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BASIC REPORT

SYSTEMATISATION OF ECONOMIC RISKS THROUGH GLOBAL ENVIRONMENTAL PROBLEMS

A THREAT TO FINANCIAL MARKETS?

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Foreword

The media regularly carry features on widely publicised global environmental problems, such as the greenhouse effect, the hole in the ozone layer or soil acidification. In addition to these «headline» ecological themes, there are a number of other less well-known problems such as hormone-disrupting chemicals, the loss of fertile farmlands, or the dramatic shortage and pollution of water in Asia[1], all of which could have serious economic consequences in the next century. As far as banks and insurance companies are concerned, these problems already pose *environment-induced economic risks*.

This study puts forward the thesis that environment-induced economic risks have a different structure from the risks that banks and insurers traditionally face. These institutions therefore need to adapt their risk management instruments accordingly, and this is another thesis of this study.

The study aims to provide a simple introduction to the problems concerning the systematisation of environment-induced economic risks. It does not attempt to examine the underlying concepts of portfolio theory in particular: readers seeking more information on this topic should refer to the specialist literature.

The final version of this study has benefited from valuable discussions and suggestions for improvement from a number of people. The author would especially like to thank Stefan Schaltegger of the University of Basel, and Erol Bilecen, Christoph Butz, Bernhard Furrer and Andreas Knörzer of Bank Sarasin & Co.

[1] Cf. FIGGE 1998.

1 Introduction

Assessing companies' future prospects is one of the key tasks performed by banks. For example, they have to determine a company's value when rating its creditworthiness or deciding whether it offers a worthwhile investment. The financial assessment of a company's value concentrates on two main aspects:

- expected returns and
- expected risks[2]

Environmental factors can impact on both these aspects, as shown in a previous study.[3] The present study concentrates on the impact environmental aspects have on investment risks, referred to throughout this study as environment-induced economic risks.

Do environmental risks erode a company's value?

In practice it is often argued that greater environmental risks are generally a cause for concern. It is frequently asserted that a company's value is eroded by environment-induced risks. But such a generalised view of the problem fails to take into account the complexity of environmental risks. As this study shows, the most important factor is not so much the scale of risk or the probability of it occurring, but rather its composition. The main point to remember is that a change in the composition of environmental risks does not necessarily lead to an overall deterioration in loss experience. If, as a result of environmental problems, the interdependencies between the occurrence of individual risks increase without any change in the actual probability of occurrence, loss experience expectations may in fact improve. A change in the composition of risks may mean that risk management instruments become less effective. This is exactly the threat posed by the economic risks induced by global environmental problems.

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[2] Here it is assumed that the company is valued on the basis of its potential earnings capacity.

[3] Cf. Schaltegger / Figge 1998.

Banks' economic role: risk transformation

Professional risk management is particularly important for businesses such as banks and insurers whose economic role is risk transformation. As far as business priorities go, effective risk management is one of the key success factors for these companies. Both from a commercial and (macro)economic viewpoint, it is disconcerting to find environmental risks being discussed with very little differentiation of the individual issues involved.

2 Risks in investment decisions

Risks erode returns. This is something recognised by both decision-making theory and portfolio theory.[4] While the former provides guidelines on how to manage risks effectively in decision-making situations, portfolio theory allows conclusions to be drawn about the simultaneous handling of a large number of individual risks contained in a portfolio.[5] The main thing is to establish the relationship between the desired return and the expected risk.

Every risk is an opportunity, but every opportunity is also a risk

A risk is always present if the actual yield turns out to be different (greater or smaller) than the expected return.[6] When a stock fails to meet its price target as a result of environmental factors, this presents an environment-induced economic risk. Strictly speaking, there is also a risk if the share price climbs higher than expected. The possibility of achieving a better return than expected is often described as an opportunity. The more the potential returns diverge and the less likely it is that the desired return will actually be achieved, the greater the risk. The risk is measured in statistical terms by a spread factor, usually known as the variance (see also Figure 1). The narrower the spread, the smaller the risk.

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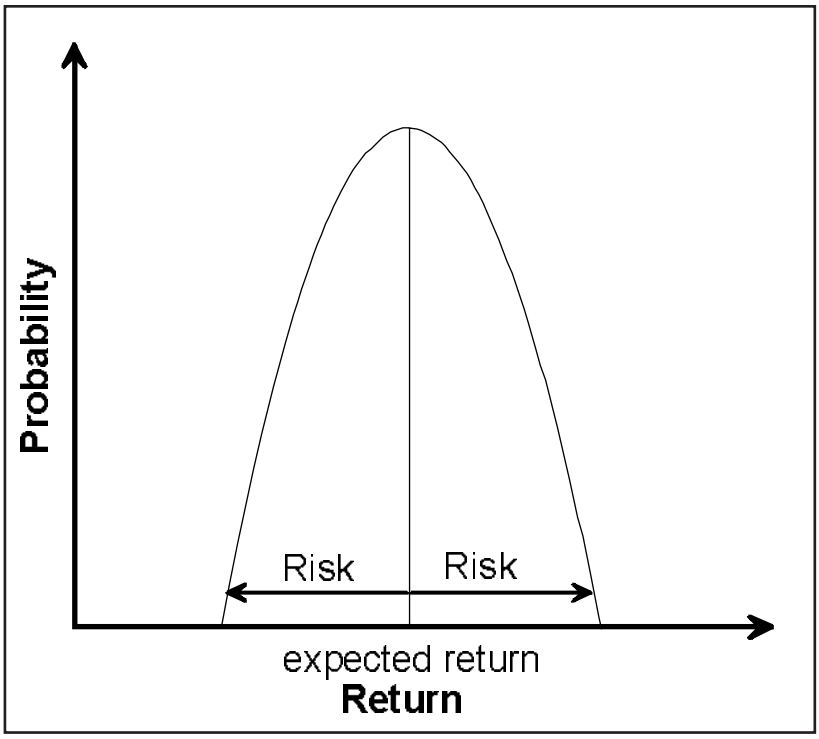
[4] This assumes risk-averse investors, as usually found in practice.

