Economics of Linux Adoption and Developing Countries

Abstract
This paper identifies and analyzes various sources that improve or worsen the economics of Linux adoption in developing countries. At the micro level, we examine how costs and benefits related to ownership; effective use; learning/switching; and compatibility with hardware, applications, and business partners’ standards influence an adopting unit’s choice of OSS such as Linux over proprietary software. At the macro level, we analyze how the economics of enforcing intellectual property laws and national security issues have influenced the diffusion dynamics of Linux. The paper also offers some suggestions as to how the situation can be improved by taking measures at different levels.

Keyword: Linux, OSS, developing countries, adoption, economics

Introduction
Open Source Software (OSS) is touted to be ideal for accelerating the growth of low-income countries’ IT industry and is expected to increase their propensity to innovate. Articles published in various newspapers, magazines and websites have reported that developing countries have adopted Linux, the flagship of OSS, faster than developed countries. A report published by the United Nations Conference on Trade and Development (UNCTAD) indicated that Linux has been a significant force behind some of the developing countries’ increased IT ascendancy in recent years.²

A closer examination, however, reveals that compared to other information and communications technologies (ICTs), Linux might have even higher bias towards developed countries. Since users can purchase it from distributors and also freely download from various ftp websites, estimating developing countries’ share of Linux market size to a reasonable level of accuracy has been a difficult task. Nonetheless, the number of registered users at the “Linux counter” (http://counter.li.org) and the number of countries they originate from are suggestive and provide some proxies for the
distribution pattern of Linux users worldwide. In 2001, whereas over 81% of the world population living in the non-OECD (developing) countries accounted for 24.1% of the Internet users, the proportion was only 18.6% for Linux users. What is more, during 1998-2001, the proportion of Linux users in the non-OECD economies grew slower than the proportion of Internet users (Figure 1).

![Figure 1: A Comparison of Linux and Internet Users from OECD and Non-OECD Countries](image)

Notes:

a) OECD stands for Organization for Economic Cooperation and Development. OECD has 28 members.


A deeper and richer understanding of the facilitators and hurdles of Linux adoption in developing countries could help software developers and marketers devise appropriate strategies to accelerate its diffusion in these countries. A focus on the developing world – home to over 80% of humanity – is also an antidote to the tendency in the field of software engineering of becoming increasingly isolated and of marginal relevance.

The objective of this paper is to demonstrate how developing countries can potentially benefit from various economics associated with Linux adoption (Table 1) and offer some guidelines as to how the current situation can be improved. Since Microsoft's Windows operating system, used in over 90% of the world's desktop computers, is the major competitor of Linux, we also compare Linux and Windows on several dimensions. The remainder of the paper: a) examines four micro (adopting unit) level factors—ownership, effective use, learning and switching, and compatibility; b) analyzes two macro level factors—enforcing intellectual property laws and national security; c) discussess Microsoft’s strategies that have influenced various economics of Linux adoption in developing countries; and d) provides some conclusions and discusses lessons learned.

Micro-level economics of Linux Adoption

The economics of ownership

The investment, maintenance, the cost of downtime, and the cost of obsolescence are a fundamental part of the economics of ownership. These costs are much higher proportion of income for a computer user in Burundi, which has an annual per capita GDP of US$ 99, compared to a user from Belgium. Advocates of OSS argue that Linux has a lower total cost of ownership (TCO) than its competing products. For instance, the price for
Microsoft's entry-level operating system was US$ 5 per computer in 1981, which increased to US$ 90 in 2002. Taking US$ 600 as the average price of a PC, Microsoft's entry-level operating system amounts to 15% of the total cost of a PC. Other proprietary and open operating systems also have higher TCO than Linux. Apple's Mac OS X, for instance, is found to have higher TCO than Windows. A comparison of The Tech Zone (http://thetechnozone.com/) indicated that although Mac OS X seems to be cheaper than Windows XP, the upgrade costs over time make the former twice as expensive as the latter. Likewise, an article published in the Internet Week on April 3, 2000 argues that Linux is less expensive than BSD/OS.

