes of low and high volatility?

I suggest we can give the same answer. Is it feasible that we have several years of little market news and other periods of lots of news about the market? I think that may possibly be true. In a recent study that Gonzalo Rangel and I did, we looked at 50 countries around the world from the period 1990 – 2005. We found some interesting answers as to what made long run volatility high and what made it low.

Briefly, what we found was that several factors raise financial market volatility. One is high inflation. When inflation is high, equity markets seem to be more volatile. Another factor is slow output growth and recession. Volatile short-term interest rates also appear to make financial markets more volatile. When output markets are volatile, i.e. when we have one quarter of positive GDP output, then a negative quarter followed by a positive one again, we say there is a lot of volatility in output growth and that leads to higher volatility in equity returns. The same is true for inflation. Inflation might be high for a while and then low and then high, and this will translate into increased equity market volatility. Emerging and underdeveloped financial markets as well as large countries also seem to have somewhat higher volatility than others. The picture is a little richer than that but this gives the general flavor and it is very intuitive, because these are all factors which give rise to a high flow of information.

It also appears that the same features make for high correlations. Typically, when market volatility is high, correlations also generally rise. Correlations within an industry or sector will generally rise when the volatility of that sector rises. And on a higher frequency basis we also see that bear markets and declining, negative returns also predict higher volatility and therefore higher correlations.

And we can go one step further and ask about default correlations. What makes default correlations high? To answer this we need to look at CDO pricing. Collateralized debt obligations are securities created to hold loans, often of low quality, and sort them into tranches which are very unlikely to default and tranches which are likely to be the first to default. The pricing of these tranches of CDO's depends fundamentally on the default correlations. If defaults are highly correlated, the whole portfolio is likely to fall at the same time, meaning both the senior tranches and the equity tranches. If defaults are uncorrelated, it is very unlikely that the senior tranches will have any defaults. Therefore we really need to know something about default correlations. It turns out that default correlations and tail dependence rise when market volatility rises just as do ordinary equity correlations.

Is risk priced over time?

We have seen that market volatility feeds all these different channels of risk. But do prices change when risk is predicted to change? Of course, they do. We know very well that when one asset is viewed as being riskier than another, we will only buy it if it is less expensive (per dollar of expected payout). The same is true over time. When we have information that an asset is riskier than we thought it was going to be yesterday, we are willing to pay less for it. Hence volatility news predicting higher future risks should be accompanied by falling valuations. This is the bear market effect that we saw earlier, that negative returns tend to predict higher volatility in the future.

This gives rise to what we call asymmetric volatility. Asset price declines today predict higher volatility in the future than do equal price increases. In the same way long term risks affect prices today: If we think that there is a long run risk of inflation or recession, this information will reduce the price we are willing to pay for an equity share today. This explains why macroeconomic policy, which can stabilize the future business cycle, will have an effect on the present behavior of financial investors.

Financial risk today

We can now take a look at what is happening right now. Figure 7 shows the rest of the picture through to Wednesday, 21 November 2007, the day before Thanksgiving in the US. On the S&P500 we see another extraordinary period of low volatility just like the one in the mid 1990's. This corresponds to a long bull market in the US punctuated finally by the high volatility starting in July this summer and a smaller episode in February which is the effect of the Shanghai markets on February 27. We see the market declining in line with this higher volatility, but the question we really want to answer is whether this is the beginning of an episode such as 2002? Are we seeing the beginning of high volatility, or is it just another little blip?

