Technology and Development: The Political Economy of Open Source Software

by

Bruno de Moura Borges

Department of Political Science
Duke University

Date:_____
Approved:

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David Soskice, Supervisor

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Frederick Mayer

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Bai Gao

_____
Eric Wibbels

Dissertation submitted in partial fulfillment of
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ABSTRACT

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Abstract

This dissertation examines the role of governments in adopting Open Source Software (OSS) for their needs and tries to explain the variation in adoption and implmentation, among both developing and developed countries. The work argues that there are different logics guiding developing and developed countries OSS adoption. As developed countries follow a pattern based on the Varieties of Capitalism model, the difference in OSS adoption in developing countries is a combination of the relation between the state and market forces (especially how business and firms are organized) and state capacity to overcome collective action problems and to reap the benefits of technological upgrade. This dissertation also presents a structured and focused comparison of two cases (Brazil and Mexico) and define which are the factors that matter for the outcomes.

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1. Technology, Open Source Software, and International Relations

1.1. Introduction

In the last decades, an important new technological development has taken place globally: the creation and expansion of open-source software (OSS).[1] These types of software go against the logic of proprietary software (or "closed-source" software) because they are produced in a system of collaboration, instead of concentrating research and development inside one firm. Individual programmers around the world contribute to the code of the program, which is freely available on the Internet. This is a *de facto* global activity, since anyone with programming skills in any part of the world can contribute to building and maintaining these systems and programs. Moreover, the fact that the source-code is always available guarantees that one can change and adapt the program directly to his/her needs. Contrary to the usual intellectual property issues brought up by the use of commercial products or commercial software, OSS is based on intellectual property licenses that allow for its modification and for its redistribution (Lessig 2001). One of the pillars of this movement has been the Linux Operating System (Varian and Shapiro 2003; Varian et al. 2004; Weber 2000, 2004; Wong and Sayo 2004),

[1] For an excellent short "history" of the open-source process of production and how it came about, see Weber (2004: 20-53).

but several other pieces of software have been extensively used for some time with impressive results.[2]

To participate in any attempt to write programs and contribute to the joint development of several of them, it is only necessary to have a computer, an Internet connection and have the necessary programming skills. Discrimination is not an issue: the only criteria needed to participate in these "programmers' virtual communities" is the skill to find "bugs" (or glitches in lines of code), to contribute with original code, or to develop individual programs and ask for help. The open-source production process is different from the traditional production of goods -- there is no final physical product, just lines of code, distributed digitally. OSS also differs from the organized production found in global commodity chains – the sites of production are both independent and do not work for profit.

Open-source software production follows a different logic of commercial technological development because unlike previous technological transfers, it does not need to be traded for something or bought. OSS and its creation process are also special global public goods, because anyone can benefit from the efforts of thousands and, unlike "normal" public goods, the more OSS is consumed, the better it gets and more people can use it (Weber 2004: 154-155). OSS has also little parallels in terms of how it is produced – despite our theories about the difficulty of collective action and how the market

[2] Some examples are: web-servers like Apache, internet applications such as the Mozilla Firefox browser, productivity applications such as OpenOffice, and programming languages such as Perl, among others.

functions, for the most part, it still works as a system of free exchange, much like the scientific *ethos* from which it came. And it works (Benkler 2006: 91-127; Weber 2004).

Parallel to the steady and constant growth of OSS for individual end-users and firms, governments have recognized the benefits of open-source adoption for their own purposes. In recent years there has been a steady movement in both developed and developing countries to implement open-source architectures for their bureaucracies, educational systems, and even defense systems (Weber 2004: 242). As a recent empirical study shows, by the end of 2005, there had been 265 initiatives from both national and local governments for the implementation of OSS (see Table 1.1). If we consider that the first attempts to implement OSS for governments are no older than the late 1990s, this number shows an increasing trend in OSS adoption. There is variation both in the ***scope*** (either *national* adoption or *local* adoption), the ***depth*** of adoption (*mandatory* adoption, *preference* for OSS when choosing software, *recommendation* for use, or just *research*), and finally, the ***progress*** *of adoption* (how fast and integrated is the process itself). This adoption has been controversial, which is only normal when distributional consequences are present. Some countries have also tried to start the process and have since failed or given up.

There is also a ***regional*** difference in the adoption of OSS. While Europe leads the number of initiatives for the implementation of OSS in absolute terms (both nationally and regionally), the composition of this implementation varies (see figure for the national

numbers). It is important to notice that, despite the number of initiatives, European countries are less extreme when it comes to implementation policies.

	National Initiatives	Mandatory	Preference	R&D/Advisory
Europe	73	11 (15%)	17 (23%)	45 (61%)
Asia	58	0 (0%)	24 (42%)	34 (58%)
Latin America	25	11 (44%)	5 (20%)	9 (36%)
Africa	4	0 (0%)	1 (25%)	3 (75%)
Middle East	3	0 (0%)	1 (33%)	2 (66%)
North America	3	0 (0%)	0 (0%)	3 (100%)

Table 1.1. Source: Lewis 2006. This table does not include supra-national initiatives promoted by the UN, the OECD or the EU.[3]

[3] This table lists the number of OSS initiatives made by governments at the national level. These initiatives can be multiple, even for a single government.

