The quality of sustainability and the nature of Open Source Software

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Abstract

Open Source Software has proved to be reliable and efficient in many cases. Therefore the technical advantages are self-explanatory. What is interesting about this work is the production model itself. As will be displayed it has a commons based structure and arises through collective action. A general economic assumption is that such forms of organisations own the risk to fail. With these conditions in mind Open Source Software likewise should break down. Therefore it is not so much a question of why it exists, which might be a more ideological discussion, it is more a question of why it is sustainable.

For that reason the conception of a commons and their failure will be examined as well as the argument of why Open Source Software is a kind of a commons and why it is sustainable. But firstly, as a deeper introduction, the emphasis will be on the nature of innovations and their meaning within the realm of software, especially in the case of Open Source.

A) The Dimensions of innovations

1.) Knowledge, innovation and science

One characteristic of science, very shortly explained, is the ability to gain knowledge using scientific methods. With this knowledge an innovative outcome is possible. Therefore innovation is characterised by its application in a commercial way. Frequently a technological innovation on or for the market initiated a historical change. Electricity, steam engines or the telephone system are qualified examples. Therefore in these situations innovations additionally have a social dimension.

But is science, the gaining of knowledge, chiefly an objective production mode? Ruled and caused only by economic and rational interests, whose effects on the social world are merely unintended and accidental by-products? Surely not.

Of course not every new piece of knowledge becomes an innovation. And not every innovation has an existential social impact. Nor is it nearly impossible on a free market to research with the confid-

ent intention that the final product will change the life of people. A general assumption is that "The more radical the invention, the less rational and predictable" (Schon, 1982, p. 299). Furthermore, as we will later see, innovation often happens outside of the market, and in some cases it is not even performed by scientists or professional researchers. Even the previously described commercial usability isn't a general character anymore.

To examine its dimensions, it is possible to interpret the production of scientific knowledge in two ways (Yearley, 1988). The first approach is governed by the 'political economy.' Here the premier motive for the development of science and technology is continually and heavily influenced by economic considerations. The needs of the companies are the main cause for technical innovations. This assumption is not very complex and only valid for the 'minority' of innovations. The second stands for 'social constructionism.' It proposes a strong social influence on the decisions about innovation and science. Scientific necessity alone can never be a sufficient logical explanation for innovation. No decisions about science are free of elements of social construction, where the development of technology is comprehended as a social process.

Even if both interpretations are differing in the question of impacts and motive, both say that science is not a body of neutral knowledge or is uninfluenced by social surroundings. And even if we would not agree with one of these interpretations and try to verbalize our own, it makes no difference to the fact that the relationship between science (with its knowledges and innovations as the consequence) and society is very mutual. There is no unbalanced dependence, both fructify each other.

As argued technological systems are "socially produced" (Castells, 2002, p. 36) and show much more complexity if they are not only regarded within the scope of science or economy. Similar to this discussion is the question of whether the character of innovation could be defined as supply-pushed or as demand-led. This more economic point of view deals with the distinction of scientific motives. It suggests theories about the market where supply and demand are important factors. Indeed new knowledge and innovations are a crucial part in economic deliberation. It sustains and supports competition in free markets. The (economic) development of companies, organisations or even countries is decisively influenced by their ability to create innovations. Particularly with regard to the post-industrial society the process of transformation is interacting with science and research. The attribute of "creative destruction" (Schumpeter, 1994) still is an applicable characterisation of the potentialities of innovations, no matter if in a scientific, economic or social sphere.

2.) Software as an example of the different dimensions of innovations

It is possible to deduce, therefore, that innovations scrutinize existing organisations and structures and their strengths. They have to create innovations and maintain these if they want to continue in their existence. This challenge concerns many spheres and is especially more widespread and weightier since the age of modernity. Even if the circumstances these days is the post-industrial, the post-modern or the information age (whatever the best expression might be) have changed, the conditions are basically the same in this case.

Good examples for the post-industrial society can be found in information technology, software and computer economy. Or, as a more general and colourful expression, the 'digital world.' They are characterised by the central importance of information and knowledge as raw materials and goods. This has been enabled by electronic data processing and communication networks. Because of this the production of material goods becomes more and more inconsequential. Crucial to the creation of value is the intelligence which flows into the creation of the product. The tendency towards the centreing of knowledge in the economy of OECD countries is measurable[1]. Beside these quantitative reasons there are qualitative ones (Zimmermann, 2004) which indicate that the information technologies are more than only a technical innovation. Their usability is universal, their application in every imaginable part of the economy led to a change compared with the industrial or Fordism production mode.

To express it in scientific terms, beside labour, natural resources and capital, digitalized knowledge can be considered here as a factor of production. The evolution of industrial production has reached a point where nearly every physical product can be produced in any desired quantity at little expense. Therefore, the importance of the labour factor is decreasing within these productively coordinated production processes. Of course labour and natural resources still matter, but their meaning is changing under the influence of (digitalized) knowledge as a factor of production. From this point of view the information technologies have another economical and social effect. They furthermore optimize the production mode and offer an alternative sphere for human employment.

Hence innovations in the development processes of software have far-reaching effects. Fundamentally changes likewise occur in social systems, structures and procedures (Castells, 2000), because software is one of the main 'tools' within the realm of the information and data processing, the information technologies, and its economic behaviour is different to the classical assumptions about utilisation or production.

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1   more informations and data can be found in OECD's annual report 2004
    http://www.oecd.org/dataoecd/28/49/31621929.pdf

For example transaction costs, marginal costs or scarcity have less importance in information centred economic areas. Software products theoretically are no exception in this case. The transaction costs are low, because software is easy to merchandise. Marginal costs have no significant importance here as the total costs won't increase notably if the number of units produced increases. This is because scarcity is an unknown phrase if a digital copy can be produced with the same quality as the original but without remarkable costs. Digital products have a 'virtual nature' (Zimmermann, 2004).

