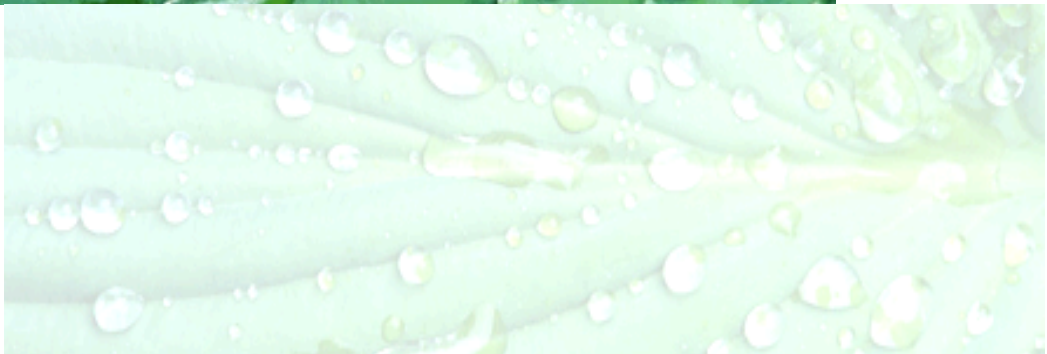




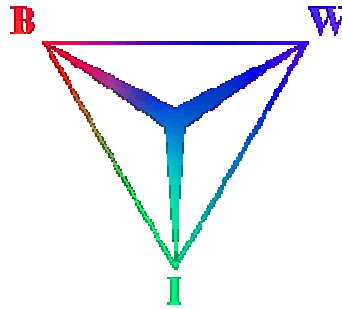
EVENT RISK EXPOSURE OF ASSET PORTFOLIOS



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Event Risk

Exposure of Asset Portfolios



Master Thesis
Business Mathematics and Informatics

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Executive summary

The main goal of the research conducted in this thesis was to develop a tool that enables risk managers and portfolio managers to assess event risk and periodically check what exposure asset portfolios have to this risk. Event risk is the risk of something happening that was not foreseen, something that could hardly be predicted and was not discounted in current prices. Examples are: a large rise in the oil price, or an unexpected decline in interest rates. An ongoing period of rising prices with no unexpected changes is not an event. One could say that events are occurrences that find themselves in the tails of a normal distribution, and are therefore usually left out of risk models. Results showed that there is a clear difference between outcomes based only on events, and outcomes that are based on a data set as a whole (i.e., without making a difference between events or regular data).

A distinction was made between positive and negative events, because expectations based on the literature supported the view that the effects of events are asymmetric. The results confirmed these assumptions.

The method that was developed and used in the tool that automates the whole process is clear and robust, and takes trend into account. It requires little time for preliminary research of the data and can be applied to basically any time series.

The effect of events, using regression, was evaluated on different levels: sectors, industry groups and industries. Literature shows that regression on stock level yields large errors and pleads for higher levels, or grouping of stocks, for this purpose. Results from this research showed that levels higher than the industry level are very prone to errors as well, so the industry level constitutes the basis for the regression outcomes.

Using the regression outcomes, only (active) weights of industries in a portfolio are needed to compute the exposure of that portfolio to the type of events under examination. Different scenarios of possible events and simple graphs make it easy for users to understand a portfolio's exposure.

The tool that was built, using VB in Excel, is able to do the event research of a factor from scratch. However, it can also easily be used for simply examining one portfolio, or evaluating a set of portfolios over all factors, constructing an overview file with the results for each factor and all portfolios. It is easily scalable and flexible in usage.

Preface

The final and most important part of the master study Business Mathematics and Informatics (BMI) is the master thesis. In line with the practical perspective and the business focus of this study, this thesis has to be written based on an internship within an external company. Besides the mandatory character, it is also an excellent opportunity to get some first experience in, and develop concrete ideas about, professional life. It is supposed to be a time where skills and knowledge gained during the study can be applied in practice, while getting to know the professional world.

During my penultimate master year I became interested in the financial world and specifically its products. Lectures and books can only give a relatively theoretical and abstract view of these products and the way financial institutions work. Therefore I chose to fulfil my internship within a bank. I happened to hear about internships at ABN AMRO bank via a friend and it seemed to be an appropriate and interesting financial institution to gain some first experience in the field in.

Once accepted as an intern for the Bank, I was given the opportunity to work on a pre-specified project: assess the exposure of portfolios against *event risk*, within the department Portfolio Risk Management, part of ABN AMRO Asset Management. This project seemed interesting and challenging: it goes off the beaten track, because its approach is very different from standard risk measurement approaches. In addition, and not unimportantly, it met the requirements set for the master thesis. Moreover, it reflected all three parts of Business Mathematics and Informatics: mathematically modelling event risk exposure of asset portfolios and developing a program that could automate this, both with a clear and practical focus. This broadly covers all three aspects of BMI. All in all, it seemed a more than suitable project to write my final thesis about.

I would like to thank Jaap Veerman, my supervisor at ABN AMRO Asset Management, for his dedicated, considerate and valuable guidance of both my thesis and my first steps in the professional world. For that last matter I also thank Rob van Oostveen. I want to thank my supervisors at the Vrije Universiteit, René Bekker and Bert Kersten for their help and advice during this internship. Finally, I would like to express my gratitude to my

colleagues of the PRM team for helping me with practical issues whenever I needed them, my colleagues/neighbours of the SRI team for accepting me in their midst, and both these teams for making my time as an intern such an enjoyable one.

With kind regards,

Anne Schoemaker,
Amsterdam, July 2007

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1 Introduction

1.1 Business context of the problem

ABN AMRO Asset Management (AAAM) is one of the business units of ABN AMRO Bank. It is its investment management division and manages around €209 billion (as at March 2007) in segregated accounts and mutual funds. AAAM has set itself a clear goal – ‘to become a premier global asset manager for institutional, private and retail clients’.

Clients of AAAM can be institutional clients (e.g. companies, pension companies, etc.), private clients (individual clients with a minimum fortune of EUR 1 million) and retail clients (other individual clients and small and medium sized companies).

Within AAAM, the Portfolio Risk Management (PRM) team services the Equity Portfolio Management team in Amsterdam, which manages assets of over €20 billion. The core activity is to provide consultancy services on risk related issues to the portfolio managers that manage the equity mandates and investment funds. The team produces mostly weekly and monthly reports, and for some special clients even daily reports on portfolio risk.

The current risk analysis focuses mainly on traditional measures of risk such as Tracking Error and Value-at-Risk. The system that is currently used for risk analysis and reporting is a factor model. This model has the advantage that it was built by professionals with excellent domain knowledge and is based on extensive historical data research, something which could not be done by a single department. It takes a great amount of factors into account, like style factors (value, size, volatility, momentum, etc.), market factors (countries, sectors, industries, etc.), and currency risk. A disadvantage of this system however is that it is not flexible; it cannot be adjusted or complemented with factors that might have been found useful by experts of the department. Another disadvantage is that, while the (statistical) assumptions underlying these measures hold quite well in ‘normal’ everyday equity markets, they are poor at modelling sudden disruptions or structural changes in the macroeconomic and

geopolitical environment (9/11, bursting of the tech-bubble, big oil price or interest rate hikes, etc.) that can have major effects on AAAM's equity portfolios.

Equity management has raised the need to address this issue. PRM therefore wants to complement its existing traditional risk analysis with a method that enables measuring the event risk exposures of AAAM's equity portfolios. Since the system used now cannot be altered, it will be a complementary model that gives extra information on portfolio risk.

1.2 The project

A lot of research has been done throughout history to find ways to model stock markets, to find relations between macroeconomic factors and stocks and so on. This kind of research is commonly focused on the 'normal' part of the data, which means that events that are not 'normal', that are in the tails of the distribution like in Figure 1, are left out.



Figure 1: Tails of a normal distribution.

In this thesis, research will go off the beaten track: instead of trying to model all the data, the focus here will be on trying to find relations with only the data in the tails, which will be called events. The assumption is thus, that behaviour in the presence of events is different from behaviour under normal circumstances and therefore cannot be

simply estimated using everyday data. Moreover, small price or rate movements might be dominated by other price relevant information (S.M. Bartram 2002), causing less significant outcomes. This assumption is crucial in the research.

Another point that is very important in this thesis is that events will not be considered a homogeneous group, but rather as two distinct groups of events: positive and negative events.

A final, crucial choice that was made in this research was that of not performing multifactor analysis but to limit the research to several partial analyses. In case one is investigating all data points instead of just events, it is inevitable to take other factors into account. These may influence the data and isolating one factor will most likely not lead to useful results. However, the situation is different in the case of events. In a way, the answer is intrinsic to the definition of event: an event is an occurrence that is very rare and is most likely to have a strong, exogenous effect, which is hardly affected by, and rules out, movements of other factors that may occur at the same time. Therefore, the assumption is that multifactor analysis will not lead to other or better results.

It needs to be emphasized here that the core issue of this thesis is not modelling if and when such events take place. This is a very complex problem and a lot of research has been done in this field during the last decades. Currently the team bases its risk analyses mostly on Tracking Error and Value-at-Risk and, like most models and tools, these do not tell much about what reactions will be like when something takes place that had not been foreseen. The aim of this project is to find the exposure of portfolios to these rare events that are hardly ever taken into account. This will be complementary to the existing risk reports made by the team and therefore provide portfolio managers with more data to base their fund strategy on.

1.3 The model

The general outline of the model that is used throughout the thesis is as follows. The first step is to identify (macroeconomic) factors that could be interesting and relevant in the sense that they are of importance to asset portfolios. The two major ones are oil prices and interest rates, but commodities, gold and copper are also part of the research. To get a better understanding of these factors, some background information and data analysis is provided.

Next, events need to be identified. For this, a description of the choices that define an event in this thesis will be given. With these definitions events can be filtered out of the factor data, using an event identification method that was developed especially for this purpose. This method will be thoroughly explained.

Subsequent, the exposure level needs to be chosen. This level determines the kind of data that will be used to regress the events against. The main structure will be based on the GICS structure, which divides the world into sectors, industry groups and industries. Another possible structure that is introduced is that based on countries, in this case emerging markets versus developed countries and Europe versus North America.

After this exposure level has been chosen, the actual regression can take place in order to find significant relations with the dates that have been identified as events. As mentioned in the foregoing paragraph, there will be distinct results for positive and negative events.

The outcomes of this regression will then be used to compute the actual results for portfolios, by means of what will be called extraction to portfolios.

A large part of this model can be automated and for this purpose a program was developed that will be explained briefly in the next section.

1.4 The program

A general description of the program will be given here, for a more detailed description the reader is referred to Appendix 1IX. The code of the program can be found in Appendix 1X .

The goal of the project is to deliver a tool that can easily and readily compute event risk exposures of equity portfolios managed by AAAM for certain factors. Following the model as explained in the previous section, a program was built to automate most of the research. The program will be set up in such a way that it is easily scalable; it will be possible to add other factors in the future, without much difficulty. Regarding portfolios, it will need to be flexible enough to be able to deal with different kinds of portfolios. The tool itself will be used by PRM but the final output will be used by portfolio managers.

The general idea is that the user chooses a factor from the list. The program then identifies the events in the factor data. When the events have been selected, a relation is proposed between these events dates and data on sectors or countries, depending on

the choice of the user. After finding these relations, the tool is ready to extract these results to portfolios. A portfolio is selected by the user and the tool computes the final results. These analyses are reflected both by numerical and graphical results, in such a way that an end user (portfolio manager), with little or no mathematical or statistical knowledge, is able to interpret and use it.

The program language is Visual Basic, because this is the language mostly used within the department and also because it works very smoothly in combination with Excel. This is a program well understood and commonly used by the end users and output data can be easily used for other relevant purposes.

1.5 Organisation

The thesis is setup as follows: chapter 2 discusses the different factors that are part of the research, like oil, interest rates, and commodities for instance. Some background information and brief data analysis is given for each factor. The third chapter is mainly about the method for event identification that was used. The next chapter deals with the exposure level that was chosen for the data that was used to regress the events against. Chapter 5 describes the actual regression, the method, and an overview of the outcomes. The way these regression outcomes are extracted to actual portfolios can be found in chapter 6. Chapter 7 describes the differences between outcomes based on events and outcomes based on data out of which events had not been filtered. A description of all the results is given in chapter 8. The last chapter is the conclusion, and after that last chapter the reader finds the references and the appendices.

2 Factors

In this thesis a factor is something that possibly influences stocks: the oil price for instance, or interest rates. Events have been filtered out of the data of each of the factors, but before that is actually executed some research was done to find out more about each of the factors: their background, the economic influences they may or may not have, and their data. The factors that are included are: oil prices, commodity, gold and copper prices, long-term, short-term interest rates, and interest rate term spreads. Each factor will be described briefly and a short data analysis is given for each factor by means of plots. The plots that contain two graphs show the actual data and a second order polynomial trend line automatically fitted in the first graph; the second differences, which will become important and necessary in the event identification phase later on (chapter 3), are depicted in the second graph.

A description of the data sets that were used for the factor data can be found in Appendix 1I.

2.1 Oil

The oil price was chosen to be the first factor for analysis. It is not a complex factor, in the sense that there is basically one single definition of the (crude) oil price, as opposed to the factor interest rate, for instance, where many different types can be distinguished. It is only a matter of specifying which price to use. For this reason it is a convenient factor to start the research with and to base the building process of the program on.

2.1.1 Background

It is quite clear that, as with basically all (macroeconomic) factors, a change in the oil price will basically never have an isolated effect on portfolios or shares. This is due to the fact that the oil price may influence economic factors, macro as well as micro, but this relation can also work the other way around. One can think of many consequences of a rising oil price, and the examples that will be treated below will not cover all of the possibilities; they are merely rough examples.

Important to note is that the consequences of movements in the oil price will not be exactly the same for all countries. In the short run a price increase has a positive effect on oil exporting countries, whereas it has a general negative effect on those importing oil. This positive effect however will be ruled out in the long run, as negative effects for importing countries work their way back to exporting countries due to their trading relation.

An interesting fact is that oil demand is very in-elastic: demand hardly decreases with an increasing price, while demand does increase when prices fall. Interesting is also that the effects of oil prices on growth are asymmetric: a rise in the oil price often has a significant negative effect on economic growth, but a fall does not cause economic expansion. This also means that price increases are more important than price decreases. The asymmetry of the relation is mostly due to monetary policies after the oil price rises. Governments will try to keep the effects on inflation minimal by raising the interest rates for instance. Important is, though, that economic response to oil price changes is smaller the more volatile the price is. It is the degree of surprise that matters, when it comes to oil price movements.

In general it can be said that an increase in oil prices leads to an increase in prices of goods and services, a decrease in retail sales, an increase in the price of domestic corporate goods, and an increase in unemployment. Furthermore, it has its influence on trade losses, on consumer expenditure and investment expenditure. Moreover, an efficient stock market will react with an immediate decline in stock prices after an oil price rise, since higher production costs (due to these higher oil prices) will cause earnings to decline. This means that individual oil price shocks depress real stock returns. The oil price also has a direct influence on economies through interest rates and inflation. A higher price leads to a lower interest rate and higher inflation. The relation between core inflation (inflation excluding food and energy prices) and the economy has weakened though. The effects on inflation are less when indirect taxes are higher.

Finally, oil prices also have their influence on commodities, and not only if oil is being used for their production. Its impact is also through price changes on real exchange rates.

The energy crises in 1973 and 1979, the Gulf War and an increase in demand lately especially from the fast-developing country China caused major oil price increases.

2.1.2 Big Oil

"Big Oil" is a term used to describe the individual and collective economic power of the largest oil and gasoline manufacturers, and their perceived influence on politics, particularly in the United States. The companies generally described as being part of "Big Oil" include Exxon Mobil, Chevron Corporation, British Petroleum, Royal Dutch Shell, and ConocoPhillips.

2.1.3 Benchmarks

In the 1980's, crude oil price benchmarks were first introduced. There are three official benchmarks nowadays:

- West Texas Intermediate (WTI). This benchmark is primarily used in the U.S.
- Brent Blend. Primarily used in Europe and the OPEC market basket, around the world.
- Dubai, also known as Fateh. This benchmark is used in the United Arab Emirates.

WTI and Brent Blend are both commonly used benchmarks. Jacobsen et al. (2003) showed that correlation coefficients between the time series of these two benchmarks are all between 0,74 and 1, which means either one can be chosen without significantly affecting the results. For this thesis the WTI benchmark will be used.

Information about oil and related topics was summarised from research by Ray Barrel and Olga Pomerantz (2004), Dermot Gately and Hillard G. Huntington (2001), and Tilak Abeyasinghe (2001).

2.1.4 Data analysis

The upper plot shows the data with its second order polynomial trend line. The lower plot shows the second differences (that will be explained later on), which give a first hint of the location of events. As can be seen in the first plot of Figure 2, the data show a trend that is roughly polynomial of the second order for 1995 until 2006. Clearly, prices have gone up a lot in recent years. The second plot already gives an idea about possible events; spikes in the second difference indicate a sharp change in prices.

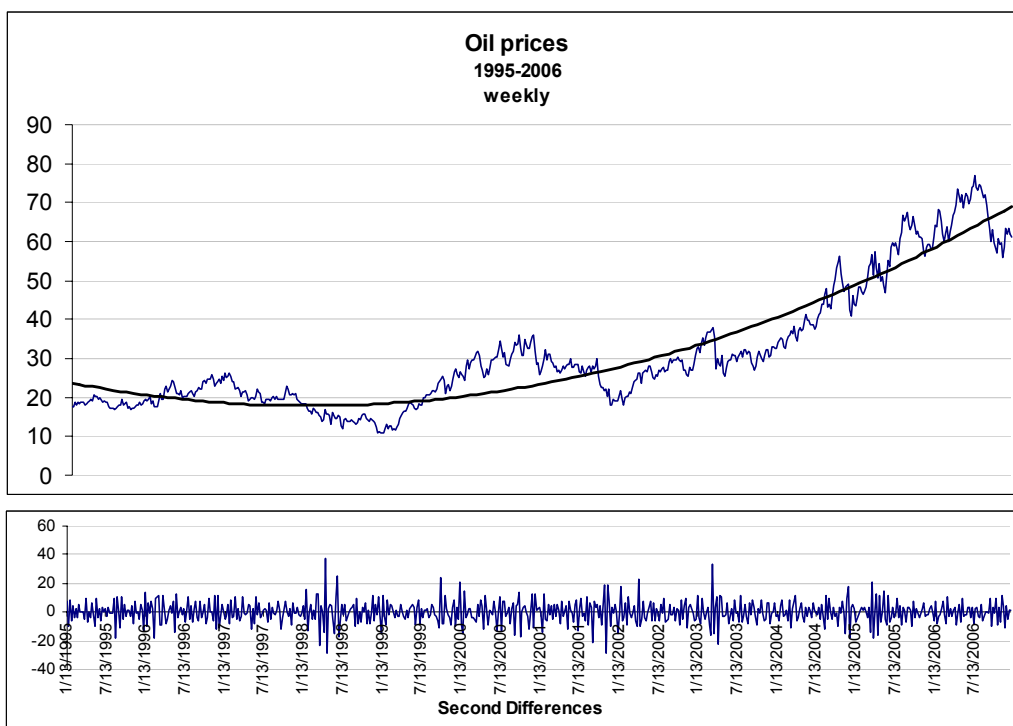


Figure 2: Plot of oil data with trend line and plot of oil’s second differences.

For oil, relative changes are much more relevant than absolute changes, so price changes are stated in percentages.

2.2 Commodities

Commodity is a factor that is similar to oil, in the sense that it is unambiguous. Some different benchmarks exist, but differences between them are small. After choosing a benchmark the factor is ready to use and can be evaluated in the same way as oil. This is why this factor is incorporated as second factor for analysis.

2.2.1 Background

A commodity is an undifferentiated product, good or service that is traded based solely on its price, rather than quality and features. Examples are electricity, wheat, coffee beans, oil, bulk chemicals, metals and even pork-bellies and orange juice. Commodity exchanges include:

- Chicago Board of Trade
- Euronext.liffe
- London Metal Exchange
- New York Mercantile Exchange

Some commodities price indices are:

- Dow Jones-AIG Commodity Index
- Goldman Sachs Commodity Index
- Standard & Poor's Commodity Index

The composition of these indices differs somewhat. An example of what the composition of such an index looks like can be found in Appendix 1I, under commodities.

Many of these commodities are quite important products, and it is for that reason assumed that a large change in the commodities index can have consequences for different sectors. Especially developing nations are very vulnerable with respect to commodities and even their currency tends to be tied to the price of a particular commodity that is important to the country, until it manages to become a developed nation.

2.2.2 Data analysis

In this thesis the Dow Jones-AIG Commodity index was used. Since oil is also a commodity and since it is part of the index, it is quite likely that the behaviour of the commodity data is similar to that of oil and that is indeed what becomes clear from Figure 3. Here the trend is also roughly a second order polynomial for data from 1995 to 2006 and in the second plot some extreme movement can already be identified.

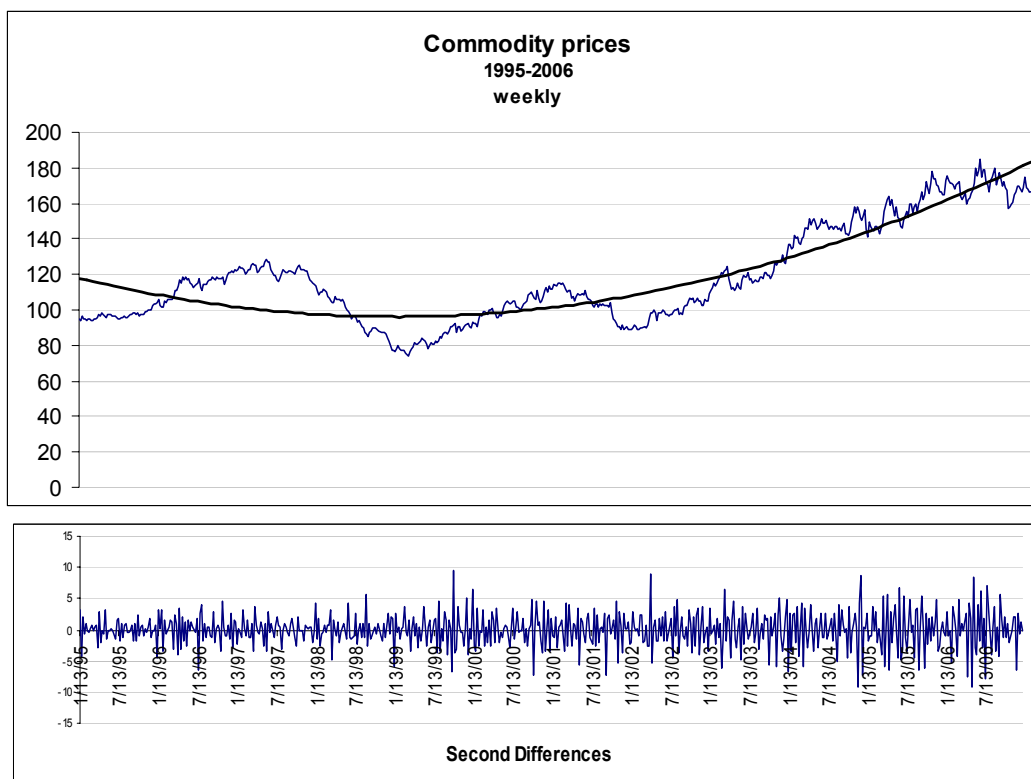


Figure 3: Plot of commodity data with trend line and plot of commodities' second differences.

As for oil, for commodities relative changes are also much more relevant than absolute changes, so price changes are stated in percentages.

2.3 Gold

Despite gold being unambiguous in the same way oil and commodities are, it is a more complicated factor, because it is usually not clear whether a price change of gold influenced the economy or whether something in the economy influenced the gold price. Nevertheless this factor was included in the thesis. Even if it is expected that results will not be very useful for daily practice, it is interesting to see whether this can indeed be concluded from the outcomes of the method.

2.3.1 Background

Until the end of the Bretton Woods system in 1971, gold was used as money, in one form or another. Since 1971 it has largely lost its role as a form of currency, but nevertheless it is still considered by many as a store of value and a safe haven in times of recession or crisis. When the general opinion is that prospects are unfavourable, a 'flight to quality' can often be observed: gold is believed to retain its value, independent of governmental, political or economical climate. It is a common perception that economic turmoil has a negative effect on the value of other investments, but the opposite effect on the value of gold.

Gold is used for several purposes. One is diversification: it can be included in portfolios as an insurance against unforeseen calamities or crises. These would negatively influence other investments, but not gold. It can be used for speculation, which is a process analogous to currency speculation. But most of all it is seen as a store of value. From a historical perspective, no other investment has the wealth preserving power of gold.

Nowadays, the price of gold is mainly driven by supply and demand, like all investments and commodities. Compared to the annual production, the quantity of above ground hoarded gold is very big, which means the price of gold is mainly affected by sentiment, rather than changes in production. When crisis threatens, the demand for gold increases. This holds for war and similar crises, but also for times of negative or low real interest rates and times of high inflation.

2.3.2 Data analysis

The first plot of gold prices in Figure 4 shows a clear second order polynomial trend and some spikes in the second differences can be observed, but prices are less volatile than for example oil prices.

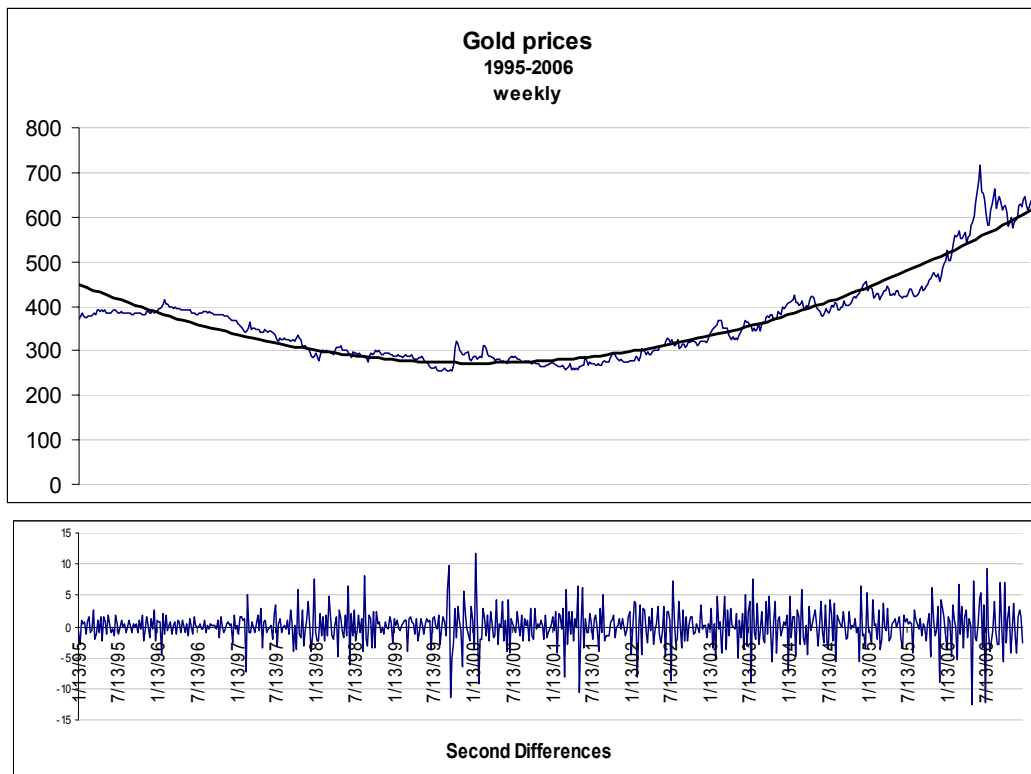


Figure 4: Plot of gold data with trend line and plot of gold's second differences.

Also for this factor price changes are given in percentages, to reflect the importance of relative price changes as opposed to absolute changes.

2.4 Copper

Copper is not expected to influence neither the economy nor stock markets in any significant way. But again, research should confirm this assumption and copper does have a fairly interesting relation with the economy, which will be explained below.