Although price is not much of an issue currently because of widespread piracy of Microsoft windows and other software in developing countries, the trade-related aspects of intellectual property rights (TRIPS) agreement of the world trade organization (WTO) requires them to provide adequate legal and enforcement tools to prevent piracy. Whereas least developed countries (the poorest developing countries) must comply with TRIPS by January 1, 2006, other developing countries are required to do so earlier. Developing countries’ full compliance with TRIPS is thus likely to make the relative value proposition of Linux adoption much stronger.

Whereas prices of proprietary software so far have not been of much concern to individuals using pirated versions, they have contributed to high prices of PCs that are bundled with proprietary operating systems. One way to bring down PC prices for manufacturers thus is to use OSS such as Linux as the operating system. LG Electronics, the South Korean multinational, for instance, sells Linux-based desktops in India that are
priced lower than brands that use commercial operating systems. The company says it has lowered the cost by legally saving the license cost of proprietary operating systems.

Lower “downtime” and maintenance costs further improve the economics of Linux ownership. This is mainly because Linux has fewer bugs and is less likely to crash compared to commercial operating systems. Quoting Symantec Corporation, an article published in Wall Street Journal on September 18, 2003 states that over 4,000 viruses and other malicious codes were launched against Microsoft Windows during the first eight months of 2003 compared to 11 against Unix and Linux combined together for the same period. Moreover, by using communications like email, bug reports, bulletin boards and various tracking mechanisms, Linux communities capture, rearticulate and refine implicit, misstated or unstated system requirements causing bugs, missing functionality and incorrect calculation. However, whereas security vulnerabilities are likely to be discovered relatively quickly in Linux, a large number of ordinary Linux users may not be able to fix their systems in case of such problems. Windows users, on the other hand, have online resources available to combat virus attacks. For instance, a part of Microsoft’s antivirus strategy has been to make security patches available online for free download which fixes Window’s vulnerabilities.

Linux also has substantial built-in features to guard against various types of software obsolescence. Many Linux programs use text files to store data and complex formats such as gnumeric and SciGraphica use XML, which itself is a text-based format. Inside editors like vi and emacs can be used to get data into a newer version of an application. Furthermore, the Linux kernel maintains a wide range of file systems types so that files previously stored can be easily read by modern Linux workstations. Thus,
Linux fares better than most commercial systems from system obsolescence perspective as well.

Contrary to the findings of a Microsoft commissioned study, which indicated that Windows become cheaper by at least 10% in four of the five common tasks, many OSS users think that Linux has a lower TCO. In a survey conducted in the U.S., Brazil, France, Germany, Sweden and Japan, for instance, 40% of the respondents perceived Linux having a lower TCO. The "free" sticker associated with OSS has further increased the perceived attractiveness of Linux. In 2002, the government of the Madhya Pradesh State of India announced the state’s plan to switch to Linux. Digvijay Singh, the chief minister said: "For us it is not a question of Microsoft versus Linux, It is just a matter of choosing between free software and monopoly software”.

Some organizations from developing countries that have adopted Linux have reported substantially lower TCO of Linux. For instance, the Brazilian UNIVATES estimates that by switching to Linux, it saved US$130,000 required to purchase proprietary software for servers and desktops and saves US$70,000 each year on upgrades and maintenance.

The economics of effective use
If we view OSS as a form of technology transfer, developing countries’ capability to employ it in “effective uses” is critical for the transfer process. OSS and proprietary software differ in terms of the economics of effective use. Most features in proprietary systems may have very little or no use for users in developing countries.

In OSS like Linux, users can see and alter the codes or add new features to fit their needs. In the language of technology transfer, this would be called a “level three” transfer. It is the most “involved” form of technology transfer in which developers and
users have shared responsibility for the application of the technology including its profitable use.

Linux’s high degree of amenability to modification makes “level three” transfer possible and improves its economics of effective use. For instance, TurboLinux is the Asian version of Linux that supports the huge Asian character sets and Connectiva is the Latin American version of Linux. Although proprietary software developers such as Microsoft have localized versions, they are not available for linguistic groups of small sizes. For instance, there is not an interface even for Hindi, a national language for India and the fourth largest spoken language in the world. OSS has a higher potential to provide more benefits to such groups.