Software is an example of innovation where its nature introduce new rules which challenge economic and social structures. Originally a merely scientific issue, software became important in economic and social spheres too. Its acceptance is prevalent such that these spheres influence each other. But the primary overspill occurred from science to economy and finally to a social dimension. By the universal use of software, boundaries between these spheres begin to disappear and reciprocal relationships evolve. The output of one part of this relationship can be the input of the other.

Software determines the scope of action for people that have to work with digitalized data. It is an interface (Zimmermann, 2004) between user, data and machine. The possibilities a user has to work with his data are limited by the complexity of functions which the software provides him to work with. This thesis combined with the aforementioned assumption, that information technology in general and software in particular pervades a major part of economy and even everyday life, is a fundamental aspect about the social coherences of software as a technological innovation. The impact of computer applications on people's life is substantial and influences their choice to engage in what information technology has to offer.

The argument should have shown that software plays a, more or less, important role in social and economic models. The specifics in the manner of production, distribution and use of software have been discussed. In this context it is interesting to have a look at Open Source Software. This subsystem with its open production processes and open codes promises to provide new solutions to the use and production of software.

3.) Open Source Software in particular

Open Source Software has an attraction which goes beyond its technological advantages. Here the innovative characteristic can be considered as even more multifaceted and greater than what is called closed source software. Everything debated before was a concept of software in general. A concept with the least common denominator, every kind of software is, less or more, fulfilling it. In most cases closed source software is not going beyond this

concept.

But Open Source Software has this ability, even if it is only a subsystem, one part of the information technology paradigm, it is powerful enough to be regarded as a social movement inside this paradigm. Before we argue about this thesis, it is necessary to classify Open Source Software in relation to closed source software in order to define them. Both are subsystems of the already mentioned paradigm. So what is their relation? Is Open Source Software only a subsystem in a subsystem? Surely not, this would mean that closed source software is identical to the nature of software in general. And that is not true. Open Source Software is not a supplement to closed source software. It is an independent domain and *de facto* equivalent to closed source software. The differences are not in the content or in the scale, they are in the attitudes towards openness and economic interests. Therefore it is logical to put both on the same level.

The differences are crucial and sufficient enough to speak about Open Source Software as a social movement. If we think about these kind of phenomena we tend to think about something like the Labour movement or the Environmental movement. Of course in this case it is a very specialised, small-scaled and finite movement, but on the other hand it is a quite active, creative and successful one. The origins comply with the similar suppositions of any other social movement. "When traditional norms no longer succeed, in providing a satisfactory structure for behaviour, the individual is forced to challenge the social order through various forms of non-conformity. A social movement develops when a feeling of dissatisfaction spreads, and insufficiently flexible institutions are unable to respond" (della Porta & Diani, 1999, p. 6).

This quote gives an adequate overview and should cover our interests as well as the already mentioned 'classical movements.' Furthermore the authors have listed four characteristic aspects (della Porta & Diani, 1999) which are defining this kind of movement. The first are the informal interaction networks. Second there have to be shared beliefs and solidarity. The third characteristic is that collective action is focussed on conflicts which is followed by the fourth one where the use of protest stands in the centre of interest. The first two aspects seem to be self-explanatory as they deal with basic conditions about the structure and their motives. Numbers three and four have a closer view on the action of social movements. The phrases 'conflict' and 'protest' might be mistaken. Here conflict means providing an alternative and facing the opposition. The forms of protests are manifold. By choosing the GPL (GNU Public Licence) for licensing the software could already considered a protest. An obvious example is the open protest against software patents.

Following this argument the question now is what makes Open Source Software a social movement? Or to put it another way, what is so special about it (beside possible technological excellence)?

What is the reason for its social innovative nature?

The techniques to produce innovations are different in comparison to the dominating methods where private proprietary rights in the field of innovations exist. In the world of Open Source, within a non-commercial context, people contribute voluntarily to common goods. Software is not necessarily the only example for this type of innovation production. The transfer of this production model is possible and is already applied in other areas. The Wikipedia as a famous representative for the Wikis is a perfect example. Or the Tropical Disease Initiative with the approach to reduce the costs of discovering and developing remedies for tropical diseases ('Open Source Drug Discovery')[2]. All these projects have vital things in common, they are voluntarily produced collective innovations without restrictive private proprietary rights (at least for the most part, in any case). The examples introduced all function outside of the pure logic of market systems. And for the adoption of this model for economic use, the persons responsible have to be aware of these conditions. It works in situations where the profit of the contributors is greater than their costs (Osterloh et al., 2004).

In a classical Open Source environment one important characteristic is the voluntariness. A predominant characteristic in an economic environment is rationality. Both are not in contrast with each other, but they have different importance within their environments.

The production of Open Source Software (or other examples which act like it) basically happens outside of conventional economic constraints, even if the strategy of some projects tends to behave more in economic ways. The user oriented usability project of KDE[3] or the marketing project of OpenOffice.org[4] are just two such examples among many. But in general the production and the development of these projects works without special economically determined rules. And if they do, they do it with the characteristics of Open Source.

The motives for this are more complex than simply the difference between successful and unsuccessful. In this case the most frequent motives for the voluntary work have an intrinsic nature (Hertel et al., 2003). The work itself isn't understood as a factor of production, it is more a "highly qualified non-work" (Holtgrewe, 2000, p. 3). Lakhani and others have characterised (Lakhani et al., 2002) four groups of Open Source developers: 'learning and stimulation' oriented (29 %), 'hobbyists' (27 %), 'professionals' (25 %) and 'community believers' (19 %). This characterisation shows that in most cases the developer of Open Source Software is an unpaid volunteer. The interests are centred around the project itself and not so much around the benefits which might result from the project (extrinsic motives) for the developer. In this context the acquisition of

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2 http://www.tropicaldisease.org/index.html

3 http://usability.kde.org/

4 http://marketing.openoffice.org/

reputation, as an example for extrinsic motivation, is not a major stimulus (in contradiction to Raymond, 1999). It has been surveyed (Ghosh et al., 2002) that for only 9.1 % of the developers it is a reason to join an Open Source community because of establishing their reputation.