What can explain this variation? Despite economic and technological reasons to adopt OSS, I argue that the main forces driving this disparity are *political* – the adoption of OSS presents governments with a series of advantages, especially regarding *autonomy* and *development*. The broad goal of this dissertation is to shed some light on how states take advantage of technological developments, specifically in the case of OSS. The process of open source software production is truly innovative in its core and it shows that public goods are not only possible under certain conditions, but in this case, they can actually provide an alternative way to think about how countries fight for a technological edge in the search for both autonomy and development.

1.2. Technology and IR

For International Relations scholars, this is a moment in time that deserves particular attention. Military strategies are now conditioned by instant public opinion, while terrorist plots are organized and benefit from the Internet. Immediate communication has shattered the image of the detached and calculating diplomat deciding matters of state on behalf of his country in far-away lands. Negotiations have become instantaneous affairs, with direct impact over constituencies, while politicians need to worry even more than previously about the short-term consequences of decisions. Whether the fundamental nature of international relations has changed its inner core (i.e., the state system) is still a matter of heated debate – there is little doubt, however, that relations among states have

been “turbo-charged” and have become intertwined, generating something close to an “Interdependence 2.0”.

Technology is not a new theme in the field of International Relations. Traditionally, technology has been associated with change. States, while looking to become increasingly autonomous from other states, develop technologies that may give them the comparative advantages needed to survive in an international system marked by competition.[4] Changes in the international system, however, are notoriously difficult to measure, to understand and even more to predict. That is one of the reasons why the IR field has mainly looked at the international system as fairly static. Even one of the modern classics of the discipline has suffered from the criticism that it can hardly account for change in power differentials in the international system (Waltz 1979).

IR scholars have previously recognized the importance of technology for change to occur -- not only in terms of economic gains and more efficient ways to organize production, but also for military ends and for state formation itself (Hintze 1975). Several times in history, the introduction of a simple process or object had a deep impact on the distribution of power among actors. It is not difficult to point out examples where the technology of war, for example, has changed both the nature of war itself and of the units fighting them, such as the invention of gunpowder and firearms, the invention of the

[4] There is a broad consensus in the field of IR, from both realists and institutionalists, regarding the anarchic nature of the international system and the systemic forces that contribute to make it a contentious realm. There is great disagreement, however, about the ways that this contention operates and the mediation of institutions to lessen its impact.

airplane, or the creation of tanks (McNeill 1982; Kennedy 1987). The industrial revolution – and the technological changes that made it possible -- brought major shifts in the distribution of power among countries, redefining what it meant to be wealthy and spurring countries to accelerate the search for markets. Military power alone could hardly account for these changes in the international system.

Technology is one of the main tools for development. With technological progress, a country can increase its productivity, reduce the time it takes to put products into markets, and can also add value to things it produces. Moreover, the services sector gets more dynamic and adaptive, while the costs of communication are reduced. Historically, technology has also helped to change (among other factors) indicators such as literacy, life expectancy, or the reduction of infant mortality. Development always involved the mastering of certain techniques together with the ability to create more efficient ways of production.

Apart from the application of technology for war, International Relations scholars have largely relegated its impact to a systemic approach, where developments in technology are never politicized. Technology and its diffusion are usually taken as environmental variables, with very little discussion as to how they translate into resources that states create, master and control. What is usually left out of the analysis is that, historically, this diffusion has not been neutral or employed in the same manner by the actors of any system. Technology is a necessary, but not sufficient condition for change in the

international system -- it, in fact, creates “windows of opportunity” in which well-defined strategies play a fundamental role in order to reap the benefits these changes generate. It is certainly not enough to know that a certain technology exists – the great challenge is to incorporate it in a way that can bring comparative advantages and an edge in a competitive international system. Some states are aware of that gap and make sure that their own technological discoveries are well-protected. As the global economy becomes more knowledge-based, the stakes in dominating certain technologies become even higher. Mastering an important technology may represent the difference between advance or stagnation, and maybe even survival or extinction.

In a book written in 1962, economist Alexander Gerschenkron mentioned what was, for him, one major characteristic of systemic change --- he called it “the advantages of backwardness”. The so-called “advantages” were represented by the fact that developing economies could “jump stages” of development by incorporating at later times the technological advances of the system without incurring the costs of producing them. Developing countries would be, in economic terms, “free riders” of technological advance (Gerschenkron 1962). Moreover, in order for that process to take place, the author believed that the role of the state in defining these strategies was central – the later the entrance in the international industrial development cycle, according to Gerschenkron, the more state intervention was required to promote the required “catching-up”.

According to Gerschenkron's logic, developed countries would have no incentives to see his prophesy come true. This creates a paradoxical situation in which there are clear incentives for the constant production of new technology, but very little incentive to share it. Even if all countries could benefit from technology in the same way (which is not true), still it would make sense to protect any technological comparative advantage from being appropriated by others. The recent battle for intellectual property protection in the World Trade Organization, embodied by the TRIPS agreement, is but one manifestation of this (Sell 1998, 2003).

The push for tighter intellectual property laws has experienced a surge in recent years. Since the establishment of the Uruguay Round of the GATT in the 1980s, OECD countries, and chiefly among them the United States, have been restricting the possibility of technological free riding by developing countries. This tightening of intellectual property protection has deep implications for the developing world. Through a series of "sticks and carrots," developing countries have to comply with patenting laws in order to enter into free trade agreements and/or have been submitted to threats of retaliation for not thoroughly enforcing these laws. In order to reap the benefits of a more integrated international economy, the developing world has had to abandon the old strategies of protectionism and the creation of "infant industries". Open source software is different because while it has the potential for major change, it is also available (as a strategy) to all -- or so it may seem.