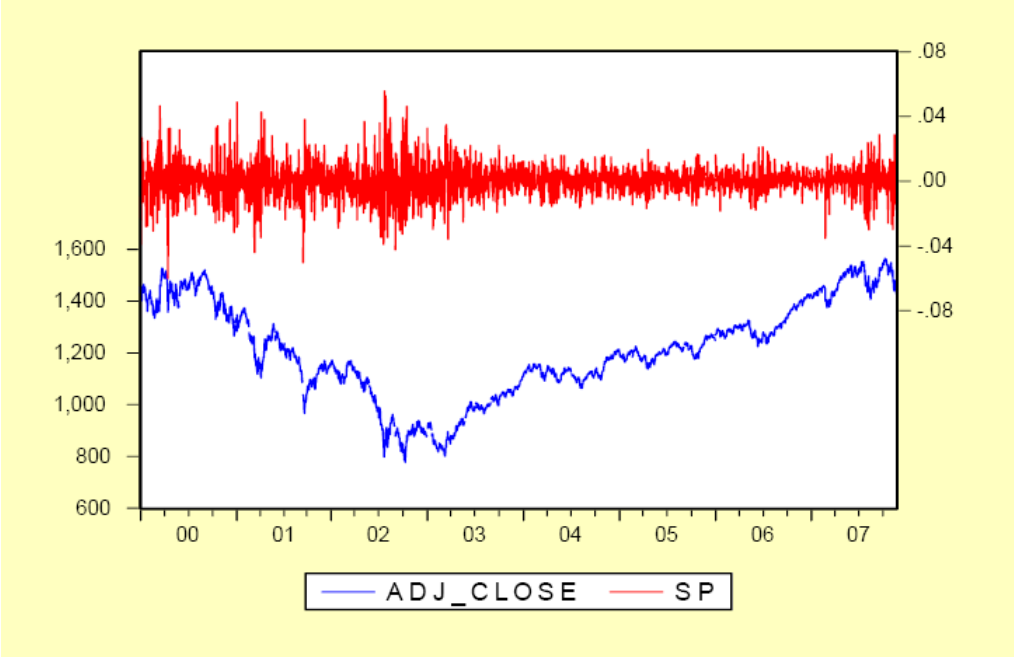

Figure 7: S&P500 – Nov 21, 2007

Well, what do we see if we look at Italy? Figure 8 shows an ETF of Italian stocks based on the MSCI Italy Index, and we can see that it presents a rather similar picture. There is low volatility through the 1990's and somewhat of an increase at the end of the decade, but actually not as much as in the US.

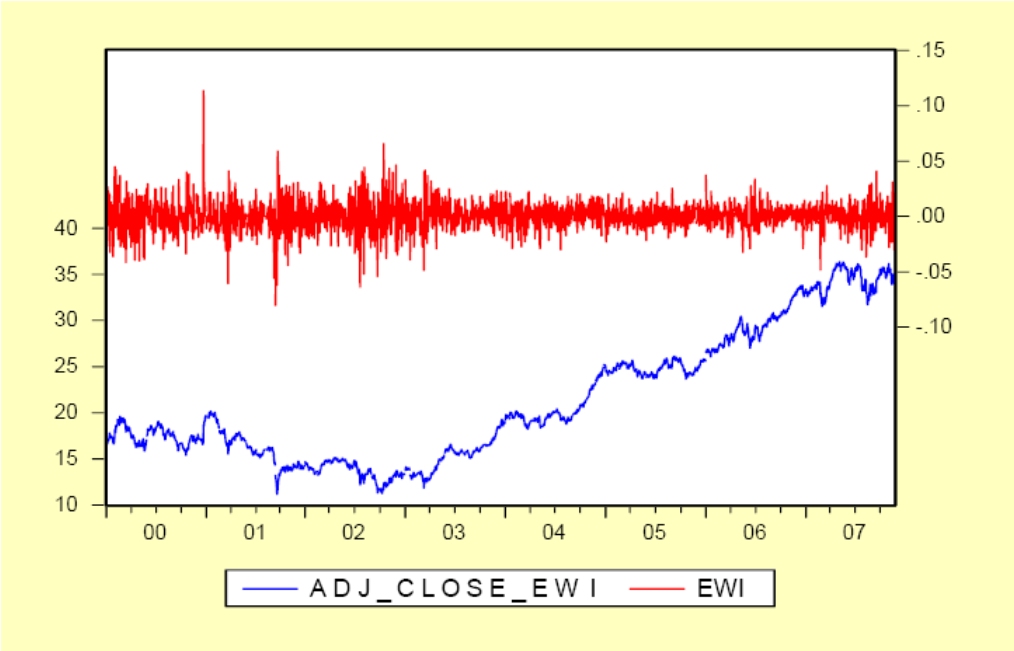

Figure 8: MSCI ITALY EWI - Nov 21, 2007

If we look at the Austrian Index (Figure 9), we see once again a low volatility period followed by a slight rise in the summer, though again, not as dramatic as in the US.

