OPEN VERSUS CLOSED: SYSTEMS AND SOFTWARE

High-tech industries feature a mix of open and closed systems. Understanding their differences is challenging, in part, because these terms are not binary. Apple's operating system, iOS, is *closed*, but Apple has invited thousands of parties to offer products and services inside its ecosystem. Samsung, which uses the *open* Android system, touts its version of Android (the Galaxy Operating System). Both smart phone manufacturers discourage the use of outside payment systems.

Similar distinctions – and ambiguities – apply to software. Open-source software (OSS) is source code that is released under a license in which the copyright holder grants users, sometimes conditional on certification, the rights to study, change, and distribute codes to others.[1] By contrast, other software is proprietary, i.e., closed. Owners of the software may license the software to others and may collaborate with users, but only the owner can change the software and offer upgrades.

The main objective of this mini brief is to explain why, in the context of dynamic industries, open systems develop and, in some cases, compete alongside closed systems.

Economists Josh Lerner and Jean Tirole (2014 Nobel Prize) posed these puzzles about OSS.[2] One, why would innovators, like Linux Red Hat and more recently OpenAI, develop valuable intellectual property and then let others change it? Two, why would thousands of programmers in diverse settings contribute to code that resides in the public domain? Three, why would their employers want them to do so?

The answers are that participants in the development of OSS benefit privately from on ongoing innovations by others. Any given innovation becomes a potential complement to another, thereby fostering more innovation. Jean Geanakoplos, a Yale economist, and co-authors describe these dynamics "strategic complementarities."[2]

OSS and open systems may remind you of ecosystems in which observing one activity may lead to the development of complements and substitute. Importantly, even in the context of open systems, participants may try to charge others for the innovations. While it is sometimes claimed that these systems are rules-based,[3] parties seeking to monetize will often find ways to do so.

To the extent that owners monetize their innovations, it again suggests that the differences between open and closed systems are less than what the terms suggest. Of note, Microsoft invested $10B in Open AI and has a 49 percent share of this for-profit enterprise. At the same time, Open AI has

[1] The Open Source Initiative, a non-profit organization, set forth ten criteria for open-source software.
[2] J. Bulow, J. Geanakoplos, and P. Klemperer (1985), "Multimarket oligopoly: strategic substitutes and strategic complements." *Journal of Political Economy* 93, pp. 488-511.
[3] Josh Lerner and Jean Tirole, "The Economics of Technology Sharing: Open Source and Beyond," *Journal of Economic Perspectives*, (pp. 99-120)

a non-profit foundation. (One might ask, what innovations go into the for-profit entity and which go into the non-profit entity?)

The opposite of OSS is *proprietary software*. The publisher retains the intellectual property (IP) rights, usually in the form of copyrights on source code. Hence, owners control access to, and revisions of, the code.[4] STATA, for example, is a statistical software used by economists, political scientists, and sociologists. It was created by William Gould and StataCorp in 1985, and is available for Windows, macOS and Linux. Stata Corp. regularly releases updates and patches, provides online support 24/7, distributes tutorials, and publishes its own journal.

Just as open and closed systems compete in the context of smart phones and payment systems, it is noteworthy that OSS and proprietary software often compete with each other. "R" is an open-source competitor to STATA. "R" was created by academics at the University of Auckland in 1993. (You can download it here.) Users from all around the world create new packages and share them with others.

Similarly, Microsoft Windows is proprietary, but Linux (Ubuntu, Debian) are open-source. Most survey design software is proprietary (Google Forms, SurveyMonkey, Qualtrics), though LimeSurvey and Typeform are open source. Microsoft Word has always been proprietary.

Could open-source rivals such as Apache OpenOffice and LibreOffice ever displace Microsoft Windows?

Why might a company choose to spend resources on creating software only to release it (and its source) for free? One reason might be market penetration. In 2008, Google released Android, a mobile operating system that as early as 2011 became (and still is) the best-selling OS worldwide for smartphones and tablets. Smartphone manufacturers who would need years to develop their own OS instead pre-installed Google's software on their new devices, thus contributing to its swift development. Piggybacking on that work, Google then developed a *proprietary* version of Android that included additional core apps such as Google Play, Google Chrome, but also system-level software such as Google Mobile Services. In 2024 the Android ecosystem is maturing but still very active, with tens of thousands of developers developing new apps. Android has also been adopted to other devices: projectors, smart TVs, smart monitors, smart home devices, video game consols, payment terminals, in-flight entertainment systems, and more – all contributing to Google's monetary success.

In the AI boom, LLaMA (an LLM developed by Meta) has been released largely as an open-source software – in stark contrast to OpenAI's ChatGPT, which source is closed and a closely guarded trade secret.

[4] A student license in the US costs between $94 and $375 annually, a business license costs about $1,000, while larger organizations such as universities negotiate the fees individually with the publisher.

Readings:

1. J. Söderberg, Hacking Capitalism: The Free and Open Source Software Movement (2015)
2. J. Lerner, J. Tirole (2005), The Economics of Technology Sharing: Open Source and Beyond, *Journal of Economic Perspectives*, (pp. 99-120)
3. For definitions and descriptions of open-source software, see opensource.com and Wikipedia.