Apart from the current tighter intellectual property regimes and the reduced possibilities for "jumping stages" as Gerschenkron envisioned, "free riding" does not come easily -- as political scientists well-know, institutions matter. The mere wish to acquire certain technologies or even the international conditions allowing it to happen are not enough if a state does not possess the institutions capable of absorbing these changes (Kohli 2004; Acemoglu and Robinson 2006). Countries differ in regards to the conditions for applying or incorporating the technology that may come from the developed world -- in other words, they need to have certain "institutional complementarities" to reap the benefits of technological change (Hall and Soskice 2001; Büthe and Mattli 2003).

It becomes clear that protectionism, for example, is not enough. Many countries used different degrees of protectionism, with many different results. Conversely, trade liberalization alone has yielded widely different results (Rodrik 1999). This happens because it is the *combination* of institutions and how they operate together that can promote or hamper development policies. New institutions always have to operate in old institutional environments, with previous equilibria. Institutions that can function well in a certain environment and promote a certain outcome can have a completely different effect if transported to a different institutional environment. Countries have institutional histories and different rates of adaptation to change. The fact that there is a clustering of different "varieties of capitalism" that can perform very differently in the same conditions highlights the importance of paying attention not only to single institutions, but to the

interaction of several of them (Hall and Soskice 2001). The case of technology is one of the most affected by these equilibria.

In order to reap the benefits of technological "windows of opportunity," states need to possess "state capacity." This is one of the concepts that have always intrigued political scientists. Principal-agent theories have tried to accommodate the fact that the goals of representatives may be very different than the represented, as well as those that emit orders and those who follow them. The decision to implement any policy is far from its actual implementation. There are many layers between authoritative decisions and who implements them. Bureaucracies can be the single most important factor in the way orders are transmitted from top to bottom, and if politicians' incentives are not aligned with what bureaucrats want, it is extremely difficult to promote any long-term changes or any policy that intend to have a broader scope. Depending on how cohesive and insulated bureaucracies are, their goals can have longer time-horizons than politicians' reelection prerogative.

1.3. Bureaucracies

Another goal of this dissertation is to shed light on an issue that has been overlooked in the literature on bureaucracies, since although not new, it is still incomplete. Since Max Weber published his works on bureaucracy as the culmination of the modern state, different applications of his ideas and challenges have been published. Especially when

studying the military, scholars highlight issues of *esprit de corps* and cohesion (Huntington 1957), or their worldviews in crises situations and decision-making (Allison 1969; 1971). Those works have not however diminished the gap between what is known regarding elective positions and bureaucracies. The literature is incomplete because of the inherent difficulty of studying closed systems and of being given access and data from usually unaccountable bureaucrats.[5] Given both their incentives and their training, bureaucrats tend to focus on the leeway they have to implement policies. I argue that despite previous attempts to infer that bureaucracies try to maximize budgets, a good way to grasp what they do is to infer that they try to maximize control over means.

States differ greatly in terms of bureaucratic capacity. But instead of seeing bureaucracies as something separate from the political process, it is necessary to stress that they are an integral part of the components that characterize each variety of capitalism. They are embedded in the political process, respond strategically to it, and try to steer it so as to get more control over the outcomes. It is important to remember that changes in the political process usually have long-term impact over bureaucratic careers and the possibility of future control. Understanding how bureaucracies operate and their interaction with the private sector is fundamental to grasp the political-economic equilibrium that underlies each society.

[5] Some works have recently attempted to find other ways to gather data on the impact of bureaucracies, especially in regards to how they can influence law making (Huber and Shipan 2002). Another traditional branch that studies the impact of bureaucracies is the so-called "public choice theory" – Gordon Tullock (2005) is an example of that line of research, usually theoretical in nature and highly critical of bureaucracies in general.

In the 1990s, due to the Washington Consensus literature, the scholarly advice was to recommend that the less the state got involved in the economy, the better (Evans 1992). Bureaucrats were seen as rent-seekers, and as such, an impediment to development. The resulting attempt to apply one-size-fits-all policies led to disillusionment to its prescriptions – by the late 90s, it became clear that what the states needed were capable and accountable bureaucracies, and not necessarily their reduction. In many cases, state capacity was affected, leaving governments with little leverage to implement reforms or any kind of planned developmental policies.

Especially in Latin American countries – given the data on career paths and legal training -- the private sector has proven to be unreliable in providing credible career structures for the middle-classes, which continuously rely on the state for both stable and high-paying jobs (Schneider 2004; de Ferranti et al. 2003). In fact, there is a fundamental political unfeasibility in Latin America of coordinating business' future development of engineering careers *and* middle-class expectations of children's careers. Technical training remains limited, while at the same time, there is a need to invest more and to attract jobs in technical sectors, especially in Information Technology (IT) and high value-added products (Rodrik 1999; de Ferranti et al. 2003).

In the realm of technology, especially in the computer industry, developing countries faced a dilemma. Not having a highly trained and available pool of autonomous programmers or engineers, and in need of IT technology, these countries still had to

import “black boxed” solutions. With closed economies (which was the case for most of the developing world until the late 80s), the only solution for some was to build, from scratch, an autonomous software industry, as Brazil, India, and China, for example, tried (Amsden 2001 205-206; Evans 1995).

