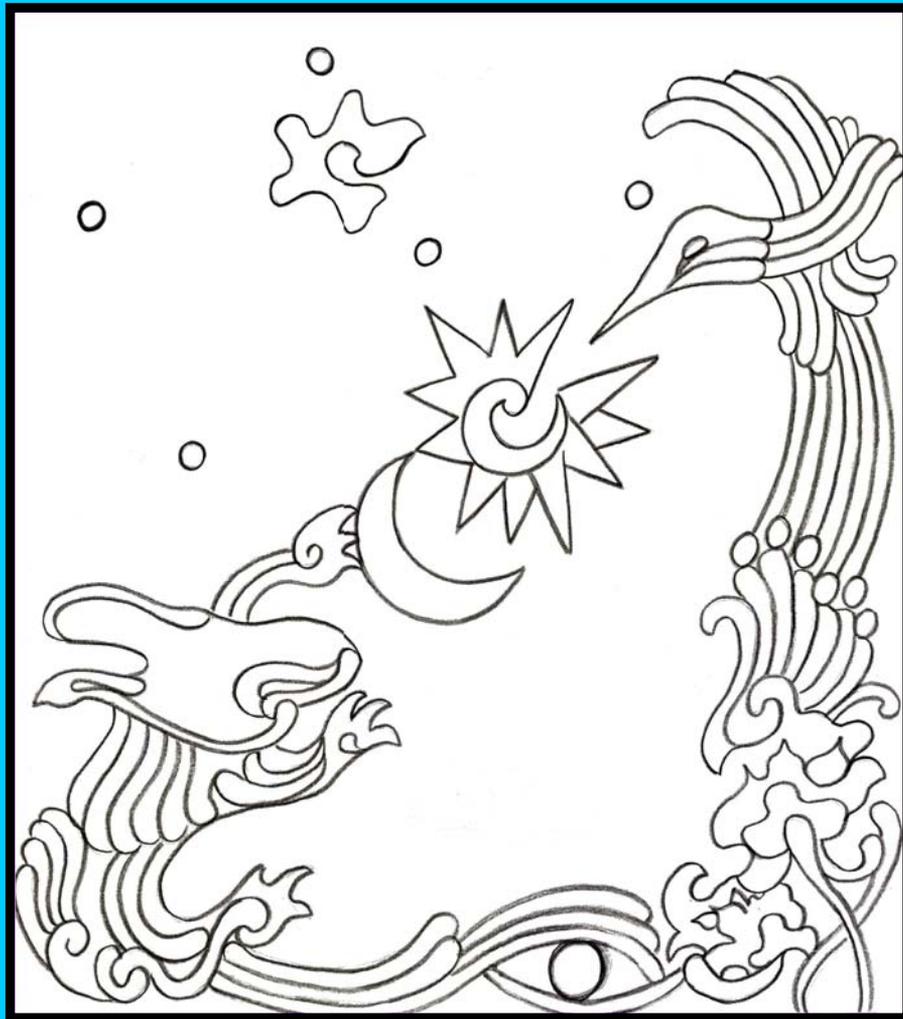


AXEL TIESSEN FAVIER

***The Principle of
Diversity***



**The Driving Force of Evolution and
the Key for Economic Progress**

Presentation (English)

'**The Principle of Diversity**' is a scientific and philosophical analysis that combines theoretical and practical insights of the phenomena occurring in both, biology and economics. Accordingly, good business administration is only possible with full knowledge of *The Magic Triangle of the Economy*.

Biological and economical systems have many aspects in common because they follow the same basic principles of evolution. This knowledge is very relevant in our daily life. One of the most precious messages from the field of biology is to admire and value the **diversity** of our planet.

Because our world is continuously changing and evolving, we have to create always-new diversity in order to survive and adapt successfully. Constant innovation, research and development are the basis of **sustainability** and the key to economic **progress** of our civilisation.

In this essay you will not only discover that **The Magic Triangle** is useful in economics, but it is also important for the field of philosophy and can be applied to some human attitudes, such as love, friendship, intelligence and leadership. Read this book to learn about the philosophy of the separability of the concepts of 'good', 'truth' and 'beauty'.

Have you ever been puzzled by questions like the meaning of sex in biology... the function of flowers in plants... the reason for death in animals... the driving force of evolution... the origin of life on earth... or the source of beauty in this universe? This essay will provide you with a diversity of answers to these and other **mysteries**.

This book is a hymn to diversity in general. Randomness, imagination, creativity, inspiration, intuition, freedom and tolerance are important aspects of the **universal beauty of diversity**.

Vorstellung des Essays (German)

'**Das Prinzip der Vielfalt**' ist eine wissenschaftliche und philosophische Abhandlung in englischer Sprache, die theoretische und praktische Erkenntnisse der Biologie und Wirtschaft analysiert. Demzufolge werden gute betriebswirtschaftliche Entscheidungen erst durch die ganzheitliche Kenntnis des Magischen Dreiecks ermöglicht. Der Autor stellt viele Ideen vor, die jedem Politiker, Manager, Betriebswirt, Philosoph und Wissenschaftler inspirieren können. Dieses Buch ist ein Versuch, die Vielfalt von dieser Welt zu preisen und aufzuwerten. Die Vielfalt betrifft uns alle, durchdringt alle Bereiche und ist essentiell für eine bessere und schönere Zukunft.

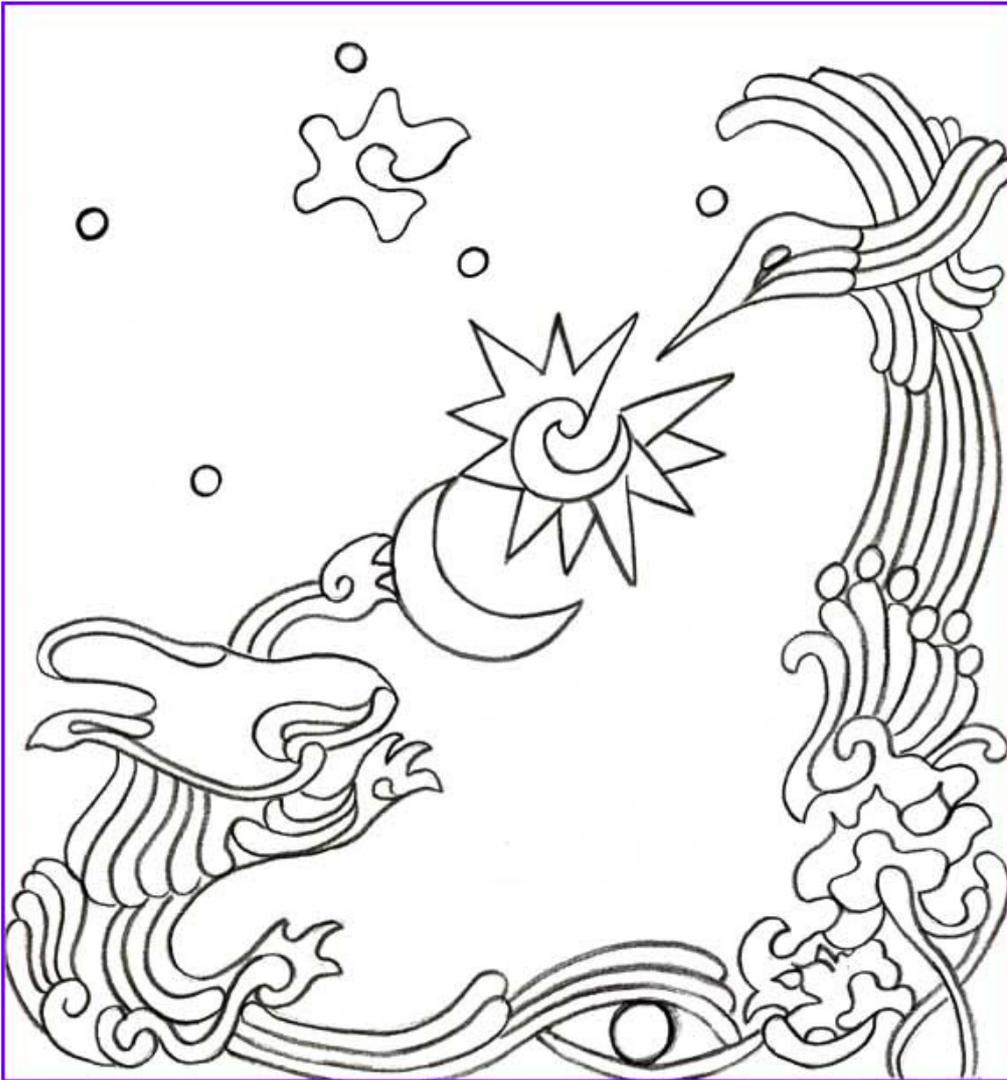
Rezension (German)

Axel Tiessen präsentiert in seinem Buch eine erfrischend vielschichtige Perspektive auf die Grundzüge wirtschaftlicher Zusammenhänge und Systeme. Die zentrale Idee des "**Principle of Diversty**" und ihre Verknüpfung mit Effizienz- und Humanitätsprinzipien in einem magischen Dreieck des Wirtschaftens leitet er aus grundlegenden Betrachtungen der Biologie und Evolutionstheorie her. Die Theoriebeschreibung ist anschaulich durchsetzt mit Beispielen, die der Autor aus seiner Molekularbiologischen Ausbildung und den mexikanischen Einflüssen seiner Jugend zieht. Das Buch ist gleichsam interessant für Manager als auch für Naturwissenschaftler, da Tiessen es schafft aufregende Ideen in der Sprache beider Disziplinen zu vereinen. Der interdisziplinäre und interkulturelle Brückenschlag macht das Buch zu einer Bereicherung der Management-Literatur.

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Cover Figure:

Cosmic fight according to a Mesoamerican indigenous legend. Two opposing forces of nature interact with each other to create the world and the stars. Out of the exuberance of the flower emerges the 'hummingbird' as the symbol of the sun and its life giving power. Out of the calm of the waters emerges the rabbit as the symbol of the moon and ruler of the night. In the very origin there remains the Divine Eye, which observes the beauty of everything.

Drawing by Josefina Favier

AXEL TIESSEN FAVIER

Biology & Economics

The Principle of Diversity

How biological evolution reveals to us
that diversity is the basis of sustainability

Good business administration
according to the three economic principles

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Preface

As a young adolescent, I did not choose to study Business Administration because I disliked the idea of working only for money. I wanted to work within a field that one could commit oneself to with a passion. At that time, money had no deep meaning for me since the accumulation of cash seemed like the representation of the lack of real purpose in life. To me, the world of economics ruled by money seemed hollow, cold and meaningless. In contrast, the world of science and research ruled by innovation promised to be a hot and interesting field. I was motivated by the possibility to reach the forefront of human knowledge and by the opportunity to create new ideas that could contribute to the advancement of our civilisation. I spent many years studying Biology, Botany, Ecology, Molecular Biology and Biochemistry. During my PhD I learned a lot about the properties of biological systems and complex networks. Then one day, I developed an idea for a business in biotechnology, and I then started to learn more about economics and business administration. It suddenly became evident to me that ecology, evolution and economics were astonishingly similar. I was surprised that by having studied Biology, it was still possible to have a fairly good understanding of many phenomena of economics and business administration. I realised that not only did they both start from similar premises, but also there were many common strategies between economic enterprises and biological species to survive *the struggle for life*. This essay is the synthesis of many of the ideas that I had developed in the field of biology, and which I am now trying to adapt to the field of economics. It is the world's economy viewed from the curious eyes of a biologist. These insights have now changed my original opinion about business administration, money and economics. Today, I can recognise that both, biological and economical systems are highly interesting and hot topics. I have discovered that business administration can have a higher purpose and meaning, if managers are able to integrate humanity with efficiency and diversity.

The aim of this essay is to show that diversity in all its forms and manifestations is the source of sustainability for the world. In a more aesthetic sense, diversity can be regarded as the expression of the

creative force of the universe. The interaction of diversity and efficiency leads to biological evolution in natural environments and to economic development in free markets. In this essay I attempt to build a coherent theory of diversity and include some biological knowledge into the context of economics and decisions of business administration.

Plan of the Work

The present essay is an inquiry into the role of diversity in biological and economic systems. Although this essay is primarily focused on the economy, it has crossed the frontier between economics, biology, science and philosophy. An essay about a fundamental and universal principle of diversity wouldn't be complete if it didn't include many different points of view. I hope that managers and administrators but also politicians, scientists and philosophers will be inspired by these ideas about value, beauty and the importance of diversity. This essay could provide useful information for the understanding and application of the principle of diversity to the different areas.

Diversity is beautiful. It is everywhere and emerging all the time. When diversity is generated we call it **creation**, and when it changes we call it **evolution**. Diversity and evolution are not only important for biology but also for business administration, the economy, society and culture.

The essay is divided in several chapters that present different but complementary approaches. To give the reader the freedom to skip sections and study the chapters according to his or her personal interest, the essay was not written in a strict linear fashion. Sometimes, some concepts are repeated more than once in order to present the ideas in a different light. It might also be useful to reread some sections in order to obtain a synergy between the information presented in different chapters.

A short introduction gives a compact summary of the main concepts of economics and business administration in order to synchronise the knowledge of expert and non-expert readers. Please skip any section, if it does not seem to be interesting to your area. In the first chapter, I will present the most important issue of this essay: **The Magic Triangle of Business Administration**. After postulating that diversity is one of the corners of this magical triangle, the Principle of Diversity is put into a scientific, biological, economical, philosophical and political context. The main message of this essay is that *the constant generation of new diversity is the basis of sustainability of any complex system*. The words **diversity** and **sustainability** are used as synonymies throughout this essay to demonstrate this intimate link.

In the chapter dealing with evolution, I will explain that the interaction of diversity and efficiency is the driving force of evolution –in the physical, biological, economical and cultural world. **Randomness** is the basis of freedom and the ultimate source of diversity in the natural world. Biological evolution is slow and driven by randomness. However, cultural evolution can be accelerated by the human **intelligence**. The humanity principle provides the purpose for economic evolution –leading to a better satisfaction of human needs– which represents economic '**progress**'.

In the fourth chapter, the *Principle of Diversity* is also analysed from a philosophical point of view. The starting premise is the separation of the concepts of **good**, **beauty** and **truth**, which can be studied independently by ethics, aesthetics and technique, respectively. That chapter might be more interesting for philosophers and scientists, but managers and administrators could also find some valuable insights.

The next chapter presents then some similarities between biological and economical systems and explains the concept of **ecological niche** and gives some practical examples in business administration. The field of investments is used to show the relationship between risk and diversity. Furthermore, a mathematical formulation is used to estimate the required minimal amount of diversity. Also, the life cycle of a product will be interpreted as a process of evolution, in which innovation and diversity play a crucial role.

I will also analyse some of the government policies using the theoretical framework of all economic principles, and explain the conflict between socialism, capitalism and environmentalism. Managers who do not have time to read the entire essay can read the summary of ideas on page 129 or study the most valuable messages on page 132.

In the appendix, I will discuss the work and ideas of other philosophers and scientists. The glossary provides an easy-to-understand explanation of scientific terms for those readers who are not familiar with biology. Throughout this essay, the small numbers in the text refer to endnotes containing additional comments, remarks or references. Despite the fact that some of these notes are highly important, they were not included in the main text because they would disrupt the flow of the arguments.

An Introduction to Economics

Basic Concepts: Needs, Goods & Property

Human beings have many needs for living. These can be organised in a *pyramid of needs*: basic needs (e.g. food and water) have to be satisfied before more extended needs become relevant (e.g. cars and jewellery). Each person has a different set of needs and assigns a different priority and value to each of his or her needs¹. The different needs arise from the activity of the human brain, from the feelings and wishes of each individual person. Thus, human needs are subjective because they arise from human desires and fears. The means to satisfy human needs are called goods. In the real world, goods are very limited i.e. there are not sufficient goods to satisfy all needs of all human beings. In its last consequence, goods are all those things that satisfy human desires or avoid human fears. The discrepancy between the many desires, fears and needs of humans and the limited amount of goods that are available to satisfy these needs is the reason for all economic problems and the starting point of all economic decisions

Goods can be divided into many categories. To mention a few examples:

Free and limited goods: The economy is based on the production, administration and distribution of limited goods. Goods that are plentifully available (e.g. air) are considered to be free and have no economic value.

Products and services: Goods are all those things that can satisfy human needs. Additionally to products, also various services can satisfy human needs (e.g. haircut, transportation, education, etc.).

Material and immaterial goods: Additionally to material goods or objects (e.g. food, clothes), there are also immaterial goods (e.g. rights, patents). Immaterial goods are directly related to human feelings, desires and fears (e.g. status, reputation, beauty and health).

Private and public goods: Private goods are those that can't be used by all persons (e.g. exclusive use of car, house or washing machine). Public goods are those, which can be used by all persons (e.g. library, street and primary education).

In the world, an organised economy is required because goods are so limited. The highest possible satisfaction can only be achieved, when the available resources are used rationally and administered efficiently in order to provide the maximum amount of goods (principle of rationality). In a paradise where all goods were plentiful, there would be no need for an economy or its administration.

The **Capitalist Economy** is based on the allowance of the exclusive use of goods. The right of exclusive use is called property. **Private property** is valuable because it allows the use of a limited good by the owner only. Property is also valuable because the right of exclusive use can be transferred to other persons². In order to protect the property and allow the transfer of goods, a regulatory system is required to define legal rules that are valid for all citizens. The government is in charge of the legal system (legislation power); it takes care that these rules are obeyed by all, perhaps even by force or by punishment (jurisdiction power) and is also responsible for the administration of public goods (administration power). This allows an optimal environment for the **satisfaction of human needs** arising from our desires and fears. The government helps to satisfy human desires (e.g. education, health, liberty and freedom of movement) and is also directly responsible for avoiding some human fears (e.g. security, police, fire and military). For these public services, the government collects money from all citizens in form of taxes. **Taxes** can be considered the cost for the allowance and protection of private property³. A government is legitimated by its open nature (any citizen can participate) and democratic elections (by majority). Thus, a democratic government, legal system, taxes and private property are intimately linked to a modern capitalist economy.

Basic Principles of Business Administration

Business administration deals with the decisions of enterprises and companies. Good decisions are required in order to achieve maximum satisfaction of human needs by the optimal production and distribution of goods. An **enterprise** is the basic economic unit that produces, administers and distributes goods to satisfy human needs. Private persons are the basic unit that consume these goods. As additional consuming units, legal persons (private or public enterprises) also have needs that can be satisfied with the goods of other enterprises. The government places the framework for the interaction between all economic units. Through the interchange of goods (**trade**) the different economic units are motivated by the possibility of obtaining profit⁴. **Absolute profit** is defined as the result of output minus input. It is the balance of each economic unit in the production and consumption of goods. Profit is also called success and is the result of achievements minus efforts. Profit is mostly measured in the economic exchange unit called money⁵. However, in principle, profit can also be measured in terms of goods or needs⁶. The success of a person is the result of his or her achievements minus his or her efforts in terms of needs or goods. The profit of a company is the result of its income minus its expenses in terms of money⁷. Complementary to the concept of absolute profit, **relative profit** is called efficiency and is the ratio of output to input.

$$\text{Profit} = \text{Output} - \text{Input} \qquad \text{Efficiency} = \frac{\text{Output}}{\text{Input}}$$

Efficiency is also called return on investment (for companies) or interest rate (for investments). Business administration is the strategy of decisions and procedures in order to increase the efficiency⁸ of economic units like enterprises and persons. Good business administration allows achieving economic success according to the three major economic principles. However, what are these principles and how could they be relevant to aid a businessman in his daily decisions?

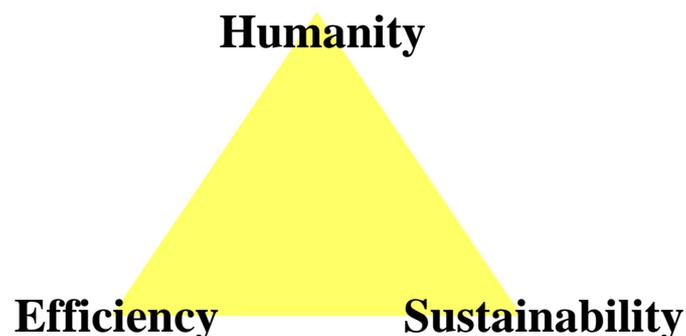
The magic triangle: **The principles of the economy**

The **efficiency principle**: Act in such a way that –at a given input of resources– the greatest possible outcome is achieved (profit maximisation). Act in such a way that –at a given outcome– the resources are saved (input minimisation).

The **humanity principle**: Act in such a way that the needs of as many people as possible can be satisfied. The economy is there to serve the human kind. Business and trade is there to satisfy human needs.

The **sustainability principle**: Do not destroy the basis of your enterprise. Make the system sustainable by decreasing risk and increasing diversity. Make judgements in the long-term. Create always-new beauty and diversity in order to adapt continuously.

Magic Triangle of Business Administration



The aim of good business administration is to find a balance –compromise– between the three economic principles. These can be in conflict sometimes. Let us examine this issue in one example:

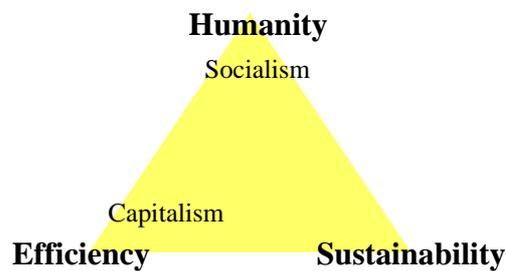
A farmer has a field with many almond trees. He takes care of the trees, waters them, fertilises them, collects the almonds and sells them to cover his needs and obtain profit. He is free to choose between the different principles. According to the efficiency principle, he will try to maximise his profit and lower his costs. He will work as little as possible, use the minimum amount of resources in order to get the maximum yield of almonds and sell them at the best price. According to the humanity principle, he will offer work to other people, he will live in peace with his neighbours and try to help the community. According to the sustainability principle, he will use only as much natural resources as there are available. He will maintain the fertility of the soil for many years, and he will plant many varieties of almond, apple and cherry trees to increase the biodiversity on his field and the beauty of his farm.

A good farmer will try to combine all of these aims and principles. A bad farmer would follow only one principle. If he only followed the efficiency principle, he could decide to fire all the expensive workers, he could decide that in the short-term it is more profitable to cut trees and sell wood instead of almonds. This would be against the humanity and sustainability principle because it eliminates the jobs of his workers and destroys the basis of his enterprise. If he only followed the humanity principle, he could offer work to many people, pay a very high salary, give the workers many holidays and donate the almonds to poor and hungry children. This would be against the efficiency and sustainability principle because he would not make profit and would also destroy his enterprise in the long-term. If he only follows the sustainability principle, he could convert the good farmland into a natural forest (a sustainable environment with much biodiversity and not disturbed by humans), where the almonds are eaten only by the animals of that forest. This would be against the efficiency and humanity principle because it does not lead to a higher efficiency or to a better satisfaction of human needs.

The bias that each company places into each of the three administration principles builds the central core of its business philosophy. Some companies are characterised by a strong bias into one of the principles. For example, many private companies seem to act only according to the efficiency principle⁹. For these companies, profit maximisation seems to be above any humanitarian or sustainability concerns. In the most extreme cases, short-term profit is maximised for chief executives at the expense of a whole company (e.g. Enron, Parmalat). On the contrary, many state companies act mainly according to the humanity principle. This is also true

for many public and private associations. Profit is not the major aim of their efforts¹⁰, but instead it is the maximum possible benefit for the whole population.

The theoretical bias placed for each of the administration principles is also reflected at the higher levels of countries and whole economic blocks. The capitalist block has a strong bias on efficiency, whereas the socialist block tried to put its bias on humanity. The theoretical basis for both, capitalism and socialism was first provided by some great philosophers and economists of the past centuries who placed much attention into the principles of efficiency and humanity¹¹.



However, the problem of sustainability has only started to be analysed in detail a few decades ago. Therefore, the principle of sustainability has not been sufficiently integrated into all the current decisions of business administration. This is the reason why both, the capitalist and socialist economic systems, are still based on a requirement of constant economic growth. Without economic growth, the actual systems are unstable, and many economic problems arise, like those we are facing now. Unfortunately, the world economy is getting less and less sustainable, and this is due to the framework of the prevailing economic theories and its consequences on practical decision-making of economical and political leaders and institutions, which additionally are very inert.

One of the reasons that in our modern economy the strongest bias is put into efficiency and the weakest bias is put into the sustainability principle is the short-term mentality of the human brain. Unfortunately, the time horizon of decision-making in business administration is very short. Even the political leaders of our world lack a long-term vision. This is why we are destroying diversity, nature and the very basis of our lives so rapidly. The

human kind is behaving like a virus, and it does not seem to understand that it needs other species –that it needs diversity in order to survive. Our present bias in the economic system is putting our whole civilisation into danger.

The sustainability principle provides a theoretical framework for the avoidance of risk. It can help the companies to make the required decisions to survive during times without economic growth –or during times of great instability and change. Constant economic growth was based in the growth of the human population and the generous availability of natural resources on our planet. However, the resources are limited and the human population cannot grow unchecked. An unlimited growing system consumes the basis of its own existence, and in the long-term, it is not sustainable.

Economists can learn a lot about sustainability from the field of biology and ecology. These sciences study complex systems that have been sustainable for many millions of years. From biological systems we can learn that in order to ensure sustainability, the risk has to be decreased by promoting diversity. The challenge of our time is to achieve the transition from our present system into a sustainable economic system. Biology can help us to make the right management decisions. We do not only need a mixture of capitalism (efficiency) and socialism (humanity), but also increased sustainability (diversity).

The Sustainability Principle

The Time Dimension

The sustainability principle is possibly the most complex of the three economical principles¹². The sustainability principle can be regarded or defined in many ways. Consider the imperative definition: *do not destroy the basis of your enterprise*. This requires that one should act only in such a way, that it is viable during an unlimited amount of time. Sustainability requires the restriction of behaviour, which destabilises or puts the system into danger in the long-term.

Cutting all the almond trees to sell the wood can be very profitable, but then the farmer will have to change his profession, as there will not be almonds to sell. Cutting all trees is not sustainable. However, cutting only few trees and planting many new

ones can be sustainable. In order to obtain a good harvest over a longer time period, the fertility of the soil must be maintained. The farmer has to minimise the dangers that could destroy or damage the almond trees. A low risk is required to be sustainable.

In a similar way, to contaminate the natural environment or destroy the rainforest is not sustainable. If the biological diversity of the rainforest cannot regenerate as fast as it is consumed, the rainforest will disappear and the whole ecosystem will collapse.

The sustainability principle introduces the time dimension into the administration decisions beyond the selfish handling and limited lifetime of a manager. One of the easiest ways to incorporate the sustainability principle into practical decisions of business administration would be as follows: Apply the efficiency principle but consider the input and output in a longer-term.

Already in the 18th century, Adam Smith postulated that selfishness was not bad nor a problem for the human economy. Today we know that neither selfishness (liberal theory) nor added value (Marxist theory) are the problem of our current economic systems. The fault is somewhere else. What is really missing in all present economic systems and economic decisions is the time dimension and the long-term vision. Most decisions of business administration are made in the scope of weeks, months or one year. A manager who thinks in the scope of more than three years is already considered a visionary. This is a far too short a time frame to be sustainable. The time scale of decisions should be at least ten or fifty years. Long-term vision is not only missing in the mind of chief executives but also in the one of many politicians¹³.

In addition, long-term efficiency must not only be maximised in units of money, but for all input-output aspects. Regardless if it is measured in units of cash or not, the efficiency has to increase for all enterprises and systems. Using less space, consuming less energy, oil, water, air, recycling the garbage and saving resources is something that should be done according to the principle of efficiency¹⁴. This is the basis of Natural Capitalism¹⁵. Complementary to the opinion of Ulrich Von Weizsäcker, in this essay I wish to postulate that saving resources (input minimisation) is more directly related to efficiency than to sustainability¹⁶.

Sustainability, Risk & Diversity

The sustainability principle can also be defined in another way: *Decrease the risk by increasing the diversity of the system*. This definition can be the easiest to say but also the most difficult to understand. Risk is a probability measure for stability and danger. Our common sense says that minimising the risks can increase sustainability. But what has sustainability to do with diversity? This single question is the most important one in this essay. I will try to provide evidence from different sources, but mainly from the field of my academic expertise. Biology reveals to us that the risk can be decreased by increasing the diversity. The relationship between diversity and stability is an important topic of ecological research of our days. Later in the appendix, I will provide more examples and give some references for further reading and scientific study. Here in the main body text, I will only provide the main statements from the science of biology. For example, biological evolution shows that a system is increasingly robust, and therefore also more sustainable, if it constantly creates new –and maintains– diversity in the ecosystems¹⁷. Natural environments are sustainable because of their great biological diversity (biodiversity). This biodiversity ensures that the system is flexible and dynamic and therefore can cope with many different conditions. Diversity allows survival (sustainability) even when the environmental conditions change dramatically. A homogenous ecosystem is less dynamic and flexible and therefore has a higher risk of collapsing sooner. The link between diversity, risk and sustainability can be explained using a case study from the field of agriculture:

In the 19th century, Ireland was a poor country that was very dependent on the production of food through local agriculture. There were different sources of food, but at that time, one crop plant seemed to be particularly efficient and productive: the potato. This crop had been domesticated by the Andean cultures in South America and was brought to Europe by the Spaniards. The efficiency of tuber production was so convincing that it seemed worthless to plant other crops in Ireland. This efficiency of food production allowed sustaining a big population. The Irish population grew by eating many potatoes. Thus, the Irish agriculture and its consumers changed their habits so they became increasingly dependent on the potato. The potato crop is propagated vegetatively, and thus all plants of a variety are identical clones. As it turned out, the Irish had to pay a very high price for the low diversity in their potatoes

and food habits. A fungal pathogen causing the potato late blight found extremely good conditions in the monoculture of potatoes and destroyed harvests of not only one year, but also of many years. The consequence was a massive shortage in food –the Irish Potato Famine cost thousands of human lives. The catastrophe was caused by a lack of diversity in the potato varieties, the practise of agriculture and habits of food consumption. Unfortunately, at that time the Irish did not know that they had to increase the diversity to avoid that risk. Luckily, many Irish were able to escape the local misery and immigrated to the New World, thus increasing the cultural diversity of the American legacy. Today, the Irish do not eat as much potatoes, but also they grow different varieties and many other crops on their fields. Additionally, they can also import a diversity of food from many different parts of the world.

The examples revealing the link between sustainability, adaptability and genetic diversity could fill many pages. However, for reasons of space and simplicity I cannot mention more biological examples here. The relationship between sustainability, risk and diversity can also be well explained in the context of economics i.e. in the field of investments. If all your money is invested only in one type of share in a stock market (e.g. Wall Street), the risk of loosing money is great. In order to decrease the risk and increase the sustainability of investments, investment brokers choose to diversify. They do not only buy different shares in different stock markets, but they also buy different funds and options. Brokers do this, because they cannot predict all the future changes and therefore have to be prepared for any change in the world economy. Although it is difficult to predict the future exactly, it is a certainty that change will come. There will be good and bad years. In any given case, the more diversity, the less risk will exist and the more sustainable it will be. Although I only mentioned two examples from agriculture or investments, this could be seen as a universally valid rule.

Diversity in all Fields is Valuable

Diversity is required for a sustainable agriculture, but it is also the basis of sustainability in biological and financial systems. The main point throughout this essay is that diversity in general –not only biological or cultural diversity– is the basis of sustainability for all aspects of the world's economy and daily life.

Diversity is so crucial for sustainability, that the principle of sustainability can also be called the principle of diversity. Sustainability and diversity can be well used as synonymies¹⁸.

Diversity = Sustainability

Later in the appendix, I will give a short overview of the common understanding of diversity –mainly associated with cultural aspects of society. Here, I would like to expand the concept of diversity referring to all fields. Diversity is the sum of everything that is not equal. Diversity is heterogeneity and is the contrary of homogeneity. **Diversity is essential.**

It is not a new discovery that diversity is so crucially important. Biology is the science that studies the diversity of life. Biologists have always known to appreciate, explore, study and admire biodiversity. Sociologists study the diversity –cultural richness– of humans. Psychologists try to understand the diversity of human thoughts and feelings. Linguists study the diversity of words, meanings and languages of this world. Musicians focus on the diversity of sounds and noises whereas painters concentrate on the diversity of colours and shapes. Wall Street brokers focus on the diversity of stock options and shares, whereas others specialise on the diversity of foreign currencies and resources like gold, silver and oil. Marketing tries to predict the diversity of consumer preferences and help to satisfy human needs by a diversity of products.

Every human being is unique because he or she is different from all the others. Heterogeneity and diversity are such an integral part of our life and surrounding world that we sometimes take it as granted. Diversity is so crucially important (without diversity the world would not exist) that the link between sustainability and diversity could be seen as a trivial conclusion¹⁹. Nevertheless, it is worth analysing more deeply how diversity is generated and how it can be placed in the general context of the fundamental principles of economics.

Diversity, Creation & Innovation

Within our human culture, the creation of diversity is called art. The generation of new ideas and concepts is called science. In the field of

economics, the creation of diversity is also called innovation. The generation of new and diverse goods is called product innovation and development. The generation of new companies is called founding. The generation of a new identity is called branding. In order to exist over time, companies have to innovate constantly. Without a constant generation of diversity, companies are not sustainable. Research and development (innovation) is an investment that decreases risk, and increases profitability in the long-term, making the company more sustainable.

The German Company BASF started its business with the production of aniline and soda. At that time, the demand was high and the profit was generous. Instead of keeping only few products, the company decided to develop, produce and sell many others. Thus, the company invested much money in research and development in order to invent and launch new products into the market. For sure, this decreased the short-term profit of the company, but it also decreased its risk. It decreased the risk of being too dependent on only few products. If the demand of single products decreases, then the company can still sell many others. Today, BASF is a chemical company that sells thousands of different products and offers also various services. Profitability can be increased by selecting the most profitable (efficient) products and discontinuing the less efficient ones. Sustainability can be increased by constant research and innovation to keep high product diversity in the portfolio. Offering good jobs to many people and contributing to the needs of the society can increase humanity.

The importance of diversity is so great, that it could have a value for itself –an aim *per se*. The options and decisions to create and maintain diversity do not require a complicated justification. For a manager it can be as simple as that: ***diversity is always good***. Unfortunately, whereas the efficiency of a company can be well measured in units of money, the risk and sustainability is a probabilistic measure²⁰ that is more difficult to quantify accurately in units of money. Even worse, the avoidance of risk and increase of sustainability represents a cost that some managers do not value enough. If they do not know and understand the value of diversity, they are tempted to minimise these costs.

The game of the roulette can give us a nice example of the lack of knowledge and short-term vision of decision-making linked to risk and efficiency. Some people like to play the roulette because of the illusion of getting profit in the short-term²¹. However, many know that for earning money in the long-term, the worst idea is to be the player,

and the best idea is to be the owner of the casino. If the bank always wins in the long-term, so why do people think that they can earn money by gambling? It could be due to the general belief that the higher the risk, the higher the profit of any business. But how much risk should we accept in order to obtain profit? Bad business administration is like ignorant gambling –playing a dangerous game unaware of all risks. Good business administration is much more than that. It is about knowing and understanding the rules of the game and taking the most intelligent decisions in order to obtain the highest efficiency with the minimum amount of risk²².

Destroying the rainforest, exterminating the biodiversity and decreasing the beauty in the world is like gambling with the roulette. It is motivated by the profit in the short-term. But when will we understand the rules of the game and see that we cannot win in the long-term?

One rule of the game is that diversity is the basis for sustainability of our world. According to the sustainability principle, the loss of old diversity and beauty should be replaced by an equal or greater amount of new diversity through creation and innovation. This does not mean that the amount of diversity should be static –or a preservation of the *status quo*. On the contrary, it should be highly dynamic. In the short-term, diversity can decrease, especially during times in which the efficiency can be increased over-proportionally. However, in the long-term, diversity has to recover and be maintained in order to ensure sustainability. The maintenance of our world requires a constant change, a continuous generation of diversity in all fields.

The direction of the present economic development is one the greatest threat to sustainability on our planet. The threat is even greater as the present business administration practices do not take biological diversity seriously enough. In a rational way, biological diversity is not something trendy or fashionable; diversity is a requisite of human survival on our planet. Without the millions of biological species, the human kind cannot survive in the long-term on this planet. Diversity should be taken as seriously as efficiency. Diversity is more valuable than profit; diversity is as valuable as life.

Diversity is a Fundamental Principle of Nature

The insight that diversity is a fundamental phenomenon of Nature not only arises from biology, the science that studies the millions of species of animals and plants, the biodiversity of our planet, but also from chemistry,

the science that studies the many different variations (diversity) of molecules and atoms. It even arises from elementary physics, the science that studies the particles of matter – electrons, protons and neutrons, but also a pretty zoo²³ of many other subatomic particles, antiparticles and quarks. In quantum physics, the principle of diversity has also some relation with the phenomenon of asymmetry. The known universe is made of an unequal amount of matter and antimatter. According to the quark theory, the world is made of unequal (diverse) particles with different mass, charge, spin, strangeness, charm, bottomness and topness²⁴. The different particles of matter are built by a combination of these elementary particles. It is this diversity and not homogeneity that allows the existence of our physical world²⁵.

Looking into the sky, we observe much diversity in our universe. The heavy matter of the universe is not homogeneously distributed: there is empty space and black holes; there are galaxies, supernovas, stars and planets. There are stars of almost all sizes and colours: Blue, white, yellow and red. Why is the universe not only made of hydrogen or helium, but burning stars constantly generate –out of the nuclear fuel of plasma– many diverse elements like carbon, nitrogen, oxygen, sulphur, phosphor, iron, magnesium, etc? The diversity of the universe is not static, but is constantly emerging, increasing and changing. The constant transformations are not only present in our colourful planet and its inhabiting beautiful life, but they are omnipresent in the whole universe and affect also the non-living matter. *Diversity is one of the fundamental laws of Nature.*

The reason that we observe evolution in our world is due to a creative force of diversification. How could it otherwise be? How could the entire universe exist from an initially homogenous origin (Big Bang Theory²⁶), if there was no fundamental principle of sustainability, which leads to the generation of physical, chemical, biological and cultural diversity? But, if diversity is a fundamental principle of nature, what is the cause behind it?

Randomness is the Source of Diversity

At this point, already deep in the field of astrophysics and quantum mechanics, the last important component –the ultimate basis– of the principle of sustainability can be revealed. I have already explained how closely sustainability is connected with diversity. But at least equally and intimately connected to these two is ***fundamental randomness***.

All the diversity of the universe arises to the largest extent from randomness. Randomness is creative and innovative. Randomness can be defined as the fact that identical conditions can lead to different results. Because of randomness, the same conditions in different parts of the universe can lead to different outcomes, and it therefore increases the diversity of the world. Theoretical physics assumes that small random variations of conditions during the first moments of the creation of the universe (Big Bang) caused an unequal distribution of matter and asymmetric action of natural forces, leading to the universe, as we know it. Thus, randomness is the reason of diversity of mass distribution in our universe. The diversity and zoo of particles in the world of quantum mechanics arises from a nebulous cloud of uncertainty and randomness. It is fundamental randomness that prevents us from looking at things only in one way, but in many diverse ways²⁷. For example, an electron can be seen as a wave or as a particle.

Now, from the strange quantum world of Planck, Heisenberg and Schrödinger let us return to the world of biology: The synthetic theory of evolution describes that a new species –biodiversity– is generated by random mutations²⁸ and random processes²⁹.

Long before Charles Darwin in the 19th century, the biological evolution had been discovered through the analysis of fossils. Many scientists already knew that the ancient world contained other species than the ones that lived in the present world. According to the Creationist Theory, God had initially created all species, but many species had become extinct after a time. This was well documented in the fossil records. The creationists believed that diversity was constantly decreasing because creation was limited to the Genesis time. According to Cuvier, the massive extinction occurred during periods of catastrophes. Other scientists preferred a view of constant change and modification of species. Some even postulated a purposeful adaptation to changing conditions of the natural environment. According to Lamarck, inheritance of

acquired skills and properties was the reason of the adaptation and evolution of organisms.

The most important contribution of Darwin's book '*The Origin of Species by Means of Natural Selection*' was not the discovery, but the formulation of one of the mechanisms leading to biological evolution – the natural selection. According to Darwin, targeted selection and random variability were the only driving forces of evolution. There were no purposeful adaptations, but only random differences and variability that would be selected according to the success in the *struggle for existence* and the process he called *natural selection*. Although Darwin focused on the phenomenon of selection, he also mentioned biological variability. However, he did not explain it or analyse how it was generated. During the 20th century, the Darwin's original theory was expanded. The synthetic theory of evolution³⁰ explains that biological variability arises from the accumulation of random mutations in the DNA sequence, the carrier of the genetic information.

The theory of evolution was hard to accept for the general public, since it is so difficult to imagine that random mutation alone can lead to such marvellous achievements like the eye or the human brain. Even today, there are many people who are sceptical to the theory of evolution by targeted selection and random variability. How could randomness be so wonderful and powerful? For them, the human body –or life itself– could not have emerged from pure randomness but only from a divine force and purposeful action.

It is clear that the creative *power of randomness* and the diversification force of the universe are severely underestimated by many people. The usefulness of randomness to become adapted to unknown conditions lies precisely in not preferring any direction, but trying all possible combinations. A purposeful change would restrict the degree of freedom and lead only to adaptation to predicted conditions. This can be more efficient but for sure it involves more risk –thus is less sustainable³¹.

Returning to the economy, much of the sustainability in economic systems is truly derived from randomness. Without uncertainty and randomness, even the stock market in Wall Street would already have collapsed. For example, if everyone would buy or sell at the same time because of a 100% certainty of an event.

Randomness, diversity and risks are especially important for stock markets. Without the diversity of heterogeneous investors the system would not be sustainable. It is especially important that different investors have different strategies and that they behave in many diverse ways. For example, if all investors were sure that a war in the

Middle East would lead to a decrease of the shares prices in the stock market, everybody would sell their shares at the same time. That would be the worst of all black Mondays. Luckily, not everybody thinks equally. Furthermore, great instability would be generated if all investors in Wall Street would use exactly the same method for the analysis of the stock market. Every broker thinks that he has the best method to predict the changes in the stock market. However, he cannot do anything better than to keep his secret and let everybody else sell or buy according to the many other and diverse methods. "*Do something else as the others*" could be the motto of diversity in Wall Street. There could not be something worse for a stock market than a truly secret formula or if everybody was completely predictable. Even if Wall Street brokers might believe in none or different Gods, in randomness they all trust.

Diversity and randomness avoid the tragedy of everybody doing the same. Moreover, all the different investors act intentionally differently from one another³². This *going against the main current* and all the anti-cyclical behaviour is a wise strategy according to the diversity principle. Although the investors are mainly motivated by the future efficiency, an *Invisible Hand*³³ of freedom leads them onto the path of diversity and sustainability. Thus, there is a fundamental driving force of randomness and diversity that promotes sustainable behaviour within the scope of a stock market.

Randomness Allows Freedom

It is important to regard randomness as a fundamental requisite for the existence of our universe³⁴. It is the source of diversity and the basis of sustainability. However, one must avoid the negative connotation of randomness with inefficiency, anarchy and chaos. Instead, randomness should be seen as the requisite of liberty and freedom. The science of physics teaches us that without randomness, our world would be totally deterministic, and all future events would be completely predictable. In such a world, the mechanical laws of nature –chain of cause and effect– would already determine everything and there would be no freedom of choice³⁵. Fundamental randomness³⁶ allows the freedom not just as an illusion but also as a real choice. Liberty and freedom of choice are also the reason why people decide to do so many different things, and therefore lead to great diversity and ensure sustainability of the system. Thus, randomness, freedom, creation, diversity and sustainability are all linked

tightly. This is not just coincidence, but has some kind of a divine source. Allow me to provide a modern interpretation of the Book of Genesis:

God created the universe by applying His divine creativity to force the diversification of the world. The diversity of the universe started to arise by the division of the initially homogeneous. He expelled all organisms from paradise by limiting the goods that would be available to satisfy all their needs. He incorporated the efficiency principle to counteract the creative force of diversity and to allow only the most efficient organism to cover their needs. When He noticed that diversity and efficiency would lead the evolution and improvement of the universe for itself, He saw that it was good, and decided to rest. He followed closely the rise of the human species and the development of its intelligence. His Will was that randomness would give us human's freedom of choice. God made us similar to his image by giving us the power of creation and the gift of imagination. He established contact with us and advised us to use our capabilities and freedom wisely.