[5] For decision-making and portfolio theory see GÄFGEN 1974, and MARKOWITZ 1959.

[6] If there is a strong chance that the return will be higher than expected, the risk can be described as an opportunity as well. For most people, however, the term «risk» usually implies a result that is worse than expected. Strictly speaking the risk could turn out to be positive or negative. In what follows, however, we always use the term «risk» in the first sense, as intuitively understood by most people.

Figure 1:
Risk in terms of spread



If the only difference between two investment alternatives, say Share A and B, is their associated risk, and if the riskier investment A promises a higher return, the difference between A and B (the one with a lower rate of return) is known as the risk premium. Investors are obviously attracted to alternatives where the risks are the same but returns are higher. All other aspects are dominated by the investor's willingness to take risks. It is fair to assume that most players in the market, such as investors, are averse to risks, i.e. they try to avoid risks where possible. Put another way, they are only willing to take risks on board in return for a reasonable risk premium. When discussing environment-induced economic risks, people often fail to fully examine their specific characteristics. This hypothesis is supported by the fact that an implicit assumption is generally made that it is possible to counteract the effects of environment-induced economic risks with existing risk management instruments, by simply adjusting the risk premiums for example. There is however a strong case for arguing that the only way to respond to environment-induced economic risks - as opposed to other traditional risks - is to modify

the instrument mix. If necessary one has to resort to other risk management instruments. The ideal composition of this instrument mix depends on the situation-specific characteristics of the risks, not on their scale. This aspect is discussed in the next section.

3 Risk characteristics

One of the most important aspects for the characterisation of environmental risks described in this chapter is the differentiation of risks according to the decision period and their interdependencies. The former differentiation is applied mainly in decision-making theory, while the latter is employed primarily in portfolio theory.

3.1 Differentiation by decision period

Relatively few decisions are made on the basis of comprehensive information. If there is insufficient information to reach a decision, this can present a risk. The risk can also be described as an uncertainty, or pre-decision risk. On the other hand, most investors are exposed to a general risk of failure, even if they are in possession of complete information when making their decisions. This risk is classed as a post-decision risk.[7] It is commonly assumed that only the probability of the post-decision risk can be accurately determined: for pre-decision risks, the best one can do is make assumptions about probability.[8] If there is reliable statistical information about the probability of a particular risk occurring, and if it is safe to assume that the probability is unlikely to change in future, this can be classified as a post-decision risk. «Traditional» environmental incidents frequently have this sort of post-decision character - the accident of the oil tanker Exxon Valdez in 1989 is a good example. Even if accidents involving tankers are fortunately very rare, insurance companies are able to estimate the probability of them occurring. By contrast, new types of environmental risks for which no loss history exists often tend to demonstrate more of a pre-decision character (uncertainty). The use of high-risk innovative technologies frequently entails a pre-decision risk. The future importance of

[7] For the differentiation of risk and uncertainty after a decision is made, see MAG 1980, p. 479f.

[8] This classification can be attributed to KNIGHT 1921, p. 197ff.

fuel cells and solar energy is a good example of this uncertainty.[9] If the costs of solar energy fall dramatically, as predicted by some industry experts, they could turn out to be «disruptive technologies» that sweep aside traditional forms of power generation and pose a threat to them.

3.2 Differentiation by interdependencies

Individual environmental risks are only of minor interest to investors prepared to take a number of different risks at the same time. As far as they are concerned, the following two questions are much more important:

1) How high is the expected return and the predicted risk of the entire portfolio during each defined time period?

2) How high is the expected return at the end of the investment period and how great the risk of the actual return being higher or lower than expected?