Compounded by affordability and economics of externality created by Linux communities worldwide, some developing countries have been able to develop low-cost technologies that meet their unique needs. For instance, Encore Software, a company based in India, has designed a handheld Internet appliance, Simputer, based on the Linux. The Simputer uses the Intel Strong-ARM chip, known for its low power consumption, has 64 megabytes of RAM, 32 megabytes of flash memory and a modem to connect to a telephone line. At a cost of less than US$ 200, Simputer provides Internet and email access in local languages; micro-banking applications; speech recognition and text-to-speech conversion. *Time* magazine described Simputer as among the best ten technological innovations of 2001. India, which has two official languages (Hindi and English), 18 major languages and 418 officially listed languages has benefited from Simputer’s low cost, efficiency and local-language capabilities. For example, the Village accountants in Karnataka state of India are using Simputers to collect land record data in
their villages and upload it to the Government's servers. Estimates suggest that the process has cut data collection time by 80-90%.

Similarly, Computador Popular (Popular Computers) in Brazil that cost US$ 250 run Linux. Computador Popular is an Internet appliance without a floppy drive or a hard disk drive, which features many of the attributes one would expect in a moderately-priced PC. Consumers also have the option of buying inexpensive hard disks and other peripherals. The first shipment of *Computador Populares* is planned to go to schools, libraries and health centers to access to the Internet.

What is more, transparent and collaborative nature of Linux has allowed developing countries to train their students on software. For instance, it is argued that children in countries that have few opportunities to use a computer because of English language constraints will find the Simputer a more feasible alternative. More profitable uses of OSS such as Linux are likely to be derived from technology education and skills development, which would help to build local programming skills and also avoid spending hard currency on foreign technologies.

An individual’s capability to enjoy the *economics of effective use*, however, is a function of the individual’s skill level. Substantial skills may be needed to custom-configure some aspects of the system to suit particular needs. Ordinary users thus may not be able to enjoy the economics associated with the effective uses of Linux.

**The economics of learning and switching**

Linux’s extreme configurability has created a major disincentive for learning and switching. J. Quittner, in his *Time* Magazine article published on May 24, 1999, describes Linux’s complexity: “The [Linux] interface is user friendly only if the user happens to be a [computer science] Ph. D.” Linux programmers, however, have been working to make
the software more user-friendly and Linux users consider Quittner’s assertion as a gross overstatement now. Compared to commercial software, a small budget of Linux project, however, has limited usability laboratories, user surveys and detailed experiment and the involvement of outside experts such as technical authors and graphic designers. Limited support and staff knowledge for Linux further worsens the economics of learning and switching.

Moreover, whereas “reactive” commercial companies such as Red Hat, VA Software and IBM are providing complementary services and products not supplied by OSS communities and thus are contributing to the economics of learning and switching to Linux⁷, such measures are heavily oriented towards developed countries. Like all other technologies commercial distributors often find developing countries unprofitable for their markets causing adverse international hierarchical pattern of Linux diffusion.

Despite proprietary software’s unaffordable prices, illegal copies are widely used in developing countries. Because of such practices, Microsoft Office has become the standard in many developing countries. Unlike in developed countries, however, third-party and vendor supports, and good books are not widely available for Microsoft's products in developing countries. Moreover, compounded by lower penetrations of PCs, Microsoft centric computer habits in developing countries may not be as widespread as in developed countries, which means relatively lower “switching” costs.

The externality and spillover effects created by Linux communities worldwide and collaborations among them nonetheless have contributed to the economics of learning OSS. They are helping educational institutions, government agencies, private businesses and individual users worldwide to adopt Linux. Linux communities are
compared with Red Cross and the United Nations and are viewed as a “model for a new kind of business organization that could form the basis for a new kind of economy”.

