Dipartimento di
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Quality, Cost, and Governance of Open Source Software

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Common beliefs on OS software

Belief	Rationale
OS has higher quality	• More open governance mechanisms are beneficial to quality, since: – Lower pressure from deadlines – Greater motivation of developers – Virtual coordination among developers through code structure
OS has lower costs	• More open governance mechanisms also reduce costs, since: – Development is voluntary/unpaid – Higher quality reduces development costs – Costs are shared

A few legitimate common concerns…

Most developers are paid

Most of the costs are often accounted to a single company

Distributed coordination is more challenging and cumbersome

Less formal governance may not force quality control explicitly

Consolidated knowledge on quality in closed source traditional software

Evidence	Explanation
Quality is an investment	• Quality involves a cost in the short term • A higher-quality software involves lower maintenance costs over time
Quality decreases over time	• Each maintenance intervention decreases software quality, unless companies invest in quality
Quality degradation causes software replacement or refactoring	• Deadlines and pressure from customers make companies favor a short-term view • Companies do not invest in quality • Software maintenance costs soar to the point of making replacement (or refactoring) economically convenient • No evidence of the long-term benefits of quality

Consolidated knowledge on costs in closed source traditional software

Evidence	Explanation
Formal governance reduces costs	• Objectives are clearly stated • Management optimizes job allocation • Decisions are centralized and faster
Distributed and informal coordination favor creativity and innovation but are more costly	• Face-to-face meetings are rare, therefore self-training and problem solving are slower • Decisions based on “consensus” are slower • Less formal roadmaps, deadlines, and schedules may translate into lower efficiency due to a lack of planning

Research questions

Does Open Source cost more or less than proprietary software?

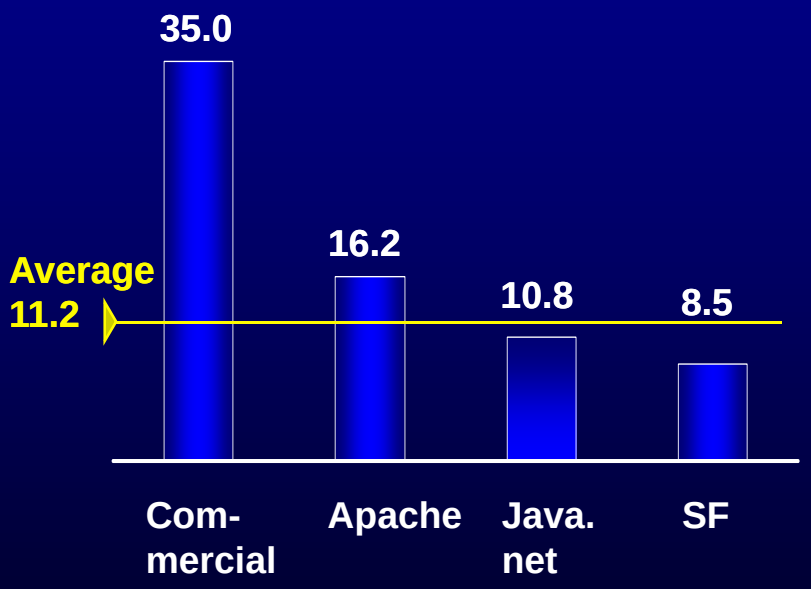
Is the quality of Open Source higher than that of proprietary software?

What are the real advantages of Open Source?

Cost metric

Time spent by developers on OS projects

Hours/ week



Source: survey of 3.346 developers and administrators involved in 268 different OS projects