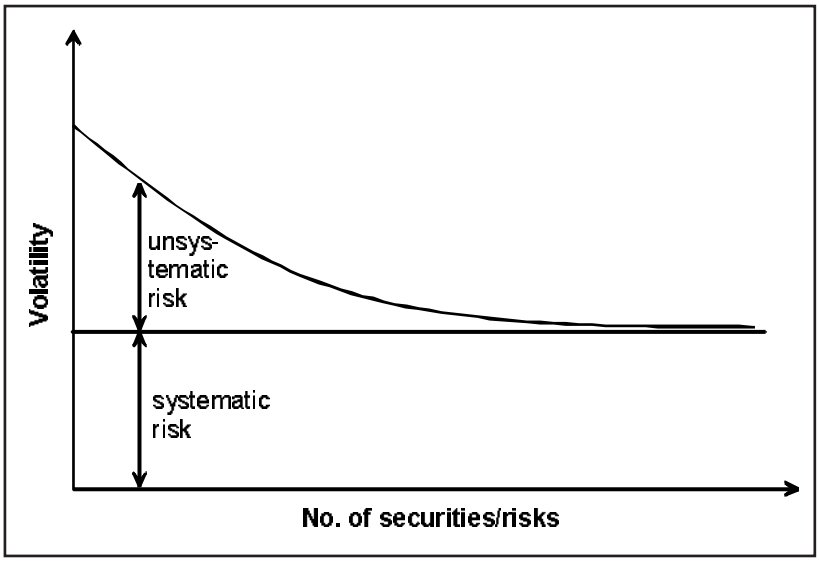
The risk associated with a portfolio of stocks over a given time period, such as one year, depends on the one hand on the volatility of the individual stocks and on the other on the interdependencies between risks. If two risks are interdependent, they are described as systematic, or unsystematic if they have no interdependency. If, for example, two different stocks respond to the news of tougher environmental regulations by similar advances in share price, it shows that there may well be an interdependency. If all - or at least most - shares in a portfolio respond the same to such news, this will have an impact on the return achieved by the entire portfolio. In this case the individual risks associated with the stocks contribute to the overall risk of the portfolio and are of interest to investors. Here we can speak of a horizontal systematology, i.e. a systematic relationship

[9] See also Figge / Butz 1998 on solar energy.

between the individual risks of a portfolio. By contrast, most environmental incidents are examples of risks that are not very systematic in nature. This distinction is important to the extent that the significance of unsystematic risks for the portfolio declines if there are more individual risks in the portfolio (see also Figure 2). One way of putting this is that the unsystematic risk is eliminated through diversification.[10] The systematic risk, on the other hand, continues to apply even when a portfolio is put together. Since the unsystematic risk can be eliminated through diversification, it is usually assumed that the risk is not compensated by the capital market.

[10] Diversification as a risk management instrument is examined in more detail later on.

Figure 2: Unsystematic/ systematic risks in portfolios

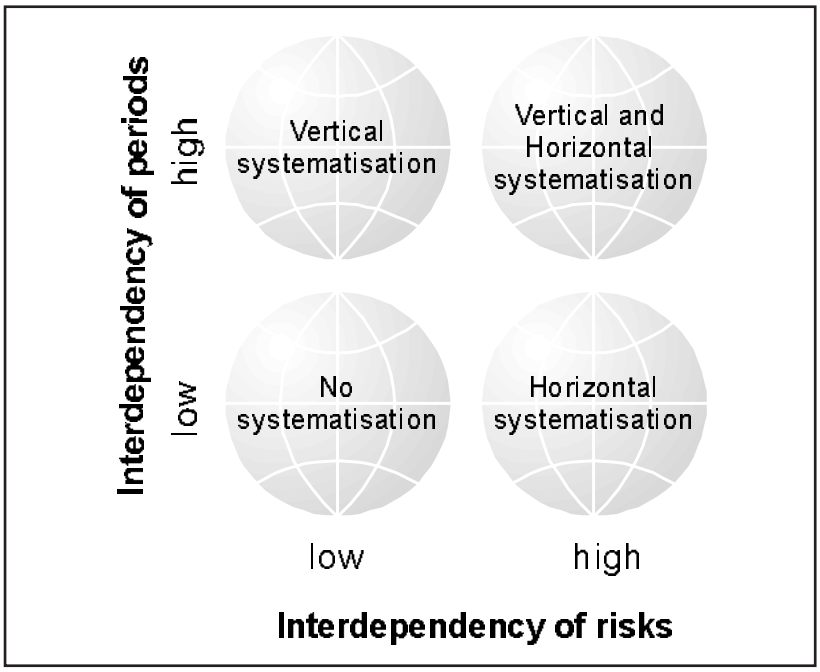


The main focus of interest has traditionally been on how well stocks in the same portfolio perform in relation to each other over a given period. The first question is therefore: How does Share A perform when Share B suffers a 5% decline in value, for example? But there's a second question that is of particular interest to investors, and subsequently to banks as well: How does share A or Portfolio A perform in the second period if it has already lost, say, 5% of its value in the first period? This interrelationship is not usually discussed within the context of systematic risks.[11] In order to measure this aspect, we have to look at how the shortfall risk develops in relation to the observation period. The shortfall risk defines how likely it is that a minimum yield (e.g. 2% p.a.) will not be achieved. The general principle is: the longer the observation period, the lower the shortfall risk. This can be attributed to the fact that an exceptionally good performance during one period may possibly be cancelled out by a particularly bad performance in the next. It is interesting to note that both theory and practice tend to overlook this relationship between performance over consecutive periods.

[11] One reason for this could be that it is generally assumed that there are no interdependencies between the price performances of individual periods if considered over the longer term.