In the meantime, the human kind invented the economy and business administration to use the limited resources that God had left for everybody. God was proud that the different cultures³⁷ managed to invent a human moral and ethic to give a meaning and purpose to their lives. However, from time to time, God comes to remind us of free will and to correct the one or the other mistake, just randomly as we think³⁸.

Randomness is a Law of Nature

If we consider all the events that happen in our life, we rapidly recognise that many of them are related to randomness. Funnily, randomness is such a predominant phenomenon –an issue important and essential to our world– that it is simply taken as granted. Sometimes, it is even forgotten or overlooked, as if it was completely normal, that randomness exists in this world. Randomness is considered to be trivial. We do not notice that it is there. We even learn to accept it, live with it and hope that science and technology will provide us the tools to master it.

However, randomness is one of the few things that are beyond the scope of scientific study. Not only because of technical limitations or lack of knowledge, but because it is fundamentally out of reach. To say it in a radical way: science ends where randomness starts. Science can be considered as the attempt to find the causes and predict the effects of all events in this universe. But is there any cause for randomness? Science

will never find a cause for it. There is no cause, but there are many effects. For sure, the ultimate effect of randomness is the existence of the whole universe.

It can be said, that parting from the effects of randomness, the resulting chain of cause and effect leads to everything that happens in this world. The scrutiny of science always ends at the same point, regardless of the question that is made. Do we ask for the cause of evolution in biology? Do we ask for the cause of diversity? Do we ask for the cause of mutations? Do we ask for the cause of death? Do we ask for the cause of life on our planet earth?

Randomness is the most underestimated cause and power of this world. It is so omnipresent that we do not even consider it or learn to value it. And this is evident because almost nobody is satisfied when scientific answers end with it. Some think that this is only a helpless answer, reflecting our ignorance because we do not know more about the causes. As we did not know the reason for thunders, clouds or rain in earlier times we thought of them as divine events led by God. For many people, randomness is too trivial and therefore they assume that there must be a deeper cause behind it, and another cause and so on... It appears that randomness cannot give us intellectual and spiritual satisfaction. If satisfaction and peace of mind is what we look for, I am convinced that it is better to believe in God³⁹.

It is interesting that there is the common perception that mathematics and stochastic have developed numerical methods to predict the effects of randomness. We call them probabilities. We use numbers and have formulas to calculate and describe them. However, this is only a poor illusion. They are only descriptions of the number of events with a given outcome, if the same thing was repeated over and over. However, it is useless to predict the one thing that will happen in the future. In principle, you cannot predict the outcome of randomness⁴⁰.

Just take a coin, which has two sides. Can you predict the result of the next throw⁴¹?
You will probably say that there is a 50% probability that it will be a figure, and a 50%

probability that it will be a number. Isn't this useless? Of course, it can only be that or the other... but which will be the exact outcome of the next one? No human could tell. If somebody could tell the numbers of the next lottery he could become rich easily. If there are people who believe that randomness could be predicted, then why do they work at all to get money?

Some scientists believe in the fundamental exactitude of the laws of nature. Throughout the history of humanity, the mathematical description of nature has been perfected and refined. The mathematical accuracy has inspired and overwhelmed great scientists like Pythagoras, Newton, Gauss, Maxwell, Planck, Einstein and many others. The simplicity of their formulas is taken as a proof of their greatness, beauty and perfection.

Randomness is taken as a small imperfection of the greatness of those natural laws⁴². Even Einstein did not believe that God did roll the dices. During my whole academic education and scientific research I never heard of randomness as being a law of nature. Instead I had to learn many principles, theories, formulas and numbers. In fact, randomness is considered as an inconvenient deviation of the natural laws⁴³. I regard this as one of the most basic dogmas of our current scientific paradigm and occidental philosophy. Is randomness so invisible that it is not adequately mentioned in our scientific theories as the ultimate cause of everything? Are we free to choose the dogmas in which we believe? Could we also do successful science, if we considered randomness the most fundamental law of nature and everything else we call natural law is just a deviation from randomness? Are scientific laws only those predictable deviations of randomness that can be described with a simple formula? In fact, there is no law of nature I am aware of, which is as perfect as the mathematical formula really predicts⁴⁴. They are only good approximations. Some are better than others. Just take the laws of Newton. Later, we learned that Einstein had better approximations. Which will be the next better one? 'The diversity of the string theory'?

Science only provides a close description of the truth, but it is never really a final answer. It provides only a provisory view. It is only close enough to the truth that it allows us to build cars, fly aeroplanes and send robots to Mars. The knowledge of these theories allows us to be efficient, run the economy, administrate businesses and manage corporations.

To conclude this section in brief: randomness is the most fundamental and powerful law of nature. It constantly creates new diversity and it can be considered as the ultimate cause of everything. But now, let us return to the actual main topic of this essay: diversity in the context of economics.

Sustainability is Independent from Humanity or Efficiency

It is good for the human kind that economic systems are sustainable. In the long-term, only a sustainable system can guarantee the satisfaction of human needs –in the present and in the future. This is the reason why many people include an ethical dimension to sustainability⁴⁵. The request for more sustainability in our world is often focused on the human moral and social aspects of an economy. In the political field, sustainability in developing countries is associated with the cultural and social needs of the local population. Indeed, there are many economic decisions in favour of sustainability and humanity⁴⁶. But it is important to understand that the principle of sustainability is independent from the humanity principle. Despite the fact that both principles can be complementary, not all that is human is sustainable and not all that is sustainable is human.

Humanity ≠ Sustainability

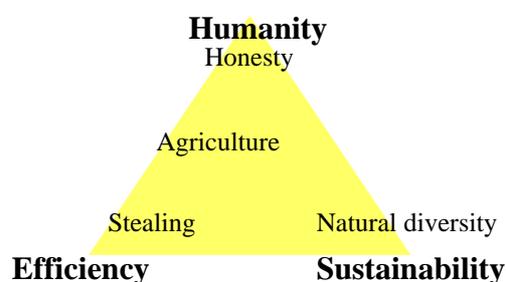
Some indigenous communities are more interested in sustainability and humanity, even though the degree of efficiency is lower. Other societies make many decisions according to the efficiency and humanity principle, which are against the sustainability principle.

Cutting the trees of the forest to obtain wood and to create new farmland for many poor people can be a decision according to the efficiency and humanity principle. It is efficient, if the land can be used for agriculture to generate more income than the natural forest before. It is human, if the land is given to poor people in order to allow them to obtain food and acquire living space for their families. However, destroying nature for human purposes is not always sustainable, especially, if all natural ecosystems are converted into homogenous urban landscapes. Destroying the natural diversity is the greatest risk for the sustainability of the human civilisation in our world. Nevertheless, the human population has grown so big –and will continue to grow– that it is necessary to increase the efficiency in order to maintain the living standard of so many people on our planet. One of the major problems will be to produce enough food for all. Agriculture is the efficient use of land for the production of food and plant materials. The efficiency of agriculture comes at the cost of biodiversity. A farmer usually grows only a few crops (the most productive ones) and kills other plants that are weeds. He also displaces animals that are plant pathogens. To increase the efficiency of his farmland, the farmer decreases the biodiversity by using all methods of modern agriculture including a chemical and biological arsenal of crop protection. In the background of an increasing human population, the increase of the efficiency of

food production can be regarded as a moral duty. It would be against the humanity principle, if we let too many people starve. It would also be against humanity (equality), if we did not let people of poor countries reach the same living standard as those of rich countries. The key question is: How much biodiversity can we afford to lose to maintain or increase our living standards? How much of the Amazon rainforest can we use for the sake of efficiency and humanity? What if in the end, it is not sustainable for the human kind?

There are also many economic decisions that are efficient and sustainable, but go against the humanity principle because they are against the moral rules of a society.

Stealing the money of others is a very efficient method to obtain profit. It is very efficient because it requires little input obtaining great return. If everybody stole money all the time, then it would not be sustainable, because in the long-term, nobody would work honestly and there would be nobody to steal from. However, stealing is sustainable, if not everybody does it all the time⁴⁷. Diversity in the system increases the stability and robustness. Having not only thieves but also detectives, policemen, lawyers and jail directors is sustainable. The coexistence of honest and dishonest persons is sustainable⁴⁸. This even applies to the behaviour of the individual: stealing, cheating and lying all the time is not sustainable. Nobody would trust or believe us anymore. The most sustainable cheaters are the ones who alternate honest and dishonest behaviour⁴⁹. Partially dishonest people benefit from the doubt of predicting, if they are telling the truth or not. Therefore, diversity in general makes any efficient behaviour sustainable. Diversity makes absolute selfishness sustainable⁵⁰. Nevertheless, stealing and cheating is always against the humanity principle, because it damages the intellectual and material integrity of other persons, i.e. it does not lead to an overall satisfaction of human needs. The victims are more damaged than the satisfaction of the criminals is increased⁵¹. Even if it is a sustainable behaviour, it does not mean that it is good or ethically correct.



These conflicts between humanity and sustainability demonstrate that despite the fact that they can be complementary in some cases, both principles are totally independent⁵². But why do humans tend to behave in an efficient and sustainable way even though it is clearly against

humanity? There is no human being who has not behaved unethically to himself or herself or experienced this behaviour from others. All individuals lie, cheat, steal and try to take advantage of others sometimes. However, we all agree on some universal human values: *profit at the cost of others is unmoral and against humanity*. We still do it even though we know that it is against humanity because profit in the short-term is a temptation too difficult to resist⁵³. For this reason, some moralists think that raw profit and efficiency are against the ethical rules of the human society. For those who assign a social component to sustainability, it can be shocking to realise that unmoral behaviour is part of the diversity that makes the system sustainable. However, I would like to stress again the fact that the moral and ethical dimension of all the economic decisions is part of the humanity principle exclusively⁵⁴. Efficiency and sustainability (diversity) are completely independent from the ethics defined by humanity. The most evident examples are provided from the field of biology.

In biological environments, there are no ethics or morals. There is no good or evil in nature. The *Homo sapiens* is the only organism on earth, which has acquired enough intelligence to enable him to experience an ethical dimension additionally to the dimensions provided by the laws of the natural world⁵⁵. Human intelligence, society and culture have invented the human moral⁵⁶. As I have previously mentioned, the purpose of the economic evolution is to serve human kind, i.e. to satisfy human needs. In contrast, biological evolution is driven by efficiency and diversity without any purpose.

From a moral point of view, almost every living organism on earth displays a behaviour that would be classified as unethical by humans. The *struggle for life* in natural environments does not follow our ethical rules because these are only a human invention. Living organisms are absolutely selfish and do everything possible to be more efficient and sustainable. Living organisms cheat, steal, kill, lie and take advantage of their own or other species whenever, wherever and as much as they can. The world of biology is ruled by absolute selfishness. This selfishness can be observed at the different levels of complexity: genes, viruses, cells, individuals, species, etc. Nature provides many examples. Animals kill other animals and plants in order to acquire food. This is not trade but blank stealing. The romantic view of nature, in which animals live in peace and happily with each other, is just a human illusion of the biological world. The struggle for life is merciless. Every individual has to look for its best possible advantage. It is not a war in the human sense, but it is raw competition of species following the rules provided by natural selection and creation of diversity⁵⁷.

The reason why biological systems are so sustainable despite the absolute selfishness and the apparent lack of any ethical behaviour is the enormous biodiversity that is found in all natural environments. There are plants that capture the energy of the sun by photosynthesis to make sugars. There are animals (herbivores) that eat these plants without giving anything valuable in exchange. There are also other animals (carnivores) that eat these animals without asking for permission to kill. There are also micro-organisms and pathogens that kill these animals without mercy. Other micro-organisms decompose the cadavers, release mineral nutrients into the soil and these recycled minerals are again used by plants to sustain photosynthesis using solar energy to fix carbon. The biological diversity leads to a closed cycle, in which every organism and species searches for the maximum efficiency⁵⁸. Sustainability is guaranteed by the enormous diversity of forms of life. An environment consisting of only plants or only animals or only pathogens would not be sustainable. It is not a coincidence that there are so many different biological species on our planet earth –every biological species has a role in a natural environment. Every piece of diversity that disappears, is a piece of sustainability that is lost.

Food Web



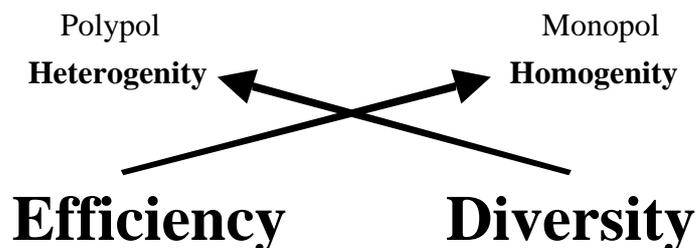
If the human kind is so blind as to rely on efficiency only, the price we will have to pay for the destruction of diversity will be very high: *the extinction of the human race*. We need to protect diversity not for the sake of the poor and defenceless animals and plants, but for the sake of the survival of

our own civilisation. Even if we would behave totally selfish, we have to protect other species in order to survive. The protection of natural environments and biodiversity is not only a moral or ethical issue; it is mainly an issue of sustainability.

The Two Driving Forces of Evolution

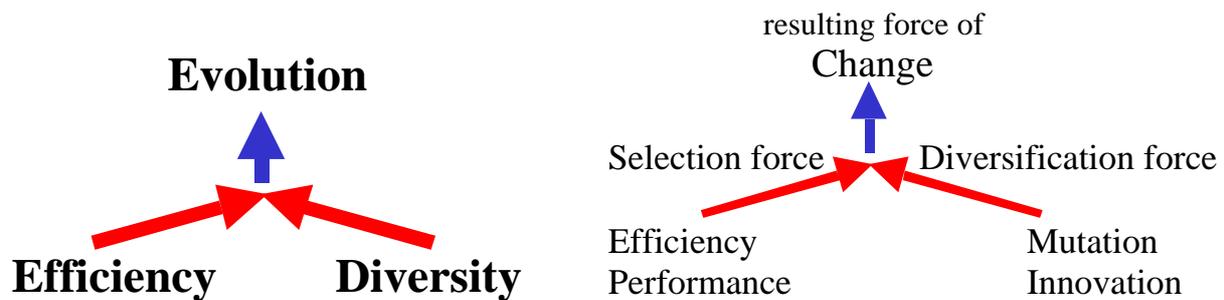
The Interaction of Efficiency and Diversity Leads to Evolution

The principle of diversity prescribes that new diversity must be constantly generated to ensure sustainability. Moreover, it is apparent that the diversity principle is similar to the efficiency principle, if it incorporates the dimension of time in the long-term. However, the diversity principle also introduces a driving force against the efficiency principle. Whereas on the one hand, the efficiency principle promotes the increase of relative profit and the tendency for homogeneity⁵⁹, on the other hand, the sustainability principle promotes the creation of diversity (innovation and diversification) and introduces a driving force against homogeneity.



Thus, it might appear that efficiency and diversity are completely opposite forces. The selection according to the criteria of efficiency decreases the diversity of the system. The most efficient will displace the least efficient. On the other hand, the increase of diversity (innovation) has a high cost and decreases the efficiency of the system because it consumes many resources. Apparently, there must be a balance of forces. But where does this balance lead?

A careful analysis reveals that both forces are not totally opposed, but they result in a remaining force. This is the **evolution**. The interaction between the driving forces of efficiency and diversity results in a sequence of events, which in biology is called *natural evolution*. In the field of economics, this evolution is referred to as *economic development*.



Evolution, Purpose & Meaning

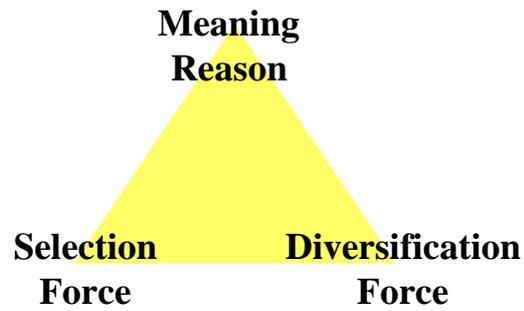
As I have already mentioned, new diversity is generated by creation. The Bible describes how the world was created by diversification of the homogenous⁶⁰. In the field of theology, creation is divinely directed through purposeful actions by God and has a spiritual meaning⁶¹. In the scope of science, creation is just the consequence of a diversifying force, which is random and has no direction. In the field of biology, biodiversity is generated by random mutations, recombination, sex and segregation (speciation). The natural selection of biodiversity according to reproduction efficiency leads to biological evolution without any spiritual meaning. Because it is random and does not contain an ethical dimension, biological evolution has no higher purpose⁶².

In the field of economics and business administration, the interaction of the diversity and efficiency principles leads to economic development. However, economic development can have a meaning, if administration is done according to all the economic principles. The purpose of economics is provided by the humanity principle. The final aim of all economic decisions is not efficiency or diversity, but to serve the human kind by allowing an optimal satisfaction of needs⁶³. Thus, economic development that is done according to all administration principles –especially humanity– can be called *economic progress*.

The word "progress" is often used in the context of economics⁶⁴ despite the fact that not all developments of the world economy can be considered as real progress. Only if the human needs are better satisfied, we can speak of economic progress. Unfortunately, the world of today is administered by too many half-capitalists for whom profit maximisation is

the single rule. Following only one half of a principle alone cannot have a meaning and cannot lead to *economic progress*.

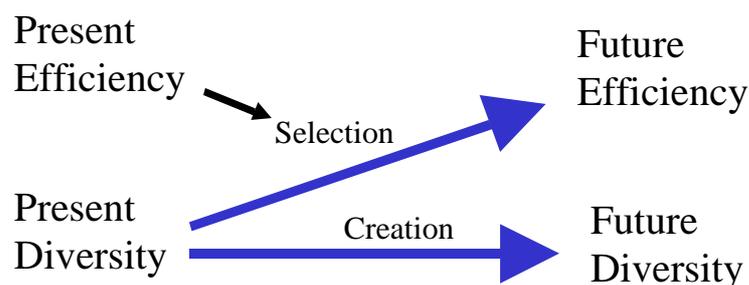
The Magic Triangle of Progress



The Theory of Biological Evolution

Evolution and diversity are terms that derived mainly from the field of biology. The common origin of the words economy and ecology already reveals that the problems of both sciences are similar. They have the identical issue of the ***limitation of available goods***. But what can business administration gain from the theory of evolution? Let me explain the theory of evolution first in the context of biology, so I can later apply some of this knowledge and principles to the field of economics.

According to Darwin's theory of evolution, the survival of individual animals or plants depends on their efficiency of the use of resources. The fittest individuals are the ones that will survive and reproduce more efficiently. Darwin called this process *natural selection*. The genetic background, the sum of all individual genes, defines the fitness of each individual. The best genes and the best combinations of genes define the most efficient individuals, which will succeed in the *struggle for life* and will pass their genes on to the next generation. However, let us consider not only the survival of individuals but also the sustainability of the population as a whole e.g. the survival of biological species over a longer period of time. The science of Ecology and the history of evolution reveal that the survival of species depends on the gene pool of the whole population. Not only is it important to have efficient genes, but also it is crucially important to possess many different and diverse genes. When the environmental conditions change, the diversity of the gene pool is the most important factor to determine either survival or extinction. Low diversity in the gene pool is the greatest risk for the survival of species. Both, efficiency and diversity are crucial for the long-term success of a species. The efficiency of a certain gene trait is only a temporary measure: it can be efficient under the present environmental conditions, but another "less efficient" gene trait can be more efficient under other conditions. Diversity is a pool of options that contains the potential of efficiency under many different conditions. But why can diversity be more important than momentaneous efficiency? On the one hand, biological species pay a high price for the constant creation and maintenance of genetic diversity. On the other hand, the price a biological species will have to pay for having too little diversity is called extinction, the dead end of the road.



Biological Strategies to Increase Efficiency

Biological species employ many different strategies to increase their efficiency. The efficiency is the most important requisite to survive in the immediate struggle for life. In biology, you die if you are not efficient. Because this essay is rather focused on strategies of diversity, I will only mention two examples of increased efficiency.

One of the biological strategies of efficiency is the symbiotic collaboration between different cells and organisms. The aggregation of biological units into bigger and more complex units allows differentiation and the accomplishment of different tasks, which in turn increases the efficiency in the use of resources. This is similar to the economical strategy of '*division of labour*' described by Adam Smith. This complementation is present at the different levels of biological complexity. The eucaryotic cell is an aggregation of cells of bacterial origin (endosymbiosis). Multicellular organisms are an aggregation of cells with identical genetic information but that carry out different functions. Different organisms in an ecosystem collaborate to carry out complementary tasks (classical symbiosis). The symbiosis allows a better overall performance of the partners as compared to non-collaborative interactions. Thus, the reward of good teamwork is to increase the efficiency for all the partners, not only in biology, but also in our businesses and economies.

The most successful strategy to increase the efficiency of organisms is the development of a nervous system that allows a certain degree of intelligence. The nervous system allows the organisms to accomplish many tasks like the screening of the surrounding environment for food, the escape from enemies and the control of a motoric system through the coordination of different body parts. This system allows a higher efficiency because it is rapid, accurate and reliable. Intelligence also allows for a higher efficiency because it stores knowledge gained from past experience in order to apply it under different circumstances. Intelligent animals are able to reason and think before they act in order to obtain what they need with a minimal use of resources. Thus, smart animals can afford to be 'lazy' most of the time because they are very effective when they need to. Intelligence is the basis of 'learning', which allows a prediction of the future.

This helped the Homo sapiens become the most successful species on earth. With the power of his technology, he is faster, stronger, smarter, and more accurate, precise and flexible than any other organism.

Biological Strategies to Increase Diversity

The continuous generation of new diversity is crucial for the sustainability of any biological species. It astonishes that even in the natural world of 'survival of the fittest', where there is no mercy for failing to be efficient, the species invest so many resources to increase their diversity. Biological species sacrifice a lot of efficiency in order to create and maintain diversity. Let me mention only some of the mechanism and strategies that can be found in nature:

Biological species use special mechanisms to increase and maintain the diversity of their gene pool. They allow a certain degree of error in the duplication of DNA⁶⁵. They also rearrange the genes through exon shuffling and recombination. To achieve this, they employ a molecular machinery of proteins to carry out these creative tasks. The creativity of the molecular machinery is tightly regulated, especially when the environment changes⁶⁶. To allow a greater diversity of genes, most species carry a multiple set of genes in their genome⁶⁷. It would be entirely sufficient and more efficient to have only one copy of the genes, but many organisms have two or more copies in order to have one good gene (allele) and additionally other diverse ones⁶⁸.

Organisms also use sex to increase diversity⁶⁹. Sex leads to the creation of diversity by recombination and new rearrangement of genes. Sex not only increases the diversity of genes, but also increases the diversity of individuals (male and female) with different physical and mental capabilities⁷⁰.

It is fascinating to realise how many resources biological species invest in for sex⁷¹. Some plants even use more biomass for the generation of sexual organs (flowers) as for any other purpose. Many animals invest more energy in finding and mating with a partner than in anything else. The extreme predominance of sex in biology could be seen as a requisite for the multiplication and growth of populations. However, this view is not fully correct. In principle, biological species do not need sex for multiplication or reproduction. The population can easily grow through vegetative (asexual) reproduction. In fact, many animals reproduce asexually through parthenogenesis, plants through vegetative cloning or apomixis⁷². Bacteria can multiply and grow exponentially without any sex. In principle, any biological species could reproduce with mitotic⁷³ divisions only. It is even more efficient to multiply and increase the number of individuals without any sex (by cloning). For example, many species of aphids (insects) multiply asexually when the population needs to increase

very rapidly, but they use sex when the population needs to adapt to new environmental conditions. If asexual reproduction is so efficient, why do not all species reproduce asexually? The answer is easy: Sex is less efficient, but it is required to increase biological diversity in order to ensure sustainability. Cloning is efficient but the lack of diversity in identical copies is not sustainable. Without the diversity generated by sex, the biological evolution would have been a very slow and boring story.

Thus, the aim⁷⁴ of sex in biology is not reproduction, but instead it is the creation of diversity. After survival, biological species give the highest priority to the generation of new diversity. In contrast, the present world economy gives the least importance to diversity. The capitalist block gives the most importance to efficiency, and the socialist block tried to give more priority to humanity –and failed. If the world leaders gave similar priority to diversity in economical systems as in biological systems, our civilisation would not have a problem of sustainability.

To become aware of the biological importance of diversity, we humans can analyse the value that we give to the basic instinct of sex in our life. There are many people who learn, work, earn money and spend a great amount of their time only satisfying this biological need. In extreme cases, the sexual desire is greater than the stability of a family or the issues of the greatest nations or companies⁷⁵. The strong biological instinct for sex is not an accident or coincidence but is required for the sustainability of biological species, and it is genetically imprinted. Within the scope of personal behaviour, the desire for power and money is often only matched by the desire for sex. If these people realised that power is linked to humanity, money is linked to efficiency and sex is linked to diversity, the personal decisions could be traduced into more wise decisions in the world economy. The power of such men could be measured by their ability to satisfy human needs⁷⁶. The fortune of men should be measured by their efficiency to use resources⁷⁷ and satisfaction of sex could be measured by the diversity they maintain and generate.

Some species even have incorporated special mechanisms in order to increase the diversity that is generated through sex. All the resources biological species use for sex are an investment for the future. A great investment needs a great return. Sex without the generation of new diversity is a waste of resources. There are many biological strategies that protect the great investments put on sex. Let me explain some strategies followed by plants:

Presently, the most successful plants on earth are the flowering plants. They cover almost all of the land on all continents and represent the greatest biomass on earth. The secret of their success is undoubtedly their efficiency, flexibility and capacity of adaptation to the many different ecosystems and environments on earth. This has not come by chance but is due to their sexual organs, the flowers and fruits⁷⁸. The flowers of plants are like pieces of art resulting from a creative act⁷⁹. This creativity is the driving force of diversification. The marvellous shapes and beautiful colours we find in the flowers of plants are nothing else than the special strategies of plants in order to increase the diversity that is generated by sex. The colours and fragrances of flowers attract animal pollinators that are used as carriers of pollen, containing the male genes⁸⁰. Through these means, flowers are pollinated with the pollen from many different and diverse individuals. The special shapes of flowers not only allow the attraction of pollinators, but they also prevent the self-pollination of flowers. Self-pollination is less desirable because it does not lead to the same diversity as pollination with foreign pollen. The whole shape of the flower and especially the arrangement and morphology (time and spatial development) of the gynoecium (female organs) and the androecium (male organs) have the special function to increase foreign pollination but also to ensure survival by self-pollination in case no foreign pollen is available⁸¹. This successful strategy to avoid self-pollination also has allowed plants to have sex as hermaphrodites (male and female in the same individual) and to build flowers with both female and male organs. However, plants with separate male and female blossoms (e.g. maize) and plants with separate female and male individuals (e.g. papaya fruit tree) are also successful.

Additionally, plants have molecular mechanisms to increase the percentage of foreign fertilisation. This strategy is called self-incompatibility of pollination. This refers to chemical and biological barriers, which promote or inhibit the growth of the pollen tube that is required to fertilise the ovule cell. For a flower of any plant with its own set of genes, the growth of pollen with the less diverse genes is inhibited. In contrast, the growth of foreign pollen with the most diverse genes is promoted. The underlying mechanisms are not fully characterised yet, but they involve several compatibility genes (signal molecules and receptors) with a high degree of variability. Self-incompatibility is a genetic mechanism that maximises the generation of new biological diversity by sex.

The aesthetic beauty we find in the flowers of plants is our appreciation of the diversification force in nature. We love the capabilities of creation and innovation of plants. It is deeply rooted in our biological instinct that we appreciate creativity in all fields, and as we like flowers we also like art, music, poetry, culture and research. The social status of artists, musicians, poets and scientists is related to their creativity and power of imagination. The creation of new diversity is one of the things that we admire most. We

should not only appreciate diversity for its beauty but also because it is really essential for our survival.

The link between sustainability, risk, diversity, creativity and randomness can be wonderfully demonstrated using an example from Immunology. The human immune system is a beautiful defence machinery that is able to protect us from pathogens and other hazards. Without an immune system, humans cannot live for long in an open environment full of risks. The robustness of the system is based on an extremely high diversity of cells and antibodies that protect us even from unknown pathogens. There is almost nothing for which we would not have an antibody. The spectacular diversity of antibodies is randomly generated through a highly creative and tightly regulated molecular machinery. A very strict selection system ensures then that this diversity is effective and efficient. Not only it has to tolerate our own cells, but also it has also to attack all foreign cells and intruders. The system is highly flexible since its efficiency depends on how fast it recognises a pathogen and reacts to it. Is this diversity of antibodies not marvellous and essential for us to survive even under unexpected conditions?

There are many other phenomena in nature that are directly related to the diversity principle. I could not mention them all here. Some of them are as marvellous as the above-mentioned flowers. Others are as exciting as the mating behaviour of lions, the colourful shapes of fish, the wonderful singing of birds or the extravagant shapes of insects. However, others are not so appealing to the human mentality.

The Other Side of Sustainability

Until now I have been speaking about creation and innovation as sources of diversity and sustainability. But it is also important to explain the other side of the sustainability principle –the necessary complement of creation and a requisite for evolution. It is time to refer to the phenomenon of death in nature. As paradox as it might sound, death is an important component and requisite of sustainability. The biological death of individuals allows the continuous creation of diversity.

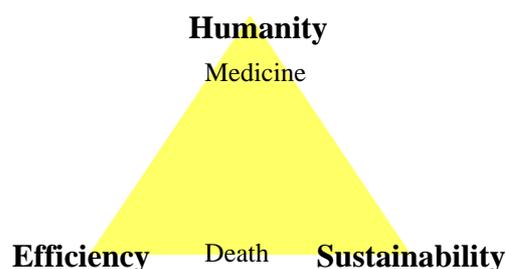
Sure, there are many ways to ask for the reason of death. Death is dramatic, important, terrible but also necessary. For many humans, this question is one of the most important motivations for the adoption of any belief or the practice of any religion. Here, I would like to avoid the theological interpretation⁸² of death but will try to view it from a scientific point of view. What is the biological reason for death? Is it impossible to live forever? Would it be sustainable to live forever? Is death something

unavoidable because of the physical use of the organic body, which at the end leads to ageing, malfunction and failure? The answer is no. Biological organisms are fundamentally different from objects like cars or aeroplanes, because they have the potential for regeneration. In contrast to a car that is being used and will malfunction sooner or later, from the organic point of view, there is no fundamental need for death of an individual organism⁸³. In principle, biological organisms could live forever. At this point, I must make a distinction between two kinds of deaths in biology depending on the stage of development. Frequent causes of death are killing, eating, accident, starvation, illness or displacement. If young or immature individuals die prematurely, this is considered a failure in the *struggle for life*, because their genes are lost. According to Darwin's theory of evolution, this kind of death is called natural selection. The second kind of death can be distinguished because it happens after the individuals have accomplished their mission for sex and reproduction. This kind of death is not considered as natural selection and does not necessarily mean a failure in the *struggle for life*, as the genes have already been successfully passed on to the next generation. This is the death of old organisms.

To make the point, the first kind of death is mainly related to the efficiency principle (selection force). Nevertheless, both kinds of death are also related to the sustainability principle. Death of the inefficient opens the space for the survival of the efficient. Death of the old opens the space for the development of new and young diversity. The requirement for death comes from the limitation of space in the world. Without death, the continuous creation of diversity would lead to continuous growth, and this is not sustainable in a limited world.

Biological ageing and degeneration is a genetic programme that is carefully controlled. Many species have chosen to live just enough time as to accomplish their biological mission for passing on their genes. Other species live longer in order to protect the coming generation and increase their probability of survival (nursing). From the biological point of view, living much longer and without reproduction is a waste of resources. It is against efficiency and diversity. Thus, sex and death are both biological strategies to increase diversity.

Natural selection can be regarded as the death of the inefficient, whereas death of mature organisms (after passing the genes) works according to the principle of diversity. Therefore, death can be placed between the sustainability and efficiency principles.



Philosophical Analysis of the Principle of Diversity

It would not be a complete essay, if I only wrote about the principle of diversity without mentioning and analysing its philosophical dimension. Readers who are only interested in economics can skip this chapter and go directly to the next chapter concerning the analogies of biology and economics and the life cycle and evolution of a product. In this chapter, I would like to present the principle of diversity in a broader philosophical context. The concept of diversity is not only useful for an economy but can also be extended and applied to the different fields of human activity. Diversity can be analysed from social, psychological, medical, scientific and theological points of view.

Human Attitudes: Sex, Intelligence and Love

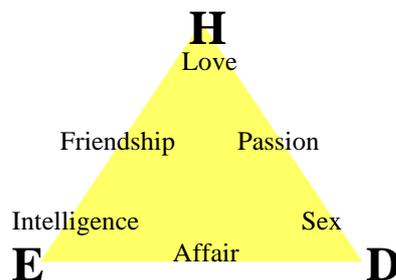
The magic triangle of 'economics' can be used to characterise many human attitudes, which can be placed within this triangle. Most human qualities are not in the centre but have some bias towards efficiency, diversity or humanity. Sometimes, there are conflicts between them. An example of this is the classical conflict between sex, love and intelligence. Humans would like to combine all these behaviours but are often confronted with difficulties, as they seem to be opposed to each other. This separation is also reflected in our language of feelings: Intelligence is commonly assigned to our brain, whereas love is felt in our heart and sex is usually directed somewhere else.

Love is closely related to our humanity. Love has a truly spiritual dimension, and for many it is our sole purpose in life. Love is usually directed to one person only (monogamy) or one God (monotheism). In contrast, sex is less spiritual and is not restricted to humanity but is also common in animals and plants. As previously mentioned, the function of sex is to increase biological diversity. Sex is required for the sustainability of biological species, but it does not provide a purpose in life. Sex is close to the principle of diversity and is far from love (humanity). In the context of human behaviour, love tends to minimise diversity, whereas sex tends to maximise diversity, not only of sexual attitudes but also of sexual partners.

The compromise can be found between sex and love that requires much tolerance. This compromise can be very far from intelligence or efficiency. Considering the amount of time, effort and resources that humans invest in sex and love, it is clear that these behaviours are not primarily intended to be efficient.

On the other hand, intelligence is a biological strategy to increase the efficiency of species⁸⁴. Intelligence allows us the efficient use of resources and to perform better than the competition. In the context of business administration, intelligence is also a source of economic success and efficiency. In the context of human behaviour, intelligence sometimes contradicts the feeling of love and the desire for sex. We then make a distinction between rational and irrational thinking. People who avoid the difficulties imposed by the compromise between sex and love are among the most efficient workers. However, they can be less tolerant.

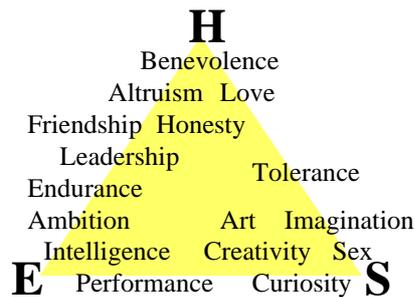
We can also find a compromise between love and intelligence, which excludes sex. It is called friendship. Similarly, a compromise between intelligence and sex, excluding love can be found as well. This type of affair is very common among young single people who act intelligently but do not wish to compromise with love or a spiritual relationship. Instead they choose something else that could give meaning to their life. We might even find a personal blend or mixture of all. Apparently, everything is possible. The ideal combination of all components could be called '*the ideal relationship*': one that is true, good and beautiful at the same time.



Besides sex, love and intelligence, there are many other qualities that are close to only one of the principles. Benevolence is related to humanity, whereas imagination is related to sustainability, and ambition is related to efficiency. There are also many qualities between two principles. For example, tolerance is not only human but it is also in favour of diversity. However, tolerance is not always efficient. On the contrary, good

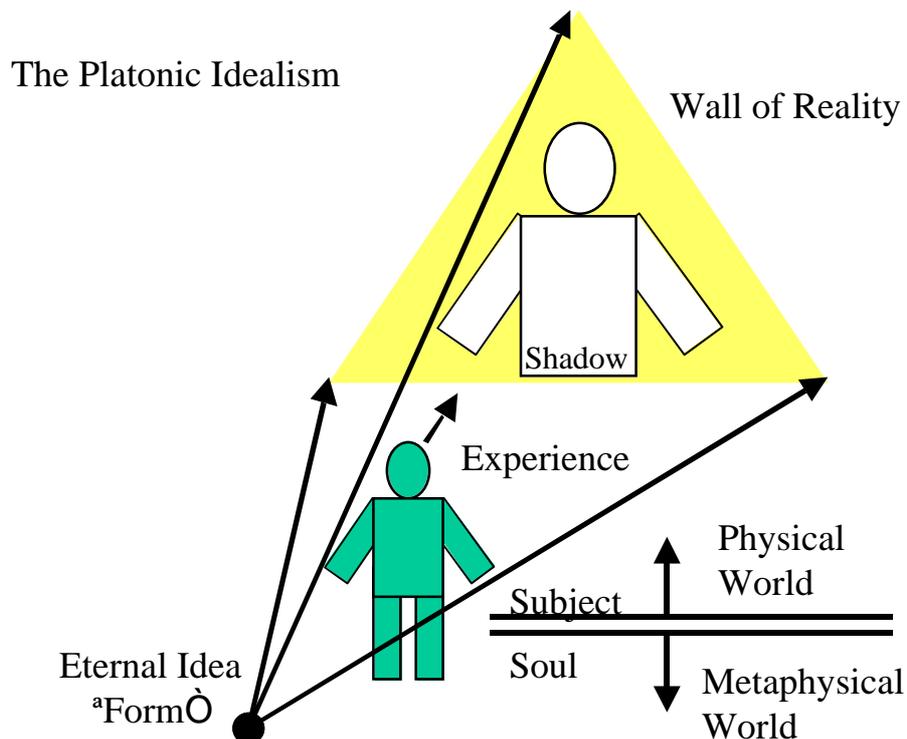
leadership is efficient and human, but tends to minimise diversity, since it is only one person who decides.

It would go beyond the scope of this essay to explain all human qualities here, but it would be certainly interesting to place all the human qualities in the magic triangle. Possibly, this could be added in a future essay. I would like to postulate that the priorities that each individual place in each of the human qualities reflects his or her personal bias, which determines the decisions he or she is likely to take in daily life and in the economic field.



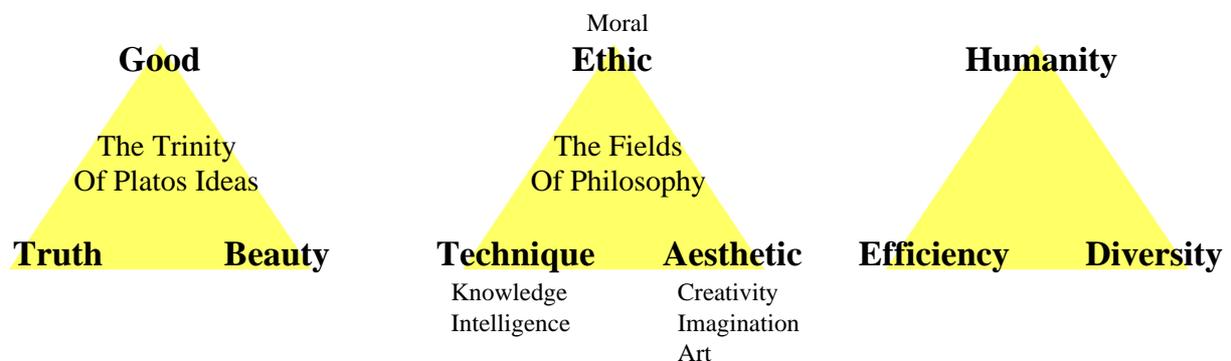
The Magic Triangle in the Context of the Philosophy of Plato

The Greek philosopher Plato (427-347 BC) is the father of all European thinking. According to his metaphysical view, the human senses can only recognise (experience) the shadows of an idealised world of eternal existence. The essence of the Platonic world is '*The Eternal Idea*'.



The centre of the Platonic universe is the idea (idealism) of the inseparable trinity of *Good*, *Truth* and *Beauty*. Unlike Plato, other philosophers separate philosophy in different fields, such as Ethics, Aesthetics or Technique. Ethic is linked to morals and religion. In turn, aesthetics is linked to creativity, imagination and art. Finally, technique is linked to knowledge and intelligence.

According to Plato, moral, knowledge and art are inseparable⁸⁵. However, many philosophers and scientists make a distinction between these fields. In this essay, I have described the separable dimensions and conflicts of the triangle of humanity, diversity and efficiency in the context of an economy. Here, in a philosophical context, I would like to present the triangle of *Good*, *Beauty* and *Truth* in order to postulate that the edges of all the different triangles are equivalent. They correspond as following: ethics defines humanity as good; aesthetics defines diversity as beautiful; and technique defines efficiency as true.



The equivalence of good-ethics-humanity is obvious and requires no detailed justification here. Ethics is the study of the "*good or bad*" using the human context. In all these cases, the top of the triangle provides the purpose for life, religion or economy. The other two equivalencies need some more explanation. Technique uses knowledge, which is obtained through science and the use of human intelligence, to improve the efficiency of nature⁸⁶. For example, technology makes cars that run faster than horses, and aeroplanes that fly higher than eagles. For many people (e.g. scientists and capitalists) knowledge and efficiency provide the only truth⁸⁷.

At first, it might be a bit surprising to link sustainability and diversity with aesthetic, because the study of aesthetics has been mainly focusing on the appreciation of human art and culture. In all cases, aesthetic deals with the question of beauty. Here, I wish to declare that diversity is beauty in an universal sense.

The imagination and creativity of artists leads to the generation of diversity (pieces of art). The human senses experience this cultural diversity as beautiful. However, beauty is not restricted to the diversity of art, such as paintings, sculptures, dance and music, but is also present in the biological diversity: green rainforest, colourful birds and coral reefs. Nature is exquisitely beautiful. Furthermore, the organs that generate diversity in plants –the flowers– are beautiful⁸⁸.

Is the conservation of the biodiversity of the world an aesthetic endeavour⁸⁹? Many current efforts for conservation of the natural diversity are indeed based on aesthetic arguments of beauty⁹⁰. If diversity is beauty, then the creation and protection of beauty means the creation and protection of diversity. Unfortunately, capitalism is focused on the efficiency principle (profit) and has therefore little understanding for the beauty (diversity) of the world. However, managers and business administrators should learn that, even if beauty (diversity) cannot always be accounted in units of money, it is essential for the company's sustainability and long-term profit. A Wall-Street broker who increases the diversity of his investment portfolio is not only decreasing the risk but also increasing the *beauty* of his investment.

The current practise of business administration has partially incorporated some but not all lessons of *The Principle of Diversity*. Constant research, creativity, innovation and generation of new products are essential for the survival of a company. Managers are aware of the importance of this diversity because it can be measured in units of money, and the future payoff can be easily calculated. Any decent company has a research and development programme. Investment brokers have learned to handle randomness, using mathematical formulas to describe the risks with numbers and probabilities.

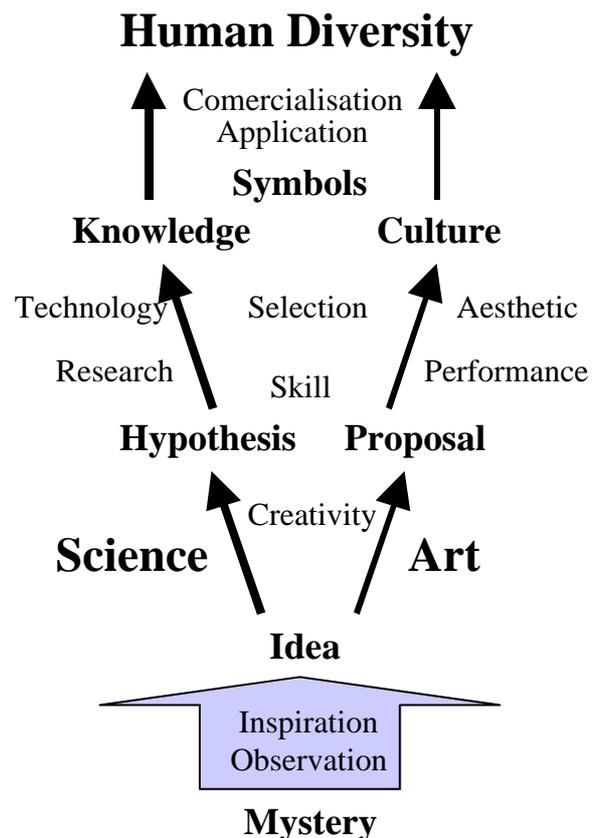
Unfortunately, many other aspects of diversity and beauty cannot be measured through numbers and money⁹¹. Therefore, the economy of the

world will not be sustainable, if managers cannot avoid measuring everything in terms of money⁹². To become a sustainable economy, not only a long-term vision is required, but also the risk has to be decreased and diversity increased, even without the justification of numbers. Capitalist managers, who learn to value and increase the diversity and beauty of this world, will be rewarded with art, but also with the cultural and biological resources that are required for long-term success of their business. The day, beauty (diversity) becomes as important as profit (efficiency) and moral (humanity), the human kind will gain a better world (economy)⁹³.

