



The impact of Open Source Software and Hardware on technological independence, competitiveness and innovation in the EU economy

EXECUTIVE SUMMARY

Knut Blind
Mirko Böhm
Paula Grzegorzewska
Andrew Katz
Sachiko Muto
Sivan Pätsch
Torben Schubert



Internal identification

Contract number: LC-01346583
SMART 2019/0011

EUROPEAN COMMISSION

Directorate-General for Communications Networks, Content and Technology
Directorate E — Future Networks
Unit E2 — Cloud and Software

Contact: CNECT-E2 @ec.europa.eu

*European Commission
B-1049 Brussels*

The impact of Open Source Software and Hardware on technological independence, competitiveness and innovation in the EU economy

EXECUTIVE SUMMARY

***EUROPE DIRECT is a service to help you find answers
to your questions about the European Union***

Freephone number (*):
00 800 6 7 8 9 10 11

(*) The information given is free, as are most calls (though some operators, phone boxes or hotels may charge you)

LEGAL NOTICE

This document has been prepared for the European Commission however it reflects the views only of the authors, and the European Commission is not liable for any consequence stemming from the reuse of this publication. The Commission does not guarantee the accuracy of the data included in this study. More information on the European Union is available on the Internet (<http://www.europa.eu>).

PDF

ISBN 978-92-76-30983-3

doi: 10.2759/526721

KK-04-21-081-EN-N

Manuscript completed in May 2021

1st edition.

The European Commission is not liable for any consequence stemming from the reuse of this publication.

Luxembourg: Publications Office of the European Union, 2021

© European Union, 2021



The reuse policy of European Commission documents is implemented by the Commission Decision 2011/833/EU of 12 December 2011 on the reuse of Commission documents (OJ L 330, 14.12.2011, p. 39). Except otherwise noted, the reuse of this document is authorised under a Creative Commons Attribution 4.0 International (CC-BY 4.0) licence (<https://creativecommons.org/licenses/by/4.0/>). This means that reuse is allowed provided appropriate credit is given and any changes are indicated.

For any use or reproduction of elements that are not owned by the European Union, permission may need to be sought directly from the respective rightholders.

Abstract

This study analyses the economic impact of Open Source Software (OSS) and Hardware (OSH) on the European economy. It was commissioned by the European Commission's DG CONNECT.

It is estimated that companies located in the EU invested around €1 billion in OSS in 2018, which resulted in an impact on the European economy of between €65 and €95 billion. The analysis estimates a cost-benefit ratio of above 1:4 and predicts that an increase of 10% of OSS contributions would annually generate an additional 0.4% to 0.6% GDP as well as more than 600 additional ICT start-ups in the EU. Case studies reveal that by procuring OSS instead of proprietary software, the public sector could reduce the total cost of ownership, avoid vendor lock-in and thus increase its digital autonomy. The study also contains an analysis of existing public policy actions in Europe and around the world.

The scale of Europe's institutional capacity related to OSS, however, is disproportionately smaller than the scale of the value created by OSS. The study therefore gives a number of specific public policy recommendations aimed at achieving a digitally autonomous public sector, open R&D enabling European growth and a digitised and internally competitive industry.

Executive Summary

a. Introduction

This study was commissioned by the European Commission's DG CONNECT to analyse the economic impact of Open Source Software and Hardware on the European economy. It provides a comprehensive picture of the current commercial uses, costs and benefits of Open Source Software (OSS), and global policy efforts to utilise and magnify the benefits of using OSS. On the basis of this information, the study assesses the potential for the European Union (EU) to achieve its policy goals (including economic growth, greater competitiveness, innovation, and job creation) through the use, promotion and support of OSS and of Open Source Hardware (OSH).

The study involved the review of relevant literature, the performance of several case studies and statistical analyses, and a detailed survey among a representative sample of companies and developers. A strong consistency was observed between the data provided by the various sources consulted, and the data collected specifically for the study.

b. Econometric Analysis Insights

EU OSS developers (solo developers, academics, government personnel and employees) contribute significantly to the global OSS ecosystem. In the EU, it is employees of small and very small businesses that are most likely to contribute OSS code ("commits") whereas in the US commits are mostly made by large ICT companies, which base their relevant business models successfully on the large body of freely available and continuously improving OSS code.

Based on public domain information, companies located in the EU invested some €1 billion in OSS in 2018. The study concludes that the OSS pool contributes significantly to the EU's GDP, and that an increase of 10% in contributions would generate between 0.4% and 0.6% additional EU GDP per year. The study also concludes that an increase of 10% would generate more than 600 additional ICT start-ups per year in the EU. Case studies revealed that by procuring OSS instead of proprietary software, the public sector could not only reduce the total cost of ownership but could also reduce or prevent vendor lock-in. Overall, the benefits of Open Source greatly outweigh the costs associated with it. These benefits relate mainly to openness (including standards and independence) and labour cost savings rather than to additional revenue generation.