Closed economies are particularly unsuitable for technological development that require dynamic and mobile innovations, which can only be provided by either an open market or by a diversified and trained IT labor force. There was a fundamental tension between dependence on foreign technology and innovation. In the 90s, the conjunction of two factors served to change this scenario. First, liberalization of markets forced countries to implement new developmental strategies based on market forces. Integration into the world economy meant “playing by the rules” that is, a constrained possibility of government intervention. Second, the growth of the network economy in the advanced industrial countries implied that investing exclusively in industrial growth was not feasible; information became the center of production (Gereffi 2001). The advent of open-source software allowed the best of both worlds: both the possibility of incorporating highly dynamic software development and the legal license to alter it and customize it to one’s own needs. This generated the possibility for what I call a “constrained strategy of development.”

1.4. The Rise of Open Source Software[6]

The technological developments that led to the present “information revolution” had been brewing since the late-60s and early-70s inside American universities and research complexes. The popularization of the personal computer and the rapid advance of firms to reap the benefits of such innovations accompanied this period of experimentation with new technologies. The early 80s consolidated the era of personal computers. By the early 90s, personal computers became intrinsically linked to the spread of information in an open and fairly unregulated space, called the Internet. The end of the Cold War merely worked as a facilitator to the widespread use and application of this massive technology, generating new political dynamics both inside and outside countries.

The main component of all this "information revolution" is called *software*. The turning point to the production of goods as we used to know happened when, in order to work, the machines needed "a set of rules" to follow, a programming structure that allowed them to receive and process commands. Software represents ideas translated into programming language -- 1s and 0s assembled in such a form as to allow orders to be followed. But much more than that, software is the necessary backbone of technology.

[6] A lot has been written about how to refer to both the software and its creation process, a debate that has major philosophical underpinnings for the open-source community. As a matter of convenience and as a way to make sure that both sides are represented, both “free software” (in the FSF definition) and “open-source software” are used interchangeably throughout the text.

Several ways to "communicate" with computers were created -- programming languages were the basis for the creation of "operating systems", or "meta-programs" that enable a computer to work. At first, operating systems were highly complex and hardly "user-friendly" -- there was no graphic interface and one needed to be fluent in computer programming in order to operate such a program. In the beginning, it was hard to determine what would be the use of computers for anybody, except engineers and hobbyists.

With the creation of the graphic user interface (or GUI), computers became friendlier and acceptable by the mass market. Programs with widespread interest were created such as spreadsheets and word processors, which helped popularize the idea of having a personal computer. In a 20-year span, a new industry (software) was created from nothing, and the focus of the computer industry overall changed from producing and selling hardware (which IBM dominated) to producing software and operating systems (which Microsoft came to dominate).

The creation of software progressively became a controversial issue. In the beginning of the production of “programmed orders for computers” no one was sure of the structure it should have. Since software was produced mainly in academic environments and the market was practically non-existent, questions of patents and property were far away from programmers’ minds – the first generation of software creators had a very specific scientific *ethos*, which stipulated that software would be created on a need-to-use basis,

as a way to solve ad hoc problems (Weber 2004: 35-37). When Microsoft sold to IBM the rights to use their operating system, most of the battle was still being fought over hardware, not software.

One of the first to publicly defend the idea of "free" software was computer scientist Richard M. Stallman. After seeing that most of the software projects developed communally in the early 70s were becoming proprietary and subjected to commercial limitations, Stallman decided to protect what he saw as a fundamental right for the development of new software (Weber 2004: 46-47; Williams 2002: 1-12). The major example for him was the development of the UNIX operating system, which despite having been created in a system of collaboration, due to the sources of funding for the project became a property of AT&T. For him, "closing the code" was a major impediment to the development of new software technology. Stallman decided that he should promote the adoption of "free software" (which he qualified: "not free as in 'free beer'; but free as in 'freedom'"). He developed the GNU Public License[7] -- anything he produced would have its code open, meaning that anyone with the understanding of computer language could not only see "under the hood" of the program but could also modify it to their needs, independently of the permission of its creator. What they could not do initially was to patent it and then sell it as his/her own. Anything released under the GNU Public License would be automatically reproduced under it: a program was born free and would remain free.

[7] http://www.gnu.org/copyleft/gpl.html

Stallman knew that corporations would have little interest in developing software that they could not patent and protect (Williams 2002: 14). However, from the beginning he was not unaware of the possibilities for profit from the software produced under the GNU License: he made sure that software could be sold under the GPL, although always accompanied by its source code. Despite being "free," the software still needed support and documentation, which might also create a demand for services (Weber 2004: 47-48).

This is what progressively happened. What Stallman could not have predicted was its scope: it would be impossible to envision companies such as IBM or Sun Microsystems ever joining forces with the open source community or that major parts of their software code would be made open. A major contributor to the transition of the open source process to the mainstream of the computer industry was brought about by another independent development that profoundly altered the importance of OSS: the creation of the Linux operating system.

When Finnish Computer Science graduate student Linus Torvalds decided to create his own version of Unix in 1991, he had no idea of the impact it would later have – he imagined that only hobbyists would use it. Torvalds worked on a kernel (the "motor" of operating systems) that could run on PCs and posted it on the Internet asking for suggestions and improvements, while immediately making its code "free" to be duplicated or changed (Weber 2004: 54-57). Linux grew in tandem with the Internet and

Torvalds used the global network to build the community around the operating system. He relied on what later became known as the "Linus' Law": "given enough eyeballs, all bugs are shallow" (Weber 2004: 113; Raymond 1999: 30). The experience of contributing to a project that allowed developers to create software without the boundaries of commercial applications was the bonus that many programmers wanted when they joined the Linux community.