Development effort = $(\alpha \cdot N \cdot \Delta T) / \Delta M$

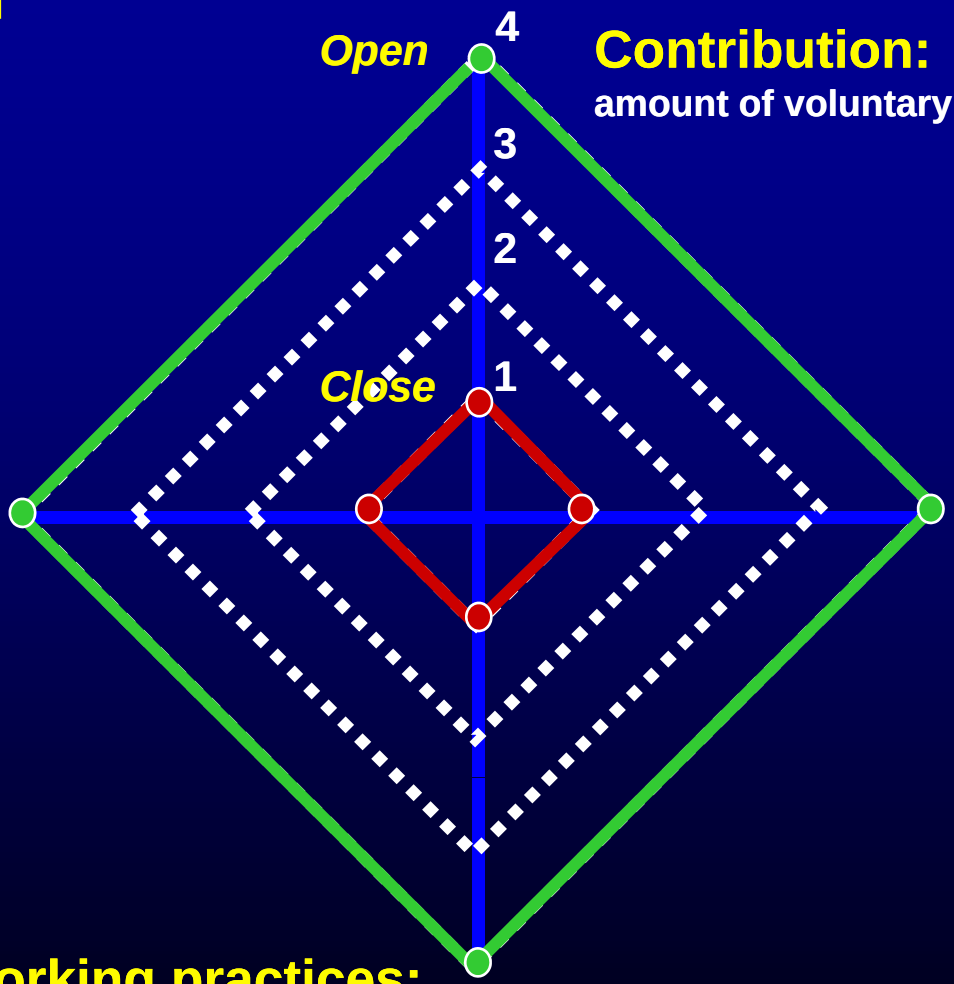
- α = percentage of time that each developer/ administrator spends on an application
- N = number of developers + number of administrators
- ΔT = time between the release of two subsequent application versions
- ΔM = number of new methods

Quality metrics

Standard code-based metrics measured with an ad-hoc tool

Metric	Definition	Average values Apache	SF	Java	Average
Coupling Between Objects (CBO)	• Number of distinct classes to which a given class is coupled (excl. inheritance relationships)	• 4.5	• 3.3	• 4.3	• 4.3
Coupling Factor (COF)	• Number of relations in pairwise sets of classes	• 0.011	• 0.018	• 0.017	• 0.013
Weighted Methods per Class (WMC)	• Weighted method complexity for a class	• 9.2	• 13.6	• 8.6	• 10.4
Depth of Inheritance Tree (DIT)	• Maximum depth of the inheritance graph of each class	• 0.6	• 0.3	• 0.9	• 0.5
Number Of Children (NOC)	• Number of immediate subclasses of a given class	• 0.4	• 0.3	• 0.3	• 0.3

The continuum between open and closed source projects along the governance dimension



