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Economic Governance Design for the Fab City Economy on FCOS

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Disclaimer

We understand that the development of a software infrastructure to empower a new global economic model is a complex and ambitious goal. Nevertheless, the current technological state of art has made this option feasible with the means we have at hand. This paper outlines the current concept of Fab City OS. We write this to go into proactive communications. The paper is an invitation to join us in this discourse. This document is written in the realm of Benedikt's PhD research at the professorship for Digital Markets at the University of Hamburg. So its main audience is familiar with economic theory; please excuse that we can not explain economic methodological theories and terms used here in sufficient length for normal people - meant in a positive sense ;)

Initial Remarks to shoulders upon which we run

Our highest thanks go to Sarah Bürger, without whom's honest criticism, this paper would not have emerged in the first place. The more we learn about openness, the more we admire Dr.-Ing. Tobias Redlich's work. Tobias, you are a giant - no doubt. Dr.-Ing. Martin Jäger is one of the people whose activism in the open source business world is, without a doubt, one of the key elements to our understanding of open source hardware and its documentation in the context of business. Last but not least, Niels Boeing is the person that makes the picture complete. We don't really know how much Niels has really done for this paper, except for what we see in the comments, but we are sure it is much more than we know.

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Glossary:

- FCF stands for Fab City Foundation, which embodies the leadership team of the Movement.
- When we say WE, we mean the Lead Team that is developing FCOS (which are People of the EU-Project INTERFACER)
- We use “Fab City OS” or “FCOS” for Fab City Operating System, the Product that we develop. It’s not an Operating System in the classical sense, like Microsoft Windows or the various Linux Distributions. The goal is to supply a substrate for economic activity across multiple actors, like what computer OSes are for the Software Applications they run.
- For the purpose of consistent wording, we say FCOS is a FEDERATED NETWORK (FN). Though many would call it a Platform, it’s not, because we don’t have a central controlling Organisation. But similar to a platform, without users it's irrelevant.
- FCOS RESOURCES are various uploaded data of products (CAD, CAM, BOM, PDF, JPEG, ...). We take advantage of git repos, product passports and other technologies.

Introduction

In the context of this paper, in 2022, the Fab City-Community is funded by the European Union via the project INTERFACER to develop an Operating System for Fab Cities - Fab City OS (FCOS). FCOS aims to be an essential layer of the digital infrastructure for Fab Cities and Regions. On top of FCOS, the economy of Fab Cities and Regions shall unfold in line with the Fab City vision - formulated in its whitepaper. This paper is written in order to assist in having an orientation - a compass - for the strategy, expectations and implications for that digital infrastructure (software). We understand this infrastructure as a Web3 as described by Roio (2022). The scope and perspective of this paper is rather unusual or new, which is why we give it a new name - "*Economic Governance Design*".

Economic Governance Design (EGD) is a 21st century version of Walter Eucken's *Ordnungspolitik*[1]. Eucken's basic insight is that for forming a new economy, one first needs to decide on the overall order that this new economy shall foster. Only then, Eucken argues, there will be order - meaning no chaos - in the economic system. Specifically, only if all rather detailed decisions on economic regulation have an overall "goal" (order), these decisions will be coherent (not contradict each other). Eucken developed his concept to answer what Germany's general economic order should look like after the centrally planned economy during Fascism. (see Eucken 1999) Now, confronted with an accelerating multiple crises (see Brandt 2009) and a technological revolution (see Perez 2010), the changing overall economic order poses a window of opportunity once more. We call it *Economic Governance Design*, because to a large degree it analyses the current techno-economic circumstances to identify the best - in the sense that it reduces harm of the forces at play to people and the planet - economic governance. Economic governance is a term used in transaction cost economics - e.g. Benkler (2002) - to analyse economic order. For example, a typical question in the economic governance science would be whether, in a given situation, a market or a planned economy is the better economic governance, i.e. order. We add "Design" to it, because not only do we argue for a certain economic governance arrangement, but also propose how to get there with a digital infrastructure that we call Fab City OS (FCOS).

The specific question that we want to answer with EGD in this paper is what the overall order and resulting power distribution of the economy that unfolds on top of the FCOS digital infrastructure shall be. Having a picture of this basic order, it will become possible to derive a coherent technical architecture and features as well as overall regulatory coherent implications needed to make FCOS successful.