Here too a distinction can be made between systematic and unsystematic risks. For more effective differentiation, these risks are referred to as vertically systematic. The performance of a stock market over a given period can, for example, be partly explained by the economic cycle. It is fair to assume that these effects can to some extent be mitigated through diversification, i.e. by selecting a sufficiently long observation period (e.g. 10 years). It is therefore difficult to eliminate the risk posed by the economic cycle over a one-year time frame, but much easier for longer periods such as 10 years. This can lead to a «double» systematisation process which is illustrated in Figure 3.

Figure 3:
Vertical and horizontal systematisation



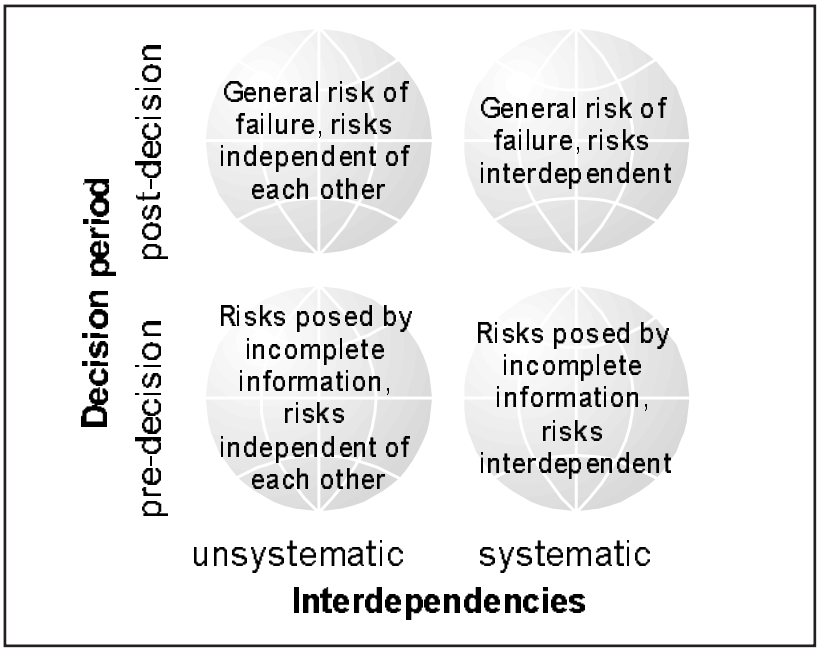
As far as environmental problems are concerned, all risks are both vertically and horizontally systematic if they impact on each individual period over a long time frame and also if their influence extends to many different sectors and regions. This study argues that this is certainly true for most global environmental problems. Later on we take a closer look at the example of climate change to illustrate this. In practice there are no purely systematic and unsystematic risks, or exclusively pre-decision

and post-decision risks. A risk usually combines all these characteristics to varying degrees. As far as the use of risk management instruments is concerned, we are mainly interested in the extent to which a risk is systematic, and pre- or post-decision.

3.3 Development of a risk matrix

It makes sense to develop the differentiation process just described into a risk matrix, as shown in Figure 4, so as to facilitate the classification of risks on the basis of their characteristics.

Figure 4:
Risk matrix



4 Risk management instruments

As we said earlier, risk management is vital for the commercial success of banks and insurers, and they use a range of instruments for this purpose. Here we assume that the banks in question merely act as transformers of risk, i.e. they are unable to eliminate the risks as such. This would appear to be a realistic assumption on the whole, particularly as far as global environmental problems are concerned[12]. Ultimately all the instruments available for risk management can be classified as one of three basic types[13]:

- Information
- Diversification
- Reserve accumulation

Information instruments

The role of information instruments is to reduce the uncertainty that exists prior to making a decision, by improving the quality of information available. This instrument is therefore suitable for dealing with pre-decision risks. Banks, for example, attempt to gain a competitive advantage over rivals through new and better information and through superior analysis of information. These activities are concentrated in the period prior to making the decision, e.g. before granting a loan or purchasing stocks.[14] This is therefore a pre-decision instrument. Diversification and reserve accumulation, on the other hand, are used to attenuate the consequences of the risks assumed, i.e. for risk mitigation.

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[12] This does not imply that banks cannot - and should not - press for solutions to be developed for global environmental problems.

[13] For these instruments, see for example MAG 1980, p. 482ff. and 491f. One often hears of insurance on behalf of a third party and self insurance in this context. But the three instruments in question are ultimately used to insure risks. Our analysis therefore limits itself to the three instruments in question.

[14] An information instrument can of course be used after a decision is made, if there is an opportunity to «think over» the decision. This is often the case when purchasing shares, for example. If an investor is faced with the decision of whether to hold or sell a new security, this is of course a new decision. In this case, information instruments serve to reduce the pre-decision uncertainty.