Linux user groups are located anywhere from Albania to Algeria, Argentina or Armenia in which less experienced users get installation and other helps from knowledgeable and experienced users.

**The economics of compatibility**

Networked technologies such as Linux derive much of their value from *compatibility*. Corporate resources such as hardware, applications and existing files; and technologies used by trading partners thus largely influence the *compatibility* and the decision of a unit to adopt a technology. First, consider the operating systems-hardware compatibility. Unaffordability of new PCs and thanks to free or charitable donations from developed countries, developing countries have a much higher proportion of computers that are used and old. The Silicon Valley Toxics Coalition, for instance, estimates that the U.S. will discard 500 million computers during 1997-2007, 80% of which will be shipped to developing countries. Since more codes are added in each new generation of Microsoft software, it can run on faster and more expensive computers, which are beyond the reach of developing countries. For instance, Microsoft recommends a minimum hardware requirement of a 233 MHz processor and 64MB of RAM to run Windows XP Professional. On the other hand, Linux is smaller and can even run on "outdated" machines powered by Intel Pentium 90 and even older 486 chips. However, device drivers for Linux may not be available for some components used in developing countries, which worsens the economics of Linux ownership. On the other hand, IBM is promoting systems that run Linux but do not run Microsoft applications.
Second, in terms of issues related to operating systems-application compatibility, Linux is experiencing a vicious circle of low penetrations of both its operating system and applications. Although some applications such as WINE and VMware can be used to run Windows applications on and within Linux, many of the Linux and Windows applications don't work on each other’s platforms. Linux, thus, can't become widely used unless its applications become popular, but its applications will become popular only if Linux is widely used. Since Linux is free, Microsoft, a vertically integrated firm (producing operating systems and applications), is not likely to gain from the demand for hybrids (Microsoft’s applications and Linux operating systems and vice versa). So Microsoft prefers incompatibility because the profit from its own-product demand is likely to be much larger compared to the hybrids demand. Microsoft's refusal to offer its applications in versions designed to run directly under Linux has discouraged some users from switching to Linux. Faced with the high cost of converting huge Word and Excel documents, desktop users have developed inertia to stick with Microsoft products.

Third, Linux users are also encountering compatibility issues with business partners’ standards. Trading relationship between firms is a function of the degree of ‘fit’ of their technologies or the ‘technological distance’. Empirical evidence suggests that because of their lower bargaining powers, firms from developing countries are forced to comply with the technologies used by their trading partners in advanced countries. For instance, more than eight years ago a study found that organizations from developed countries accepted new suppliers only if they could demonstrate an electronic data interchange (EDI) capability. Similarly, the pressure from American multinationals such as Wal-Mart and JC Penney require their foreign suppliers to transact on the Internet. The
suppliers, mainly from developing Asian countries, adopted the Internet because of such pressure.

Software upgrading thus tends to diffuse from big to small companies and from companies located to OECD to those in developing countries—commonly known as the rank effect in industrial economics literature. When the trading partners from developed countries follow Microsoft standard--as a large number will—firms in developing countries are less likely to adopt Linux. In this aspect, Linux is attractive to governments and more so to municipalities because they are not much connected with the outside world and don't have to exchange information with customers that follow the standards of Microsoft.

**Macro-level economics of Linux Adoption**

**The economics of enforcement of intellectual property laws**

The trade-related aspects of intellectual property rights (TRIPS) agreement of the world trade organization (WTO) has obligated developing countries to provide new enforcement tools to combat piracy and to ensure the adequacy of such tools.9 Strengthening intellectual property protection in developing countries arguably creates incentives for domestic innovation. Nevertheless, developing countries feel that TRIPS agreement has created a “disproportionate burden” on them without “tangible development benefits”.