2.4.1 Background

It is generally thought that copper prices are an indicator of future economic situations. It is the world third most widely used metal and it is said to be a great coincident indicator: as copper's fortunes go, so goes the world economy.

Copper is a cheap metal, but it resists corrosion and is a good conductor of heat. As a result, it is widely used in important parts of the world's industrial economy. Almost half of the copper in the US is used for building construction and this pattern is representative for the world. Another large player is China, where, besides its usage in the construction industry, 20 percent of copper goes into electrical and electronic products. The transportation sector and the industrial machinery are also heavy users.

The copper market, and therefore the price, responds to trends in demand and supply, which makes that the price of copper commonly represents a pretty accurate measure of the demand for it in the real world, rather than an irrational bet on its future value. It is cheap, heavy and plentiful, so no one bothers to hoard it; it is just used as needed. Another characteristic is that if the spot price gets way higher than the futures price, companies that have some inventory will sell it. This does not hold for other commodities in general.

2.4.2 Data analysis

Another second order polynomial trend can be observed in Figure 5 of the copper data, but it is also quite clear that prices were rather stable. The only exception is at the end of 2006-start of 2007, when prices rose sharply at first and fell later on, due to a copper price bubble. For this factor again, price changes are given in percentages.

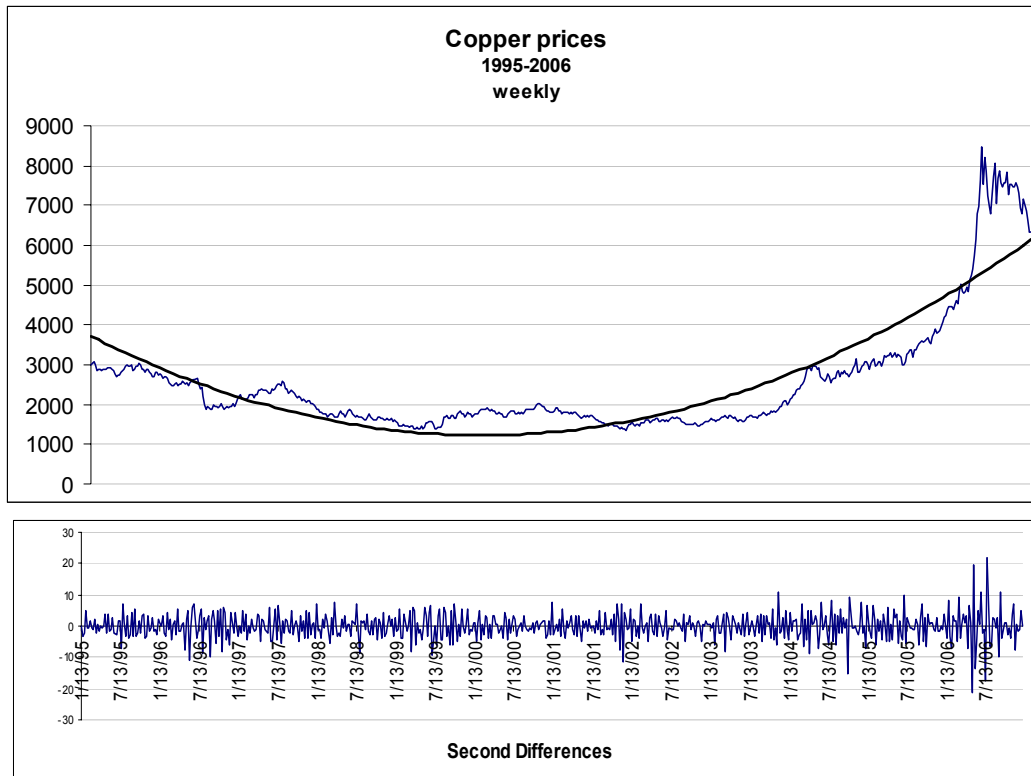


Figure 5: Plot of copper data with trend line and plot of copper’s second differences.

2.5 Interest Rates

This factor is a complicated one in different ways. On the one hand there is not one unique interest rate, like there is (basically) one oil price for instance. On the other hand there is the clear relation with other macroeconomic factors that cannot be ruled out. It is however one of the most important factors, because it has a great impact on the economy, on companies and therefore on stock markets.

The following paragraph will give background information about long-term and short-term interest rates, about central banks and the yield curve.

2.5.1 Background

There are interest rates on a short term, a medium or a long term, the interest rate set by the Central Bank, the inter-banking rates LIBOR and EURIBOR, and Treasury Bills, Bonds and Notes with different maturities. Then of course one can distinguish between interest rates in the US for instance, or in Europe or Japan, which are three major ones. The obvious necessary question is now, which of these to choose for research?

Interest rates influence the economy in the broader sense, but this relation is not exactly unambiguous and lucid. Figure 6 is a 'simplified' model of how economical factors influence each other.

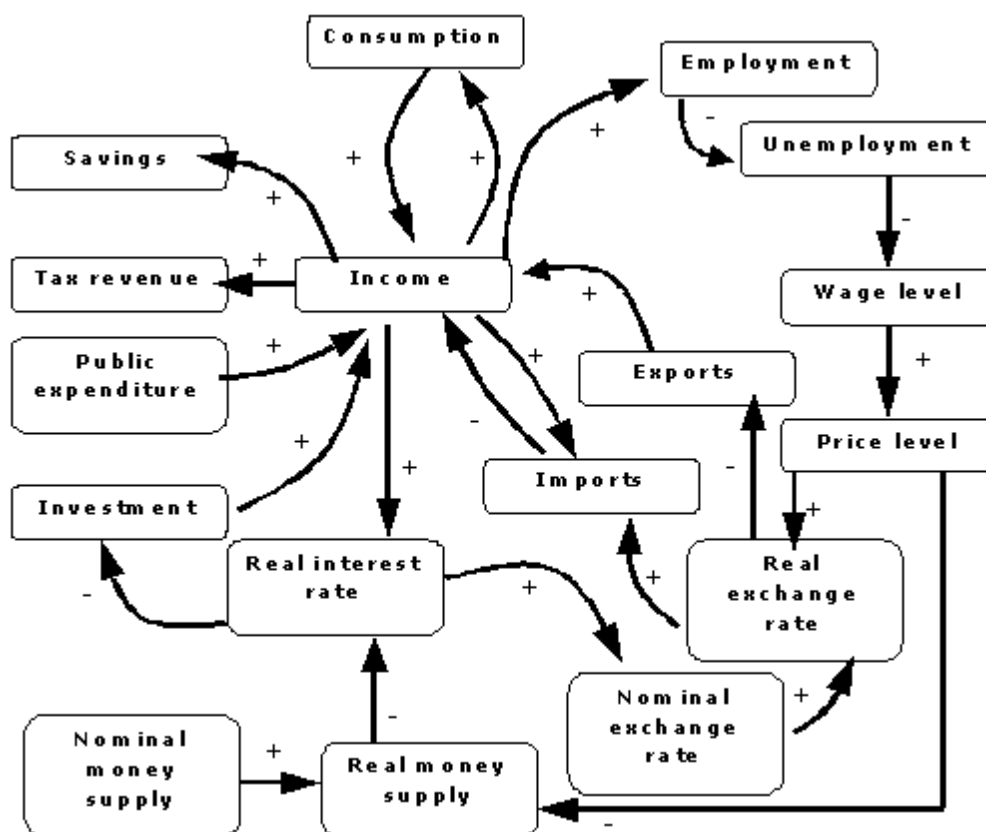


Figure 6: A graph representation of a basic macroeconomic scheme: the IS-LM model, by V. Piana (1998-2001)

One of the most important relations would be that of interest rates and consumer spending and investment by both consumers and businesses. A lower rate makes it cheaper for people to borrow money in order to buy goods or homes for example. It also makes it cheaper for companies to borrow to invest, which in turn makes the economy

grow faster. In contrast, an interest rate hike means borrowing money becomes more expensive, for consumers as well as for companies. For consumers a higher interest rate means it becomes more interesting to put their money on a savings account to earn interest on it, or to invest in other safe investments, than to borrow money to spend it or invest it. This results in fewer people investing their money in stocks, because bonds and other debt instruments become more attractive than common stocks and other such investments. For companies a higher rate makes it more expensive to borrow money to invest, which slows down their growth. Slower growth of a company means outlooks are less positive, which makes stock ownership less desirable. The conclusion is that a higher interest rate leads to a declining stock market. The rates also have a direct influence on discounted cash flows, which in turn influence dividends (and hence dividend yields) and related issues, which affect the desirability of stock ownership as well.

Another imperative factor is inflation. It is virtually impossible to see those two factors separate from each other, as interest rates are an instrument for the Federal Reserve Banks to control inflation. So inflation is influenced by interest rates, but also vice versa.

Interest rates also have a strong relationship with exchange rates, although this relation is primarily valid on the short run. Lower interest rates tend to reduce the foreign exchange value of the respective currency; it is less appealing for foreign investors to invest there, which causes a decrease in demand for the currency and with a lower foreign exchange value prices of domestic goods are lower. That consequence leads to higher aggregate spending on domestic goods and services.

Besides being influenced by and influencing other macroeconomic factors, interest rates are also influenced by other interest rates. This makes it even harder to isolate events in the interest rates and to say whether such an event is due to the interest rate or that something else has triggered it.

Rates also have a direct influence on discounted cash flows, which in turn influence dividends (and hence dividend yields) and alike. These factors are related to the valuation of a firm, and therefore to their attractiveness and as a consequence to the stock price.

The relation that might cause most problems for this research is the relation between interest rates and the foreign exchange rate. All others things held constant, when real interest rates in a country are higher than in other countries, it is more attractive for foreigners to invest their money in that country, which increases the demand for the currency, which in turn pushes up its value. Although maybe not as direct, the relation works the other way around too. (www.newyorkfed.org/education/economy.html).

Nevertheless it is a very interesting factor and useful for portfolio managers, so it will be included in this thesis. One needs to bear in mind though, that results are affected by the correlations described here.

Central banks

A core purpose of a central bank is to maintain the financial stability of a country -or Europe in the case of the European Central Bank. The main tool for a central bank is the interest rate. This particular type of interest rate is one that is not suitable for this paper, because the market anticipates on changes in this type of rates: if people expect a central bank to lower rates, prices will immediately reflect these expectations. If the actual event is in line with expectations nothing or very little will happen in the market at the moment of the change. If the event is not what was generally assumed to happen, the market will react sharply. This is in line with the 'no arbitrage' argument for long-term interest rates. These should be an average of current and expected nominal short-term rates, because if they were not, there would be an arbitrage opportunity. This would consist of selling short one investment and buying long into the other, for instance, for a positive profit with no risk of loss.¹

This reasoning also holds for central bank interest rates. If the market expects an interest rate hike, this will be reflected in the prices. For this reason this particular rate would have to be used in a different way, like for example looking at the difference between expectations and actual changes. This, however, yields a new complicating factor: time. How to determine the moment when the market expects something and how to deal with the actual change? Market expectations on the Federal funds rate could be read off the futures market for the federal funds rate, but this on its own would make a whole new topic for a paper and will therefore not be done in this thesis.

LIBOR and EURIBOR

LIBOR and EURIBOR are the inter-banking interest rates of the US and Europe respectively. They are the rates at which US/euro inter-bank term deposits are offered by one prime bank to another prime bank, for maturities ranging from one week to one year. They are calculated based on the overnight interest rates used by the banks that are in the respective panels and the rates are spot rates. EURIBOR is also called the benchmark rate of the Euro money market, and LIBOR in the same way the benchmark

¹ The following story explains this 'no arbitrage' argument in an illustrative way:
An economist and a non-economist are walking down the street. The non-economist sees a EUR 20 bill on the sidewalk and wants to pick it up. "Don't bother", says the economist. "If it were real, somebody would have picked it up already." (www.frbsf.org/publications/economics/letter/2005/el2005-09.html)

for the Dollar money market. More detailed information about EURIBOR can be found on www.euribor.org and about LIBOR on www.bba.org.uk.

Both EURIBOR and LIBOR make interesting factors –short term interest rates- for this thesis.

Bonds

A bond is a debt security, in which the issuer owes the security holders a debt. The issuer is obliged to repay the principal and interest (in the case of non zero-coupon bonds). US Treasury securities are debt securities issued by the US government and backed by its full faith and credit. The likelihood that the US government will default is very small and that is why US Treasury securities are considered zero risk securities. They commonly have maturity dates of two, three, five or ten years. When discussing the performance of the US government-bond market, 10-year securities have become the securities most frequently quoted. It is used as a reflection of longer-term macroeconomic expectations. The US mortgage market uses the 10-year bond as a benchmark for setting mortgage interest rates and therefore it is also important to the US mortgage market. Moreover, ten years is a term on which companies commonly base their financing. For the economy in general a change in this interest takes quite a while to manifest itself because the impact of it is on a medium term. The stock market on the other hand is supposed to reflect this kind of changes immediately. This interest rate has an impact on companies' finance, which in the end influences their stocks. Concluding, the 10-year US Treasury security as interest rate is an interesting factor for this thesis. As this is clearly dollar-focused, a European equivalent could be interesting for European markets. Germany is the largest economy in Europe and has been relatively stable throughout recent history, so the German interest rate is a good European reference rate. As a representative for long-term US bonds the *US Generic Bonds* will be used. These make a good benchmark and are widely used. The German Bond rates will be used as a European equivalent for the US bonds.

Yield curve

Interest rates with different maturities do not go up and down similarly. Rates on bonds that have different maturities behave quite independently of each other, with long-term and short-term rates often moving in opposite directions simultaneously. This makes it interesting to view the overall pattern of interest-rate movement, rather than only one type of rate. This movement of interest rates with different maturities is captured by the yield curve, or *term spread* when speaking simply of the difference between two interest rates with different maturities.

Generally, short-term bonds carry lower yields –interest rates- than long-term bonds. This reflects the fact that the longer you invest your money, the more risk is involved, since you cannot know what will happen in the mean time. This is why a ‘normal’ yield curve has an upward slope as maturities lengthen and yields rise. This effect smoothens itself out for higher maturities. An example is the following yield curve in Figure 7:

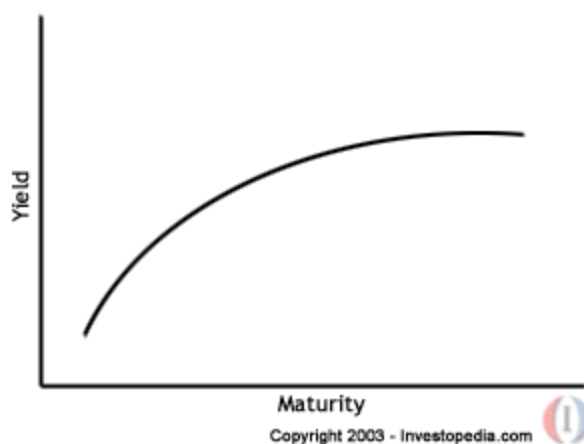


Figure 7: Yield curve (investopedia.com)

The yield curve can be seen as a reflection of expectations and assumptions about future economic growth and stock market performance, which makes it an interesting factor for this thesis. The general notion is that the risk of future adverse events is higher than the chance of those happening in the short term, which makes short-term yields lower than long-term yields. The opposite situation –a flattening or an inversion of the curve- is usually a precursor to a financial crisis.

2.5.2 Data analysis

The data analysis for the interest rates will be divided in a paragraph about long-term and one about short-term rates, as they were treated as different factors during research. Note that whereas for the previous factors relative price changes were used, for this factor absolute changes were chosen. Interest rates generally move in certain amounts of basis points, usually independent of their previous value. Therefore the choice was made to use absolute changes in basis points for all interest rate factors in this thesis.

Long-term interest rates

Preliminary analysis was performed on the data of all interest rates that were included, which are: US generic bond 2 years, US generic bond 10 years, German generic bond 2 years, German generic bond 10 years and the term spread of both the US bonds and German bonds. Figure 8 shows these different type of long-term interest rates:

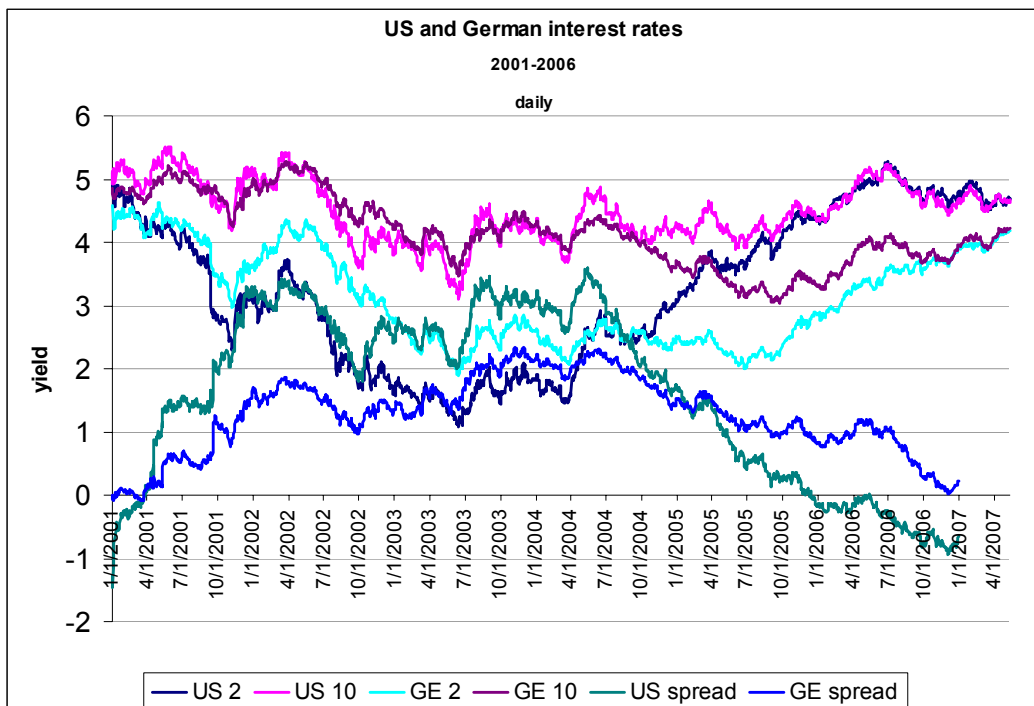


Figure 8: US and German long-term interest rates.

This plot gives a first hint about similarities between different data sets. The assumption was that bonds of 2 years and bonds of 10 years are very much comparable. To check this, the correlations in Table 1 can be used:

	US 2YR	US 10YR	GERMAN 2YR	GERMAN 10YR
US 2 yr	1			
US 10yr	0.68	1		
German 2yr	0.50	-	1	
German 10yr	-	0.55	0.74	1

Table 1: Correlation coefficients of long-term US and German bonds.

The correlation coefficients of the 2-year and 10-year bonds were not extremely high (0.68 and 0.74 respectively), but still they were high enough to conclude that incorporating both would not add extra value. Due to these correlations, outcomes are likely to be quite similar for 2-year term and 10-year term bonds. This indicates the presence of multicollinearity, which means investigating interest rates of both terms could negatively influence the results. As the 10-year bonds are more widely used as benchmark, these will be used for research. Figure 9 shows the US and German 10-year bonds:

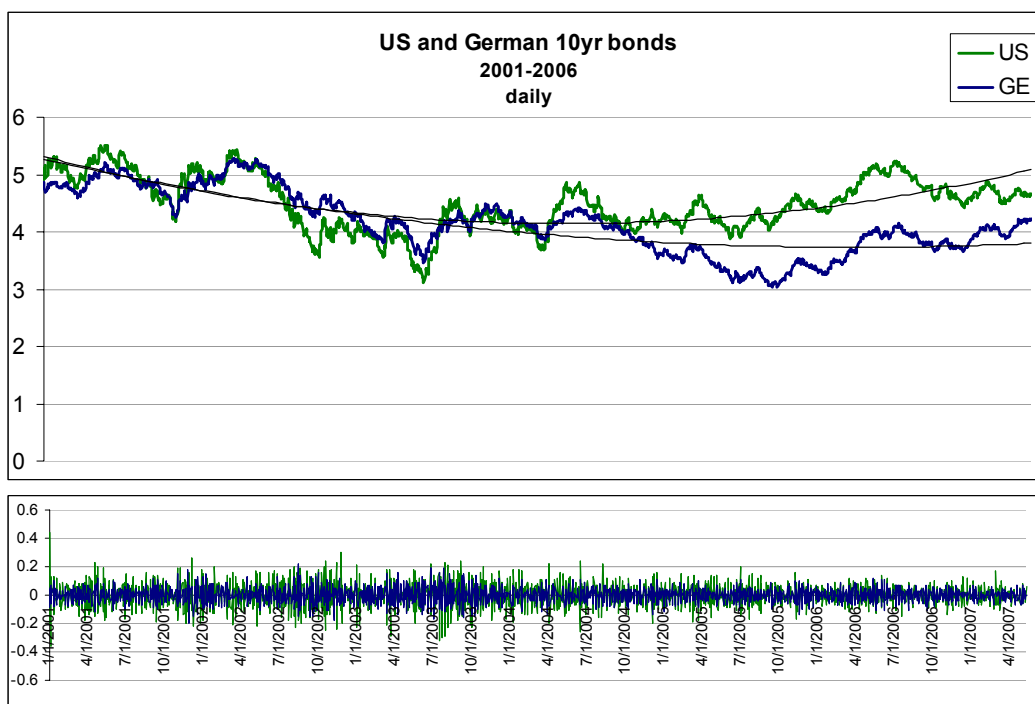


Figure 9: Plot of 10yr US generic bonds and German bonds data with trend lines and corresponding second differences.

Term spreads

Figure 10 displays the US and European term spread data:

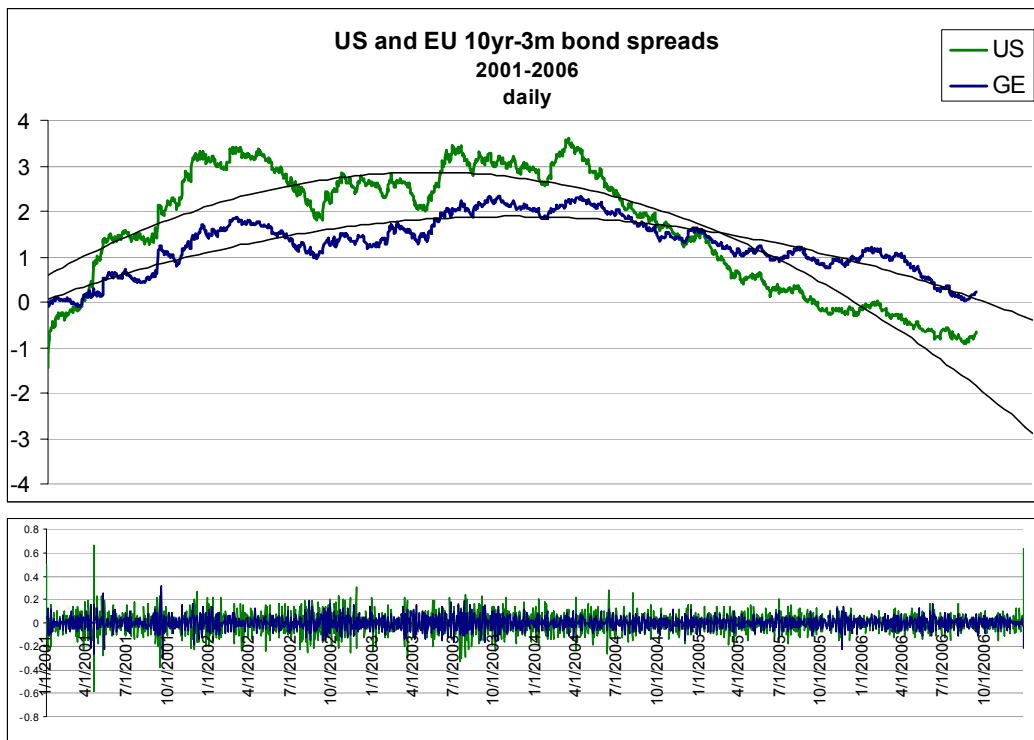


Figure 10: Plot of US and European 10yr-3m bond term spread with polynomial trend lines and corresponding second differences.

Short-term interest rates

European and US LIBOR rates were used as short-term interest rates. Different terms of these rates are available, ranging from one week to twelve months. Correlations between rates with different terms were very high (>0.94), so there was no use for examining them all. The benchmarks that were finally chosen for this research were the three month US and European LIBOR, mainly because three months is a commonly used short-term benchmark term. It must be noted that the US and European rates show very little correlation amongst each other. Figure 11 shows the US and European 3-month LIBOR rates.

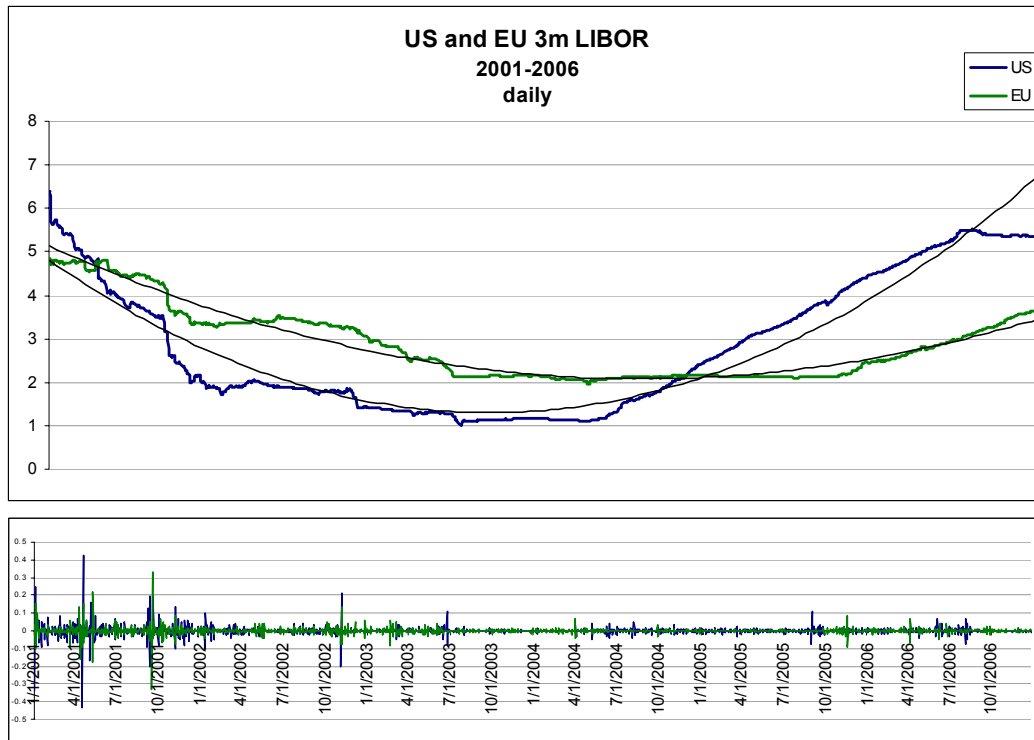


Figure 11: Plots of US and European 3 month LIBOR rates with polynomial trend lines and corresponding second differences.

2.6 Other factors

Because data about certain other factors were readily available, some exploratory analysis of these has been done as well and for the sake of completeness this is mentioned here. These factors are: the London Metals Index, nickel, aluminium, silver, platinum, palladium, and precious and industrial metals. The expectations and results of these factors were such that they were not incorporated in this thesis; indeed, these factors showed no significant influence on industries and countries.

3 Event identification

To be able to point out events in data ranges, one needs a definition of event. When can an unusual change in a time series be called an event? What then must be the absolute or relative change in value compared to the former value? What period must an event cover? Should a relatively large increase or decrease in value over a relatively longer period of time also be called an event? A general definition of event to be used further on will be a 'sharp rise or fall' in the data. Important here is that an event is not just a big rise or a fall, it needs to be an unexpected change. If people expect the oil prices to make a certain movement, this will already be reflected in the prices. This ensures the efficient market hypothesis² holds; if the markets expect an interest rate hike, prices will be discounted for this expectation. So even though a rise over, say, ten weeks may be extremely big, it is not considered an event if not a sharp rise took place in a short period of time, short enough to surprise investors. The method that will be adopted only considers a data point an event if the sign and/or slope at that point in time differs significantly from those of the foregoing data point. The period that will be considered will be one week, or one day, depending on the factor.