Diversification

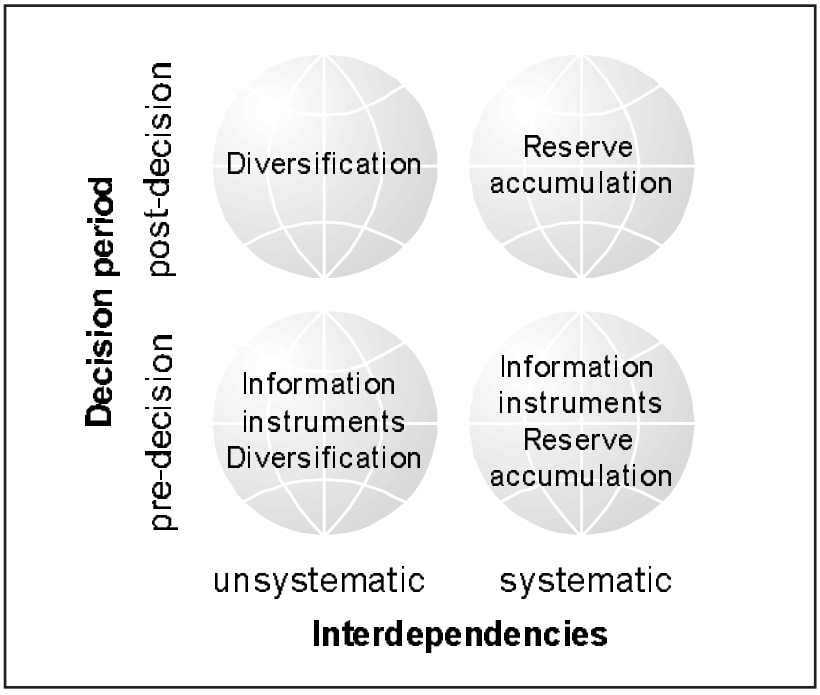
The diversification instrument, as already explained in the section on the characterisation of risks, is based on the idea that the volatility of individual risks created by combining many risks in the same portfolio can be swapped for the virtual security of such a portfolio. Many investors are unable to put together their own portfolio, however, so they pay a premium to transfer their risk to another financial agent that looks after diversification for them. A risk-averse investor, for example, can hand over his money to a bank that is just as risk averse and can use the money to finance higher risk investments. The risk is removed both for the investor and for the bank. One of the prerequisites for a risk to be eliminated through diversification is that the collective risks must all be unsystematic. A portfolio that contains exclusively systematic risks is ultimately just as volatile as the risks it is made up of. It is impossible for a bank to eliminate such a systematic risk for its clients through diversification. In order to remove the unsystematic risk through diversification, there must be an adequate number of shares in a portfolio. The remaining horizontal systematic risk can in some circumstances be reduced by selecting a sufficiently long observation period, e.g. one that stretches across an entire economic cycle. If this strategy is chosen, the investor takes a higher risk during each individual period in the expectation that the risks specific to each period will be balanced out over the entire observation period. The shortfall risk already mentioned declines as the observation period gets longer.

Reserve accumulation

The instrument *reserve accumulation* can in theory be used in all the situations just described. Reserves are the portion of assets set aside to cover possible losses. The reserves must be built up to a level that matches the risk they are supposed to cover. Opting for this instrument is a form of deliberate risk-taking. But if a large number of unsystematic risks are bundled together, diversification is achieved in any case, so there is no need for reserves as an extra form of protection. They would be superfluous, and ultimately inefficient from an economic viewpoint. In such a situation an investor would not have any risk exposure at all - even

though he had taken out several risky investments. One particularly interesting point is the amount of reserves to be set aside for each period. For the borderline case of purely systematic risks, this level is the sum of all the maximum potential losses associated with each individual risk. The question is therefore: If a loss occurs, are there sufficient reserves to pay for every single loss? If a risk is completely unsystematic and there is a sufficient number of risks in the portfolio, there is no need to set aside any reserves. The risks are eliminated by diversification and the portfolio as a whole will definitely produce the expected return. For cases that fall between purely systematic and purely unsystematic risks, the rule is that reserves must be high enough to cover the maximum possible losses occurring simultaneously. It must be noted that the level of reserves to be accumulated does not depend on the probability of a loss occurring. For an investor who puts his money in equities, the reserves represent part of his investment that he is prepared to lose if the risk materialises. An investor that pursues this strategy can therefore be labelled a «risk-taker». The instruments described can be positioned on our risk matrix as shown in Figure 5.

Figure 5: Classification of risk management instruments



5 Characteristics of environment-induced economic risks - Example: climate change

To find out how best to manage environment-induced economic risks, we first need to determine where to position the risks on our risk matrix. This task is made more difficult by the fact that one of the main features of pre-decision risks is that only a small amount of information is available about them. Economic risks caused by global environmental problems in particular show a high pre-decision element, since environmental and environment-related information is often not concerned with price (which makes it difficult to incorporate into financial decisions), is very fast moving, and carries a big element of uncertainty.[15] Assessing the type, scale, probability and regional distribution of risks arising from environmental problems is often a difficult task. A number of divergent forecasts usually exist at the same time. Despite intensive research, for example, there are still no clear and undisputed forecasts about what losses we can expect when and where as a result of the greenhouse effect, nor is it possible to establish the probability of the various scenarios occurring.[16] This is of course attributable to the complexity of the underlying problems. Sceptics always point to the fact that the Intergovernmental Panel on Climate Change (IPCC) has already revised its forecasts for the expected rise in global temperature several times.[17] Other critics even dispute the relationship between carbon higher dioxide concentrations in the atmosphere and global warming.[18] On the other hand the IPCC also predicts that the greenhouse effect could eventually lead to deforestation, a decline in agricultural production and a rise in the sea level

[15] Compare with features of environmental and environment-related information, SENN 1986, p. 71f.