The actions of the economy are based on rational deliberations. The aspiration for profit is the motive for these deliberations. Therefore their structures are dominated by extrinsic motives. A volunteer developer of Open Source Software is free to behave irrationally (in an economic sense). A company can't afford the luxury to deliberately behave in a similar way.

The nature of companies and the nature of Open Source Software (or Open Invention at all) are oppositional in many ways. But obviously this model seems to be attractive enough that efforts have been made to enforce this ideal, for the very reason that a classical market economy has always been faced with the danger of market failures, so it has always tried to solve this problem. As an alternative the example of Open Source Software shows that innovation and production outside of the markets is possible. Some theoreticians regard these advantages under a Marxist point of view where innovations now are undocked from economic constraints and exploitations, which is the direct consequence of the fact that knowledge, as a factor of production, is free for everyone and not a tradeable commodity anymore (Gorz, 2002). It is seen here as a challenging social model inside the information society. The determining factor 'inside' is decisive here, which will be explained later.

As we can see, the ideologies within Open Source are very multidimensional. Even the concept itself offers the possibility to be redefined from different perspectives. Today the pragmatic term of 'Open Source Software' is quite common. In contradiction to this approach many activist prefer to use the more idealistically affected perception of 'Free Software.' No matter if the concept is regarded as 'Free' or 'Open', the model itself is based upon mutually reliant specific social and technical requirements (Holtgrewe, 2004). Social requirements are of course not as easy adoptable as technical ones. For economic use it is important to reflect upon the mutual characteristic of Open Source Software. Even if the commercial interests are mainly on the technical characteristic, the innovation must not be regarded as a 'Black Box.' The peer review by the community is the crucial point. Otherwise a community would not be anything other than a group of consumers.

But as it is already difficult to pinpoint exactly why the innovation model of Open Source Software is successful, it is even more complicate to predict where else it could work. As mentioned before there are existing interests from societal and economic positions. As a social movement it is limited within the boundaries of the technological sphere of the information society. It would hardly be applicable outside of this digitalised world of this information society.

In this context it is likely that this technological system is able to avoid inefficiency if it concentrates itself on the necessary work, the creation of knowledge and innovation in the form of software (Tuomi, 2002). Any further attempt to use it in a societal context would be unemployable.

The idea behind Open Source Software functions inside the production of technological artefacts. Other similar working projects like the briefly mentioned Wikis are aware of this circumstance. Even if they don't look very technological on the first view, at a closer inspection they are. It is not so much the content of an Open Source (or Open Invention, Open Content, etc) movement that ensures the success of the idea. It is so much more convincing because of the technological environments. These environments are vital for two reasons. Because they can be new and innovative in themselves, and because they provide a perfect production platform which is (in most cases) easy to use and accessible for almost everyone who is interested. That's why 'Open' products exist, because they are technological products or at least produced with the help of them.

The form of the content (the form of the invention) can be variable, but in actual fact it is all about technical innovation. With these deliberations in mind, it becomes more clear that many economically targeted firms and companies are exceedingly interested in this model, because technical innovations are a classic domain of the economy, and as mentioned before the alternative innovation process of Open Source Software promises benefits while at the same time minimizing failures and investments. But the economic use could be complicated if the interested firms are not aware that "Open source / free software is by design a process rather than a product" (Holtgrewe & Werle, 2001, p. 61).

Of course the idea to produce something through collaborative action and share or provide it as free for everybody isn't really new. Even the concept of Open Source Software is as old as the first computers. But in contradiction to the 'classical' collective actions, here a public good is produced with different attributes. For example the state plays absolutely no role in production, distribution or maintaining of this public good. At least not within the context of welfare. And the question of the ownership is different as well as the technical accessibility. These points, among others, will be discussed later.

For now it is more interesting to see that Open Source Software exists for totally different reasons other than 'classical' public goods. It exists not only because of the non-excludable attribute and the absence of scarcity and to profit from it. Nor is it defined by the idea of welfare. It is the characteristic of the alternative that makes this product so special, compared to others. By its characteristics it is not possible to commercialize them (remember – this is a particular feature of the classical assumption of a public good – think of environmental goods like fresh air, fishing grounds or even the law enforcement as a further example), but Open Source Software

owns other qualities. It stands in competition with other software like closed source software or even Open Source Software in some cases. And it is possible to adopt a business idea around it.

The collective action as a production mode is a common way to produce public goods. Even if the usage and the production of it implies a certain mass of technical knowledge, it is basically nothing new. But what is new can be found inside the production and the usage. All the social and technical network effects, the social norms and structures or the answers on the questions about organisation and leadership. The communities which arose around the projects are exceptional and extraordinary. The organisation is a crucial point. Public goods and private goods have a tendency to fail and produce inefficiency under a poorly directed organisation. The free-rider problem on the one side and market failures on the other are threats for the respective systems.

But Open Source Software can evade these threats. It might be because of the special position it has. Under this aspect it is worthwhile to have a closer look on the area of tension between public goods and conventional economic behaviour. To understand their relationship can be very useful for looking into the innovation and production process of Open Source Software.

Here the social dimension is affected by its very special collective action. Because the collective actions produce 'Common-Pool Resources' (Hess & Ostrom, 2003) or could be even self considered as a common-pool resource. Furthermore this phrase is more adequate in this case than the notion of public goods. That's why it is necessary to define it in detail and to have a look at possible disadvantages and threats. These explorations and assumptions will be considered under the perception of Open Source Software. It is administrable to look at the concept from this perspective simply to try to comprehend why it works the way it does. Why the common-pool resources won't be abused as has happened to many systems of commons before.