It would not be late for companies to realize the potential that lied under this process of production. By the late 90s, just a few years after Torvalds created his kernel, companies that adopted the open source paradigm started to appear, such as Red Hat and VA Linux. It would take little time for other companies already established in the market to realize that the open source community was an untapped source of innovation and test base for applications and ideas. Moreover, as open source programs started to show reliability and to be used on a larger scale, companies started providing hardware and support for anyone willing to adopt OSS for different needs. A critical mass of users (both corporate and individual) had already been providing scale to this new market (Varian and Shapiro 2003: 5-6).

1.5. Governments and OSS Adoption: Autonomy and Development

It is not trivial to implement OSS as new systems in government bureaucracies. There are at least three major problems. First, there are the sheer costs of adopting a new

system (Arthur 1994; Pierson 2000; Shapiro and Varian 1999; Varian, Farrell, and Shapiro 2004 21-25). Once the implementation of a certain piece of software happens, it becomes almost path dependent, because changing would involve not only the transition costs themselves, but also the costs of re-training the labor force that will be using the system. It is difficult to change patterns of software use and ways to organize information that users have been accustomed to accept and consume on a daily basis.

Second, even with the *open* aspect of "open-source," in which the costs of maintaining the software updated diminish (as this is done by the programming community around the world, instead of the need for constant paid upgrades and royalties required by the proprietary company), it does not eliminate the need for software support and maintenance. In fact, the opposite may happen: unlike proprietary software that offers support with the software it provides, OSS requires a pool of programmers that can modify the software to the needs of both the government and the users, as well as provide support for its use.

And finally, due to the commercial implications of the adoption of open-source systems for countries' bureaucracies, lobbying is intense. It is no secret that Microsoft has a major stake in maintaining the *status quo* (Hahn 2002), i.e., preventing the adoption of open-source software. Microsoft is currently investing in a Windows system (Starter Edition) that is exclusively targeted to developing countries. Despite the strategies from companies like IBM and Sun Microsystems that have decided to provide software and

services for open-source architectures supporting large-scale projects, like *OpenOffice* or *RedHat Linux*, for example, Microsoft is still largely dominant in the software market (Weber 2004; OECD 2006: 55).

If adopting open source software is so difficult, how can we explain the recent surge in government usage? And how can we explain the variation that underlies these changes? From an economic perspective, two major explanations can be offered to explain general adoption of OSS. Although these explanations seem reasonable, they do not seem to fully explain the variation in adoption patterns.

The first one is purely *based on costs*: supposedly, the fact that this software is "free" (i.e., with no license fees) can reduce costs of implementing computer systems in a large scale. It is argued that given the availability and open nature of this software, the mere change from paid proprietary software will automatically reduce the costs, strengthening the logic for adoption. However, this seems an incomplete explanation because it leaves out three important factors. The first one, and most important, is that if costs are the main reason for adoption, this does not help to understand the great variation discussed above and it prevents us from understanding why some developing countries adopted OSS while others did not. Second, costs may not be reduced by the implementation of OSS since there are still the expenses of retraining the workforce and paying for software support. Explanations of this kind usually leave out what is called *total cost of ownership* (TOC), which includes transaction costs and time related costs. For now, it is unclear if

OSS possesses any real advantages in TOC (Varian and Shapiro 2003: 12-13), due to the inherent difficulty of measuring some intangible costs. A third factor limiting a cost-based explanation is the inherent assumption that governments choose policies based on cost-reduction. This is an explanation that leaves out the motivation of politicians in regards to government spending, as well as assumes that governments are efficient in all areas.

The second explanation is *technological*: OSS may simply be better software than proprietary software. Although OSS advocates claim that this software is more stable and secure, and even though it appears that in certain cases they are (Varian and Shapiro 2003: 15-16), I remain skeptical of claiming that government adoption is based on mere software superiority. Again, the assumption behind the technological explanation is that governments not only are enlightened in the decision of what is better, but also that they are able to choose efficiently between these options. Moreover, the question of variation remains: if the choice for OSS is based on technological superiority alone, how can it explain the variation among countries?

The two explanations above are incomplete and do not help us fully understand the variations in adoption patterns. While they may point to an *overall* adoption by developing and developed countries alike, I argue that two major factors matter for government implementation of OSS in *developing countries*: autonomy and development. In turn, these factors are mediated by the capacity the state has to implement these new

technologies – I will show through the use of two major case studies that *state capacity* is a fundamental aspect of OSS adoption.

The quest for *autonomy* is a perennial issue for countries, and especially for some. Fear of being trapped in a closed-source system, and thus jeopardizing its own sovereignty in regards to information lead countries to adopt software systems that have an open architecture at their core. By promoting OSS, developing countries can hedge their bets by switching reliance on a few firms with great power to several communities of programmers that produce openly.

States have longer time-horizons than firms: archives and databases have to be both protected and accessible for many years, and in some cases, even centuries. The processes a country uses to organize its information go to the very core of state organization. As technologies get more proprietary and the rules for usage get tighter, countries that depend heavily on foreign technology, that cannot count on a widespread domestic base of technical workforce and programmers, and have large bureaucracies, may have a higher propensity to avoid lock-in risks.