[16] An overview of unresolved research questions can be found in VOLZ et al. 1998.

[17] Cf. also KRAUTHAMMER 1997.

[18] Cf. also BOLCH/LYONS 1997.

of up to 90 centimetres over the next 100 years.[19] It also warns that the number of malaria cases worldwide will increase by 80 million, and that mosquitoes carrying the disease could spread to parts of Southern Europe as well.[20] Initially the IPPC predicted a lower incidence of storms for Europe, but recent studies now show that the trend is expected to move in exactly the opposite direction.[21]

Risks not in spite of, but because of inadequate information

In conclusion it may be said that as far as financial markets are concerned, the risks associated with the greenhouse effect or any other environmental problem do not arise in spite of incomplete information but because of it. Anyone who argues that environment-induced economic risks are of no concern to financial markets because there is too little information about them, fails to realise that they are actually important to financial markets precisely because we know too little about them.

Systematic character

The economic risk associated with environmental problems also has a heavily *systematic* character. This applies not only to the systematic relationship between individual risks, but also between individual periods. Control measures taken in response to the greenhouse effect could, for example, result in environment-induced economic risks of a very systematic nature. One of the most likely control measures could be an energy tax or a levy on CO_2 emissions.[22] It is worth noting here that there is not a single economy or sector that does not contribute directly or indirectly to the greenhouse effect through energy consumption or CO_2

[19] Compare with more recent forecasts, which do not reflect the most pessimistic estimates, e.g. «Global Warming Forecast Is for Slower Rate Than Previously Feared» from Washington Post news agency, 25.10.95.

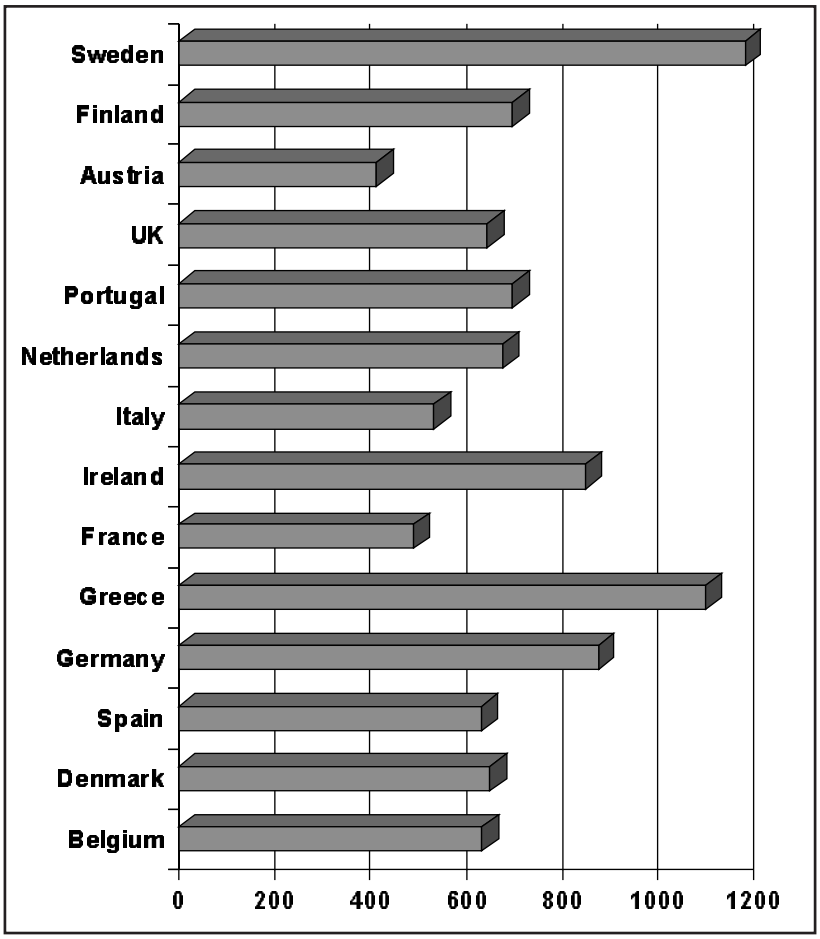
[20] Cf. «UN Global Warming» news agency report by the Associated Press, 10.07.96.

[21] Cf. Dlugolecki 1996, p. 73f.

[22] See also Schaltegger / Figge 1998, p. 31ff.

emissions. The next figure illustrates this by showing the level of carbon dioxide emissions for each of the 15 EU member states as a percentage of their gross domestic product (GDP).

Figure 6: Carbon dioxide emissions in tonnes per USD million of GDP (1990, adjusted for purchasing power)[23]



Horizontal systematisation

As we already said, carbon dioxide is not just emitted by every economy, but by every industrial sector as well. The only difference is in how much they contribute to the greenhouse effect. If the potential risks associated with environmental problems do become reality, this would undoubtedly affect both

[23] Carbon dioxide emissions taken from Corinair 1990. GDP figures taken from Switzerland's official statistics, *Statistisches Jahrbuch der Schweiz*.

a wide section of the overall population and the national economy. This supports the assumption that risks have a heavily *systematic* character. If, for example some of the more dramatic forecasts about the greenhouse effect turn out to be accurate, we have to realise that all coastal regions could be affected, storms will occur more frequently, and malaria will not only increase in the regions where it is already prevalent but will spread to new areas as well.