B) Commons based systems and Open Source Software

1.) The system of the commons

The idea of the commons is a very old one as well as it is multifaceted. The basic categories deal with the terms of access, use or consumption in the context of property. Theorists of the commons have been talking about these categories, its values and meanings for a long time. In this context it shouldn't be forgotten that the idea of property has altered in the history of mankind. The questions about what is common, what is public and what is private property have been answered in many different ways. And to make

it even more complicated, these answers have been interpreted and transformed by world views and ideologies like, beside many others of course, liberalism, communism or conservatism.

Therefore it makes sense to start with finding some common ground on which it is possible to base the theories of law, politics, economy and the experiences of their history. That will help us to understand what special position the concept of Open Source Software holds within the theories of the commons.

The concept of the commons is very interesting for historians. Even though it is much older, the commons established in the mediaeval times as a useful and prospering system to manage resources. It was a working economic system based, in most cases, on a piece of land, meadow, lake, river or pasture. Although the nature of the commons and its definition can be different in different communities or countries, they often include natural resources as a basis.

Another important characteristic is that, despite the fact it is a common resource, it does not mean there is no owner for that resource. It is a freehold in possession of the village, a part of the asset of the community where members of that community are allowed to use it. And this is the next crucial point.

In the original concept of the commons the access to it is only available for the locals. The residents of other communities or strangers did not had the right to use it or to benefit from it. But the question of access and the rights to use what and how can be different even inside these traditional commons. Because there often existed several kinds of rights. These resources can be either used by all members of the community or only by a few. Another way to organise these common resources was to determine which rights a user had. For example he might have had the right to pasture his sheep but he was not allowed to take sods of turf.

That shows how aware the communities were (even at this time) about possible disorders. But it was more than a simple opposition to private property. The idea of common resources, or common property in general, owned by the community and therefore equally by all members, is the attempt to benefit from a special type of public good. The differences between commons and public goods have been quite often discussed differentially. Simply because of the fact that the boundaries between them are fluctuating, as we will see later. But it should be possible to describe the commons as a subset of public goods. Because it is not infinite but replenishable. That means the communities had to use it deliberately if they wanted to keep it working. They recognised that the number of users had to be limited. So only locals could utilise it and sometimes even only under restrictions.

Additionally the law provides administrable informations about these assumptions. 6 Halbury's Laws (4th edn) para 507 (Saunders, 1996) lists rights of common, which have their origin in common law. Rights of common are either a) appendant (to seize a certain land from another's ground, but holding it in common and use it

only under specific conditions), b) appurtenant (land annexed by an adjacent landowner, to hold it in common), c) in gross (a landowner, by his deed, grant to another that he have common in his land), or d) by reason of vicinage (commoners of adjoining certain lands allow each other to let their cattle stray over the dividing boundaries)(Greenberg & Millbrook, 2000). These rights show how sophisticated the system of the commons has been in some regions and how the common law created economic sustainable structures. Under these conditions the law provides its definition of the traditional commons. 6 Halsbury's Laws (4th edn) para 505 (Saunders, 1996) simply defines it as a "the land where rights of common are exercised."

What we have seen up to now is a structure for an agricultural society. The idea of the commons still exists, but it has to face different rules and conditions. Nevertheless the contemporary common property theory still has its own character. "Common property regimes are an alternative regulatory model to private and public ownership" (Cahir, 2003, p. 18).

It could be a thesis that in a time where the Mercantilism was the predominant economic theory, common property regimes were able to prosper (Engel, 2002). However there are a lot of doubts for economists about the strengths of these regimes in times of international division of labour and free floating currencies. At this the rights of disposal have to be defined absolutely, simply because of the precise, fast and effective control over the allocation of resources.

For this economic point of view a system of a common property would be more than irrational, it would be a danger for the property. Because it is considered as risky if the rights of disposal would be diluted. Although often regarded as a threat, the dilution is not *per se* a dysfunction. But most companies, for example, dislike the idea. They fear that, with diluted rights of disposal, others could adopt the use of their product (property) apart from the market. As a direct consequence of it, the incentive for the owner of the product to invest more efforts in the production or the maintenance of that product is decreasing.

These difficulties, which will be discussed more precisely later, won't be ignored in modern theories about the commons. But the basic approach has changed. To satisfy the requirements of the markets property law has to be constituted. Of course there is no doubt about the question if there should be private property. "This does not mean that commons are anarchic spaces. Purely free action is illusory" (Benkler, 2003, p. 6). But what are commons today? At first the characteristic of freedom is probably is very important one. The freedom can be described as the ability to act outside of market constraints.

Property laws, for example, are such a market constraint. For the implementation of rights of disposal, property laws are necessary. No one would doubt that. However, the commons, on the other

side, simply tries to offer resources to its users, but with other rules than the free market has. Its institutions and arrangements are different. In the commons, exclusive control over the usage of a resource can't be owned by a single person. This arrangement works if four types of the commons, which are based on two parameters, can be discerned (Benkler, 2003).

The first parameter distinguishes if the commons is open to anyone or to a certain group (open commons vs limited access commons). The second parameter differentiates between regulated and unregulated systems. For Benkler every system of the commons can be defined along this classification. Here the characteristic of freedom is increased if the classification aligns towards an unregulated system with open access. Whereas limited access is merely regarded as a common property regime.

Lessig (a jurist as well as Benkler) discerns the same parameters, but he introduces a rating whereby the precondition of access has a higher importance (Lessig, 1999). Regulations are allowed, in some cases they have to happen (for the most part, it makes sense to think about norms in the case of governing or regulating). But the open access to the property that is hold in a commons is the essence of the commons. These kinds of property shouldn't be held or controlled by private hand.