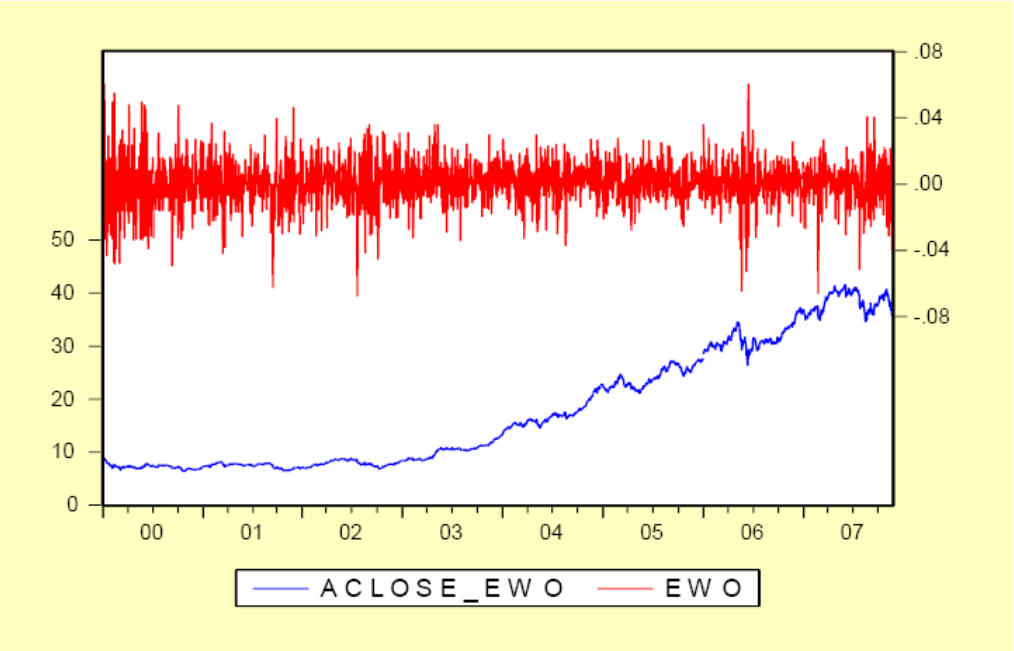

Figure 9: AUSTRIA MSCI: EWO: - Nov 21, 2007

And if we look at EFA as a whole, we do not appear to have such a big effect as happened a few years ago.