Econometric time series analysis of EU Member State GDP data indicates that in 2018, across all Member States, the economic impact of OSS was between €65 and €95 billion. Individual contributors numbered at least 260,000, representing 8% of the almost 3.1 million EU employees in the computer programming sector in 2018. In total, the more than 30 million commits in 2018 from EU Member States represent a personnel investment (based on full-time equivalents) equal to almost €1 billion, and the results of this investment are available in the public domain and therefore do not have to be developed by others again.

The data indicate that the smaller the company, the greater the relative investment in OSS (companies with 50 or fewer employees made almost half of the commits in our sample of the most active companies in OSS). Although more than 50% of contributors are from the ICT industry (8% of all employees participated in OSS development EU-wide), there was also strong involvement from professional, scientific and technical companies and, to a lesser extent, from wholesale, retail and financial companies.

On a cumulative basis, the study estimates that, up to 2018, the contribution of OSS to EU GDP, and contributions of EU employees to OSS, yield a cost-benefit ratio of slightly above 1:10. After taking into account hardware and other capital costs of the 260,000 EU contributors to OSS, the cost-benefit ratio is still slightly above 1:4.

c. Survey Insights

More than 900 companies and developers responded and approximately 100 replied to all the questions, which focussed on information about cost and benefits in areas not well covered in previous OSS research. Almost 25% of respondents were software development companies, and another 10% individual developers. A further 40% of company respondents produced components, final goods or services, or were platform providers, systems integrators or network operators. Only a small number of respondents meaningfully participated in OSH development. Start-up companies were strongly represented. Among the survey respondents, micro companies including start-ups make disproportionately significant contributions to, and investments in, OSS, both in absolute terms and relative to their size. Several small and micro companies reported that more than half of their revenues were attributable to OSS, and particularly OSS related services. Respondents (and particularly small and micro respondents) also reported a high percentage of innovation-related expenses, and almost 50% of their OSS contributions related to internal product development and another 40% to already existing OSS. Respondents rarely filed patents in relation to their public code contributions, but did find alternative ways to protect their intellectual property.

Motivations to participate in OSS, in order of priority, were: Finding technical solutions, avoiding vendor lock-in, carrying forward the state of the art of technology, developing high quality code, knowledge seeking, and knowledge creation. Personal interests of individual participants were also important. Accessing new markets and customers via contributions to OSS were not significant incentives. However, cost saving was an important motivation, through lowering internal maintenance efforts, gaining access to royalty-free code, and increasing returns on R&D investment. Other above-average motivations included: the establishment of networks, development of non-differentiating features (e.g., commonly used libraries) and enhancing reputation. Respondents using OSS and contributing code to OSS projects identified supporting open standards and interoperability as generating the highest benefits, with the benefits being indirect and arising through network externalities rather than from direct revenues. Respondents also assigned above medium importance to: access to source code, reduced expenditure, avoidance of vendor lock-in, access to an active community for knowledge exchange, the innovation fostering effect of participation, and enhancement of security and quality.

In terms of their own assessment of overall cost-benefit ratios, one third of respondents perceived very high benefits and low costs, and more than another third either very high benefits and medium costs or at least high benefits and low costs, with the most cited value being 1:10, followed by 1:5. For comparison, taking non-personnel costs (e.g., hardware) into account, the study estimates a cost-benefit ratio of 1:4 based on econometric based benefits.

d. Case Study Insights

To address the lack of data, in particular on OSH, from both the literature and our survey, five case studies were conducted on community development of Open Source Software

and Hardware (OSSH), which can lower barriers to participation, enable experimentation and contribute to development of de facto standards. Foundations are a significant driver in the OSS and OSH ecosystems, providing a number of important services, such as standardisation, knowledge transfer and project management. Businesses participate in foundations to engage deeper with the OSSH community, not merely as technology consumers but also as key contributors and stewards. However, while several OSS and OSH projects (some with public funding) are headquartered in the EU, participation is not limited to EU individuals or companies. Participation correlates with company size and thus many participating companies are large US-based enterprises using OSS for their platform based business models. Thus it is difficult clearly to distinguish European OSS or OSH projects. It is also too early in most cases to assess benefits, as the OSH discipline is still emerging, with product development yet to come. However, the cases did reveal that both OSS and OSH ecosystems are highly and efficiently integrated with some overlaps, e.g., software support for OSH. The qualitative insights from case studies are used as a basis for the analysis of the strengths, weaknesses, opportunities and threats (SWOT) for the EU.

e. Policy Analysis

The study reviewed the scope, effectiveness and impact of governments' public and private sector policies relating to OSS in a number of EU Member States (Bulgaria, France, Germany, Italy, Poland and Spain) and other countries, in Europe (the UK), the Americas (the US and Brazil) and Asia (China, Japan, India and South Korea). The study used both qualitative and quantitative methods. The review revealed significant differences of scope and purpose between geographies. Finally, creating and implementing effective OSS and OSH policies remains challenging.