This openness is a crucial point because it has a great influence on the establishing of network effects. Network effects can be identified as a good substructure for the commons (Rose, 2003). They appear if a service of a network has a higher value to a member the more other members of that network use this service. These synergies in the network effects are also known as network externalities. And open access promotes these externalities. The number of people who use a service, a product, a land or a good determines the value it has for the people. Or spoken like a Marxist theoretician, these externalities increase the use value of a product, while in some cases (not in all) it decreases the exchange value. And these examples can be predestinated for the use as a commons. But it is going a bit too far for the moment. We will discuss that point later and go back to contemporary common property theory.

The nature of a good is often characterised as either private or public. That difference is easy to explain for economists. Private good has the ability to solve problems very efficiently on the market. Everything else, where it is not possible to manage with the help of a market, needs to be produced or protected by the state as a public good. For that reason, nobody can be excluded from a public good. That is basically its most conspicious feature.

A public good is an appropriate example for uncompleted rights of disposal. Three main causes can be found where rights of disposal deliberately stay uncompleted and a public good arises. The first reason occurs if it is technically impossible to commodify a good (e.g. the air). At the second point it is technically possible to commodify a good, but it would be too expensive to implement it, think

about streets for instance. The third reason can be a political one. In some particular cases it is possible to commodify a good as well as it is possible to implement it. But the legal system won't allow it because the state has a monopoly on it. That happens in situations where a market failure could cause serious problems for certain communities or even the society in general. Organ trade or prisons would be eligible examples (Engel, 2002).

It should be apparent now that a commons shows many similarities with public goods. Therefore it is not unusual that a commons can be a public good at the same time. But to show the differences it is useful to introduce another theory. Common-pool resources, a term mainly established by the political scientist Elinor Ostrom, refines the idea of the commons for contemporary conditions and helps to clarify the deviations from the system of the public goods.

It has the same quality as a public good where it is unable to exclude users from the benefits. But the commons, or more modern expressed the common-pool resources, likewise own characteristics of private goods. Not within the context of private property, but within the context of consumption. "The products or resource units from common-pool resources share with what economists call 'private goods' the attribute that one person's consumption subtracts from the quantity available to others" (Hess & Ostrom, 2003).

A common-pool resource shows attributes from both sides. It is not possible to completely assign it to one side of the dichotomy. That might be the reason why economists have problems with the concept of the commons. They usually categorise it as a public good. Even if it is actually not correct, it is not vital in situations where common-pool resources are defining a piece of land or something very abstract like the air. Until now all these concepts had a conception about physical products, what can be traced back to the historical fact, where the origin is located. But how do theories of the commons behave in cases where knowledge is the product? The differentiation from classical public and private property regimes has to be done more accurately.

The rules are changing if we speak about knowledge as a common-pool resource. Especially digital knowledge demands to scrutinise previous assumptions. And Open Source Software is the best example for that kind of commons.

2.) Open Source Software and the commons of knowledge

Knowledge as a common-pool resource, as a product of collective action, owns a very special character. Because intellectual property has a different nature than property in goods. Here there are other conditions to produce, to trade or to maintain it. The alternatives to allocate resources are more manifold than with other sorts of property. Open Source Software is a perfect example for that thesis.

The innovation model and the collective action makes it a kind of prototype for a new, a 'present-day commons.' "Open source is an innovation model that challenges conventional views that innovation is best supported by strong private intellectual property rights" (Osterloh & Rota, 2004, p. 3).

In traditional production modes distinctions are drawn between users and manufacturers of an innovation. These categories will be constructed under the aspect of who benefits from what. If you benefit from using the innovation, you are an user. If you benefit from producing it, you are the manufacturer (and so on). These categories are named 'functional classes' (von Hippel, 1988). The economist Eric von Hippel has researched about the so called user innovation theory, where all functional classes can be sources of innovations (von Hippel, 2005). He invokes many examples like the tractor shovel or plastics additives. According to that user innovation is not merely a theory for intellectual property regimes.

But the fact that makes, in this context, the case of Open Source Software interesting is that the process of innovation happens collectively. It is a 'private-collective' model of innovation (von Hippel & von Krogh, 2003) where the participants invest their private resources and create a commons. This collective model is termed private in order to distinguish it from classical collective action models, where the existence of a central agent is possible (for example a company or the state), who grants selective incentives (Osterloh & Rota, 2004).

Similar to that theory is what Benkler describes a commons-based peer production (Benkler, 2002) for information systems which have the ability of a decentralized collaborative production mode. This is a process where the creative energy of participating individuals leads to a joint effort that creates products of information. These actions are not administrated by tools of the market. The price for example is not a regulative signal. The commons-based peer production is a model different from markets or firms. It seems to be a derivative of the user innovation approach, but it merely concentrates on the information economy.

Such a commons-based peer production is predicated on the fundamentals of what sociologists of science (e.g. Parsons, Popper, Luhmann) call the norms of science. What is interesting within the framework of common-pool resources and commons-based peer production is that they mainly require the segregation of science and state, ideas and interests, as well as the segregation of knowledge and property. The last argument has been extended by the sociologist Robert K. Merton as he postulates that the results of research have to be published, free for anyone. This has to be done to facilitate a peer review process, which allows others to validate the results. Merton called this postulation the norm of communism (Grassmuck, 2004).

Especially the norm of communism is fundamental for the information commons. Its application can be prototypically found in the

area of Open Source Software where this norm is even part of most of their licences. The process of peer review requests open access in order to collaborate and build on each other's work. A digital environment seems to be the best place for it.

The nature of Open Source Software interprets the norm of communism new. As a common-pool resource, it has its own characteristics. That's for sure, Open Source Software is standing between the realm of public and private good. But the similarity with a private good merely is the attribute that it can be made for profit. Whereas the consumption of one person does not reduce the chance of another person's consumption. It is not a *res extra commercium*, it is not outside of any potential economic transaction. The conditions are different here.

Giving information away does not mean to the donator he will lose the information (the 'product'). And he won't lose the rights of disposal with it, except he gave it away by contract. That is the same situation with the code of software. And the suppositions are changing again if we start from the assumption that information, as well as the code of software, can be published with the help of the internet. If the access to these information products is open to everyone, a system of information commons arose. As it can be seen within the example of Open Source Software.