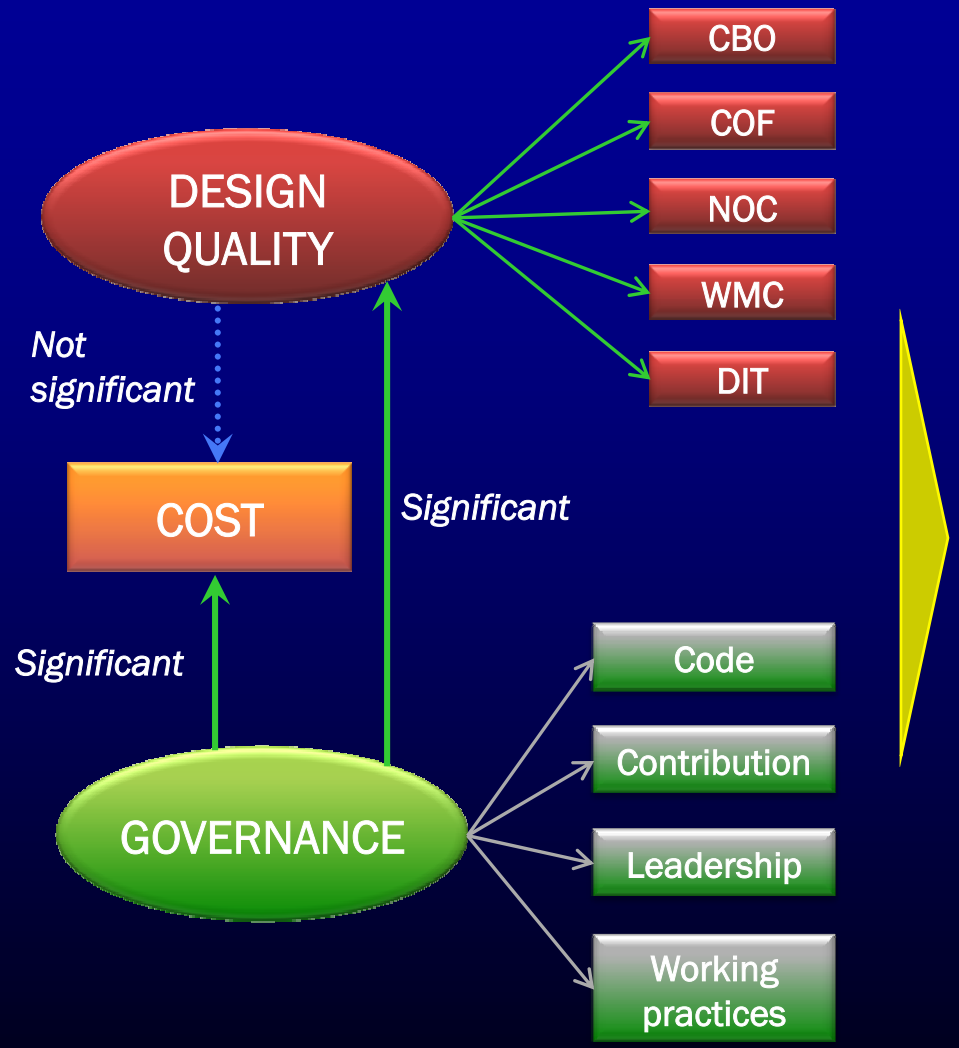
Contribution:
amount of voluntary code development

Code:
percentage of code that is available under an OS license

Project Leadership:
degree to which the leadership of a project is hierarchical

Working practices:
degree to which the working and communication practices of a project are geographically distributed and virtual

Correlation model



Results

- A more open governance is correlated with higher quality
- A more open governance is correlated with higher costs
- Quality is not correlated with costs

Observations

- Refactoring is continuous in OS projects (40% of new versions have higher quality with respect to the previous version)
- The long-term balance of quality investments is neither positive nor negative: quality is a zero-sum game
- Quality is necessary to operate with an open approach
- Quality metrics cannot be taken as predictors of maintenance effort in OS projects
- Quality does not translate into savings
- Effort is partly due to the coordination overhead

Why should companies adopt the OS development model?

- Quality is higher and visible to the community
- Feedback from the community is faster, richer, and more constructive (all types of feedback, on code, requirements, bugs, documentation)
- Contribution is from a broader community: faster and cheaper internationalization through business networking, especially for system software
- New marketing medium through word of mouth within communities
- OS image can help adoption, especially in industries where regulation promotes OS as a standard

…OS is not cheaper

Why should companies adopt OS software?

- Design quality is higher
- The community helps select the best software solutions
- The community supports users through forums, mailing lists, wikis, etc.
- OS promotes interoperable standards that can help cooperation, especially across companies
- Depending on the governance model, users can play a more active role in the definition of the requirements for new functionalities
- Depending on the governance model, TCO can be lower