Science and Art Generate Diversity

Science and art are both truly aesthetic efforts. They are creative processes that are based on inspiration, imagination, intuition, interpretation and technical skill. Both develop best in an environment of intellectual freedom. Both require talent, dedication and a lifetime of learning. Material resources are needed, but more important is the human input. Science and art are similar because they both create new diversity that is required to maintain our world. The practical skills and efforts in art are called performance and in science they are called research. In art, the selection of diversity is called beauty, and in science it is called truth. My uncle – a very talented architect, artist and writer – once told me that art was the revelation of the mystery... he also mentioned the importance of the generation of symbols. I replied to him: Science does the same!

Both will never provide a final view of the world, but only provisory answers. The value and usefulness of both resides in generating and



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Both will never provide a final view of the world, but only provisory answers. The value and usefulness of both resides in generating and

understanding the beauty of this world. Both are able to create new beauty that is required for the success of our civilisation and progress of our economy.

The Concept of Beauty in Relation to Universal Aesthetic

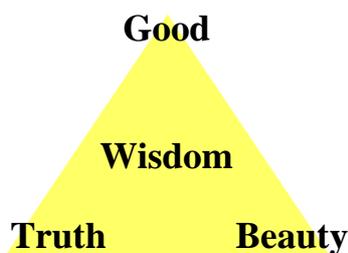
Is the aesthetic restricted to the appreciation of human creations⁹⁴? Why not apply aesthetic judgement to all creations of the universe? As this essay is mainly focused on economics, I will not go into much detail here. However, I might discuss these questions in some future essays –if God allows. Possibly, the field of aesthetics should not be the exclusive domain of artists, but it could also be discussed among a broader audience. The approximation of art and science could provide very valuable new insights. My first personal experiences have been very encouraging. The scientific and artistic endeavours are not as different as one might think. Having said this, I can now reveal why I chose such an artistic cover for the present book, despite the fact that this essay is more scientific and mainly focuses on economic issues. Certainly, the cover suggests more art and esoterism than useful economical knowledge. Possibly, more books could be sold if using a more commercial figure in the cover. However, I see a deeper reason in this figure. Science, art and beauty are all part of The Universal Principle of Diversity. The constant creativity and the balance of the two forces of efficiency and diversity lead to evolution. Do you think that the cover fits to what I have been trying to explain and postulate in this essay? My hope is also my struggle. I am writing this essay with the following conviction: Business administrators and managers, who recognise the value of diversity and beauty, will be the ones who bring a sustainable economy to our world. If business administration would incorporate aesthetical arguments into the daily decisions, the economic enterprises would not only be more beautiful but also more creative, diverse, robust and flexible.

The Separability of Truth from the Good

Up until nowadays, the legacy of Plato's philosophical Idealism has deeply influenced European thinking. Plato's inseparable trinity of truth, good and beauty is deeply rooted in our occidental culture. In the American Declaration of Independence, Thomas Jefferson included the sentence:

ÓWe hold these Truths to be self-evident, that all Men are created equal, that they are endowed by their Creator with certain unalienable Rights that among of these are Life, Liberty and the Pursuit of HappinessÓ

This sentence is the cardinal premise of America's civil religion. It is evident, that in the above assertion, the concept of "Truth" is used to validate and justify an ethical statement. The term "self-evidence" is used to justify the "good" of human equality. But is it really necessary to use science or knowledge to give more power to our ethics? Would our ethics loose too much of their authority, if we accepted that moral laws are just a human invention and not part of any universal law? I believe that in the real world, in which we live, we have to separate the concepts of what is true, good or beautiful. If we return to the Jefferson statement: the fact (truth) is that all men are unequal. The self-evidence is that all men are different. Consider alone colour, height or weight. Even twins, who are genetically identical, have a different character and different opinions. However, regardless of the truth, our ethics should be independent. It is good that all men are declared as being equal and have the same rights. Can we all agree on this consensus? Don't we have the choice between good and evil, independent of what is true or not?



The Truth is that all Men are different.

The Good is that all Men are equal.

And the Beauty is that Men are diverse.

Is There a Good Untruth or a Bad Truth?

The separation of the concepts of good, truth and beauty builds the very core of the philosophical premises of this essay, and therefore I would like to add some more details here.

Although the separability is not a new revelation, it is not evident to everybody and it is still not accepted by all humans. We all know many examples of our daily life, where we do make a distinction. Sometimes we are not aware of it, and some people do not agree on that.

Let me mention only a few examples. A frequent case is the concept of a 'white' lie. We all have heard or expressed a statement that is not true, but it is nevertheless good. Any specific example that I will mention should not distract from the many more that occur personally to the readers. But what is exactly a 'good' or a 'bad' lie? A good lie is something that is untrue but nevertheless leads to a better satisfaction of human needs. A bad lie does not lead to a better satisfaction of human needs

Is it that easy? Possibly not. Objectively, it is easy to distinguish the truth from the untruth, because science and technology can provide us the tools for this task. Subjectively, it is difficult to make a distinction between a 'bad' lie, and a 'good' lie. If a corporate criminal steals the money from the government or from a company by making false statements and lying, this satisfies his selfish interests, but it damages the ones of the stakeholders and the rest of the population. This is certainly not good. It might be easy to agree on what is a 'bad' lie⁹⁵, but it is more difficult to agree on what is a 'good' lie. This is due to the diversity of opinion of the human beings. For some persons a *good lie* is to tell the children that Santa Claus comes at Christmas time to bring us gifts and presents. For some others, it is good to avoid hurting the feelings of their partner by not mentioning that he or she had sex with another person. In Spanish there is a common saying that 'Eyes that do not see, heart that does not hurt'. For others, it is good to calm sick people by reassuring them that they will go to heaven when they die. In many cases, a good untruth is more able to satisfy our human needs than the plain truth.

Not only the good and truth are separated, but also the beauty is independent. In our daily experiences, we recognise not only good lies and

bad truths, but also beautiful lies and awful truths. A movie or a novel can be beautiful and good without being true. A story can also be true and good without being beautiful. An exciting experience can be true and beautiful without being good.

Many religious and moralist persons will not agree with these views and opinions. For them, something that is false cannot be good, or something that is true cannot be wrong. Therefore, some religions rely on dogmas that are unquestionable and should be always accepted as the absolute truth and divine good. The Virgin Mary was truly virgin and divinely pure. The Bible contains the absolute truth. There is only one true God. The Pope says not only what is good, but he always says the truth and he is never wrong (infallible). If you are catholic, you have surely heard of the inseparable Trinity.

When the concepts of truth and good are not separated then a problem can arise when something that is believed and accepted to be good turns to be false by scientific scrutiny. Science and religion then become enemies. Therefore, the big religions ask for unconditional fate, despite any conflicting evidence. They ask for religious fate, even if the knowledge of the truth can be contradictory. Consequently, some religions have been the fiercest censors of science, and oppose to the discovery of the truth. Many famous and other less known scientists and honest persons had to give up their work and even burn in the stake because their ideas or theories contradicted the religious opinions of that time. Galileo Galilee was forced by the Church to change his views but in the end he could not stand the lie because the earth was indeed turning.

There are many more examples of the desire to regard the truth and good as inseparable. The socialist block was characterised by a censorship (restriction of the truth) and oppression of the personal opinion that contradicted the communist ideal (ideological definition of the good). Even today in the 21st century, George Bush and Tony Blair cannot recognise that they lied on the issue of weapons of mass destruction because they believe that it was good to invade Iraq and get rid of Saddam Hussein. The Anglican imperialist leaders believe that their western political and economical system will be more able to satisfy the needs of the Afgani and

Iraqi people. Hopefully, this political desire for the good becomes a true reality for the invaded Arab nations.

There are many people who do not wish to make a difference between the concepts of truth, good, right and justice. They rely on the idealism of merging them all. However, many conflicts arise in the process of trying to make them equivalent.

Concept Pairs	Explication
True - False	Scientific concept of the truth based on experimental facts and knowledge. It is objective and testable.
Good - Bad	Ethical concept of the good based on philosophical premises and a broad social consensus.
Good - Evil	Religious concept of the good based on mythology, sacred scripts and interpretation by prophets and priests.
Right - Wrong	Practical concept of the good based on the human experience.
Legal - Illegal	Political concept of the socially desirable and allowable based on rules, legislative scripts and their interpretation by officers, lawyers and judges.
Beauty - Awful	Aesthetical concept concerning the subjective appreciation of the diversity of this world. Requires a personal interpretation that is sometimes influenced by the opinion of 'experts'.

Human Curiosity and Age

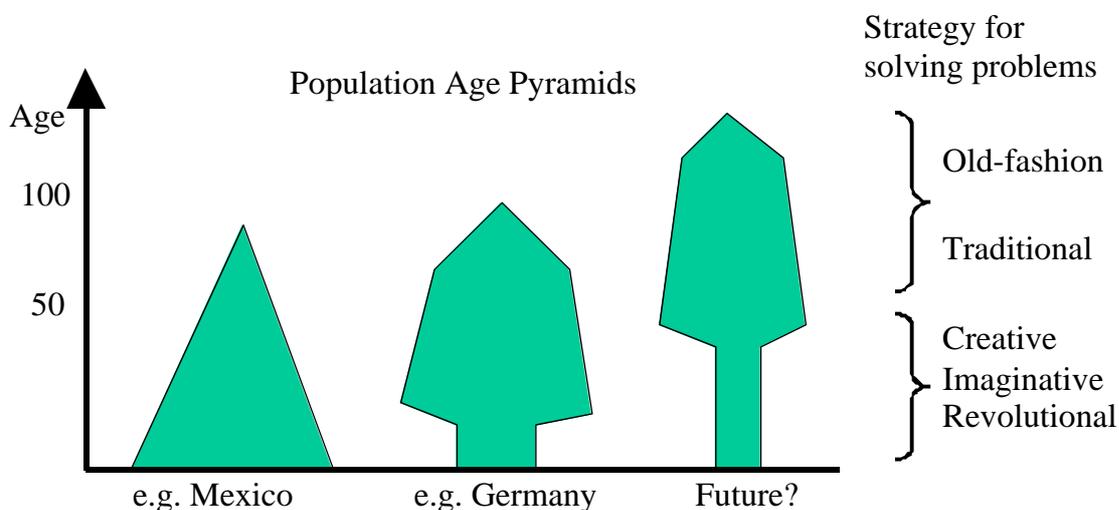
The human kind is a curious species that is always searching for new ideas. We want to know more, travel all around the world and experience all kinds of feelings. As children we play a lot, we have an enormous imagination and invent and try many things simply out of curiosity or for the thrill. Intellectual curiosity makes us spend a great amount of time, money and effort to study and learn our whole life.

But why are we so curious? Is it bad to want to learn more? Is it a sin to be curious⁹⁶? Could it be that a universal principle is generating the

intellectual curiosity and diversity in the human mind? Is it the innate curiosity, which is biologically imprinted in our nature, a constant search for higher efficiency that is required to sustain our species?

Interestingly, the drive of curiosity is developmentally regulated, since it decreases with age. Young adolescents are much more curious, imaginative and creative than older people are. Very often, the conflict between the old and new generations is rooted in the difference of this creative power. Older people are more interested in continuity and doing things in the old way. They are carriers of traditions and holders of established values. They use their experience of the past to solve the problems of tomorrow. However, instead of preserving the world, static and established methods are a barrier for the sustainability of an ever-changing planet. It is not experience or tradition that is required to maintain our world, but it is the power to learn and the creativity, flexibility and dynamic that is essential in order to adapt our way of living to new conditions. The problem of sustainability of our world is not linked to a lack of experience or tradition, but it is related to a lack of adaptation and is due to administrative inertia. Established stability should not be confused with future sustainability⁹⁷.

Remarkably, the wealth and power of the world is concentrated in a group of people whose average age is increasing. Improvements in medicines have led to increased longevity of humans. In Europe, this is leading to an inversion of the age pyramid.

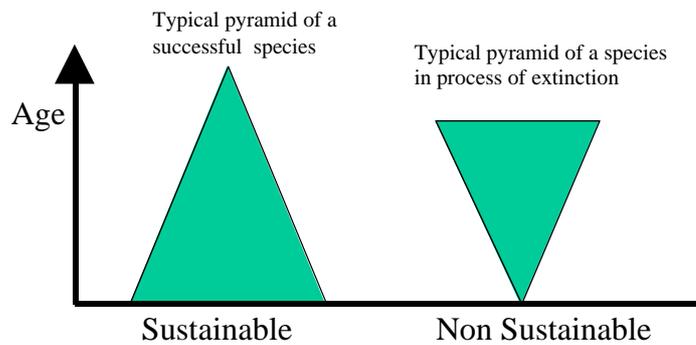




Today, it is becoming increasingly common that a 30 years old person is accused by a 60 year old of not having the experience to make decisions. In turn, 15 years old adolescents need to teach their 50 years old parents about the importance of recycling waste, saving natural resources, avoiding contamination and protecting the rainforest.

There is no reason to believe that young people are less able to make wise decisions and rule the world. Most of the greatest rulers in mankind's history were younger than 40 years. But today, we live in a world where it is increasingly common that people older than 65 years are still ruling the world and making the most important decisions for our future. If the holders of power are getting older on average, why is their experience not preventing our world from getting less and less sustainable? Could their inertia and reluctance to change be the reason for some of the sustainability problems? The experience of the old people is very valuable, but this has to be combined with the flexibility and creativity of the young people.

In a discussion about sustainability and age limits, it should be questioned that, if somebody younger than 18 years is not allowed to vote or rule the world, people older than 65 years still have the right to vote or rule the world. Why does our society deny the right of young adolescents to vote or make political decisions? Why should our grandparents have more rights to decide about the future than our children? Whom does the future concern more?



The Humanity Mission of Medicine

In an earlier chapter, I have claimed that biological death is necessary for diversity and sustainability. From the arrangement as a triangle it is not surprising that death is one of the aims most opposed to the humanity principle. Medicine in turn, is a fight against death.

According to the humanity principle, death is not desirable and should be avoided. With some exceptions, humans do not want to die nor do they wish death to other humans. However, following the humanity principle with all possible technical means is against the sustainability principle. Let me explain this through the example of human medicine:

The practice of medicine can be considered as one of the working fields most closely related to the humanity principle⁹⁸ and the furthest away from biological death. The education of medical doctors includes indoctrination to the use of all possible means to avoid the death of humans. With the increase of biological and medical knowledge and the innovation of technical tools that are available to cure human diseases and repair the human body, the conflict grows steadily. It is no science fiction that modern medicine will soon be able to expand the life-expectancy of humans well beyond a full century. From the point of view of biology, eternal life can be achieved, if we are able to turn off all the biological mechanisms that promote ageing, prevent regeneration and lead to death. But shouldn't we first ask why biology chooses to include these mechanisms into our genetic programme? Could the answer be that without the death of individuals, the species would not survive in the long-term? Could it be that one of the major problems of modern medicine is that it is becoming so successful that it is leading us to a path of unsustainability?

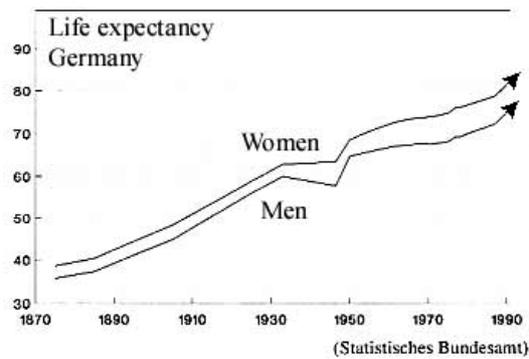
Ethical, Aesthetical and Technical Challenges

As frequently mentioned in this essay, the three economic principles can be regarded as the corners of a triangle, which are more or less opposed

to each other. It is not possible to fulfil all aims at the same time. Instead, a balance or compromise must be found between them. How can we solve the problem of our survival since biological death is according to the principles of efficiency and diversity, but is opposed to our humanity principle?

One of the greatest challenges of ethics in our days is to solve the moral conflict between the necessity of biological death, derived from the sustainability principle, and the unlimited medical life extension dictated by the humanity principle. This ethical conflict can only be solved by moral authorities, such as priests or religious leaders, i.e. a Pope⁹⁹, Rabbi, Caliph, Dalai Lama, etc. However, politicians can also try to tackle the conflict from the rational and legal point of view. One of the roots of the problem resides in the legal prohibition of death; it resides in the legal punishment of doctors who fail to apply all available methods of medicine to save a person's life. We are morally proud that we have created a modern society, in which it is legally prohibited to die or let die. However, despite the fact that death is not desirable, it is still necessary¹⁰⁰. Nevertheless, no human should determine on the fate or death of another human. In our modern society, no one could avoid a wave of moral disapproval, if he or she dared to propose another solution. Scientists will never be able –or wish– to provide a solution to ethical questions. Science and technology can tell the truth from a technical point of view but cannot judge on the good from an ethical point of view. However, as a person, concerned with ethics, I have always been unsure about some moral questions. I wonder, if Jesus Christ wanted to give us a final message, we never managed to understand from the moral point of view. He said that his death was required to save humanity. Does this mean that personal death is required for the sustainability of the human race? It would be interesting to hear more about this from the ethical authorities of our world...

It is very important that we start to provide answers to those moral questions, before technology gives us the tools to extend our life indefinitely. Modern medicine is not very far from achieving eternal life. The average life expectancy is rising steadily and will soon exceed a whole century. Some people would prefer to slow down the pace of technology, but at the same time it is also necessary and highly important to speed up the pace of ethics¹⁰¹.



The Problem of Succession

Ironically enough, modern medicine is accentuating the problem of succession between generations. The old guard does not want to hand over anything to the youngsters because medicine keeps the old fit and healthy. Unfortunately, modern medicines increase the length of life but do not prevent the decrease of creativity, imagination and flexibility to a great extent. According to the humanity principle, old people should certainly be treated with respect and dignity, but care is also needed to avoid that the old generation puts the sustainability of our planet too much into danger. The experience and diversity of the past must be conserved, but it has also to allow enough room for developing new diversity. We must judge how much sustainability we can afford to lose for the sake of humanity.

In natural environments, a genetic program of death solves the problem of succession of generations. The programmed cell death is called apoptosis in biology. Not only single cells but also whole organisms are programmed to die. Many animals and plants die automatically when they have accomplished their mission of passing their genes on to the next generation. In some cases, the problem of succession is solved in a violent way. For example, the black widow kills and eats the male spider just after it has fecundated the female with male sperm. In animals living in social groups with many females and one dominant male (e.g. deer, lions), there is a continuous fight between old and the young males for the supremacy of the group. In many cases, the old lion gets severely injured or killed by the young lion. Not only this but the young lion also kills the babies of his old competitor. As I had previously mentioned, in the world of biology there is no ethics or humanity principle. Therefore, the violent behaviour of animals cannot be judged morally. Instead, we must recognise that it is for the sake of diversity, sustainability and efficiency that the old individuals and genes have to be displaced by the young ones¹⁰².

Diversity and Moral: The Requirement for Creative Ethics

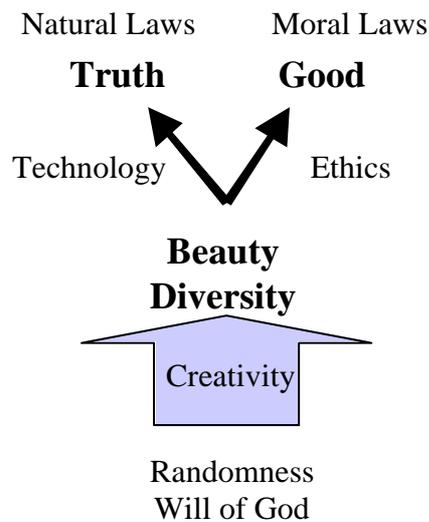
The different civilisations of the world each have invented and created a particular set of ethical rules. The diversity of the different cultures of the world is too great to find a common denominator of a universal definition of good and evil. There is no universal and fixed concept of ethics, but the moral rules depend on the time, culture and society. Even major religions of love, like Christianity, have morally justified killing other humans in the name of God. In the name of the Holy Virgin, the Spanish conquerors of the 16th century subjugated pre-Columbian civilisations and stole their land and property. Indigenous American, African and Asiatic people have been enslaved by the European powers, which were using the moral justification that these “primitives” lacked a soul. Despite the fact that industrialised countries are proud of their universal declaration of human rights, these rules are still more theory than common practise. The moral justification and ethical tolerance of wars, bombings, invasions, terrorism, displacements, kidnapping, punishment, torture, eye-per-eye and death penalty has not yet disappeared from this world¹⁰³.

The flexibility and the evolution of ethics show that the human moral depends on the cultural and social environment of each civilisation. Even within one society, moral was not invented once and then remained constant, but has been adapted throughout its history. When the cultural and technological development of a society is proceeding faster than the pace of its ethics, this generally leads to conflicts. During those times, moralists complain about the degradation of human values. The immediate response is to defend the *status quo* of the old-established ethics and turn against new developments. In those cases, religious conservatism tries to censure and restrict all new culture and technology.

The advance of technology constantly opens new possibilities and options, which again raise new ethical questions¹⁰⁴. Under the new circumstances, inspired prophets also provide new interpretations of the world. Ethical leaders are able to reshape the human moral. Moral is adapted to the new cultural and technological environment.

The future of societies depends on the right balance between the amount of creative science and creative ethics. Science and ethics are both human

efforts that will never provide a final view of the world. They only provide provisional views, which will always be incomplete and must be reshaped continuously. This is the constant change dictated by the principle of diversity. On the one hand, technology is focused on selecting the diversity that seems efficient. Science tries to find the truth within the beauty of the universe¹⁰⁵. On the other hand, ethics is focused on defining the diversity that is human. Human moral tries to find the good within the beauty of the world. In both cases, the sustainability of technology and ethics requires the continuous creation of new diversity (beauty)¹⁰⁶.



Fundamental Dogmas of Science and Religion

The analysis of *The Principle of Diversity* from a philosophical perspective would not be complete, if I did not include some important remarks on *continuous creation* as the process that generates new diversity. When we speak about creation, we cannot avoid mentioning the fundamental difference of the scientific and religious views of the world. In the religious view, creation is divine. In fact, creationism is more associated to religion than to science¹⁰⁷. In the scientific view of the world, creation is as inevitable as destruction. The scientific view is less magical and inspiring to the human mind, but both views are equally valid depending on the purpose. The scientific view is more useful for the development of technology, whereas the religious view is more useful for the development of a good human society¹⁰⁸. Both views try to build a coherent set of arguments. However, they are based on certain premises or basic dogmas

that cannot be proven or questioned further. The practise of religion or science requires a blind fate that is based on these premises. In mathematics, these dogmas are also called axioms. The following table shows a personal selection and comparison of some of these dogmas, especially those related to the principle of diversity and humanity. As I have mentioned earlier, the battle of science and religion is rooted in the negation of the separability of truth and good. As a matter of fact, there are still many philosophers who search for a justification of moral laws, using the laws of nature¹⁰⁹. But is it not better to separate both, the truth and the good, and accept that ethics is just a human invention, which gives us a purpose in life? I am convinced that science and religion can coexist, if they tolerate and accept the different interpretation of their dogmas leading to equally valid but separate aims¹¹⁰.

Religious Dogmas (Useful for humanity)	Scientific Dogmas (Useful for efficiency)
God's Will (divinity) exists.	Fundamental randomness exists.
The world exists not because of us but because of God.	The world exists independently of us as observers or subjects.
God is the ultimate Creator. He is the ultimate reason.	Randomness is the ultimate creating force. It is the ultimate reason.
God's Will determines the fate of the universe.	Fundamental randomness determines the fate of the universe.
God invented the laws of nature.	The laws of nature are a deviation from randomness and emerged from the complex interaction of diversity ¹¹¹ . They allow some prediction of future events.
God is omnipresent. He is independent from time or space.	Randomness is omnipresent. It is independent from time or space.
God is the cause of everything. God mediates causality. The effects do not have an influence on Him in return.	Cause and effect are separated. Causality is mediated by time. The chain of cause of effect allows a certain prediction of the future.
God can shape, create and destroy the world.	Randomness can shape, create and destroy the world.
A miracle is the demonstration of the action of God.	A miracle is an extremely unlikely event. It is possible by the action of randomness.

God created the world and said that it was good.

God created Man similar to His image. Humans have some divine properties.

God gave us free will and made us responsible for our actions.

The Bible was written by God and contains the absolute truth and good.

God invented a universal and static moral.

God's Will cannot be fully understood but only accepted, and it cannot be predicted.

Moral laws provide a useful tool for coping with God's Will. Religious laws describe the good.

God and religious fate give meaning to our lives.

Humans have a soul. This soul is the immaterial essence that makes us eternal.

The universe was created by randomness. The world has evolved because diversity is continuously created. We as intelligent humans decide on what it is good or evil.

Humans have the gift of creativity and the power of imagination. Humans can create new diversity and beauty. Humans are also very curious about this diversity and want to understand it. Therefore, they make efforts on e.g. science and art.

Randomness gives us free choice, which makes us morally accountable for our actions.

The Bible was written by inspired prophets and contains not the truth but only a description of the good in Jewish culture and during that time.

Humans invented ethics according to a particular environment, society and civilisation.

Randomness cannot be fully understood but only accepted. Randomness cannot be predicted.

The laws of nature provide a useful tool for coping with randomness. Natural laws describe the truth; ethical laws describe the good.

Human moral and ethics give meaning to our lives.

Humans have the ability (intelligence) to make a compromise between truth, good and beauty. This compromise and wisdom is the immaterial essence that makes us eternal.

Summary of Philosophical Postulates

Since the intention of this chapter was to give a philosophical analysis of the principle of diversity and other concepts presented in this essay, I decided to summarise here what I believe to be the key postulates. This essay tries to provide a coherent set of ideas and a logical building of arguments. Nevertheless, most – if not all – of the ideas are rooted, and the argumentation is based, on a few basic statements¹¹². Everybody is free to decide, if these basic postulates are right or wrong. My intention was, that if these statements seem right, then the argumentation I have presented and all the ideas derived from it should also be right.

Philosophical Ideas
Explanation and Comments

Efficiency, humanity and diversity are the three corners of the triangle of the economy.

The different corners of the triangle represent different aims that can be in conflict. A compromise must be found between them. Efficiency is the ratio of output to input. Selection takes place according to the efficiency. Constant creation and innovation maintains diversity. Diversification is required in order to decrease risk. Humanity provides the purpose for change and evolution.

In the real world, truth, good and beauty can be separated.

Therefore, ethics, aesthetics and technique can be separated in philosophy. In real life, there are many things that are true but are not beautiful or good. There are also things, which are only beautiful or only good but not true. It is only in the Platonic idealism where all corners of the triangle merge into its eternal "form".

Humanity is good. It is ethics –not aesthetics– what provides a purpose.

The purpose for the human endeavour is given by the good and evil described by the ethics. In economics, the purpose is to lead to a better satisfaction of human needs. Truth is required for efficiency, and beauty is required for sustainability. But only humanity is purposeful. Selfishness does not provide a purpose in life.

The biological world is dominated by absolute selfishness.

In biology, there is only absolute selfishness. It is found at the different levels of organisation and complexity: genes, organelles, cells, individuals, populations and species. Selfishness is efficient. In biology, co-operation and symbiosis are only a form of calculative selfishness. There is only apparent altruism (but not true altruism) because it is only done, if it leads to a personal advantage (e.g. Mycorrhizal symbiosis).

Ethics is not universal; It is a human invention.	Morals are a human invention. They are shaped according to the needs of the society and adapted to culture, space and time. In biology, there is no ethics. Animals and plants behave absolutely selfish and according to their own personal advantage. Moral judgement cannot be applied to nature. At the same time, biology and nature have no purpose. The meaning of life may only be found by overcoming selfishness (e.g. love).
Aesthetics is universal, It is not a human invention.	Aesthetics deals with the concept of beauty. Not only humans can create beauty, but beauty is also present in the whole universe. Humans, animals and plants can create beauty. Beauty is not homogeneity but diversity, i.e. not statics but dynamics. The source of beauty is freedom and randomness. Above the limited concept of the human mind about beauty stands the universal concept of beauty, which is diversity in general. There is a taste for everything. It is part of the diversity principle that people have different perceptions of beauty. The subjectivity of beauty is useful as it increases diversity.
Diversity is a requisite for existence.	Diversity is the basis of sustainability. It requires the constant generation of new diversity, i.e. continuous change. This is a requisite for the existence of the world. In nature, there is no sustainable monopol. If matter and antimatter merge, they cease to exist. The ultimate source of new diversity is randomness. This applies for physical, chemical, biological and cultural diversity of the world.
Fundamental randomness exists.	Randomness is omnipresent in the universe. It is not restricted to the quantum or microscopic world, but it also influences the macroscopic world (e.g. Schroedinger's cat). Randomness avoids the total determinism of the world. It allows the freedom of choice. There is no fixed fate.

Using the Analogy of Biology

Similarities between Economical and Ecological Systems

According to the definition in a dictionary, an economy is the relationship between production, trade and the supply of money in a particular country or region. Ecology in turn, is the study of the relation of plants and living creatures to each other and to their environment. The prefix of the words economy and ecology are derived from *oikos*, the Greek word for house. In Latin, *oeconomia* means distribution, order and administration in the context of the affairs of a house. Whereas the suffix of economy derives from *nomos* (law), the suffix of ecology derives from *logos* (word, science). It is no coincidence that there are a lot of similarities between the science of economics and ecology. Although economics and ecology have a different focus and subject, both follow the same core principles. Both are sciences that study the complex interaction of many components, which are connected in several ways. To understand this, it is necessary to study the essence of each of them.

Economy	Ecology
Economic units: enterprises and persons. Goods are limited.	Ecological units: species and individuals. Resources are limited.
Companies compete with each other in order to survive in a free market. The behaviour of companies is predominantly selfish. Money and economical success is all that counts.	Biological species compete with each other in order to survive in an ecosystem. The behaviour of species is predominantly selfish. Survival and successful reproduction is all that counts.
The government defines the rules that apply in the market. In most capitalist countries, these rules are very free and allow the self-regulation of the free market by its own dynamics. Companies are free to choose their activity and focus. However, this liberty is restricted by ethical rules.	Interactions between species are governed by the laws of nature, and the ecosystem is regulated by its own dynamics of biotic and abiotic factors. Species are free to eat, behave and perform in whatever way. They have total liberty, without any ethical barriers.
In order to survive, a company has to	A biological species has to obtain benefits

make profit it has to earn money. Only when the efforts are less than the income, a company will succeed in the long-term. Thus, companies have to be efficient.

In the economy, there is much more mercy than in nature. When companies are not efficient, there might be people that inject more money into them. Additionally, banks and the government also put money into companies in order to save them from the crisis. When companies do not make profit, they do not need to pay taxes. The reason of mercy within the economy derives from the humanity principle. Nevertheless, if the company does not pass the break-even line, then it will die someday.

Diversity is created mainly as a planned effort of research and innovation. Human intelligence is used to predict economic trends and solve future problems. Diversity is created in certain predefined directions. Due to the advantages of culture and civilisation, the speed of economic evolution can be very fast. However, sustainability is only guaranteed for the predicted changes.

with the minimum amount of efforts. For example, a species will only survive, if it gets more food than it spends energy get it. Biological species must be highly efficient.

In natural ecosystems, there is absolutely no mercy. If a species is not efficient enough, it will not survive. A humming bird will die if it does not obtain more nectar from flowers than the energy it spends to swing its wings. Even further, the humming bird not only have to be auto-sufficient, but also more efficient than other animals, which could take its food away. Therefore, the humming bird cannot afford to visit nice flowers only; it has to look for those flowers that provide the most nectar and try to be "better" than e.g. butterflies.

Although there are mechanism to increase the creation of new biological diversity, this does not impose any predefined direction. Diversity is created randomly. The speed of evolution is adjusted to the speed of the average environmental change. The random production of diversity consumes a lot of resources and takes more time. Nevertheless, sustainability is guaranteed in case of – unpredictable – environmental change.

The free market economy corresponds to the ecosystem of the ecology. In a free market, the economic units (e.g. enterprises) exchange needs in order to obtain profit. More detailed, in the world of economy, the exchange of these needs can be divided in two categories. The flow of goods is compensated by a corresponding counter flow of money. Because the needs are subjective, the goods have a different value for each enterprise¹¹³. For example, the value of a vehicle for a car company is much less than the value of a car for a taxi driver. The difference in

values is the driving force of trade as a win-win strategy. The Car Company, as well as the taxi driver, both get benefits from trading a car. Trading goods is not just an exchange, but it leads to an increase of the total goods. The human input in terms of time and work is the reason why the total amount of goods and money increases over time¹¹⁴. Therefore, we can say that human lives are consumed (a life of work) in order to create more total wealth¹¹⁵.

In natural ecosystems, species compete with each other. There is a flow of matter (food) and energy between different species. Because this food and energy is required to cover the needs of the animals, we can say that there is a flow of goods¹¹⁶ in natural environments. It is not an exchange (trade), but it is a mono-directional flow of goods. A lion does not ask for permission to kill nor does it pay anything to eat a zebra¹¹⁷. It would take too long to explain all analogies and subtle differences of the economical and ecological flows in detail. However, I must point out that the *flow of money* in an economy can be seen analogue to the *flow of energy* in an ecosystem.

Money (energy) flows and accumulates within the different enterprises (species). If money (energy) is depleted from an enterprise (species), then the latter goes bankrupt (dies). Enterprises (species) are forced to be more and more efficient in order to compete with others and survive. Enterprises (species) that are able to make the most efficient use of money (energy) are the most successful ones. In order to survive different enterprises (species) choose many different strategies to perform in a free market (ecosystem).

The main principles of diversity and efficiency provide the framework of action. Creation and innovation lead to diversity, and selection is done according to efficiency. As it is not the absolute profit, but the efficiency what is maximised, there are many different strategies and sizes that can be successful. An elephant or a whale will operate on a very different level than bacteria or micro-organisms. Both are efficient at their respective scale. Similarly, companies like General Motors or Wal-Mart operate on a very different level than a local bakery or hairdresser¹¹⁸.

The skills of enterprises (species) are inherited over longer periods of time. Biological species inherit their genetic information contained in their DNA

sequence¹¹⁹. Not only the genetic information contained in the nucleus is inherited, but also the one contained in their mitochondria or plastids. More intelligent species also inherit culture and skills, which lead to the establishment of traditions.

Enterprises also maintain their skills over prolonged periods of time in forms of traditions. Some are the personal skills and knowledge of employees (technical and intellectual know-how), which is passed from the experienced to the less experienced. Another form is the written philosophy (company mission and vision) that describes the aims of the company. This leads to a certain stability of the operative focus. As each activity requires a great investment, an enterprise does not change its commercial focus very often. This poses a limitation on the flexibility of an enterprise. In addition, stability in the company focus is increased by the awareness of the image that has developed over time. The market and product image (brand) is important for the success of each enterprise. Sometimes, it is only the name or the brand what remains after a massive restructuring of an enterprise. For example, the name of a washing powder might remain the same, although the formulation or the producing company might have changed.

In both, natural ecosystems and free markets, the interaction of diversity and efficiency leads to biological and economical evolution, respectively. Thus, it can be said that because both, economical and biological systems are very similar in their premises and structure, the forces that prevail in those systems are also very similar and lead to the same effects. If we understand the causes and effects in one system, could this help us to understand the other system better?

The Ecological Niche

All these biological analogies might be interesting, but what are they useful for? What can economics learn from ecology and the theory of biological evolution? First of all, it is important to notice that our modern economy and the free market are not as artificial as one would think of a purely human invention. They are very similar to natural systems. This was already noticed and promulgated by Adam Smith in the 18th century¹²⁰. Let

me mention some aspects of ecology that could be relevant for the world economy.

One of the most important concepts in ecology is the idea of the ecological niche. Ecological niches are the living space and requirements of a species within an ecosystem. It is the sum of many different factors, such as physical space, timing and food source. The ecological theory predicts that in the long-term, only one species can occupy an ecological niche within a closed ecosystem. The only way for two species to survive is to occupy different ecological niches or to live in separate ecosystems. Changing the ecological niche can be as easy as changing the time of food acquirement of a species (e.g. hunting during the night instead of during the day). In natural ecosystems, diversification has led to many different species, which occupy separate ecological niches. However, they still compete for certain resources. For example, some whales, sea lions and many birds compete for the same fish for food, but they do not occupy the same space for breeding. Other species compete for the same breeding space but not for food. Overall, the overlapping competition between species is fierce (*struggle for life*), and only the most efficient species survive over time. The natural selection pushes the evolution into a higher efficiency.

The speed of evolutionary change can vary, and it can be very different for each species. There are some organisms like bacteria, which apparently have not changed much during millions and millions of years, whereas others like apes have changed so much as to become *Homo sapiens*.

The concept of the ecological niche can also be applied to the free market. An enterprise occupies a niche within the free market. Most enterprises compete with each other for the same resources. In this case, one of the major resources is the money of the customers. All enterprises want the money of customers, but there are only a limited number of customers and each of them has only a limited amount of money. However, enterprises also compete for other resources, such as the physical place for opening a shop, or the human working power and intellectual resources that are available in the market. Enterprises also compete for political influence and

for the capital available in the financial markets (loans). The survival of an enterprise depends on the efficiency in obtaining these resources. The more money a company can get from its customers (or shareholders) and the less money it requires to obtain the other resources, the more successful it will be. An enterprise employs many different strategies to get more money¹²¹. Firstly, it will try to get more customers. Secondly, it will try to convince the customers that they indeed need the goods the company offers (consumerist marketing). Thirdly, it will try to manipulate the needs of the customers in order to obtain the maximum amount of money for the goods. If the goods of other enterprises can also cover the same needs, the enterprise will try to convince the customers of the advantages of their own products over those of the competition. Fourthly, the company will try to convince shareholders that it is good enough to make a significant investment. And fifthly, it will try to persuade the government to adapt the legal system to allow a better company performance. In some cases, the company will also ask for money for credits and subventions – or in the worst cases, steal money from the government by evading taxes. Some companies will even bluff and cheat on their customers and shareholders in order to obtain the money for further investments that they require (e.g. Cargolifter and many dotcoms). In the world of biology, as well as in the economy, absolute selfishness is omnipresent. This is not a new revelation but was already known since the time of Adam Smith. Not because of benevolence but out of self-love, we expect goods from others. Smith asked for more freedom and liberty in the 18th century. If there were something to add in the 21st century, it would surely be diversity and sustainability. If there is something to learn from the ecological niche, it is that a company has to create or find a unique niche in order to survive; it has to adapt constantly to a variable environment.

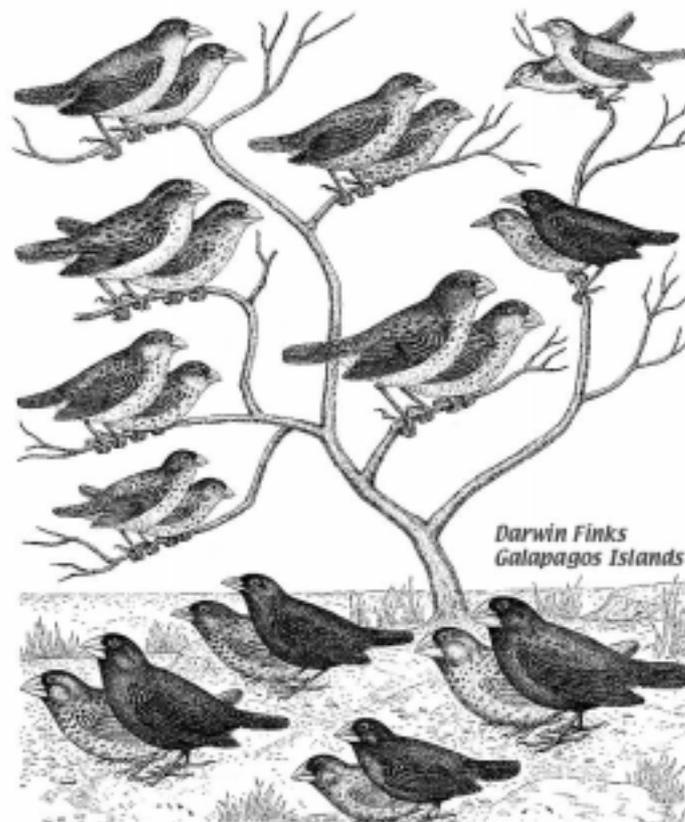
The Struggle for Life

Enterprises in a free market are in a struggle for life like animals in the jungle. Diversity is generated through constant innovation and creation of new products, strategies, ideas and solutions. The driving forces of efficiency and diversity also leads to evolution; it leads to economic progress, if it includes the humanity principle. As already mentioned, the

speed of evolutionary change can be very different. There are activities that have not changed much in the last centuries (e.g. in farming, writing, dancing and prostitution) and others that are completely new (e.g. in computer software and air transport).

The concept of the ecological niche predicts that the most efficient enterprise will displace all other enterprises that occupy the same niche. Indeed, every year, many companies are displaced by others. Companies are not only displaced but also absorbed by others. In the same way as in biology, the big fish eats the small fishes. However, sometimes the small fish's reproduce more rapidly, are more flexible, and therefore adapt more readily to changing conditions. Those cases lead to the extinction of "big dinosaurs". In biology as in economics, the inefficient "dinosaurs" do not live forever.

Sometimes, new markets appear, and we see a rapid evolution, creation and diversification of enterprises, e.g., in the field of communications and biotechnology today. The same phenomenon can be observed in nature. When the Galapagos Islands emerged from the Pacific Ocean, the Darwin Finks reached the island first and occupied the many different ecological niches. In biology as in economics, success also depends on who arrives first. Much of the reward of research, creation and innovation is due to being there first.



Sometimes, markets also disappear, and we see a massive extinction e.g. for industries related to sailing boats, steam machines, horses and railroads. In nature, massive extinction is due to big catastrophes, such as the power of a meteorite from space or the axe of human civilisation¹²². In an economy, massive extinction is due to changing consumer preferences¹²³. During times of crisis, those enterprises with the most diversity are more likely to survive changing conditions. However, survival depends on the efficiency that can be found within this diversity¹²⁴.

Extinction also occurs when two formerly separate markets merge. In every ecosystem, almost all available ecological niches are occupied. Differing species can occupy corresponding ecological niches in separate environments. However, when those different environments merge, for example when two continents merge, then there will be a fierce competition between the species that occupies an identical niche. Only one species will survive per niche.

The same can be observed in the economy. When two separate countries open their borders and fuse into one big market, competition between the companies occupying the same niche becomes fierce and in the long-term, only one will survive. Usually, the enterprise from the more developed country will outperform the enterprise of the less developed country. This is

exactly what is happening in our present time of economic globalisation. Instead of having separate economies with separate ecological niches, the borders are being wiped out, creating one single big market. Even though a single market is bigger, there are less ecological niches than in two separate markets. In such a global market, only very few will survive. Indeed, this could lead to higher global efficiency, but it will be at the cost of a massive reduction of global diversity. The concept of the ecological niche predicts that the total number of enterprises in the world will decrease according to the number of separate and independent markets, and the number of separate ecological niches. Thus, by setting the number of separate markets on our earth, politicians are already deciding how many enterprises will survive in the end. It is not mainly the private enterprises that are leading to globalisation, but the politicians who are modifying the global economic environment and legal framework of action. Enterprises are only seeking a higher efficiency and are reacting to the changed environment.

The Difference Between Biological and Economical Evolution

Until now, I have been trying to describe all the similarities between the world of biology and the world of economics. I have put some effort in this topic, because initially, an economist or manager would see more differences than similarities. The reason why I presented the analogies was, because I believe that the biological knowledge can be useful, if applied to economics. On the other hand, I do not need to make the point that there are obviously many differences that are important. As a biologist, I would like to explain only one difference that I consider being scientifically and philosophically important. The evolution in biological and in economical systems follows slightly different mechanisms. In both, there is an interaction between two forces (efficiency and diversity) that leads to evolution. The main difference between evolution in biology and economy resides in the way in which diversity is generated. As I have already mentioned, in biology, randomness is the ultimate creative force that leads to diversity. However, in an economy, there is an additional factor that plays a highly important role: human intelligence.

I have already mentioned that intelligence is a biological strategy to increase the efficiency of species. However, intelligence does not yet influence the way in which genetic diversity is generated in biology¹²⁵. In contrast, in an economy, the human intelligence is one of the most important sources of diversity. Research and innovation is not done randomly, but purposefully and specifically, using the accumulated knowledge and the experience, intelligence and creativity of humans. This allows us to generate diversity that is much better adapted to future conditions.