The property is nonrival, because it is digital. The marginal costs are zero. It is not a physical product, not a physical commons. Rivalry is not part of the concept if software is open. Ones and zeros are infinitely available. The internet makes publishing source code or information as easy as never before. Open access, the most important requirement for a veritable system of a commons, can be easily complied within digitalized information commons.

As described many concepts are, partially or entirely, adaptable on Open Source Software. The ideas of user innovation, collective invention, common-pool resources or commons-based peer production depict a structure where it seems to profit from all the advantages while avoiding the disadvantages. Simpler expressed "open code creates a commons" (Lessig, 2002, p. 68). The combination of this absolute openness with other characters of the commons, and the digital platform of the internet established a special case where traditional assumptions about common-pool resources or public goods aren't valid anymore.

To regard Open Source Software as a pure public good means to regard closed source software as a market failure. Both presumptions are not right. But physical common property resources (not the air or fishing grounds for example) exist because of a market failure. The market has not found a way to allocate these resources efficiently in order to produce them as a private good. That is the general theory. But software is not a real physical product. At least not real enough to comply with that theory. And on the other hand software is not discarnate enough to be unable to trade it (of course here we speak about Open Source Software – anything else

isn't really admirable). And you can apply licences to it, which clarifies the rights of disposal.

The collective use (the collective action) of resources like knowledge and information can lead to a greater benefit (norm of communism) than an exclusive use (Weber, 2004). It should be transparent now that this thesis is adaptable on Open Source Software. But the inversion of this thesis does not automatically mean exclusive use leads to an under-utilizing of a resource. This market failure of the anticommons (Heller, 1997) occurs when the rights of disposal are too closely defined. The rights of exclusion will lead to an inefficient use of a scarce resource. However software is no scarce resource. Within the realm of closed source software the rights of disposal might be defined too close in some cases but that won't inevitably lead to a 'classical' market failure. It is another example how difficult it is to describe digital products with economic theories which have been created in the context of physical products. Therefore many companies and firms try to 'reconquer' the product from digital rules and install strict licences or use patents as protective tools.

This strategy turns software into a physical good. Instead of conforming economic theories to software, here software will be adapted to economic constraints. This strategy is the paradigm for the major part of software. The advantage is that it makes it easier to trade with software, to earn money, to create incentives.

Under the perspective of the commons it is quite clear that this is not the only alternative. But entrepreneurs react with doubts on the idea of an economic strategy based on common-pool resources, even in the case of software production. The reason is a market failure from the traditional assumption about the commons.

3.) About failures and tragedies – the reason why no commons

Common-pool resources are not sustainable. That's the general opinion from most of the theoreticians of economics. They explain it with rational analyses. Overexploitation and free riding would be unavoidable effects. The conflict between the interests of individuals and the common good is likewise attractive for the science of political philosophy. To determine the moral basis of individual private property they go back to the rationalistic nature of men and to the state of nature where resources were held in common. But it was a biologist who gave the problem a well-established name. In 1968 Garrett Hardin wrote an article about the commons and introduced the colourful metaphor of the "Tragedy of the commons."

Property related market failures basically have two causales (Engel, 2002). The rights of disposal on a property can be defined too completely or not completely enough. The second case is connected with the "tragedy of the commons." The first case is the "tragedy of the anticommons" (Heller, 1997). Instead of overusing a resource,

it will be under-utilised. The transaction costs of an economic exchange of that resource are high priced, it won't be used anymore. That can be a problem if, for example, it is not worth to develop a technology further because the innovator has to buy too many licences (Osterloh et al., 2004). If multiple owners each have a right to exclude others from using a resource, the transaction costs might be higher than the expected profit. "Transaction costs are positive, and the greater the number and complexity of negotiations, the higher the transaction costs" (Hope, 2004, p. 36). As a result the resource remains unused.

Although markets are considered as the best place to efficiently organise production and to allocate goods, they can fail as we have seen. Economists take that problem seriously, corrections have to be done. But for them a failure in the commons seems to be more fatal, because regulating institutions from the market are not existing. A conflict appears in the efficiency of distribution. This form of economic organisation will be confronted with overuse and free riding.

Under the assumption of an individual as a *Homo Oeconomicus* who is always looking for the most advantageous option, he will exploit an ungoverned good, hold in a commons, as much as he can because he expects the others will act in the same way. Additionally it is likely that a free rider problem will occur if consumers of a common-pool resource take advantage of it without contributing adequately to the creation of this resource. From this point of view the economic nature of men seems to inhibit the idea of a successful commons. But it is for sure that human behaviour and acting is not as simple as described. For example private welfare or social work would not exist under these assumptions. The economic and strategic behaviour of men or organisations is more complex.

This paradox is a social dilemma, a social conflict situation. The optimal state of a group (a commons) is violated by merely individual, egoistic actions. Everyone knows they benefit if everybody cooperates. But at the same time everyone is aware about the fact that a non-cooperative behaviour of a group member would lead to a higher benefit for him then a cooperative behaviour. However (theoretically) no one knows the strategy of the other group members and no one has enough information about the resource itself. It is not clear how long the resource will be sustainable under non-co-operative behaviour. The date of exhaustion is unknown.

These conditions create a situation where a rational choice performance is most attractive. Likewise other dilemma (e.g. Braess' paradox, prissoner's dilemma) the problem with the commons shows that individual and rational decisions can lead to suboptimal results for the collective. The commons seems to be opposing the nature of men - sustainability needs a regulative institution.