Societies in many developing countries do not support the concept of private ownership of ideas and hence lack the support for intellectual property protection laws.11 Compounded by low income and ever-increasing costs of proprietary software, a very high proportion of software products in developing countries are illegally copied. For
instance, 96% of software used in China and Indonesia, 97% in Thailand, 95% in Turkey and 99% in Vietnam are estimated to be illegally copied.\textsuperscript{12}

Providing adequate enforcement tools to combat piracy by changing the prevalent social beliefs has been a costly proposition for the governments of developing countries. The citizens also perceive such enforcement tools as supports to foreign software companies. For instance, Taiwanese government’s attempt to force students using pirated versions of Microsoft Windows to pay was perceived as supporting a foreign company rather than its own citizens. What is more, enforcement of intellectual property laws also results in spending hard-earned foreign currency in software imports. OSS such as Linux, on the other hand, can be copied and, broadly speaking, used freely with no restrictive copyright problems.

Rapid OSS diffusion in developing countries is likely to result in lower economic losses and reduce administrative costs for enforcing intellectual property laws. Governments in these countries have, thus, opted for promoting OSS by applying various measures of institutional intervention. In Asia, for instance, almost every country has a ‘National Linux' and a number of high-profile national OSS projects. For example, under India’s Indlinux.org, a vast army of programmers is working on Linux to make the benefits of IT freely available. Similarly, Pakistan Government has established Technology Resource Mobilization Unit to enable groups of professionals to exchange views and coordinate activities. The Chinese government established Beijing Software Industry Productivity Center to organize Linux development in China. Yangfan Linux, a version developed by the center, has already been used in a large number of government computers.
Developing countries’ orientations toward intellectual property protection and the requirement to comply with TRIPS, however, will have differential impact on the penetration of free and proprietary versions of Linux. Whereas free versions may diffuse faster in these countries, proprietary versions of Linux largely depend on the availability and enforcement of intellectual property laws.

**The economics of national security**

Policy makers around the world are realizing the increasing influence of technologies in the national security game. In some countries, national security has been an important element in the equation of choice function that involves OSS and proprietary systems. An article published in *China Economic Times* on June 12, 2000 discusses three mechanisms that Xu Guanhua, Chinese vice minister of the science and technology, thinks high technology affects national security—military security, economic security, and cultural security.

Regarding military security, Guanhua said that developed countries have put many hi-tech arms into actual battles and discussed the likelihood that technology-exporting countries might have installed software for “coercing, attacking or sabotage”. Some governments, like those of China, thus perceive proprietary software’s hidden protocols threats to national security because it is difficult to know what the software is doing or whether data is being shared inappropriately. Chinese government, for instance, thinks that Microsoft and the U.S. government spy on Chinese computer users through secret “back doors” in Microsoft products.

What is more, because of the national security concerns, the U.S. and its allies in the Coordinating Committee for Multilateral Export Security (COCOM) restricted high technology exports to China. To overcome the impacts of such restrictions, the Chinese
In terms of economic security, developing countries do not want to make themselves as “markets” for the multinational corporations’ (MNCs) products. Some governments believe that Linux may reduce their dependence on developed countries. The Chinese government, for instance, perceives Linux as a leapfrogging technology that would allow them to overcome the inability to develop an independent operating system and to catch up in the global technology race. Some signs of success are beginning to materialize. For instance, in 2002, Eforce, Culturecom, and Mobile Telecom introduced the Chinese 2000 Mobile Linux Operating System for mobile devices. Beijing Government has named it as its official operating system.

The issue of cultural security has been equally important, especially in countries with prevalent Anti-Americanism. The Chinese government, for instance, has been building systems based on Linux to liberate itself from "information colonialism". The Chinese government also thinks that a custom-made operating system can contribute to national pride as well. Similarly, a memo distributed at a Microsoft meeting in Berlin in 2002 mentioned that international customers were interested in Linux mainly because it relieved them of a dependence on U.S. based company.

To contribute to national security, developing countries are enacting new laws and providing guidelines to facilitate Linux development. By the mid-2002, Latin American countries such as Brazil, Mexico, Argentina and Peru proposed bills that mandate the use of OSS in government organizations.
Some countermeasures taken by Microsoft to address the concerns of security-minded governments have, however, increased the relative attractiveness of Windows. Microsoft, for instance, opened its Windows XP, Windows 2000 and other systems programs to government technical security experts of Russia among other countries. In February 2003, Bill Gates also signed an agreement to share the Windows operation systems source-code with the Chinese Government.