3.1 Method

A common and logical way to evaluate a time series is applying an ARIMA model (autoregressive integrated moving average model) to the data. It is a statistically sound method, well known, and in general very useful for this type of problem. The problem here is that it is only possible to apply such a model when a time series is stationary, i.e. when its mean, variance and autocorrelation are constant through time. If a time series

² The efficient market hypothesis asserts that financial markets are efficient in a way that all available information is reflected in the prices of traded assets. They are therefore assumed to be unbiased in the sense that they reflect the collective future prospects of all investors.

is not stationary, and the model can therefore not be readily applied, there are different ways to try to make the series stationary. The simplest one is differencing, which is taking the difference between time t and time $t+1$. This can be done as many times as necessary until the data becomes stationary, but commonly once or twice is enough.

It is not uncommon though that a stationary series cannot be found, despite differencing or applying other methods for stationarity. In that case the statistical basis is not sufficient for applying an ARIMA model, as it will never fit the data well enough. If the requirements for modelling with ARIMA are not met, it is very questionable whether outcomes using this model will be correct and useful. Even though in theory the mathematical background is sound, there are reasons to assume that an ARIMA model is not the appropriate model to apply to this problem.

Nevertheless the events need to be identified and therefore a method was developed that has a more intuitive basis. The basic idea of the method is that it takes the so-called second difference, which means it takes the difference of the difference between two data points:

Consider some factor, for instance oil, and let X_t be a realized value at time t , D_t the relative first difference at time t and DD_t the second difference at time t :

$$D_t = \frac{X_t - X_{t-1}}{X_{t-1}}$$

$$DD_t = D_{t+1} - D_t$$

In some cases it is not relevant per se to take the first difference as a percentage. In that case, like with interest rates, as they usually move in basis points, the formula for the first difference will reduce to:

$$D_t = X_t - X_{t-1}$$

There is no direct (statistical) proof that it works, but the method it is quite clear and Adya et al. (2001) also recognize this as a good method for the purpose of identifying outliers and level shifts in a data set. Compared to going through great lengths to find a statistical model for the data which might not even detect events correctly, this method has some clear advantages:

- Intuitively it is relatively easy to grasp how and why it works, which is why non-expert end users will understand the method;

- Applying it is much less time consuming than finding an ARIMA model and no artificial assumptions need to be made;
- It can be implemented without much difficulty, which makes it possible to easily repeat the process for future data sets;
- An incorrect model will find many outliers in a data set, for the simple reason that it does not model the data correctly, which automatically leads to the conclusion that a lot of data points do not satisfy that model;
- Not using a model makes the method very flexible. Being 'model-free', the method can be applied to any data set, which makes the model flexible and robust.

In terms of the data series used in the research, it detects sharp peaks and a sharp rise or fall that is followed by a more stable period. An important feature of second differences is that the trend has been removed and therefore is no longer of any influence.

Figure 12 shows examples of points in a dataset that may be classified as events. They can be categorized basically in negative and positive events –a sudden fall as opposed to a sudden rise in price- and peaks and level shifts –values return to approximately the value before the peak as opposed to values stay at the new level.

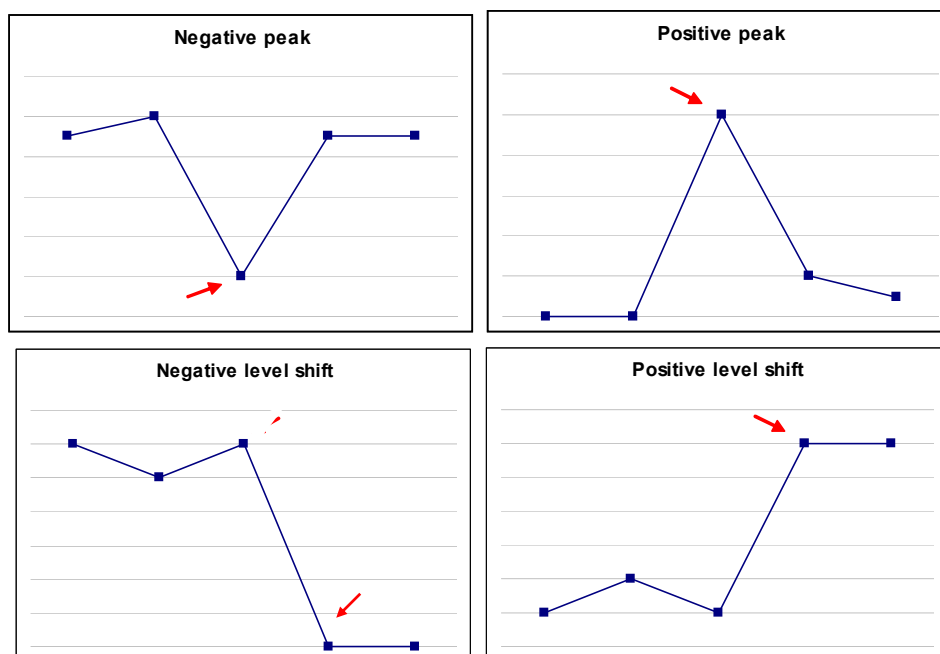


Figure 12: Examples of events in a data set.

A negative peak has a positive second difference, caused by a negative first difference before that specific data point and a positive one after it. Vice versa, a positive peak has a negative second difference. Second differences for level shifts are found in the same way.

For a first idea of what these second differences look like for a certain data set, they are plotted together with horizontal lines that indicate the standard deviation, two times and three times the standard deviation. A second plot that displays both the actual data and the second differences helps the user to see which large second differences belong to which events in the data set. The following two examples in Figure 13 show oil price behaviour:

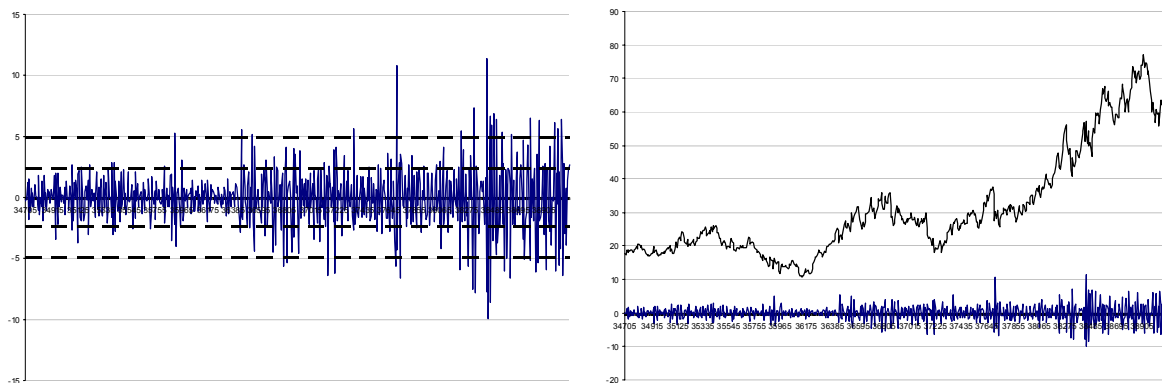


Figure 13: Examples of second differences of a data set (here: oil) and second differences combined with prices.

To find the events, one first needs an approximate number of events. This number of data points will be selected from the data points with the highest absolute value of second difference. When these outliers have been identified, a final check is performed with the first difference: if DD_t is found to be an outlier and $|D_t|$ is larger than a pre-specified boundary, the date will be classified as an event. If $|D_t|$ is smaller than this boundary this date is not an event itself, but merely predicts an event at the date that follows. After this the final set of events is ready for usage.

An important choice that was made for this research is that events are divided into positive and negative events. As a result, positive and negative events will not automatically be considered to have similar consequences, and potential asymmetries in factor exposure are allowed for.

3.2 Argumentation

One could argue that it is enough to base event detection on first differences. Intuitively this is a clear and obvious method: a large jump means something special has happened and hence this date is an event. However, the problem with this method is that it does in no way consider trend nor surprise as a factor. If in a certain period trend is upwards, a positive jump, even if large, does not mean it comes as a surprise and since in the economic world surprise is a very important factor, as mentioned before, this needs to be taken into account. An example of a situation where this method filters out jumps that have a very small element of surprise is graphically displayed in Figure 14:

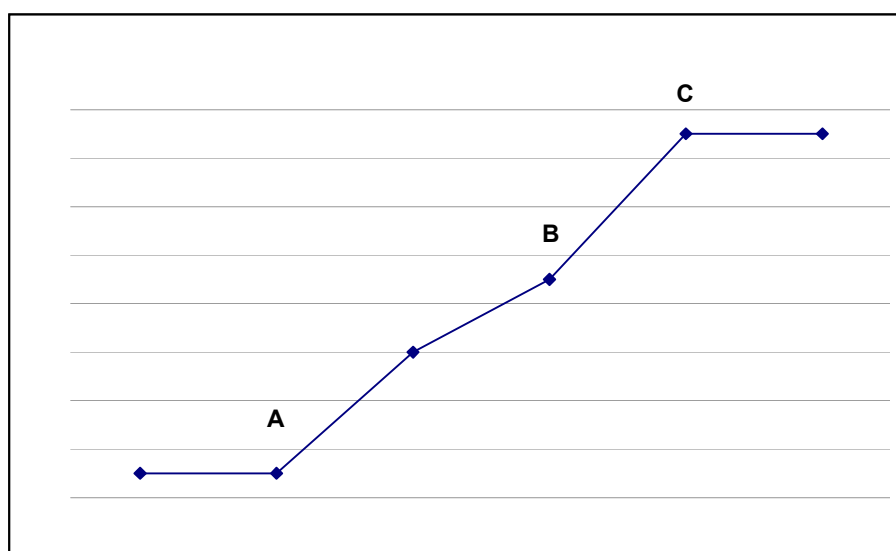


Figure 14: Example of surprise and non-surprise situations.

Point A will be classified as an event, if the rise right after A is big enough, because this movement comes as a surprise compared to the situation right before point A. Point C can be seen as similar to A. Point B, however, will not be detected as an event. The movements right after and right before B have the same direction, and even though the slope of the line right after is bigger than that of the line right before, it does not come as a real surprise. This distinction could not be made using just first differences and this is therefore a clear advantage of second difference method.

In general, differencing is a way of removing trend. There are more sophisticated methods, but in general differencing works well. It can be shown that the number of times data should be differenced to remove trend is equal to the order of the trend. For instance, for a parabolic trend of order two, differencing twice should be enough. To take oil prices for example, in the data description of the oil prices the graph shows a trend that is roughly polynomial of the second order, so second differences are sufficient. As differencing is an intrinsic part of the event identification method, this also supports the choice for this method.

Electing events solely based on second differences would mean that dates with a small first difference could possibly be selected. This is why, as also mentioned above, besides a boundary for the second difference a boundary for the first difference is added as a parameter.

Besides the reasons mentioned here, some clear advantages are those summed up in the preceding section.

3.3 Parameter choice

The choice of the initial number of events and the choice of the boundary for the first difference have a clear effect on the event that will finally be selected. The former indicates the number of dates with the highest absolute second difference that will be chosen from the dates that are sorted by second difference. If this number is small, only the ones with a very high second difference are picked, if low, this criterion is less strict. This number also depends on the amount of data: the percentage of events cannot be too high, as that violates the definition of event, i.e. something that only rarely occurs.

The boundary for the first difference determines which of the dates selected by second difference are actually seen as events. If it is large, only the dates with a big jump are considered events; if it is small, more dates will comply with the criterion. The two parameters combined determine the number and the kind of events to be selected: a high initial number together with a low boundary will select many events; vice versa will select few events. Moreover, one could understand a high initial number as not very restrictive, in the sense that it selects dates that possibly are not events because of their relatively low second difference. The same holds for a low boundary. The goal is of course to find a good combination, but on the other hand one cannot be too restrictive in the choice of these parameters, as this will give too few dates to base statistics on. A

good combination can therefore be seen as one that has an initial number that is not too high and a boundary that is not too low, but nevertheless gives a statistically sufficient number of events. Table 2 displays an example of the parameters of the factor oil.

FACTOR	TOTAL # DATES	INITIAL #	BOUNDARY FIRST DIFF	# NEGATIVE EVENTS ³	# POSITIVE EVENTS
<i>Oil</i>	630	65	6%	32 (5.1%)	37 (5.9%)

Table 2: Example of event identification parameters for the factor oil.

A summary of the parameters that were found optimal during research is given in Appendix 1V.

³ The percentage between brackets is the percentage of the total number of data points.

4 Exposure level

The final step in the research is to link portfolios to the events found in the factor data. For this an intermediate step is necessary, for it is not possible to do it directly. One can think of several ways to do this. From a very simple perspective, a portfolio is invested in stocks. A straightforward link would be finding the impact of events on the assets, and then immediately the relation with the portfolio is known, since at any moment information is available about assets included in the portfolio.

This is a method that is clear and intuitive and many believe it to be successful. Yang Liu and Dimitris Melas (2007) show in their presentation 'A tale of two taxonomies: macroeconomic and fundamental' and their whitepaper 'Macroeconomic factors in a fundamental world' (2007) for MSCIBarra that this is a common misconception. In their study Lui and Melas illustrate that it is subject to so much noise -i.e. the error is so large- that it no longer leads to significant results. They conducted research to the exposure to changes in oil prices of all the stocks in three US industries: Airlines, Oil Services and Oil Reserves. For stocks in these industries one would expect direct and obvious macroeconomic relations with changes in oil prices. Figure 15, taken from their whitepaper, shows the distribution of exposures of stocks in the three industries:

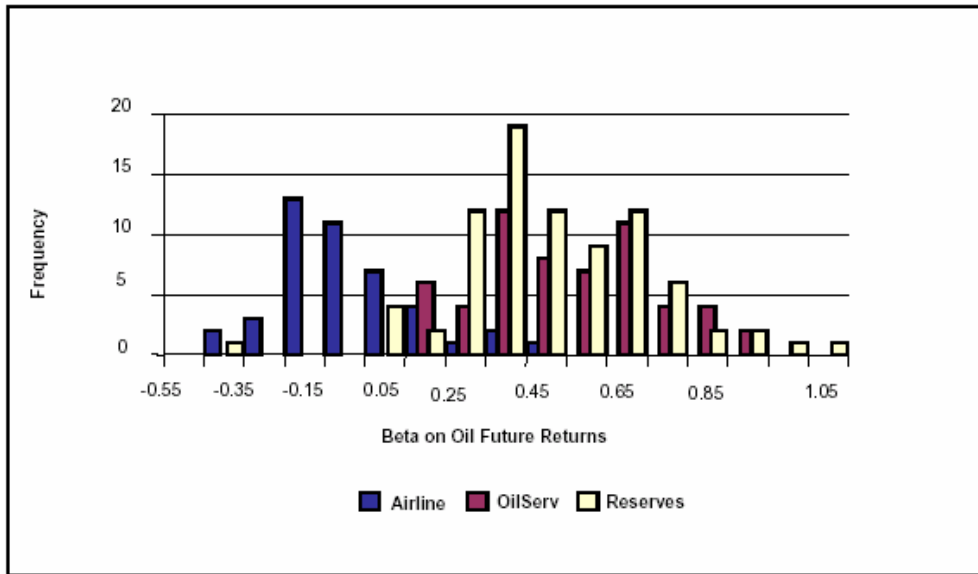


Figure 15: Betas of oil future returns for three different sectors Yang Liu and Dimitris Melas (2007).

The figure shows the betas of several stocks within three distinct industries. It makes clear that the betas of companies can be very different, even if these companies belong to the same industry.

The betas are taken from the following equation:

$$y = \beta x + \varepsilon$$

where y 's are the stock returns, x 's are the oil future returns in this case and ε is the noise term. The conclusion that can be drawn from the graph is that stock level exposures estimated in this manner give a wide range of exposures and are neither informative nor useful.

Regressing macro factors against industry factor returns, however, gives statistically significant betas and positive adjusted R^2 's⁴. To see if there are any missing macro sources of return commonality they regress specific returns (i.e. individual asset returns) against oil future returns. This gives (median) adjusted R^2 's for the residuals of specific returns that are mostly negative and very near to zero, whereas the factor adjusted R^2 's are clearly larger and positive.

⁴ Adjusted R^2 is a modification of R^2 that adjusts for the number of explanatory terms in a model. Unlike R^2 , the adjusted R^2 increases only if the new term improves the model more than would be expected by chance. The adjusted R^2 can be negative, and will always be less than R^2 . The adjusted R^2 is defined as

$$1 - (1 - R^2) \frac{n - 1}{n - p - 1}$$

where p is the total number of regressors in the linear model and n is the sample size.

The conclusion that can be drawn from this research is that regressing the macro factors against specific returns yields errors and noise, much more than regressing it against industry factor returns does. This means that there is no explanatory power beyond fundamental factors, i.e., it is not useful to model assets individually. Using factors instead of assets diversifies errors and reduces noise.

It is however also possible that a level is chosen that is too high. This would mean that assets, companies or industries that are significantly different from each other are bundled into a group, which would lead to incorrect or useless results. Members of a group should be similar and have similar reactions to factors; otherwise results are again contaminated with noise.

4.1 GICS

The Global Industry Classification Standard (GICS®) divides the MSCI World Index into Sectors, Industry Groups and Industries. (The deepest level is actually Sub Industries, but few data are available for this group.) It was developed by Morgan Stanley Capital International (MSCI) and Standard & Poor's (S&P). The MSCI World Index contains about 1900 companies and each of them is assigned to a distinct industry, which in turn belongs to an industry group that belongs to a sector. The GICS structure consists of 10 sectors, 24 industry groups, 67 industries and 147 sub industries, of which only the top three levels will be used in this thesis (MSCIBarra). Appendix 1II shows this GICS structure. The data sets that were used for the research can be found in Appendix 1IV.

The crucial point now is to determine on what level the relation will be computed. Just as with individual assets as is described above, one could imagine that regression on industries might be a level too deep, in such a way that it is prone to errors and noise. Too high a level on the other hand might yield results that do not have a meaning, for it includes deeper levels that do not respond in the same way to certain changes. To find the trade-off regression will be started off on a high level. If results are such that no logical conclusions can be drawn from them, regression will be performed on one level deeper. Some portfolios are fully invested in one sector, like sector funds. For these portfolios it is of no use to assess regression on sector level, as results are always relative to a benchmark (see chapter 5.3). For these it will be inevitable to take it one or two levels deeper, to industry group or industry level.

In general, for all factors the conclusion was that no significant relations were found that were the same for both industry group level and respective industries, or likewise for sectors and respective industry groups. Overall, results were by far the best on industry level. For all factors can be said that in general relations on a higher level than industry were only 'valid' when no relation had been found in the corresponding industries either.

This conclusion does not come as a surprise. Industry groups within a sector are often quite different from each other, and in the same manner industries can differ quite a bit within industry groups. Unless results clearly show otherwise or other factors play a role in the choice of the level, the focus will be on the industry level. For informative reasons, however, the results of the higher levels will not be left out.

4.2 Geographical structure

The GICS structure based on the MSCI World as a whole is the most common way to partition data. However, it is not the only possible way. One could think of differentiating between geographical regions, where a difference is made between for example emerging markets and developed countries, or between North American and European economies, as an addition to the GICS structure. This could possibly lead to different or even better results, as effects may be different throughout the different regions.

The data sets that were used for the following geographical structures can all be found in Appendix 1IV.

4.2.1 Emerging markets vs. developed world countries

Emerging Markets are those markets that are not yet developed but are in the process of industrialising or emerging. They find themselves in the transition phase between developing and developed status. Examples include China, India, countries in Eastern Europe, many countries in Southeast Asia and parts of Africa and Latin America.

Emerging markets could theoretically be subdivided into sectors like was done with developed markets. In practise, however, this is not very meaningful for these kinds of markets. The economies of this type of countries usually rely heavily on one sector and therefore may have to be seen as separate countries. An example is Russia, where the

oil industry is of major influence. Applying the GICS method as used for the developed world as such for emerging markets could cause problems and so could the MSCI World index, for this index only includes developed countries.

Nevertheless, it could be interesting to investigate the impact of certain factors on emerging markets, because some funds are invested partly or entirely in emerging markets. In general, it is true that these markets react more substantially to changes in for example the oil price. Under these circumstances, indices are not simply corrected in the way indices of the developed world are. Reactions are much more extreme and therefore volatility is much higher.

Countries in the developed world are much less sensitive to changes in the oil price, or commodity prices for instance, because they are not as dependent on those factors as emerging markets often are. Still, the results of these developed countries may provide useful insight.

A list of the developed world countries and the emerging markets as used by MSCI can be found in Appendix 1III.

Some expectations with respect to emerging markets are for example that oil producing countries have a very significant reaction towards events in oil prices or commodity prices. Results, however, were very inconsistent. The first analysis was done with data from 1998 to 2006, and only very few countries seem to be influenced by either oil or commodity events. The next step was to see whether data from too long ago are possibly irrelevant because markets that are currently emerging can be entirely different from emerging markets some years ago. For this reason the same analysis was done with data from 2000 until 2006. The results were a bit different from prior results, but again not many useful outcomes were found. One interesting but disturbing result was that neither oil nor commodities seemed to influence Russia. This is a very surprising result, since Russia, as mentioned before, is a country whose economy is heavily dependent on the oil industry, and materials and commodities as well.

Regression results of developed world countries were not significantly different or better either, just as those of emerging markets. From both emerging markets and developed countries results can be concluded that adding this structure does not add any extra value, despite expectations, and will not be used further on.

4.2.2 North America vs. Europe

Up till now it has been assumed that the developed world reacts as a homogeneous group to events. One could however reason that an event might have a positive effect on North American economies, but a negative effect on European countries. This could especially be so in the case of interest rates. What is positive for American companies might have an opposite effect in Europe. If this were true, results using this structure should be better than without discriminating between these two regions. However, results were not significantly better than or different from the results using the original structure. This leads to the conclusion that this specific structure adds no extra value and will therefore not be adopted in the final method.

5 Regression

After selecting the events from a data set and matching them with the GICS or country data, linear regression can be performed. A regression line is fitted through the returns (e.g. first difference) of a factor:

$$y = mx + b$$

where the shocks in the factor price are on the x-axis and the returns of an industry are on the y-axis. m is the slope of the regression line and b is its intercept.

This is done separately for negative and positive events. To get a first idea of this regression line, scatter plots can be made, like the two examples for the factor oil in Figure 16.

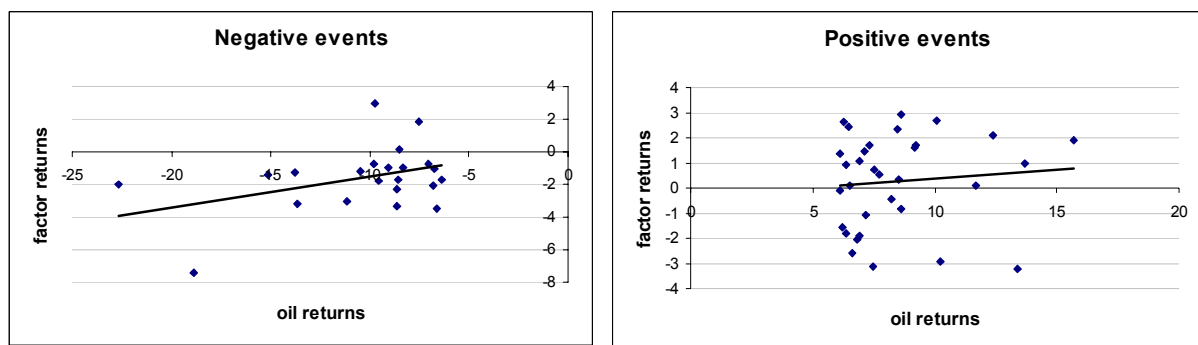


Figure 16: Examples of regression lines for negative and positive events.

5.1 Statistical interpretation and significance tests

The data in Table 3 is interpreted after regression, to check the statistical validity:

REGRESSION RESULTS	
Slope m	Intercept b
Standard error slope (se_{slope})	Standard error intercept (se_{icept})
R^2	Standard error (y)
F test	Degrees of freedom
Regression Sum of Squares	Residual Sum of Squares
t-statistic (m)	t-statistic (b)
F critical value	T critical value

Table 3: Results of regression as used for significance tests.

A high R^2 value indicates that there is a strong relationship between the variables, which means the regression line that was fitted actually says something about the data. To test how strong this relationship is, the F-test can be used. For significance it needs to be higher than the corresponding critical F-value, to be obtained from a table. For this table one needs $v1=k$ and $v2=n-(k+1)$ (degrees of freedom), where k is the number of variables and n the number of data points.

To test whether the slope and the intercept that the regression found are useful, the t-test can be used.

$$t_{slope} = \frac{m}{se_{slope}}$$

For the slope the t-value is computed with:

$$t_{icept} = \frac{m}{se_{icept}}$$

For the intercept the t-value is computed with:

and the number of degrees of freedom is $v2$. If t is higher than a one-tailed significance level, again taken from a table, the slope or the intercept respectively is useful. The sums of squares say something about the goodness of fit: the smaller the residual sum of squares compared to the total (regression) sum of squares, the better/higher the R^2 .

For each of the indices first a scatter plot is made, like the two above in this section. To this plot a regression line is added, to see what the relationship between the variables is. After finding the regression relations, the next step is to investigate these relations by checking for significance. The following hypotheses will be tested:

$$H_0: m=0$$

$$H_1: \text{other}$$

for the slope of the regression line, and

$$H_0: b=0$$

$$H_1: \text{other}$$

for the intercept of the regression line.

If the (absolute) t-value is higher than the critical t-value (with an α -confidence level of 10%), the zero-hypothesis can be rejected and the test proved significance. As an additional test, the line as a whole is tested on its F-value, with hypotheses:

$$H_0: \text{regression line is not significant}$$

$$H_1: \text{regression line is significant}$$

If the F-value of the regression line is above the critical F-value (again with an α of 10%), the alternative hypothesis may be accepted. If the F-value is too small, the line as a whole might not be significant, because the H_0 cannot be rejected. Even though t-values might say the individual components are significant, none of them will be accepted as significant.

5.2 Argumentation

There are many different ways to find relations between two data sets. Linear regression is one example, logarithmic, exponential and polynomial regressions are others, but one can also think of *data mining techniques* and *neural networks* for instance. One reason for choosing regression is that it does seem quite logical to assume a linear relation between a factor, say oil, and sectors. Even though it is a simplified view, it is definitely not unrealistic. Another reason that is indeed quite important in this case, is that one can easily understand the output and relate it to portfolios. In the same perspective, it is clear in what way the output can be influenced: an example is when a portfolio is over weighted in a sector that is very sensitive to shocks of a certain factor, this becomes clear from the output and one can immediately see what should be changed in order to undo the overweighting. It is possible that more complicated methods have better

estimation accuracy, but these would not be as easy to use for end-users with no expertise in statistics.

5.3 Beta adjusted data

There are different ways to deal with the data that will be used to regress against the factor event data. One could simply take the returns of each sector (industry group, industry or country) and regress this against the factor event dates returns. A problem with this approach is that it does not differentiate between events of different kinds. Something else might have happened in the world that affected all sectors and this may influence the outcomes.

To deal with the aforementioned problem the data should be adjusted for the benchmark in order to eliminate these possible events that might have had their influence on the world as a whole. When dealing with MSCI World sector data, these should be adjusted using the MSCI World index; in the same respect other data sets should be adjusted using the appropriate benchmark index.

There are basically two ways to adjust the data: a simple one and a more sophisticated one:

- a. simply adjust the data by subtracting the benchmark from the sector:

$$x'_s(t) = x_s(t) - x_{BM}(t)$$

where $x_s(t)$ and $x_{BM}(t)$ are the sector s data and the benchmark data at time t respectively.