In times of globalization, autonomy is directly connected to the issue of risk-avoidance. For developing countries, diplomatic capital is scarce – these countries usually lack credibility when they threaten to exit from disadvantageous deals or when they try to defy the rules of the system (Borges 2004; Gruber 2000). Choices are constrained in an

international system in which deviance from established paths of prescribed conduct represent retaliation. Remaining autonomous in times of high interdependence does not mean withdrawal – which is far too costly for industrialized countries; instead, it means two things: ability to choose from more alternatives in the future, if needed, *and* the ability to survive the costs of changing, if needed.

The second major factor is development. Adopting OSS presents a transparent and legal way to promote internal technological development (the "constrained strategy of development"). Although the question about the total costs of implementation is debatable, the opportunities for growth generation and upgrading in the IT sector can be better realized if the country has capacity to implement this change. The OECD countries have a major advantage over developing countries: the bulk of the production of software and the expertise to change it is centered there. The major software companies are located in the US and Europe (OECD 2006: 55), where the most trained labor force in software programming also works.8 With a pool of software programmers and developers, the issues of autonomous IT technology or development seem secondary, if not null. In fact, costs can be reduced if a country already possesses a trained and abundant IT labor force and implements OSS.

[8] That may change in the future, but for now the learning centers and the bulk of innovation still come from the advanced industrial countries, especially the United States (in the list of top 10 software companies, 8 are American, while 1 is European and 1 is Japanese) (OECD 2006: 55). As for open source development, there is a wider variation: while major open source projects are located in the US (the Mozilla Foundation, for example), Europeans still contribute massively with code (Weber 2004: 67-70).

For developing countries, implementing OSS can generate the demand and the impetus for further investment in the IT area, both in terms of domestic capital and international capital. By investing in OSS, developing countries can have several benefits: first, they bypass the problems of intellectual property ever present in technology debates, using software tools that have very broad licenses and that several major corporations in the IT world support. Second, they are able to create an "industrial policy" without closing the market with protectionist measures or protecting a priori any specific companies. OSS, ironically, represents an answer to the pressures of liberalization by providing an extreme form of market openness: instead of relying on a handful of firms, the focus changes to the communities that produce the software – anyone can participate, the standards are open, and there is no product lock-in. And finally, governments can concentrate resources on training the workforce for producing and modifying software, which is one of today's pillars to upgrade a country's economy. This is also a policy that tends to create positive externalities through time – by stimulating both demand and offer for programmers, it seems normal that the private sector will join at a future point (the extend of which will depend on the institutions and the variety of capitalism present "on the ground").

1.6. The Structure of this Dissertation

This dissertation is divided into four major chapters, after this introduction. In Chapter 2, I examine theoretically how the connection between the structure of government and its

relation to market forces helps to explain how and why countries adopt open source software or not. Government usage is introduced along with the variation patterns and how the internal institutional complementarities of countries are central to understand how countries adopt this technology. The major theoretical claims are made, differentiating countries according to their models of development.

The third chapter will deal specifically with the statistical evidence of OSS adoption throughout the world. I will explain why we can find stark differences between developed and developing countries' software strategies. While for developed countries OSS adoption varies along the lines of Liberal Market Economies and Coordinated Market Economies, the developing world follows a different logic. With the model presented in this chapter, we can also gauge with more precision how exactly the difference between regions pans out, as well as the differences in national and local OSS adoption. We can also observe that among developing countries there is a marked difference between large, middle-income countries (which I call "middle powers") and small, poor countries, being, in great measure, a function of the state capacity of each of these groups.

The fourth chapter deals specifically with the case of Brazil. A country noted by analysts to be on the forefront of open source adoption, the Brazilian state has had a long history of technology promotion with huge costs involved. I will try to show how the open source adoption policy of the 2000s provided some advantages over previous attempts to

create domestic technology and a path to development, and how it was implemented with the help of key parts of the bureaucracy. The process of implementation still faced several problems, with pressure from multinational corporations and sectors from the government itself. The case of Brazil helps to illustrate the importance of insisting on an industrial policy, even though it does not seem to bring immediate or apparent results, as well as the constant need to boost state capacity in the long run.

In the final empirical chapter (Chapter 5), I will discuss the case of Mexico, where the national government did not adopt OSS. This chapter highlights a case where existing theoretical explanations do not hold well, i.e., where according to the economic models we would predict OSS adoption but there is none. I show why this happens, consistent with the theoretical argument that I develop in Chapter 2. In the final chapter, I relate these empirical findings to broader conclusions.

2. Adopting Open Source Software in Developing Countries: Theoretical Explanations

2.1. Introduction

In the last five years, developing countries have been on the forefront of open source software adoption. However, not every developing country is adopting OSS and those that are adopting it show variation – not only in the ***scope*** *of adoption* (central governments initiating the program of OSS migration or not), but also in terms of ***progress*** *of adoption* (how fast and integrated is the process itself) and the ***depth*** *of adoption* (*mandatory* adoption, *preference* for OSS when choosing software, *recommendation* for use, or just *research*). While in some developing countries the government has been on the forefront of OSS adoption, in others it has refrained from pursuing a more assertive role. Moreover, the will to implement OSS does not necessarily translate into full implementation – some countries have had more success than others.