**Microsoft’s strategy: Economics of discounts, gifts, donations and investments**

The “Casino of Technology” requires several things including “deep pockets, strategic pricing, and a willingness to sacrifice current profits for future advantage”. The strategies and tactics employed by Microsoft, the deep pocket competitor of Linux, have influenced the economics of Linux adoption. Microsoft’s measures include allocating funds to provide heavy discounts to governments; giving away software for free to institutional buyers; and providing gifts and donations; and devising investment strategies to counter Linux spread. Developing countries’ IT industry and computer users, however, are benefiting from Microsoft’s measures related to computer literacy programs, cooperation in academic and research activities, hardware manufacturing and other investments. Some measures such as computer literacy programs may also facilitate Linux diffusion as computer literacy is the prerequisite to Linux adoption.

In July 2002, Microsoft’s head of sales reportedly sent a memorandum to Microsoft executives suggesting a strategy of giving heavy discounts and even giving away the software for free to institutional buyers and governments. According to an article published in *The Economist* on March 24, 2003, Microsoft has allocated special
funds to provide deep discounts on sales of Windows. Such discounts are arguably aimed at stopping governments from switching to Linux.

Linux advocates argue that Microsoft is providing `gifts' and donations to develop Microsoft centric habits and to influence Linux related policies of developing countries. For instance, in South Africa, following National Advisory Council on Innovation’s call for the government to adopt OSS, Microsoft offered to provide free software for 32,000 schools. Similarly, Microsoft reportedly donated US$ 550,000 to Peru's school system, where a Bill called for government agencies to use OSS unless a viable alternative is available.

Microsoft’s investments strategies in developing countries are also likely to decelerate the spread of Linux. For instance, it announced a US$ 750 million investments in China in 2002 in the areas of training, academic and research cooperation and hardware manufacturing and software outsourcing. Microsoft also announced a US$ 400 million investment in India. A significant proportion of the investments will be spent in computer literacy programs and localization of its software products. Microsoft is contributing its software to schools, providing training to 80,000 schoolteachers and 3.5 million students in government-run schools in India. Arguably these activities instill Microsoft-centric computer habits and by increasing the cost of learning and switching to OSS would stop Linux from gaining popularity within the end-user community. Consequently, Indian software developer will not find it necessary to develop Linux-based applications. Indian market seems to be critical from this angle because it accounts for 10% of the world's software developers. Analysts also saw Microsoft’s influence on
the Indian IT Minister’s announcement in April 2003 that the government will not back OSS by excluding proprietary software.

Table 1: Various Economics Influencing the Choice of Linux in Developing Countries

<table>
<thead>
<tr>
<th>Factor</th>
<th>Positive effects on Linux diffusion</th>
<th>Negative effects on Linux diffusion</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ownership</td>
<td>• Lower “downtime” and obsolescence costs and hence TCO.</td>
<td>Lack of supports to deal with security vulnerabilities.</td>
<td></td>
</tr>
<tr>
<td>Effective use</td>
<td>• Amenity to modification: “level three” transfer easier.</td>
<td>Ordinary users cannot custom-configure the system.</td>
<td></td>
</tr>
<tr>
<td>Learning/switching</td>
<td>• Switching costs may be lower compared to developed countries. • Linux communities have created positive effects.</td>
<td>• Complexity: higher learning/switching costs.</td>
<td>“Reactive” commercial companies can take measures to reduce learning/switching costs.</td>
</tr>
<tr>
<td>Compatibility</td>
<td>• Compatible with old and used hardware.</td>
<td>Likely to be incompatible with business partners’ technologies.</td>
<td>If device drivers for Linux are unavailable, hardware-OS incompatibility issues arise.</td>
</tr>
<tr>
<td>Enforcement of IP laws</td>
<td>• Promotion of Linux more attractive than enforcing IP laws.</td>
<td>Proprietary versions of Linux depend on IP laws.</td>
<td></td>
</tr>
<tr>
<td>National security</td>
<td>• Linux seems to be superior.</td>
<td>Microsoft’s opening of codes: increases Windows’ relative attractiveness.</td>
<td></td>
</tr>
<tr>
<td>Microsoft strategy</td>
<td>• Computer literacy programs may provide skills needed to adopt Linux.</td>
<td>• Discounts: worsen economics of Linux ownership. • Gifts/donations: influence policies and increase switching costs to Linux. Investments: increase switching costs to Linux.</td>
<td>Developing countries benefit in some ways from such measures.</td>
</tr>
</tbody>
</table>