Overall, four main motivations were found, with changing emphasis over time: (i) cost savings; (ii) switching costs and network effects; (iii) underproduction of public goods; and (iv) market competition and technology neutrality. The study also identified two main waves of OSS government support, the first starting in the early 2000s and the second in the mid-2010s. Both these waves were driven by different narratives.

Public sector policies aim either to improve competence regarding Open Source and optimise results within the public sector, or to favour OSS over proprietary software in public procurement. Such policies have different scopes, implementation mechanisms and levels of prescriptiveness, ranging from binding laws to simple norms. Private sector policy actions are more varied. They include guidance and support for OSS. Some governments impose or influence industrial policy to produce innovation through OSS, while others work with universities to foster OSS training and development, or reach out directly to support the creation, or support, of OSS communities. Governments can also directly fund or certify Open Source projects to achieve policy goals.

Broadly speaking, government policies in Europe and the Americas focus on the public sector, while governments in Asia tend to focus on the private sector. A majority of surveyed EU Member States and other countries in Europe have formal policies on OS at the national level - in most cases, an OSS public procurement policy. Overall, the study found that public sector OSS policies were often not successful, even in the case of public procurement. The only truly convincing implementations occurred where Open Source has become a core component of a digital shift and thus ingrained in the digital culture of the administration. Laws requiring the development and reuse of OSS within the public sector were also

generally not successful, often due to the absence of concrete implementation guidance. In the countries which today have increased software capabilities in the private sector (i.e., South Korea and China), Open Source has played an important role in industrial policy. European governments have taken a more laissez-faire approach and today, the EU is on the back foot when it comes to capabilities in this area. The success in the private sector is related to economic incentives associated with Open Source playing a smaller role in the public sector.

With respect to OSH, there are significant differences from OSS, because: the potential market for OSS solutions is far broader than for OSH, funding OSS-based start-ups may often be less expensive than for those based on OSH, and a greater degree of management sophistication is needed to launch many OSH businesses. And it remains to be seen whether industry will find an open approach to hardware to be as appealing as it has in the case of software. The return on investment of public funds with respect to OSH is therefore both more speculative and likely to be narrower than would be the case with OSS.

Finally, current events provide a window of opportunity for EU leadership and commitment to yield disproportionate results. OSS foundations and standards developers have relocated to the EU as a result of recent trade conflicts. The history of neutrality represented by non-governmental entities headquartered in the EU therefore provides an appealing solution to a problem that is likely to persist regardless of policy changes elsewhere.

f. Policy Recommendations

Based on the results of our empirical analyses, the following recommendations are derived.

A digitally autonomous public sector

Building Institutional Capacity

- It is recommended to create a Commission-funded network of up to 20 OSPOs (Open Source Project Offices) intended to support and accelerate the consumption, creation, and application of open technologies.

Creation of Legitimacy

- It is recommended to promote digital autonomy and technological sovereignty via Open Source.
- It is recommended to integrate OSS and its communities not only into European research and innovation policies, but also into general policy frameworks, such as the European Green Deal and European industrial strategy. Engaging with OSSH foundations in research and innovation programmes may offer a suitable approach to manage funding and support.
- It is recommended to evaluate options for direct contributions to OSS.
- It is recommended to reference the Open Source Initiative's Open Source Definition when legislating on Open Source.

Strategic Intelligence

- It is recommended to integrate Open Source in Eurostat's data collection activities and into EU benchmarking activities.
- It is recommended to expand the Open Source Observatory by components of strategic intelligence.

Open R&D enabling European growth

Knowledge Creation

- It is recommended to provide more R&D funding related to OSS and OSH projects through existing programmes, such as Horizon Europe, and new initiatives, in particular targeting SMEs or even microenterprises and start-ups, as well as individual developers; this funding should focus on EU-specific goals, such as the European Green Deal and European industrial strategy.
- It is recommended to launch research awards and prizes for OSS and OSH communities, students, and professors.

Knowledge Diffusion and Networking

- It is recommended to provide strong incentives for uploading code generated in publicly funded R&D projects in publicly accessible EU-based OSSH repositories.
- It is recommended to support the development and maintenance of platforms and depositories, as well as networks hosted in the EU. Expanding the remit of the current Open Source Observatory could be a starting point.