The state of nature has always been an important concept within the political philosophy. It is used to describe the situation and the condition for men if there is no such regulative institution. Depend-

ing on the philosopher's conception of man, the state of nature is a starting point for a society and can be used to explain the genesis of a state (as the social contract theories do for example). Thomas Hobbes depicted the state of nature in his 1651 published "Leviathan" as a kind of war. As he wrote it is a '*bellum omnium contra omnes*.' It is a very pessimistic view on a structure which could be compared with a commons. Although the individuals act rationally and look for peace, within the state of nature they live in an everlasting war about resources and products. "Hereby it is manifest, that during the time man live without a common Power to keep them all in awe, they are in that condition which is called Warre; and such a warre, as is of every man against every man" (Hobbes, 1968, p. 185). Every product, good or resource is hold in a commons, property rights does not exist. And struggle about them occurs because everyone is equal in mind and power while everyone is trying to allocate the common-pool resources. Those who want to respect the rules have to fear others, who do not respect them. That's why it is a rational strategy within the state of nature to ignore the rules or contracts. This set of options for action can be interpreted a social dilemma. Common-pool resources create unsure legal positions if everybody ignores the rules. The individual action inside a collective disables an optimal condition. An optimum (or at least a better situation than the state of nature) for Hobbes can be found with the help of a 'common Power', a Leviathan.

Adam Smith on the other side pursued a more moral approach. He contradicts the idea of the commons as well, but opposing to Hobbes he had a more complex perception of the human nature. The sympathy we have for our fellow men is the basis for our morale. And this would be the stimulus for human work (Smith, 1982). In other words the people have to foster there own reputation, establish relations with other people and try to respect their needs. The reason why they should do so is quite simple. Because of the market. Within Hobbes' state of nature the individuals had to get, had to produce everything they wanted by themselves. For Smith it is part of the rational nature that people use resources or produce goods with the help of division of labour. Relations are important. It is necessary to follow rules. "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" (Smith, 1994).

There is no place for a commons because under rational conditions a market would evolve instead of establishing a common-pool resources. The efficiency is guaranteed by an 'invisible hand', as Smith described it. Under this liberal theory of economics the market and the price is the organising institution. Private property is always favoured over common-pool resources. Because they are considered as unreliable if their existence depends on the benevolence of their users not to exhaust it. It simply would not be rational behaviour. Rationality is a necessity under the condition that nearly every good or resource man needs to survive is scarce. And the

success of a form of economic organisation is determined by the fact how it copes with this scarcity.

The utilitarianism delineates this idea as the aim to find the greatest happiness for as many people as possible. However it is not meant to find this optimum merely through individual action. It is more an instruction, an advice for political action (Bentham, 1996). A regulative institution is necessary to achieve that aim. Self-interested individual action helps to increase the wealth of a community, though it does not work as a commons. The maximum amount of happiness to the maximum amount of people would not be possible as the danger with the social dilemma exists. For the utilitarianism a commons has a complete opposite character. Instead of a regulator (politics) and increasing wealth through self-interested action it has no regulator and the probability of decreasing wealth through self-interested action.

Even Thomas Aquinas, a theologian from the mediaeval times, can be interpreted from this point of view. Man is a social being and has to live in a community where the division of labour is a foundation. Sustaining the peace is the most important task for the community. Private property ensures the peace. "First because every man is more careful to procure what is for himself alone than that which is common to many or to all: since each one would shirk the labour and leave to another that which concerns the community, as happens where there is a great number of servants. Secondly, because human affairs are conducted in more orderly fashion if each man is charged with taking care of some particular thing himself, whereas there would be confusion if everyone had to look after any one thing indeterminately" (Aquinas, 1947, 2/2 q. 66). Property hold in a commons causes disorderliness and disorientates the society.

These conceptions worked on the stability of a state or a society. Peace and stability are supposed to be the highest values for these systems. And the market is the basis for a dependability. That adds a social dimension to the economic theory about the 'tragedy of the commons'.

That phenomenon itself has already been observed by many other scientists before. But it was Garrett Hardin who gave the name to it, although he considered it under ecological points of view. He originally wrote his article after some thoughts about the problem of overpopulation and the optimum population size. Hardin described an old vision of the commons and mainly pictured common-pool resources like pastures which are open to all. Thereby the tragedy of the commons is an unavoidable destiny. If a resource is open to all, without any restrictions, everyone will try to gain as much profit as possible from it. That works as long as the amount of exploiting people is small enough and the resource won't get exhausted. But if the number of users exceeds a certain level, the tragedy of the commons will occur. Everyone still tries to gain a maximum of profit, however the resource is not sufficiently available anymore.

"Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all" (Hardin, 2001, p. 29). Costs will arise because of the unconsidered exhaustion and have to be borne by the community. For an individual the short-dated profit is higher than the long-dated costs. The theory predicates everyone will have a personal loss and contributes to the ruin of the community. Therefore under these circumstances a lack of private property and governance will lead to a standstill of economic activity and produce considerable disadvantages.

With all these evaluations about common-pool resources in mind, the question is why and how commons of knowledge, like Open Source Software, are able to survive. If such a system is doomed to fail why isn't everything organised by the apparent comedy of private property (Lessig, 1999)? The classical assumption is that a tragedy of the commons can only be avoided if the common-pool resources will be migrated into private property or if they will be organised by a central institution, like a government. With this considerations in mind Open Source Software should not be successful and fall down. But the opposite happens - it is very vital.

4.) The absence of the tragedy

Economically considered, Open Source Software, as well as knowledge or information, share several attributes with a public good and a commons. It is very interesting to see these systems demonstrate a strong sustainability and have a vital character. More than this, Open Source Software shows an innovative, successful and efficient production mode. What seems to be a phenomenon is easier to understand if the conditions of existence and production will be determined. The classical tenet, where the rights of disposal are the only incentive to innovate and produce a good, does not apply for the model of Open Source Software. It offers the product (software) for free and distributes itself quite easily and fast for that reason. The conventional presumption is that expenses for imitation will be lower than the expenses for innovation. Therefore will be no long-term incentive to innovate. The engine for the growth slows down (Heller & Nuss, 2004). But the opposite happens. Obviously the *Homo Oeconomicus* acts a bit more multifariously.