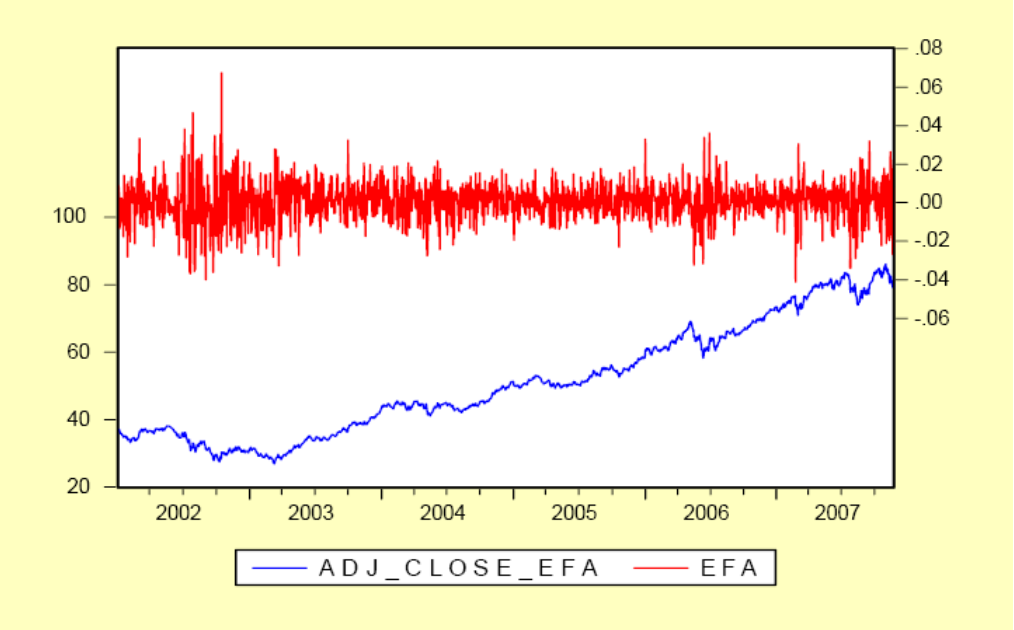

Figure 10: MSCI EAFA: EFA: - Nov 21, 2007

If we put all these indices together as a GARCH picture we have a model of the data through to November 21 (Figure 11). What we see is that the lowest curve through the entire period is the US. In other words, the S&P500 has very low volatility throughout. The highest volatility of these was Austria, followed by Italy and then EFA. This is not surprising since a smaller number of stocks generally means a more volatile index. However, towards the end of the period the US has moved up and is more or less level with the others. Notice also that none of the indices have risen as high as back in 2002.

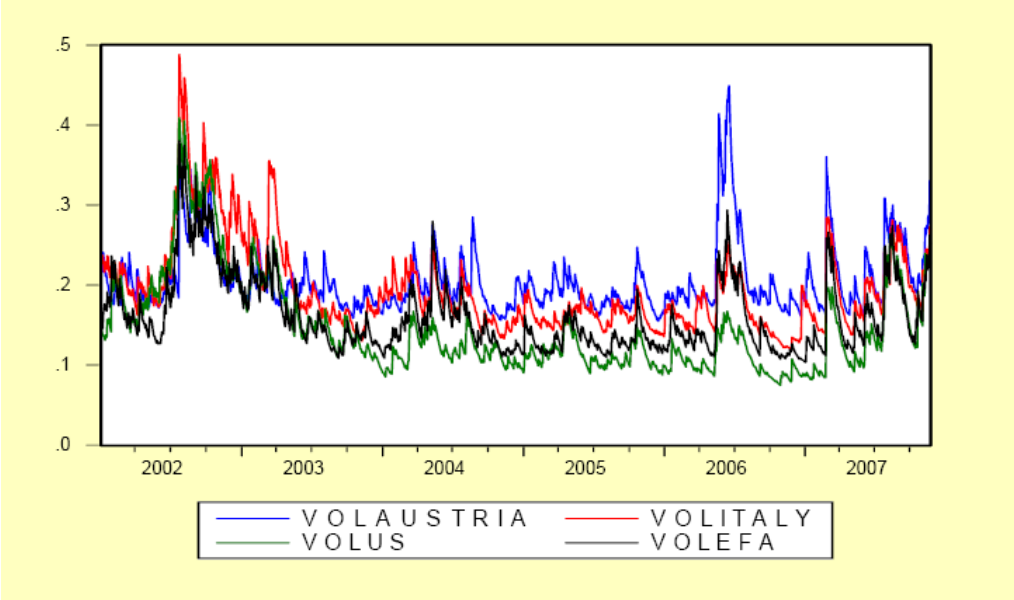

Figure 11: All GARCH volatilities 2007

Considering what a dramatic event in European economics this is, it is actually only a small event on the chart.

Finally, let us take a look at the most recent period which highlights the February 27 peak that I mentioned earlier (Figure 12). All the indices leapt up when the Chinese imposed a tax on transactions in Shanghai, but it was only a short-lived jump in volatility.