This slight difference brings an astronomical advantage in the speed of evolution in economical systems¹²⁶. In biology, all possible combinations, which represent enormous diversity, have to be tried out in order to improve efficiency. This consumes much of the resources and takes a lot of time¹²⁷. In contrast, in an economy, innovation is done less randomly, generating a better diversity with less resources and more rapidly.

In other words: Evolution in biology follows a Darwinian mechanism of random variability and targeted selection. In contrast, the economical (and cultural) evolution follows a Lamarckist mechanism. The Lamarckist mechanism involves a purposeful adaptation and the inheritance of acquired skills. According to the synthetic theory of evolution, in the strict sense, the word 'adaptation' should not be applied to biological evolution¹²⁸. In Lamarckism, however, adaptation is the central feature. A specific adaptation also implies that predictions about the future give a motivation to change, revealing also the direction of the evolution. In the case of an economy, this is humanity. The final aim of an economy and business administration is to lead to a better fulfilment of the human needs; the purpose of economic evolution is to lead to '*progress*'. It is good that humans use their intelligence and all other faculties to achieve this aim, but what we also need to know is that diversity is absolutely essential for our survival and success.

Applications of Diversity in Economics

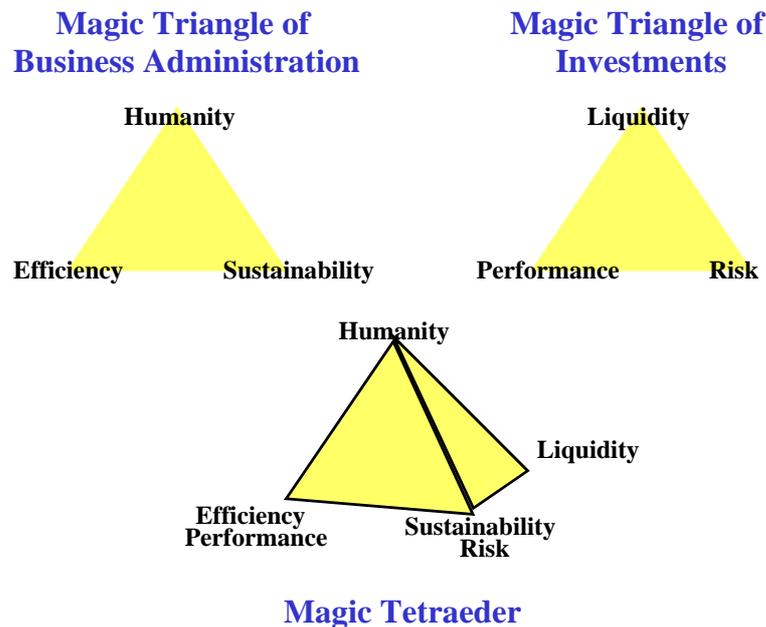
Risk Management in the Field of Investments

Risk management can be defined as a set of special strategies in order to cope with random and unpredictable events. This essay tries to present examples showing that the theoretical framework provided by the principles of efficiency, humanity and diversity can be useful for the daily and practical decisions of business administration. The following example from the field of investments also shows how randomness, information, risk and diversity are components of the sustainability principle:

When a broker in Wall Street makes a strategic decision to invest money, he has to make a compromise between the three different economic principles. According to the efficiency principle, he will try to achieve the highest possible profit by buying the most promising shares at the cheapest price. The final purpose of his efforts is to lead to a better satisfaction of human needs (clients, partners, customers and society in general). Therefore, according to the humanity principle, he should also consider what shares to buy and avoid e.g. those of chemical companies that produce weapons of mass destruction and deliver them to terrorist groups. According to the sustainability principle, he will try to manage his risk by avoiding homogeneity but promoting diversity. Therefore, he will diversify by investing in many different shares and options. Investing in only one share can be much more profitable, but it involves a high risk of losing everything. *Do not put all eggs in a single basket*. Diversity lowers the risk, increases the robustness and ensures the sustainability of the investments over time. To increase efficiency and sustainability, diversity should not be static but change constantly (selection and creation). By using accurate information, which allows predicting the future, a higher efficiency will be achieved. If this information is not available or not reliable, a higher diversity –even if it is generated randomly– will allow sustainability in totally unpredictable conditions or in a high-risk market.

For the sake of completeness, the golden triangle of investments can also be mentioned in this context: performance, risk and liquidity are aims that are opposed to any given investment. At least this is what a bank will tell you, if you are not happy with their interest rates. To get a higher performance you either invests the money for a longer time (less liquidity), or you accept higher risks and go speculative. The performance (interest rate) is equivalent to the output to input ratio (efficiency) of the invested money. Furthermore, randomness and the diversity of the investment portfolio influence the risks. The more diversity the less risky and more sustainable will be the investment. Thus, it is clear that performance and risk correspond to the efficiency and sustainability principle, respectively. However, although liquidity and humanity provide both a final purpose, the liquidity aim is not identical with the

humanity aim if it considered in the daily practice of banking business¹²⁹. Therefore, the magic triangle of business administration and the magic triangle of investments could also be seen as different sides of a magic tetrahedron of economics.



How Much Diversity is Required for Sustainability?

The amount of diversity, which is required to make a system sustainable, is a critical question that cannot be answered easily. There is no threshold of minimum diversity that is universal for all systems. Every system requires a different amount of diversity. The only way to find out is to try it out. However, sometimes, trying it out can already be the end of the story. If we tried to discover all poisonous substances by eating them, few of us would remain alive at the end. Fortunately, God gave us intelligence so we can perform better than animals. Can humans do better than the trial and error of animals? Can the human civilisation become sustainable? Can we become more efficient without destroying all the diversity of the world? Can human intelligence and reasoning help us to become masters of the universe¹³⁰?

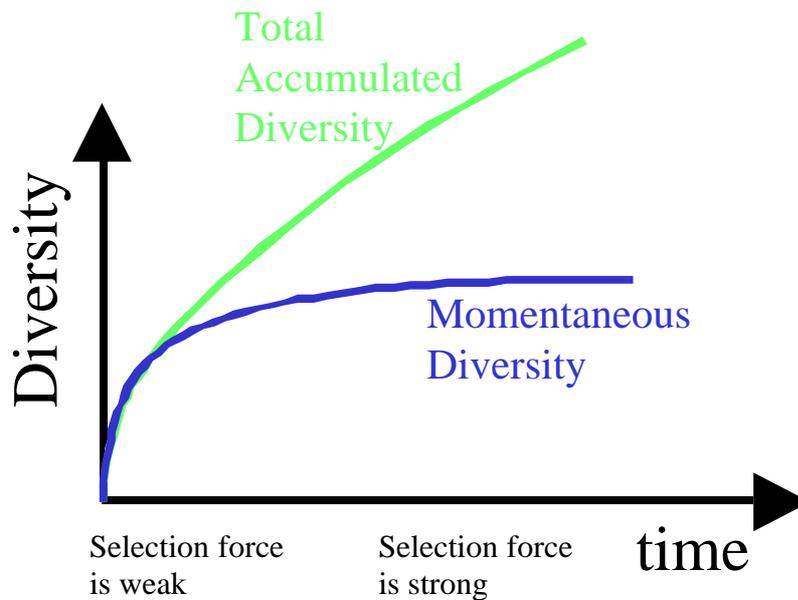
We can learn a lot through observation and scientific analysis. If we observe the world that surrounds us, we will learn how much diversity is required to make the different systems sustainable. Nature can show us the possible compromises between efficiency and diversity.

In some cases, a diversity of two is already enough. There are only positive and negative charges... matter and antimatter... male and female...

Ying and Yang... In other cases, there is a diversity of three, four, or even hundreds, thousands or millions. It depends on the system.

Diversity at a lower level gives rise to diversity at a higher level. The ability to communicate with other humans depends on the diversity of the language. Our western European alphabet has more than 26 letters; a language like English has more than ten thousand words and many million different books. There are more than thousand different languages in the world.

The genetic code of the DNA requires only 4 bases. Proteins require more than 20 amino acids. A gene requires more than hundred bases. A virus requires more than five genes. A bacterium requires more than a thousand genes. Our human body requires more than thirty thousand genes, hundred thousand proteins and many million cells. A sustainable ecosystem requires more than ten thousand different species. It is estimated that there are over a million different insect species, 250000 flowering plants, 130000 molluscs, 6000 reptiles, 9000 birds and 6000 mammals. However, the biodiversity of our planet should not only be seen as the total number of alleles, genes or species. Diversity is also found on the structural and functional level. Our planet Earth contains more than a thousand separate macro-environments with many billion micro-environments. The different ecosystems represent a wide range of conditions for the establishment of separate living forms and allow a diversity of biological strategies. There are carnivores, predators, symbionts, dominators, and parasites...



Mathematical Formulation of Diversity

If diversity and risk are so closely related, then it should be possible to use many of the mathematical tools and formulas, which are already employed by brokers in financial markets for investments and related activities in order to quantify economic risks. There is already a wide range of mathematical formulas available. However, as a biologist, I would like to formulate a few simple ones –especially to stress the fact that diversity can also be presented in hard numbers. Some capitalist managers, who are not impressed by arguments of humanity and beauty, would find it valuable to read some formulas related to diversity. Instead of an ethical or aesthetic argument, I will attempt to use a technical one.

If the beauty and diversity of nature are essential for the survival and sustainability of our civilisation, how could we put this into mathematical terms? As I have mentioned early in this essay, the time dimension is a key component. The key for sustainability is that –among the present diversity– enough efficiency can be found, which allows survival under the present and future environmental conditions. The environment is not constant but changes with time. To describe the velocity of change, we can define a variable T_{environ} that represents the average time for a change in the environment. We can define another variable P_{dras} that describes the probability that the environmental change will drastically affect the survival.

Both variables build a quotient, which describes the degree of risk in that particular environment. The quotient can be considered as the amount of drastic events per time units.

$$\left(\frac{P_{dras}}{T_{environ}} \right) \Rightarrow \text{drastic events per units of time}$$

Another variable T_{diver} can be defined to give the average time that is required to create a new unit of diversity. The corresponding variable $P_{intelli}$ describes the probability that the new diversity is suited to allow survival under a new environment.

These variables build a quotient that describes the degree of adaptability (e.g. of a biological species). The quotient can be considered as the amount of successful adaptations per time units.

$$\left(\frac{P_{intelli}}{T_{diver}} \right) \Rightarrow \text{Successful adaptations per units of time}$$

The reason I named the variable P_{dras} is because of the word 'drastically'. The reason I named the variable $P_{intelli}$ is because of the word 'intelligence'. I would like to avoid too much confusion here, but the probability to invent a new thing that solves a problem is indeed linked to intelligence.

When the value for $P_{dras}/T_{environ}$ is high, we can speak of a high-risk environment. When $P_{intelli}/T_{diver}$ is high, we can speak of highly flexible and adaptive organisms.

$$\left(\frac{P_{dras}}{T_{environ}} \right) \gg 1 \rightarrow \text{High Risk Environment}$$

$$\left(\frac{P_{intelli}}{T_{diver}} \right) \gg 1 \rightarrow \text{Highly Adaptive Species}$$

$$\left(\frac{P_{dras}}{T_{environ}} \right) \geq \left(\frac{P_{intelli}}{T_{diver}} \right) \rightarrow \text{High Diversity is Required}$$

Proceeding with the mathematical postulation, we come to the conclusion that survival can only be guaranteed, if the capacity for adaptation of one species is higher than the degree of risk in the environment.

$$\left(\frac{P_{intelli}}{T_{diver}} \right) \gg \left(\frac{P_{dras}}{T_{environ}} \right) \rightarrow \text{sustainable species}$$

Sustainability of the system can only be maintained, if not all species die after a particular drastic event. So, the higher the number of different species, each with its own and independent potential of survival, the higher the sustainability of the biological system will be as a whole.

$$\sum_{i=1}^{diversity} \left(\frac{P_{intelli}}{T_{diver}} \right)_i \gg 1 \rightarrow \text{sustainable system}$$

Thus, the higher the diversity, the higher the sustainability will be. As I have mentioned repeatedly, this statement is the central issue of this essay. My hypothesis is that this is not only true in biological and economical systems, but it is a general rule of all complex systems.

$$\frac{1}{Sustainability} \Rightarrow Risk \Rightarrow \frac{1}{Diversity}$$

$$Diversity \rightarrow \infty \Rightarrow Risk \rightarrow 0$$

The last postulation¹³¹ I would like to make is that the minimum amount of diversity, which is required to ensure sustainability of the system, can be estimated from the above-mentioned assumptions and variables as follows:

$$Diversity \Rightarrow f \left(\frac{P_{dras} \cdot T_{diver}}{T_{environ} \cdot P_{intelli}} \right)$$

When we look at this postulation more deeply, we can make some conclusions about the diversity we observe in natural systems. If the time for adaptation is much longer than the time of environmental change, a high diversity is required. When drasticity is high and intelligence is low, a

high diversity is also required¹³². This situation is what we observe in natural environments containing a magnificent diversity.

This formula is also relevant when comparing biological with economical and cultural systems, especially, when estimating the required minimum amount of diversity. Do economical systems need as much diversity as ecological systems to be sustainable? Possibly not. The most striking difference between these systems is the amount of intelligence. The creative source of new solutions in biological systems – randomness – is not 'very intelligent', and therefore, very high diversity is required. In contrast, '*intelligent creativity*', which always finds a solution for a new problem, can operate with much lower diversity for the same level of risk.

This could have important consequences for the economic decisions of humanity. If we are able to decrease the required time for the creation of new diversity (e.g. biotechnology), we could afford to lose some diversity without increasing the risk or affecting the sustainability of the whole system. Also, if we can increase our intelligence (science and knowledge), we could afford to lose some diversity without increasing the risk¹³³. This change from a random and slow reaction time to an intelligent, flexible and rapid change corresponds exactly to the change from a Darwinian to a Lamarckist evolution. It involves an increase of adaptability.

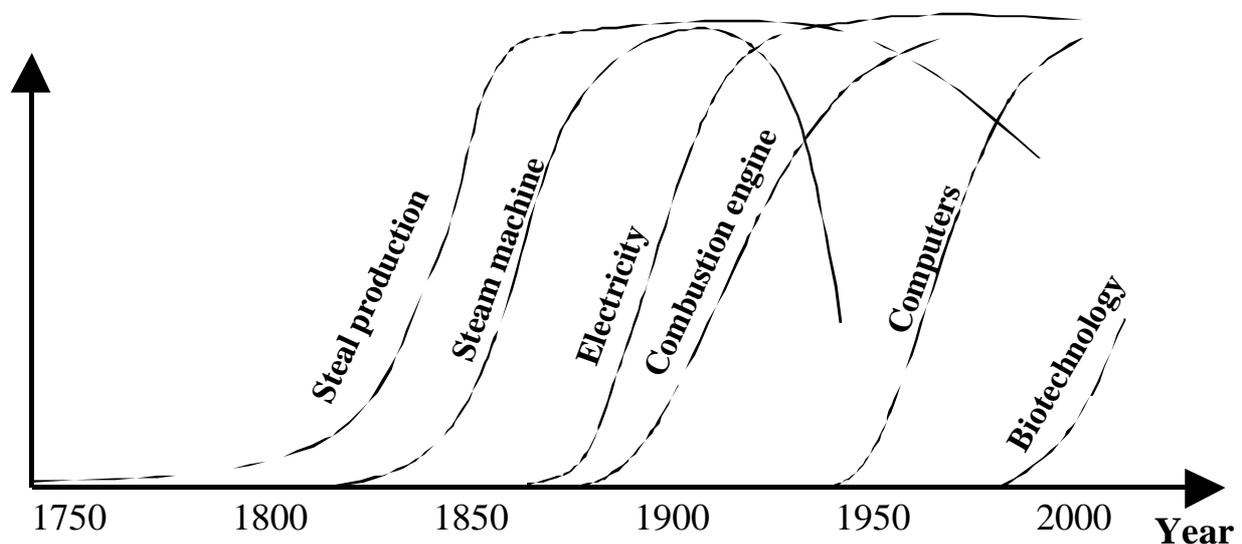
This request for more flexibility is not a new idea for our economic systems. In the appendix I will also explain that this is also exactly the request in Meyer & David's book¹³⁴ ***It's Alive: implement more adaptive management!*** I highly recommend to interested managers to read that essay.

To sum up all the previous postulations: If humanity became more intelligent and adaptive, we could afford to lose some biodiversity from the rainforests. However, the problem is that we are rapidly destroying the biodiversity of our world without showing any sign that we are behaving more intelligently, reacting more flexibly and becoming more adaptive. Instead, our bureaucratic systems are turning more inflexible, inert and slow. Simply consider the bureaucratic machinery of the European Union or the United Nations¹³⁵.

To use the language of Michael Moore's book '*Stupid White Men*': If we are getting¹³⁶ such an illiterate president as the Idiot-In-Chief of the most powerful nation of the world, at least we should not be destroying the biodiversity of this beautiful planet. Wait until we get more intelligent leaders.

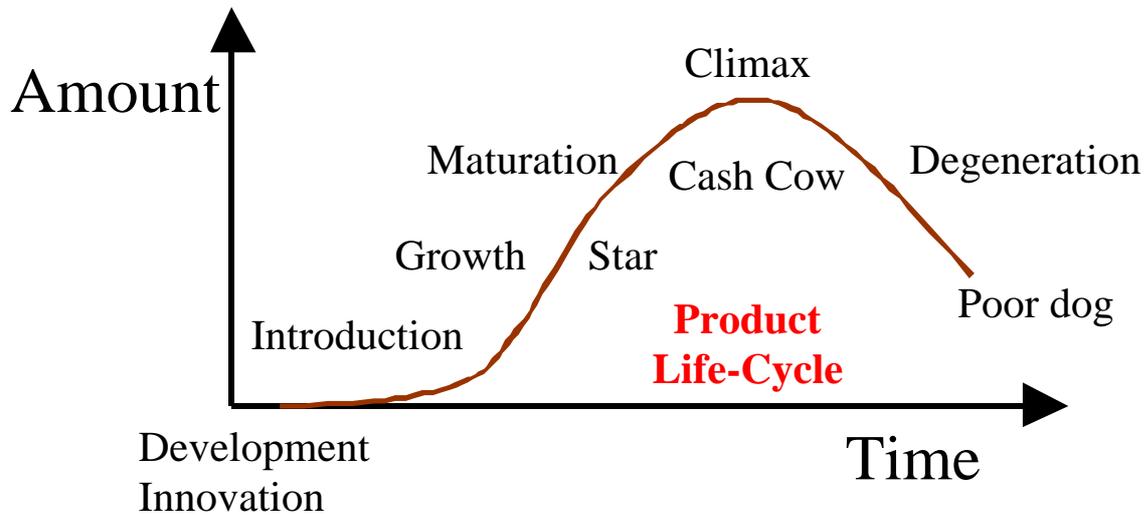
Evolution of a Product

After explaining the driving forces of evolution in biology and economics and presenting a theoretical, philosophical and mathematical background of the principle of diversity, I would like to explain one example of rapid evolution within free markets more in detail: The life cycle of a product. Again, the sole use of the word "*life cycle*" to describe an economic phenomenon provides another example of how tightly linked biology and economics are. This chapter is aimed at readers with a strong economic bias and focuses on the practical process of innovation and evolution in markets. I would like to discuss the market cycle of any given product, e.g. a video recorder or a flatscreen, using the theoretical framework of the efficiency and diversity principle. The creation, rise and subsequent fall of a technology or even a single commercial product within a market are examples of economic evolution and is similar to the processes observed in natural environments.

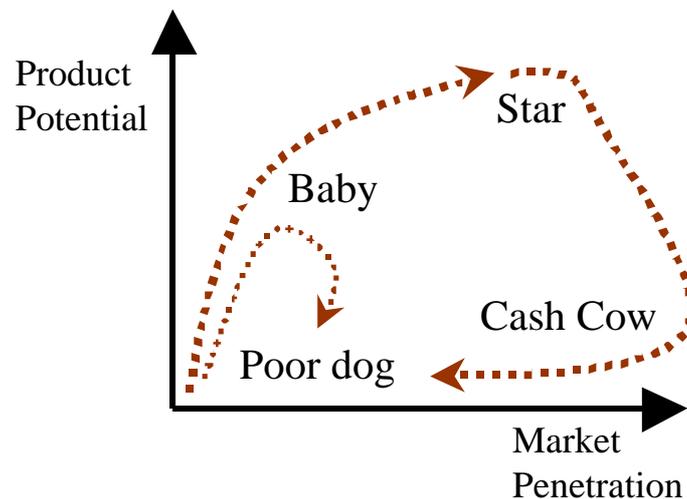


Since there is already an extensive literature dealing with product innovation, market cycles and many related phenomena, I will only focus on a few key points and detailed aspects, specifically relating them to the diversity principle and using two-dimensional plots. A standard textbook of business administration separates the different phases of a product life into

a phase of innovation, market introduction, growth, maturation, saturation and degeneration. The typical life cycle can be plotted as following:



During the introduction, only few units are sold, whereas growth leads to greater market penetration and to high revenues as a 'cash cow' product. Finally, the product can degenerate and disappear¹³⁷. Sometimes, a 'baby' product becomes a 'poor dog' without ever being a 'cash cow'. More desirable for the company is when the product undergoes the complete life cycle.



The life cycle of a product can also be presented as a time-dependent change (dynamic) of two functions in the **price-amount dimension**. The first function is the break-even line and the other is the price-demand line.

The Break-even Line

The production of a certain good requires certain efforts and causes costs that can be divided in two categories: fixed and variable costs. Since any textbook of business administration explains the sources, differences and peculiarities of costs, I will only refer to the common practise of calculating the break-even point of a certain product. The break-even point gives the amount product units that must be sold before the company starts to make profit. The profit starts when the company has a greater income through selling than the sum of the fixed and variable production cost. The break-even point shows the minimum selling of a product at a fixed price. However, what if the price cannot be fixed? In this case, the break-even line can be considered as the alignment of all break-even points at different prices. The break-even line is nothing else than the plotting of the total production cost in the price-amount dimension. The break-even line is a simple mathematical function that can be solved by any variable.

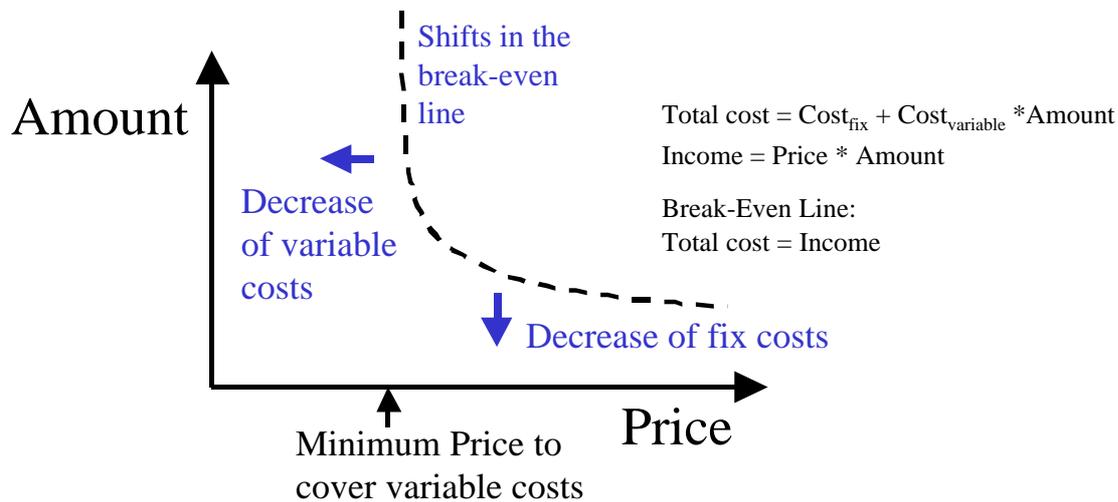
$$Income = Costs_{total}$$

$$Price * Amount = Cost_{fix} + Cost_{var} * Amount$$

$$Price = \frac{Cost_{fix} + Cost_{var} * Amount}{Amount}$$

$$Amount = \frac{Cost_{fix}}{Price - Cost_{var}}$$

As expected, the higher the price, the fewer products must be sold in order to recover the investment. The break-even line considers the production costs from the point of view of the enterprise. During the innovation and product development phase, a shift in the break-even line can be achieved by decreasing the fixed or variable production costs.



The break-even line has two asymptotes. The horizontal asymptote is the x-axis (price). For the company, this is the least desirable part of the line since it represents the costs when only few products have been sold. The vertical asymptote is the minimum price to cover the variable costs. It is in this part of the break-even line where the companies would like to operate. For trade, we do not only need the offer but also a demand. How can the selling aspect and the consumer preferences be plotted graphically? The amount of products and the price that can be obtained for a certain product can be characterised by the price demand line.

The Price-Demand Function

While the break-even line is a simple mathematical function, which can easily be determined by the enterprise, the price-demand line is a much more complex function. In fact, the knowledge and the manipulation of this line are the most important factors for the success of any enterprise in a free market. One of the major challenges of marketing is to reveal the price-demand function for a certain product. Unfortunately, the price-demand line is an empirical curve determined by the preferences and subjective feelings of the consumers. Intuitively, the lower the price the more units of the product can be sold. The higher the price, the fewer consumers will buy the product. The standard theory of trade predicts that price is a function of the offer and the demand of a product. The higher the demand –or the lower the offer– the higher will be the price.

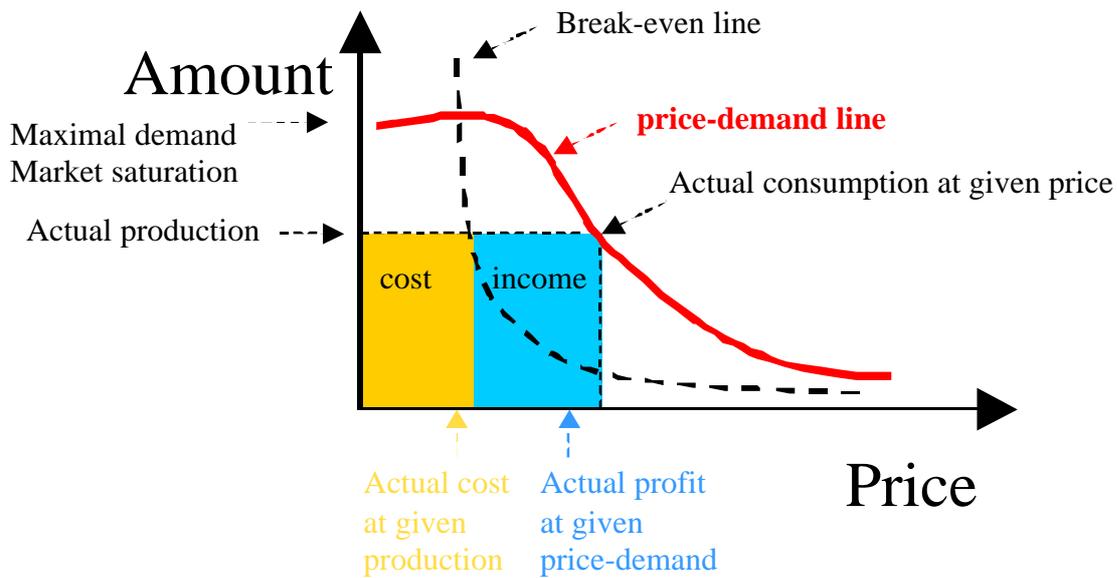
$$\text{Price} \Rightarrow f\left(\frac{\text{Demand}}{\text{Offer}}\right)$$

In practice –*a priori*– this function is of little use for the strategic planning of the market introduction of a new product. The offer is easy to calculate, as it depends on the production capacity of the company. The price is easy to calculate from the production costs and profit margins. The greatest practical and strategic problem resides in predicting the actual demand by consumers in advance. In practice, the real demand is highly dependent on the product price and not the other way round¹³⁸. This is even true in saturated markets, where consumers can choose between several alternative products. As consumers have only a limited amount of money, they must balance their priorities of needs and evaluate the cost and use of each good (principle of rationality). Enterprises have also a limited amount of capital and resources and therefore cannot over- produce, but have to set priorities. In order to be more efficient, enterprises have to produce (offer) only as much as they can possibly sell. Thus, in a free market, the consumer demand is a function of the offer and the price. At a given offer, marketing can modulate the demand by changing the price.

$$Demand \Rightarrow f\left(\frac{Offer}{Price}\right)$$

Companies can establish the price of a product using different methods. One would be the extensive calculation of production costs and the other comparative pricing of similar products. The ideal method would be to know the price-demand function in advance. The price-demand function is the real demand of a specific good at a respective price. The price-demand function is a subjective function resulting from the consumer's preferences and priority-of-needs¹³⁹. This function is not static, but can be highly dynamic and change over time¹⁴⁰. Over the long-term, the price-demand function changes according to the life cycle of a certain product. Here, the line will be plotted as a sigmoidal function.

A typical price-demand plot



With a given production, the break-even line defines costs. At the given price, the price-demand line gives consumption. One of the advantages of plotting the curves in the price-amount dimension is that the total cost or the total income can be simply represented as the surface of the rectangle at a given price or amount of products. The profit is the difference of the surface of the two rectangles. Supposing that the input is the cost and that the output is the income, the momentary efficiency is the ratio between the two surfaces at a given point in time.

$$Profit = Income - Cost \quad Rentability = \frac{Income - Cost}{Capital} \quad Efficiency = \frac{Output}{Input}$$

However, the input-output is not always equivalent to the cost-income. Looking at the input we must also take into consideration all the efforts that have to be made to keep the business running. This requires a full accounting of all efforts (e.g. time, health of the workers, contamination of the environment) in order to translate everything in units of money. At the same time, the output not only includes the money through the selling of products but also other non-contabilised benefices (e.g. happiness, beauty, personal fulfilment of the workers, social mission).

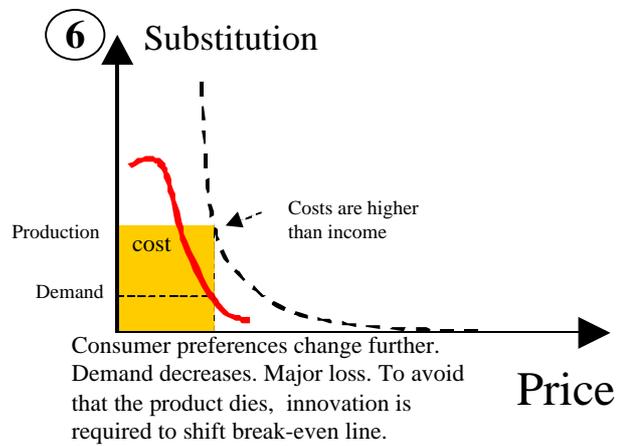
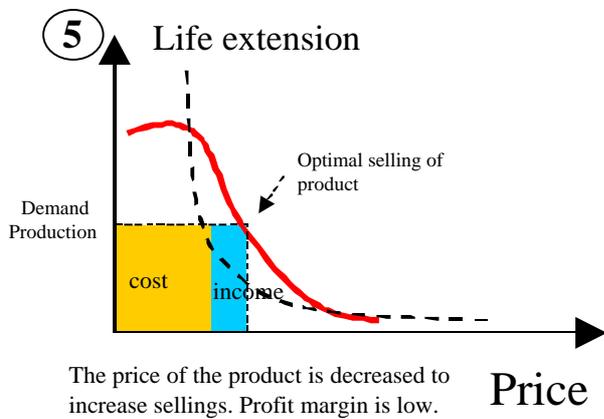
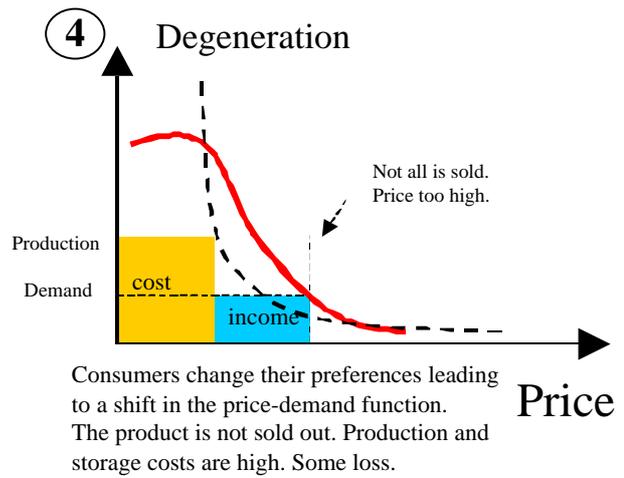
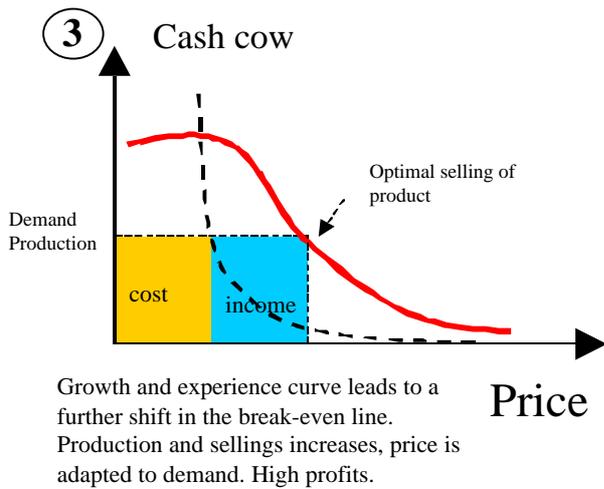
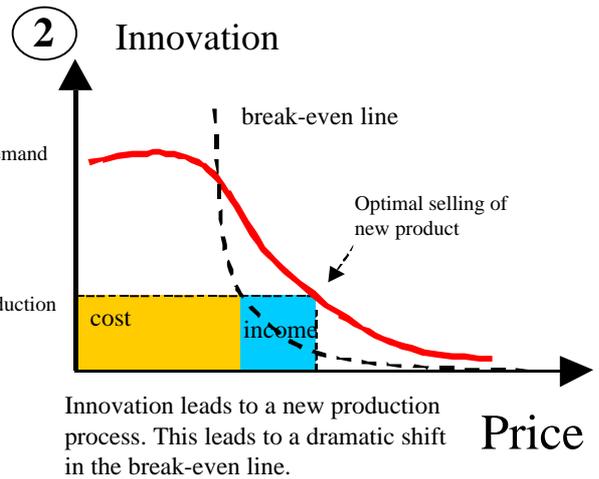
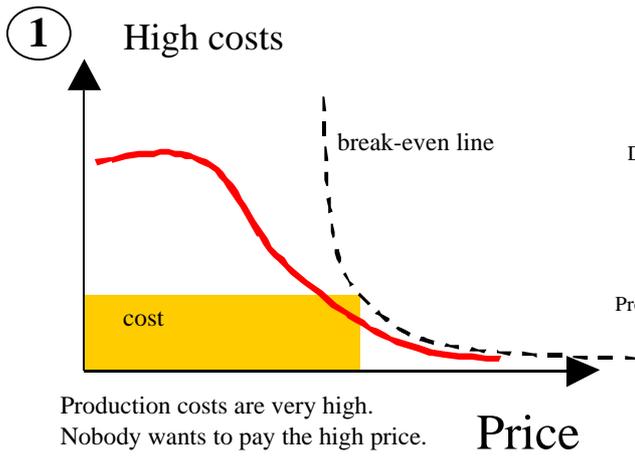
$$Input = Cost_{fix} + Cost_{var} + \sum Efforts_{money} \quad Output = Income_{selling} + \sum Benefices_{money}$$

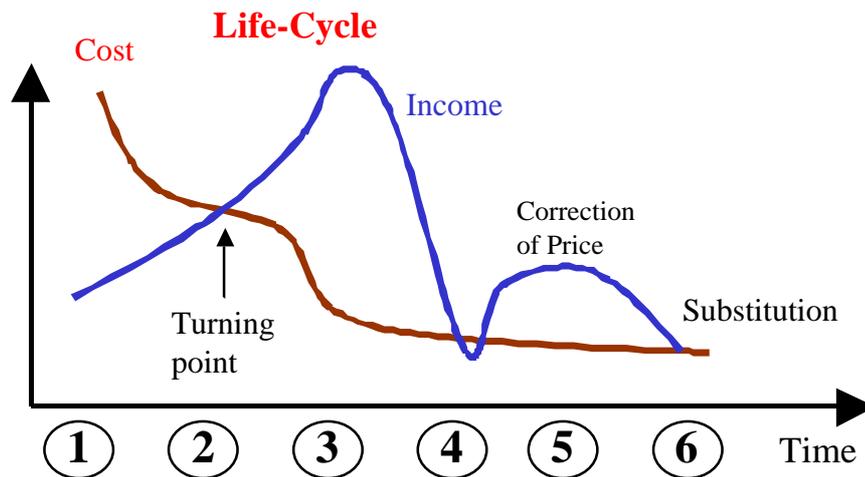
Assuming that the company does include all these aspects in one way or the other and translates everything into units of money, then the efficiency can be seen as the ratio of income to cost.

$$\begin{array}{l} \text{Assumptions: } \text{Input} \approx \text{Cost}_{total} \\ \text{Output} \approx \text{Income}_{total} \end{array} \rightarrow \text{Efficiency} = \frac{\text{Income}_{total}}{\text{Cost}_{total}}$$

Product Life-Cycle

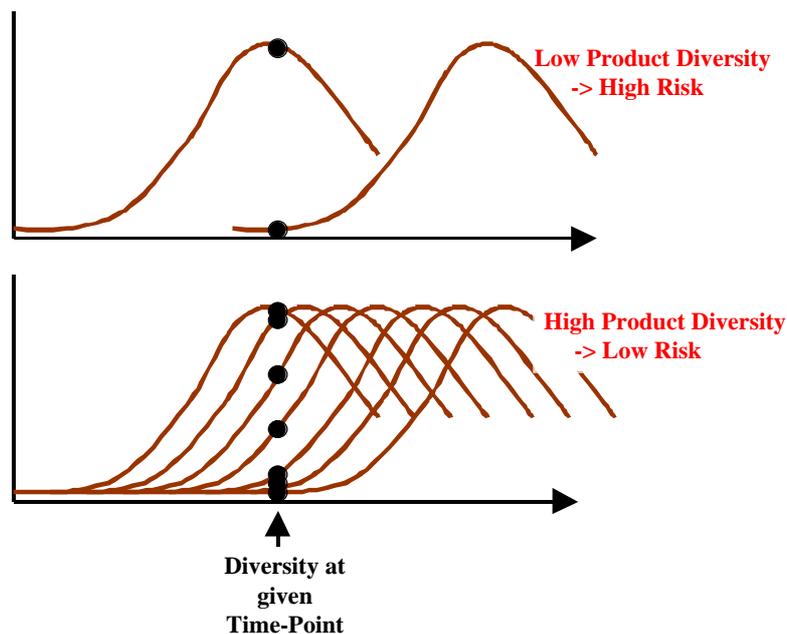
In the following graphs, I will display the dynamics of the two functions (break-even line and consumer demand) during the lifecycle of a product. At the start of the life cycle, the break-even line is above the price-demand function, and therefore not many consumers buy the new product, as it is too expensive. Research and innovation can lead to a drastic decrease of cost of production and to a shift in the break-even line. The product will start to be sold at a higher price. When the cost of production can be decreased further, the product can be offered at a lower price and sold in higher amounts, generating higher profits (cash cow). After some time, consumers will respond by changing their preferences. They are no longer willing to pay the high price but want to get a cheaper price. This leads to a shift in the price-demand line and to a decrease of the amount of products, which are sold at that price. If the enterprise does not decrease the price fast enough, this can lead to loss. The price and the profit margin will decrease. If the consumer preferences continue to change, and if innovation or rationalisation cannot lead to a further decrease of costs, the product might disappear from the market. There might be a better product available (substitution effect).





Product Diversity Increases Robustness and Stability

After showing the evolutionary process of a product, it should be clear that there must be constant innovation in order to always create new products. The old ones will disappear with time. Using these graphs, we can also show why diversity is so important to decrease the risk and increase the sustainability of the company.

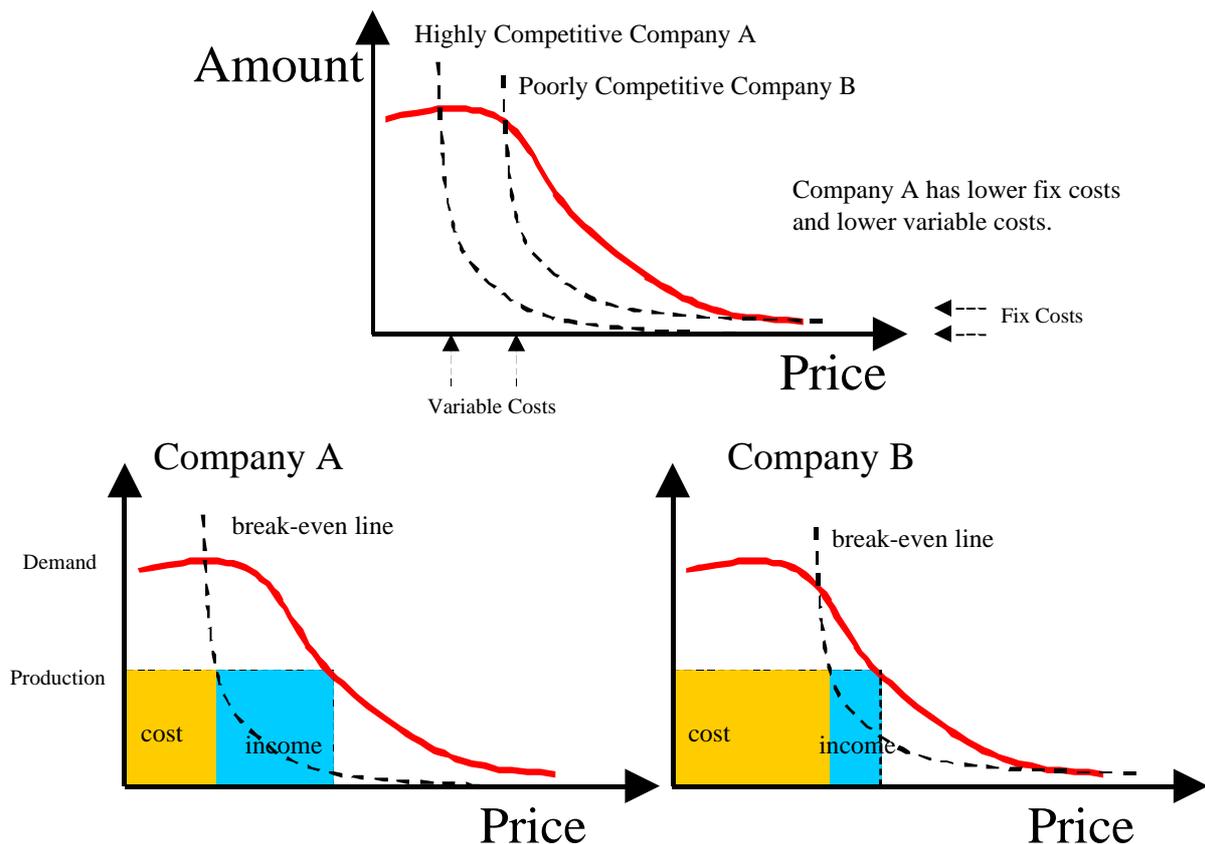


A company with low diversity has the risk of having income gaps because the selling of old products decreases. This has killed many companies with a small product portfolio; they realised too late that new products were required. Even if the products in the market are selling well, the company should start working on the next ones. It is more than obvious that research and development takes considerable time. Therefore, diversity and continuous creativity are highly important.