Entrepreneurial Activities

- It is recommended that the Higher Education Institutions in the Member States should provide entrepreneurial skills facilitating OSSH based start-ups, e.g., in the various Master programmes on entrepreneurship, as well as in ICT studies.
- It is recommended to support OSS and OSH foundations by providing financial support, e.g., for their education programmes and for their collaborations with companies, in particular SMEs and start-ups.

Human Capital Development

- It is recommended to include OSS and OSH as topics into the European Qualifications Framework (EQF).
- It is recommended that national organisations which are responsible for education should promote the inclusion of Open Source (development, business models and licensing) in the programmes of their HEIs.
- It is recommended to provide incentives for Higher Education Institutions (HEIs) and Public Research Organisations (PROs) and business schools to offer specific OSSH-focused management courses, e.g., as mini MBAs.
- It is recommended to develop an EU Certification Scheme for individuals who have developed Open Source skills in particular fields.
- It is recommended that the EU should increase the diversity of Open Source contributors, starting with a research project.

A digitised and internationally competitive industry

Financial Capital Development

- It is recommended that OSSH contributions from both individuals and corporations should be treated as charitable donations for tax purposes.
- It is recommended to continue the Enhanced European Innovation Council (EIC) (including the EIC Accelerator) programme and explicitly open it to applications from young, high-risk, R&D-intensive OSSH-based entrepreneurs, in order to address the lack of venture capital in the European small business ecosystem.
- It is recommended to launch financing instruments, like focused Venture Capital funds, that help newly funded OSSH-based start-ups to team up with established companies.

- It is recommended to fully exploit the potential synergies between pre-commercial procurement and OSSH in a more strategic and systemic way.

Regulatory Environment

- It is recommended to clarify the liability for individual developers of OSSH.
- It is recommended to fund security audits of critical OSS projects requiring specific security-improving changes with public resources.
- It is recommended to promote OSS in addition to standardisation as a further channel of knowledge and technology transfer, e.g., as an explicit dissemination channel for Horizon Europe projects.
- It is recommended to improve the inclusion of OSS in public procurement, e.g., in directives or strategies, taking into account the needs of OSS-based SMEs.
- It is recommended to consider Open Source in future revisions of European copyright and patent legislation.
- It is recommended to consider the interrelationship between OSS (as well as OSH and open data) in related policy initiatives.

Market Creation

- It is recommended to consider Open Source explicitly in competition and platform policies, e.g., relating to the governance of Open Source communities.
- It is recommended to consider Open Source explicitly in SME policies.

Open Source Hardware specific recommendations

- It is recommended to fund a project to develop innovative regulatory mechanisms for Open Source Hardware, such as the approaches being considered in relation to white space spectrum deployment.
- It is recommended to fund the development of centres of excellence in the area of Open Source Hardware consisting of partnerships between academia, research institutions and the private sector.

Domain specific recommendations

- It is recommended to provide funding opportunities for OSS developers and companies related to Artificial Intelligence.
- It is recommended to consider OSS explicitly in the EU's future AI strategies.
- It is recommended to launch a standard request (mandate) to the European standardisation bodies to develop a European standard for a bitstream format for Field Programmable Gate Arrays (FPGAs).

Sustainability

- It is recommended to establish a right to repair, including the right to software changes once the manufacturer ends device support, because OSSH contributes to sustainability by extending the life cycle of devices, enabling reuse of components and reducing duplicate development effort.
- It is recommended that additional funding or incentives be applied in support of OSS and OSH projects, if they provide supplemental green benefits.

GETTING IN TOUCH WITH THE EU

In person

All over the European Union there are hundreds of Europe Direct information centres. You can find the address of the centre nearest you at: https://europa.eu/european-union/contact_en

On the phone or by email

Europe Direct is a service that answers your questions about the European Union. You can contact this service:

- by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),
- at the following standard number: +32 22999696 or
- by email via: https://europa.eu/european-union/contact_en

FINDING INFORMATION ABOUT THE EU

Online

Information about the European Union in all the official languages of the EU is available on the Europa website at: https://europa.eu/european-union/index_en

EU publications

You can download or order free and priced EU publications at: <https://publications.europa.eu/en/publications>. Multiple copies of free publications may be obtained by contacting Europe Direct or your local information centre (see https://europa.eu/european-union/contact_en).

EU law and related documents

For access to legal information from the EU, including all EU law since 1952 in all the official language versions, go to EUR-Lex at: <http://eur-lex.europa.eu>

Open data from the EU

The EU Open Data Portal (<http://data.europa.eu/euodp/en>) provides access to datasets from the EU. Data can be downloaded and reused for free, for both commercial and non-commercial purposes.



Publications Office
of the European Union

doi: 10.2759/526721
ISBN: 978-92-76-30983-3