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[1] "Ordnungspolitik" is a German word that combines the German word of order (Ordnung) with the German word for policy and/or polity (Politik).

The relation of a digital infrastructure such as FCOS and an Economic Governance of a Fab City Economy

For those not engaged with FCOS yet, it might be blurry how FCOS relates to an Economic Governance of a Fab City Economy. So in this chapter we elaborate this relation, before we continue with the methodology and guiding principles of the overall EGD. Infrastructure influences the way an economy is. Analogous to that, our hypothesis is that FCOS as an underlying digital infrastructure for a Fab City Economy guides the way economic transactions are conducted within such an economy. FCOS is being developed as an operating system upon which different end user friendly applications would operate. So for these applications to operate on FCOS, they would need to adopt its terms and conditions. Depending on the type of application, these terms and conditions are technical and non-technical. So whoever develops FCOS and sets its terms and conditions, has the power to influence the Economic Governance.

What are typical applications that operate on FCOS? First and foremost such applications that enable distributed production, including the whole value chain, from distributed design to distributed manufacturing, repair and recycling. For distributed design, there is an application utilising the Git protocol. So with FCOS, distributed design of hardware will be as easy as it is to participate in distributed software development on Github or Gitlab for example. There is different applications for different stages of the value chain of distributed production.

So with FCOS, it will become easier to participate in hardware production. A method to analyse the effect of change of threshold to participate in production is transaction cost analysis. As the example with the FCOS application for distributed design shows, the average cost of participating in production would fall dramatically. In line with Coase (1937), the higher the transaction cost, the further away the value creation is from an economic actor. Or put differently, the lower the transaction cost, the more distributed the value creation becomes. In economic science such overall economic structures are dealt with as economic governance (eg Benkler 2002). So because FCOS and its applications would influence overall transaction of production significantly, it is a legit endeavour to outline a suited economic governance, i.e. conduct Economic Governance Design.

Methodology and Guiding Principles

To argue for a certain order of the economy that shall unfold itself on top of FCOS, we set guiding principles, also with the help of economic theory. For economic governance, we utilise transaction cost economics. For a guide in terms of power distribution within institutions/networks, we use institutional economics (see Elinor Ostroms, a prominent scholar of the commons). For the price mechanism, we choose microeconomics.

One of the key methods we apply comes from Transaction Cost Economics. Transaction costs are the costs of an economic transaction. For example, these can be transportation or bargaining costs as well as fees for blockchain transactions. Once a certain level of transaction costs is reached, firms (companies) emerge. This was Ronald Coase's (1937) basic insight for his theory of the firm. The higher the transaction costs in a given economic system, the bigger the firms (companies) will be that are able to sustain/emerge in that economic system. Building on top of this, Benkler (2002) argues that when the transaction costs become extremely low, peer production emerges. For example, it does not take much to contribute to Wikipedia, meaning the transaction costs are low. Therefore Wikipedia is as powerful as it is because it is so open for everyone to contribute, meaning Wikimedia - the software under the hood of Wikipedia - provides an open infrastructure that allows peers to collaborate (do economic transactions) with low transaction costs. Therefore, to succeed **FCOS and the economy on top of it should also be open** - it should be as easy as possible to contribute.