In order to avoid such a slow-down, a resource like software which is easy and cheap to distribute and to copy has to be kept in scarce. By doing this a market value will be created. On the other side there is the innovation model of Open Source Software, which is a hybrid one (Yuwei Lin, 2005). It takes place in communities and firms and uses the advantages from both sides to acquire resources. It is very dynamic and easily crosses the boundaries between social groups. These socially created institutions of developers and authors provide a sufficient incentive to innovate and

to contribute without a payment.

Of course the situation is a bit more complex. Under these assumptions every Open Source project would automatically be successful. What is needed to explain it more precisely is the theory of network externalities again. A larger group has a higher probability to succeed than a smaller group. Although it is actually not the size that matters, it is their resources and their organisation. Within a larger groups it is more likely to have a higher number of people or institutions who reveal a lot of interest and who are able to share their resources. The challenge is to bring these people together and assure they will have an effect for the collective request (Kuwabara, 2000). It is easier and more probably for larger groups to establish such a 'critical mass.'

After such a critical mass has evolved and their contributions boost the project, it will attract others who want to become involved. The project is sustainable now and can become successful. The big advantage Open Source Software has at this point is its close association with the internet. It is even more than an association, it can be better described as a dependency. Without the internet most Open Source projects would not exist. And without the software from these projects, many internet services would not exist or would not work as we got used to it. The internet as a technical network makes it easier for Open Source Software to profit from economic and social network externalities. It uses the internet as a basis (e.g. communicating, distributing or marketing) and orientates oneself on whose structure as a part of its own nature. That helps to achieve the positive externalities and profit from it.

The conception of the critical mass can be interesting within the context of the ideas from the economist Mancur Olson about the logic of collective action. He examined the problem groups have if its members act rationally in the sense of rational choice theory. In contrast to conventional 'tragedy-of-the-commons-authors' (in fact his work deals with similar problems) he depicts conditions where collective action avoids the free-rider problem. This problem occurs acutely in what he called latent groups. Here, because of the large size of the group, the contribution of a single group member is not noticeable anymore. This would be the point where the individual acts rationally and maximizes its profit by free-riding. That's why it needs selective incentives (positive or negative) in order to motivate the members to carry on contributing (Gillinson, 2004). Just to precise it, the term 'selective' can be understand here as artificially created by an institution. It is possible to use and to create common-pool resources without artificial selective incentives if all the members have the same knowledge about the resource and if a certain number of participants have such a high interest in that resource so they will contribute and give an input (Holtgrewe, 2000). These people and their input are the critical mass which motivates others to have a share in the common-pool resource. Here the incentives have a social, an 'artless' nature.

If the incentives to sustain Open Source projects as a commons are mostly socially produced, does it mean everything happens without economic self-interest of the developers or without any rational choice behaviour at all? Is it rational to contribute to these projects? At the first view it appears as if Open Source Software would undermine the assumptions about rational choice. But at a closer inspection there is no necessary contradiction between them. Even economic theories do not deny the possibility of non-material incentives which can attract people (Cahir, 2003). And evidently in practice no individual behaves absolutely rational within the economic sense. The self-interest as a motivation for contributing to Open Source Software is not an exotic phantom. The best evidence are the plenty of companies who drive a business strategy according to that.

That illustrates the imbalance of the assessment about the commons. In present time, where the idea of common-pool resource has been upgraded with the commons of knowledge, the evaluation has to be more complex. It takes more than an unidirectional and economical conception of man. Human acting is not only leaded by profit maximisation. A merely *Homo Oeconomicus* oriented individual does not exist. Additionally men will be stamped by other men. Everyone is playing his social roles, the human being as a social individual (*Homo Sociologicus*). That's why it is necessary to consider economical as well as social aspects of human actions. This social character created common measures and incentives which make it possible to manage a common-pool resource. In the case of Open Source Software it means technological tools will be guided by social norms, rules or even sanctions.

These norms and rules probably would not be enough to ensure a trustworthy legal basis. Licences have been constituted to give Open Source Software a juridical framework. Once again we can recognise here a difference to a classical commons where the ability to protect the resource with the help of the law was not considered as an option or it was simply impossible. There are many licences for such open projects available. The most prominent one undoubtedly is the GPL. With its clever copyleft construction it secures the character of openness for the software. That's why Lawrence Lessig described the GPL as a combination of copyright law and contract law (Lessig, 2002).

With this deliberations in mind it is very interesting to have a look at other licence models which abandon the option of copyleft. The Apache licence from the Apache Software Foundation is a well known representative. The assumption would be, if distributors of Apache software don't have to distribute the source code as well, every distributor will benefit from it without having to contribute to it. The innovation will suffer a slow-down. But distributors of software are aware about the fact that software is a long-term business. No customer will buy software if he has to be afraid about its future. Especially in the case of a webserver, like the Apache web-

server for instance. For that reason it is rational for a company to contribute and push the innovation forward if they want to earn money with it.

If a developer contributes to an Open Source project, he is not giving up any property rights on his contribution. That is the big contradiction to a public domain product. Actually he shares his intellectual product with others. And nobody can be excluded from using it. Another difference to the assumption about a classical common-pool resource appears, as there is no rivalry in consumption. The digital nature assures that overuse does not emerge. As an astonishing effect the complete opposite happens. Open Source Software has the ability to generate positive network externalities from the increasing number of users instead of suffering overuse from the increasing number.

It should be clear by now that the theory about the tragedy of the commons is not adaptable on the commons based system of Open Source Software. The economical rule, where the tragedy can be avoided if a) the commons turns into a pure public good, governed by the state, or if b) it will be transferred into private ownership, finds an exception here. Open Source Software is based on a structure where it benefits from the characteristics of public and private property while avoiding their failures. Users can be innovators at the same time - it has the quality of a collective action, rather than being a pure resource. Open Source Software does not remain stationary, it is no (scarce) resource. It is progressing all the time, more and more.

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