Competition Between Companies

Plotting of Competitvity

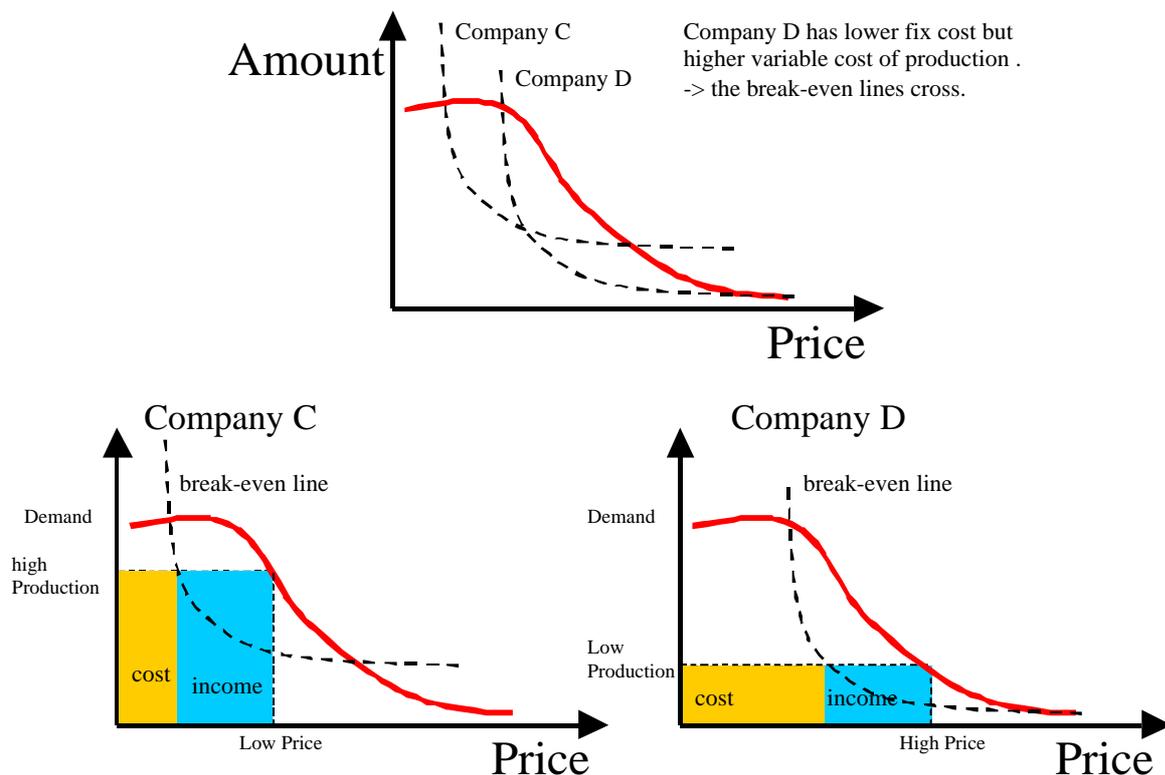
The competition of different companies can also be plotted in the price-amount dimension. The concept of the ecological niche was explained earlier in this essay. Here it can be defined in the present context. If different companies share the same ecological niche, it means that they share the same price-demand line (consumer demand-line). The companies that share the same market and customers still have different costs and therefore independent break-even lines. Under such circumstances, the ecological theory predicts that only one will survive in the long-term. During a price war, the more efficient company (A) will survive.



Ecological theory: only one species can survive in one ecological niche.

If the company B does not find another market niche, it will be displaced by company A.

An interesting situation arises when the break-even lines of different companies cross. This happens, e.g. when company D has lower fixed costs but higher variable production costs than company C. Company C is competitive when production and demand are high. Company D is competitive when production and demand are low. The marketing campaign of the two companies will be different, since it needs to be tailored to the intended niche of the product. Both companies will try to occupy different “ecological” niches.

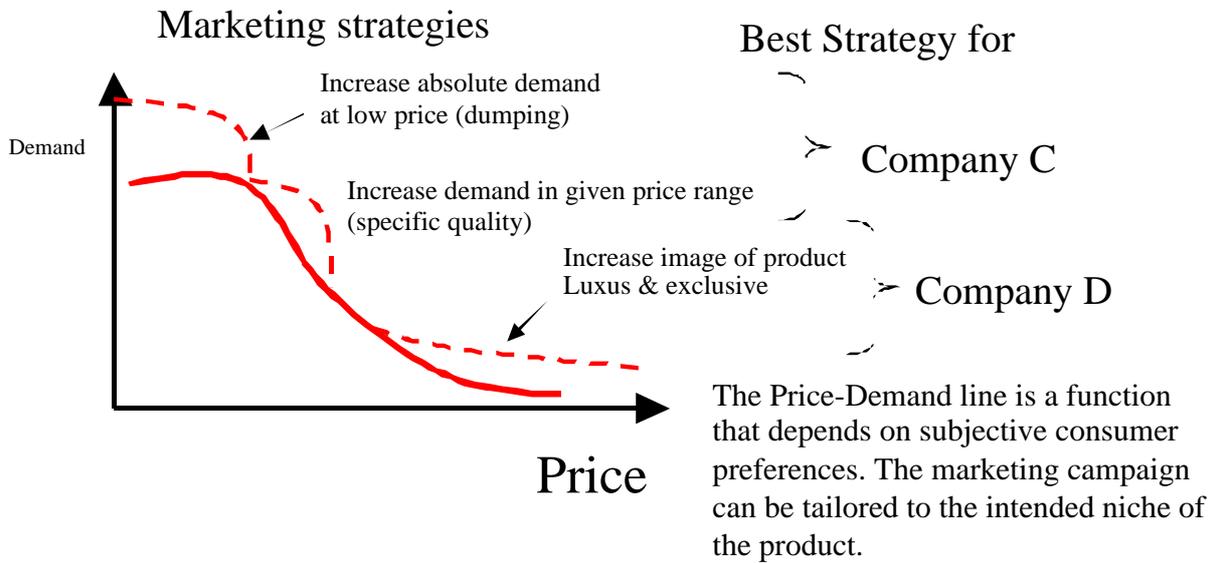


Ecological theory: two species avoid competition by diversification into different ecological niches.

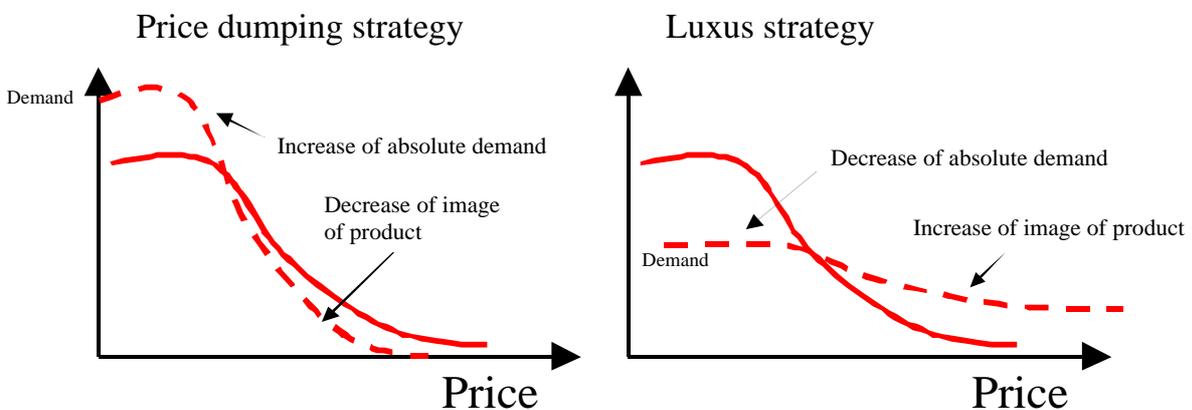
Company C will search for a high volume low price market. Company D will search for a low volume high price market. In order to survive, company D has to create a high quality image. The image of product D has to be much higher as the image of product C.

Marketing Strategies

The marketing strategy of a company is one of the key factors for the economic success of a company. Using the analogy of biology, it can be said that marketing is nothing else than the effort to shape and improve the ecological niche of a company. Therefore, marketing is the effort to shape the consumer preferences. The marketing strategies that companies will adopt during competition also depend on the intended niche. This should suit the break-even line of that company. For example, the strategy of company C will be different from that of company D. The shaping of the price-demand line can also be plotted graphically in the Price-Amount dimensions:

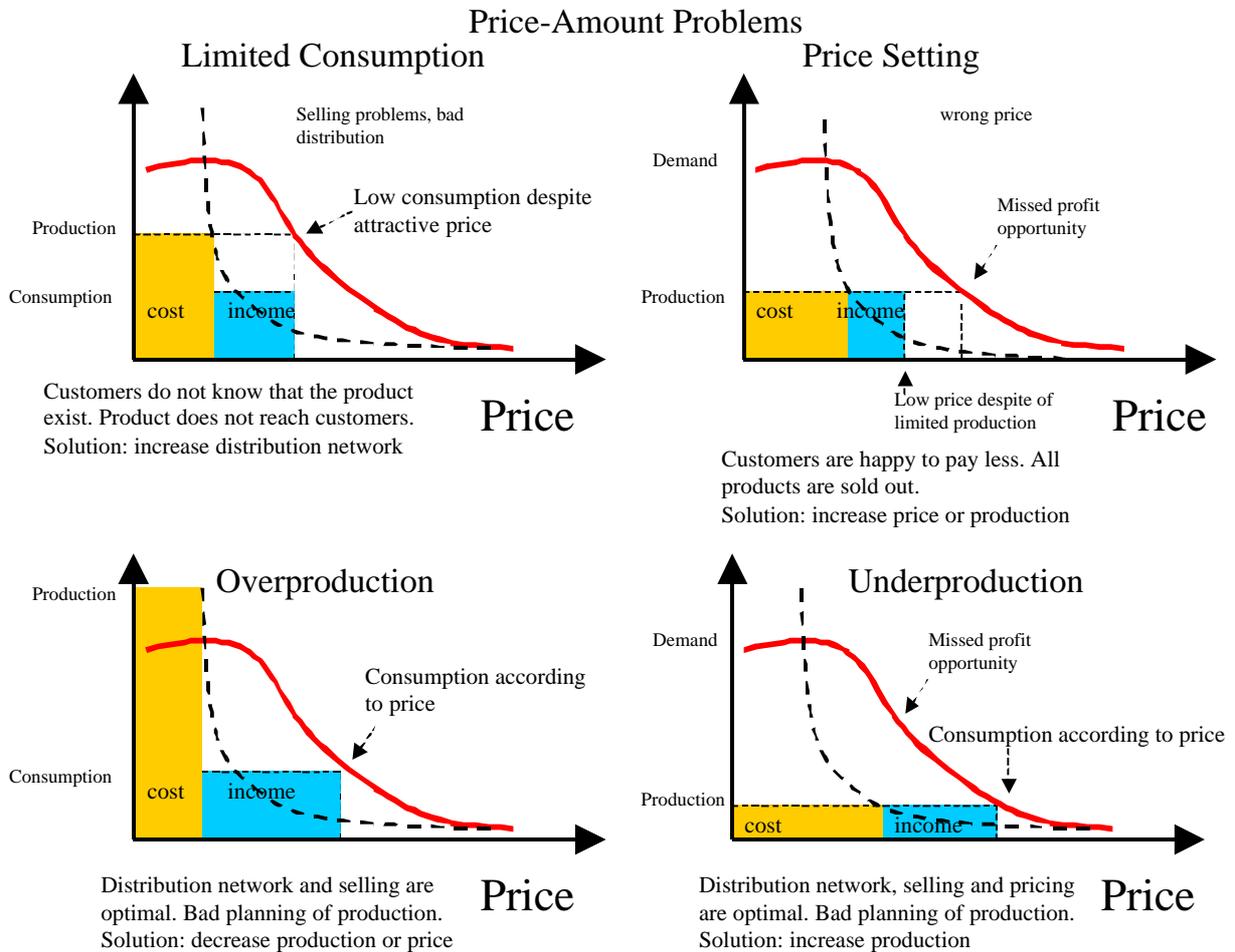


Marketing = Shaping consumer preferences = Shaping the Price-Demand line



Problems of Marketing, Production and Price-Setting

Besides the product-cycle, the plots in the price-amount dimension can be used to show the problems of a company. Such plots also reveal, if it is a distribution, selling, pricing or production problem.



The Government Policies

After having focused on the principle of diversity in the context of private enterprises, in this chapter, I will analyse the policies of the government in the light of all economic principles. This analysis reveals the political strategies, which are increasing or reducing diversity. First, I will present some policies that reduce diversity and then I will describe those, which are increasing it. I will try to generalise as much as possible, but the examples will be mainly from Germany.

Policies Against Sustainability & Diversity

Is Globalisation Such a Great Idea? Efficiency Versus Diversity.

Globalisation is the political and economical effort to increase the efficiency of the world. Our dream is to achieve a single global economy without borders and boundaries. Nationalism and protectionism are *passé*. Free trade zones and GATT agreements are trendy. The aim is to create an efficient and uniform world, with universal rules and homogenous specifications. Globalisation leads to homogenisation and to the destruction of diversity. It leads to a monopolisation of the world with gigantic corporations (e.g. Daimler-Chrysler, Exxon-Mobil) and economic regions (e.g. EU, NAFTA). Even the ISO 9000 quality standard is a good example of the intended efficiency related with homogenisation. Globalisation seems to be omnipresent and inevitable.

However, we really need to ask our politicians who are promoting the globalisation of the world economy: Is globalisation good at all? Why do we constantly hear that the creation of always-bigger economic units is such a great idea? Why do we often hear that the European Parliament in Brussels is all we need in a sustainable Europe? Do political leaders really know the consequences of these actions? Will they be responsible for the consequences of their decisions?

It remains to be seen, if the globalisation of the world economy works according to the humanity principle. That would be the case, if wars between different countries were abolished by globalisation, or if more jobs were created. Will globalisation lead to a better satisfaction of human needs? The preliminary evidence shows that globalisation is leading to fewer jobs and to an increase of the social gap between the rich and the poor. If this is confirmed, then it will become apparent that although globalisation works according to the efficiency principle, it is the greatest enemy of sustainability and humanity. Describing it with the terms used in the philosophical chapter: Globalisation can be efficient and true, but it is neither good nor beautiful¹⁴¹.

The Anti-globalisation Protest

The anti-globalisation protest is something to take seriously. The big capitalist bosses should not regard these young and radical protesters only as blockers of progress¹⁴². Perhaps, the radical youth has not yet found the right words and expressed the deepest reasons for their protest; they intuitively feel that globalisation, big monopolies and super multinational companies are something wrong. They are against the worldwide homogeneity of Mac Donald's, Coca Cola and Microsoft. They are against transnational monopols. Could it be that those protesters are in favour of diversity and of sustainability? Possibly, they are in favour of beauty. What they are saying to the managers and politicians of this world is: Business administration is not just about profit and efficiency.

The modern world does not require half capitalists as managers. The future world requires intelligent leaders and good business administrators who apply all economic principles and find the right balance between efficiency, diversity and humanity¹⁴³. If globalisation is not the right choice, it should be possible to change directions. Is it inevitable that we are destroying so much diversity and beauty of this planet? It is inevitable that the world has to change, but aren't we powerful enough to decide in which direction we should be travelling?

The Homogenisation of Europe

The creation of the European Union is the most ambitious project of political homogenisation. The dream is of a single European state without borders and boundaries. Presently it allows the free movement and exchange of goods, people and capital. The direction it is heading to is leading to a homogenisation at the economical, legal and political level. Is such a monopolised Europe desirable? The concept of cultural diversity is one of the main issues in the debate on cultural policy in Europe. The diversity of cultures is regarded as one of the most important values and wealth of the European Union. The proclamation of "*the unity of diversities*" stands in contrast to the respect of "*national and regional diversity*". One legal instrument to make a compromise between these extremes is leaving the responsibility for culture at the national and regional levels. *The International Network on Cultural Diversity* is an essential instrument for the preservation of cultural diversity in a global market economy. Nevertheless, it is clear that although cultural diversity is indeed a matter of political concern, diversity –in general and in all aspects– is not equally valorised. The economic diversity has been one of the first victims of the European contamination¹⁴⁴. Without import-export taxes and with the Euro as the common and single currency, economic homogenisation has just begun. Now with the European Central Bank deciding all monetary issues it is not possible to help the national economy by allowing different inflation rates in the different states. Soon, the economical and legal framework of the EU will wipe out many of the economical, political and legal differences between members. And more dramatically, the European Union is expanding and inviting more and more countries to merge into "the black hole" of the union. Even countries outside the European continent (e.g. Turkey) are being seriously considered as future members.

All should become equal. Will this be a sweet dream or a nightmare? In the short-term consumers will benefit from the hard competition of the companies in a bigger market. The prices for several products will fall, but we can also predict that many companies will not survive in the *struggle for existence*. This will eliminate many jobs for Europeans. Not only the politicians in charge but also all European citizens have to evaluate, if the

dream of one European State is sustainable and human. It might be easy to convince the public opinion by defining the idea of a unified Europe as a campaign against wars, borders and protectionism. For some people the idea of the European Union is just about travelling without a passport and forgetting about duty free shops, currency exchange and national coins. Certainly, the low participation of the population in European elections demonstrates the lack of political interest. The average people do not really care about Europe and its future. But for those Europeans, who can see further than the limited vision of our elected politicians, there is a great economic risk beyond the loss of diversity: The economy will be less sustainable. The risks will increase. If we choose an ethical argument: less jobs, higher taxes and more bureaucracy are certainly not good. If we choose an aesthetic argument: a unified Europe is less beautiful than a diverse Europe¹⁴⁵. And if we ask a technical question: will a unified Europe be really more efficient at the political and administrative level?

The creation of the European Community is a perfect example of political and economical homogenisation. The political reason for the formation of a great market might not be as simple to understand. Possibly, the psychological need of peace within the nations of Europe (after 2 World Wars) and the political desire of greatness might be the most important reasons. From the economical point of view, the merging of separate markets might give rise to a higher efficiency, since the most efficient companies in Europe will displace all the national, less efficient ones that cannot compete. This will lead to a massive reduction of diversity. Clearly, a homogenous European Community is against the sustainability principle. If it is in favour of efficiency then what about humanity? The decrease in the number of companies will possibly lead to fewer jobs and to a disadvantage of workers of different nations. For example, highly paid jobs, which require higher qualifications will be taken by the nationals with the better educational system, whereas those who do not care to earn much will take low profile jobs. Nationals of both countries will blame each other of taking always their jobs. It can be seriously doubted, if a big Europe is at all in favour of the humanity principle. Where are the new jobs in a unified Europe? The quest for peace would only make sense, if in a unified Europe the wars and violence between different people could be abolished.

On the political and administrative aspect, the creation of a European Parliament could mean –in theory– an increase of the political efficiency.

Instead of having many parliaments and different legislation systems, with each country having its own peculiarities, a single efficient parliament would answer all political questions. The politics in Brussel would solve all European problems. However, it would be too naïve, if the European taxpayers really believed that this is going to happen. Apparently, there are different rules in the world of politics, compared to the world of economics or biology. The efficiency of Europe can only increase, if we get rid of all the bureaucracy in Berlin, Paris, Madrid, Rome, Athens, etc. and leave only one single bureaucracy in Brussels. Many national and local politicians would need to be fired in order to decrease government spendings. Who will tell the German or French parliamentarians that their services are no longer required, since there are already colleagues in Brussels doing the job¹⁴⁶?

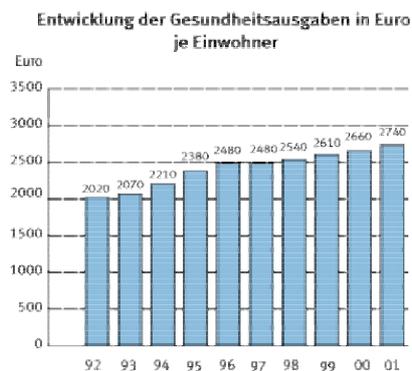
Will we get less or more politicians and bureaucrats? Will the European community increase the political efficiency and decrease the taxes? I do not believe this. In fact, the creation of the European Community looks suspiciously like an audacious measure to increase the amount of jobs (and salaries) for politicians and bureaucrats. Helmut Kohl promised the German people that the Unification would not cost much. Now the German citizens –who did not lose their job– are paying the taxes for it. Soon the European people will notice the reality of "The Union" when they lose their jobs or start to pay taxes for the extended European bureaucracy. How many taxes are we willing to pay for Europe? The most ridiculous is that politicians are trying all psychological tricks to convince the public opinion that they are making efforts to decrease taxes, whereas in reality, they need to increase taxes. Apparently, politics in these days is no longer possible without cheating and lying. As in biological systems where ethics does not exist at all, in political systems the ethics is also a very peculiar one, if it exists at all. The inefficiency of the bureaucracy has to be compensated by the efficacy of false promises, words and unmoral political action¹⁴⁷. Otherwise, our modern democracies could not function at all. However, if the citizens still care about honesty in the world of politics, politicians have to be made accountable for their decisions and mistakes. And they are indeed responsible for our present situation. Who else could be responsible, if not the politicians and legislators? Some will blame randomness, but others will blame the inertia, inefficiency and lack of vision of politics.

Political Compromise of Ethics and Medicine

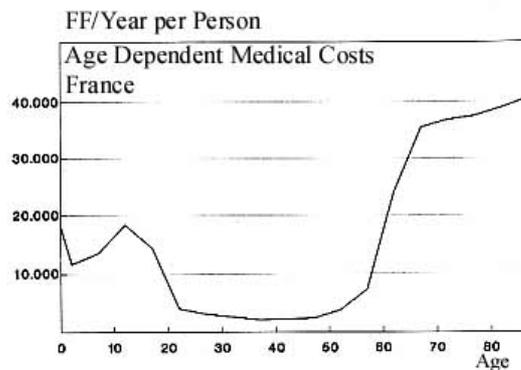
As mentioned in the philosophical chapter, the moral conflict between sustainability and humanity leads to many practical problems in our economy and medical system. This is one of the most difficult tasks that the elected politicians have to solve in their administrative function: to choose the correct bias between efficiency, sustainability and humanity.

The medical system and the health insurance system regulated by the German government are everything else than sustainable. The cost of medicine is growing

steadily. The tragedy is that despite the fact that everybody is aware of the problem –and the calls for reforms have been louder than ever– politicians have no vision and real determination to change this. Is it administrative and political inertia? Of course there is a need to reform the health insurance system and distribute the cost of medicine evenly across the population and maintain the humanity and solidarity in the German medical system. But this is not the solution to the real problem. The medical tools to cure diseases and to extend the human life will not stop to get better and better, but will also become increasingly expensive. Presently, it is legally and morally impossible to tell the people of a modern and civilised country that even if there are medicines available, not everybody can have access to them¹⁴⁸. Medical resources are limited and therefore the ideas of solidarity and the maintenance of an insurance system covering the needs of everybody are impracticable.



Source: Statistisches Bundesamt

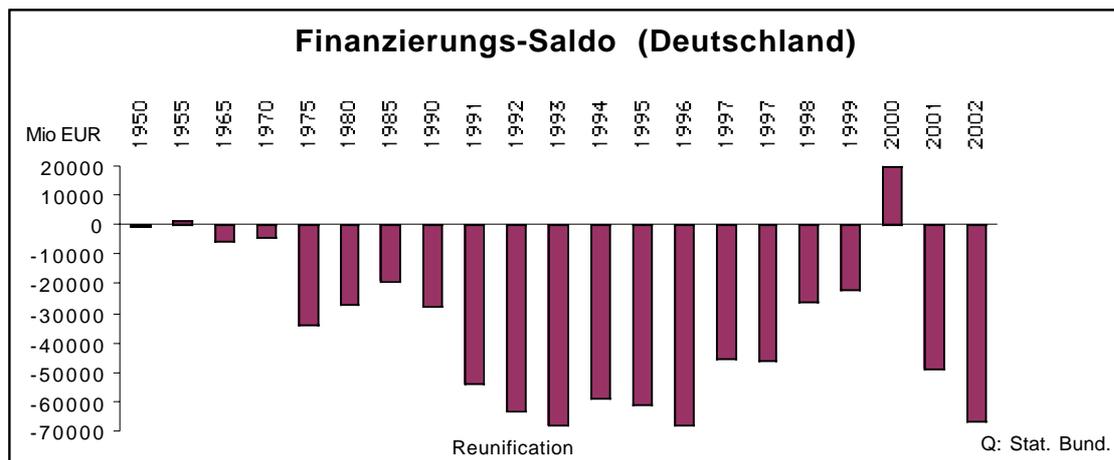


After Stolnitz 1992

Who Will Pay our Debts?

There is one certainty: it is neither efficient nor sustainable that a government spends more money than it can collect in one year. Clearly, the continuous deficit of the government is the most striking example of the lack of long-term vision of political administration. Without vision, there is no hope for sustainability. The German Government has continuously spent more money than it has collected. German children must pay this back some day. If this is to be paid, and if Europe is getting fewer children every day, the efficiency of the European government must increase

dramatically. Will this happen? The tragedy is that no politician will get elected by promising higher taxes and less government spendings to pay our debts. Is the political lie the only solution out of this dilemma? Are the long-term debts of the government (letters of treasury) as safe as the government say they are? If a small businessman is loosing money all the time, it is unlikely that a bank will lend him more money. However, the same does not apply to whole countries, or does it¹⁴⁹?



Limitation of Political Diversity

A modern democracy is based on the representation of the public opinion for political decision-making. Since it is not possible to ask all citizens all the time, a few political representatives are elected from time to time to fulfil the role of the people in the government and rule the country. Interestingly, this practise has shown that political representatives have a higher impact and a higher probability to be elected, if they are associated in political parties. These associations represent a co-operation of different political representatives in major mainstream political philosophies, e.g. conservative or liberal, right wing or left wing, royalist or republicans, socialist or capitalist, etc. Very often, new politicians do not act as individuals with their own political opinion, but as representatives of a political mainstream party. Only when politicians have enough curriculum and are very well known they also start to shape the political party. In some extreme cases, the political party is strongly shaped by the opinion and power of a single person (e.g. Margaret Thatcher, Konrad Adenauer, etc).

Every citizen has his or her own particular political opinion and this leads us to an enormous diversity of public opinions. A maximum level of political diversity would be achieved in a direct democracy (without representation), in which all citizens participate all the time in all political decisions. However, it would be difficult to consider all these different opinions at the same time. Such a political system would be extremely inefficient because many of the opinions would be contradictory, thus, there would be many conflicts and a lack of continuity. The other extreme, the minimum amount of political diversity, would be a dictatorship. This type of political system could be extremely efficient, provided that the dictator really cares for the well-being of his people and makes the correct decisions. However, such a dictatorship is a utopia, since political power is too much of a temptation, and the personal desire to stay in power is stronger than the desire to serve the country¹⁵⁰.

Using the theoretical framework presented in this essay, it can be postulated that a minimum amount of political diversity – a political monopoly – is not sustainable. Apparently, the balance of diversity and efficiency has led to many political systems somewhere between dictatorship and direct democracy. But which is the best balance for political systems? How many different political parties are efficient and at the same time still sustainable? How much political innovation do we require? In the following, I would like to discuss the diversity of the political system in Germany a bit more in detail.

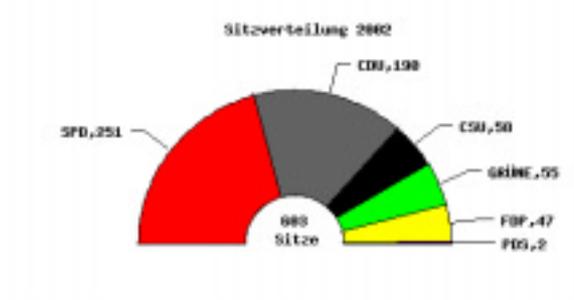
The political history of Germany is very interesting because it has experienced great changes and political diversity. In the 17th century, Germany was only an agglomeration of different kingdoms, in the beginning of the 20th century, it was an empire, and then it became a democracy, turned into a dictatorship, to finally become a democracy again. The history of the second half of the 20th century is particularly interesting because the democracy in East Germany (German Democratic Republic) consisted of only one major political party (Sozialistische Einheitspartei Deutschlands), whereas the democracy in West Germany (German Federal Republic) consisted of several major political parties (CDU/CSU, SPD, FDP, DIE GRÜNEN, etc). The German perception of democracy was strongly influenced by the political experience of the Weimar Republic in the period between the two World Wars. As it turned out, the high diversity of political opinion during the Weimar Republic was so inefficient, that the Germans soon preferred to restrict it. The establishment of the dictatorship of the "*Third Reich*" would not have been possible without the disappointing experience of the Weimar democracy. German history is full of

examples of prohibition of different political parties. Those restrictions and prohibitions not only have been directed towards socialist and communist parties, but also towards parties of the extreme right wing. Even today, the German system is still characterised by a restriction of political diversity. One of the most subtle but also most effective ways to restrict political diversity in Germany are the threshold values for elections. According to this, a political party needs at least 5% of the total votes to have the right to be represented in the parliament. This means that a political opinion is not considered until it reaches the 5% threshold. The measure favours the big parties and avoids the rise of small parties with an alternative political opinion. This threshold also leads to the merging of different political parties in order to form bigger conglomerates. For example, the 5% threshold delayed the rise of the Green Party into the political arena of the 80-90's. It was also the reason for the merging of the Green Party with several other smaller political parties (Bündnis 90) to form a bigger coalition. The present German parliament in Berlin contains only five major political parties. For some people this is enough political diversity, but others think that it is not sustainable enough, especially because it is too inert and reluctant to change.

Could it be that the present crisis in the German political affairs is related to the limitation of political diversity? The current crisis offers a great opportunity to study the principle of diversity in the political field. Firstly, the 5% threshold limits the rise of new parties with new and interesting ideas. Small parties are not allowed to perform and put into practice their ideas; without evaluation, they will hardly get more votes. Secondly, the threshold promotes that individual politicians with brilliant ideas are first obliged to comply with the will and philosophy of a mainstream party. Many ambitious and brilliant politicians have failed on this road of accommodation to the old political elite. Some politicians do not join a major party because they agree with its political vision, but only because they want to get elected. Cheating, lying and bluffing have become a common practise in the political arena. The old political elite is against new ideas and therefore inflexible and old-fashioned. When economic and social conditions change, they are not willing to respond rapidly enough.

The big parties do not represent a clear political opinion anymore, but a fuzzy mixture of many opinions of the different politicians. In the past German elections, the people did not really know for whom to vote because there were no clear differences between the two major parties. The choice has been shifted away from the people as the major parties only offer very broad options. Instead, diversity within the big parties increases and leads to the dramatic problem to find a consensus inside the same party. Fundamental decisions are made inside the parties and not in democratic elections anymore, where all citizens are involved. Dictatorship and ultimatums within the political party are the only way to avoid total inefficiency. It is no surprise that people are so disappointed and loose interest in politics. Even the old party members are disappointed of their own party as it no longer follows a clear line but is a bad compromise between many opposed philosophies. However, nobody dares to initiate a new political party because the 5% threshold would make success very unlikely¹⁵¹. This restricts the renovation of political opinions. The major parties become old-fashioned conglomerates, and small parties are only exotic opinions without any hope

to get a mandate ever. Without innovation, the system is not sustainable. Many citizens think that the problems with the German economy, work, health and pension system are all due to the political inertia, lack of vision and courage.



Source: Statistisches Bundesamt

Zero Tolerance of Mr. Bush

As I have mentioned in previous chapters, tolerance is in favour of diversity and humanity. The European countries have learned to value the cultural, social, political and biological diversity of the world. However, the superpower of the world, the United States of America, does not only refuse to value the biodiversity of nature¹⁵², but has very little tolerance for alternative cultures or governments in other parts of the world. If the most powerful leader divides the world only in two –in good and evil– the chances for diversity and sustainability of the world are truly miserable.

It is a tragedy that the superpower of the world, whose rise was originally based on the cultural, social and technological richness of its people, has now gone into a campaign to monopolise the world with its homogenous culture and ideas. This has led commentators such as Michael Moore and many other Americans to asking the same question: Why has America become so totalitarian? Isn't this stupidity? How does an illiterate become an Idiot-In-Chief through electoral fraud? How can a war be justified with lies and false evidence? How can we tolerate a president like Bush if he does not tolerate other opinions, religions or countries?

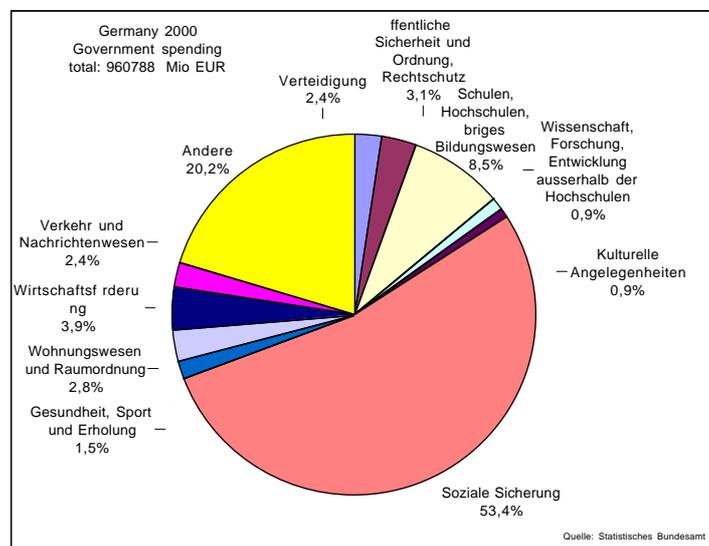
The American president John F. Kennedy once said: *Let us make the world safe for diversity!* Such political vision is what world leaders most need today. Instead, diversity is being destroyed deliberately. War and globalisation are bad and awful because they are against humanity and diversity. The intolerant political behaviour of President Bush can only be described with following words: *an awful stupidity*.¹⁵³

Policies in Favour of Sustainability & Diversity

Art, Culture & Research

The German Government uses tax money for many different purposes; many of those purposes are related to the humanity principle, e.g. the social system, medical infrastructure and the supply of basic services like roads, water, electricity and waste disposal. However, some money is also spent for purposes related to the sustainability principle. As I have mentioned several times, sustainability is related to the creation and maintenance of diversity in all aspects. All the money the government spends on libraries, schools and universities, on books, teaching, education, research¹⁵⁴ and innovation is according to the sustainability principle. Science and research create new ideas and knowledge. Teaching and education distribute and maintain this knowledge. All these purposes serve to maintain the intellectual richness and technological diversity of a country. This technology is also the basis for the efficiency of the national economy.

The government is the most important promoter of diversity in the cultural and social field: museums, arts, theatre, opera, ballet, films, etc. The government conserves the biodiversity through a wide range of environmental policies, such as the protection of natural habitats, parks, reserves, etc. Thus, the government's spending on diversity in all fields –social, cultural, technological and natural– is very important and significant.



Subvention of Economic Activities

The government also spends some money on the conservation of certain economic activities, even if they are no longer efficient or profitable. These measures conserve a certain degree of economic diversity. For example, money is spent in the form of subventions or subsidies to support agricultural activities in regions where it is no longer possible to compete with the prices of the world market. Farmers in Germany receive money to continue growing crops on their fields. And while the government does not want to loose industrial activities, such as steel production and coal mining, it will spend money to keep coal mines running despite the fact that they are no longer profitable. From the efficiency point of view this is a waste of resources, but from the sustainability point of view this is an investment for the conservation of industrial diversity. Additionally, the subvention of the coal mining industry is also related to the humanity principle as it preserves jobs for many people. Such investments in diversity should never be underestimated, since the world conditions could change unexpectedly so that agriculture or coal mining could become very profitable under the new conditions. It is always worth conserving diversity and preserve knowledge, even if it is apparently inefficient. Thus, the bias and priority the government puts into the principles of efficiency, humanity and diversity will determine its decision on subventions. The government should not judge only from the point of view of efficiency, but must use the whole triangle of the economy.

Prohibition of Monopolies

Although the diversity principle was not explicitly postulated in the economic theory of the past, human intuition has already introduced several measures in favour of sustainability in present economic systems. One is the example of the diversification of investments, another is the value that is put into applied research and product innovation; and a third example is the prohibition of economic monopolies.

An economic monopoly can arise when more and more companies disappear, merge or fuse into bigger units, until only one remains. There have been several ways to justify a legal prohibition of monopolies, using arguments of both, the efficiency and the humanity principle. However, the

efficiency principle is actually in favour of monopolies¹⁵⁵. Therefore, it is surprising that capitalism prohibited monopolies. In the United States of America, one of the most capitalist countries of the world, the prohibition of monopolies is taken very seriously. Why is a monopoly efficient? A monopoly is the climax of economic efficiency because it allows the highest profits with a minimum of resources. Resources do not need to be wasted for competition. Especially in economically hard times, during which momentaneous efficiency is crucial for immediate survival, there is a significant trend to establish monopolies¹⁵⁶.

But why should monopolies be prohibited? The justification from the point of view of the diversity principle provides the most important argument¹⁵⁷: Monopolies are wrong (*not-beautiful*) because they are not sustainable. A monopoly is against the sustainability principle as it represents the absolute minimum of diversity. When diversity is lost, the system becomes unstable and has a great risk of collapsing. In the case of economic monopolies, this happens in many ways. First, by having a monopoly for a certain good, the offer is only determined by a single company and therefore the product price will rise, because the company will want to increase its income (profit maximisation). Consumers will lack any freedom of choice and will have to pay whatever price. The uncontrolled rise of the price and lack of freedom will lead to an imbalance in the economic system. Second, with generous profits and without competition from other companies, a monopoly will not see any need for improvements or innovation. Without constant innovation, the system will become old fashioned. Consumers will have no choice but to buy the only product available. Without innovations and improvements, a vicious circle of increasing prices and less efficient production is the consequence. There are numerous examples of this phenomenon, especially in the former socialist countries where there was no competition but only a big state monopoly.

After the Second World War, cars produced in Germany had the best quality and lowest price of the world¹⁵⁸. After Germany was split into a capitalist and a socialist block, the car industry developed differently in both blocks. In West Germany, there were many companies producing different cars. These companies had to compete with their products. In East Germany, a state company had the monopoly of car

production. Consumers in East Germany had no choice but to buy the only models of cars available. The Trabant became the car of the socialist block. In West Germany, the constant competition, innovation and diversity led to better cars that were still among the best of the world (e.g. BMW, Mercedes, Porsche, Audi, Opel and Volkswagen). Not only the esthetical and technical quality, but also the efficiency of fuel consumption, safety and price were improved. In contrast, in East Germany, the quality of the cars did not improve much since the World War. These socialist cars were not only ugly, but they were less safe, less comfortable and produced a lot of noise and smog. On top of it, cars were extremely expensive and many East German consumers had to wait more than ten years from the day they ordered a car until they actually received delivery. This was only possible because the East German State had the monopoly of car production, and West German companies were not allowed to sell their cars in East Germany. Ironically, the socialist ideal led to the exploitation of the East German consumers by offering such bad quality at such a high price, and people were still forced to queue and wait. Under other conditions, the monopoly of car production would have led to an immense profit for East German companies because it was possible to get a high price for very low quality. However, the socialist ideal was not interested in profit or efficiency, but only in the humanity principle. This led to a waste of money as many workers were employed and a completely bureaucratic and inefficient system was maintained. Even the most unproductive workers in East Germany had a job. The needs of many people were apparently covered, but the lack of freedom and diversity made the socialist system unsustainable. After the fall of the Berlin Wall in 1989, the East German monopolies did not have the slightest chance against the West German competition. The “Trabi”, as fondly named by the East Germans, was one of the best examples of lack of innovations and monopolies being not sustainable. This rule does not only apply for a car, but also for whole countries or economic blocks. Despite the intended humanity, for the lack of diversity: Good-bye Lenin¹⁵⁹!

German history has clearly shown that the state monopolies of the socialist block were not sustainable. Such monopolies succumbed when the highly efficient companies of the capitalist countries entered the market, offering better products at a better price and thus displacing the old fashioned monopolies¹⁶⁰. The relationship between diversity, competition and the pressure for innovation and increase of efficiency has been well known for a long time. In the 18th century, Adam Smith already postulated that freedom¹⁶¹ would lead to efficiency, and in the long-term, to the well-being of the whole society as by an *Invisible Hand*. Though he did not mention diversity explicitly he surely meant it when he argued against monopolies. Recently, economists and politicians have noticed that a low diversity in a market is not sustainable. Many politicians are even confident enough as

to open the market of formerly government only domains. The state monopolies are being abandoned. Not only the telecommunications, but also oil and energy, water and waste disposal, public transport and many other domains of former public monopolies are being liberalised and opened for diversification¹⁶². The trend is clear, and the results confirm that the liberalisation of markets leads to higher diversity, higher efficiency and the development of better products. In this case, diversity not only leads to sustainability but also to improved efficiency and to a better satisfaction of the needs of all humans.

The Political Conflict Between Capitalism and Environmentalism

The Search for Raw Profit

The efficiency principle prescribes an increase of the output to input ratio. Unfortunately, it seems that many managers are willing to understand only half of this principle. They only concentrate on increasing the output. This is the reason why capitalism often gives the impression to be only interested in profit and money. However, profit-only oriented managers should only be regarded as half-capitalists. Full capitalist managers are interested in both aspects of efficiency: output maximisation and input minimisation. Additionally, efficiency cannot only be seen in terms of money, but also in terms of goods, resources and needs. Earning a lot of money but increasing other needs –like medical treatment– is not very efficient. Using less water, consuming less energy and recycling products is not only good for sustainability but is something that should be primarily done for the sake of efficiency.

The best manager is not the one who cuts all the trees on thousands of acres of rainforest to make a million-dollar profit in one year. The best manager is the one who cuts only a few trees to make the same profit year after year. The best business is not the one that returns two millions using one million. A better business is one that returns ten thousands using ten dollars only. The best business is the one that is efficient and maintains a high diversity.

Unfortunately, the media places much more attention on raw profit numbers of companies. We hear continuously about profit or loss, but we barely hear of efficiency or inefficiency. The trend to increase the size of a company has been mainly derived from the pursuit of absolute profit. Unfortunately, the indiscriminate growth of companies not always leads to higher efficiencies. Only in few cases this massive expansion has led to a higher efficiency¹⁶³. In fact, some big companies waste a lot of resources precisely because they are too big. Therefore, the crisis of the present companies is not only caused by the external world but by the strategic decisions of their managers. Of course, some of the executives do not recognise their mistakes, and they usually blame others – terrorists, Arabs,

wars, etc. If managers and politicians excuse themselves by saying that they could not predict that the world economy would change in this way, then it is even worse because this clearly demonstrates a lack of vision and the inability to understand the basis of sustainability. The world will always change, thus diversity is essential.

Change of Focus

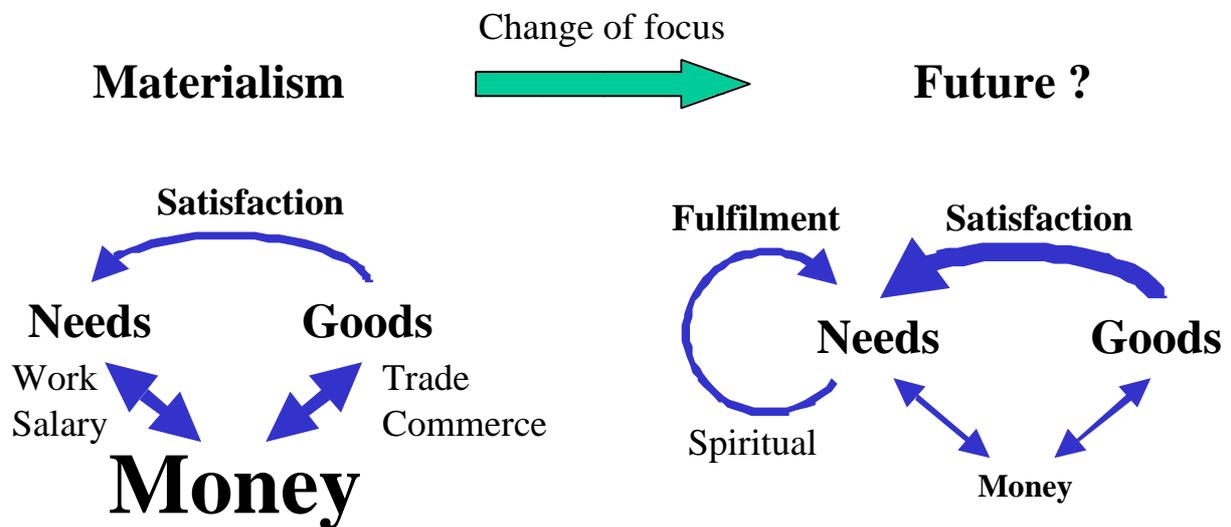
The corporate management should think about the possible mistakes that it might have committed in the past and start to correct them. The focus in the economic philosophy must change. Bigger is not always better. Only if it is more efficient it is better. More diverse is more beautiful. There can also be progress when becoming smaller and more flexible. Look into the world of biology. There are both trends to become smaller and bigger and both strategies are successful. If you are a big dinosaur –for the sake of diversity– grow smaller and be sure to be flexible and acquire feathers to survive as a beautiful bird before the next meteorite strikes¹⁶⁴.



It is not so important how much money a company has or earns, but how efficient it uses the money. The success of the company should not only be measured in terms of capital but in terms of how good it satisfies the

human needs of the customers and employees. Also at the individual level, not only we need to work hard in order to maximise our income, but we can also work hard to minimise our subjective needs. According to a more spiritual view, the control of needs, desire and fear is more important than the worry to earn or lose money. We can build a better economy if we are able to find answers to many important questions concerning our daily decisions.