Vertical systematisation

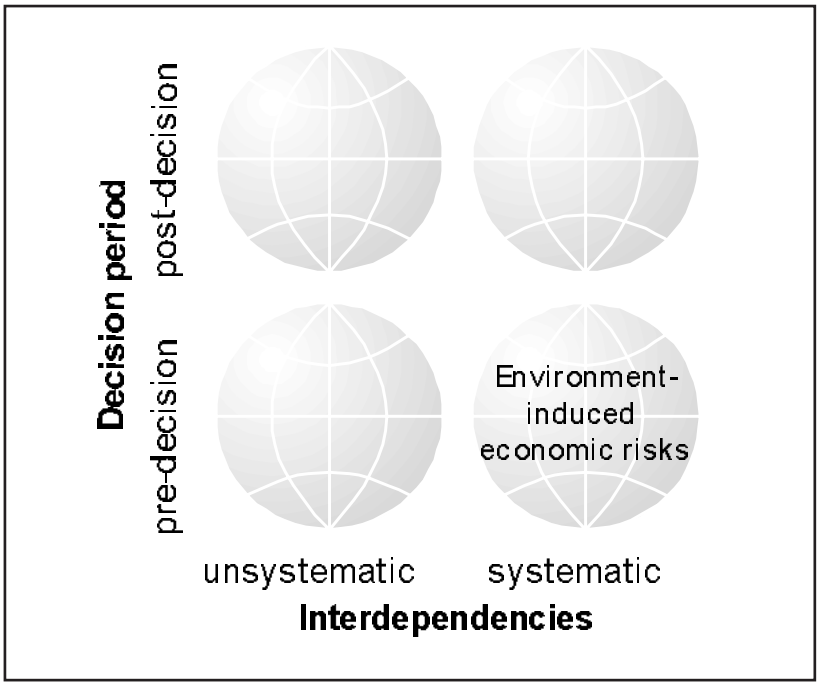
The financial risk associated with the greenhouse effect also has a systematic character as far as its time frame is concerned. It is true that the existence of the greenhouse effect still has to be conclusively proven. But if the greenhouse effect does turn out to be a genuine phenomenon, we can expect it to have consequences for many years to come. This is partly because it has a cumulative effect. It is widely assumed that its impact on our global climate depends on the CO_2 concentration in the atmosphere. Since the Industrial Revolution, the level of CO_2 concentration has already increased from 280 ppm (parts per million) to 360 ppm. By the end of the next century the IPCC predicts that this concentration could climb to between 480 and 800 ppm.[24] Even if we suddenly managed to halt all man-made carbon dioxide emissions, the CO_2 concentration in the atmosphere would only fall very slowly. There is a danger that the high levels of CO_2 will continue to have a detrimental effect on the environment for many years to come. In other words, we would see vertical systematisation. Extending the observation period would therefore only reduce the resulting risk slightly. The more sweeping the consequences of an environmental problem or the contribution to an environmental problem, the more systematic the risk. The depletion of the ozone layer, acidification of the soil, excessive use of fertilisers and greater use of hormone-disrupting chemicals are other examples of environmental problems with a very systematic character.

[24] Cf. RAUBER 1997.

Environmental risks have a systematic and pre-decision character

To summarise, we can say that there is strong evidence to show that environment-induced economic risks have a strong systematic and pre-decision character. This is especially true of economic risks caused by global environmental problems. They therefore need to be positioned on our risk matrix as shown in Figure 7.

Figure 7: Classification of environment-induced economic risks



6 Instruments for managing environment-induced economic risks

If we accept the assumption made in the previous section that global environmental problems will result firstly in greater systematisation of environment-induced economic risks and secondly increase the pre-decision proportion of risks, the positioning of the risk management instruments on our risk matrix shows that compared with typical instrument mixes used to date, an effective instrument mix must have a higher proportion of information instruments and reserve accumulation. It will become increasingly difficult to achieve a «naive» diversification of environment-induced risks, in other words to eliminate their threat by including a large number of them in a portfolio, or by extending the observation period.

6.1 Information instruments

These include any environmentally oriented measures that help provide a better understanding of the microeconomic or macroeconomic consequences of global environmental problems. In this context one example that comes to mind is climate research into the greenhouse effect. One problem is that most of these information instruments entail basic research, and their findings tend to be considered public goods. Public goods are unlikely to be financed by individuals seeking to forward their own interests. There is therefore a danger that insufficient information becomes available. Without the knowledge provided by information instruments, however, investors have to rely on assumptions about the probability and scale of risks. This increases the risk associated with an investment even further and could lead to the imposition of higher risk premiums. These risk premiums would also have to be paid by companies which in reality - i.e. in a situation where the information base is superior - are less risky than assumed, as market players are unable to distinguish between good and bad risks because of inadequate information.[25] In other words, this would lead to a situation that

[25] A similar relationship has been described in the used car market by AKERLOF (1970) and in environmental reporting by SCHALTEGGER (1997).

would be detrimental to the economy, in which higher-risk companies would be cross-subsidised by lower-risk companies. This could potentially stifle investors' willingness to take risks. The resulting cross-subsidy of high-risk options by lower risk alternatives can prevent the optimum allocation of resources, which in turn usually has a detrimental effect on levels of prosperity.