- b. adjust the data by subtracting the benchmark from the sector but now taking a measure of the sector's volatility in relation to the rest of the market, or in this case the benchmark, into account. This measure is called *beta* and it leads to the following equation:

$$x'_s(t) = \beta_s \cdot (x_s(t) - x_{BM}(t))$$

where $x_s(t)$ and $x_{BM}(t)$ are the sector s data and the benchmark data at time t respectively.

The first method seems logical enough, but it does not take into account that a sector (or country or so on) has a certain relation with the benchmark and that this is different for all sectors. It is basically a special form of the second method under the assumption that betas are equal to one for all sectors. This assumption is not correct, since different

sectors have different linear relationships with the benchmark. Take for example an industry in the financials sector and one in the energy sector. These industries have a relation with the benchmark –the world in this case- that are most likely not the same. They will also probably differ from one, as they do not move perfectly simultaneously (on average) with the benchmark. The second method is more complete in that sense, as it incorporates this relation by incorporating a factor β_s : the beta coefficient for sector s . This parameter is given by the following equation:

$$\beta_s = \frac{\text{COV}(x_s, x_{BM})}{\text{var}(x_{BM})} = \rho_{s,BM} \cdot \frac{\sigma_s}{\sigma_{BM}}$$

where x_s and x_{BM} are the entire data sets of sector s and the benchmark respectively. This beta can be calculated based on the whole data set, but one could also argue that it should be computed using only recent data, up to a certain point in time. Different betas were computed for the various data sets, using different time spans, but the main conclusion is that betas do not change significantly when using different time sets. For this reason, and also because it seems reasonable to take a beta that covers the whole data set, as this whole data set is used in further steps, the betas were computed using all data.

The expectations were that using the second method instead of the simple or first method one would lead to significant differences and improvements in the results. This, however, was not the case: results obtained with the second method were only slightly better. The second method will still be adopted though, as it showed a slight improvement in the outcomes, but mainly also because it is the most complete and correct way to go about.

5.4 Regression outcomes

In this chapter the outcomes of the regression that was performed on all factors included in this thesis will be given. This will be of a descriptive nature, as there is a great amount of result data of which only parts are interesting. An example of the output of the program can be found in Appendix 1VII, which is a screenshot of the regression results for the factor oil.

5.4.1 Oil

The first thing that becomes clear is that quite a lot of insignificance was found in the regression results. This means that no relation could be found between events in the oil price and certain sectors, or that at that specific time something else happened, besides a large change in the oil price, that might have had major effects. The latter case is very hard to identify or to check, but is something that is obviously very probable. However, it is of course not at all unlikely that a certain sector is simply not influenced (on the short term) by a change in the oil price. Another outcome is that more significant relations were found in negative events than in positive events. This is an interesting fact in itself, but it also shows that it is indeed important to distinguish between positive and negative events, rather than assuming that results will be the same for both groups.

As mentioned before in this research, the results are most significant and therefore most useful on industry level. The focus of the results will thus be on this specific level, and less on the levels sector and industry group.

On industry level the most important ones are Oil Gas & Consumable fuels, Construction & Engineering, Airlines and Gas Utilities. On sector level relations were found in Energy, Industrials, Consumer Discretionary and Utilities, where Industrials is the only sector that has a relation for both negative and positive events. The other sectors only had significant relations with negative events.

Remarkable is that the Energy Equipment & Services industry does not give a relation with events in the oil price. This is something that is definitely expected. Sector experts commented on how this sector experienced some major changes over the last years, and this led to the conclusion that data from before 2000 might not be relevant for this sector, due to these large changes. Before this date the sector supposedly was quite insensitive to oil price changes, but afterwards it did become sensitive to oil events.

For this reason the dataset was shortened to 2000 until 2006 and the same analysis was now performed. With a dataset that is almost half the size of the original, a lot less events are found of course. The number of events must be enough for the analysis to be statistically valid, so the boundaries need to be relaxed somewhat in order to find enough events.

The results were actually precisely in line with expectations: indeed a significant positive slope for positive events was found in the regression analysis. This leads to the conclusion that for this specific industry the dataset has to be different from the one that is used for the others in order to get useful results.

5.4.2 Commodities

Results of the commodity factor were comparable to those of oil. For the most part this can be explained by the fact that oil is also a commodity and it is likely that this factor has influenced the data. Most of the relations that were indeed significant are in Industrials and Materials, which is not unexpected. Electrical Utilities was also found to have a significant relation with commodity prices, with negative events to be exact.

5.4.3 Gold

As mentioned in the descriptive paragraph of gold (chapter 2.3), this factor was not expected to be of major influence. This is indeed what becomes clear from the results. Some outcomes are interesting to note here though. Gold seems to influence mostly Consumer Staples and partly Materials as well. It is not a surprise that a relation was found between gold and Metals & Mining.

5.4.4 Copper

Like with gold, copper outcomes showed that indeed this factor has no real influence of its own. Most relations were found in Consumer Staples and Utilities.

5.4.5 Silver, Nickel, Aluminium, Platinum, Metals

There were no high expectations for these factors to have big implications on industries, and this is indeed what the results showed. They basically only had a relation with Materials and this is quite straightforward. Precious and Industrial metals have results that are quite similar to the results of silver, nickel, aluminium and platinum, with the only difference that there are some relations within consumer staples and some in industrials.

5.4.6 Interest rates

10-year interest rates

What immediately becomes clear from the results of US long-term rates is the difference between the results of negative events and those of positive events. Hardly any significant relations were found for downward shocks, whereas quite a lot of significance was found for upward shocks. This result is the same throughout all three levels. For positive events the most important relations resulted from industries in the Utilities sector, Health Care, Consumer Staples, Consumer Discretionary and Energy. In the Financials sector only Commercial Banks (with a negative slope) and Diversified Financial Services (with a positive slope) showed significance; the Insurance industry gave no significant relation.

German long-term interest rates seem to be of very little influence on MSCI stocks. Very few relations were found in the regression phase and the conclusion is thus that this factor is not of much use for the event risk exposure research.

3-month interest rates

These short-term LIBOR interest rates are not very volatile on a day-to-day basis, and the European rates are even less volatile than the US rates. In other words, the changes that occur are usually very small and to be able to identify events the boundaries need to be relaxed quite a lot. This makes the distinction between events and normal data points harder and less clear. Results might be influenced by this fact.

This factor does show a lot of significant relations, of which most are detected within negative events. The same is true for European rates, although these show fewer significant outcomes. The relations could be found in most of the sectors, only the industries in the Industrials sector stood out, as in these industries few relations were significant, but one needs to bear in mind that the notion *event* has not been as strict here as it should preferably be.

Term spreads

The term spreads show quite a lot of jumps. Significant relations were mostly found for negative events and much less for positive events. The latter group shows significant regression lines mostly in industries in the Utilities sector. Relations with negative events were discovered predominantly in industries in the Energy sector, the Industrials, Consumer Staples, Information Technology and Utilities sector. Interestingly, no relations here were found in the Financials sector.

6 Extraction to portfolio

The next step in the process is to extract the regression results to portfolios. The goal is to see what the exposure of portfolios to certain factors is, which from here on will be called *event risk exposure*. Note that the exposure of a portfolio to events is not merely a function of the market's movement but is due to active management decisions made by the portfolio manager. Performance is usually measured relative to a benchmark and therefore it is not just the exposure to events, but the active exposure to events. As a result, risk management is also performed compared with a benchmark. For this reason the risk assessment is done with active weights instead of normal weights. The active weight of a portfolio p in subset i , for example, can be defined as:

$$aw_i(p) = w_i(p) - w_i(BM)$$

where $w_i(p)$ is the weight of portfolio p in sector i and $w_i(BM)$ is the weight of the benchmark in sector i . When a portfolio is over weighted in a sector, i.e., has more weight in it than the benchmark does, the active weight will be positive. When it is under weighted it will be negative.

Assessing event risk exposure requires:

- a regression line; a significant line with a slope and an intercept, as described in chapter 5,
- active weights of a portfolio,
- scenarios, which will be described below.

It leads to the following equations:

Event risk exposure of portfolio p for subset i^5 :
$$E_i(p) = aw_i(p) \cdot (s_k \cdot m_i + b_i),$$

Total event risk exposure for portfolio p :
$$TE(p) = \sum_{i \in I} E_i(p),$$

where $aw_i(p)$ are the active weights, m_i is the slope and b_i is the intercept. s_k is a scenario from a set S of k scenarios.

Scenarios

Here the question is: what is interesting for a portfolio manager and how should the results be displayed in order for the portfolio manager to quickly and easily interpret them? Using scenarios is a practical solution for this. A scenario s_k can be: how does this portfolio respond to a $x\%$ price change? Different scenarios can be thought of, but they need to be relevant and straightforward, like for example -10% , -20% , $+10\%$, and $+20\%$. The total set of k scenarios is defined as the set S . The final choice of scenarios depends on the data, on the results and on the user’s preferences. Guidelines for this are that the smallest scenario should be at least the boundary for the first difference, and the maximum scenario should be around the maximum first difference that was found in the data. Scenarios in between should be chosen between the lowest and the highest scenario and they should be intuitively clear and readily interpretable. Scenarios that were found suitable for the different factors that are incorporated in this thesis can be found in Appendix 1VI, but an example is given for the factor oil in Table 4.

	NEGATIVE SCENARIOS				POSITIVE SCENARIOS			
<i>Oil</i>	-25	-20	-15	-10	10	15	20	25

Table 4: Example of scenarios for the factor oil.

Extraction outcomes

The outcome of this extraction to portfolios is a matrix with exposures per industry (industry group / sector) for each chosen scenario. That way the user can see for each industry (industry group / sector) what the corresponding risk is and if this risk is unwanted one can easily deduct what must happen in order to change this. As said before, results are best on industry level. However, it can be interesting to see what

⁵ A subset can be either the set of sectors, or the set of industry groups or that of industries.

happens on sector level. Since the results on that level are generally not satisfactory, industry results are grouped into their respective sectors and results are added per sector. Now, a user also has a sector view on the exposure risk. Finally, results are added per level, which leads to a total exposure risk for the whole portfolio. These totals may differ for each level, but this is due to different outcomes on the different levels. The outcomes of the industry level and those of the industry level grouped per sector are the same, and these are the most reliable. As will be shown in the appendix about the program (Appendix 1IX), graphics will help understanding the outcomes. An example of what such portfolio results look like is given in Appendix 1VIII. It shows possible outcomes for a certain portfolio for event scenarios of the oil price.

7 Events vs. non-events

As described in the Introduction part, the main idea of this thesis is to investigate what effects certain events have on asset portfolios. The focus is especially on events, on the tails of the normal distribution, and not on regular data. It is, however, interesting to assess what differences exist between regression estimates based on event data and those based on everyday data. Preferably, results show significant differences, which would confirm the assumption that markets respond differently under abnormal circumstances. For this purpose regression was performed on (almost) all data points in the series of the factors oil, commodities and interest rates.

The results were indeed quite different from the results obtained using the specified boundaries. The differences found were similar for all the factors that were tested on this. More regression lines had significant outcomes, but this is probably mostly due to the fact that the set of non-events dates contains many more data points than the set with event dates. For the factors where regression was found to be significant both in the data set with boundaries and in the large data set, the findings were that the slope and intercept had larger values in the small data set. This is in line with expectations: the small data set only contains large price changes, whereas the large set contains (almost) all changes. Since there are more relatively small changes than large jumps, the big changes are of less influence in the large data set, which causes the overall slope and intercept to be smaller than in the 'event' data set. These results support the assumption that reactions are different to event circumstances than to relatively stable situations and that it is worthwhile to investigate these events separately instead of simply incorporated in a data set as a whole.

8 Overall results

The two factors oil and interest rates are most important for this thesis, because it is clear that they can have large implications on sectors, industries, companies, and hence on stocks, asset portfolios and portfolio managers. Factors like gold and metals were merely included because data was readily available, but they confirmed that they are of very minor influence. Commodities as a factor could be interesting, since they were very important for the economy. Results were not exceptionally promising and they are similar to those of oil, but still useful and informative. Interest rates –considering them as one group for the moment- were the most complicating in several ways. To start with, it was not straightforward which rate(s) to use, which led to quite extensive research before the actual risk assessment could be performed. Second, interest rates have complex, recurrent relationships with other (economic) factors and with stocks. This makes it harder to say with certainty if and when a shock in the interest rates is exogenous and if it had a one-way impact. This needs to be kept in mind always, as this may have affected results. This last comment is however also true for all other factors, though much less than for interest rates. This may explain why many of the regression outcomes for all factors showed behaviour comparable to that in Figure 17:

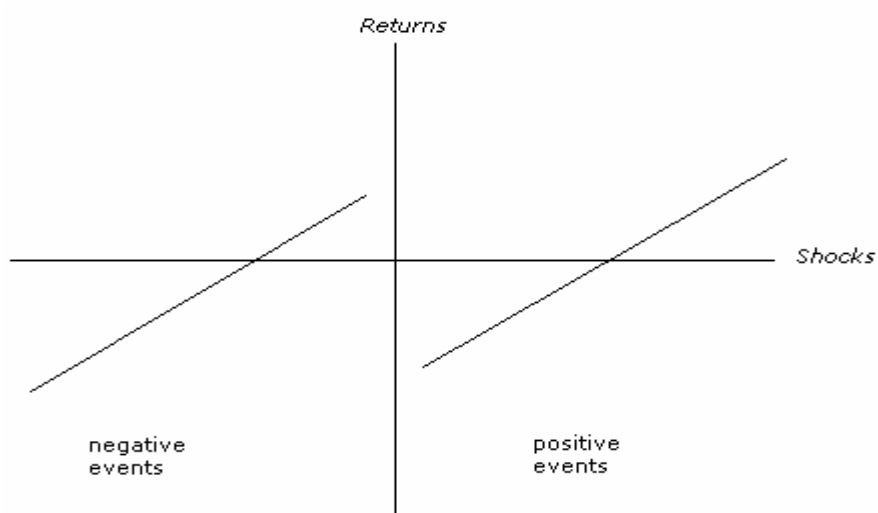


Figure 17: Example of contradictory regression results.

As can be seen, many of the (significant) outcomes had an intercept and a slope with opposing signs, where the x-value of the intersection with the x-axis was usually higher - in absolute terms- than the value set as a classification boundary for events (that is, the boundary for the first difference). To clarify this with an example: say a certain regression line for positive events had a slope of 0.50 and an intercept of -2.50. This means that events below 5% have a negative effect, whereas events beyond 5% have a positive effect. The opposite version also occurred, and a similar example can be thought of for negative events.

At first, these results seem somewhat strange and are difficult to interpret. A possible explanation for this, or similar, behaviour of the regression lines is that smaller shocks are not 'powerful' enough to cause a significant change in stock behaviour. These shocks could be dominated by other events, as stated by Choi and Elyasiani (1996). Intuitively this reasoning makes sense. One can argue that a small change in the interest rates does not have a fully exogenous effect, because other, stronger events might overrule this effect. A big shock on the other hand is more likely to have an exogenous effect on stocks, as it is the main event.

Another conclusion that can be drawn from the regression results is that the slope is almost always about a factor ten times as big as the intercept (10 for relative values, 1/10 for absolute values). This means that the intersection of the regression line with the x-axis is often around 10bp (10bp for interest rates, 10% for other factors). No logical explanation can be readily found for this, but it must be noted that this behaviour is strange, since it is true for most of the outcomes.

As a result of these observations, the direction of the regression line is more valuable and relevant than the intercept, but nevertheless the intercept will not be left out a priori.

To comment on the topic of the exposure level, the results made clear that making a distinction between different geographical regions does not lead to significantly better results.

The results from the analysis of data sets that contained (almost) all data points, as opposed to the event data set used in the main part of the research, supported the view that reactions in the market are different and more extreme under abnormal circumstances. All the more reason to treat these events separately in order to enable portfolio managers to take these event risks into account.

9 Conclusion

There are a number of things that became clear from this research, but the most important conclusion is that the output the program gives, based on all the research, is very useful for portfolio managers. The main objective of this thesis was to provide risk managers, and via them portfolio managers, with a tool that made it possible to assess event risk, which is a type of risk that is not included in most standard risk models. The risk reports, as they were before, can now indeed be complemented with the outcomes of this tool.

Besides this very clear accomplishment, the results from all the research confirmed the most important assumptions of this thesis. The results showed that there is a difference between regression outcomes based on the whole data set and those based on events solely. This strengthens the main assumption of this thesis, namely that behaviour under event scenarios is different from normal, everyday behaviour. This is important, since it is the basis of this thesis.

Another finding that supports the way the research was conducted is the fact that results of negative events are quite different from those of positive events. Beforehand, the choice was made to distinguish between these two groups of events, rather than treating them as a homogeneous group. It was expected that effects of positive and negative events would be asymmetric, and this is indeed what the results showed.

The method that was used for event identification is one that is not directly backed by (statistical) evidence, but it is a very straightforward way to select events out of any data set. It is robust, easy to understand and implement. Moreover, the method also deals with the problem of trend in a data set.

The results were not always as perfect as might have been hoped for. They displayed unusual behaviour, even though a reasonable explanation could be found for this. Nevertheless, the results were useful and could smoothly be extracted to portfolios and hence used to assess portfolio event risk exposure. However, results of the research of dividing the data into different regions (North America-Europe, Emerging Markets-Developed Countries) were not useful, so these were not used for the final event risk exposure assessment. The GICS structure on the other hand did prove to be very

valuable, mostly on industry level. Some results were also found for sectors and industry groups, but the focus was on industry levels, because their results were much better than those of the other levels. The literature shows that stock level regression comes with large errors, and also pleads for regression on a level higher than stock level.

Industry (and industry group and sector) regression results were always relative to the benchmark belonging to the data set in question (the world for MSCI World, Europe for MSCI Europe, and so on), adjusted with a beta measuring the relation between that sector and its benchmark. Results were only slightly better than results not adjusted for a benchmark, but that, combined with the fact that this is a formally better way, was enough to decide to use this method anyway.

Also for the extraction to portfolios the results are relative to a benchmark. This is a choice, as absolute results may give a useful insight too, but in general performance measurement and risk assessment is done compared to a benchmark as well. This made it an obvious choice to adapt a similar method here.

For some factors, like oil and commodities, weekly data gave enough statistically useful results. For interest rates however, weekly data were not sufficient and daily data were needed. To prevent overloading of the program a shorter time period was chosen for these daily data sets. The number of events depends partly on the number of data available, but the number of events found in daily data sets is relatively lower than the number found in weekly data sets. The choice of the number of events will always remain arbitrary to some extent, but common sense and some restrictions –enough to ensure statistical validity, but not too many, compared to the total number of data, to comply with the definition of event- will lead to a good approximation.

The program that was developed made the research process infinitely much easier, which made it possible to work with large data sets and investigate many without being very time consuming. Moreover, the program was set up in such a way that it is easily scalable: if the need arises to incorporate a new factor, this can be added without any difficulty; the number of portfolios is variable and can be chosen according to the user's needs. Parameters, file paths and other variables can be changed manually, without affecting the program. This makes it a very flexible program to use and it also adds to its scalability. As a final remark, the program can be used both for investigation of new factors as well as for periodic event risk assessment, which makes it robust and versatile.

Recommendations for further research

Some studies find that large factor movements are better described by non-linear relations than by linear relations. An interesting topic for further research could thus be to use non-linear relationships between certain factors, like oil and interest rates, and sectors.

In this thesis only partial analyses have been performed. The assumption underlying this choice is that no added value will come from including multifactor analyses, as an event is supposed to have an exogenous effect that rules out other factor movements. Nevertheless, comparing multifactor analysis with partial analyses under event circumstances is a possible subject for research.

Estimation of interest rate exposure could also be done with a different perspective: instead of modelling exposures directly on industries, the modelling could also be done based on intermediate economic factors that are directly influenced by changes in the interest rate, and that, in turn, influences businesses. Regarding economic factors, one could think of dividend yields, liquidity, leverage, and other such factors and ratios. This could also make an interesting subject for further research.

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11. Appendices

I Factor data sets

Table 5 gives a description of the data sets for the factors that were used during the research.

FACTOR DATA SETS	
COMMODITIES	
Oil	
Specifics	West Texas Intermediate Crude Oil Price (WTI)
Period	Jan 1995 – Dec 2006
Periodicity	Weekly
Dates	Fridays
Unit	\$/barrel
Source	<i>Bloomberg</i>
Gold	
Specifics	Gold spot price
Period	Jan 1995 – Dec 2006
Periodicity	Weekly
Dates	Fridays
Unit	\$/oz
Source	<i>Bloomberg</i>
Copper	
Specifics	Copper spot price
Period	Jan 1995 – Dec 2006
Periodicity	Weekly
Dates	Fridays
Unit	3mo \$
Source	<i>Bloomberg</i>
Silver	
Specifics	Silver spot price
Period	Jan 1995 – Dec 2006
Periodicity	Weekly
Dates	Fridays
Unit	\$/oz
Source	<i>Bloomberg</i>

Nickel		
Specifics	Nickel spot price	
Period	Jan 1995 - Dec 2006	
Periodicity	Weekly	
Dates	Fridays	
Unit	3mo \$	
Source	<i>Bloomberg</i>	
Aluminium		
Specifics	Aluminium spot price	
Period	Jan 1995 - Dec 2006	
Periodicity	Weekly	
Dates	Fridays	
Unit	3 mo\$	
Source	<i>Bloomberg</i>	
Platinum		
Specifics	Platinum spot price	
Period	Jan 1995 - Dec 2006	
Periodicity	Weekly	
Dates	Fridays	
Unit	\$/oz	
Source	<i>Bloomberg</i>	
Industrial metals		
Specifics	Dow Jones Industrial Metals Index (DJAIG IND METALS SP)	
Period	Jan 1995 - Dec 2006	
Periodicity	Weekly	
Dates	Fridays	
Unit	\$	
Source	<i>Bloomberg</i>	
Precious metals		
Specifics	Dow Jones Precious Metals Index (DJAIG PREC METALS IND SP)	
Period	Jan 1995 - Dec 2006	
Periodicity	Weekly	
Dates	Fridays	
Unit	\$	
Source	<i>Bloomberg</i>	
Commodities		
Specifics	Dow Jones Commodity Index (DJAIG AIG COMMODITY IDX)	
Period	Jan 1995 - Dec 2006	
Periodicity	Weekly	
Dates	Fridays	
Unit	\$	
Source	<i>Bloomberg</i>	
Index percentages	Natural Gas	12.5%
	Crude Oil	12.7%
	Unleaded Gas	3.9%
	Heating Oil	3.8%
	Live Cattle	6.1%
	Lean Hogs	3.0%
	Wheat	4.7%
	Corn	5.6%
	Soybeans	7.7%
	Soybean Oil	2.8%
	Aluminium	6.8%
	Copper	6.2%
	Zinc	2.8%
	Nickel	2.7%
	Gold	6.8%
	Silver	2.3%

	Sugar Cotton Coffee	3.1% 3.1% 3.0%
INTEREST RATES		
US Generic 10y rate		
Specifics	US Generic 10y interest rate	
Duration	10 years	
Period	Jan 2001 - Dec 2006	
Periodicity	Daily	
Dates	-	
Unit	\$	
Source	<i>Bloomberg</i>	
German Generic 10y rate		
Specifics	German Generic 10y yields	
Duration	10 years	
Period	Jan 2001 - Dec 2006	
Periodicity	Daily	
Dates	-	
Unit	\$	
Source	<i>Bloomberg</i>	
US LIBOR 3m		
Specifics	US 3 month LIBOR yields	
Duration	3 months	
Period	Jan 2001 - Dec 2006	
Periodicity	Daily	
Dates	-	
Unit	\$	
Source	<i>Bloomberg</i>	
EU LIBOR 3m		
Specifics	European 3 month LIBOR yields	
Duration	3 months	
Period	Jan 2001 - Dec 2006	
Periodicity	Daily	
Dates	-	
Unit	\$	
Source	<i>Bloomberg</i>	
US term spread		
Specifics	US term spread	
Spread	10yr yields minus 3m yields (10yr-3m)	
Period	Jan 2001 - Dec 2006	
Periodicity	Daily	
Dates	-	
Unit	\$	
Source	-	
EU term spread		
Specifics	European term spread	
Spread	10yr yields minus 3m yields (10yr-3m)	
Period	Jan 2001 - Dec 2006	
Periodicity	Daily	
Dates	-	
Unit	\$	
Source	-	

Table 5: Description of factor data sets.

II GICS Structure

Table 6 shows the GICS structure collapsed by Sector, Industry Group and Industry.

MSCI WORLD INDEX: GICS STRUCTURE		
Sector	Industry Group	Industry
Consumer Discretionary	Automobiles & Components	Auto Components Automobiles
	Consumer Durables & Apparel	Household Durables Leisure Equipment & Products Textiles Apparel & Luxury Goods
	Consumer Services	Diversified Consumer Services Hotels Restaurants & Leisure
	Media	Media
	Retailing	
Consumer Staples	Food & Staples Retailing	Food & Staples Retailing
	Food Beverage & Tobacco	Beverages Food Products Tobacco
	Household & Personal Products	Household Products Personal Products
Energy	Energy	Energy Equipment & Services Oil Gas & Consumable Fuels
Financials	Banks	Commercial Banks Thrifts & Mortgage Finance
	Diversified Financials	Capital Markets Consumer Finance Diversified Financial Services
	Insurance	Insurance
	Real Estate	Real Estate Investment Trusts Real Estate Management & Development
Health Care	Health Care Equipment & Services	Health Care Equipment & Services Health Care Providers & Services Health Care Technology
	Pharmaceuticals Biotechnology & Life Sciences	

		Biotechnology
		Life Sciences Tools & Services
		Pharmaceuticals
Industrials		
	Capital Goods	
		Aerospace & Defence
		Building Products
		Construction & Engineering
		Electrical Equipment
		Industrial Conglomerates
		Machinery
		Trading Companies & Distributors
	Commercial Services & Supplies	
		Commercial Services & Supplies
	Transportation	
		Air Freight & Logistics
		Airlines
		Marine
		Road & Rail
		Transportation Infrastructure
Information Technology		
	Semiconductors & Semiconductor Equipment	
		Semiconductors & Semiconductor Equipment
	Software & Services	
		IT Services
		Internet Software & Services
		Software
	Technology Hardware & Equipment	
		Communications Equipment
		Computers & Peripherals
		Electronic Equipment & Instruments
		Office Electronics
Materials		
	Materials	
		Chemicals
		Construction Materials
		Containers & Packaging
		Metals & Mining
		Paper & Forest Products
	Telecommunication Services	
		Diversified Telecommunication Services
		Wireless Telecommunication Services
Utilities		
	Utilities	
		Electric Utilities
		Gas Utilities
		Independent Power Producers & Energy Traders
		Multi-Utilities
		Water Utilities

Table 6: Sectors, industry groups and industries in the GICS structure.

III Countries

Table 7 shows the countries in the developed countries and the emerging markets as parted by MSCI.

MSCI WORLD COUNTRIES	
<i>Developed Countries</i>	<i>Emerging Markets</i>
Australia	Argentina
Austria	Brazil
Belgium	Chile
Canada	China
Denmark	Colombia
Finland	Czech Republic
France	Egypt
Germany	Greece
Greece	Hungary
Hong Kong	India
Ireland	Indonesia
Italy	Israel
Japan	Jordan
Malaysia	Korea
Netherlands	Malaysia
New Zealand	Mexico
Norway	Morocco
Portugal	Pakistan
Singapore	Peru
South African Gold Mines	Philippines
Spain	Poland
Sweden	Portugal
Switzerland	Russia
United Kingdom	South Africa
USA	Sri Lanka
	Taiwan
	Thailand
	Turkey
	Venezuela

Table 7: Developed countries and emerging markets.

IV Return data sets

Table 8 gives a description of the data sets that were used for the return data, used in the lookup function.