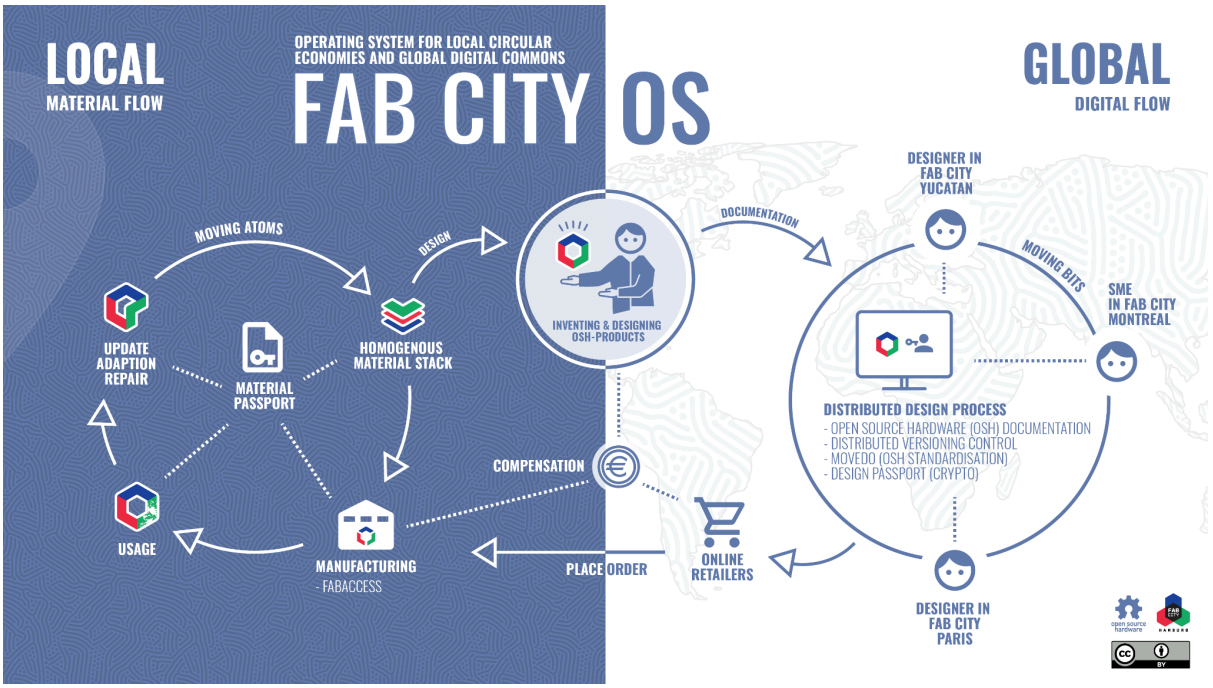
For the price mechanism, we analyse marginal costs, which are the costs that arise when producing an additional unit of a given asset/artefact/product. Thereby, we get a grounded idea on what the prices in the different realms of the economy should be. If prices are zero, there is no market, one could argue. In microeconomic theory, it is best when prices equal marginal costs. In such a theoretical situation, there are no passive rents, meaning income without effort. **Therefore, since copying (reproducing) bits (digitised information) is almost free (low marginal costs), its prices should also almost be zero**. In line with this, we adhere to the classical theory of value according to which - put simply - human labour is what determines value. So if resources are (re)produced without human labour involved, the economy on FCOS would not provide exchange value for the asset owners/producers. Because of being open source or source available (see conclusion of paragraph above), FCOS and its products reduce information asymmetry in the overall economy, which also reduces passive rents. What is more, we also state that all economic gains should be moderately balanced with effort in terms of resources and risk.

For the power distribution, we adhere to a **commons-based governance**. This means that, generally speaking, the rules of the network(s) are defined by the network(s) itself (themselves). So, principly, decisions should be made by those who are affected by them. Whenever possible and reasonable, decisions are made locally. So the **principle of subsidiarity** applies. As an overall highest goal of Fab City, we choose, achieving establishing conditions in which humans can live in dignity.

The Economic Governance of Fab Cities and Regions

For describing the economic governance in Fab Cities, we first differentiate two spheres, which is in line with the Data-in-Data out Fab City Vision:

1. The local level - meaning each Fab City or Region - material flows.
2. The global level - represented by the FCF and its bodies (collective, fc network, ...) and an FCOS development organisation which is interwoven with the FCF - digital flows.



Infographic - Fab City OS, Fab City Hamburg Association 2021

The Local Sphere

In the local sphere, we hope that each fab city or region will have a local legal entity that is controlled by the actors of the local network (Commons-governance) by law of the respective legal/regulatory system the city or region finds itself in. This can be an association or a comparable organisation that is ruled by the local community by law of the organisation's statutes (Decidim may also/alternatively play a role here - to be seen). The local legal entity shall host a FCOS node[2] upon which the local Fab City or Region's economy unfolds. Perspectively, hereby the local community can utilise FCOS as a technology governance tool to steward the local network.

[2] We currently think that other actors could host FCOS instances as well in the future. For the start though, we think it would add complexity where it is not totally necessary.

Circulating atoms locally (in Fab Cities, material flows of a circular economy) has significantly higher marginal costs then circulating/reproducing/copying bits has. Therefore, the economic governance on the local level is one where economic transactions are not executed for free, but people shall be able to make a living from it. For example, the effort a manufacturer has for manufacturing a product - even if its design was sourced for free - is worth being compensated by the customer.