What is the value of money, if it is not used to satisfy human needs? What is the meaning of power, if it is not used for the sake of humanity? What will be the beauty of this world, if diversity is destroyed? What is the purpose of profit, if diversity and humanity are left apart? What is real success?



How to Convince the Half-Capitalists?

There can be several ways to incorporate the sustainability principle into the mind of all managers. One is to point to the fact that the sustainability principle has something to do with long-term profits. If we wish to obtain profit in the future, we must behave in a sustainable way. Other attempts have tried to incorporate the right of children and future generations into our decisions. Destroying nature and consuming the basis of life for future generations is just another form of child abuse. However, this does not help, if those half-capitalist managers do not value humanity at all. If they do not care about the jobs or needs of people, why should they care about the children of these employees? Other groups think that the best strategy is to assign more legal rights to animals. The argument is that, if we

provided legal rights to all living organisms, we would have a jurisdiction tool to punish the killing of animals and extermination of biodiversity and thus avoid the destruction of nature. Some religious groups even support this approach by not only assigning a soul to humans but also to animals, plants, stones and hills.

There are many other indirect ways to try to convince the profit-only oriented managers. Managers are supposed to be intelligent administrators and as such they should be fully aware of all the economic principles and not only half of one principle. If they only considered both aspects of efficiency –input and output– that would improve the economy. It would be better, if they valued diversity as much as they value efficiency. And if they additionally included more humanity they would already be close to the ideal. If the leaders of the world could find a reasonable balance between the three economic principles, we would not only get a sustainable economic development towards higher efficiencies, but this would also have a meaning for humanity.

There are many options to start a change. Very often, this only requires very simple and small details. Just to give an example, the incentives to employees should not be awarded according to the profit or the size of the company¹⁶⁵. Instead, employees and managers should get awards depending on the efficiency of their company. Another example: The government should not only apply taxes for the profit (output of capital) but also for the input of capital and resources. Another example: If the government wants to create jobs then it should not apply such high taxes to the workforce of people. For example, the German government charges a 30-60% tax for earning money with a job or work, but only a 7-16% tax for our consumption. Why does the government not apply taxes for the workforce of robots and machines¹⁶⁶? Are we really surprised that there are such high unemployment rates? Who is responsible for the situation in Germany, the economics or the politics?

What is Contamination?

One of the most important issues of many ecological initiatives is the conservation of the environment. For many, this is simply regarded as the conservation of the natural resources and the avoidance of contamination.

But, what is contamination? Intuitively, nobody would find it difficult to define it. If we see rubbish in the forest or an industrial chimney expelling grey smog we declare that contamination. According to a dictionary, contamination is to make something impure, for example by adding substances that are dangerous. For many ecological groups, contamination is everything that comes from humans; anything that is created by civilisation and that should not belong to a natural environment. For many, contamination is something that smells bad, looks ugly or does not sound nice. But why is contamination considered as bad? Is it the impurity *per se* or is the human source of the contamination the reason of this negative connotation?

I would like to suggest a definition of contamination in the context of the principles presented in this essay. Using a philosophical description, contamination is not '*bad*' but only '*ugly*'. In nature, there is no '*good*' or '*bad*'. Only if the contamination is against humanity should be considered as bad. Contamination in a broad sense is ugly, mainly because it decreases sustainability. **Contamination is everything that decreases the diversity of the system.** Contamination has something to do with danger and risk. It is diversity what is in danger. In the context of the natural environment, contamination is everything that kills animals and plants, everything that destroys natural environments and decreases biodiversity. To throw toxic substances into a river and kill many aquatic species is contamination; to destroy the amazon rainforest and exterminate thousands of species is contamination; the smog that decreases the health of humans, animals and plants is contamination...

However, this definition relating contamination to biodiversity can also be against our intuitive feelings or impressions. A substance released into the environment, e.g. the rubbish in the forest, can be contamination, if it really decreases the diversity of species. However, not everything coming from a human source and being foreign to a natural environment decreases the biodiversity and should be regarded as contamination.

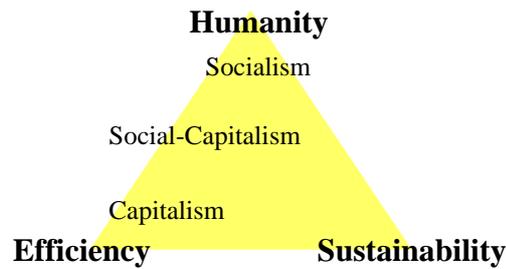
As humans live mainly on the land, oceans are regarded as one of the last environments where everything human is unnatural. The ships and sea platforms that populate the seas are regarded as contamination of the otherwise clean and pure ocean. Human garbage that is thrown into the sea is regarded as contamination. For

example, some of the greatest ecological disasters threatening the biodiversity of the oceans are accidents with oil. The extensive contamination with oil kills many fishes, birds and plankton. This is terrible because it decreases the biodiversity of the affected region. Another frequent case is when ships sink or new sea platforms are constructed. Since this is an unnatural impurity of the ocean floor, is this also a contamination? Well, if the biodiversity is not affected then it is not. Even the most radical green activist groups recognise that the sinking of ships or the construction of sea platforms are not always a contamination of the sea. Sometimes, it is the contrary, because it promotes the establishment of many species of animals and plants on the seabed. Astonishingly, discarding metal garbage (e.g. ships) within the shallow waters of the continental shelf can increase biodiversity of the region considerably, because it offers home and shelter to many species of algae and animals. The established biodiversity is comparable with the one in natural coral reefs. Therefore, human garbage on the seabed is not always contamination but can represent an artificial reef with much biodiversity.

Environmentalism

The sustainability principle provides an imperative explanation for why diversity in all aspects is essential for survival. According to the magic triangle of business administration, we need a balance between efficiency and diversity. Capitalism started in the 18th century and was centred in the principle of efficiency. In the beginning of the 20th century, the socialist revolution led to the recognition of the humanity principle as an important component of any economy. This led to the development of socialism and communism.

In the second half of the 20th century, it also became apparent that our planet Earth had its limits¹⁶⁷ and that something was wrong with constant growth and profit. Neither the human population nor the world economy can grow infinitely. At the end of the century, many conservationist groups started to stress the importance of the natural environment and the protection of nature's resources. The destruction of nature and extermination of animal and plant species became a political and economic issue. Men and women started to recognise sustainability as an important component in any human activity. However, the concept of sustainability was not developed in depth, and many groups incorporated a particular interpretation out of their own intuition and feelings.



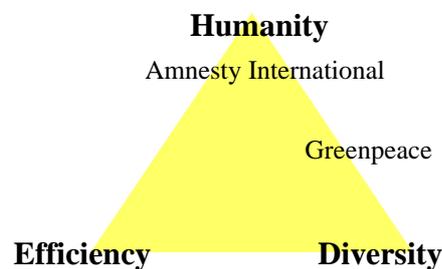
Most green activist groups started as a protest movement against the capitalist giants that seemed to care only about one aspect of the efficiency principle: profit maximisation. They protested against capitalist profit and the destruction of nature. The Earth was no longer regarded as a simple planet, but it was a living organism (Gaia) surrounded by a tiny and delicate biosphere. Many groups thought themselves as *defenders of the earth*. Some of them started to protect the birds; others decided to protect the whales, dolphins or panda bears. Some groups concentrated on individual species, others on whole natural habitats and environments. Nowadays, there are almost as many protectionist groups as there are animals in the zoo. Some of these *rainbow warriors* take their duty as serious as not to care about legal implications or trespassing on private property. The most radical groups even think that their aim, the protecting of nature, justifies all their actions.

Some of the first battles were spectacular. It was a fight between a green David against a capitalist Goliath. Many of the capitalist giants did not take the green threat serious, as they were too confident in their capitalist ideas. They had the money; thus they had the power. They did not think there was anything more powerful than absolute profit and money. However they were wrong. Big multinational corporations like Exxon, Monsanto and many others had to feel the power of the green movement in their own bones and finally succumbed. Although pure capitalism has lost many battles, the war is not yet over. Some of the hardcore capitalists see the protection of the environment as an inconvenience they have to adapt to unwillingly. Others saw an opportunity in the changed human preferences and needs. The green desire of many customers was used as the basis for new markets and enterprises. The green point and environment friendly labels became powerful marketing strategies leading to new products and opportunities of profit. In those cases, in which the green cause was in

favour of the principle of efficiency, it was easy to establish. The half-capitalist administrators who only followed 'profit maximisation' finally had to recognise that 'resource minimisation' also belonged to the same principle. Corporations were even happy to increase their efficiency and at the same time tell the public that they were behaving environmentally friendly and cared about sustainability. Thus, many aspects of the conservation of our natural resources were nothing else but the correct application of the principle of efficiency, the credo of capitalism¹⁶⁸.

If the socialist revolution was linked to the humanity principle, then the green movement is associated with the sustainability principle. Some groups formed a coalition of humanism and environmentalism in order to encounter the common enemy of capitalism. For example, Amnesty International and Greenpeace compete for the same conscious people to gain as members and supporters. The young protesters not only want to defend the whales or dolphins, but are also in favour of the rights of women and homosexuals. However, most of the time, they are against something and not really in favour of anything.

Green activists are against nuclear energy, chemistry, biotechnology, modern medicine and industry. They are against roads, cars, companies, oil and money. Therefore, they have gained a reputation of blockers and are commonly called conservationist groups. Their main aim is to conserve the present world. Are they *defenders of the status quo*? They are against any risks and want to increase sustainability of our world by freezing it in its present status or slowing down the pace of development. They are in favour of biodiversity, but the only way they see, is protection and conservation of the presently available diversity.

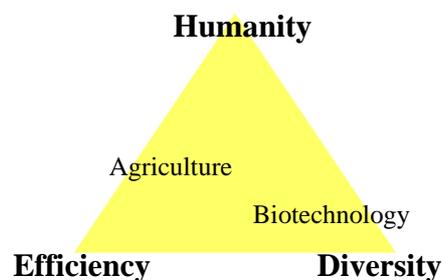


The green movement is associated with terms like protest, defence, conservation, preservation and protection. Astonishingly, the green movement is usually not associated with terms like creation, innovation, improvement, research and development. Was everything better in the past? Should humanity go back to the Middle Ages? Presently, the green

movement is one of the strongest forces against the development of new products, new ideas and technologies. For example, they are fundamentally against genetic modification and the generation of new and better plant varieties. Ironically, biotechnology is one of the few tools, which are currently available to generate new biodiversity. Furthermore, biotechnology is a tool to create diverse and improved plants, which are good for humans and efficient for agriculture.

Sustainability of the human kind requires a constant generation of new diversity – the same as in the natural world. Natural environments are always and constantly changing. It is not enough to try to conserve the past diversity to counteract the loss of old diversity. Some species will always fail to be efficient in the *struggle for existence*. Sustainability requires the increase and generation of new diversity, but it does not mean going back to the diversity of the Stone Age. Some conservationist groups regard the natural environment as a static entity, which must be protected from human intervention. The human kind is regarded as an unnatural addition to the environment¹⁶⁹. Thus, they believe nothing humans create or produce should ever go back to the natural environment.

One of the biggest risks green conservationist groups see in genetically modified organism is that these new organisms will be released and succeed in a natural environment. Should we be sad, if there is an increase of diversity in the world? And even if an old species was displaced, because it is less efficient, is it wrong if efficiency increases at an equal amount of diversity? This is indeed biological evolution. We should worry only, if genetic engineering decreases diversity more than it increases the efficiency of agriculture. The discussion around genetic modification of plants should not be focused only on moral or conservationist ideas, but should also be approached from the diversity point of view.



The reason why some groups (e.g. Greenpeace) are against plant biotechnology is because they do not separate it from agriculture. In principle, environmentalism is not against biotechnology but against modern agriculture¹⁷⁰. Many conservationist groups are against agriculture in the rainforest and many other environments of the world.

According to them, European farmers should not be efficient producers of food, but park-keepers who conserve the diversity of landscapes and species. The green political movement is willing to pay subventions to allow farmers to be inefficient¹⁷¹ and convert them into organic farmers and tourist attractions¹⁷².

Even when modern agriculture and genetic engineering are separated, there are still many groups that are against genetic modification. Some groups opposed to biotechnology argue from the ethical point of view (not yet from the diversity point of view). According to a static view of the world, which leads to fixed morals, humans should not be allowed to shape the environment and change the original creation of God. Only the Will of God (randomness) can decide about death and creation. Some religious groups see no purpose in changing the genetic information of organisms. They do not believe that the genetic modification will allow a better satisfaction of human needs. They are against biotechnology because genetic modification is done on purpose and specifically, not randomly. In fact, random genetic modification (mutation) is considered natural and is not legally regulated as opposed to transgenic organisms, which are even prohibited in some countries. Although in principle, it is possible to get a similar result with random mutation and extensive selection, the advantage of targeted genetic modification is that it can be done more rapidly and efficiently. Instead of generating an enormous diversity to select the very few, more efficient cultivars, modification could be done using human intelligence and knowledge and thus leading to the desired changes in a more specific way. Additionally, genetically improved plants could be more resistant to pathogens, contain more vitamins, be more productive and lead to a better satisfaction of human needs.

Incomplete Application of Economic Principles

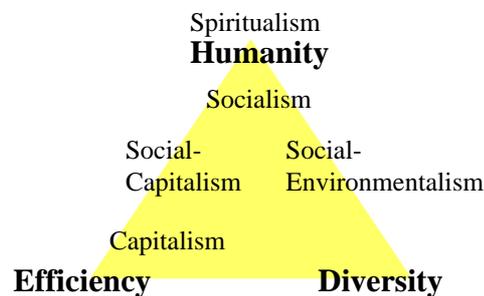
The most important reason why there is still a fundamental disagreement between capitalism and environmentalism is the incomplete comprehension of the three economic principles.

Capitalism, which is focused on profit maximisation, must not only apply the efficiency principle correctly, but should also incorporate the principle of humanity and diversity in all economic decisions. Efficiency dictates the minimum use of natural resources to obtain the best possible result. To use less energy is efficient, not ecological as the corporations usually advertise. To be called truly 'ecological' it has to increase the biodiversity. Unfortunately, the capitalism and socialism systems of the past centuries completely disregarded sustainability. Sustainability requires long-term vision and the avoidance of risk. Sustainability can only be guaranteed by a constant process of creation and innovation. Diversity can be increased

by a naturally random, or an artificially directed process. The failure of capitalism and socialism are most evident from the way that they consumed natural resources and continue to destroy the diversity of this world.

The environmentalist movement has to expand the interpretation of the diversity principle from the pure conservation of the *status quo* to the *continuous creation and maintenance of diversity*. Of course, the protection of the present biodiversity is highly important, even more at the rate at which we are exterminating thousands of species every day and destroying a great number of ecosystems¹⁷³. However, additionally to conservation, creation and innovation must be included in the doctrine of environmentalism. Creation must be accelerated intelligently. We have to innovate and to invent new things. Diversity can only be maintained, if as much new diversity is created as the old one that is destroyed. The green movement should not be a blocker of economic development, but should instead show and promote the way for sustainable economic progress.

Strong bias on the principle of:		
Capitalism	Efficiency	It is only considered profit maximisation but does not implement resource minimisation. In the course of the 20 th century, it has integrated some humanity into the economy (social capitalism), but it still relies on constant economic growth. The value of diversity has started to become important only in very few aspects, such as product innovation or cultural diversity (division of labour), but it still does not value diversity in general (e.g. biodiversity, anti-globalisation).
Socialism	Humanity	Based on the original ideas of Marx, it tried to focus on humanity by abolishing private property and added value. This was only possible by a massive reduction of personal freedom (communism). It failed to promote diversity and it became very inefficient in the end. Unfortunately, the system became authoritarian and failed to provide the humanism it was intended to provide.
Environmentalism	Diversity	It started as a protest movement against profit. Environmentalism tried to combine humanity and sustainability to counteract raw capitalism. It included an ethical dimension to nature conservation. However, until now it has only focused on half of the diversity principle, i.e. on the conservation of the present diversity. As long as environmentalist groups are against the creation of new diversity, they can be called <i>defenders of the status quo</i> or blockers of progress. Thus, it appears that half-environmentalists are fighting against half-capitalists.
Spiritualism	Morals and Ethics	It started as a movement against materialism and money. It concluded that the human economy had no meaning, as it is not able to satisfy all human needs. Instead, the purpose of life must be sought in another way. Spiritualists do not believe in technological progress but only in the spiritual progress, which can be achieved on the inner path. Creation and selection, diversity and efficiency are seen as the domain of God. The only task of humans is to reach divinity (heaven) following the path of absolute fate and unconditional acceptance of the Will of God.



Testable Hypothesis and Postulates

The Principle of Diversity as a Theory

Throughout this essay, I have postulated many concepts related to biology, economics and philosophy. The motivation to write this essay was not the '*elegant presentation*' but the ambition to elaborate a coherent scientific theory. The value of any theory, in terms of truth and efficiency, relies on its usefulness for making predictions, which can be confirmed in further observations or tested in experiments. Therefore, here, almost at the end of the main part of this essay, I would like to repeat some of the most important ideas related to the principle of diversity. It is an invitation to make experiments and evaluate, if the results speak against or in favour of a universal theory of diversity.

Statement	Comments
Diversity is the basis of sustainability.	Diversity in all aspects is valuable. Physical diversity is required for the stability of the universe. Biological diversity leads to a stable balance of the individual selfish interests of species. Social and cultural diversity is required for the long-term success of the human kind. Personal diversity is the key to avoiding the risk of failure in the struggle for happiness and fulfilment.
Fundamental randomness leads to the continuous generation of diversity.	Randomness allows freedom of choice, because identical circumstances can lead to different results. Randomness breaks the total predetermination of the laws of the universe. Without randomness, everything would already have being decided. Freedom is also required for the generation of diversity. Diversity is generated in every moment and in any place of the world.
The total diversity of the universe is constantly increasing.	The overall diversity and the total disorder (entropy) of the universe are increasing steadily. At the beginning of any system, diversity increases most rapidly. After the saturation phase (balance between diversity and efficiency), the momentaneous diversity is stable, but the diversity accumulated over time is always increasing. The diversity of yesterday was different from the one of today. The diversity of tomorrow does not exist yet but must be created today.
Diversity and efficiency are complementary forces.	Whereas diversity leads to heterogeneity, efficiency leads to homogeneity. The natural tendency for monopolies is driven by the principle of efficiency. The increase of diversity is driven by the principle of sustainability.

The interaction of diversity and efficiency lead to evolution.

Depending on the motives behind the generation and selection of diversity the evolution will have a purpose.

The free market of the economy is an ecosystem in which different companies struggle for efficiency.

In each ecosystem, species try to occupy all available niches.

The number of separate and independent ecosystems will determine the amount of companies that will survive in the world.

Without constant innovation and generation of new diversity, companies are not sustainable.

Evolution is the direct consequence of the creative force of the universe and the selection force due to limited resources. There is not only an evolution of the universe, but also one of biological life, human cultures, civilisation, ideas, products and companies.

Because the generation of diversity is a law of nature, it does not have an ethical purpose for itself. Only the reasons behind the choices can provide a meaning for evolution. Absolute selfishness does not provide a purpose. In nature, there is no ethics and no purpose. Only intelligence similar to the human is able to recognise the consequences of its actions and has been able to elaborate – invent – ethical rules that provide a higher meaning for all human efforts.

In free markets and ecosystems, resources are limited and there is competition for existence. Efficiency is crucial for immediate survival. Companies adopt strategies to ensure survival, which are very similar to those of biological species.

Ecological niches are not static but are the consequence of the current conditions. The appearance of one species can create many new ecological niches for many other organisms. In natural environments, this leads to a more or less predictable succession of biological communities. The conservation of genetic information restricts the creativity of biological species. *A fish cannot ride a bicycle* in as few generations as a monkey can get adapted to fast wheels. Life is a race of species to move forward and occupy the free and new niches first.

Humans are exterminating so many biological species not because of direct killing, but because of elimination of ecological niches and natural environments. Governments are exterminating so many companies because they are merging separate markets and creating a single global economy. Not companies, but politicians are determining the number of jobs that will be available in the future. In a unified Europe, the number of companies will decrease proportionally to the total number of countries prior to the unification.

Efficiency can only be improved through creation. Because the conditions of the world will always change with time, the present efficiency cannot guarantee survival forever. It is only through new inventions and diversity that companies can secure survival in the market of the future. Some companies will create this future diversity themselves, but other parasite and opportunistic companies will copy the diversity that proves to be efficient. The coexistence of innovators, imitators and terminators will ensure the sustainability of the system.

Human intelligence can be used to generate diversity.

In nature, it is randomness that creates new diversity. Natural evolution is slow, but it is able to cope with all unexpected changes of conditions. Cultural evolution is so rapid because humans use their intelligence to generate the diversity that leads to higher efficiency under the predicted conditions. Humans do not invent all possible things but only a few that could be useful. For example, not all possible combinations of sounds and noises are used for making songs, but in their creative imagination musicians make a pre-selection to compose such wonderful music.

Experimental Systems

Use of computer **simulation models** to reveal the link between diversity, risk and sustainability in complex systems.

Use of the **immune system** to study the link between cell and antibody diversity, randomness, somatic hypermutation, selection and the effective protection against unknown pathogens.

Use of **agricultural systems** to study if monocultures are more susceptible to pathogenic attack and if they are more efficient or/and sustainable than polycultures.

Use of **natural ecosystems** to understand why there is so much biodiversity on earth. Comparison of the stability, robustness and efficiency of environments containing more or less diversity.

Use of **computer networks** to study if the use a single operating system (e.g Microsoft) is more or less robust and sustainable as computer networks having a mixed environment and different operating systems (Microsoft, MacOS, Linux, etc.). Study of the susceptibility to computer viruses or predict the danger of complete network breakdown.

Use of **financial markets** to study the components and ingredients of stable stock markets. Explore the role of information, heterogeneity (diversity) and predictability (randomness).

Use of **cultural systems** to study the importance of diversity for the different human societies. Understand why there are so many different languages, customs and ideas.

Use of **political systems** to investigate the role of diversity, freedom and democracy in sustainable systems.

Short Final Message to Managers

This essay offers an extensive analysis of diversity in biological and economical systems from different perspectives. It shows some ways, in which this knowledge can be applied to the world of business administration. However, the messages and conclusions are diluted all over the length of the manuscript. A manager who does not have much time –and interest– in reading all these pages could still get the most important messages, if he or she reads, understands and keeps in mind the following 4 statements:

- 1) **Increase the efficiency** –not the profit
- 2) **Increase the diversity** – continuous innovation & adaptation
- 3) **Satisfy human needs** – it gives a purpose
- 4) **Use all your intelligence** – it is faster

Appendix – Discussion of Other Theories

Ideas Mainly Related to the Diversity Principle

To my best knowledge, the concept of a fundamental principle of diversity, i.e. the link between sustainability, diversity, creation, randomness, freedom, aesthetic and beauty, has never been analysed as a whole but only been considered in pieces in the past. For example, the link between randomness and freedom was postulated especially in the field of physics, where the deterministic laws of nature (Laplace daemon) do not allow any real freedom, because all future events would be determined by present conditions. According to physics, the randomness of the quantum world is the only way to introduce freedom into the macroscopic world. The open choices that can be made out from the cloud of randomness give us the possibility to experience freedom. The link between randomness and freedom was also confirmed in the field of psychology and the study of the human mind¹⁷⁴. The link between randomness and creation has been postulated mainly from the theory of complex systems, the theory of chaos. Furthermore, the link between creation and diversity can be tracked back to the Book of Genesis, and it was also common in the field of biology even before Darwin introduced the concept of natural selection. The link between randomness and biological creation was experimentally confirmed with the discoveries of mutations: genes by Mendel, genetic recombination by Morgan, structure of DNA by Watson and Crick and many other scientific contributions. The synthetic theory of evolution integrates all these results to build the very basis of biological research in our days. Thus, the link between randomness, creation and diversity is a central paradigm of modern biology. Although, this biological knowledge has not yet been introduced to economics or business administration. The connection between diversity and sustainability, and the connection between diversity and beauty had been studied the least. The present essay focuses on the analysis of sustainability and diversity using an economic context. In future essays, other aspects and components of

diversity could be analysed in more detail. I might write more about randomness in a scientific but also in a theological context. A manuscript dealing with some of the absurdities of materialism and the meaning of money is also in preparation.

In the following, I would like to discuss the work of other scientists and philosophers who have made very relevant contributions. Because it is not possible to discuss all their ideas and theories, I selected only some of the concepts that I considered important and relevant to the present essay.

Cosmogogenesis

There have been some essays, which have postulated theories and ideas that are related to the principle of diversity. In his book "Cosmogogenesis", David Layzer tries to explain 'the growth of order in the universe'¹⁷⁵. He sees a contradiction between the emerging order he observes in the universe and the second law of thermodynamic, the increase of the overall entropy (disorder) of the universe. He postulates that a type of order in the universe is being created by cosmic expansion. According to him, expansion of the universe leads to an increase of the maximum possible randomness of the universe, and therefore to a growth of the relative order of the remaining matter.

He postulates that *'astronomical evolution and biological evolution are both stories of emerging order'*. He also speaks of a fundamental randomness in the universe, leading to an unrestricted liberty of creation. Contrary to Laplace and Einstein, Layzer postulates that chance is not a product of human ignorance, but a fundamental property of the universe independent from any knowledge. Randomness and choice lead to freedom because *'without freedom there can be no responsibility'*. In this way, Layzer justifies the view that humans are morally accountable for their actions.

Layzer asks why the universe has not remained uniform. He suggests *'that a tendency to form clumps is a natural property of an expanding, initially uniform gas filling all space'*. For Layzer, some special properties of the gravitation force are the reason for diversification of the universe. The theory of gravitational clustering might show how structural diversity evolved in an expanding universe.

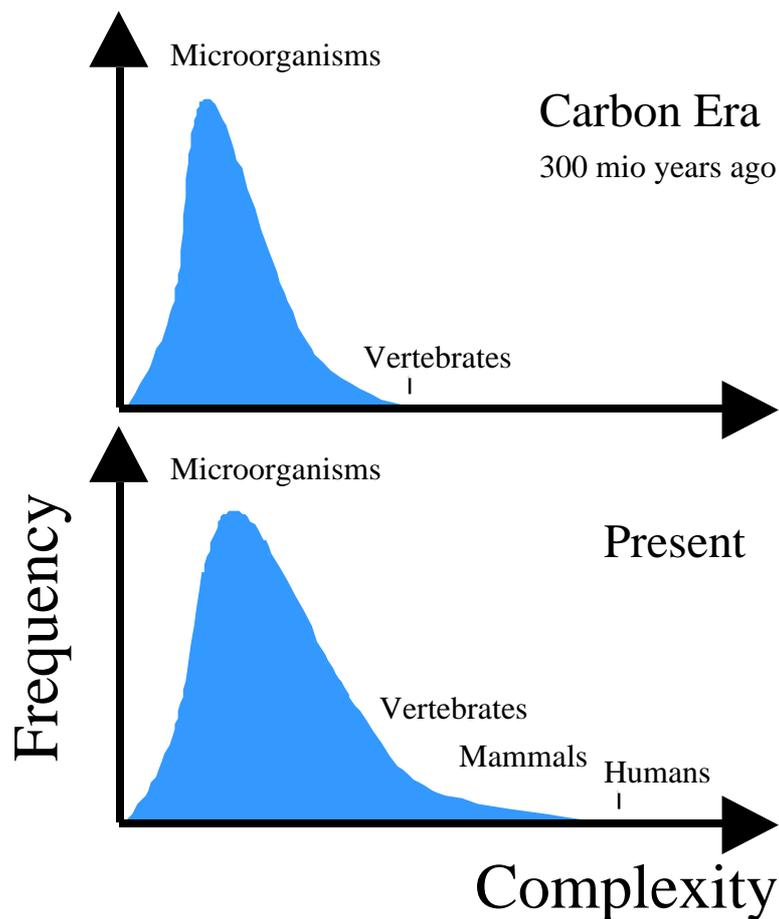
Layzer combines scientific and probabilistic (randomness) measures of disorder (entropy) and uniformity (isotropy) with a human perception of what is order (a beautiful earth landscape of mountains and valleys is described as being highly ordered). I would fully agree with Layzer, if his perception of order was related to diversity. The match would be almost perfect, if he had developed the concept of "*diversity*" instead of "*order*" in his book. Layzer's '*Cosmogogenesis*' would have been very interesting, if he had also explained 'the growth of diversity and beauty in the universe'.

Layzer also analysed the phenomenon of biological evolution. Life is an *infection of inert matter*. This infection leads to the growth of order (diversity) in matter. A bacterium is less ordered (diverse) than a worm or a human being. In the chapter dealing with biology, he postulates that '*reproductive instability is the driving force of evolution*'. The reasons for reproductive instability are the frequent mistakes that are made when DNA is copied and passed on to the next generations. We both agree that '*evolution is a genuinely creative process*'. Like the life force, reproductive instability is inherently dynamic and inherently without direction; it has no purpose or project. He also speaks about '*evolutionary innovations that enable organisms to exploit their environment more effectively*'. Layzer's idea of *reproductive instability* is a close concept to what I define as the *creative force of randomness*.

There are a lot of common aspects between Layzer's ideas of Cosmogogenesis and a fundamental principle of diversification in nature. Unfortunately, Layzer does not make any link between diversity and sustainability. I agree with Layzer's idea of freedom and creative power. Nevertheless, I disagree with his concept of the overall growth of order in the universe. Contrary to Layzer, I see no reason to question the second law of thermodynamic, as the overall entropy (disorder) of the universe does increase and not decrease. It is just that order can increase locally. I would rather recognise *a fundamental principle of diversity*, if in different parts of the universe, the entropy either increased or decreased. I would add that the increase of diversity in the universe is not driven by gravitational force but by the most fundamental force of nature: *randomness*. Also, instead of evolution leading to an increase of order or complexity in biological systems, the increase of diversity could be

interpreted as a tendency for the occupation of all possibly ecological niches.

In this respect, I agree more with the view of evolution that Stephen Jay Gould described in his book "Life's Grandeur– The spread of excellence from Plato to Darwin"¹⁷⁶. According to Jay Gould, we cannot speak of a fundamental tendency of all biological species to become more ordered or organised, for not all bacteria try to become multi-cellular organisms, not all fish try to go on land, not all mammals try to become monkeys and not all primates try to become humans. The view of biological evolution as a ladder that leads from bacteria, worm, monkey to *Homo sapiens* is an incredibly anthropocentric view. As if the only purpose of biological evolution was to generate intelligent humans! It has to be clear that from the scientific point of view, biological evolution has no purpose. Unfortunately, no book of evolution will omit the famous picture of the monkey becoming an *Australopithecus*, *Homo erectus* and *Homo sapiens*. There is a tendency in biology to higher efficiency¹⁷⁷, but by no means there is an overall tendency in the whole animal kingdom to walk upright or become intelligent. A more accurate view of the trends of biological evolution is the tendency for the occupation of currently free ecological niches. We should rather see this as a schemed distribution curve for which there is a kind of diffusion into free ecological space¹⁷⁸. The earth is dominated by a huge number of simple micro-organisms, such as bacteria, protozoa and fungi. There are many millions of micro-organisms and more than one million insect species compared to few thousand mammals or hundreds of primate species or only one hominid species. Gould postulated that the reason for many trends in evolution is that the origin of life started at the *left wall* (minimum level) of biological complexity. As long as there is no wall on the right side, there will be diffusion into the free ecological space.



The spreading of the distribution curve to the right can be seen as an increase of biological diversity. We humans are at the right edge of the distribution curve and have been lucky to occupy the ecological niche of the most intelligent organism on earth. As long as we do not auto-destroy ourselves or are displaced by an extraterrestrial civilisation, we can aspire to occupy the –still empty– ecological niche of a much more intelligent organism that understands how to build a sustainable civilisation on a limited planet. If we fail to survive and become extinct as a human species, our disappearance from earth might not even get noticed in the biological distribution curve. Since we humans do not want to avoid the extermination of thousands of biological species every year, there would be no species in favour of avoiding the extinction of the human race. Our survival depends on our intelligence and long-term vision. In this context, let me use a religious argument: God gave us freedom, creativity and intelligence to generate diversity and not to destroy it. It is up to us how to use these gifts correctly.

The Diversity of the String Theory

Just in the final stages of the preparation of this manuscript, I read an interview with Leonard Süsskind on the www.edge.org site. He was one of the first physicists working on the development of the string theory, an attempt to unify all physical theories of the universe. I was not totally unfamiliar with the terminology of strings and rubber bands because during my PhD I worked at the Max Planck Campus in Golm, where besides the institute of plants, there is an institute of gravitational physics (The Albert Einstein Institute). On the Campus, biologists, chemist and physicist play football, eat in the cafeteria and share seats on the train home to Potsdam and Berlin. On such and other opportunities, we all hear the scientific gossip of the other fields... special relativity, quarks, strings, worms, black holes, cosmological constant, etc. I have always been very curious of such ideas, but I am rapidly overwhelmed by complicated theoretical physics and mathematical formalism. Nevertheless, in the mentioned interview I read some passages that I could understand and that took my breath away by excitement and comfort. To me, it sounded like one of the strongest indications that *The Principle of Diversity* is indeed a fundamental principle in nature, based on the very essence of matter and the universe. Let me quote some passages of Leonard Süsskind's interview:

The beginning of the 21st century is a watershed in modern science, a time that will forever change our understanding of the universe. Something is happening, which is far more than the discovery of new facts or new equations. This is one of those rare moments when our entire outlook, our framework for thinking, and the whole epistemology of physics and cosmology are suddenly undergoing real upheaval. The narrow 20th-century view of a unique **universe**, [...] with a unique set of physical laws, is giving way to something far bigger and pregnant with new possibilities. Gradually physicists and cosmologists are coming to see our ten billion light years as an infinitesimal pocket of a stupendous **megaverse**. [...]

The reason is because over the last couple of years we've begun to find that **string theory** permits this incredible **diversity of environments**. [...] Mostly physicists have hated the idea of the anthropic principle; they all hoped that the constants of nature could be derived from the beautiful symmetry of some mathematical theory. [...] Physicists always wanted to believe that the answer was unique. [...] But the **myth of uniqueness** is one that I think is a fool's errand. [...] If that were to be true, then every place would have to have exactly the same constants of

nature. If there were some fundamental equation which, when you solved it, said that the world is exactly the way we see it, then it would be the same everywhere. [...] The question is whether our environment in a bigger sense **is** in terms of the laws of nature that we have, the elementary particles and the forces between them **are** environmental things which are contingent in our particular region of the universe, or are exactly the same throughout the whole universe. [...]

What we've discovered in the last several years is that **string theory has an incredible diversity** —a tremendous number of solutions [...]. It's a theory, which simply has solutions which are so diverse that it's hard to imagine what picked one of them in the universe. More likely, the string theory universe is one with many different little patches of space that Alan Guth has called pocket universes. Of course they're big, but there are little patches of space with one environment, little patches of space with another environment, etc. [...]

In the context of string theory [Joe Polchinski] was one of the first to realise that all this diversity was there [...]. The reason [for the diversity] is because the theory has an enormous number of what I call moving parts [...]. There are so many variables that this creates an enormous amount of diversity. [...]

String theory started out, a long time ago, not as the theory of everything, the theory of quantum gravity, or the theory of gravitation. It started out as an attempt to understand hadrons. [...]

String theory [became] a theory of gravity. [...] [Susskind] demonstrated that black holes did not lose information, that things don't fall into the black hole and disappear, that they eventually come back out. [...] Black holes have been understood. To this day the only real physics problem that has been solved by string theory is the problem of black holes. It led to some extremely revolutionary and strange ideas. [...]

Up to now string theory has had nothing to say about cosmology. [...] This is going to change very rapidly now because people have recognised the **enormous diversity** of the theory. [...]

The thing which is really unique and very, very special is that [...] it gives rise to an incredibly wild number of different kinds of environments that physics can take place in. ¹⁷⁹

All these words, concepts and ideas sound wonderful to me. It was incredible that a theoretical physicist was speaking so much about diversity! Beautiful ¹⁷⁹! It gives even more strength to the belief that diversity is so deeply rooted and fundamentally important for our world. Instead of looking for a single formula of the universe, theoretical physics could search for the many formulas of the diverse ¹⁸⁰. If biology and physics independently come to such similar conclusions about the greatest value of diversity, then it cannot be wrong to include this knowledge into our

world economy and into the decisions of business administration, politics and daily life. If all this does not lead to a complete renewal of scientific and economic theories, then I cannot imagine anything else that would change our world more beautifully.

The Power of Diversity

Despite the fact that diversity was never seen as a fundamental force of nature, several authors from the fields of social sciences and economics have recently recognised the value of cultural diversity. Indeed, the concept of diversity in Northamerica is predominantly used in the cultural and social context. In his book '*Creating the Multicultural Organisation: A Strategy for Capturing the Power of Diversity*' Taylor Cox provides a definition of diversity:

Diversity is the variation of social and cultural identities among people existing together in a defined employment or market setting.Ó

This shows clearly that Cox considered diversity only in the social sense. For him, the power of diversity is an expression of the richness of the human capital, and it gives multinational companies an advantage to perform well in the many different countries of the world. Also, Marilyn Loden shared a similar opinion in his book *Implementing Diversity: Best Practices for Making Diversity Work in Your Organisation*. Even commercial advertisements are full with views of the cultural diversity of the world and recommendations to '*never underestimate the power of local knowledge*'.

I totally agree with Cox and Loden about the enormous value and power of diversity. However, I would not restrict diversity to the socio-cultural field. In the working field, diversity within a company mainly refers to discrimination issues, for example the percentage of employees with different sex, race, origin or capacity (e.g. male/female, black/white, native/foreigner, able/disabled). The concept of cultural diversity is limited since it does not cover all aspects of economics or the world and universe. I would value diversity in all fields: cultural, social, ethical, esthetical, political, economical, technological, biological, genetical, chemical, physical, atomical, etc.

I would like to invite every human to create, invent and imagine new diversity. I am convinced that we are able to tolerate, conserve and **increase the diversity of this world**. If you were an artist, I would like you to discover the beauty that is embodied in that diversity. If you were a scientist, I would like you to discover the truth that is hidden in that diversity. If you were a philosopher, I would like to ask you to analyse the separate dimensions of truth, beauty and good and develop an universal principle of aesthetics. If you were a representative of an apostolic religion¹⁸¹, I would ask you to tolerate the diversity of the ethical and religious beliefs of all the cultures of this world. If you were an economist, I would ask you to consider diversity –not homogenisation– as the basis of the sustainability of this world. If you were a manager or business administrator, I would ask you to consider innovation and diversity as the basis of profit in the long-term. If you were a politician, I would ask you to consider constant change and renovation –not inertia– as the secret of progress. If you were a green activist, I would ask you to consider continuous generation and protection of biodiversity –not the static conservation of the status quo– as the source of a better future for our children. And if you were a writer who does –or does not– agree on some or many of the concepts I presented in this essay, I would like to invite you to publish and share your ideas with all readers and increase the intellectual richness of our human civilisation.

Implementing Adaptive Management

The essay of Christopher Meyer & Stan Davis *It's Alive* is an interesting approach combining biology with economics¹⁸². The authors speak about the coming convergence of information, biology and business. The essay motivates managers and investors to focus their efforts and invest their money in biotechnology. Besides increasing the attractiveness of channelling venture capital into new start-up companies, the essay describes the advents of the next revolution: the molecular economy. One of the most interesting and useful concepts is the idea of *Adaptive Management*. The authors argue that the world is changing so fast, that our old perception of static management should be replaced by a more

dynamic and flexible type of management. The reaction time should be shortened in order to function effectively during times of turbulent change. This form of management promotes creativity, flexibility and allows the success and long-term profit that every company desires today. Because it is focused on change and innovation, I consider this essay one of the best attempts to implement some aspects of the principle of diversity into the world of management and business administration.

Ideas Mainly Related to the Efficiency Principle

The Liberalism of Adam Smith

Adam Smith was not only an economist but also a philosopher, a full intellectual of the 18th century. In *'The Theory of Moral Sentiments'* he laid the basis of moral behaviour despite the human drive for personal self-interest. In his book *'An Inquiry into the Nature and Causes of the Wealth of Nations'* (1767) he extended his moral ideas to economic activities. Because I have a deep admiration for him, I would like to present his work here and honour his contribution to the development of our modern liberal economy. Leo Rosten summarised Smith's work as follows:

¶ [Wealth of Nations] is one of the towering achievements of the human mind: a masterwork of observation and analysis, of ingenious correlations, inspired theorizings, and the most persistent and powerful cerebration. [...] Smith published it [...] as a polemical cannon aimed at governments that were subsidizing and protecting their merchants, their farmers, their manufacturers, against "unfair" competition, at home or from imports. [...] He challenged the powerful interest who were profiting from unfree markets, collusive prices, tariffs and subsidies, and obsolete ways of producing things. ¶

The essence of Smith's thinking was the postulate that:

¶ If all men are permitted to act freely, to work how and where they want, to charge whatever prices they can get; if men, that is, are given maximum freedom to try to maximise personal gain; if all men act out of their rawest self-interest, pursuing whatever enterprise best satisfy their needs and their egoism and their cupidity; if the government keeps hands off the economy — then the result will not anarchy or chaos or a jungle of selfish social destructiveness, but an ordered harmony in which the automatic forces of supply and demand, in a responsive and resilient free market, must bring about the most efficient utilization of all resources (labour, land

capital, skills, brains, ingenuity, inventiveness) to secure the largest and most lasting advantages to a nation.

Smith heralded freedom and individualism and noted that although men act out of self-interest (private interests and passions of men) this nevertheless leads to *the most agreeable interest of the whole society* –as by an Invisible Hand, despite the intentions of rapacious landlords, greedy merchants, mendacious traders, or ruthless profiteers.

It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their own interest. We address ourselves to their self-love, and never talk to them of our own necessities but of their advantages.

Despite the crude view of absolute selfishness of men, in *'The Theory of Moral Sentiments'* Smith also demonstrated an unshakeable conviction about man's nobler propensities: the instinct of Sympathy, a sense of Benevolence and an impulse for Justice. He thought that *man, for all his acquisitive and predatory appetites, is a social creature, put on this earth for God's purposes.*

It is clear that for Smith, *The Invisible Hand* has its higher purpose in the welfare of the whole society –in humanity. According to Smith, 'freedom', 'work' and 'reward of the efficiency' are enough driving forces for economic progress, and the government should keep its hands off. Radical to the ideas of his time, Smith postulated that not gold, silver or natural resources but the workforce and skills of men were the source of the wealth of nations. Smith described the ***division of labour*** as a powerful strategy to increase the efficiency of the whole economic system. Using the concepts of the present essay, such division of labour represents the increase of economic diversity. Such specialisation of labour arises naturally from the particular interest of each individual as the most beneficial employment of his or her faculties and resources. Each person knows best his or her own skills and therefore, freedom of choice for the performance in a free market are essential to his philosophy. Smith's liberal ideas are rooted in the belief that –by a natural law– the selfish interests of individuals harmonise with the common interests of the public. For him, a sufficiently free economy

would lead to economic progress per default. Attempting a new interpretation of Smith's ideas, selfishness and efficiency are sustainable because of freedom (diversity). Furthermore, the economy is human because of 'liberty of action' and the guiding of an Invisible Hand.

Smith was also convinced that monopolies, subventions, regulations and restrictions imposed by governments were less beneficial than the order it would emerge from trade in a liberal market. He rejected monopolies from the efficiency point of view¹⁸³ as he thought that only competition would lead to economic prosperity.

"Adam Smith formulated his theory in a verbal manner –but many years later– other scholars reformulated Smith's basic problems in more mathematical terms. As a result, modern price theory emerged, which differed radically from previous concepts of "just" prices or prices based exclusively on production costs for labour. At the end of the 19th century, the French economist Léon Walras formulated a model of the economic system as a large system of equations, which described the individuals' demand for goods and their supply of labour and other productive input along with the firms' supply of goods and their demand for various factors of production. A set of prices that gave rise to equilibrium between supply and demand could, in fact, be regarded as a solution to this complex system of equations."

The work of Smith is profound and far-reaching. He laid the foundations of a liberal and modern economic system. Despite all the complexity and depth of his analysis, he could not envision all the developments that would emerge in a modern economy like ours. For example, he only considered men for economic activities, leaving women only the ambition of becoming the mistress of a family. Additionally, Smith's view of the role of the government, limited to three domains (militia, justice and administration of public goods), is too simplistic. Today it is acceptable that the government cannot keep both hands off the economy but still has to act regulatory with one hand in order to achieve the humanity aims and care for sustainability. Although the economic theory developed by Smith contains some elements that can be ascribed to the sustainability principle, he only captured the power of freedom but did not translate this into a creative power leading to diversity in all aspects –and not only in the *division of labour*. Apparently, he valued the manufacturing skills but did not recognise the value of creativity and technical innovations (Smith lived

only at the beginning of the industrial revolution). Furthermore, only centuries after Smith, sustainability became an important issue for the human economy.