DESCRIPTION OF DATA SETS	
MSCI World Weekly Returns	
Specifics	Morgan Stanley Capital International World, stock market index
Structure	GICS
Period	Jan 1995 – Dec 2006
Periodicity	Weekly
Dates	Fridays
Unit	\$
Source	<i>Factset</i>
MSCI World Daily Returns	
Specifics	Morgan Stanley Capital International World, stock market index
Structure	GICS
Period	Jan 2001 – Dec 2006
Periodicity	Daily
Unit	\$
Source	<i>Factset</i>
MSCI World Country Weekly Returns	
Specifics	Morgan Stanley Capital International World, stock market index
Structure	Countries
Period	Jan 1995 – Dec 2006
Periodicity	Weekly
Dates	Fridays
Unit	\$
Source	<i>Factset</i>
Other	Deleted countries: Greece, Malaysia, Portugal, South Africa,
MSCI World Emerging Markets Country Weekly Returns	
Specifics	Morgan Stanley Capital International World, stock market index, Emerging Markets
Structure	Countries
Period	Jan 1995 – Dec 2006
Periodicity	Weekly
Dates	Fridays
Unit	\$

Source	<i>Factset</i>
Other	Deleted countries: Egypt, Greece, Malaysia, Morocco, Portugal, Sri Lanka, Venezuela Merged Countries ⁶ : Indonesia, Thailand
MSCI World North America Weekly Returns	
Specifics	Morgan Stanley Capital International World, stock market index, North America
Structure	GICS
Period	Jan 1995 - Dec 2006
Periodicity	Weekly
Dates	Fridays
Unit	\$
Source	<i>Factset</i>
Other	
MSCI World Europe Weekly Returns	
Specifics	Morgan Stanley Capital International World, stock market index, Europe
Structure	GICS
Period	Jan 1995 - Dec 2006
Periodicity	Weekly
Dates	Fridays
Unit	\$
Source	<i>Factset</i>
Other	

Table 8: Description of the return data sets.

⁶ Some countries had two registrations: a former one and a current one, where the former had data until a certain point and the current one had data starting two weeks after the end of the former. It is unclear what this split means, but the two sets were merged into one in order to be able to keep the country in the data set.

V Parameter summary

Table 9 shows the parameters of each factor.

FACTOR PARAMETERS					
Factor	Total # dates	Init #	Boundary	# negative events⁷	# positive events
<i>Oil</i>	630	65	6%	32 (5.1%)	37 (5.9%)
<i>Gold</i>	630	70	2.3%	34 (5.4%)	32 (5.1%)
<i>Copper</i>	630	90	3.8%	33 (5.2%)	34 (5.4%)
<i>Silver</i>	630	65	4%	33 (5.2%)	37 (5.9%)
<i>Nickel</i>	630	80	5%	29 (4.6%)	38 (6.0%)
<i>Aluminium</i>	630	80	2.8%	32 (5.1%)	39 (6.2%)
<i>Platinum</i>	630	70	3%	33 (5.2%)	36 (5.7%)
<i>Industrial metals</i>	630	75	3.3%	31 (4.9%)	36 (5.7%)
<i>Precious metals</i>	630	65	2.2%	39 (6.2%)	37 (5.9%)
<i>Commodity</i>	630	65	2.1%	34 (5.4%)	42 (6.7%)
<i>US Generic 10years</i>	1565	150	10bp	39 (2.5%)	58 (3.7%)
<i>German Generic 10years</i>	1565	150	7bp	39 (2.5%)	40 (2.6%)
<i>US LIBOR 3months</i>	1565	150	2bp	76 (4.9%)	55 (3.5%)
<i>EU LIBOR 3months</i>	1565	150	2bp	50 (3.2%)	38 (2.4%)
<i>US term spread</i>	1565	160	9bp	55 (3.5%)	72 (4.6%)
<i>EU term spread</i>	1565	160	6bp	55 (3.5%)	69 (4.4%)

Table 9: Factor parameters.

⁷ The percentage between brackets is the percentage of the total number of data points.

VI Scenarios

Table 10 below shows the scenarios that proved useful per factor.

SCENARIOS								
	Negative scenarios				Positive scenarios			
<i>Oil</i>	-25	-20	-15	-10	10	15	20	25
<i>Gold</i>	-5	-4	-3	-2.5	2.5	3	4	5
<i>Copper</i>	-10	-8	-6	-4	4	6	8	10
<i>Silver</i>	-15	-12	-9	-5	5	9	12	15
<i>Nickel</i>	-15	-12	-9	-5	5	9	12	15
<i>Aluminium</i>	-10	-8	-6	-4	4	6	8	10
<i>Platinum</i>	-7	-6	-5	-4	4	5	6	7
<i>Industrial metals</i>	-10	-8	-6	-4	4	6	8	10
<i>Precious metals</i>	-9	-7	-5	-3	3	5	7	9
<i>Commodity</i>	-5	-4	-3	-2.5	2.5	3	4	5
<i>US Generic 10years</i>	-25	-20	-15	-10	10	15	20	25
<i>German Generic 10years</i>	-25	-20	-15	-10	10	15	20	25
<i>US LIBOR 3months</i>	-20	-15	-10	-5	5	10	15	20
<i>EU LIBOR 3months</i>	-20	-15	-10	-5	5	10	15	20
<i>US term spread</i>	-25	-20	-15	-10	10	15	20	25
<i>EU term spread</i>	-25	-20	-15	-10	10	15	20	25

Table 10: Factor scenarios.

VII Example of regression results

Figure 18 is a screenshot of part of the actual regression outcomes as the program computed them. The grey columns contain the outcomes for negative events; the white columns contain those for positive events. The sheet is structured in three major columns (one for sectors, one for industry groups and one for industries), each of which contains results for both negative and positive events. The header rows contain the parameters and an example of how to read the results.

	A	B	C	D	E	F	G	H	I	J	K	L
1	REGRESSION RESULTS				Bound	6.00	neg #	32.00				
2	(world adjusted data)				Init #	65.00	pos #	37.00			Slope	Intercept
3											F-stat	dF
4											T(slope)	T(cept)
5	Sector Level				Industry Group Level				Industry Level			
6	The World Index		The World Index		Energy		Energy		energy equipment & serv		energy equipment & servi	
7	(0.18)	(1.66)	0.07	(0.25)	0.26	0.72	0.02	0.77	0.31	0.27	0.06	2.20
8	3.68	30.00	0.64	35.00	4.81	30.00	0.05	35.00	1.68	30.00	0.14	35.00
9	(1.92)	(1.61)	0.80	(0.29)	2.19	0.57	0.21	0.68	1.30	0.10	0.37	1.31
10	ENERGY		ENERGY		Materials		Materials		oil gas & consumable fue		oil gas & consumable fuel	
11	0.26	0.72	0.02	0.77	(0.07)	(1.09)	(0.06)	0.25	0.25	0.73	0.02	0.70
12	4.81	30.00	0.05	35.00	0.74	30.00	0.54	35.00	4.99	30.00	0.03	35.00
13	2.19	0.57	0.21	0.68	(0.86)	(1.30)	(0.74)	0.31	2.23	0.60	0.17	0.61
14	MATERIALS		MATERIALS		Capital Goods		Capital Goods		chemicals		chemicals	
15	(0.07)	(1.09)	(0.06)	0.25	(0.08)	(0.95)	(0.04)	0.33	(0.15)	(1.45)	0.03	(0.86)
16	0.74	30.00	0.54	35.00	2.76	30.00	0.93	35.00	4.05	30.00	0.12	35.00
17	(0.86)	(1.30)	(0.74)	0.31	(1.66)	(1.87)	(0.96)	0.70	(2.01)	(1.83)	0.35	(1.11)
18	INDUSTRIALS		INDUSTRIALS		Commercial Services & S		Commercial Services & S		construction materials		construction materials	
19	(0.06)	(0.72)	(0.06)	0.41	(0.10)	(0.75)	(0.03)	0.21	(0.07)	(1.00)	(0.01)	(0.33)
20	3.61	30.00	2.96	35.00	3.56	30.00	0.23	35.00	0.58	30.00	0.00	35.00
21	(1.90)	(2.00)	(1.72)	1.17	(1.89)	(1.26)	(0.48)	0.33	(0.76)	(1.07)	(0.06)	(0.34)
22	CONSUMER DISCRETION		CONSUMER DISCRETION		Transportation		Transportation		containers & packaging		containers & packaging	
23	(0.09)	(0.79)	0.01	(0.20)	0.05	0.54	(0.12)	0.76	0.00	(0.32)	(0.04)	(0.04)
24	5.95	30.00	0.09	35.00	1.16	30.00	3.31	35.00	0.00	30.00	0.11	35.00
25	(2.44)	(2.01)	0.29	(0.48)	1.08	0.98	(1.82)	1.09	0.01	(0.36)	(0.33)	(0.04)
26	CONSUMER STAPLES		CONSUMER STAPLES		Automobiles & Componer		Automobiles & Componer		metals & mining		metals & mining	
27	0.11	1.16	0.04	(0.87)	(0.00)	(0.23)	(0.09)	1.02	(0.00)	(1.12)	(0.22)	2.37
28	1.62	30.00	0.37	35.00	0.00	30.00	0.81	35.00	0.00	30.00	3.36	35.00
29	1.27	1.20	0.61	(1.23)	(0.04)	(0.34)	(0.90)	0.97	(0.00)	(0.88)	(1.83)	1.91
30	HEALTH CARE		HEALTH CARE		Consumer Durables & Ap		Consumer Durables & Ap		paper & forest products		paper & forest products	
31	(0.08)	(0.31)	0.00	(0.32)	0.02	0.02	(0.08)	0.69	0.08	0.92	(0.04)	(0.29)
32	1.19	30.00	0.00	35.00	0.05	30.00	0.76	35.00	0.40	30.00	0.13	35.00
33	(1.09)	(0.38)	0.07	(0.42)	0.22	0.02	(0.87)	0.72	0.63	0.72	(0.37)	(0.29)
34	FINANCIALS		FINANCIALS		Consumer Services		Consumer Services		aerospace & defense		aerospace & defense	
35	0.06	1.00	0.01	(0.49)	(0.11)	(1.15)	0.22	(2.37)	0.06	0.96	(0.07)	0.60
36	1.29	30.00	0.01	35.00	1.51	30.00	11.64	35.00	0.41	30.00	0.36	35.00
37	1.14	1.69	0.11	(0.93)	(1.23)	(1.23)	3.41	(3.55)	0.64	1.00	(0.60)	0.51
38	INFORMATION TECHNOLOG		INFORMATION TECHNOLOG		Media		Media		building products		building products	
39	(0.12)	(0.97)	0.09	(0.04)	(0.15)	(1.53)	0.14	(0.72)	0.03	0.06	(0.07)	0.46
40	1.16	30.00	0.59	35.00	3.95	30.00	2.07	35.00	0.14	30.00	0.59	35.00
41	(1.08)	(0.79)	0.77	(0.03)	(1.99)	(1.84)	1.44	(0.72)	0.37	0.07	(0.77)	0.45

Figure 18: Example of regression results for the factor oil.

VIII Example of portfolio results

Figure 19 is a screenshot of part of the outcomes for an imaginary portfolio XYZ, extracted from oil price events. The results are on industry level. Each industry is represented by a slope and an intercept (or 0 in case of non-significance) for negative and positive events. The portfolio has active weights in each of these industries. Together they make the results in the table and a total result for the portfolio as a whole.

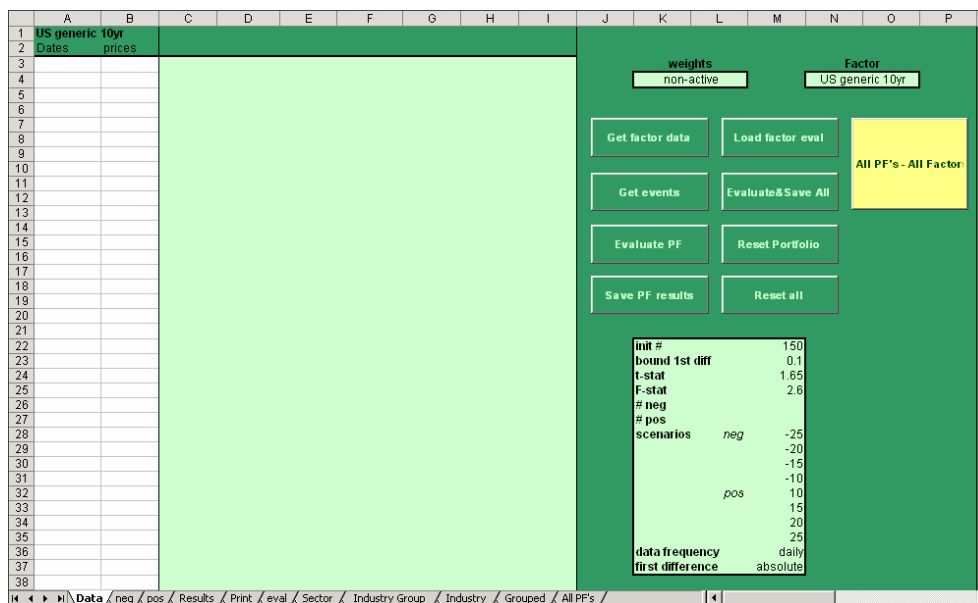
1	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
2	XYZ							Oil		Note: results are in %					
3	Negative events		Positive events		Active weights (%)			Negative scenarios			Positive scenarios				
4	slope	intercept	slope	intercept				-25	-20	-15	-10	10	15	20	25
5															
6	TOTAL PORTFOLIO RISK						0%	0.488	0.358	0.228	0.098	0.229	0.362	0.495	0.628
7															
8	energy equipment & services						5%	0.000	0.000	0.000	0.000	0.230	0.345	0.460	0.575
9	0	0	0.46	0											
10	oil gas & consumable fuels						0%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.250428	0	0	0											
12	chemicals						1%	0.028	0.018	0.009	0.000	0.000	0.000	0.000	0.000
13	-0.14663	-1.45295	0	0											
14	construction materials						-1%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	0	0	0	0											
16	containers & packaging						0%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	0	0	0	0											
18	metals & mining						-4%	0.000	0.000	0.000	0.000	-0.008	0.035	0.078	0.120
19	0	0	-0.2175	2.371444											
20	paper & forest products						2%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	0	0	0	0											
22	aerospace & defense						1%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0	0	0	0											
24	building products						-1%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0	0	0	0											
26	construction & engineering						-1%	0.053	0.042	0.032	0.021	0.000	0.000	0.000	0.000
27	0.204823	0	0	0											
28	electrical equipment						-1%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	0	0	0	0											
30	industrial conglomerates						-2%	-0.043	-0.029	-0.014	0.000	0.000	0.000	0.000	0.000
31	-0.17786	-1.78493	0	0											
32	machinery						-2%	0.000	0.000	0.000	0.000	0.005	0.020	0.035	0.050
33	0	0	-0.16293	1.378226											
34	trading companies & distributors						0%	0.015	0.012	0.009	0.006	0.000	0.000	0.000	0.000
35	0.185533	0	0	0											

Figure 19: Example of portfolio results for the factor oil.

IX Program

The program used in this thesis was developed in VB and works with Excel, in such a way that it is run via an excel file and the data files that the program uses are also Excel files and sheets. The original VB code can be found in Appendix X. Below a detailed description of the program can be found: the data flows, the functions and processes, the input and the output. Screenshots of the program, to which will be referred in this appendix, can be found in Section IX.VI.

Screenshot 1 shows the front page of the program, where the user finds the buttons, the dropdown boxes and the parameter matrix.



Screenshot 1: Front page program.

IX.I Data flow charts

All three functionalities can be described by data flow charts. The first functionality is captured in the data flow chart in Figure 20 and the second two functionalities are represented together in Figure 21.

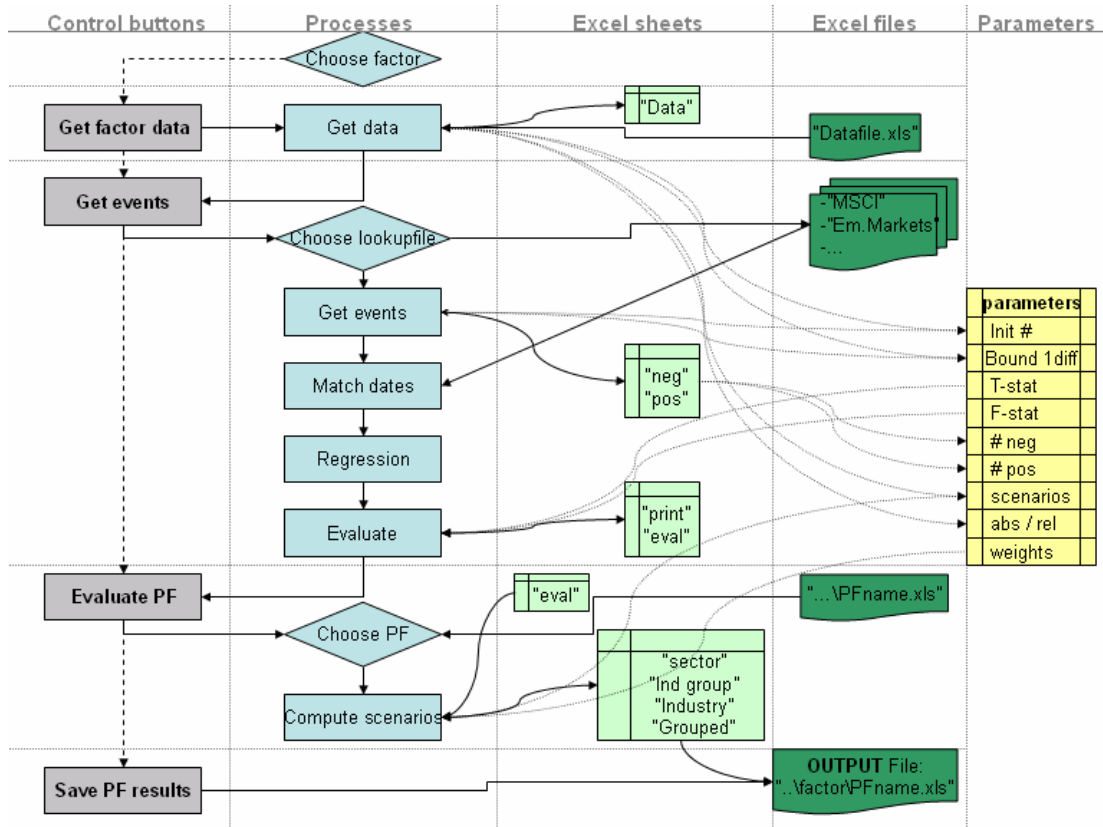


Figure 20: Dataflow chart of Factor Research functionality.

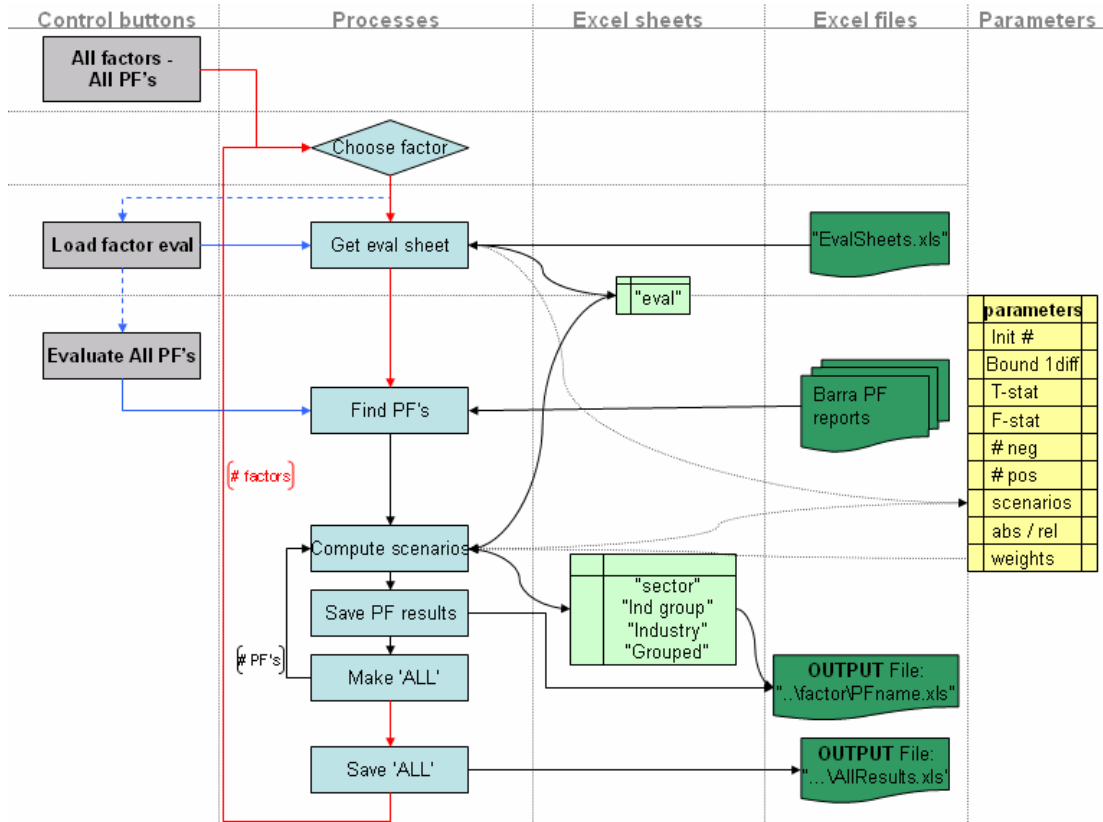


Figure 21: Dataflow chart of Single Factor Portfolio Exposure and Periodic Reporting functionalities.

The flow charts are divided into five columns:

- Control buttons: these are the buttons that are actually in the program ready to be used by the user. Clicking on a button activates the processes that underlie the specific button.
- Processes: these are the processes that are activated upon clicking on the respective button. A diamond represents a choice to be made by the user; a square represents an internal process done by the program.
- Excel sheets: the sheets existing in the file and manipulated by the program.
- Excel files: this column contains the excel files that are used or made by the program. A multi-file image means that a choice can be made by the user between various files.
- Parameters: these parameters are used both internally and externally by the program.

The charts are also divided into four rows. Each row contains the processes, sheets and files that are activated or used by the respective button. The parameter table is used globally and therefore does not belong to one specific row.

Figure 20:

- *choose factor* (choice): pick a factor from the dropdown list.
- *Get factor data* (button): the program gets the correct factor data from *datafile.xls* and pastes it in blank spaces within the *Data* sheet. The first column shows the dates, the second column shows the price levels (Screenshot 2).
- *Get Events* (button): its goal is to identify events in the given data set, using the model specified earlier in this paper.
 - *Choose lookupfile* (choice): asks the user to choose from a set of files called the lookup files. They include the return data of sectors, or countries, etc.
 - *Get events* (process): uses the parameters initial number and boundary for the first difference to identify the events. A number x equal to the initial number is chosen from the data set: the x events with the highest second difference for negative events and the x with the lowest second difference for positive events. The negative ones are pasted in sheet *neg* and the positive ones in sheet *pos* (Screenshot 4). Then all these dates are checked on their first difference: if this is lower than the pre-specified boundary for the first difference, the date is not an event and is deleted from the events set.

- *Match dates* (process): for all events that have been found the matching return data is looked up in the so called *lookupfile* chosen earlier in this stage (Screenshot 4).
- *Regression* (process): runs regressions on the events and the corresponding returns from the matched dates. In the case of the GICS structure regression is performed on three levels: sector, industry group and industry level. The results are pasted in a sheet and this sheet is made up in such a way that it is ready to be printed. This way a user can scan the results manually in order to get a good idea of the results and of the t- and F-statistic that will have to be chosen. The sheet is called *print* (Screenshot 5).
- *Evaluate* (process): based on the t- and F-statistic, the *print* sheet is evaluated on significance. All regression results that are found to be insignificant are set to zero. Then all results except for the regression slope and intercept are deleted in such a way that the *eval* sheet only shows slopes and intercepts (Screenshot 6).
- *Evaluate PF* (button): evaluates actual portfolios.
 - *Choose PF* (choice): Clicking on the *Evaluate PF* button opens a screen where the user can select the excel file of the portfolio to be evaluated.
 - *Weights (optional choice)*: choose between active or normal weights in the dropdown box.
 - *Compute scenarios* (process): the program can now compute the results for all the scenarios that are set in the parameter table. It makes a sheet for each level that shows:
 - The sectors (respectively industry groups and industries).
 - The slopes and intercepts for negative and positive events that have been found to be significant.
 - The active weights that are taken from the portfolio file that was chosen by the user.
 - A result table with the percentage change for each of the scenarios.
 - A total risk row that shows the total risk per scenario.
 - (Screenshot 7)
 - It also makes a *grouped* sheet where all industries are grouped in sectors. The sheet is similar to the first three sheets, but the results are the summation per sector of the industries that fall under that sector. It shows a row with the total risk as well. Below

the data table are three graphs that graphically represent the results (Screenshot 8, Screenshot 9).

- *Save PF results* (button): saves the sheets that were made in the evaluate portfolio phase into a new file. The file will have the name of the original portfolio file but with the factor name appended; it will be stored in a folder with the name of the factor.

Figure 21:

This figure captures two functionalities in one. The black arrows represent the flows that take place in both functionalities; the blue arrows belong only to Single Factor Portfolio Exposure and the red ones only to Periodic Reporting. The former constitutes the basis for the latter.

Single Factor Portfolio Exposure:

- *Choose factor* (choice): pick a factor from the dropdown list.
- *Load factor eval* (button): gets the *eval* sheet of the chosen factor from *EvalSheets.xls* and pastes this in the sheet called *eval*. FIGURE EVAL
 - *Weights (optional choice)*: choose between active and normal weights.
- *Evaluate All PF's* (button): will evaluate portfolios and save their results as long as it finds new portfolio files in the folder (*[# PF's]*):
 - *Find PF's* (process): searches all the Excel files in the specified folder (*Barra PF reports*) that contains the portfolio files.
 - *Compute scenarios* (process): see explanation Research Factor functionality.
 - *Save PF results* (process): see explanation Research Factor functionality.
 - *Make 'ALL'* (process): copies the rows that contains the total exposures of each portfolio and pastes these in the *All PF's* sheet (Screenshot 10).

The Periodic Reporting functionality is basically represented by the red arrows. It simply creates a loop around the whole process used for the Single Factor Portfolio Exposure, where factors are not manually chosen but the program runs a loop for each factor in the list and skips the buttons otherwise needed. The only extra function is:

- *Weights (optional choice)*: choose between active and normal weights.
- *All factors – All PF's* (button): loops around all functions as described above.
 - *Save 'ALL'* (process): this is the only process that is not in the original process. After a loop is performed, the *All PF's* sheet is copied and pasted

onto the sheet in *AllResults.xls* that corresponds with the factor that is currently examined.

IX.II Parameters

- *Factor*: the factor that will be used (e.g. oil, commodities, US interest rates, etc.). The list below the parameter matrix contains all available factors, to which a new one can be added by expanding the list.
 - Set in: manually, before *Get factor data* and *Load factor eval*.
 - Used in: *Get factor data*, *Load factor eval*.
- *Weights*: a dropdown list gives the user the choice between active weights or non-active weights.
- *init #*: initial number of dates that will be chosen from the ordered data set: x equal to the initial number of dates with the highest second difference and x dates with the lowest second difference (negative).
 - Set in: *Get factor data*, *Load factor eval*.
 - Used in: *Get events*.
- *Bound 1st diff*: the dates that have been chosen based on the initial number parameter are now checked on their first difference: if the absolute first difference is lower than this boundary the date is eliminated from the event set.
 - Set in: *Get factor data*, *Load factor eval*.
 - Used in: *Get events*.
- *T-stat*: this is the t-statistic used for significance tests of the slope and the intercept (both have their own respective t-statistic). If the t-statistic of an element (either slope or intercept) is above this critical t-value, it is significant. If not, it is set to zero. It is a static parameter that is not changed throughout the process. It can however be altered manually in its cell.
 - Set in: *Get factor data*, *Load factor eval*.
 - Used in: *Get events*.
- *F-stat*: this is the F-statistic used for significance tests of the regression line. If the F-statistic of the line is below this critical value the slope and intercept are set to zero. If it is beyond the critical value all remains the same. This parameter is also static but can be changed manually.
 - Set in: *Get factor data*, *Load factor eval*.
 - Used in: *Get events*.