On the local level, FCOS does not enable peer production, because the transaction costs can not be reduced sufficiently in the foreseeable timeframe. So on the local level, the economy that shall unfold on top of FCOS is a local market and circular economy that is enabled - only possible because it is fed - by a global digital commons. We therefore call the economic governance in the local sphere a commons-enabled market and circular economy. Still, as the tools of and access to digital fabrication develop(s), also the transaction and marginal costs of production on top of FCOS decrease. So in the very long run, we have hope to also see commons-based peer production in the local realm.

The Global Sphere

In the global sphere, the existing Fab City network can be understood as a federation of Fab Cities and Regions. There is no single entity in Fab Cities that controls everything. FCOS reflects this; it is/builds a federated software network. Each Fab City and Region shall host its own FCOS node/instance and thereby be sovereign over the data it needs to produce locally. So there is not a single entity controlling FCOS - which is different from big tech.

The digital resources - shared and co-produced in and by the global federated network of FCOS nodes - are understood as a digital commons. The economic governance in the global realm in the medium term can therefore be described as commons-based peer production (compare with Benkler 2002; Benkler 2006; see Glossary of the commons, 2022). There will never be 100 % peer production, where all prices are equal to zero, but its share will increase with network size and density.

From Product-in-Trash-Out to Data-in-Data-out, Fab City Foundation, 20xx

Actors of the Fab City Economy

Following Benkler (2002), we see transaction costs (transportation costs, negotiation costs, information gathering costs, ...) as a main factor in economic governance. The lower the transaction costs, the smaller the economic actors can be that are able to sustain economically. FCOS aims to decrease transaction costs of a circular economy significantly, which is why big corporations are out of our scope. The users of FCOS are peers, small and medium-sized organisations (SMEs and legal entities representing local Fab Cities and Regions, Fab Labs) and those who are interested in connecting with the FCOS API (e.g. Local Marketplaces).

We categorise the users of FCOS into five categories:

1) Fab Cities and Regions - B2B relation for us
2) Fab Labs, Designers, Manufacturers, After-Manufacturers and SMEs - B2B/B2C
3) End Product Customer - B2B2C
4) Fab Marketplace Providers - B2B
5) FCOS App Developers/OSS-Developers - B2B

The institutional setting for developing, maintaining and providing FCOS as the digital infrastructure of the Fab City economy are:

- Local Fab City's (Region's) Associations: Governing and providing a local Fab City Node is also resource intensive and shall eventually be compensated with sales on FCOS.

- The Fab City Foundation (FCF): the FCF owns the Fab City brand and ultimately decides on who and what is part of the overall Fab City network.

- As it is the basic idea of Fab Labs and Fab Cities to reduce access barriers for participation in production, the FCOS code base is a common pool resource, i.e. transaction costs are reduced as much as possible. Theoretically, there could be one FCOS development organisation to develop, maintain and promote FCOS, but it can also be a multitude of organisations or individual developers contributing to the code base. Compliance with local regulation and book keeping of financial and other transactions are an argument for centralization. Numerous scandals in the context of crypto exchanges and its effects on trust in the respective economy give reason for the FCF to ensure reliability and trustworthiness of the one or more organisations providing the “back-office” infrastructure. A main task is to find appropriate partners to delegate the handling of money flows. Developing and maintaining FCOS software as well as offering support for it, requires ressources. So the seed financing needs to come from separated funding.

- If FCOS holds what it promises, then it is legit to fund this development, maintenance and support through financial cuts (win-win). Here, it should be tried to reach the principle of marginal costs equaling the price, meaning that we want to avoid passive rent. Pricing and budget of the FCOS development should be transparent to the global network. The FCOS development should be non-profit. The brand *FCOS* should be based on an agreement with the FCF. The agreement should make sure that FCOS always stays connected to the FC Values, controlled by the FCF.

The Price Mechanism

The global network and the local network each have efforts that are worth being compensated for. These efforts are made transparent in budgets - probably annually. The respective controlling/supervising entity has agency over the budget. Once the budget is confirmed, the respective sales for that time period are estimated. Then a share per sales on FCOS is calculated that is added to/subtracted from the prices to gain the budget needed to provide, develop and maintain FCOS.