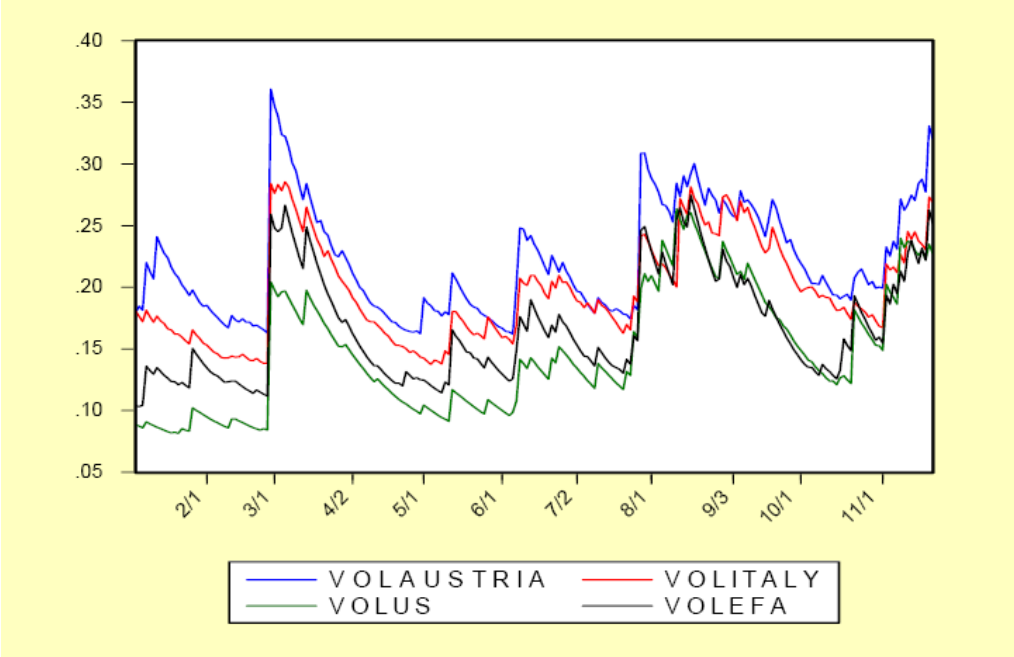

Figure 12: All GARCH volatilities Jan – Nov 2007

We then saw a gradual rising trend leading to higher volatility in September and October before easing off. Now in November it is going back up again and has actually eclipsed the values we saw in the summer.

The next question is a very familiar one: Why are volatilities so high and will they stay high? In reality, for most assets volatility is high relative to the last seven years but not high relative to the peak of 2000/2002.

Implications for the banking sector

In the US, I think the high volatility is due to the effects of macroeconomic uncertainty discussed above: the credit squeeze particularly associated with sub-prime mortgages. The concern is, are we heading into a recession? That is what the housing industry thinks. Or are we heading into a growth period with inflation problems? That is what one might expect looking at export industry given the weak dollar and the corporate profits reported by many domestic and multinational companies in the US. There is a huge amount of macroeconomic uncertainty right now.

The new feature is the credit industry, which is receiving a great deal of attention, and I would like to set out my views on that.

Holders of sub-prime mortgages generally expected a certain number of defaults. These are now predicted to be greater than historically observed, but this should not come as a big surprise. So, why have events since August been such a shock? First of all, our historical approach to risk management is unable to provide much information on this, because there was very little sub-prime lending when our last housing recession occurred in the early 1990's. The only data we have are house price increases. Secondly, there was some inappropriate fraudulent lending, which surprised investors. Most interesting, the securitization of the loans into CDO's has made it difficult for investors to figure out how risky they really are.

Indeed, it is hard for the rating agencies, and even for the people who manage the CDO's, to know how risky they really are. I think the reason for this is that the default correlations are changing over time and it is not easy to understand what makes them change. However, we have suggested what those factors might be. As market volatility is high and particularly as the housing market is going into a slump, just as with a downturn in equities, we would expect to see higher and higher default correlations, and this presumably means that the risks in the senior tranches of CDO's are higher than they were before the correlations rose.

Risk managers needed to know something about default correlations and how to model them in a world of changing volatilities and changing housing prices. Were we prepared? I guess not! I think one of the things we have learned from this episode is the importance of good risk management and investing in technology to measure risk just as fast as the financial industry is developing new products. The drive for new products is insatiable, because they have new profits associated with them. But by the same token the risk management field must progress just as fast if these products are to be included in the portfolio.

Very long run risks – Peace permits prosperity

When we talk about volatility, we are talking about risks. We are talking about short run risks, but perhaps we should talk about long run risks, because when we look forward we said macro economic risks were maybe apparent to us, but we ignored them. Well, what about some long term risks, what about the risk of war? What about the risk of terrorism? What would be the effect of war or terrorism on these financial markets? These are events which would reduce the investment opportunities; these are events which make the entire economy worse off. Investors today, thinking of the possibility that there might be war or terrorism, are likely to be more cautious and likely to require higher risk premiums for putting their money into this risk. As we see a deteriorating global economy with increasing income differentials between have and have not countries and rising fundamentalism, it seems like the risks of war and terrorism are probably increasing.