How can we explain this variation? In this chapter, I argue that there are three major "paths" to OSS adoption and each one is based on what I call the balance between "economics versus politics" or the ability of the state to regulate and impose its rules on market forces. This variation – or three paths – can be traced to the great wave of liberalization among developing countries in the 1980s and 1990s and their reactions to

previous experiences with industrialization (Haggard and Kaufman 1992; Haggard and Maxfield 1996; Simmons and Elkins 2004).

What I will argue in this chapter is that it is impossible to understand patterns of government adoption of OSS without understanding the balance of forces that prevail in certain countries between governments, bureaucracies and firms (and, consequently, the "structure of capitalism" they embody). This balance of forces is in turn a result of how developing countries previously dealt with the wave of liberalization in the 1980s and 1990s – the responses to the challenges of liberalization and internationalization are key to the set of incentives that stimulate or hamper policies of open source software adoption. The argument in this chapter is an attempt to link two collective, aggregated concepts – *development* and *autonomy* – with individual preferences, showing that patterns of adoption are inextricably linked with how society functions and how these preferences are connected with prevailing equilibria.

I will first present the set of incentives of individual actors, highlighting the benefits for each (as well as the problems) of implementing OSS. This helps us understand individual motivations for policy and the possible constraints faced by each actor. I will then proceed to establish the connection between actors' strategies and the causal mechanisms that generate three different equilibria: the *market* path, the *state* path, and the *pendulum* path. Each of these "paths" presents an outcome based on collective responses to liberalization – in each case, the balance of forces between the state and the

market produces constraints that shape individual incentives and the presence of an Information Technology (IT) policy.

2.2. Individual Incentives

What are the individual incentives that create the need to push forward the agendas of development and autonomy? In the case of OSS adoption, the institutional structure in which actors are involved helps to explain the variation in adoption among developing countries.

2.2.1. Government

It is a consensual assertion among political scientists that politicians want to be reelected and stay in power (Mayhew 1974; Hinich and Munger 1997). Either as a means to an end or an end in itself, this goal provides the motivation for any rational analysis of political action (Riker 1982; Mueller 2003). Because of the instability of a political career, politicians are said to be myopic most of the time, i.e., they focus their scarce political capital on what is going to assure them immediate victories and continuation in power (Buchanan and Tullock 1962; Mueller 2003). These assumptions do not mean necessarily that politicians' goals are automatically dissociated from long-term development – at certain points, individual incentives are aligned with the implementation of long-term policies, especially in cases where short-term rewards are

also present.

How can politicians in government benefit from the adoption of OSS? There are three major incentives for going the course of OSS:

(1) *OSS may provide governments with a "visible policy" that allows credit claiming* – The discourses of cost-saving and technological edge are powerful. By stressing the supposed savings brought about by the adoption of OSS as well as the benefits of openness, the government creates a strong sense of caring about the budget and being on the forefront of the "digital revolution" and "e-government." If the government expands the policy to include public schools, the impact can be even greater, since this creates a direct link between governments and constituencies. In developing countries, public schools are mostly frequented by the poor, which allows for credit claiming in larger groups.

(2) *Bringing the middle-class in* – The government can provide a "free lunch" to the middle-class (and gain political support in return), by offering training and technical jobs *inside* the government. These jobs provide security and mobility for employees, and the government reduces the risk of upsetting the prevalent equilibrium without a radical disruption in educational policies. The government would also be in charge of training the middle-class to use OSS by investing in jobs as a way to guarantee support and a skilled base of programmers with good technical education.

(3) *Overcoming international obstacles* – Adopting OSS does not create the need for protectionism (which can be divisive at home) and generates no friction with litigation in international forums in regard to the intellectual property regime. It is a form of promoting an "industrial policy" of information technology without the previous costs of the import substitution (ISI) policies of the last century (lack of incentives for innovation, inefficiency in production, creation of long-term entrenched interests, and trade retaliation from developed countries, for example).

What are the disincentives to the government's goals? Again, there are two main factors that can prevent or delay adoption:

(1) *Internal lobby of coordinated software firms* – If there is a previously established domestic software industry, if it is coordinated and it already represents a significant proportion of the economy, the calculus of implementation for the government is complicated. If firms are able to present a credible threat to the political group in power, the policy has few chances of being implemented – the logic of concentrated losses and diffuse benefits applies here (Haggard and Kaufman 1992).

(2) *Bureaucratic capacity* – It is extremely difficult to implement this policy if the bureaucracy does not have the capacity to implement it. Although the government might have perfectly good individual reasons to go forward, it needs to count on a bureaucracy

that can reliably stay the course (Evans and Rauch 1999). Even if the policy appeals to the bureaucracy and is aligned with the bureaucracy's incentives, this may not be enough – it may not have the tools or be too fragmented to actually implement the policy.

2.2.2. Bureaucracy

According to Max Weber's work, bureaucratic capacity is synonymous with modernization and the professionalization of the state. Weber identified the creation of a professional corps as the single most important development of the modern era (Weber 1958). By creating predictable career goals, valuing merit, and insisting that a state worker needs a specific kind of training to operate efficiently, the modern state could not only *plan* its actions, but could also serve as springboard for development itself, employing a new kind of trained worker. These workers could also have the advantage of larger time horizons than politicians, since they would not need to be bound necessarily with the current administration (Huber and Shipan 2002).