In line with the data-in-data out model, (digitised information) bits circulate globally and (materials) atoms circulate locally. As stated before, the event of circulating bits around the globe themselves via the internet is almost free, its marginal costs are almost zero. But in the context of FCOS, gaining the information in the first place, that is then digitised, is significantly more resource/effort intensive. For the price policy, this means that after the

initial effort and an appropriate margin are compensated for, digital resources will be free (price) and open (undisclosed and unrestricted) for economic use. So one can make a living from it, but probably won't become a millionaire with one day of work (can vary from city to city - details TBD). Put differently, one could possibly generate a need based income depending on the place of residence.

However, many digital resources require maintenance, which is itself an effort and tendentially legitimate to be compensated. Still, with a growing size and density of the network, the time until the initial investment and an appropriate margin are compensated for, decreases. In the medium term, FCOS aims to be adopted worldwide, which would be a huge network. Therefore, in the medium term, almost all digital resources - or the global realm - on FCOS will be free and open for economic utilisation/use.

The prices for the end product customers are determined in the local markets. For example, a local e-commerce shop connects with the FCOS API, fetches product documentation (digital asset) and promotes it as a product to the local market. Then the “Fab Market Place”[3], which is the infrastructure for the local market to operate, determines the price. The original designers/developers of the documentation only determine shares of the repository that is promoted in different markets across the globe.

Conclusion

To conclude, in this paper we have aimed to propose an economic governance for the economy of Fab Cities and Regions. We have done so to establish reasons, a direction and order for the development as well as outline possible implications of the deployment of Fab City OS, the digital infrastructure upon which that economy shall unfold. Specifically, the economic governance of Fab Cities and Regions is to be differentiated between a local physical realm and a global digital realm. In the global digital realm, we see a realistic chance for commons-based peer production to become the dominant economic governance model in the middle term. We have argued for this twofold. 1) because the essential economic transaction here is copying digital resources which have near zero marginal costs and should therefore be almost free. 2) The technology at hand with FCOS enables a significant reduction of transaction costs which enables smaller economic actors to sustain and/or emerge. A precondition for Commons-based peer production in the global realm are better and more accessible digital and physical tools for digital design and fabrication as well as high network effects through a large and dense network of FCOS users.
In the local physical realm, we argue for a commons-enabled circular market economy to be the best economic governance. Analogous to the arguments above, we say that 1) because the economy in the local realm can only be a lot more physical, its marginal costs have to be

[3] “Fab Market Place” is the name for a specific software that can be integrated into FCOS Core. It is a headless e-commerce shop that enables to subscribe and, or publish to/from designs (OSHD) of the Fab City OS federated network (digital commons).

higher and ergo higher prices are legitimate from a microeconomic perspective. 2) The transaction costs will be significantly higher than in the global realm, because more effort is involved in producing goods locally by people and physical machinery than in sharing software worldwide.
Based on this insight on the economic governance of the Fab Cities and Regions Economy, we have categorised and briefly outlined the different economic actors and uses of it. We propose a structure that reflects the differentiation of the Fab City governance spheres into a local and a global level. Having the means at hand to actually develop Fab City OS, to develop, maintain and promote Fab City OS as the digital infrastructure upon which the described economy of Fab Cities and Regions shall flourish.

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There may be other references missing due to a copy-paste mistake … will be added later

Notes:
- add terminology “market place” from softw architecture

→headless e-commerce
→there is headless pub/sub ecommerce that can be integrated to fcos core
- highlight degressive pricing /fab share/ scheme to avoid passive rents
- add reference to eleanor ostroms work
- Carlo Vercellone: document jaromil hints at → not only intangible, but also tangible.
- From Bob

- “From the explanations of institutional economics cited above, it should be clear that institutionalists contradict marginal costs and similar price mechanisms. In fact, one of the well-known institutionalist papers is entitled “Redefining economics: from market allocation to social provisioning”.
- Institutional economists would observe and analyze the economic networks of FabCity and very probably (as suggested in the Strategic Collaboration level of supply chain integration) share some risks and rewards, for example, rewarding designers even though marginal cost theory might say otherwise.
- Likewise, the overall goals and network designs of FabCity are very consistent with institutional economics, with their circular glocal economy principles, while microeconomics would advise self-interested agents who pass their externalities off to their communities (the indivisible foot accompanying the invisible hand)."