- *# neg*: the number of negative events. This is the number of events that entail a price fall, hence a negative first difference. It should be used as output information only.
 - Set in: *Get events*.
- *# pos*: the number of positive events. Similar to the number of negative events explained above.
- *Scenarios*: these are the scenarios that will be used when evaluating a portfolio. Four negative and four positive scenarios are used. They are percentages or basis points, depending on the factor, and are used as such. These parameters can be changed manually in the respective cells according to the needs of the user.
 - Set in: *Get factor data, Load factor eval*
 - Used in: *Evaluate PF, Evaluate&Save All, All PF's-All Factor*
- *First difference*: this parameter is represented as a dropdown box. It gives the user the choice between absolute and relative first differences. Values are given in the list below the parameter matrix.
 - Set in: *Get factor PF, Load factor eval*
 - Used in: *Get events*

The parameters all have specific default values for each factor and getting factor data or an *eval* sheet activates these. The default parameters are the values that proved best during research and unless new research provides better parameters, these should not be changed. They are stored in the parameter part of the *Data* sheet. In the research functionality the parameters can be changed manually in the parameter table according to the user's needs.

IX.III Input and Output files

The paths of the files are static and are stored in the parameter part of the *Data* sheet (Screenshot 3). If a path needs to be changed, it can be altered there.

EvalSheets

This file has a sheet with regression results (*eval* sheets, Screenshot 6) for each of the factors that have already been examined. These sheets must be exactly as the program produced them. After a factor has been chosen, the *Load factor eval* button retrieves its results sheet from this file.

Datafile

This data file contains all factors available in the program. The data sheet called 'daily' contains all factors and their data that need to be evaluated based on daily data; the sheet called 'weekly' contains those with weekly data. Other than that, the setup is the same: the first column (A) shows all dates from 1995 until 2006, starting in row 3. The next columns contain the price levels of the factors, where the actual data start in row 3 and the names can be found in rows 1 and 2. If factors are added, they also have to be added to the *getIndex()* function and the relevant parameters should be set in *setParams()*. The file is called upon in *Get factor data*. Screenshot 11 shows this data file.

PfReports

When clicking on the save results button the result sheets (*Sector, Industry Group, Industry and Grouped*) for a portfolio are saved in the folder that has the name of the factor (e.g. oil, commodities, etc.), which can be found by the *pfReports* path. The file automatically gets the name of the original portfolio input file, to which the factor name is added.

BarraReports

This file should have the data of the portfolio that needs to be analysed. It should be stored in the folder. It should have three sheets that have names that coincide with the names as they are specified in the parameter part of *Data* sheet (Screenshot 3). Column A displays the sector names, B the Asset ID, C the Weights (%), D the Active Weights (%) and E the Holdings and this is the same for all three sheets. The file is used in compute scenarios. An example of such a file can be found in Screenshot 13.

AllResults

The *All PF's* sheets of all factors are stored in this file, where each factor has its own sheet. This file is only used when activating *All PF's-All factors* (Screenshot 10).

Lookup files

These are the files that contain the data that will be regressed against the event data. Such a file should have a sheet called *adjusted* that shows the data adjusted for the world⁸. The first column shows the dates, from 1995 to 2006, starting in cell A4. The

⁸ 'Adjusted for the world' means that for each date the World Index return is deducted from the returns of all sectors/countries/... This is done to try to eliminate movements that are due to factors that are unidentifiable but are equal for the 'whole world' and correcting them with a beta (Section 5.3).

actual data start in B4, where each column contains a sector (or country, or industry, etc., depending on the data). Row 3 shows the names and row 2 shows the level (sector is level 1, industry group is level 2, industry is level 3). The file needs to be chosen in *Get event*. The formulas for computing the correct, adjusted data are given in Table 11.

FACTOR LEVEL	1	1	2	3	...
Dates	Benchmark	Sector	Industry group	Industry	...
6-1-95	RBM (t)	$(RS(t)-RBM(t)) * \beta_S$	$(RIG(t)-RBM(t)) * \beta_{IG}$	$(RI(t)-RnBM(t)) * \beta_I$...
3-1-95	RBM(t+1)	$(RS(t+1)-RBM (t+1)) * \beta_S$	$(RIG(t+1)-RBM (t+1)) * \beta_{IG}$	$(RI(t+1)-RBM (t+1)) * \beta_I$...
...

Table 11: Formulas for the data sheets in the lookup files.

Screenshot 12 shows what the file looks like.

IX.IV How to use the program

The program was set up in such a way that it has different functionalities: it can be used for:

- factor research
- single factor portfolio exposure
- periodic reporting.

The buttons that are involved in the factor research process enable the user to investigate a single factor, from event identification to regression to portfolio exposure. If a user wants to assess portfolios on their exposure to a single factor that has already been studied and of which the results are readily available, a different set of buttons can be used. For periodic reporting, all portfolios in a specified folder can be evaluated for all factors available and for this only one button has to be pushed. The distinction between these three main functionalities makes it possible for a user to:

- easily switch between factors;
- examine a single factor;
- retrieve factor results without having to do the event research each time;
- asses the event risk exposure of a single portfolio to one factor;
- save portfolio exposure results in a corresponding folder;
- delete portfolio results without losing factor results;

- evaluate all portfolios in a pre-specified folder, automatically save the results of each portfolio and obtain all totalled exposures of each portfolio;
- evaluate and save all portfolios for all available factors, save these data and obtain a file that contains all totalled exposures of each portfolio for all factors.

The next sections will explain the data flow and the buttons and functions involved for each of the three core functionalities.

IX.IV.I Factor research

Examining a (new) factor requires the following steps from the user:

- choose a factor from the list in the dropdown box (assuming data is already in the data file; if not, add the new factor following the steps in the section 'How to add a factor' (IX.V));
- choose 'relative' or 'absolute' from the first difference dropdown box;
- push the *Get factor data* button to retrieve the data;
- (optional) manually change the parameters;
- push the *Get events* button to let the program do the research and return the significant relations.

Now the chosen factor has been fully researched and the output is ready to be extracted to a portfolio:

- push the *Evaluate PF* button to evaluate a portfolio -that will have to be selected by the user- on the factor;
- push the *Save PF results* button to save all the relevant information of this portfolio. The file will have the name of the original portfolio file but with the factor name appended; it will be stored in a folder with the name of the factor.

IX.IV.II Single factor portfolio exposure

Computing the exposure of a series of portfolios to a factor of which event results are available takes the following actions:

- choose a factor from the list in the dropdown box;
- push the *Load factor eval* button to get the event result sheet of the chosen factor;
- choose between active and normal industry weights for a portfolio using the dropdown box;
- push the *Evaluate&Save All* button to evaluate all portfolios and save the portfolio results.

Note that this procedure does not allow a priori changing of parameters.

IX.IV.III Periodic reporting

- Choose between active and normal industry weights for a portfolio using the dropdown box;
- push the *All PF's – All Factors* button to evaluate all portfolios on all available factors, save these results in the corresponding files and folders and make a file that contains all overall results of all portfolios for each of the factors.

Note that this procedure does not allow a priori changing of parameters.

IX.IV.IV Resetting

The program offers two reset-possibilities.

- The *Reset Portfolio* button clears the contents in the sheets: *Sector, Industry Group, Industry, Grouped* and *All PF's*. Everything else is left intact.
- The *Reset all* button clears all the data in every sheet, including the *Data* sheet.

IX.V How to add a factor

Adding a new factor requires a few steps:

- Obtain the right data.
- Add these data to the *datafile*:
 - Daily data from 2001-2006 in the daily sheet.
 - Weekly data from 1995 to 2006 in the weekly sheet.
- Add the factor index to *getIndex()*, where the index number is the number of the column that contains the data of that factor.
- Manually choose the parameters *init#*, *bound 1st diff*, *scenarios* (and if wanted the t-statistic and F-statistic) until optimal.
- Add the final parameters to the list in *setParams()*.

After these steps the factor is ready for the Research functionality. When the user decides the results of the research are ready to be used, the following steps should be taken to prepare the factor for the two other functionalities:

- Produce an *eval* sheet that contains the results that are satisfying.
- Copy this sheet into *evalSheets* and give the sheet the factor name.

Now, the factor is fully integrated into the program. Note that the name of the factor should be the same in all functions, lists and files.

IX.VI Screenshots

This section includes screenshots of all relevant sheets in the program. Every screenshot will be explained briefly.

IX.VI.I Data sheet: main

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Oil															
2	Dates	prices	1st diff	2nd diff	Data ordered by second diff											
3	19/1/1995	17.67			4/24/1998	13.27	-14.5525	36.8584								
4	1/12/1995	17.52	-0.8489	7.298668	3/21/2003	27.36	-22.6682	32.9021								
5	12/2/1995	18.65	6.44377	-10.2031	6/19/1998	11.89	-5.93354	25.3616								
6	12/2/1995	17.95	-3.75335	8.377307	10/8/1999	20.9	-14.8329	24.0195								
7	2/10/1995	18.78	4.62396	-6.3279	4/12/2002	23.47	-10.454	22.8528								
8	2/10/1995	18.46	-1.70394	4.141644	3/25/2005	51.29	-9.57334	21.2325								
9	2/17/1995	18.91	2.4377	-4.12993	1/7/2000	24.22	-5.39063	21.0801								
10	2/24/1995	18.59	-1.69223	1.907396	11/16/2001	18.03	-18.8569	18.4686								
11	3/2/1995	18.63	0.21517	-4.0799	11/2/2001	20.19	-8.35225	18.4067								
12	3/9/1995	17.91	-3.86473	5.81895	1/18/2002	18	-8.53659	18.0921								
13	3/17/1995	18.26	1.95422	0.345894	12/10/2004	40.71	-4.30183	17.984								
14	3/24/1995	18.68	2.30011	0.323017	1/23/1998	15.59	-5.57238	15.9637								
15	3/31/1995	19.17	2.62313	-0.01488	5/20/2005	46.8	-3.8422	14.6328								
16	4/7/1995	19.67	2.60824	-5.25186	1/28/2000	27.22	-8.65772	14.5357								
17	4/14/1995	19.15	-2.64362	9.484351	1/1/1996	18.25	-9.92103	13.7019								
18	4/21/1995	20.46	6.84073	-7.23174	10/6/2000	30.86	0.06485	13.3182								
19	4/28/1995	20.38	-0.39101	0.145668	3/20/1998	14.35	4.28779	13.0641								
20	5/6/1995	20.33	-0.24534	-3.73892	4/15/2005	50.49	-5.30758	13.0319								
21	5/12/1995	19.52	-3.98426	6.750653	3/13/1998	13.76	-8.44977	12.7376								
22	5/19/1995	20.06	2.76639	-9.5959	12/8/2000	28.44	-11.1805	12.6925								
23	5/26/1995	18.69	-6.82951	1/9/1900	12/22/2000	26.06	-9.73329	12.5729								
24	6/2/1995	19.14	2.4077	-4.18409	5/31/1996	19.76	-9.14943	12.4389								
25	6/9/1995	18.8	-1.77638	1.98915	1/26/2001	29.77	-7.51786	12.2878								
26	6/16/1995	18.84	0.21277	-5.78601	10/29/1999	21.75	-6.20957	11.9567								
27	6/23/1995	17.79	-5.57325	3.381006	6/10/2005	53.54	-2.70761	11.9157								
28	6/30/1995	17.4	-2.19224	0.69739	11/29/1998	23.75	-4.0404	11.9141								
29	7/7/1995	17.14	-1.49425	2.544428	11/27/1998	11	-9.7621	11.7621								
30	7/14/1995	17.32	1.05019	-2.60907	4/2/2004	34.39	-3.75035	11.7469								
31	7/21/1995	17.05	-1.55889	3.78763	12/13/1998	24.47	-4.48868	11.8812								
32	7/28/1995	17.43	2.22874	-0.62231	4/28/2000	25.74	-5.64516	11.8669								
33	8/4/1995	17.71	1.60643	-0.75945	8/27/2004	43.18	-9.77852	11.6544								
34	8/11/1995	17.86	0.84698	-0.79099	3/29/1996	21.47	-5.4185	11.3803								
35	8/18/1995	17.87	0.05599	9.960797	1/15/1999	12.13	-7.40458	11.2793								
36	8/25/1995	19.66	10.0168	-18.2569	1/10/2003	31.68	-4.23216	11.2713								
37	9/1/1995	18.04	-8.24008	10.45738	3/8/1996	19.61	0.87449	11.2622								
38	9/8/1995	18.44	2.21729	0.385742	4/25/2003	26.36	-13.7717	11.1541								

Screenshot 2: Data sheet, main part.

This picture shows the *data* sheet. The white columns show the data of the factor that was selected, with above in cell A1 the factor. The light green columns show the first difference and the second difference of the data as it is in the white columns. The four columns under the header *Data ordered by second difference* show all the data including differences ordered by second difference (in descending order).

The right part of the screen has the control buttons, the two light-green dropdown boxes and the list of parameters.

IX.VI.II Data sheet: parameters

	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
1						Paths										
2						<i>name</i>	<i>subfunction</i>	<i>type</i>	<i>path</i>							
3																
4																
5																
6						evalSheets	getEvalSheet	xls file	//abc...xyz.../evalSheets.xls							
7						datafile	pastedata	xls file	//abc...xyz.../datafile.xls							
8						pfReports	savePortfolio	folder	//abc...xyz.../pfReports							
9						barraReports	analyseAll	folder	//abc...xyz.../barraReports							
10						AllResults	copyAllSheet	xls file	//abc...xyz.../allResults.xls							
11																
12																
13																
14																
15																
16						<i>Industry</i>	GICS Industry_annes									
17						<i>Industry Group</i>	GICS Industry Group_annes									
18						<i>Sector</i>	GICS Sector_annes									
19																
20																
21																
22																
23						<i>name</i>	Oil	Gold	Copper	Commodi	US generi	GE generi	US LIBOR	EU LIBOR	US spread	
24						<i>index</i>	2	3	4	5	2	3	6	7	4	
25						<i>init #</i>	65	70	90	65	150	150	150	150	160	
26						<i>bound</i>	6	2.3	3.8	2.1	0.1	0.07	0.02	0.02	0.09	
27						<i>scenarios+</i>	-25	-5	-10	-5	-25	-25	-20	-20	-25	
28							-20	-4	-8	-4	-20	-20	-15	-15	-20	
29							-15	-3	-6	-3	-15	-15	-10	-10	-15	
30							-10	-2.5	-4	-2.5	-10	-10	-5	-5	-10	
31							10	2.5	4	2.5	10	10	5	5	10	
32							15	3	6	3	15	15	10	10	15	
33							20	4	8	4	20	20	15	15	20	
34							25	5	10	5	25	25	20	20	25	
35						<i>data frequency</i>	weekly	weekly	weekly	weekly	daily	daily	daily	daily	daily	
36						<i>first difference</i>	relative	relative	relative	relative	absolute	absolute	absolute	absolute	absolute	
37																

Screenshot 3: Data sheet, parameter part.

This screenshot shows the right side of the *Data* sheet: the part that holds the parameters, paths and other variables.

IX.VI.III Neg sheet

1	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
2	NEGATIVE SHOCKS				Level											
3	date	return	1diff	2diff	Factor	The Work	Energy	Energy	Energy Ec	Oil	Gas & Materials	Materials	Chemical	Construct	Contain	
4	4/24/1998	13.27	-14.5525	36.85843		-0.98623	0.665851	0.665851	0.779468	0.654837	0.64228	0.64228	-0.25599	1.370353	0.71482	
5	3/21/2003	27.36	-22.6682	32.90209		6.148562	-2.02494	-2.02494	-3.23311	-1.94579	0.172659	0.172659	2.893066	-0.2628	-0.42492	
6	10/8/1999	20.9	-14.8329	24.01953		2.911539	-5.34535	-5.34535	-15.9144	-4.73473	-1.51193	-1.51193	0.493088	-2.35421	-1.97505	
7	4/12/2002	23.47	-10.454	22.85283		-1.48235	-1.18312	-1.18312	-2.20602	-1.12017	0.734368	0.734368	0.785434	1.590973	0.427297	
8	3/25/2005	51.29	-9.57334	21.23254		-1.89476	-1.79641	-1.79641	-0.80253	-1.86544	-1.46746	-1.46746	0.104717	-1.32727	-0.7246	
9	11/16/2001	18.03	-18.8669	18.46864		1.279587	-7.39557	-7.39557	-13.2061	-7.05654	1.672304	1.672304	0.972192	0.661935	0.800807	
10	11/2/2001	20.19	-8.35225	18.40673		-1.60085	-0.97987	-0.97987	-8.64225	-0.56192	0.325953	0.325953	0.594856	-1.48832	1.41359	
11	1/8/2002	18	-8.53659	18.09214		-1.69807	0.1154	0.1154	-2.05645	0.235521	-1.41689	-1.41689	-1.43724	-0.16538	-0.18895	
12	1/28/2000	27.22	-8.65772	14.53575		-3.05431	-2.26456	-2.26456	-8.30404	-1.90404	-1.18102	-1.18102	-0.50527	-1.69047	-0.61331	
13	1/12/1996	18.25	-9.92103	13.70185		-2.00872	-0.65258	-0.65258	1.292798	-0.70028	0.342086	0.342086	1.050145	0.457952	0.11291	
14	3/13/1999	13.76	-8.44977	12.73756		1.758583	-1.30644	-1.30644	-5.71798	-1.10941	0.443962	0.443962	-0.35048	1.985784	0.30151	
15	12/8/2000	28.44	-11.1805	12.69247		2.878409	-3.06604	-3.06604	-0.05021	-3.24144	1.017794	1.017794	0.656415	0.986767	-1.56444	
16	12/22/2000	26.06	-9.73329	12.57289		-1.11625	2.98047	2.98047	5.963006	2.780499	5.151925	5.151925	5.831578	3.155079	0.772163	
17	5/31/1996	19.76	-9.14943	12.4389		0.011835	-0.8312	-0.8312	-3.59009	-0.72179	-0.29578	-0.29578	-0.49226	0.610995	-1.10635	
18	1/26/2001	29.77	-7.51786	12.28777		0.184044	1.887448	1.887448	5.995541	1.604767	0.367603	0.367603	-0.01771	0.084706	-0.50903	
19	10/29/1999	21.75	-6.20957	11.9567		3.74184	-3.95337	-3.95337	-5.61405	-3.84579	-2.95603	-2.95603	-2.42778	-4.50066	-1.06516	
20	11/27/1998	11	-9.7621	11.7621		2.222612	0.415489	0.415489	-7.92332	0.633432	-1.15122	-1.15122	-0.93749	-2.16217	3.200493	
21	8/27/2004	43.18	-9.77852	11.65439		0.904476	-0.73114	-0.73114	0.385909	-0.80819	-0.36852	-0.36852	0.72797	-0.02563	-0.35608	
22	1/15/1999	12.13	-7.40458	11.27927		-3.08297	-0.99979	-0.99979	-4.35246	-0.89514	-0.68466	-0.68466	-1.66576	-1.59351	1.354223	
23	4/25/2003	26.36	-13.7717	11.15407		0.207249	-1.27681	-1.27681	2.751293	-1.53271	-0.90746	-0.90746	-0.63165	0.662596	1.295547	
24	4/29/2005	49.72	-8.58614	11.0801		-0.55029	-1.71376	-1.71376	-4.88356	-1.48853	-1.17145	-1.17145	-0.32796	-0.84651	-1.34202	
25	11/17/2006	55.81	-6.34335	11.05576		0.550598	-1.67846	-1.67846	-1.01319	-1.773	-2.41162	-2.41162	-0.69718	0.081614	-1.13199	
26	2/28/1997	20.3	-6.19224	11.01982		-0.83917	-1.31282	-1.31282	-2.27011	-1.26666	0.673901	0.673901	0.521555	0.96956	0.26909	
27	7/7/2000	30.28	-6.83077	10.52959		1.206629	-2.07494	-2.07494	-6.65399	-1.75365	-1.69417	-1.69417	-1.68656	-1.32724	-1.91782	
28	9/22/1995	17.25	-8.82664	10.5078		0.153644	-1.13635	-1.13635	-3.27076	-1.05551	-1.73288	-1.73288	-1.61975	-0.11534	-2.37853	
29	6/12/1998	12.64	-16.4021	10.46857		-2.6663	-1.89364	-1.89364	-4.25418	-1.7803	-1.95468	-1.95468	-1.22937	-0.99274	-1.8147	
30	9/1/1995	18.04	-8.24008	10.45738		0.213397	0.292591	0.292591	7.996134	0.077761	-0.30933	-0.30933	-0.07749	0.425317	0.133426	
31	6/5/1997	18.79	-10.0086	10.22246		1.59287	0.632562	0.632562	2.443571	0.56043	-0.14789	-0.14789	0.432919	-0.53908	-0.73426	
32	4/4/1997	19.12	-7.63285	10.19561		-2.27789	-2.1427	-2.1427	-6.24145	-1.99201	0.189774	0.189774	0.450926	-0.89026	-0.26694	
33	11/1/1996	23.03	-7.36122	9.792634		0.163703	-1.28637	-1.28637	-1.6174	-1.25903	-0.59372	-0.59372	-0.05168	-1.30121	-0.58453	
34	12/3/2004	42.54	-13.6419	9.340067		1.012981	-3.15058	-3.15058	-6.44963	-2.92459	-1.45879	-1.45879	0.233832	-0.30072	-0.47373	
35	5/25/1995	18.69	-6.82351	1/9/1900		2.36576	-0.92096	-0.92096	-1.78594	-0.88402	-0.17754	-0.17754	-0.11945	0.337633	1.072931	

Screenshot 4: Neg sheet.

This picture shows the *neg* sheet as it is in the program. The *pos* sheet looks and functions the same. The events as identified by the program are pasted in the first four columns, including the first and second differences. Starting in the sixth column, the data from the lookup file that was matched with the event dates is shown, with name and level above each column.

IX.VI.IV Print sheet

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	
1	REGRESSION RESULTS				Init #	65.00	neg #	32.00				Slope	Intercept		
2	Oil				Bound	6.00	pos #	37.00				F-stat	dF		
3											T(slope)	T(cept)			
4	Sector Level				Industry Group Level				Industry Level						
5	The World Index	The World Index	The World Index	The World Index	Energy	Energy	Energy	Energy	Energy Equipment & Serv	Energy Equipment & Serv	Energy Equipment & Services	Energy Equipment & Services			
6	(0.18)	(1.66)	0.07	(0.25)	0.26	0.72	0.02	0.77	0.31	0.27	0.06	2.20			
7	3.68	30.00	0.64	35.00	4.81	30.00	0.05	35.00	1.68	30.00	0.14	35.00			
8	(1.92)	(1.61)	0.80	(0.29)	2.19	0.57	0.21	0.68	1.30	0.10	0.37	1.31			
9	Energy	Energy	Energy	Energy	Materials	Materials	Materials	Materials	Oil Gas & Consumable Fu	Oil Gas & Consumable Fu	Oil Gas & Consumable Fuels	Oil Gas & Consumable Fuels			
10	0.26	0.72	0.02	0.77	(0.07)	(1.09)	(0.06)	0.25	0.25	0.73	0.02	0.70			
11	4.81	30.00	0.05	35.00	0.74	30.00	0.54	35.00	4.99	30.00	0.03	35.00			
12	2.19	0.57	0.21	0.68	(0.85)	(1.30)	(0.74)	0.31	2.23	0.60	0.17	0.61			
13	Materials	Materials	Materials	Materials	Capital Goods	Capital Goods	Capital Goods	Capital Goods	Chemicals	Chemicals	Chemicals	Chemicals			
14	(0.07)	(1.09)	(0.06)	0.25	(0.08)	(0.95)	(0.04)	0.33	(0.15)	(1.45)	0.03	(0.86)			
15	0.74	30.00	0.54	35.00	2.76	30.00	0.93	35.00	4.05	30.00	0.12	35.00			
16	(0.86)	(1.30)	(0.74)	0.31	(1.66)	(1.87)	(0.96)	0.70	(2.01)	(1.83)	0.35	(1.11)			
17	Industrials	Industrials	Industrials	Industrials	Commercial Services & S	Commercial Services & S	Commercial Services & S	Commercial Services & S	Construction Materials	Construction Materials	Construction Materials	Construction Materials			
18	(0.06)	(0.72)	(0.06)	0.41	(0.10)	(0.75)	(0.03)	0.21	(0.07)	(1.00)	(0.01)	(0.33)			
19	3.61	30.00	2.96	35.00	3.56	30.00	0.23	35.00	0.58	30.00	0.00	35.00			
20	(1.90)	(2.00)	(1.72)	1.17	(1.89)	(1.26)	(0.48)	0.33	(0.76)	(1.07)	(0.06)	(0.34)			
21	Consumer Discretionary	Consumer Discretionary	Consumer Discretionary	Consumer Discretionary	Transportation	Transportation	Transportation	Transportation	Containers & Packaging	Containers & Packaging	Containers & Packaging	Containers & Packaging			
22	(0.09)	(0.79)	0.01	(0.20)	0.05	0.54	(0.12)	0.76	0.00	(0.32)	(0.04)	(0.04)			
23	5.95	30.00	0.09	35.00	1.16	30.00	3.31	35.00	0.00	30.00	0.11	35.00			
24	(2.44)	(2.01)	0.29	(0.48)	1.08	0.98	(1.82)	1.09	0.01	(0.36)	(0.33)	(0.04)			
25	Consumer Staples	Consumer Staples	Consumer Staples	Consumer Staples	Automobiles & Component	Automobiles & Component	Automobiles & Component	Automobiles & Component	Metals & Mining	Metals & Mining	Metals & Mining	Metals & Mining			
26	0.11	1.16	0.04	(0.87)	(0.00)	(0.23)	(0.09)	1.02	(0.00)	(1.12)	(0.22)	2.37			
27	1.62	30.00	0.37	35.00	0.00	30.00	0.81	35.00	0.00	30.00	3.36	35.00			
28	1.27	1.20	0.61	(1.23)	(0.04)	(0.34)	(0.90)	0.97	(0.00)	(0.88)	(1.83)	1.91			
29	Health Care	Health Care	Health Care	Health Care	Consumer Durables & Ap	Consumer Durables & Ap	Consumer Durables & Ap	Consumer Durables & Ap	Paper & Forest Products	Paper & Forest Products	Paper & Forest Products	Paper & Forest Products			
30	(0.08)	(0.31)	0.00	(0.32)	0.02	0.02	(0.08)	0.69	0.08	0.92	(0.04)	(0.29)			
31	1.19	30.00	0.00	35.00	0.05	30.00	0.76	35.00	0.40	30.00	0.13	35.00			
32	(1.08)	(0.38)	0.07	(0.42)	0.22	0.02	(0.87)	0.72	0.63	0.72	(0.37)	(0.29)			
33	Financials	Financials	Financials	Financials	Consumer Services	Consumer Services	Consumer Services	Consumer Services	Aerospace & Defense	Aerospace & Defense	Aerospace & Defense	Aerospace & Defense			
34	0.06	1.00	0.01	(0.49)	(0.11)	(1.15)	0.22	(2.37)	0.06	0.96	(0.07)	0.60			
35	1.29	30.00	0.01	35.00	1.51	30.00	11.64	35.00	0.41	30.00	0.36	35.00			
36	1.14	1.69	0.11	(0.93)	(1.23)	(1.23)	3.41	(3.55)	0.64	1.00	(0.60)	0.51			
37	Information Technology	Information Technology	Information Technology	Information Technology	Media	Media	Media	Media	Building Products	Building Products	Building Products	Building Products			
38	(0.12)	(0.97)	0.09	(0.04)	(0.15)	(1.53)	0.14	(0.72)	0.03	0.06	(0.07)	0.46			
39	1.16	30.00	0.59	35.00	3.95	30.00	2.07	35.00	0.14	30.00	0.59	35.00			
40	(1.08)	(0.79)	0.77	(0.03)	(1.99)	(1.84)	1.44	(0.72)	0.37	0.07	(0.77)	0.45			

Screenshot 5: Print sheet.