6.2 Reserve accumulation

Obviously it is also important to have a sufficiently high level of reserves, i.e. enough to cover the maximum losses that can occur at any one time. If an investor takes on different types of systematic risk that have no systematic interrelationship, there is no need to set aside separate reserves for each type of risk: it is sufficient to set the reserves at a high enough level to cover the aggregate loss for all types of risk. This multiple usage of reserves, a method also practised by insurance companies, for example, also has a number of important consequences in the event of a loss. If compensation paid on a loss is so high that it eats up a substantial part of the reserves, cover for other risks may have to be withdrawn. If, for example, the consequences of the greenhouse effect mean that reinsurers have to draw heavily on their reserves, a situation could arise in which other systematic risks, such as earthquakes, are no longer insurable in future.[26] But direct insurers also call on the resources of reinsurers to cover their conventional mass business.[27] The end result: reinsurers may be forced to scale down their business activity, while direct insurers could have to restrict the types of insurance offered. The same situation applies to financial markets - and is obviously important as far as banks are concerned as well. Since the Japanese stock market collapsed

[26] Reinsurance is not usually necessary for unsystematic risks. One exception is insurance cover for nuclear power plants, for example, which do not present a systematic risk, but one with high potential losses but a very low probability of occurrence.

[27] For example through quota share reinsurance, where the direct insurer assumes a proportion of the risk agreed down in the treaty, or through excess of loss reinsurance, where the reinsurer covers any amount exceeding an agreed maximum loss.

in 1990, for example, there has been repeated speculation that any further drop in the equity market could result in a situation where Japanese investors are forced to pull out of investments outside Japan. In other words, the sharp decline in the Japanese stock market has caused a steep fall in the level of reserves, which are no longer available for investment in other markets. If we translate this to the question of systematisation of environment-induced economic risks, this means that an investor whose reserves have been eroded due to the occurrence of a systematic environmental risk may have to pull out of investments in certain cases, even if these investments are not themselves affected by the environmental problem. This can trigger a chain reaction, as has already happened in the Japanese stock market.

7 Summary

Global environmental problems can influence economic decisions. The debate in both expert circles and the public at large has been biased towards possible loss of earnings and exacerbation of risk. However, an analysis using tools from decision-making and portfolio theory shows that the interdependency of risks is also of prime importance. There is the danger that global environmental problems could lead to greater interdependency between risks. This is referred to as systematisation of economic risks. But this systematisation process should not focus purely on the price performance of different stocks in relation to each other, but also on the performance of different shares of portfolios over consecutive periods. This «double systematisation» of economic risks allows environment-induced economic risks to be clearly distinguished from traditional financial risks. Another factor to consider is that the consequences of environment-induced risks are extremely difficult to predict. Greater systematisation of risks would however reduce the effectiveness of the instrument mix used up to now for risk management, since systematic risks, unlike unsystematic risks, can no longer be eliminated through diversification. In addition, it is not possible to refer to reliable statistical and empirical data when attempting to cover environment-induced economic risks. In future an effective instrument mix will have to rely less on diversification and more on reserve accumulation and good information instruments. If risk management is to be effective in future, there must in any case be sufficient reserves available.

8 Main considerations for environment-induced economic risks

- The economic consequences of global environmental problems are difficult to predict accurately, which makes them a threat to financial markets. Risks occur not in spite of, but because of incomplete information.
- One particularly important aspect for financial markets is not just the existence of these risks, but also the fact that they are significantly different from traditional risks. Many market players have failed to appreciate this up to now.
- The scale and the probability of environmental damage (i.e. environmental risks that become reality) associated with individual companies are of no interest to financial markets - they are interested solely in the risks associated with a well-diversified portfolio.
- Environmental risks are of a «double systematic» nature. On the one hand they cannot be eliminated (at least, not entirely) through diversification - by the creation of a portfolio, for example. This means the financial market is unable to perform its risk transformation function, or is severely restricted in this capacity. On the other hand, environmental problems can also have a systematising effect on performance over consecutive periods. This makes it more difficult to balance out performance over several periods, so that it is impossible to eliminate risks through diversification by extending the observation period.
- Classic agents of risk diversification such as banks and insurance companies rely heavily on the diversification effect. This means environmental risks pose a threat because they reduce the effectiveness of the traditional risk management instruments employed by banks.
- The systematisation of economic risks through global environmental problems does not have to imply lower returns, and this is what makes environment-induced risks such a danger. In fact loss experience can improve with a higher degree of systematisation. Systematic risks are those without any advance warning.

- The debate about environmental risks has so far failed to address the extent of their systematisation and therefore ignores the needs of financial markets.

- For a systematisation of economic risks to be possible, banks must first adapt their risk management instruments. The environmental know-how of most banks is not yet up to the mark.

- One of the potential consequences of the systematisation of economic risks could be that banks are no longer in a position to take on certain risks. A logical consequence of this would be that banks are forced to pass on the risks to their customers. A similar trend can already be observed in the insurance industry.

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