Discussion, Contribution and Lesson Learned

An important contribution of this paper is to identify and analyze various sources that improve and worsen the economics of Linux adoption for users in developing countries.

The findings have added to the sparse literature on OSS and can help various stakeholders of developing countries— software developers, Linux communities, OSS promoters especially the reactive commercial companies, national governments and international agencies—to devise appropriate policies to bridge the global digital divide.
or at least decelerate the rate at which it is increasing. In the following paragraphs, we offer some suggestions as to how the situation can be improved.

Among the various economics discussed in this paper (Table 1), Linux probably fares the worst in terms of the economics of learning and switching. Although over fifteen million people touched Linux codes by 2001\textsuperscript{14}, very little has been done to increase its user-friendliness and extend its reach outside highly technical and knowledgeable individuals and those in academic computing environments. Without a reasonable level of user-friendliness, Linux cannot attract a critical mass of users required for its success. Linux communities and the “reactive” commercial companies discussed above thus should redefine the priorities and put relatively higher emphasis on improving Linux on the dimension of \textit{simplicity or ease of use} rather than other software quality dimensions such as \textit{accuracy, completeness, features} and \textit{structuredness}. The economics of learning and switching can be further improved by intensifying support for installing and using the software. They include setting up dedicated toll-free numbers for existing and potential Linux users, Linux awareness campaigns and training programs targeted to those that are on the wrong side of the digital divide.

\textit{Compatibility} issues associated with business partners’ technologies have the least influence on governments in developing countries. This is mainly because governments have limited connection with the outside world and don't have to exchange information with customers that follow Microsoft standards. Governments’ adoption of Linux nonetheless can influence its diffusion dynamics in multiple and significant ways. First, the state is the biggest single user of hardware and software in developing countries and hence the government’s adoption can effectively contribute to the critical mass necessary
to achieve Linux’s success. Second, given government agencies’ power, individuals and organizations, in an attempt to reduce the “technological distance” with government agencies, are more likely (even forced) to adopt Linux if the government does so.

To further improve Linux’s economics of compatibility, software developers should work toward making Linux more compatible with Windows applications. Given the current market positions, whereas Microsoft is likely to benefit from Linux-Windows incompatibility, the opposite is the case for Linux. Higher degree of Linux-Windows compatibility will significantly overcome the inertia of existing users to stick with Microsoft products.

The lower “downtime” costs have been important sources to significantly improve the economics of Linux ownership. Although there are a very few viruses and other malicious codes for Linux so far, ordinary Linux users lack supports to fix their systems in case of system vulnerabilities. Microsoft Windows users, on the other hand, have online updates available to fix such problems. To sustain Linux’s perceived lower TCO compared to commercial systems, Linux communities and “reactive” commercial companies should work toward providing such supports to ordinary Linux users.

Governments in developing countries should work toward exploiting the economics of effective uses, which has been far from the full potential so far. Especially countries that have capabilities and competence such as Brazil and India should shift their priority from serving technological needs of advanced countries to making effective uses of suitable technologies such as Linux domestically. Consider, for instance, the Simputer. Neither the Indian ICT industry nor the Indian government has taken Simputer as seriously as the software industry. Whereas software exports are likely to benefit the
digital elites in these countries, the benefits of effective uses of OSS such as Linux are likely to accrue to people in the thousands of miserable villages and at the bottom of the global digital divide.

References


   http://r0.unctad.org/ecommerce/docs/edr02_en/ecdr02press1.htm