Additionally, Smith did not make a clear division between efficiency and humanity. For him, *The Invisible Hand* is the link that combines individual with public interests. Smith's moral ideas and the selfish pursuit of profit and efficiency are seen as part of the same natural law. Also, he regarded freedom and liberty as moral components of an efficiency-humanity principle¹⁸⁴. He did not associate freedom with creativity, diversity or sustainability. Smith could not have known about evolution at that time, but he was correct in anticipating that a free market was somehow similar to a natural system (an ecosystem), in which selection would lead to higher efficiencies.

Surprisingly, Smith did not discuss in detail the consequences of total freedom and selfishness that could lead to unmoral but very efficient behaviour, such as killing, cheating or stealing –like in biology. The human moral of that time possibly did not prohibit piracy, the conquest of new colonies or the enslavement of other races. Smith was a believer of the benevolence of the human spirit and trusted in hard work and labour skill as the only and real basis of wealth. He assumed that either *The Invisible Hand* would guide us through the correct moral path of benevolence, or the government would establish the required legal system to guard the humanitarian side of the economy.

The Input-Output Method of Leontief

In 1973, Wassily Leontief won the Nobel Prize in Economics for the development of the input-output method and for its application to important economic problems. The ratio of output to input can be considered within the principle of efficiency. According to the official press release:

Professor Leontief is the sole and unchallenged creator of the input-output technique. This important innovation has given to economic sciences an empirically useful method to highlight the general interdependence in the production system of a society. In particular, the method provides tools for a systematic analysis of the complicated interindustry transactions in an economy. The input-output analysis describes the interdependence in the production systems as

a network of deliveries between the various sectors of production. For every production sector, technical coefficients define the quantities of intermediary products which are required per unit produced of each commodity. Final demands of products for consumption, investment and exports in the model are usually treated as determined by conditions outside the production system. The purpose of the analysis is then to find out how much production has to be increased in the various sectors of the economy to satisfy a given desired or planned increase in final demand for consumption, investment and exports. The increased production in each sector then has to cover not only the change in final demand, but also the derived changes in demand for intermediary products in the various production sectors.

The input-output system has found extensive use especially in forecasting and planning, both in the short and in the long run. The input-output technique [...] is used in forecasting and planning in [...] decentralized market economies with mainly private enterprise as well as centrally-planned economies dominated by public ownership. The method has proved particularly effective in the analysis of sudden and large changes, as in the case of military mobilization or other far-reaching transformations of an economy. The method has also been applied in studies of how cost and price changes are transmitted through various sectors of an economy. [The method has recently been extended] to include residuals of the production system — smoke, water pollution, scrap, etc., and the further processing of these. In this way the effects of the production on the environment can be studied.Ó

Theory of Optimum Allocation of Resources

In 1975, Leonid Kantorovich and Tjalling Koopmans won the Nobel Prize in Economics for their contributions to the theory of optimum allocation of resources. According to the official press release:

ØThey] studied the problem —fundamental to all economic activity— of how available productive resources can be used to the greatest advantage in the production of goods and services. This field embraces such questions as what goods should be produced, what methods of production should be used and how much of current production should be consumed, and how much reserved to create new resources for future production and consumption. [Both] renewed, generalized, and developed methods for the analysis of the classical problem of economics as regards the optimum allocation of scarce resources.

Professor Kantorovich [...] wrote an essay on the meaning and significance of an efficient use of resources in individual enterprises. In [...] his book, *The Best Use of Economic Resources*, Professor Kantorovich has analyzed similar efficiency conditions for an economy as a whole, and there, particularly demonstrated the connection between the allocation of resources and the price system, both at a certain point in time and in a growing economy. [...]

Professor Koopmans has in his work [...], *Analysis of Production as an Efficient Combination of Activities*, developed the so-called activity analysis. Within this theory, new ways of interpreting the relationship between inputs and outputs of a production process are used to clarify the correspondence between efficiency in production and the existence of a system of calculation prices. This shed a new and interesting light on the connection between the normative allocation theory and the general equilibrium theory. [...] Professor Koopmans studied the problem of finding criteria for an optimum growth rate for an economy. [He] paid particular attention to factors which [...] determine the value individuals and society place on consumption at different times —such as population growth and technological advance.Ó

Theory of Markets and Efficient Utilisation of Resources

In 1975, Maurice Allais won the Nobel Prize in Economics for his pioneering contributions to the theory of markets and efficient utilisation of resources. According to the official press release:

One of the principal tasks of basic research in economics is to formulate a rigorous model of equilibrium in markets and examine the efficiency of this equilibrium. The problem dates back to Adam Smith and his theory of the "invisible hand" which coordinates — to all appearances — a chaotic structure comprised of a multitude of independent and individual decisions based on self-interest. Paradoxically, this chaos gives rise to coordinated equilibria based on market prices. Firms' production decisions will correspond to consumers' planned consumption. Maurice Allais [provided] increasingly rigorous mathematical formulations of market equilibrium and the efficiency properties of markets. On the basis of mathematical models of households' and firms' planning and choice, he introduced a very general formulation of the conditions for market equilibrium.

Traite d'Economie Pure contains a general and rigorous formulation of the two basic propositions of welfare theory. An economic situation with equilibrium prices is socially efficient in the sense that no one can become better off without someone else becoming worse off. In addition, under certain reasonable conditions, each such socially efficient situation can be achieved through redistribution of initial resources and a system of equilibrium prices. These propositions are important [...] as guidelines for planning in *e.g.*, the public sector by means of prices (instead of direct regulation). Allais also formulated a generalization which covers the case where various kinds of returns to scale may give rise to natural monopolies. Through his analysis of market equilibrium and social efficiency, Allais laid the foundations for the (analysis of) the conditions for efficient use of resources in large public monopolies [...], but also in many instances applied the theory to business management.

Allais's used new mathematical methods to analyze the stability of equilibria, *i.e.*, the conditions under which an economy —after a disturbance— will return to equilibrium through price formation. [...] The work of Allais served as a basis for the analysis of market equilibrium and social efficiency [...]. [He] is perhaps best known for his studies of risk theory and the so-called **Allais paradox**. He has shown that the theory of maximization of expected utility, which has been accepted for more than forty years, does not apply to many empirically realistic decisions under risk and uncertainty.

Allais tried to generalize market theory by emphasizing its dynamic aspects. The impetus for consumers' and producers' economic behavior consists of efforts to use any surpluses that may arise in an economy through previously unexploited exchange opportunities. Equilibrium is reached when these surpluses have been exhausted. Allais summarized many of his early and more recent research contributions in *La Theorie Generale des Surplus* (1981).^Ó

Factor Four: Doubling Wealth, Halving Resource Use

Ernst Ulrich von Weizsäcker was a professor of Biology in Essen, Germany, and now is active in politics as a member of the German parliament. He has published several essays dealing with economics and ecological politics. In his book "Factor Four: Doubling Wealth, Halving Resource Use" he explains his idea of a *Global Revolution*. This fits perfectly into the series of reports of the Club of Rome. The central argument of E. von Weizsäcker is that resource minimisation is the key to a sustainable economy. Although I fully agree in almost all of his argumentation, I disagree on the mixing of the concepts of efficiency with ecological sustainability. In my opinion, a car that uses less fuel is not an ecological car, but it is only an efficient car. An ecological car would be one that promotes biological diversity or one that is constantly changing its diversity and getting adapted to the environmental conditions. Overall, Weizsäcker seems not to make any distinction between what is socially desirable (humanity), what is technically efficient (efficiency) and what is ecologically sustainable (diversity). I believe this is rooted in the philosophical Idealism of Plato for whom something true –is good and beautiful at the same time. According to the theoretical framework presented in this essay –which parts from the separability of the corners of the magic triangle– the valuable ideas and argumentation of Weizsäcker

can be placed in the context of the principle of efficiency, and are only complementary to the principle of diversity.

Natural Capitalism: Creating the Next Industrial Revolution

Possibly, the most recent book, which nicely demonstrates that capitalism is primarily based on the efficiency principle is the work of Paul Hawken, Amory Lovins and L. Hunter Lovins: 'Natural Capitalism'. The essay explains many detailed examples of resource minimisation of companies within different economic sectors. It follows the same line of argumentation as in Ernst von Weizsäcker's 'Factor Four' –that the savings of the natural resources are going to bring the necessary change into our presently unsustainable economic system. The authors suggest that the next revolution in the economy is when resource minimisation will become equally important as profit maximisation. I fully agree with Weizsäcker and Hawken on the importance of that revolution. In this essay, I have referred to this as the transformation of the *half-capitalist* (profit-oriented-only) into the *full capitalist* who considers both aspects of efficiency. Furthermore, the maximisation of efficiency should not be restricted to those aspects that can be accounted in units of cash or money. It should be more than obvious that everything in a company or system should become more efficient –regardless of the cash¹⁸⁵.

However, considering the limited vision of companies and its focus on money, it is understandable that the government introduces new regulations, taxes and indirect costs so that companies are obliged to account in units of money such things like energy use, fuel consumption, land use, noise production, air pollution, waste production, health of the workers, etc. To quote the words of Hawken *et al.*:

Traditional capitalism [...] has always neglected to assign monetary value to its largest stock of capital —namely, the natural resources and ecosystem services that make possible all economic activity, and life. Natural capitalism, in contrast, takes proper accounting of these costs. As the first step toward a solution to environmental loss, it advocates *resource productivity* —doing more with less, wringing up to a hundred times as much benefit from each unit of energy or material consumed. [...] The companies that practice it [...] will gain a competitive advantage through the worthy employment of resources money, and people.Ó

For those managers and readers who are interested in the principle of efficiency, I can highly recommend studying all the concepts and ideas of Weizsäcker and Hawken, particularly the ones presented in 'Factor Four' and 'Natural Capitalism'. In those books, the readers will find several interesting examples and numerous references and links to the extensive literature on this key aspect of business administration. In this essay, I have not included case studies of specific companies in order to avoid focusing on individual cases and best practise examples. Instead, I preferred to take a general view based on biological knowledge. My intention is to present a scientific theory of diversity, only. I am sure that everybody can find many examples within his or her own field, company or personal experience.

Ideas Mainly Related to the Humanity Principle

The Prout Principles

One of the greatest philosophers of India, Shri Prabhat Rainjan Sarkar, provided a theoretical background for the development of a human society according to a progressive utilisation theory, abbreviated as PROUT.

Prout is a complete socio-economic theory, comprising all potentials and resources of life — physical mental, supramental and spiritual. Based on spiritual values of life Prout aims to tackle socio-economic challenges through progressive maximum utilization and rational distribution of all types of resources [...]. The theory advocates economic democracy based on cooperatives and local planning eventually supported by a democratic world government as the cure for today's economic and political ills. [...]

This theory was compiled into the Prout principles by Sarkar in 1959. There is a total of 16 principles of Prout, which are subdivided in several categories and are numbered confusingly. However, the first of the Prout principles within the socio-economic category states that "*Diversity is the law of nature and sameness will never be*". This principle says that diversity is a necessary consideration for the human economy. Sarkar means that diversification should be promoted and that diversity must be maintained through a system of incentives and income differentials. The incentives are required to promote higher labour productivity. Remarkably, Sarkar assumes that diversity cannot be lost because it is a law of nature¹⁸⁶. Although this principle could refer to diversity in all aspects of the universe, Sarkar refers to diversity mainly in the human and social field. Sarkar uses this principle to solve the contradiction between the theoretical equality of all humans, and the practical impossibility of giving all persons the same salary¹⁸⁷. This is the only principle of Prout that ensures that the humanity it proposes is more sustainable. Sarkar's idea of diversity corresponds somehow to the "*division of labour*" of Adam Smith. In many aspects it also complements our present concept of social diversity.

Prout principles of the socio-economic category:

- 1) Diversity is the law of nature and sameness will never be.

- 2) In any particular age the minimum necessities of all shall be guaranteed.
- 3) The surplus goods and services, after distributing the minimum requirements, are to be given according to the social value of the individual's production.
- 4) The increase in the standard of living of the people is the indication of the vitality of society.

Prout fundamental principles:

- 1) No individual should be allowed to accumulate any physical wealth without the clear permission or approval of the collective body.
- 2) There should be maximum utilisation and rational distribution of all mundane, supramundane and spiritual potentialities in the universe.
- 3) There should be maximum utilisation of physical, metaphysical and spiritual potentialities of the unit and collective bodies of human society.
- 4) There should be a proper adjustment amongst these physical, metaphysical, mundane, supramundane and spiritual utilisations.
- 5) The method of utilisation should vary with the changes in time, place and person and the utilisation should be of a progressive nature.

Sarkar advocates socialism in the context of neo-humanism. [...] Thus, Sarkar's socio economic principles are rooted in human values and he seeks to blend the expression of human potentiality with economic efficiency and prosperity in the context of a progressive socialist society. The fundamental principles [...] are intended to endure both flexibility and universality in economic management to guarantee *the good and happiness of all*.^Ó

The above paragraphs make clear that most of the theory of Sarkar is according to the humanity principle. Sarkar includes a religious and spiritual dimension and therefore goes much further than Karl Marx¹⁸⁸. Today, we know that the critique of capitalism by Marx and Engels is no longer valid, as some of their arguments were even wrong. For example, the postulate that the creation of added value¹⁸⁹ is the source of all ills in capitalism is no longer taken seriously by any economist. Thus, many of

the economic predictions by Marx never occurred in the evolution of capitalism. In comparison to Marx, most of the theory of Sarkar is still valid¹⁹⁰, despite the fact that spiritual ideals continue to have little value in our present economic systems.

Nevertheless, Sarkar did not include sustainability as a separate principle, complementary to efficiency. He also did not see economic evolution as the result of the forces of diversity and efficiency. Furthermore, the link between randomness, diversity and sustainability was not discussed in his theory. Instead, he provided a deep spiritual meaning for the economic efforts of a *progressive society*. Here lays the strength of all his arguments, for anybody who is interested in the principle of humanity should study in depth the Prout principles¹⁹¹.

The American Humanist Association

The philosophy of this association elevates the human kind to the highest levels. It is based on the conviction that the ability for ethical behaviour does not depend on the religious belief, nor on the proof of the existence of God or personal faith in Him. Humans can decide to be 'good' without the need of a religious doctrine or any justification of the metaphysical world. Equality, liberty, love, benevolence, altruism, tolerance, respect and many other human values provide the highest meaning to all our lives. Even though they are human inventions, which dynamically change over time, and even if religion or science does not provide a justification for them, they are good values. Visit the website of the American Humanist Association and get in contact with them, and if you agree with their statements, become an active member (www.americanhumanist.org). It is always good to do something for humanity.

Diversity in Scientific Literature

The present essay was written primarily for the readers outside the field of biology. I did only present a few biological examples in the main body text to support the many statements around the concept of diversity. For example, that sex and death are biological strategies to increase diversity and that intelligence is a biological strategy to increase efficiency. The generalisations were made for the sake of easy understanding. However,

the scientists and biologists might feel that I have not presented all the evidence and they will miss some of the references¹⁹². Therefore, as a compromise, in the following section of this appendix, I will try to make a short review of the scientific literature that contains much more background information and references on biological diversity. I selected some recent articles from the scientific journals *Nature* and *Science* to show how important the concept of diversity is in modern ecological and biological research.

Besides describing the main findings of these articles, I will also generalise some of the results and mention why they are relevant in the context of this essay.

Female sticklebacks count alleles in a strategy of sexual selection explaining MHC polymorphism

Reusch, T.B.H., Hberli, M.A., Aeschlimmann, P.B. and Millinski, M. *Nature* **414**, 300-302 (2001)

This paper describes the process of sexual selection that explains the maintenance of high allele diversity of MHC genes. The authors propose two strategies to avoid inbreeding and promote parasite resistance in fishes (sticklebacks). They present evidence that the choice of the mating partner is done according to the odour preference. Females choose sexual partners that maximise the number of different MHC alleles in their offspring. This report provides support for the statement that the sexual strategies in biology serve to increase gene diversity.

Parasite Selection for Immunogenetic Optimality

Wegner, K.M., Kalbe, M., Kutz, J., Reusch, T.B.H., and Milinski M. *Science* **301**, 1343 (2003)

This report shows an example of the selective advantage of genetic diversity. It suggests that diversifying selection increases heterozygosity. The authors suggest that there is a balance of different factors, but that multiple parasites select for optimal rather than maximal MHC diversity.

Reputation Helps Solve the 'Tragedy of the Commons'

Millinski, M., Semmann, D., and Krambeck, H-J. *Nature* **415**, 424-426 (2002)

This paper describes the simulation of games with the problem of sustaining a public resource that everybody is free to overuse (tragedy of the commons). Indirect reciprocity (*give and you shall receive*) is built on reputation and can sustain a high level of co-operation. The authors show that alternating the games of public goods and indirect reciprocity led to higher profits for all players.

This report provides evidence that many forms of social co-operation are indeed only a strategy to obtain a higher personal profit. It suggests also that the need to build and maintain a reputation is a key factor in social dilemmas. It shows also that without reputation or indirect reciprocity the contributions to the public good drop quickly to zero. This report provides support for the statement that absolute selfishness in certain social systems can still lead to co-operation and avoid the *tragedy of the commons*. The key to the problem is 'reputation' that is based on long term vision.

Density and Diversity

Steege, H. and Zagt, R. *Nature* **417**, 698-699 (2002)

This report provides an explanation of the rich diversity of trees as found in tropical and temperate forests. The authors give references and describe the concept of 'density-dependent mortality', in which the survival rates of species decrease as they become more common. The report also stresses the importance of studying diversity at the different scales (regional and local), because many mechanisms act to influence the diversity of an ecosystem.

The ecological theory of 'density-dependent mortality' is in support of the statement that as a biological species becomes more abundant and predominant and the system becomes more homogenous, the probability of survival (sustainability) decreases.

Pathogen-driven Forest Diversity

Van der Putten W.H. *Nature* **404**, 232-233 (2000)

This report analyses the question why some forests are more heterogeneous than others in terms of the tree species they contain. It is proposed that the diversity of trees in tropical rainforests is a result of the presence of organisms –specifically herbivores– that thrive on only one tree species. It explains that some soil pathogens also control the richness of plant species. This report and its references add evidence to the ecological theory of density-dependent mortality.

Species Diversity Enhances Ecosystem Functioning Through Interspecific Facilitation

Cardinale, B.J., Palmer, M., and Collins, S.L. *Nature* **415**, 426-429 (2002)

This report provides empirical evidence that biodiversity affect the rates of resource use that govern the efficiency and productivity of ecosystems. The authors show that the increase of the species diversity of a functional group of aquatic organisms induces facilitative interactions. Increasing the richness (diversity) of insect larvae enhances the feeding success of individuals. Diverse assemblages capture more resources than any species monoculture. This shows that species diversity increases the probability of positive species interactions, thus allowing better functioning ecosystems. This report suggests that diversity, in addition to increasing the robustness, can also lead to better efficiency of the whole system.

Global Environmental Controls of Diversity in Large Herbivores

Olf, H., Ritchie, M.E., and Prins, H.H. *Nature* **415**, 901-904 (2002)

This paper investigates how the diversity of large herbivores changes across gradients of global precipitation and soil fertility. The results show that water availability (rainfall and moisture) increases plant productivity but decreases the nutrient content (per fresh weight) of plants. In turn, the fertility of soils increases both, the productivity and the nutrient content of plants. The highest potential for herbivore diversity is found in locations with intermediate moisture and high nutrients. The results suggest that the gradients of precipitation, temperature and soil fertility might explain the global distribution of large herbivore diversity.

This report suggests that the amount of diversity in an ecosystem depends on environmental factors that provide the basic resources, which can be distributed to a greater number of different ecological niches. Thus, the amount of ecological niches defines the diversity that is present in an ecosystem.

Crop Strength Through Diversity

Wolfe, M.S. *Nature* **406**, 681-682 (2000)

This article addresses one of the problems of modern agriculture: the spreading of monocultures. It explains that monocultures have expanded to different levels, reducing the number of species, and particularly the genetic differences within varieties. Monocultures are convenient as it is easier to plant, harvest and market a single crop. However, monocultures are much more susceptible to pathogenic attacks. The report shows the advantage of growing a mixture of varieties and crops on a field, leading to a restriction of spreading of pathogens and diseases. The alternative methods of farming show that the increase of crop diversity leads to a more sustainable agriculture.

Further recommended references and readings:

- **Chance and Necessity: the Evolution of Morphological Complexity and Diversity.** Carroll S.B. (2001) *Nature* 409 p1102-1109

This is a nice review on biological evolution. It also includes the latest results, ideas and theories and provides many references to the scientific literature. This is a must-read for anybody who is interested in evolution.

- **The Diversity-Stability Debate.** McCann, K.S., (2000) *Nature* 405 p 228-233

This article summarises the ecological theories and ideas that link diversity with stability. Some results and opinions of different scientists are contradictory to each other. The author favours a view, in which diversity is indeed linked to the stability of the ecosystem.

- **Dynamic Diversity.** Knapp S. (2003) *Nature* 422 p475

This article describes that preserving nature is not about stasis, but about maintaining the exciting, ever-evolving variety of life on earth. It argues against the '*half-environmentalists*'

who have not yet understood that nature doesn't paint a static picture, so that we shouldn't try to preserve one.

- **A Plea for Diversity.** Roughgarden J. (2003) *Nature* 422 p368
This article adds some evolutionary ideas about gender role and sexuality. Especially interesting is the inclusion of the author's personal experiences.
- **Patterns and Processes in Reef Fish Diversity.** Mora C. et al. (2003) *Nature* 421 p933-936
- **The Roots of Antibody Diversity.** Gearhart P.J. (2002) *Nature* 419 p29-31
This article describes the random mutations that lead to genetic diversity of antibodies.
- **Diversity Peaks at Intermediate Productivity in a Laboratory Microcosm.** Kassen R., Buckling, A., Bell, G., Rainey, P.B. (2000) *Nature* 406 p 508-512
This report shows the complex relationship of diversity and productivity in simulated environments and bacterial cultures.
- **Functional Diversity Governs Ecosystem Response to Nutrient Enrichment.** Hulot, F.D., Lacroix, G., Lescher-Moutoué, F., and Loreau, M. (2000) *Nature* 405 p340-344
The relationship between species diversity and ecosystem functioning is a central topic in ecology today. This article describes a simulation model of a complex food chain. This model shows the importance of functional diversity as a response of the ecosystems to perturbations.
- **Consumer Versus Resource Control of Species Diversity and Ecosystem Functioning.** Worm, B., Lotze H.K., Hillebrand, H., and Sommer, U. (2002) *Nature* 417 p848-851
This report describes some of the complex relationships between diversity, productivity and resource supply. The model simulation suggests that there are many compromises and solutions in different ecosystems.
- **Disturbance and Diversity in Experimental Microcosms.** Buckling, A., Kassen, R., Bell, G., and Rainey P.B. (2000) *Nature* 408 p961-964
- **Genetic Diversity and Disease Control in Rice.** Zhu et al. (2000) *Nature* 406 p 718-722
- **Plant Diversity Enhances Ecosystem Responses to Elevated CO₂ and Nitrogen Deposition.** Reich et al. (2001) *Nature* 410 p809-812
- **Energy Availability and Habitat Heterogeneity Predict Global Riverine Fish Diversity.** Guégan, J-F., Lek, S., and Oberdorff, T. (1998) *Nature* 391 p382-384
- **Scaling, Energetics and Diversity.** Whittaker R.J. (1999) *Nature* 401 p865-866

- Power behind Diversity's Throne. Naeem S. (1999) *Nature* 401 p653-654
- Top Dogs Maintain Diversity. Saether B-E. (1999) *Nature* 400 p510-511
- Electrifying Diversity. Ryan M.J. (1999) *Nature* 400 p211-213
- A Yeast Prion Provides a Mechanism for Genetic Variation and Phenotypic Diversity. True, H.L., and Lindquist S.L. (2000) *Nature* 407 p477-483
- Environmental Controls on the Geographic Distribution of Zooplankton Diversity. Rutherford, S., D'Hondt, S., and Prell, W. (1999) *Nature* 400 p749-753
- Resource-Based Niches Provide a Basis for Plant Species Diversity and Dominance in Arctic Tundra. Mckane et al., (2002) *Nature* 415 p68-71
- Large-Scale Processes and the Asian Bias in Species Diversity of Temperate Plants. Qian H., and Rickefs, R.E. (2000) *Nature* 407 p180-182
- Density-Dependent Mortality and the Latitudinal Gradient in Species Diversity. Lambers, J.H.R., Clark, J.S., and Beckage B. (2002) *Nature* 417 p732-735
- Pervasive Density-Dependent Recruitment Enhances Seedling Diversity in Tropical Forest. Harms K.E. et al. (2000) *Nature* 404 p493-495
- Mycorrhizal Fungal Diversity Determines Plant Biodiversity, Ecosystem Variability and Productivity. Van der Heijden et al. (1998) *Nature* 396 p69-72
- Diversity and Endemism of the Benthic Seamount Fauna in the Southwest Pacific. De Forges B.R., Koslow J.A. and Poore G.C.B. (2000) *Nature* 405 p944-947

Epilogue

I tried to pay tribute to the valuable work of other philosophers and economists who have inspired me. I must ask for forgiveness, if I have missed and failed to mention other essential and interesting works here. I would be grateful for comments, suggestions or additions. Some expert readers will blame my partial ignorance of the many fields I have dared to trespass. My intellectual expeditions have always been motivated by curiosity but never by presumption. Please correct me and help me heal part of my human imperfection.

I feel that this essay has acquired its own dimension independent of my person. I have enjoyed writing this essay, and this has given me enough satisfaction. I do not expect the readers to believe blindly in all the statements I have postulated. Sometimes, for simplicity and space reasons, many ideas and concepts are presented without the complete supporting arguments. In some cases, I tried to provide some references and additional details in the footnotes. Otherwise, I believe that the essay would become increasingly long and confusing. At the same time, many readers will disagree on some of these ideas and will tend to reject the statements that were presented in a pragmatic way. Provided that *randomness* provides me the resources and the time, I will try to fill some of the gaps I left in this essay.

I do not ask the readers for blind trust but only for vivid reflection... I love receptive and critical comments. It would make me happy enough, if the essay was read at all. I would be even happier, if I could learn from the feedback of the readers. These ideas can only develop in a dialogue –not in a monologue. The intention of this essay –focused on beauty and diversity– is to prepare the ground for these ideas to germinate and develop outside the jail of my restricted mind. These ideas are not property of a single individual, but of the whole of humanity. Read and understand them... discover their beauty and truth... accept, modify or reject them... and let us all share them.

And finally, I would like to end with one last romantic remark. Before I had investigated the link between sustainability, diversity and beauty, I never imagined that the wonderful words of Johann W. Goethe would have such a deep meaning:

Verweile doch. Du bist so schön!

Glossary

Because this essay contains many special terms from biology, Dr. Natalia Palacios kindly agreed to write this glossary explaining some words and concepts to non-experts readers. Young people interested in biology should know that "*La Pandilla ADN*" has already published one booklet explaining biology to children and adults in a highly amusing and didactic way. This booklet –others will follow soon– can be ordered via the Internet. <http://www.ciencia-activa.org/>

Aminoacids: Any of a class of 20 molecules that are combined into a linear chain to form proteins. Aminoacids contain a negatively charged acid group and a positively charged amino group.

Androceum: The male organs of a flower; the assemblage of stamens carrying the pollen.

Aphids: Soft-bodied insects that use their piercing sucking mouthparts to feed on plant sap.

Apomixis: Generation of fertile daughter seeds that are genetically identical to the mother plant.

Asexual reproduction: Production of organisms that are genetically identical to its progenitor.

Bacteria: Single-celled, microscopic organisms that are present everywhere and can survive in a wide variety of environments.

Base: In molecular biology, the positively charged part of the nucleotides, the building block of the DNA. The bases can pair with their complementary base to build the double helix of the DNA.

Biochemistry: The scientific study of the reactions and metabolism of living cells, tissues, organs and organisms.

Biodiversity: The existence of a wide range of different types of organisms and biological entities in a given place at a given time.

Biology: The scientific study of living organisms.

Biomass: The total weight (in kilograms) of living matter.

Biotechnology: The use of living organisms or biological techniques for human purposes. The use of biological knowledge acquired through basic or applied research. Biotechnology products include antibiotics, insulin, genetically modified food, beer, yoghurt, etc, and techniques such as sewage treatment and waste recycling.

Black holes: A region of space, which contains so much mass that it generates such a strong gravitational force that not even light can escape from it.

Botany: Area of biology that studies the plants.

Carnivores: Animals that feed on meat. They kill other organisms to survive.

Cell: The basic structural and functional unit of living organisms. Cells can function cooperatively as a part of a tissue or organ or can function independently as free-living microorganisms.

Chemistry: The scientific study of the composition, structure, properties, and interactions of atoms, elements and molecules.

Chromosome: A structure in the cell nucleus that contains the genes. It contains a tightly packed piece of DNA and many proteins associated to it.

Clone: An identical copy, e.g. a high number of cells all descended from a single ancestral cell. Twins are clones because they are genetically identical. A clone is genetically homogeneous.

Cloning: Is the act of preparation and propagation of identical DNA fragments, cells or organisms.

DNA sequence: The order of bases (nucleotides) in the linear DNA molecule. This sequence contains the genetic information and is used to make specific proteins.

Diversity: In biology: the number and variety of species present in an area and their spatial distribution. In social sciences: the difference in culture, sex, race and customs of the people.

Duplication: A type of random mutation where a part of the DNA sequence is copied twice.

Ecological niche: An area of the environment and sum of conditions that allows the long-term survival of a biological population or species.

Ecology: The scientific study of the relationship of organisms to each other and to their environment.

Ecosystem: Is the dynamic and interrelating complex of plant and animal communities and their associated non-living environment.

Environment: The external surroundings of an organism that allows its survival.

Evolution: In biology: a change in the genetic composition of a population over time. In many other contexts, evolution is used to describe any gradual change.

Flowering plants: Plants having seeds in a closed ovary. Opposed to algae and ferns that are non-flowering plants.

Fungi: A group of diverse organisms that lack plastids with green chlorophyll and therefore do not photosynthesise. They live on the organic matter produced by plants or other organisms. Fungi include mushrooms, moulds, rusts, smuts, and yeasts.

Gamete: A cell (e.g. spermatozoid or egg) containing a half number of chromosomes.

Gene: The basic unit of inheritance. A piece of DNA which contains the information to build a protein.

Gene shuffling: Performed by fragmenting large pieces of DNA and reassembling the small pieces into new large DNA molecules.

Genetic information: Inheritable information contained in the DNA sequence.

Genome: The complete DNA sequence of an organism.

Gynoecium: The female portion of a flower (e.g. the pistil and the ovary of a flower).

Herbivores: Animals that consume plant material as a source of energy.

Hermaphrodites: Having both female and male sexual characteristics and organs.

Inheritance: The process through which the genetic material is passed on from parents to offspring.

Mass: A physical quantity related to its weight. It is a measure of a body's resistance to changes in velocity (**inertial mass**) and also of the force experienced in a gravitational field

(gravitational mass): according to Newton, inertial and gravitational masses are equal. On earth, one kilogram of weight contains one kilogram of mass.

Matter: Substance that occupies space and has a positive mass. Particles with negative mass are called antiparticles, or antimatter.

Microorganism: A general term used to refer to very small life forms (microscopic: not visible to the unaided eye).

Mitochondria: Organell or part of the cell where the respiration takes place and oxygen is consumed.

Mitosis: A type of nuclear division where one cell divides in two identical daughter cells. In contrast to mitosis, **meiosis** leads to unidentical cells and a reduction of the chromosome number.

Molecular biology: The study of the biochemical and molecular processes within living cells.

Mutation: A random change in the genetic material that is caused by e.g. an error in the replication of DNA. Mutations occur naturally, but the frequency can be increased artificially by chemical and physical agents (mutagenisers).

Natural selection: The differential survival and reproduction of organisms that differ from one another in one or more heritable characteristics. Through this process, the individuals in a population that are best adapted to their local environment increase in frequency relative to less well-adapted forms over a number of generations.

Nucleotide: A unit building block of DNA and RNA. A nucleotide consists of a sugar and phosphate backbone with a base attached. Nucleotides are aligned in a linear DNA strand and combine with a complementary strand to build the DNA double helix. The pairing of nucleotides is specific and therefore allows the replication of the genetic information to generate identical copies.

Nucleus: The region of the cells containing the chromosomes (DNA).

Organism: A living unit that is able to grow, metabolise and reproduce in a less complex environment.

Parthenogenesis: Reproduction by identical cloning, especially in insects. It arises from the development from an egg cell that did not fully divide by meiosis nor had been fertilised. It is the counterpart of the apomixis of plants.

Pathogen: An organism that lives at the expense of the host and causes a disease. The pathogen is usually much smaller than the host.

Photosynthesis: The set of chemical reactions driven by energy of light. It is mainly the process carried out by plants, in which carbon dioxide and water combine to produce oxygen, organic acids and sugars.

Plastid: Compartment of the plant cells that contains green chlorophyll and makes photosynthesis.

Pollen: The pollen grains are dust-like particles on the *anthers* of a flower; these contain the male gametes. Pollen is carried by bees and other insects to other flowers where they can unite with the female gametes.

Pollination: The transfer of pollen from the *anther* to the *stigma* of the same or a different flower to ensure fertilisation of the *ovules* to produce seeds.

Population: A group of individuals of the same species occupying a particular geographic region. A reproductory unit of a biological species.

Potato late blight: An extremely destructive potato disease caused by a fungus. The plants die and the tubers rot rapidly and become uneatable.

Protein: A large molecule composed of amino acids arranged in a specific order. Proteins are required for the structure, function, and regulation of the cells.

Randomness: Lacking any definite plan or prearranged order. Unpredictable since identical conditions lead to different results.

Recombination: An event, occurring by the crossing-over of chromosomes, in which DNA is exchanged between a homologue pair of chromosomes.

Segregation: Separation of populations to become different species.

Species: A group of actually or potentially interbreeding populations. The individuals of the same species are able to have sex and generate fertile offspring.

Star: A large celestial body composed of gravitationally contained hot gases, emitting electromagnetic radiation, especially light, as a result of nuclear reactions inside the star. In economics, a star is a commercial product or service with high potential to bring profit to a company.

Sugars: Usually sweet tasting carbohydrates. The major energy storage molecules for living organisms.

Sustainability: Relating to or being a method of using a resource for an unlimited amount of time without depleting or permanently damaging it.

Vegetative propagation: Propagation of plants by asexual means, such as stem and leaf cuttings, layering, root division, or bulblets.

Virus: A biological unit usually consisting of a single nucleic acid surrounded by a protein coat and capable of replication only within the cells of animals and plants. Because viruses cannot grow outside living cells, they are not considered living organisms.

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Endnotes

- ¹ Nice clothing is more important for some people, whereas for others it is more important to play sports or travel around the world.
- ² A good that cannot be transferred to other persons has little value in the economic sense.
- ³ Taxes would not make sense, if the government did not allow private property (e.g. communism). Neither do taxes make sense if the government cannot protect your private property (e.g. anarchy).
- ⁴ According to the *Invisible Hand* of Adam Smith, the search for private profit is a search for public profit. The reason for this is that trade is a win-win strategy of exchange. Trade is not a profit at cost of others but is beneficial for the seller and for the buyer.
- ⁵ In an additional essay following soon, I will explain the concept of money and other concepts of materialism.
- ⁶ Some readers might be a bit confused that profit can be measured in terms of goods or needs. Usually, cash and money are the sole considerations for profit. However, this view can be expanded. In reality, money is just an invention, and it is never the final aim of the economic efforts. The motivation of trade is to lead to a better provision of goods for everybody. However, not even the goods are the final aim, but it is only the satisfaction of needs. Therefore, money and goods are only the means to reach the aim. Profit can also be measured in terms of needs. Let me explain one extravagant case: one person is lonely and afraid at home, and the other is cold outside... both agree on an exchange of 'goods' so that one is no longer afraid and the other is no longer cold. This represents profit for both because their needs have been satisfied. In this case, money was not required for trade. But sometimes, a significant amount of money is involved, especially if one of the persons is not really cold –but is only working barely dressed.
- ⁷ Contrary to public understanding, companies do not really make profit in terms of money. In the long-term, everything a company earns is also spent, either to build an infrastructure, or to grow, or to return some cash to the owners and shareholders. Money is flowing in a circle and is only temporarily accumulated at some points. What a company really does is to satisfy human needs. It satisfies the needs of customers, it satisfies the needs of workers who need a job, and it satisfies the need of the owners to earn money. Then, workers and owners spend the money to satisfy their needs and introduce it back into the circle. Additionally, the company pays taxes to satisfy the needs of the government and of hungry politicians.

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- ⁸ It is important to distinguish between relative and absolute profit. Efficiency is both: To increase profit and to minimise the use of resources. The best company is not the one with the highest profit, but the one with the highest efficiency.
- ⁹ Many companies seem to act only according to the first aspect of efficiency (profit maximisation). These companies do not take into account that the second aspect of efficiency (input minimisation) is equally important.
- ¹⁰ The government has even created some special legal categories for all enterprises that do not seek profit. The aims of each of these associations have to be defined in advance, and are mostly related to the different aspects of humanity (e.g. liberty, dignity, health, culture, basic science, etc.)
- ¹¹ For space reasons, it is not possible to mention all the scientists, economists and philosophers who have contributed to the theories underlying the principles of efficiency and humanity. See the appendix for a minimum account of some of the most important contributions.
- ¹² This complexity is one of the reasons why it has not been incorporated into all the decisions of business administration. The easiest issue to understand might be profit maximisation within the efficiency principle. In contrast, resource minimisation has been less regarded in capitalism. The humanity principle is also very complex to understand, but fortunately, most religions have provided a framework for actions and values. Furthermore, Marx, Engels and Lenin led to the incorporation of the humanity principle into economics as an opposing force to the crude capitalism of the 19th century. Additionally, the declaration of the universal rights of humans defines many of the ethical aims.
- ¹³ An efficient and sustainable democracy requires an alternation of power (diversity of political opinions). Unfortunately, the time horizon of political decisions is limited by the time intervals between democratic elections.
- ¹⁴ Many people think that saving resources is related to sustainability and to the environment. For example, a company that uses less energy is said to be ecological. A car that uses less fuel is referred as being environmentally friendly. I think it would be more accurate to say that a company that uses fewer resources is more efficient – not more ecological. In contrast, a company that promotes biodiversity could be called ecological.
- ¹⁵ Natural Capitalism. Paul Hawken, Amory Lovins and L. Hunter Lovins. Little Brown and Company. ISBN 0-316-35316-7
- ¹⁶ The main concept in Weizsäcker's Book '*Factor Four*' is that the minimisation of resources is the key to a sustainable economy. I would like to expose a different view of

sustainability that is more linked to diversity than to efficiency. The ideas and the work of Ulrich von Weizsäcker will be presented latter in the appendix.

- ¹⁷ It turns out that diversity is one of the most important components of complex functioning systems.
- ¹⁸ In this essay, I have used diversity and sustainability as synonymies to demonstrate the intimate link between them. Since *sustainability* in the economic field has a connotation of social and human aspects, I preferred to use *diversity* to stress the independence of this principle from ethics or morals. Diversity is totally independent from humanity.
- ¹⁹ A trivial conclusion is one that is obvious or it is contained within its definition. For example: without water the oceans would not exist. It can be obvious that without water, there cannot be a sea. But there are exceptions to this. In a map of the moon you will find the names of many oceans and seas, despite that there is no water in the moon.
- ²⁰ For economic decisions including risk and uncertainty consult the work of Maurice Allais (Nobel Prize 1988).
- ²¹ Some people play and get addicted to gambling. The worst cases are people who really believe they have secret formulas and the magical talent to win against the bank. Others are more realistic about the chances and play not for long-term profit, but spend their money in a fashionable way.
- ²² For the sake of completeness, there is indeed a strategy to win money in the game of the roulette. However, it requires an infinite amount of credit. The strategy is that after any loss, the bet must be consecutively doubled until you win. However, this is not very efficient, because you need a lot of capital to make very small profit. Furthermore, no casino will let you play this strategy in their roulette.
- ²³ A zoological garden contains many different animal species... biological diversity. To learn more about the zoo of quarks visit a particle accelerator or consult a modern book of physics.
- ²⁴ Consult any modern book in physics for more, including the latest details on the quark theory and the hundreds of particles that have been discovered with particle accelerators. For example, some people might have heard of neutrinos, positrons, pions or mesons.
- ²⁵ See the appendix for more details on the latest exciting findings of theoretical physics –*the string theory*. It allows an enormous diversity of solutions, giving rise to pocket universes.
- ²⁶ The Big Bang theory explains that the universe is not infinitely old, but that there was a beginning of time when all mass of the universe was concentrated in a smaller spot. The theory is supported by the observation that the universe is expanding. According to some estimations, the universe is 10^{10} years old.

- ²⁷ The Heisenberg relation describes that a photon can be seen as a particle or as a wave. Quantum mechanics says that the properties depend on the subject and the point of observation. As there are many different points of observation, there are many diverse properties of the system. Schroedinger's cat can be alive or dead at the same time. For some people the glass is half-full, for others it is half-empty.
- ²⁸ Contrary to Lamarck's ideas of directed evolution (inheritance of acquired properties) in which the use of a certain organ leads to a change in its size (e.g. giraffes), the Theory of Evolution by Charles Darwin says that among random variability natural selection allows only the survival of the fittest. Thus, for biological evolution, mutations are random, but selection is directed. For Darwin, some giraffes just happened to have longer necks by random, and because these individuals were more successful, they multiplied faster and displaced the giraffes that had shorter necks.
- ²⁹ These random events were also described by Charles Darwin during his world trip on the Beagle. The colonisation of new ecosystems depends on random events of which species gets there first. The Darwin Finks reached the Galapagos Islands first, multiplied and diversified and therefore occupied the ecological niches that would normally be occupied by other bird species on the continent.
- ³⁰ Darwin and Wallace provided an explanation of evolution by the selection of variability in small steps over several generations. Although they mentioned that variability was random – and not a purposeful adaptation or dependent on use and disuse – they did not provide an explanation for the source of variability. It was only later in the next century that genes and DNA were discovered as carriers of genetic information and the mechanisms of inheritance were understood. The synthetic theory of evolution combines the original ideas of Darwin, Wallace, Spencer, Mendel, Morgan, Watson, Crick and many other scientists. Today, *nothing in biology makes sense without the concept of evolution*.
- ³¹ In this context, it can be useful to introduce the concept of information. The generation of diversity in the economic field is not always random, but it is driven by some knowledge and information *a priori*. The reason for the success of the human species is the ability of the human brain to make useful predictions of the future in order to adapt to it. Our brain has evolved to understand the laws of nature because this allows us to adapt better and survive in the natural world. Our intelligence has led to an increase of the efficiency of the human species, but this concentration also poses a great threat if our imagination or vision becomes limited. Some people believe that the human civilisation will not survive because of this limitation of our brain and the tendency of self-destruction.
- ³² In this context I should also mention the unmoral behaviour of some investors, who communicate to others how to act or invest in a certain way just to create a main current, which they then can take advantage of. There have been famous cases, in which

inhuman (unscrupulous) brokers have advised others to buy shares, only to enable them to sell their own shares at a higher price. This sort of behaviour, commonly known as insider trading, is legally punishable.

³³ See the appendix for a review of the work and ideas of Adam Smith.

³⁴ Without randomness, there would neither be constant creation nor new diversity. Without diversity, the universe would not exist. Without randomness, the universe would not be sustainable.

³⁵ Sometimes, we have the impression of key events, in which choices are open and significant decisions are made, and times during which everything follows a path of inevitability (a static and unavoidable fate). During his wars, Julius Caesar used to say: 'The die has been cast!' Once some decisions have been taken, everything seems to proceed according to destiny.

³⁶ For the sake of completeness, I must mention that there are two alternative views of randomness in physics. For some scientists, apparent randomness is only a consequence of human ignorance. According to this view, the properties of matter and the laws of nature are totally deterministic, but randomness arises from the act of observation (subject-object interaction). The alternative view is that fundamental randomness is the basic essence of matter and laws in nature. Randomness exists independently of the subject or act of observation. Since in the experimental practise it is impossible to discriminate between these two alternative views, each scientist is free to believe in any of these basic dogmas.