This is the sheet where all regression results are summarized and which is ready to be printed (due to its layout), so the user can easily scan the results from a hard copy. It shows the factor, some relevant parameters and an example of how to interpret the results in the grey header. The body shows the results per sector per level. Normally the regression functions outputs more information about the regression, but to avoid having too many variables to interpret, only the most relevant were kept: slope and intercept (first row), F-statistic and degrees of freedom (second row) and t-statistic for slope and intercept (third row).

IX.VI.V Eval sheet

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
1	REGRESSION RESULTS				Init #	65.00	neg #	32.00			Slope	Intercept				
2	Oil				Bound	6.00	pos #	37.00			F-stat	t(df)				
3	non-active				Bound t-stat	1.65	Bound F-sts	2.60			T(slope)	T(cept)				
4	Sector Level				Industry Group Level				Industry Level							
5	The World Index	The World Index	Energy	Energy	Energy	Energy	Energy	Energy	Energy	Energy	Energy	Energy	Energy	Energy	Energy	Energy
6	(0.18)	-	-	-	0.19	-	-	-	-	-	-	-	-	-	-	-
7	Energy	Energy	Materials	Materials	Materials	Materials	Materials	Materials	Materials	Materials	Materials	Materials	Materials	Materials	Materials	Materials
8	0.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	Materials	Materials	Capital Goods	Capital Goods	Capital Goods	Capital Goods	Capital Goods	Capital Goods	Capital Goods	Capital Goods	Capital Goods	Capital Goods	Capital Goods	Capital Goods	Capital Goods	Capital Goods
10	-	-	-	-	(0.08)	(1.03)	-	-	-	-	(0.13)	(1.31)	-	-	-	-
11	Industrials	Industrials	Commercial Services & S	Commercial Services & S	Commercial Services & S	Commercial Services & S	Commercial Services & S	Commercial Services & S	Commercial Services & S	Commercial Services & S	Commercial Services & S	Commercial Services & S	Commercial Services & S	Commercial Services & S	Commercial Services & S	Commercial Services & S
12	(0.06)	(0.72)	(0.06)	(0.10)	-	-	-	-	-	-	-	-	-	-	-	-
13	Consumer Discretionary	Consumer Discretionary	Transportation	Transportation	Transportation	Transportation	Transportation	Transportation	Transportation	Transportation	Transportation	Transportation	Transportation	Transportation	Transportation	Transportation
14	(0.09)	(0.83)	-	-	-	(0.09)	-	-	-	-	-	-	-	-	-	-
15	Consumer Staples	Consumer Staples	Automobiles & Componer	Automobiles & Componer	Automobiles & Componer	Automobiles & Componer	Automobiles & Componer	Automobiles & Componer	Automobiles & Componer	Automobiles & Componer	Automobiles & Componer	Automobiles & Componer	Automobiles & Componer	Automobiles & Componer	Automobiles & Componer	Automobiles & Componer
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	Health Care	Health Care	Consumer Durables & Ap	Consumer Durables & Ap	Consumer Durables & Ap	Consumer Durables & Ap	Consumer Durables & Ap	Consumer Durables & Ap	Consumer Durables & Ap	Consumer Durables & Ap	Consumer Durables & Ap	Consumer Durables & Ap	Consumer Durables & Ap	Consumer Durables & Ap	Consumer Durables & Ap	Consumer Durables & Ap
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	Financials	Financials	Consumer Services	Consumer Services	Consumer Services	Consumer Services	Consumer Services	Consumer Services	Consumer Services	Consumer Services	Consumer Services	Consumer Services	Consumer Services	Consumer Services	Consumer Services	Consumer Services
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	Information Technology	Information Technology	Media	Media	Media	Media	Media	Media	Media	Media	Media	Media	Media	Media	Media	Media
22	-	-	-	-	(0.17)	(1.71)	-	-	-	-	-	-	-	-	-	-
23	Telecommunication Servi	Telecommunication Servi	Retailing	Retailing	Retailing	Retailing	Retailing	Retailing	Retailing	Retailing	Retailing	Retailing	Retailing	Retailing	Retailing	Retailing
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	Utilities	Utilities	Food & Staples Retailing	Food & Staples Retailing	Food & Staples Retailing	Food & Staples Retailing	Food & Staples Retailing	Food & Staples Retailing	Food & Staples Retailing	Food & Staples Retailing	Food & Staples Retailing	Food & Staples Retailing	Food & Staples Retailing	Food & Staples Retailing	Food & Staples Retailing	Food & Staples Retailing
26	0.11	1.13	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Screenshot 6: Eval sheet.

The eval sheet looks similar to the print sheet, because it is derived from it. The main difference is that only slopes and intercepts are shown (their value if they are significant, - if they are not significant).

IX.VI.VI Industry sheet

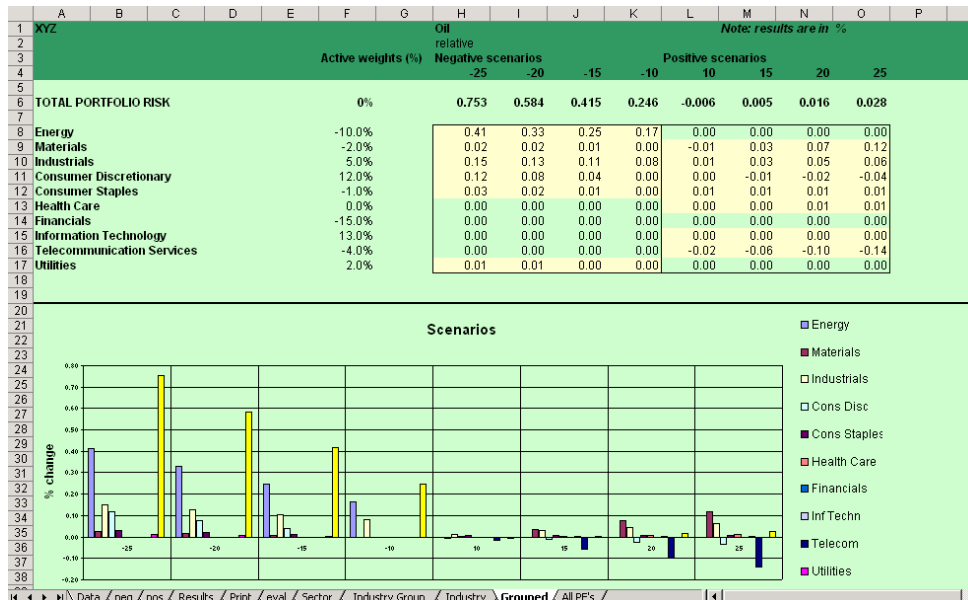
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O																									
1	XYZ	Note: results are in %																																						
2	Negative events				Positive events				Active weights (%)				Oil relative																											
3	slope				intercept				-25				-20				-15				-10				10				15				20				25			
4	slope				intercept				-25				-20				-15				-10				10				15				20				25			
5																																								
6	TOTAL PORTFOLIO RISK						0%	0.753	0.584	0.415	0.246	-0.006	0.005	0.016	0.028																									
7																																								
8	Energy Equipment & Services						0%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000																								
9	0	0	0	0	0	0	0.413	0.331	0.248	0.165	0.000	0.000	0.000	0.000	0.000																									
10	Oil Gas & Consumable Fuels						-9%	0.025	0.016	0.008	0.000	0.000	0.000	0.000	0.000																									
11	0.178884	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000																										
12	Chemicals						1%	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000																									
13	-0.13269	-1.3148	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000																										
14	Construction Materials						-1%	0.000	0.000	0.000	0.000	0.000	0.000	0.000																										
15	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000																										
16	Containers & Packaging						0%	0.000	0.000	0.000	0.000	0.000	0.000	0.000																										
17	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000																										
18	Metals & Mining						-4%	0.000	0.000	0.000	0.000	-0.007	0.034	0.075	0.116																									
19	0	0	-0.20141	2.195976	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000																										
20	Paper & Forest Products						2%	0.000	0.000	0.000	0.000	0.000	0.000	0.000																										
21	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000																										
22	Aerospace & Defense						4%	0.000	0.000	0.000	0.000	0.000	0.000	0.000																										
23	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000																										
24	Building Products						-1%	0.041	0.033	0.025	0.016	0.000	0.000	0.000																										
25	0.158509	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000																										
26	Electrical Equipment						-1%	0.000	0.000	0.000	0.000	0.000	0.000	0.000																										
27	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000																										
28	Industrial Conglomerates						-2%	-0.056	-0.037	-0.019	0.000	0.000	0.000	0.000																										
29	-0.21565	-2.16423	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000																										
30	Machinery						-2%	0.000	0.000	0.000	0.000	0.005	0.019	0.034	0.048																									
31	0	0	-0.15853	1.341034	0	0	0.014	0.011	0.009	0.006	0.000	0.000	0.000	0.000																										
32	Trading Companies & Distributors						0%	0.000	0.000	0.000	0.000	0.000	0.000	0.000																										
33	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000																										
34																																								

Screenshot 7: Industry sheet.

The Industry sheet is one of the result sheets after evaluating a portfolio. The name of the portfolio is in the upper left corner (in this case the imaginary portfolio XYZ); column titles are in the green header. The light green body shows the results. On the left side industry names with from left to right slope and intercept for negative events and slope and intercept for positive events. Next is a column that shows the active weights for each industry. The table displays the results in percentages or basis points for each one of the scenarios. The interpretation is as follows: for a percentage (basis points) change (the scenario) in the price level of the factor the industry in the portfolio is affected with the percentage (basis points) displayed in the table. For industries that have results different from zero the results are highlighted in yellow and the industry name is shown in bold. This makes it easy to identify industries that are affected by the factor.

Finally, row 6 shows the total portfolio risk, where results are added for each scenario. The interpretation of the numbers is like this: for a percentage (basis points) change (the scenario) in the price level of the factor the total portfolio change is the percentage (basis points) shown. The sheets Sector and Industry Group look and function the same way.

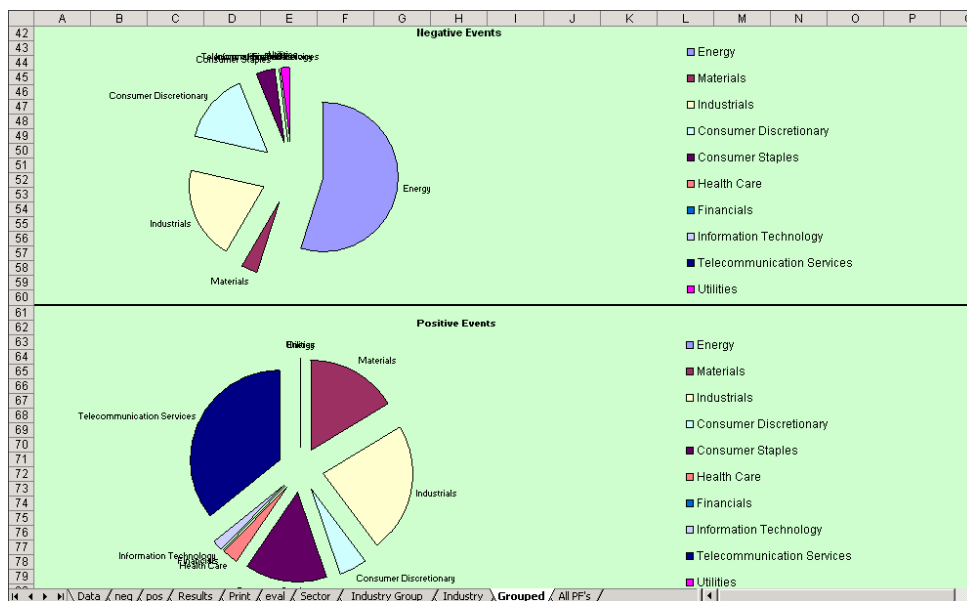
IX.VI.VII Grouped sheet



Screenshot 8: Grouped sheet (1).

The results are shown per sector: the industries were grouped into sectors and, to get the sector results, the industry results were summed per sector. In the same way the active weights per sector were obtained by summing the active weights of the industries in that particular sector.

The graph shows the percentage change per sector, based on the grouped sheet, for all negative and positive scenarios.



Screenshot 9: Grouped sheet (2).

These two graphs are also in the Grouped sheet, below the scenario chart. The charts show the attribution of each industry to the total result of the portfolio; one chart for negative events and one for positive events.

IX.VI.VIII All PF's sheet

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O				
1	Oil																		
2	<i>Note: results are in %</i>																		
3																			
4	<table border="0" style="width: 100%;"> <tr> <td style="width: 50%; text-align: center;">Negative scenarios</td> <td style="width: 50%; text-align: center;">Positive scenarios</td> </tr> <tr> <td style="text-align: center;">-25 -20 -15</td> <td style="text-align: center;">-10 10 15 20 25</td> </tr> </table>															Negative scenarios	Positive scenarios	-25 -20 -15	-10 10 15 20 25
Negative scenarios	Positive scenarios																		
-25 -20 -15	-10 10 15 20 25																		
5																			
6	Portfolios																		
7																			
8	ABC	0.433	0.320	0.208	0.096	-0.020	-0.010	0.000	0.010										
9	BCD	0.060	0.054	0.028	0.002	0.067	0.108	0.129	0.150										
10	CDE	-0.060	-0.038	-0.015	0.008	0.153	0.240	0.327	0.415										
11	DEF	0.080	0.054	0.027	0.000	0.093	0.124	0.155	0.186										
12	XYS	-0.186	-0.157	-0.129	-0.101	0.124	0.030	-0.064	-0.158										
13																			
14																			
15																			
16																			
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33																			
34																			

Screenshot 10: All PF's sheet.

This is an example of an *AllPF's* sheet. These sheets look similar other factors. The results in the table are the total results per portfolio, based on the scenarios in above.

IX.VI.IX Datafile

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1															
2		oil	gold	copper	Commodities										
3	1/6/1995	17.67	371.5	2988	94.949										
4	1/13/1995	17.52	378.95	3026	94.265										
5	1/20/1995	18.65	384.2	3063	96.67										
6	1/27/1995	17.95	378.25	2993	94.933										
7	2/3/1995	18.78	376.3	2863	95.094										
8	2/10/1995	18.46	376.3	2875	94.487										
9	2/17/1995	18.91	379	2876	94.802										
10	2/24/1995	18.59	376.6	2854	94.887										
11	3/3/1995	18.63	376.8	2896	94.485										
12	3/10/1995	17.91	382.3	2900	94.291										
13	3/17/1995	18.26	383.7	2887	94.802										
14	3/24/1995	18.68	382.3	2936	95.219										
15	3/31/1995	19.17	391.4	2924	96.044										
16	4/7/1995	19.67	392.9	2932	97.583										
17	4/14/1995	19.15	389.5	2892	96.306										
18	4/21/1995	20.46	390.4	2847	97.958										
19	4/28/1995	20.38	387.1	2790	97.531										
20	5/5/1995	20.33	390	2714	96.886										
21	5/12/1995	19.52	383.7	2753	95.515										
22	5/19/1995	20.06	383.5	2740	97.119										
23	5/26/1995	18.89	386	2826	97.202										
24	6/2/1995	19.14	383.6	2868	97.109										
25	6/9/1995	18.8	388.5	2880	96.899										
26	6/16/1995	18.84	390	2971	96.817										
27	6/23/1995	17.79	390.3	3007	96.596										
28	6/30/1995	17.4	384.6	2960	94.961										
29	7/7/1995	17.14	385.9	2958	94.712										
30	7/14/1995	17.32	388.9	3004	96.063										
31	7/21/1995	17.05	386.6	2842	95.729										
32	7/28/1995	17.43	383.5	2893	96.425										
33	8/4/1995	17.71	384.1	2972	95.859										
34	8/11/1995	17.86	384	2955	95.959										

Screenshot 11: Datafile.

This is what the *datafile* looks like: a daily and a weekly sheet, each containing a column with the dates and columns with factor data.

IX.VI.X Lookupfile

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1															
2	factor level	1	1	2	3	3	1	2	3	3	3	3	3	1	2
3		The World In	Energy	Energy	Energy Equip	Oil Gas & Co	Materials	Materials	Chemicals	Construction	Containers &	Metals & Mini	Paper & Fore	Industrials	Capital Good
4	06-Jan-95	(1.11)	0.78	0.78	1.92	0.74	(0.05)	(0.05)	0.48	0.81	1.03	(1.99)	2.50	0.13	(0.05)
5	13-Jan-95	0.49	(0.84)	(0.84)	(2.45)	(0.79)	0.35	0.35	0.19	(1.00)	0.67	0.59	1.24	0.51	0.47
6	20-Jan-95	(1.11)	1.92	1.92	5.19	1.81	0.02	0.02	0.32	1.95	(0.10)	(1.01)	0.29	(0.08)	0.06
7	27-Jan-95	(0.60)	1.13	1.13	1.66	1.10	(1.27)	(1.27)	(1.90)	(0.06)	(1.97)	(0.43)	(2.06)	(0.23)	0.10
8	03-Feb-95	1.41	(1.37)	(1.37)	(2.32)	(1.32)	(1.63)	(1.63)	(1.07)	(1.32)	(0.21)	(2.91)	(0.72)	(0.63)	(1.00)
9	10-Feb-95	0.65	(0.37)	(0.37)	(1.07)	(0.35)	(0.36)	(0.36)	0.22	0.98	(0.65)	(1.49)	(0.24)	(0.42)	(0.60)
10	17-Feb-95	(0.01)	0.58	0.58	3.29	0.50	0.08	0.08	0.18	(0.73)	1.93	(0.61)	1.42	0.04	(0.15)
11	24-Feb-95	0.04	(0.19)	(0.19)	1.09	(0.22)	(0.03)	(0.03)	(0.19)	(0.74)	(1.07)	0.36	0.65	(0.50)	(0.58)
12	03-Mar-95	1.08	(0.23)	(0.23)	(0.13)	(0.23)	(0.63)	(0.63)	0.10	(0.15)	(0.56)	(0.75)	(3.02)	(0.03)	(0.10)
13	10-Mar-95	(0.58)	1.23	1.23	0.46	1.23	(0.26)	(0.26)	(0.61)	(1.66)	(0.11)	0.65	(0.20)	0.51	0.62
14	17-Mar-95	1.26	(0.53)	(0.53)	(1.67)	(0.49)	0.13	0.13	0.99	0.15	0.10	(0.22)	(1.86)	(0.39)	(0.80)
15	24-Mar-95	(0.47)	0.99	0.99	0.68	0.99	(0.58)	(0.58)	(0.06)	0.16	0.04	(1.81)	(0.06)	(1.00)	(1.33)
16	31-Mar-95	3.17	(0.51)	(0.51)	(1.66)	(0.47)	1.38	1.38	1.57	(0.18)	(0.38)	2.06	1.16	0.86	1.15
17	07-Apr-95	0.66	(0.72)	(0.72)	0.62	(0.74)	0.58	0.58	0.07	(0.23)	(0.02)	1.21	1.72	(0.30)	(0.10)
18	14-Apr-95	0.97	(0.60)	(0.60)	(1.21)	(0.57)	(0.04)	(0.04)	(0.27)	(0.42)	(0.52)	0.49	(0.07)	0.58	0.75
19	21-Apr-95	1.25	1.05	1.05	3.18	0.98	(0.21)	(0.21)	0.41	(1.31)	0.09	(0.46)	(0.77)	0.70	1.15
20	28-Apr-95	0.40	0.31	0.31	(0.14)	0.31	0.01	0.01	0.43	0.25	(0.12)	(1.08)	1.40	(0.95)	(1.08)
21	05-May-95	1.19	1.00	1.00	(0.61)	1.03	(0.60)	(0.60)	(0.49)	(0.51)	0.14	(0.61)	(1.31)	(0.47)	(0.19)
22	12-May-95	(1.05)	(0.66)	(0.66)	1.30	(0.70)	(0.80)	(0.80)	(0.80)	1.44	(0.04)	(2.27)	0.73	(0.68)	(0.77)
23	19-May-95	(1.44)	0.30	0.30	1.50	0.26	0.19	0.19	(0.08)	(0.17)	(0.20)	0.87	(0.14)	(0.04)	(0.40)
24	26-May-95	2.37	(0.92)	(0.92)	(1.79)	(0.88)	(0.18)	(0.18)	(0.12)	0.34	1.07	(0.20)	(1.42)	(0.71)	(0.57)
25	02-Jun-95	0.61	0.10	0.10	(0.71)	0.12	(1.42)	(1.42)	(1.42)	(1.45)	(0.67)	(1.82)	(0.57)	(0.68)	(0.71)
26	09-Jun-95	(1.65)	0.26	0.26	0.30	0.25	0.06	0.06	0.18	0.73	(0.03)	(0.59)	0.76	0.00	(0.15)
27	16-Jun-95	0.55	0.39	0.39	(0.01)	0.39	(1.00)	(1.00)	(1.09)	(0.67)	(1.03)	(0.90)	(1.12)	(0.48)	(0.62)
28	23-Jun-95	1.84	(2.86)	(2.86)	(6.06)	(2.73)	0.39	0.39	0.15	(1.05)	0.90	0.31	2.36	(0.08)	(0.09)
29	30-Jun-95	(1.82)	0.84	0.84	1.21	0.82	0.20	0.20	0.48	(0.69)	0.09	(0.38)	1.57	0.09	(0.26)
30	07-Jul-95	3.43	(1.19)	(1.19)	(1.56)	(1.16)	1.85	1.85	1.19	1.19	0.81	2.97	2.07	1.38	2.10
31	14-Jul-95	0.71	(0.23)	(0.23)	(0.07)	(0.23)	0.66	0.66	0.10	(0.87)	(0.41)	2.52	(0.37)	(0.17)	(0.22)
32	21-Jul-95	(0.96)	0.79	0.79	2.17	0.74	(0.23)	(0.23)	0.09	0.45	(0.20)	(0.53)	(1.01)	0.08	0.13
33	28-Jul-95	1.60	(0.54)	(0.54)	0.97	(0.57)	(1.06)	(1.06)	(1.14)	(0.65)	(0.49)	(1.40)	(0.47)	(0.69)	(0.87)
34	04-Aug-95	(0.73)	0.20	0.20	1.19	0.17	0.11	0.11	(0.53)	(0.18)	(0.58)	1.34	(0.48)	(0.40)	(0.51)

Screenshot 12: Lookupfile.

A *lookupfile* needs to have (at least) a *return* sheet and an *adjusted* sheet. As explained in Section IX.III, the adjusted file has the adjusted data that is used by the program.

IX.VI.XI BarraReports

	A	B	C	D	E	F	G	H	I	J	K	L
1	Grouping: GICS Industry	Asset ID	Weight (%)	Active Weight (%)	Holdings							
2	by distinct	600	100.00%	0.00%	112,891,755.57							
3	Biotechnology	2	8.16%	8.15%	2,926,980.85							
4	Communications Equipment	5	7.55%	5.42%	6,554,794.07							
5	Commercial Services & Sup	22	7.54%	6.59%	2,772,512.43							
6	Media	36	7.49%	4.89%	4,539,151.12							
7	Aerospace & Defense	9	5.41%	4.48%	312,611.00							
8	Consumer Finance	2	5.38%	5.31%	667,522.58							
9	Health Care Technology	1	5.10%	5.06%	370,113.00							
10	Multiline Retail	5	5.06%	4.56%	17,774,728.82							
11	Insurance	31	4.87%	-1.14%	2,452,094.01							
12	Internet Software & Servic	1	4.76%	4.76%	2,816,684.00							
13	Food Products	17	4.74%	1.18%	3,575,592.73							
14	Pharmaceuticals	12	4.47%	-1.91%	7,513,762.29							
15	IT Services	6	4.32%	4.08%	1,129,080.00							
16	Chemicals	18	4.05%	1.23%	119,302.61							
17	Capital Markets	14	3.87%	0.22%	347,350.00							
18	Distributors	3	2.92%	2.86%	348,952.00							
19	Textiles Apparel & Luxury	12	2.65%	1.50%	312,111.00							
20	Food & Staples Retailing	12	2.63%	0.49%	46,211.00							
21	Software	5	2.62%	2.01%	1,038,462.34							
22	Electric Utilities	12	2.50%	-0.71%	435,065.72							

Screenshot 13: BarraReport.

Most important about this file is that it has three sheets (one for industry, one for industry group, and one for sectors) and that the normal weights are in column C and the active weights in column D.