These risks are going to affect financial markets, and we expect that that would lead to lower prices in financial markets. Investors may be withdrawing from financial markets because of the risks of a global slowdown, but they might also be reducing their investment in the financial markets, because of their fear of the long term risk of war and terrorism. If this risk premium rises for the financial market, this is going to raise the cost of doing business, raise the cost of raising capital, it is going to reduce the income of entrepreneurs and cost jobs. This is a recipe for economic slowdown as a consequence of these long term risks.

Well, what should we do about this? There are some economic proposals that I think are actually pretty effective in reducing the risks of war. Trade and capital flows are key ingredients of co-operation. Building economic inter-dependencies are a good thing for reducing the tensions for conflict. Poverty needs to be reduced because that is a key ingredient of dissatisfaction and conflict. Education should be reformed to show the value in co-operation. Basically, the economy cannot function well when war is a threat, when war is close by, and I think political confrontation is probably in the same category. If you have too much political unrest, the economy can't do its job, it can't produce the jobs and income that are needed so a little simple mantra is that 'peace permits prosperity'. Without peace the economy can't grow. So we can do something about these long term risks today by moving toward a more peaceful solution to our problems. If we reduce the future risk of war, we will have benefits today. These benefits will improve business and stock-market valuations and create jobs - seems simple, doesn't it?

I would like to close with a couple of remarks concerning other very long run risks. If macro risks are long run risks, what are very long run risks? Two that immediately come to mind are climate change and public pension fund solvency. Climate change is obviously something that is going to evolve over the next decade or possibly two. It appears to be occurring quite quickly, but I am certain that we have not seen nearly the worst of what may very well happen. Both of these long run risks are likely to require massive public expenditures and higher taxes at some time in the future.

The higher taxation is likely to come at a particularly bad moment, just as we have a reduced workforce as the baby-boomers go into retirement, and that is a worrying prospect. At the same time, we will need to pay for whatever mitigation is necessary on the climate question. We need to find a solution because these two risks are very likely to depress equity values and investment today, even if the risks are in the distant future.

Most economists believe that the best solution to the climate change problem is a comprehensive tax on carbon emissions and other greenhouse gases. Only if it is comprehensive, will it encourage alternative energy solutions. However, most people believe that this is a quite impractical and politically unworkable solution, so there is a great deal of discussion about possible alternatives.

My proposal would be to introduce green taxes, but use the revenue to solve the pension problem as well. This would mean establishing a fund to support long run social costs such as retirement, similar to the sovereign funds that many countries already have, and fund it through a carbon tax. Actually, I learned today that this is something that Germany already does.

This would reduce both risks at the same time as they offset each other. It would have the advantage of being a tax on a “bad” rather than a tax on income or some other “good”. It would create a large sovereign fund that I would envisage being managed by an independent body like the Federal Reserve which would invest it in a generic indexed portfolio.

Contrary to many proposals urging more individual discretion in pension schemes, this would actually reduce individual discretion. But it has the advantage that social security benefits primarily lower and middle income recipients and therefore provides a progressive solution to offset the regressiveness of the carbon tax. An additional suggestion would be to pass the proposal today, but delay implementation for five years to give people a chance to buy a more fuel-efficient car, change their work or job location, insulate their home and take other steps to mitigate the costs of the tax.

That may not seem like a solution that is very easy to implement. But take a look at this picture.

You may recognize some of these people. This appears to be an office photo from Microsoft in 1978. We can see Bill Gates in the lower left corner, probably one of the richest men in the world now, though no longer the richest. Looking at this picture we might say, look at what has happened in 30 years. Microsoft went from this unpromising looking investment to one of the major global corporations which today runs almost all of our computers and has really re-shaped the world around us.

So, a 30-year horizon is really not that great. Imagine what we can do in 30 years, if we put into place something like this climate / pension proposal, modified perhaps in a thousand ways. We could have a huge impact on the future risks that we are facing and if we can ameliorate these risks today, we will also see the benefits today - we do not have to wait 30 years to feel the effects. I conclude on an optimistic note and a couple of suggestions: Make sure you only take the risks you intend to take, and keep an eye on the long run risks and not just the short term. Policy makers take note.