³⁷ God loves diversity because it is the expression of His own divine power of creativity. He is proud of the diversity of cultures and religious beliefs. He is against monopolies of any kind. Contrary to a mono-religious expectation of absolute theological homogeneity, God wants many religions on Earth. He does not only tolerate many different religions, but he even tolerates the ones that believe to be the only true one. Humans do have the freedom to act against the humanity principle and start wars to kill, displace and indoctrinate people with other religious beliefs. However, a war between religions is wrong and will never give a purpose in life or bring heaven to earth.

³⁸ The conflict of science and religion has led to the conclusion that the only remaining space for a God in a universe ruled by deterministic natural laws is randomness. No religion will want to regard God as the sum of all laws of the universe. Laws can be predicted, but God cannot be predicted. Many people will resist viewing God as randomness. The Dogma is that God is powerful beyond any imagination. However, contrary to the opinion that randomness has too little power, I rather think that there is no stronger power than randomness. As a scientist, I tend to regard randomness as the most powerful phenomena in nature. The one who controls randomness not only controls the

mind of humans and the course of evolution but also determines the fate of the whole universe. I do not agree with Albert Einstein who said that God does not roll the dice –I believe that the Will of God is the result of the dice.

³⁹ Considering the religious mentality of the human kind, scientific randomness can hardly be used as the basis of a modern religion. In the past, some cultures and civilisations included randomness in their pantheon (e.g. Fortuna), but this has been replaced by the idea of the all-powerful God of the monotheistic religions. Although the inquiry of science always ends with randomness, this insight cannot be used to build a good human society. It is not science but only religion that can satisfy our spiritual needs. Nevertheless, science can be used to find the truth, enhance our knowledge and intelligence, and improve the efficiency of our technology.

⁴⁰ This statement is even trivial. The definition of randomness already states that it is not predictable.

⁴¹ Of course, some people would ask, if the throwing of a coin were at all a random event. Some would even say that, if you exactly measured the height, the velocity, impulse, mass, gravity, etc., you could actually predict the outcome. Some skilled people even have the ability to throw and catch the coin and get the right result. Some scientists believe that it is only out of the quantum world from where randomness can emerge into the macroscopic world. For the sake of simplicity, let us assume that our hand, air, coin and soil were indeed affected by this randomness.

⁴² There are certainly many scientists who believe that the world is made out of mathematical formulas. One of the greatest scientific debates you can enjoy with a mathematician is to deny that mathematics provides the final truth of the world. Or to say that mathematics is not a natural science but only human science. Have you been involved in such discussions? Have you heard any philosophical discussion between a physicist and mathematician? It is an experience one cannot forget.

⁴³ Very often during scientific education or experimentation you can hear from your teachers: *'in theory, the results should be this according to this formula... but this time we got a slightly different value... damn variability'*. It is said that the theoretical formula is accurate, it is just randomness that is disturbing its perfection. But who says that the formula is really the truth? Experimental scientists learn to tolerate randomness and are very happy when the experimental results are close to the theory. In physics, a 2% deviation is already alarming, whereas in biology, scientists are more than happy when the results are only 20% away from the formula.

⁴⁴ Biology is among the sciences that most suffers from the 'pain' of the variability of experimental data. In my career as a scientist, one of the most comforting feelings that I often experienced was, when I could convince myself that it was not my technical mistake

or experimental error, but that it was biological variability. It is such a wonderful word and beautiful concept: '*biological variability*'. If there is something that experimental biology can contribute to other fields, it is to deal with variability, and to learn the value of diversity.

⁴⁵ In literature dealing with economics, sustainability is very often associated with economic and social development in poor countries. Sustainability is seen as a moral duty for the well being of the local population, ethnic groups, culture, etc. I would like to make clear that in the context of this essay, I define the principle of sustainability totally independent from the human kind. Sustainability is linked to diversity in all aspects (physical, chemical, biological, social, cultural, technological). Sustainability alone has no purpose or ethical dimension. All moral aspects of the economy are linked to the humanity principle, not to sustainability.

⁴⁶ For example the economic help to developing countries, in the form of money and technology transfers.

⁴⁷ Stealing money is efficient. If only a few people do it sometimes, then it can also be sustainable. However, stealing money is against the humanity principle, because it damages the integrity of other persons.

⁴⁸ An interesting question is whether it is sustainable to have only honest people. According to the sustainability principle, the less diversity the less sustainability. This predicts that a society of only honest people would be less stable and sustainable. In such a society, everybody would infinitely trust in everybody. As soon as a dishonest person infiltrates such a naive society, he or she will take advantage of everybody and destabilise the society. Therefore, it can be said that the diversity of dishonest people (liars, thieves and vandals) helps honest people to become more aware and avoids an unhealthy innocence. The fact that they lead to sustainability of the society does not mean that criminals are good, on the contrary, these people should get punished hard because they damage the humanity principle. Legal punishment is a measure to decrease the efficiency of dishonest behaviour. We need also the diversity of detectives, policemen, and lawyers to put these people in jail to avoid wide spread dishonest behaviour.

⁴⁹ Contrary to the impression of many people, cheating was not invented by humans. Cheating and stealing is common behaviour in biology. Many animals and plants cheat to survive. All the interesting examples of cheating in biology could fill many books. In a strict sense, all animals steal the food that was produced by defenceless plants. Carnivore plants attract insects with different colours and odours but then kill the innocent insects. Pathogens live at the expense of their hosts. Viruses are the extreme example of biological parasitism and many defenceless animals take advantage by mimicry of other fearful species. To demonstrate something, which you are not (bluffing and cheating) is a behaviour deeply rooted in our biological origin.

⁵⁰ Adam Smith would also recognise the action of an Invisible Hand here.

⁵¹ This basic ethical premise, that stealing money leads to a decrease of the overall needs of humans, is sometimes put into question. According to the ethics of Robin Hood, stealing money from the rich to give it to the poor is an exception. The rich do not suffer as much from the loss, as the poor gain from the extra money. Therefore, even if it was against the legal system, Robin Hood believed in an ethical justification for his criminal behaviour.

⁵² The conflict of humanity and sustainability is also nicely demonstrated by the doctrine of the Roman Catholic Church. The Bible says that the human kind should multiply unlimited and dominate other organisms. According to the Pope there should be no method of contraception and everybody should get as many children as God provides. It is more than clear that the Church has no interest in sustainability. In the theological sense, we do not need to care about sustainability, if we only have unconditional faith and let our entire destiny in the hands of God. Even if the world ends (Apocalypse), we should not be afraid, if we believe in God.

⁵³ The latest trends in unmoral behaviour within a capitalist economy are cases of falsification of accounting (e.g. the Enron case). Funnily, this practice is also called *creative accounting*. Nevertheless, the diversity generated by mankind's creativity is not always according to ethical laws. Despite any legal measures, the temptation for immoral behaviour in the economy will always be very great –because it can be very efficient. To be effective in avoiding such behaviour, the punishment has to be much greater than the immoral gains of the dishonest behaviour to be a deterrent.

⁵⁴ This is also the reason why the ethical meaning of economics is only provided by the humanity principle. Efficiency and diversity alone can lead to evolution yet alone they have no meaning or purpose.

⁵⁵ We usually speak about three dimensions of space and a fourth dimension provided by time. More complex theoretical physics includes more dimensions. Without going into any more detail here, it is said that at some point during the creation of the universe, these additional dimensions shrunk.

⁵⁶ Within the theological view of the world, morals are not something invented by humans, but given by God. For the Christian World, morals are defined by the Bible. However, even the most religious people recognise that humans have to interpret morals and judge for themselves between good and evil. Sometimes, there are human leaders, who provide the definition of good and evil for all humans. For example, the Roman Catholic Pope is always right and defines which form of marriage, sex and contraception is moral or unmoral. In the field of world politics, the President of the United States defines which country is in the “axis of good or evil”.

⁵⁷ There are many people opposed to this drastic and unethical view of the natural world. They prefer to interpret some kind of harmony and good will in the interaction between species. Therefore, the examples of altruism and mutual benefice in biology are always considered with particular interest. A herbivore eats plants but fertilises them with excrement. The insects pollinate flowers in exchange of nectar. The symbiosis of plants with mycorrhizza fungi provides mutual benefit. Nevertheless, some flowers cheat on insects by offering no nectar, and some fungi become pathogens. Therefore, the co-operation between different individuals and species can be better described as an equilibrium of egoistic interests. In biology, we cannot speak of real altruism. Even genes are selfish, but selfishness is not bad or chaotic. Adam Smith believed in a balance of absolute selfishness in the economy. It is only that selfishness does not provide a purpose. For a more detailed account on the dynamic equilibrium of egoism in the world of economics, please consult the work of John Nash (Nobel Laureate in economics 1992).

⁵⁸ I will never get tired to stress that it is not profit, but efficiency what should be optimised.

⁵⁹ In the field of economics, the loss of diversity and establishment of homogeneity is also called monopolisation. The tendency into monopolies is driven by the efficiency principle. A monopoly is efficient but not sustainable. Therefore, they are '*not good*' and are legally forbidden by the government.

⁶⁰ Genesis 1-4

⁶¹ *God saw that it was good.* Genesis 1-10

⁶² Even in the religious view, evolution of the universe has no human purpose, but is only the divine Will of God. As simple humans we will never be able to understand the purpose and the Will of God. We can only aspire to have Faith and accept His Will. The New Testament says that, if humans can accept to leave their destiny in the hands of God, they will be saved.

⁶³ Business administration that only incorporates the efficiency principle is not only unsustainable but has also no meaning or contains no reason.

⁶⁴ In contrast, the word of progress is not used in biology. In science, we only speak about evolution, without implying any purpose.

⁶⁵ DNA is the molecule that contains the genetic information. It is the abbreviation for deoxyribonucleic acid. An error in the duplication of DNA is called mutation. There are single point mutations, but also more complex mutations that involve deletion, duplication, insertion and inversion of whole genes or chromosomes. A chromosome is a single DNA molecule, which contains the genes.

- ⁶⁶ For example, the heat shock response of bacteria makes them take up DNA pieces from the external medium. This effect is used in molecular biology to transform microorganisms with plasmids. Also, after UV damage of the DNA, some bacteria increase the creativity of their DNA repair machinery. These are common strategies of microorganisms to survive drastic changes of the environment.
- ⁶⁷ Cells that contain only one set of genes are called haploid. Cells with two or more copies are called diploid or polyploid.
- ⁶⁸ The carrying of "bad copies" of genes is sometimes called genetic burden. I prefer to call this genetic diversity. It is not a burden, but it is bliss to carry diversity.
- ⁶⁹ It is also interesting that there exist many biological mechanisms to avoid sexual intercourse that does not increase diversity. Sex, which increases diversity is favoured (opposite attracts), whereas sex that does not increase diversity is punished, for example incest (animals) and genetic incompatibility (mainly in plants).
- ⁷⁰ In biology, the difference between male and female individuals is called sexual dimorphism. In some extreme cases, the differences are so strong that the male and female were described as separate species before it was discovered that they were engaged in sexual activity together.
- ⁷¹ During the first semesters of his or her academic studies, any student of biology will get confronted with the predominance of sexual organs in many organisms. Some of my university colleagues made jokes about our classes of zoology and botany: They jested that they were courses on biological pornography... all the time looking at the most intimate sexual parts of animals and plants (flowers).
- ⁷² The multiplication of identical individuals is called cloning. Plants can be vegetatively propagated by cutting the shoot in several pieces and planting them in soil. Apomixis is a vegetative cloning of plants, which does not require pollination but involves the formation of seeds that are genetically identical to the mother plant.
- ⁷³ The division of one cell into two identical cells is called mitosis. Vegetative reproduction only involves mitosis. In contrast, meiosis is the division into four unequal cells. Meiosis is required for sexual reproduction. Genetic recombination and random rearrangement of chromosomes occur during meiosis.
- ⁷⁴ To be philosophically correct, we should not say that there exists an aim in biology. An aim implies knowledge of the future and involves rational adaptation. In biology, there is no real adaptation but only random change and targeted selection. This process leads to an increase of those creatures that are better adapted. However, it would be too complicated to speak in these terms all the time. For the sake of simplicity, sometimes, it

is better to say that the sun moves in the sky, than to say –more accurately– that it is actually the earth that is moving.

⁷⁵ I would not like to mention the name of any politician or world leader here. We all know some examples; but we also know that it is as human to fail, as it is human to forgive.

⁷⁶ Unfortunately, this definition of power is not shared by all humans. Sometimes, power is seen and used for the contrary: restrict the needs of others. What is your opinion? Who do you consider more powerful? Somebody who takes your food away, or somebody who satisfies all your needs?

⁷⁷ Again unfortunately, this definition of fortune is not shared by all humans. What is your opinion? Who do you consider more successful? Somebody who inherited one million from his parents and earned one million in his life, or somebody who inherited ten dollars and earned half a million in his life?

⁷⁸ The success of flowering plants is the result of a powerful strategy for the generation of diversity (flowers) combined with a powerful strategy of seed dispersal (fruits).

⁷⁹ According to a dictionary, art is the expression of human creative talent, especially in a visual form. It is no coincidence that flowers are regarded as natural art, since they are indeed organs for the creation of new biological diversity. Flowers are the reason for –and expression of– the *creative talent of plants*. This creativity derives from the principle of diversity and sustainability.

⁸⁰ Pollen can be considered the donator of the male genes for the female ovule. However, the sexual reproduction of plants is not as simple as we know from spermatozoids and ovules of humans. To be biologically precise, pollen is the starting cell of a proper organism (male Gametophyt) that lives only shortly and delivers two sexual cells to the female Gametophyt. One of the male sexual cells (generative cell) fuses with the female ovule cell and delivers the embryo. The other male sexual cell (vegetative cell) helps to build the seed endosperm. The embryo and the endosperm build the seed that is able to grow into a new plant.

⁸¹ For more details on this subject I would highly recommend a book of one of my former professors of Botany at the University of Heidelberg, Prof. Dr. Peter Leins. His book "Blüte und Frucht" (Blossom and Fruit) has been published in German by the E Schweizerbart'sche Verlagsbuchhandlung. Stuttgart, 2000. ISBN 3-510-65194-4

⁸² In the religious sense, death is the Will of God. As I have previously mentioned, the creation of the diversity of the universe can also be regarded as the Will of God. Thus, creation and death are both part of the Will of God. In the scientific sense, creation and death are related to randomness and are part of the sustainability and diversity principle. In a theological sense, it is no coincidence that God invented death –because eternity is

against creativity and the diversification force. Could it be possible to reconcile the scientific and religious views of the world, if randomness is regarded as the Will of God?

⁸³ The life spans of different animals, ranging from a few days to more than one hundred years, show that longevity is not something limited by external factors, but is determined by internal factors. Organisms become older and die because it is genetically programmed. The genetic programme can also be changed in order to become immortal. For example, all bacteria and many plants are immortal. In the field of animal medicine, this is called cancer. The medical example of cancer shows that immortality is not good but terribly bad. In a philosophical context, immortality and cancer are awful because they are against diversity.

⁸⁴ This is a very strong biological statement that I will not substantiate further. Intelligence is not restricted to humans, but many animals use a nervous system and some degree of intelligence to become more efficient –obtain higher profits with fewer resources. Intelligence is just a biological strategy to become more successful in the struggle for existence.

⁸⁵ In the platonic view, something true is automatically good and beautiful. The unity of both appears only in its eternal form (idealism). The ideal to unify love and sex is an example of the platonic inseparability of good-beauty and humanity-diversity. Not surprisingly, platonic love is an ideal hard to achieve. Furthermore, the platonic view is that philosophy is ethical, beautiful and erotically attractive (see the ladder of love in *Symposion*).

⁸⁶ For example, technology uses the knowledge of the laws of nature to build cars that are more efficient. The car works properly, runs fast and consumes little fuel, because its construction was based on true assumptions and knowledge.

⁸⁷ Efficiency alone is not the truth for everybody. In Christian theology, which is strongly influenced by Plato, *truth* is not separated from the *good*. Using this view, it is the efficiency-humanity that is truth-good. In fact, the religious view assumes that God is the only truth, and the Bible is the only source of knowledge. Because Christian theology assumes the inseparability of truth and good it concludes that science cannot provide the real truth but only a description of the projection of platonic shadows. This gives rise to the metaphysical conflict between soul and body. It goes beyond the scope of this essay, but we can say that Christian Theology would be very different without the influence of the Platonic Philosophy.

⁸⁸ As previously mentioned, blossoms are the sex organs of plants. Furthermore, sex in biology is a strategy to generate and increase genetic diversity.

⁸⁹ Previously, I described that some groups use ethical arguments for the conservation of the environment. However, I prefer to separate humanity from diversity, ethics from aesthetics, and good from beauty. In my view, ethics is a human invention that is alien to

the natural world. In biology, there is no ethics or morals. I have avoided using ethical arguments to protect animals and plants. Animals and plants are not human and have no legal rights. What would be the ethical justification, if I destroyed the rainforest to build my house, and if I killed a plant and a cow to eat? I prefer to use an aesthetical justification for the protection of diversity. If my house is less beautiful than the rainforest before, then I have committed an aesthetical crime –not an ethical crime. It is not bad that we destroy the Amazon rainforest to satisfy the needs of the poor people, it is only terribly awful and unsustainable.

⁹⁰ Animals and plants that are considered beautiful by the human perception are more likely to be protected (e.g. panda bears, birds, dolphins, whales, and orchids). The tropical rainforest is beautiful because it contains so many colours, flowers, trees, plants and animals. Human behaviour leading to the destruction of diversity and beauty is anti-aesthetic (e.g. contamination). Human behaviour leading to the creation of diversity and beauty is aesthetic (e.g. art and science).

⁹¹ This conflict is rooted in the difference between quantity and quality. Although business administration is primarily based on quantitative measures, it has managed to apply some qualitative arguments. The most prominent example is the quality control of products, services, etc. However, the concept of quality has not been introduced into all fields of business administration. The world would have a different economy, if the quality of money was as important as the quantity of money.

⁹² Unfortunately, business administration gives too much importance to money. This is the reason why the efficiency of companies is not being maximised in all aspects. If the efficiency is not paid back in terms of money, it is not considered. Using less water, energy and resources for the same outcome is more efficient, even if it does not pay back with money (e.g. when the price of clean water or air is too low). For this reason, the government has artificially increased the prices for certain resources, so that companies start to become more efficient. Interestingly, the government justifies these policies as being ecological (e.g. ecological tax) whereas companies agree on these taxes because it is nothing else than consequent capitalism based on the maximisation of efficiency.

⁹³ The day we can overcome the platonic reduction of ethics, aesthetics and technique and obtain the correct compromise in the magic triangles of good-beauty-true and humanity-diversity-efficiency, we will obtain a better world.

⁹⁴ The question arises, if aesthetics is anthropocentric or if it is universal –independent of the human eye. My answer is that while ethics and good are a human invention, aesthetics is a universal principle of nature. In biology, there is no good or bad, there is no ethics –there is only beauty in nature. An animal that kills other animals to survive and feed its babies does not behave ethically, but it behaves aesthetically. Having said this, the Principle of Diversity might well be renamed 'The Principle of Aesthetics'.

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- ⁹⁵ It is easy to recognise a bad lie, but it is very difficult to punish such bad people legally. It is easier to punish a black child that steals a candy from a supermarket than to punish a corporate criminal that steals millions of dollars from a company. Michael Moore would say in a film like 'Bowling for Columbine'... we need Corporate Cops to put handcuffs on these really bad guys...
- ⁹⁶ According to the Genesis, the sin of Adam was to eat the fruit of the tree of knowledge. Despite the prohibition by God, it was the curiosity of Eve and the temptation of the serpent that led him to taste the Apple.
- ⁹⁷ In molecular biology, the identical replication of the DNA is also an expression of old stability. However, the driving force of evolution is not the stability of genetic information but all the contrary – genetic instability.
- ⁹⁸ However, it would be naive to think that doctors and hospitals work only for the sake of humanity. Their work – as everybody else's – is also motivated by the possibility to obtain profit (salary) for their skills and expertise.
- ⁹⁹ There is little hope from a Pope like John Paul II as he is not interested at all in sustainability. Not only does he not see a reason for condoms, but also he sees no reason for renovation, succession and death. Not the humans but only the Will of God can decide on this.
- ¹⁰⁰ I wonder if the conflict between death as a necessity and the individual freedom and right to live as long as possible (eventually eternally) has already been partially incorporated into the ethics of various religions. For example, could it be that the religious promise of an eternal life in heaven after the biological death is a way to convince people to let go and die willingly? I cannot avoid thinking about the novel of Aldus Huxley '*Brave New World*' in which he described a perfect world where people were indoctrinated to die willingly, because they were taught to associate death with something very sweet.
- ¹⁰¹ To say it in different words: to avoid conflicts, the pace of ethics has to keep up to the pace of aesthetics.
- ¹⁰² We cannot apply ethics to the natural world. Animals and plants should not be judged using the morals invented by the humans. Animals and plants are neither good nor bad. Nature is not ethical but it is aesthetical. Nature is beautiful because of its diversity. Nevertheless, beauty and aesthetics alone do not provide a purpose.
- ¹⁰³ Take Mr. Bush who had to invade two Arab Nations as a revenge for a terrorist attack. Do you believe him when he says that the world is safer now?
- ¹⁰⁴ In Biblical times, medicine did not allow birth control using e.g. the pill or condoms. Today, the world has changed and the circumstances are novel. Humans have to make decisions that involve a new interpretation of good and evil. Nevertheless, the Catholic

Church does not see any reason to change its old-fashioned ethics and morals, which are based on the circumstances of an ancient society. Today, the technology of modern science opens new ethical questions: When does human life start? When does it end? Does a fertilised egg have the same rights as newborn baby? Should modern medicine fight against the Will of God?

¹⁰⁵ According to the method of science and in order to be philosophically accurate, the following restriction must be mentioned: Science does not actually discover the truth of the world, but it invents scientific theories that are useful (close enough to the truth) for making efficient (accurate) predictions. The view of science is always provisory. Neither the theories of Newton nor Einstein revealed the physical truth of the universe. They only provided a remarkably coherent and useful set of mathematical formulas to describe the laws of nature.

¹⁰⁶ Diversity (Beauty) can be created naturally by a divine power or artificially through human imagination. The ultimate source of this creativity is the same: Freedom and randomness. In the religious interpretation, it is not called randomness, but it is considered *The Will of God*. In the scientific interpretation, miracles are only a very unlikely event, whereas in the religious interpretation, miracles are the demonstration of the divine action of God.

¹⁰⁷ The word creation is presently banned from science and biology. Its religious connotation is too strong. This is rooted in the fight that Darwin had with his contemporaries, who preferred a view of creation in nature. Instead of saying that a species has been created, biologists prefer to say that a species has evolved. But this is indeed less accurate and even absurd. I think that it is a pity that creation is still a taboo word in biology. Instead of creation, biology uses a different word, which in my view is less fancy but is used to describe the same process: mutation. A modern biologist says: the gene has been extensively mutagenised to yield a mutant isoform. I would rather say: A new gene isoform has been created. I would be curious to know, if the public opinion accepted that biology starts to speak of creation instead of mutation. Certainly, our society partially rejects modern science because it feels that it is playing God. But what can it do, if this creativity is really the Will of God?

¹⁰⁸ Attempting to build a human society based on scientific knowledge alone will always lead to worlds as described e.g. by Plato in Atlantis, Huxley in *Brave New World*, etc. A modern version of such an inhuman world is described in the film *The Matrix*.

¹⁰⁹ For those readers interested in morals and biology I highly recommend the essays of Edward O. Wilson, particularly 'The Biological Basis of Morality'.

¹¹⁰ Religion is not intended to provide knowledge, it is intended to give us purpose and meaning in life. As a biologist, I have realised that science cannot provide purpose. The

truth cannot give me purpose; therefore I search for love. I search for the wisdom of efficiency and diversity that will help to better satisfy human needs.

¹¹¹ For example, the laws of electricity are based on the interaction of positive and negative particles.

¹¹² Of course, more experienced philosophers and the experts in logic would be able to distil other premises and reduce the amount of postulations more coherently than I have presented. Possibly, I have forgotten many more. I would be grateful, if somebody worked on really finding all axioms and leaving as few as possible.

¹¹³ Since Adam Smith, the concept of absolute value has been replaced by the concept of relative value according to the laws of offer and demand in the free market. In a strict sense, nothing has a value of its own. The value always arises from the particular context – from the interaction of the goods with humans in a given place and time.

¹¹⁴ If goods and money would only be exchanged, the total amount should remain constant over time. But apparently the total amount of goods and money increases with time. In the 18th century, this was already recognised by Adam Smith who postulated that peoples' skills and the labour were the origin of the increase of the wealth of nations. Karl Marx also analysed this reproduction of the capital. He concluded that the increase of capital represented unpaid work; instead of *Mehrwert*, he spoke of *Mehrarbeit*. He was fundamentally opposed to added value, efficiency and technological advance because the capital would accumulate in the hands of only a few, and this would lead to the exploitation and expropriation of the working class.

¹¹⁵ Sometimes the total wealth also decreases. For example, wars lead to a massive destruction of goods (in Germany in the Second World War, or in Iraq during the invasion by the American troops).

¹¹⁶ Goods are everything that satisfies needs. The term of good in economics should not be confused with the ethical meaning of good (and evil).

¹¹⁷ If one would like to put the biological world in an economical context, then the best description is total anarchy and widespread theft. Co-operations are only done, if they contribute to a species' own benefit. The perception that there is harmony, altruism and ethical respect in biological systems is truly a romantic view, not based on scientific facts, but on personal views, religious desires and utopias.

¹¹⁸ Both, the strategies of a big or a small company can be successful. However, as there are many half-capitalists ruling the world, they try to increase the profit, leading to always-bigger companies. Bad business administration leads to expansion, growth and raw profit without considering the efficiency or diversity. These big companies do not make profit when the world economy ceases to grow or when small changes take place. Managers

and politicians can blame unpredictability and randomness, but the world should blame the lack of vision of these half-capitalists.

¹¹⁹ Today we know that not only the raw DNA sequence is inherited, but also epigenetic factors like the methylation pattern, Micro-RNA and Chromatin structure. Maternal RNA and proteins also play an important role in the early development of embryos.

¹²⁰ The work of Adam Smith will be discussed later in the appendix of the book.

¹²¹ Enterprises also employ many different strategies to get more money from their shareholders. For example, the image of the company is polished before it issues and releases shares in the stock market. Marketing and promotion of shares is done via television, radio and in newspaper ads. The company does not give all shares away but gives them in limited contingents, etc.

¹²² Dinosaurs became extinct after the impact of a big meteorite more than 60 millions years ago. Today we are the protagonists –within the whole history of our planet– of the period of the greatest mass extinction of biological diversity. In this case it is not the *Invisible Hand* of Adam Smith, but it is the real hand of the *Homo ignorantis*. Funnily, in his book, Adam Smith mentioned the *Invisible Hand* only once, but his term became very famous. In his book, Smith mentioned more often *The Invisible Death*. This term did not become so famous despite the fact that the destruction of biodiversity in the Amazon rainforest can be best described as an *Invisible Death*, which we are not aware of, yet.

¹²³ The terrorist attack of the World Trade Centre was not directly the reason for the economic recession as it was not the material loss, but the psychological shock of a danger that led to changed consumer preferences in the whole world. This caused a change in many economic decisions in a snowball effect.

¹²⁴ It is very important to distinguish between present efficiency and future efficiency. Efficiency is absolutely dependent on the momentary conditions. Diversity is valuable, because it contains the potential for future efficiency under changed conditions.

¹²⁵ I say "yet" because there are already the first attempts to do exactly this. The fertilisation in vitro with the sperm of selected individuals is one of the examples, in which our intelligence is starting to have an influence on the future of our genes. Prenatal diagnosis and gene therapies are further examples going in this same direction called eugenics. Another example is biotechnology and genetic engineering with plants and micro-organisms. Human intelligence and science is helping to generate new alleles, genes and genotypes that are more efficient and useful for humanity, i.e. better for health, medicine, industry, agriculture and environment.

¹²⁶ In biology, evolution takes millions of years. In economics, evolution takes just a few years and in some cases only months or days.

¹²⁷ It requires more resources and more time, but it is also much more sustainable. What else could be expected, if the diversity is so much higher in biological systems?

¹²⁸ Nevertheless, many modern biologists still use the word adaptation very often. It is not rare to hear statements like "...a species has adapted well to the environment". However, this is not a true and purposeful adaptation, but only random variability that has been favoured by natural selection.

¹²⁹ If it is analysed more deeply, liquidity and humanity are indeed equivalent because they both dictate the purpose of all decisions and give a meaning for all efforts. They both provide a motivation. For economics, the final aim is not profit or diversity, but humanity. For investments, the final aim is not the interest rate or the risk, but the liquidity on a future date. An investment only makes sense, if you get the money back some day. Investment banks and brokers are mainly interested in liquidity (money) on the long term. However, for the private persons this liquidity is only really meaningful, if it is used to satisfy human needs (humanity). Thus, liquidity is not a purpose itself, but only a means to obtain something else. In a future essay I will explain why money is not an aim but only a tool.

¹³⁰ According to the physicist Steven Hawkins, it's human kind's tendency to dream about becoming master of the world and of the universe.

¹³¹ If your hobby or job is mathematics, you could expand all these formulas and include some more. I am not a mathematician, and therefore I believe that these are enough formulas for an essay that should be understandable to business administrators. These variables and formulas already contain most of I wanted to say.

¹³² It is particularly interesting to study this relationship for the immune system. If our antibodies would not be randomly generated but instead could be generated intelligently and rapidly after a pathogenic attack, we would require much less diversity in our antibodies. It goes beyond the scope of this short essay, but this is a very interesting field that should be explored further.

¹³³ The contrary is also the case. If humanity is becoming less intelligent then it will be necessary to increase diversity.

¹³⁴ It's Alive. The Coming Convergence of Information, Biology and Business. Christopher Meyer & Stan Davis. Crown Business, New York. ISBN 1-4000-4641-6

¹³⁵ These are slow and heavy dinosaurs. It takes too long for them to react. It is no wonder that some people get impatient awaiting for them to act. No wonder that humanity has problems of sustainability. Therefore, if you are a dinosaur, beware of meteorites!

¹³⁶ Even if it is not by majority voting, but out of electoral fraud.

¹³⁷ This whole cycle is well explained in any modern textbook of business administration.

- ¹³⁸ A posteriori, the consumer demand is also very easy to calculate since the enterprise knows how much was sold. A posteriori, the offer-demand theory says that the price was correct, or if there was a missed opportunity of profit. However, the offer-and-demand theory is of little use for *a priori*, the most common case for the strategic planning of business administration.
- ¹³⁹ However, the priority-of-needs of humans do not always correspond to the real amount of money people pay for a certain good. For example, air, water and food are absolutely essential needs of humans, but we pay none or relatively little money in comparison to jewels, hats and shoes. Therefore, the price-demand function needs to be empirically and individually measured by the real consumption of the product.
- ¹⁴⁰ The price-demand line can even change periodically during the course of the day, week or year. Consumer preferences are highly complex. For example, a consumer will not drink a beer in the morning, but is willing to pay a high price at night. People are willing to pay a high price to watch movies on the weekend, but not during the week. Therefore the price for the same movie is not fixed for all days of the week. Seasonal variations of selling (summer-winter) are also related to these consumer preferences and are the reason for end-of-season dumping strategies. Consumers do not want to pay a high price for a warm jacket at the end of the winter. However, marketing often considers overall demand without the dynamics during short periods.
- ¹⁴¹ For more details on truth, good and beauty see the corresponding chapter of Plato's philosophy.
- ¹⁴² On the contrary, because globalisation is against the diversity and humanity principle, it should be said that globalisation itself is the opposite of economic progress.
- ¹⁴³ This would be called the *Platonic Ideal*, in which good, truth and beauty are unified.
- ¹⁴⁴ As previously mentioned, contamination in a broader sense is everything that decreases diversity.
- ¹⁴⁵ Because diversity is beauty, homogenisation is awful. For example, if an unified Europe leads to a reduction of culture, art, food, customs, languages...
- ¹⁴⁶ Would it be the same managers that are telling the European workers that their services are no longer required because the Chinese are doing a better and cheaper job?
- ¹⁴⁷ To give you only recent examples, consider G. Bush and T. Blair. Without lying and false statements they could not stay longer in power. They deliberately lied to the American and British people. The war on Iraq served only to enlarge their political and personal ego. But the tragedy is not that some politicians lie and cheat, but that the citizens forgive and re-elect the same criminals again and again. Michael Moore says it without shame, the adequate Idiot-In-Chief for a Nation of Stupid Men.

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- ¹⁴⁸ It appears that there is not a great moral problem in poor countries. There, it seems to be possible to justify the death of many million Africans by AIDS despite the fact that there are medical treatments available for infection with the HIV virus.
- ¹⁴⁹ To mention a song from the musical “Evita”: Don't cry for me Argentina... (I am not cynical, I have indeed many friends from Argentina, and feel also very bad about their situation)
- ¹⁵⁰ It is no surprise to realise that politicians act principally out of selfish interest and not – as they sometimes say – to serve the public. In biology as in economics, absolute selfishness dominates. However, it is sustainable because of diversity.
- ¹⁵¹ Only a few weeks prior to the printing this book, some members of the SPD announced the intention of founding a new political party in Germany (Linke Partei). As it could be expected, the established elite of the SPD party was notoriously against such an initiative. Thus, not only the 5% threshold, but also the oral and moral punishment by the old party restricts the renovation of the political arena in Germany.
- ¹⁵² The United States of America were one of the few countries that did not agree in full with the commitments on biological diversity of Rio de Janeiro.
- ¹⁵³ If political leaders like Bush do not read books, this will not change in the future. If we cannot get more intelligent leaders, at least it would be more sustainable if our leaders would do some beautiful stupidities.
- ¹⁵⁴ The German Government finances research in universities and scientific institutions like the Max Planck Society, the Helmholtz Society and Fraunhofer Society.
- ¹⁵⁵ From the point of view of the efficiency principle, a monopoly is desirable, because it allows the monopolist company to be more efficient, to produce more goods using less resources, and thus obtain higher profits. The competition between companies has a high cost and consumes many resources. Nevertheless, consumers benefit from such competition. Prices decrease and products improve because of competition. Therefore, diversity and competition is desired from the consumers' point of view.
- ¹⁵⁶ The trend to monopolise is greater during times when the efficiency of a company is critical. This occurs during times of decreasing profit margins. In good times when business can run without so much pressure for efficiency, there is even an opposite trend of diversification. Immediate survival depends on efficiency, but future survival depends on diversity.
- ¹⁵⁷ Not only against monopolies, but also dipolies or oligopolies... against the loss of diversity in general.

¹⁵⁸ Volkswagen means "*car for the people*" in German. This name was chosen because it was so cheap that almost everyone could afford it.

¹⁵⁹ There is an amusing German film with this name. It tells the story of the fall of the Berlin Wall and the decadence of the socialist block from a different perspective.

¹⁶⁰ The fall of the socialist block occurred in two different aspects – political and economical. For the political fall of the socialist block there are many reasons. For the economic fall of the East German companies the major reason was indeed the mentioned problem of monopolies and lack of diversity. Remarkably, when the German counsellor Helmut Kohl spoke about the German Reunification in 1989, he assumed that the economy and companies of East Germany would continue to exist. However, this was not the case and the German Reunification meant more than just a political change. This was a serious mistake, which shortened his political career and continues to drag down the economy of the unified Germany. The next key question is whether the recent massive expansion of the European Union will increase unemployment rate and the taxes.

¹⁶¹ In this context, it is important to distinguish between the different interpretations of freedom. From the humanity point of view, freedom is linked to liberty and the equal rights of all humans. From the diversity point of view, freedom is linked to randomness, diversity and sustainability. Adam Smith never distinguished between these two points of view and therefore was so convinced that the total freedom of the economy was both human and stable (liberalism). Today our economic systems are influenced by a revival of these ideas (Neoliberalism).

¹⁶² It must be noted that privatisation and liberalisation is not the same. The government has to liberalise the market to allow the diversification and the establishment of competing companies offering their products and services. In theory, liberalisation and diversification can be done without privatisation. Privatisation with a legal protection of the supremacy of one single company is only a political strategy to fill the empty pockets of the inefficient government and State Company.

¹⁶³ For example, when expansion leads to monopolisation, this can indeed cause higher efficiency for the company. However, the size of a company and percentage of market penetration does not always correspond.

¹⁶⁴ For non-biologists who do not know the biological basis of this joke. Around 65 million years ago, the big dinosaurs became extinct because the environmental conditions changed much more rapidly than they could adapt to. Birds are one of the few evolutionary branches of dinosaurs that did survive. Crocodiles are another branch.

¹⁶⁵ It can be said that one of the reasons that the corporations are getting bigger and bigger is because the top managers get a higher salary if their company grows. The argument is

that if the size increases, so do also the responsibilities and therefore also the salaries. Some managers have such a high salary, that it is even top secret and not even the shareholders know how much do the executives earn. In this case, the selfishness of the top-managers is no longer lead by an *Invisible Hand* to lead to a better being of the whole.

¹⁶⁶ Managers and corporations cannot be blamed because they buy robots and install labour saving devices –instead of hiring people. The enterprises are only reacting to the conditions that the government is creating. The decisions of politics and the taxation system are the cause of many of today's problems. I know that this is a very dangerous and complex field, but I am convinced that experts in taxation could make a significant contribution to solving many of the problems of our economic systems (unemployment, contamination, natural resource consumption, etc.).

¹⁶⁷ Meadows work on the limits of growth was a milestone in the development of economic theories.

¹⁶⁸ In this context I can recommend the book "Natural Capitalism" by Paul Hawken, Amory Lovins and L. Hunter Lovins. Little Brown and Company. ISBN 0-316-35316-7

¹⁶⁹ There is an absurd view that human beings are not natural. As if humans were artificial and opposed to nature...! Humans are not special from the biological point of view. Humans are as natural as monkeys, lions, birds and plants. The house of a human is the same as the dam of a beaver or the nest of a bird.

¹⁷⁰ As I have previously mentioned, agriculture is the efficient use of land for human purposes. Agriculture requires a decrease of diversity in order to be efficient and human. Agriculture is human because it leads to a better satisfaction of human needs.

¹⁷¹ In Germany, the government pays farmers to not cultivate or harvest their land. Thus, despite the input by the farmer but without a production of food (output), this is equivalent to zero efficiency in respect to the agricultural use of land.

¹⁷² The European Union should consider, if subsidies for farmers should be taken out of the budget of tourism and not from the budget of agriculture.

¹⁷³ Current ecological estimations confirm that the present rate of extinction is at least thousand-fold higher than the rate of creation of new species. Humans are currently living in the period with the highest rate of biological extinction. In the whole history of earth, not so many species were exterminated so rapidly as today.

¹⁷⁴ '*Elemental Mind*' is an excellent book by Nick Herbert, dealing with the human mind and relating human consciousness to elemental physics and quantum theory. It is a truly inspiring essay and a must-read for those searching for solutions to the mind-body problem. I am delighted to admit that this book was one of the sources of inspiration for many of my ideas around the strange world of quantum mechanics and concepts of

randomness, freedom, consciousness and the mysteries of the human mind. Thank you Nick, for being in a place like that. Elemental Mind. PLUME Book by Penguin Group. ISBN 0-452-27245-9

¹⁷⁵ Oxford University Press. New York 1990. ISBN 0-19-506908-0

¹⁷⁶ Vintage, London 1991. ISBN 0-09-991380-1

¹⁷⁷ I must remind you that efficiency is not absolute but only a momentaneous property depending on the present conditions. What is efficient today might not always have been efficient under the conditions of the past. The analogous question can be asked in another context: Is a football team of today better than a football team of the past century? Who would win? Would the victory depend on whether the teams play using the conditions (pitch, grass, ball, shoes, and food) of today or from the past?

¹⁷⁸ The physical phenomenon of diffusion and the tendency of gases to occupy all available space are related to the second law of thermodynamic (increase of entropy). Great care is needed to distinguish between the concepts of randomness and entropy (disorder) in physics and the concept of creation and diversity. Crucially, the scientific concept of *order* should not be confused with *diversity*. This is probably my only disagreement with David Layzer's book *Cosmogogenesis*.

¹⁷⁹ I cannot avoid making a further comment in this context: Süsskind says that there is no uniqueness of the laws in the universe, there are many different environments (pocket universes). Instead of **uni-verse**, he mentions **mega-verse**. Allow me to make a suggestion to the terminology in cosmology: why not speak of **di-verse**? I would say that the diverse is more beautiful than the universe. If the string theory needs a short description I would use the following: From the unifying theory of the uni-verse, to the beautiful theory of the di-verse.

¹⁸⁰ The more simple the mathematical formula, the more beautiful it appears to physicists. For example, $E=mc^2$ is the most famous formula of Einstein. However, the beauty should not rely in its simplicity, but in the freedom, liberty and diversity that it allows. Dear Einstein, your formulas might be simple and elegant, but I prefer to include the dices because determinism is so terribly awful.

¹⁸¹ Apostolic religions are those which send apostles out to convert other people. This is based on the belief that if your religion is true, then all others are false. If there is only one God then not all religions can be correct, can they?

¹⁸² It's Alive. The Coming Convergence of Information, Biology and Business. Christopher Meyer & Stan Davis. Crown Business, New York. ISBN 1-4000-4641-6

¹⁸³ In contrast, this essay shows that monopolies are efficient but should be rejected from the diversity point of view.

¹⁸⁴ In the present essay, freedom and liberty are used as separate concepts. Freedom is related to the diversity principle, whereas liberty is related to the humanity principle.

¹⁸⁵ As I will present in a future essay 'A Critique to Materialism', one of the most fundamental problems of our present economic behaviour is that not everything is accounted in units of money. Why does a diamond cost millions of dollars but the happiness or fulfilment of a worker is not even considered in the accounting of any company? Why do we say that some things are priceless, when in reality they are so highly valuable? Why –if there is a saying that 'time is money'– the accounting of companies never assigns money to the time that is required for each activity?

¹⁸⁶ Sarkar does not explain, if it is a law that created an initial diversity or a law that prevents a loss of this diversity, or if it is a law that leads to a constant generation of new diversity.

¹⁸⁷ We must keep in mind that diversity is independent from humanity. The humanity principle grants the same universal rights to all human beings. But, if all humans are equal, why should there still be a difference between individuals? The ideal of a socialist society is that all members should have the same wealth, property and salary, i.e. socio-economic homogeneity. However, according to the Prout principles, this *sameness* is not possible. Long before the communist block collapsed, in the middle of the 20th century, Sarkar already knew that one of the major errors of Marx, Engels and Lenin was the lack of diversity in a communist society. Most unfortunate and inhuman was the fact that contrary to the ideal of socialism there was indeed a diversity in the society of the communist countries –the working proletariat against the ruling elite of the communist party, militia and secret police. It was for this social diversity that the regimes of the communist countries indeed sustained for so many years. Without the political elite around Stalin, Mao or Castro the communist countries would not have lasted long after the social revolution of the working proletariat. But as we know today, these regimes did not –or will not– last forever. Nevertheless, some hard-to-convince communists still dream about the utopia of a human society, in which there is no social and economic diversity (communist homogeneity).

¹⁸⁸ Karl Marx disregarded many spiritual values as he considered religion as the *opiate of the people* and the church as an instrument of oppression.

¹⁸⁹ Marx discussed extensively the concepts of *Mehrwert* and *Mehrarbeit*. According to him, all the problems of capitalism are rooted in the generation of added value. The working class is exploited and expropriated from this value (unpaid work). The capitalist elite increases its wealth by a reproduction cycle of added value and capital. This leads to an increase of the capital and to the enslavement of the working class. From today's perspective it is obvious that Marx was wrong in much of his analysis and conclusions, and that it is not necessary to expose his mistakes in more detail.

¹⁹⁰ The second of the Prout principles in the socioeconomic field –*In any particular age the minimum necessities of all shall be guaranteed*– is very human, but it is against the law of natural selection as found in free environments. During hard times with little food and resources, animals do not feed all baby animals equally. In order to ensure the survival of the species, parents give more food to some babies. During such difficult times, a specific priority and diversity of treatment is required not only for the sustainability but also for the efficiency of the species.

¹⁹¹ An extensive documentation and explanation of the Prout principles can be found at the internet address <http://www.proutworld.org/>

¹⁹² Diversity is such a central concept in biology that some scientific colleagues have sometimes failed to see the novelty of what I have presented about the importance of diversity. For some of them, diversity and constant change are so obvious and necessary, that this is self-evident. Some will feel that such self-evident concepts do not need to be mentioned in a lengthy essay. Others will feel that my statements are too revolutionary and the ideas so radical that they will not be accepted at all. I have written this essay in the awareness of this conflict. I hope that the compromise that I have chosen does indeed reach a broader audience.