X VB-code program

Below the VB code is given that underlies the program described in the previous section.

```

Private Sub getEval_Click()
' loads eval sheet of selected factor from evalSheets.xls and
corresponding parameters
Application.ScreenUpdating = False
Application.DisplayAlerts = False

Dim factor As String
factor = Range("N4")
Call getEvalSheet(factor)
Call controls
Range("A3:B65536").ClearContents

Application.ScreenUpdating = True
Application.DisplayAlerts = True
End Sub

Private Sub prepareFactor_click()
' loads factor data from datafile.xls and corresponding
parameters
Application.ScreenUpdating = False
Application.DisplayAlerts = False
Dim factor As String
factor = Range("N4")
Call setParams(factor)
Call pastedata(factor)

Application.ScreenUpdating = True
Application.DisplayAlerts = True
End Sub

Private Sub getEvents_Click()
' prepares data for event selection, regression and results
Application.ScreenUpdating = False
Application.DisplayAlerts = False

Dim lookupfile As String, fileType As Integer
lookupfile = openfilename("Select Lookup file")
Select Case lookupfile
Case "MSCI World Weekly Returns.xls"
fileType = 0
Case "MSCI World Country Weekly Returns.xls"
fileType = 0
Case "MSCI EM Country Weekly Returns.xls"
fileType = 1
End Select

progname = ThisWorkbook.name
Workbooks(progname).Activate

Call PREPARE(fileType)
Call lookup(lookupfile)
Call regress(1)

Call pasteresults
Call regress(2)
Call pasteresults
Call regress(3)
Call pasteresults
Call makeprint
Call eval
Application.ScreenUpdating = True
Application.DisplayAlerts = True
End Sub

Private Sub evalPortfolio_Click()
' evaluates a PF on factor event results
Application.ScreenUpdating = False
Application.DisplayAlerts = False
Dim currentfilename As String '*'
currentfilename = openfilename("Select Portfolio") '*'
Call doScenarios(currentfilename) '*'
Call makeGrouped
Call controls
Range("K21").FormulaR1C1 = "=Grouped!R1C1"
Workbooks(currentfilename).Close
Application.ScreenUpdating = True
Application.DisplayAlerts = True
End Sub

Private Sub resetPF_Click()
' resets all sheets concerning PF evaluation
Application.ScreenUpdating = False
Application.DisplayAlerts = False
Call deletePF
Call deleteAllPF
Range("K21").ClearContents
Application.ScreenUpdating = True
Application.DisplayAlerts = True
End Sub

Private Sub reset_Click()
' resets all
Application.ScreenUpdating = False
Application.DisplayAlerts = False
Call deleteAll
Range("K21").ClearContents
Application.ScreenUpdating = True
Application.DisplayAlerts = True
End Sub

Private Sub savePFresults_Click()
' saves PF results in folder with factor name. storing filename
equals filename input
Application.ScreenUpdating = False
Application.DisplayAlerts = False
Call savePortfolio
Application.ScreenUpdating = True

```

```

Application.DisplayAlerts = True

End Sub

Private Sub ALLPFs_Click()
' evaluates and saves all PFs for 1 factor
Application.ScreenUpdating = False
Application.DisplayAlerts = False
Call analyseAll
Application.ScreenUpdating = True
Application.DisplayAlerts = True

End Sub

Private Sub ALL_Click()
' evaluates and saves all portfolios for all factors and
' saves All PF's sheets in AllResults.xls file
Application.DisplayAlerts = False
Application.ScreenUpdating = False
Call deleteAll
Call allFactors
Application.ScreenUpdating = True
Application.DisplayAlerts = True

End Sub

Private Sub resetAllSheet_Click()
' resets 'All PF's' sheet
Call deleteAllPF
End Sub

Public Sub PREPARE(fileType As Integer)
' Prepare sheet data
Dim startrow As Integer
Select Case fileType
Case 0
startrow = 3 '264 for 2000, 3 for startyear 1995 when
'normal' data
Case 1
startrow = 159 '264 '159 'startyear 1998 due to
incomplete data
End Select
Sheets("Data").Activate
count = countrows(3, 1) 'count number of non-empty rows

' relative or absolute first diff
If Range("M37") = "relative" Then
Range(Cells(4, 3), Cells(count + 2, 3)).FormulaR1C1 =
"=(RC[-1]-R[-1]C[-1])*100/(R[-1]C[-1])"
Else:
Range(Cells(4, 3), Cells(count + 2, 3)).FormulaR1C1 =
"=(RC[-1]-R[-1]C[-1])"
End If

'calculate second differences
Range(Cells(4, 4), Cells(count + 2, 4)).FormulaR1C1 =
"=R[1]C[-1]-RC[-1]"

' copy, paste, order data by second diff
r = 1 'dummy for start row
If startrow <> 3 Then
r = 0
End If
Range(Cells(startrow + r, 1), Cells(count + 2, 4)).Copy
Range("F3").PasteSpecial
paste:=xlPasteValuesAndNumberFormats
Selection.Sort Key1:=Range("I3"), Order1:=xlDescending
Range("C2") = "1st diff"
Range("D2") = "2nd diff"
Range("F2") = "Data ordered by second diff"

Call selectEvents(startrow)
End Sub

Public Sub selectEvents(startrow As Integer)
' selects the events from the sorted data set, using manual
input parameters initial number
' events and boundary.

Sheets("data").Select
Dim numEvents As Integer, bound As Double
numEvents = Range("m22")
bound = Range("m23")
count = countrows(startrow, 1)

' copy negative events and paste in respective sheet
Range(Cells(3, 6), Cells(3 + numEvents - 1, 9)).Copy
Sheets("neg").Activate
Range("A3").Select
Selection.PasteSpecial
paste:=xlPasteValuesAndNumberFormats
' copy positive events and paste in respective sheet
Call controls
Range(Cells(count + 2 - numEvents, 6), Cells(count + 2,
9)).Copy
Sheets("pos").Select
Range("A3").Select
Selection.PasteSpecial
paste:=xlPasteValuesAndNumberFormats

Call check(bound) ' delete incorrectly identified events

End Sub

Public Sub check(bound As Double)
' checks for incorrectly identified events and deletes them
' event is incorrect if first difference is smaller than boundary
For i = 2 To 3
startrow = 3
row = startrow
Worksheets(i).Activate
Do While Cells(row, 1) <> Empty
If Cells(row, 4) > 0 Then
If Cells(row, 3) > -1 * bound Then
j = row & ":" & row
rows(j).delete Shift:=xlUp
row = row - 1
End If
Else
If Cells(row, 3) < bound Then
j = row & ":" & row
rows(j).delete Shift:=xlUp
row = row - 1
End If
End If
row = row + 1
Loop
count = countrows(3, 1)
Call controls
Cells(24 + i, 13) = count
Next

End Sub

Public Sub lookup(ByRef lookupfile As String)
' finds the data in MSCI Weekly Returns matching the selected
event dates

progname = ThisWorkbook.name

startcol = 6 'pasting lookup values starts here
Dim numCols As Integer
numCols = 104

```

```

Header = 2

For i = 2 To 3
    row = 3
    col = 0

    Worksheets(i).Activate
    Cells(Header - 1, 5) = "Level"
    Cells(Header, 5) = "Factor"

    Do While col < numCols
        header naming
        Cells(Header - 1, col + startcol) = "=" & lookupfile &
"jadjusted"!R2C[-4]"
        Cells(Header, col + startcol).FormulaR1C1 = "=" &
lookupfile & "jadjusted"!R3C[-4]"
        lookup
        Do While Cells(row, 1) <> Empty
            Dim c As String
            c = "A" & row 'reference cell
            'perform lookup
            If b Then
                Cells(row, col + startcol).Formula =
"=VLOOKUP(" & c & ",![" & lookupfile &
"jreturns"!$A$4:$DA$3133, " & col + 2 & ",0)"
            Else
                Cells(row, col + startcol).Formula =
"=VLOOKUP(" & c & ",![" & lookupfile &
"jadjusted"!$A$4:$DA$3133, " & col + 2 & ",0)"
            End If
            row = row + 1
        Loop
        col = col + 1
        row = 3
    Loop
Next
Workbooks(lookupfile).Close
Workbooks(progname).Activate
Call controls

End Sub
Sub regress(level As Integer)
' performs regression on returns-factor data and first
difference-factor data
' regression level, e.g. sector/ind group/ industry is chosen
through optionbuttons

    startcol = 2 'set start cell for results
    startcolfac = 6 'first column in lookup results
    Dim factors, numEvents, firstrow, lastrow As Integer

    firstrow = 3 'startrow events

    For s = 2 To 3
        numEvents = 0
        col = startcolfac
        factors = 0
        Worksheets(s).Activate
        numEvents = countrows(3, 1)
        startrow = numEvents + firstrow + 2 'regression results
start here
        row = startrow
        lastrow = numEvents + firstrow - 1

        'count factors
        Do While Cells(firstrow, col) <> Empty
            factors = factors + 1
            col = col + 1
        Loop

        col = startcol
        count = 0
        For i = 0 To factors - 1
            If Cells(1, startcolfac + i) = level Then
                'set correct cell references
                j = (-lastrow - count * 8)
                k = (-firstrow - count * 8)
                Cells(row - 1, col).FormulaR1C1 = Cells(firstrow - 1,
startcolfac + i) 'factor name
                'regression
                If s = 2 Or s = 3 Then
                    Range(Cells(row, col), Cells(row + 4, col +
1)).FormulaArray = _
                        "=LINEST(R[" & j & "]C[" & i + 4 & "]:R[" & k &
"]C[" & i + 4 & "], R[" & j & "]C3:R[" & k & "]C3, TRUE,TRUE)"
                Else: Range(Cells(row, col), Cells(row + 4, col +
1)).FormulaArray _
                        = "=LINEST(R[" & j & "]C[" & i + 4 & "]:R[" & k
& "]C[" & i + 4 & "], R[" & j & "]C4:R[" & k & "]C4,
TRUE,TRUE)"
                End If
                'calculate t-value
                If Cells(row + 1, col) = 0 Or Cells(row + 1, col + 1)
= 0 Then
                    Cells(row + 5, col) = "N/A"
                    Cells(row + 5, col + 1) = "N/A"
                Else: Cells(row + 5, col) = Cells(row, col) /
Cells(row + 1, col)
                    Cells(row + 5, col + 1) = Cells(row, col + 1) /
Cells(row + 1, col + 1)
                End If
                row = row + 8
                count = count + 1
            End If
        Next
    End Sub

Public Function countrows(startrow As Integer, startcol As
Integer) As Integer
' counts and returns the number of rows in a column, specified
by a starting cell: row and column number parameters

    If startrow = 0 Then
        startrow = 1
    End If

    countrows = 0
    Do While ActiveSheet.Cells(countrows + startrow, startcol)
<> Empty
        countrows = countrows + 1
    Loop

End Function
Public Sub deleteAll()
' deletes everything but the original data in 'data' sheet
    Call controls
    Columns("C:I").ClearContents

    Sheets("neg").Activate
    Columns("F:IV").ClearContents
    Range("A3:D65536").ClearContents

    Sheets("pos").Activate
    Columns("F:IV").ClearContents
    Range("A3:D65536").ClearContents

    Sheets("Results").Activate
    Cells.ClearContents

```

```

Sheets("Print").Activate
Cells.Clear
col = col + 3
Next

Sheets("eval").Activate
Range("A5:IV65536").ClearContents
Range("F1:F3").ClearContents
Range("H1:H3").ClearContents
Range("A2").ClearContents

Call deletePF
Call deleteAllPF
Call controls
Range("M26:M27").ClearContents

End Sub
Public Sub deletePF()
' resets all sheets regarding PF evaluation
startsheet = 7
For i = startsheet To startsheet + 2
  Sheets(i).Activate
  Range("A7:O65536").ClearContents
  Range("A1").ClearContents
  Range("H1:H2").ClearContents
  Range("O1").ClearContents
  Range("F4").ClearContents
  Range("A7:O65536").Interior.ColorIndex = 35
Next
Sheets("Grouped").Activate
Range("A7:O19").ClearContents
Range("A1").ClearContents
Range("H1:H2").ClearContents
Range("O1").ClearContents
Range("F4").ClearContents
Range("A7:O19").Interior.ColorIndex = 35
Call controls
End Sub
Public Sub deleteAllPF()
' resets 'All PF's' sheet
  Sheets("All PF's").Activate
  Range("A8:O65536").ClearContents

  Call controls
End Sub

Public Sub pasteresults()
' pastes regression results in 'results' sheet
  Dim rows, startrow As Integer
  startcol = 1
  col = startcol
  b = True
  Sheets("Results").Activate
  Do While b
    If Cells(9, col) = Empty And Cells(9, col + 1) = Empty
    Then
      b = False
      col = col + 1
    Else:
      col = col + 1
    End If
  Loop

  For i = 2 To 3
    Sheets(i).Activate
    rows = countrows(3, 1)
    startrow = rows + 4
    Range(Cells(startrow, 2), Cells(1500, 3)).Copy
    Sheets("Results").Activate
    Cells(8, col).Select
    Selection.PasteSpecial
    paste:=xlPasteValuesAndNumberFormats
    col = col + 3
    Next

  End Sub

  Public Sub controls()
  Public Sub makeprint()
  ' makes a sheet 'Print' that is ready to be read and printed
  controls
  Dim init As Integer, bound As Double, negnr As Integer,
  posnr As Integer, factor As String, firstdiff As String
  init = Range("M22")
  bound = Range("M23")
  negnr = Range("M26")
  posnr = Range("M27")
  factor = Range("A1")
  firstdiff = Range("K4")

  startrow = 5 ' start pasting in this row
  row = 8 ' start copying in this row
  count = 5
  ' copy and paste relevant rows from 'result' sheet
  Do While row < 550
    Sheets("Results").Activate
    j = row & ":" & row + 1
    rows(j).Copy
    Sheets("Print").Select
    Cells(count, 1).Select
    ActiveSheet.paste
    count = count + 2

    Sheets("Results").Activate
    j = row + 4 & ":" & row + 4
    rows(j).Copy
    Sheets("Print").Select
    Cells(count, 1).Select
    ActiveSheet.paste
    count = count + 1

    Sheets("Results").Activate
    j = row + 6 & ":" & row + 6
    rows(j).Copy
    Sheets("Print").Select
    Cells(count, 1).Select
    ActiveSheet.paste
    count = count + 1

    row = row + 8
  Loop
  ' delete unnecessary columns
  Range("A:A").delete
  Range("C:C,F:F,I:I,L:L,O:O").delete

  ' copy and paste parameter data
  Cells(1, 5) = "Init #"
  Cells(1, 6) = init
  Cells(2, 5) = "Bound"
  Cells(2, 6) = bound
  Cells(1, 7) = "neg #"
  Cells(1, 8) = negnr
  Cells(2, 7) = "pos #"
  Cells(2, 8) = posnr
  ' titels etc
  Range("A1") = "REGRESSION RESULTS"
  Range("A2").FormulaR1C1 = factor
  Range("A3").FormulaR1C1 = firstdiff

```

```

Range("k1") = "Slope"
Range("l1") = "Intercept"
Range("k2") = "F-stat"
Range("l2") = "dF"
Range("k3") = "T(slope)"
Range("l3") = "T(icept)"
Range("B4") = "Sector Level"
Range("F4") = "Industry Group Level"
Range("J4") = "Industry Level"
Range("K1:L3").Font.Italic = True

'set font, style, margins, etc
Range("A3:N3").Borders(xlEdgeBottom).LineStyle =
xlContinuous
Range("D4:D235,H4:H235").Borders(xlEdgeRight).LineStyle
= xlContinuous

With ActiveSheet.PageSetup
.LeftMargin = Application.InchesToPoints(0.5)
.RightMargin = Application.InchesToPoints(0.5)
.TopMargin = Application.InchesToPoints(0.5)
.BottomMargin = Application.InchesToPoints(0.5)
.HeaderMargin = Application.InchesToPoints(0.5)
.FooterMargin = Application.InchesToPoints(0.5)
.Orientation = xlLandscape
End With
Cells.Select
Selection.Style = "Comma"
Selection.Font.Size = 8

Range("A5:B235,E5:F235,I5:J235,A1:L3").Interior.ColorIndex =
15

Cells(1, 1).Select
End Sub

Public Sub eval()
' runs through 'print' sheet and checks for each sector slope
and intercept
controls
Dim bound As Double, boundF As Double
bound = Range("m24")
boundF = Range("m25")

Start = 5
finish = 228
count = Start
' copy print sheet
Sheets("Print").Activate
Cells.Copy
Sheets("eval").Select
Cells(1, 1).Select
ActiveSheet.paste
Range("E3") = "Bound t-stat"
Range("F3") = bound
Range("G3") = "Bound F-stat"
Range("H3") = boundF
row = Start

Do While row < finish + 1
For j = 1 To 12
' if t-value<boundary -> set to 0
If Cells(row + 3, j) <> Empty And Abs(Cells(row + 3,
j)) < bound Then
Cells(row + 1, j) = 0
End If
Next
For i = 1 To 6
' if F-value<boundary -> set line to 0

```

```

If Cells(row + 3, i * 2 - 1) <> Empty And Cells(row +
2, i * 2 - 1) < boundF Then
Cells(row + 1, i * 2 - 1) = 0
Cells(row + 1, i * 2) = 0
End If
Next
' only intercept and slope are saved
r = row + 2 & ":" & row + 3
rows(r).delete
row = row + 2
Loop
controls
End Sub

Public Sub getEvalSheet(factor As String)
' loads eval sheet of requested factor from evalSheets.xls
Dim index As Integer
Dim current As String
setParams (factor)
current = ThisWorkbook.name
Workbooks.Open filename:=getCellname("evalSheets")
""\eu.am.abnamro.com\nl01\home\sc6438\Data\STAGE\PROG
RAM\EvalSheets.xls"
Sheets(factor).Activate
Cells.Copy
Workbooks(current).Activate
Sheets("eval").Activate
Cells.PasteSpecial paste:=xlPasteAll
Workbooks("Evalsheets.xls").Close
Call controls
Range("A1") = factor
Range("N4") = factor
End Sub

Public Sub doScenarios(currentfilename As String) '*
' adds 3 sheets in which the scenario results will be shown
Dim scensArray(8) As Integer, w As String
progname = ThisWorkbook.name
Workbooks(progname).Activate

For j = 1 To 8
scensArray(j) = Cells(j + 27, 13)
Next
w = Range("k4")
' set variables
Start = 8 'start row sectors
scens = 4 'row where scenario percentages will be set
startcol = 8 'start column scenarios
Dim numscenN As Integer, numscenP As Integer
numscenN = 4 'number of negative scenarios
numscenP = 4 'number of positive scenarios
count = 228

'make sheet array containing sheet names
Dim sheetsarray(3) As String
sheetsarray(1) = "Sector"
sheetsarray(2) = "Industry Group"
sheetsarray(3) = "Industry"

' for each sheet do:
For t = 1 To 3
' copy and paste from results from eval
Sheets("eval").Activate
Range(Cells(5, 1 + (t - 1) * 4), Cells(count, 4 + (t - 1) *
4)).Copy
Sheets(sheetsarray(t)).Activate
Cells(Start, 1).Select
Selection.PasteSpecial paste:=xlPasteValues

For i = 1 To 8

```

```

' set scenarios
Cells(scens, startcol + i - 1) = scensArray(i)
Next

' compute scenarios
row = Start
Do While Cells(row, 1) <> Empty
  For i = 1 To numscenN + numscenP
    If i < numscenN + 1 Then
      Cells(row, startcol + i - 1) =
"=RC6*(R[1]C1*R4C+R[1]C2)" 'negative events
    Else
      Cells(row, startcol + i - 1) =
"=RC6*(R[1]C3*R4C+R[1]C4)" 'positive events
    End If
  Next
  Cells(row, 3).ClearContents 'delete spurious name
  row = row + 2
Loop

Cells(1, 1).Select
Call findweights(currentfilename, w)
'*Call total(row - 2)
Dim pf As String
pf = Left(currentfilename, Len(currentfilename) - 4)
Range("A1") = pf
Range("H1") = "=Data!R4C14"
Range("H1") = Range("H1").Value
Range("H2") = "=Data!R37C13"
Range("H2") = Range("H2").Value
Range("F4") = "=Data!R4C11"
Range("F4") = Range("F4").Value
If Range("H2") = "relative" Then 'relative vs absolute
  Range("O1") = "%"
Else: Range("O1") = "bp"
End If
Next
Workbooks(progname).Activate
End Sub

Public Sub findweights(currentfilename As String, w As String)
' finds active weights of respective sector/ind group/industry
  Dim row As Integer, currentsheet As String, sheetname As
String
  startrow = 8 'start row for sectors
  If w = "active" Then 'column in portfolio file that contains
active/nonactive weights
    col = 4
  Else: col = 3
  End If

  row = startrow
  currentsheet = ActiveSheet.name

  If currentsheet = "Sector" And Cells(startrow, 1).Value =
"The World Index" Then ' no active weight available for world
index
    row = startrow + 2
  End If

  If currentsheet = "Industry Group" Then
    currentsheet = "IndustryGroup"
  End If

  MsgBox currentsheet
  sheetname = getCellname(currentsheet) 'sheet name as in
portfolio file exported from barra

  'lookup active weights

```

```

Do While Cells(row, 1) <> Empty
  c = "A" & row 'set lookup cell
  Cells(row, 6) = "=VLOOKUP(" & c & "," & '[' &
currentfilename & "]" & sheetname & "!$A$3:$D$630, " & col
& ",0)"
  Cells(row, 6) = Cells(row, 6).Value
  If IsError(Cells(row, 6)) = True Then
    Cells(row, 6) = 0
    Cells(row, 6).Interior.ColorIndex = 3
  End If
  row = row + 2
Loop
Calculate
Call colors(2)
End Sub

Public Sub total(row As Integer)
' computes total portfolio risk
  totalrow = 6 'row where total risk will be computed
  For i = 8 To 16
    Cells(totalrow, i) = "=sum(R7C:R" & row & "C) "
  Next
  Cells(totalrow, 6) = "=sum(R8C:R" & row & "C) "
End Sub

Public Sub colors(i As Integer)
' sets colors in sheets
  startrow = 8
  row = startrow
  Do While Cells(row, 1) <> Empty
    For j = 8 To 16
      If Abs(Cells(row, j)) > 0 Then
        Cells(row, j).Interior.ColorIndex = 19
        Cells(row, 1).Font.Bold = True
      End If
    Next
    row = row + i
  Loop
End Sub

Public Function openfilename(text As String) As String
' opens file that is selected from pop-up menu
  fileToOpen = Application.GetOpenFilename("Excel Files
(*.xls), *.xls", , text)
  Workbooks.Open filename:=fileToOpen
  openfilename = ActiveWorkbook.name
End Function

Public Sub pastedata(factor As String)
' picks the correct column from 'datafile.xls', copies and pastes
  Dim freq As String, s As Integer
  freq = Range("M36")
  startrow = 3
  If freq = "weekly" Then
    endrow = 628
  Else:
    endrow = 1567
  End If

  Range("A3:B65536").ClearContents
  progname = ThisWorkbook.name
  fileToOpen = getCellname("datafile")
""\eu.am.abnamro.com\nl01\home\sc6438\Data\STAGE\PROG
RAM\datafile.xls"
  index = getIndex(factor) ' get column index for factor

  Workbooks.Open filename:=fileToOpen
  Workbooks("datafile.xls").Activate
  Sheets(freq).Select
  If factor = "Euribor 3m" Or factor = "Euribor 12m" Then
    startrow = 211
  End If

```



```

'copy dates
Range(Cells(startrow, 1), Cells(endrow, 1)).Copy
Workbooks(progname).Activate
Call controls
Range("A3").PasteSpecial
paste:=xlPasteValuesAndNumberFormats
'copy data
Workbooks("datafile.xls").Activate
Range(Cells(startrow, index), Cells(endrow, index)).Copy
Workbooks(progname).Activate
Call controls
Range("B3").PasteSpecial
paste:=xlPasteValuesAndNumberFormats

Cells(1, 1) = factor
Cells(1, 1).Font.Bold = True
Workbooks("datafile.xls").Close
End Sub
Public Function getindex(factor As String) As Integer
' returns column index for chosen factor. index corresponds
with column number in datafile.xls
Call controls
Dim col As Integer
factor = Replace(factor, " ", "") 'remove spaces from factor
name
col = Range(factor).Column
getindex = Cells(25, col)
End Function

Public Sub setParams(factor As String)
' set parameters for the factor that was chosen
Call controls
Dim col As Integer
factor = Replace(factor, " ", "") 'remove spaces from factor
name
col = Range(factor).Column
Range("M24") = 1.65 'tstat
Range("M25") = 2.6 'fstat
Range("M22") = Cells(26, col) 'init #
Range("M23") = Cells(27, col) 'bound 1diff
Range("M28") = Cells(28, col) 'scenarios
Range("M29") = Cells(29, col)
Range("M30") = Cells(30, col)
Range("M31") = Cells(31, col)
Range("M32") = Cells(32, col)
Range("M33") = Cells(33, col)
Range("M34") = Cells(34, col)
Range("M35") = Cells(35, col)
Range("M36") = Cells(36, col) 'data frequency
Range("M37") = Cells(37, col) 'first difference

End Sub

Public Sub makeGrouped()
' makes the grouped sheet
' new sheet, paste data and layout
Sheets("Industry").Select
Range("A1:O7").Copy
Sheets("Grouped").Select
Cells(1, 1).Select
ActiveSheet.paste
Range(Cells(3, 1), Cells(4, 4)).ClearContents

Call addsectors 'put sectors in sheet
Call compute 'compute sector changes

Call colors(1) 'highlight non-zero results
Cells(1, 1).Select
End Sub

Public Sub addsectors()
' put sectors in sheet
Start = 8
Cells(Start, 1) = "Energy"
Cells(Start + 1, 1) = "Materials"
Cells(Start + 2, 1) = "Industrials"
Cells(Start + 3, 1) = "Consumer Discretionary"
Cells(Start + 4, 1) = "Consumer Staples"
Cells(Start + 5, 1) = "Health Care"
Cells(Start + 6, 1) = "Financials"
Cells(Start + 7, 1) = "Information Technology"
Cells(Start + 8, 1) = "Telecommunication Services"
Cells(Start + 9, 1) = "Utilities"
End Sub

Public Sub compute()
' compute percentage change per sector, by adding up values
of all industries in sector
' NOTE: #rows per sector is static
Dim count(10) As Integer 'number of industries in sector
count(1) = 2 'energy
count(2) = 5 'materials
count(3) = 13 'industrials
count(4) = 11 'cons disc
count(5) = 6 'cons staples
count(6) = 3 'health care
count(7) = 3 'financials
count(8) = 6 'inform techn
count(9) = 2 'telecom
count(10) = 4 'utilities
Start = 8
aw = 6
row = Start
r = Start
For i = 1 To 10
For col = 8 To 15
' summing industry results
Cells(r, col) = "=sum(Industry!R" & row & "C" & col &
":R" & row + count(i) * 2 - 1 & "C" & col & ")"
Next
' summing active weights
Cells(r, aw) = "=sum(Industry!R" & row & "C" & aw &
":R" & row + count(i) * 2 - 1 & "C" & aw & ")"

r = r + 1
row = row + count(i) * 2
Next
End Sub

Public Sub makeAllSheet(count As Integer)
' copies relevant info to All PF's sheet from TOTAL outcomes
per PF
Sheets("Industry").Activate
Range("H6:O6").Copy
Sheets("All PF's").Activate
Cells(8 - 1 + count, 8).PasteSpecial xlPasteValues
Sheets("Industry").Activate
Range("A1").Copy
Sheets("All PF's").Activate
Cells(8 - 1 + count, 1).PasteSpecial xlPasteValues
Range("A1") = "=Data!R1C1"
Range("A1") = Range("A1").Value
Range("O1") = "=Industry!R1C15"
Range("O1") = Range("O1").Value
Range("A4") = "=Data!R4C11"
Range("A4") = Range("A4").Value

End Sub

Public Sub savePortfolio()

```



```

' saves portfolio results in factor folder with corresponding
name
  Dim pfname As String, pfpath As String
  factor = Range("A1")
  pf = Range("k21")
  pfpath = getCellname("pfReports") & factor & "\" & pf & "
& factor & ".xls"

""\eu.am.abnamro.com\nl01\home\sc6438\Data\STAGE\PROG
RAM\portfolio reports\" & _
  factor & "\" & pf & " " & factor & ".xls"

  Sheets(Array("Sector", "Industry Group", "Industry",
"Grouped")).Copy
  ActiveWorkbook.SaveAs filename:=pfpath
  ActiveWorkbook.Close

End Sub

Public Sub analyseAll()
' analyses all portfolios found in folder for given factor
  Dim pfname As String, dirname As String, i As Integer,
currentfile As String
  currentfile = ActiveWorkbook.name
  dirname = getCellname("barraReports")
""\eu.am.abnamro.com\nl01\home\sc6438\Data\STAGE\PROG
RAM\test\"
  With Application.FileSearch 'search specified folder for .xls
files
    .LookIn = dirname
    .SearchSubFolders = True
    .filename = ".xls"
    .MatchTextExactly = True

    If .Execute(SortBy:=msoSortByFileName,
SortOrder:=msoSortOrderAscending) > 0 Then

      'MsgBox "There were " & .FoundFiles.count & " file(s)
found."

      Call deleteAllPF

      For i = 1 To .FoundFiles.count
        'pfname = Right(.FoundFiles(i), Len(.FoundFiles(i)) -
Len(dirname) - 8) 'aanpassen!!
        Workbooks.Open filename:=.FoundFiles(i)
        pfname = ActiveWorkbook.name
        Workbooks(currentfile).Activate

        Call deletePF
        Call doScenarios(pfname)
        Call makeGrouped
        Call controls
        Range("k21").FormulaR1C1 = "=Grouped!R1C1"
        Call savePortfolio
        Call makeAllSheet(i)

        Workbooks(pfname).Close
      Next i
      'copy scenarios
      Sheets("Industry").Activate
      Range("H4:O4").Copy
      Sheets("All PF's").Activate
      Cells(4, 8).PasteSpecial xIPasteValues

    Else
      MsgBox "There were no files found."
    End If
  End With

  Exit Sub

End If
End With

End Sub

Public Sub allFactors()
' analyses all portfolios for all factors
  Dim factor As String, i As Integer

  i = 40
  'Do While Cells(i, 14) <> Empty
  For i = 44 To 53
    Call controls
    factor = Cells(i, 14)
    'MsgBox factor
    Call getEvalSheet(factor)
    Call analyseAll
    Call copyAllSheet(factor)
    Calculate
    'i = i + 1
  'Loop
  Next
  controls
End Sub

Public Sub copyAllSheet(factor As String)
' copies ALL sheet to AllResults.xls file which saves ALL sheets
  Dim currentfile As String, allFile As String

  currentfile = ActiveWorkbook.name
  Workbooks.Open filename:=getCellname("AllResults")
""\eu.am.abnamro.com\nl01\home\sc6438\Data\STAGE\PROG
RAM\portfolio reports\ALL.xls"
  allFile = ActiveWorkbook.name
  Workbooks(currentfile).Activate
  Sheets("All PF's").Select
  Cells.Copy
  Workbooks(allFile).Activate
  Sheets(factor).Select
  Cells(1, 1).Select
  ActiveSheet.paste
  ActiveWorkbook.Save
  ActiveWorkbook.Close
  Workbooks(currentfile).Activate

End Sub

Public Function getCellname(pathname As String) As String
' gets path to file or folder
  sheetname = ActiveSheet.name
  Call controls
  getCellname = Range(pathname)
  Sheets(sheetname).Activate

End Function

```