The nature of bureaucratic work, again according to Weber, is to scientifically coordinate and implement political goals by finding the right "means" (Weber 1958). Bureaucrats, however, the same as other workers, respond to incentives. The economic literature that promotes the virtues of free markets has, rather successfully, maligned bureaucrats. The mere use of the word invokes images of inefficiency and inaction at best, and at worse, corruption and rent-seeking (Tullock 2005). By focusing on "means," the bureaucracy

can have a great deal of discretionary power. Not only does it understand how things operate inside the "machine of the state," it can also provide more or less support for certain policies by the way it implements them.

How can bureaucracies benefit from OSS implementation? There are three main incentives for the bureaucracy:

(1) *More control over processes* – Implementing OSS guarantees access to the source code and gives the bureaucracy great leverage over what is installed and how information is organized. This is a way to customize *de facto* how the government operates, transferring this power from firms' proprietary software to the bureaucracy's own vision of how this software should work. Instead of using proprietary pre-packaged software that is produced to cater to a greater scope of consumers, the bureaucracy can tailor OSS to its own needs, without the fear of infringing patents or the need to wait for future versions of the programs it requires.

(2) *More control over the budget* – Budget money that used to be allocated to purchase licenses tend to stay "in-house" and can be used in many other ways, often chosen by bureaucrats themselves. This does not mean specifically that money is saved, but assuming bureaucracies have no incentives to decrease their own budget, they can have more control over how they spend this money. Using this money in training or purchasing hardware, for example, can increase bureaucratic control significantly. Even

if there are no substantial differences in the final budget, more money is used to the bureaucracy's discretion.

(3) *More leverage out of future governments* – Having more control over how things are implemented means creating path dependent conditions inside the state. Bureaucrats use their power of implementation to "lock-in" their own software architecture, making present policies more resilient over time. Bureaucrats use OSS as a means to reduce dependence on firms and future administrations. This need for control mostly arises because of the asymmetry of time horizons between the bureaucracy and the government (Pierson 2004). By controlling the tools of implementation now, bureaucracies guarantee that the costs of change for a government that intends to change the structure in the future are significantly increased.

What are the main disincentives to the bureaucracy regarding an OSS policy?

(1) *Bureaucratic infighting and organized lobbies* – Bureaucracies are not monolithic. Inside groups that are connected to opposition lobbies may delay and disrupt the policy from the inside. Lobbies have the potential of dividing and influencing the bureaucracy either with bribes or with the possibility of offering jobs outside. This is mitigated by the political support the bureaucracy can guarantee from the government and the degree of cohesion it maintains. For example, strong ministries that are in charge of technology may push policies more effectively than a piecemeal policy implementation. However, if

the bureaucracy is not reasonably insulated from every outside political force, it can be easily captured by special interests, thus hampering government efforts to apply a coherent policy change.

(2) *Bureaucratic inertia* – Bureaucracies are, by nature, averse to change. It is difficult to overcome inertia because of established habits and ways of doing things – institutionalization is at the soul of bureaucracies. Overcoming inertia requires new ways of implementing policy and involvement of key sectors. The main leverage a bureaucracy can have over a government is being able to control the means to policy implementation; in other words, the bureaucracy's power is a *de facto* veto power. Time and institutionalization are bureaucratic allies -- the more control a bureaucracy wields inside the state over time, the greater is the resistance to obey policies from above that may undermine its coherence, and the more the government is forced to delegate authority in order to get things done. Not working with the bureaucracy may mean policy deadlock for governments – which can be fatal for politicians' shorter-term horizons. Sometimes, governments are forced to dismantle whole bureaucracies instead of reforming them because of enormous resistance to change.

2.2.3. Firms

Firms are more ambiguous actors. They have both long-term and short-term strategies, which can be either favorable or disrupting to policy implementation depending on how

government's decisions and bureaucratic implementation affect them. Firms can be vocal supporters or vocal opposition, in some cases having great leverage over financial support for parties and politicians or having the means to lobby. They are flexible actors; even in places where there is an "unfriendly" market atmosphere, firms can still prosper by adapting to unfriendly conditions.

Despite having the means to lobby, it is not always the case that this will happen. Firms face a typical problem of collective action – they would rather not spend resources and time protesting for something from which other firms might also benefit, without coping with the costs (Olson 1965; Hardin 1982). That is why firm coordination is the key to understanding political pressure – the degree to which domestic firms are coordinated may explain why governments make decisions that affect them. Strong business associations, for example, mean stronger pressure on governments and bureaucracies. What are the motivations of firms?

(1) *Selling software to the government* – Firms that produce and sell proprietary software are usually at odds with OSS implementation. If the government has a specific policy of mandatory use or preference for OSS, the business model in which these firms operate is directly threatened.

(2) *Control over licenses and upgrades* – The business model on which proprietary software is based requires a certain degree of "lock-in" in order to keep selling upgrades

when firms decide no longer to support previous versions of a program or operating system. There is a great incentive to keep producing new versions and to keep restricting both the level of support for previous versions and the backward compatibility with older data. Moreover, required features can only be added if this is in the best interest of firms, not in the client's.

The level of coordination between firms is essential to lobby and the pressure the government and the bureaucracy against the implementation of OSS. If there are established and strong entrepreneurial associations or lobbying groups for these companies, it is harder for governments to oppose them (Schneider 2004).

2.2.4. Social-Economic Groups

How does the population (the potential voters and constituencies) fit in? I assume a basic societal division into two groups that can be found in different degrees practically everywhere (with all the caveats involved in a broad comparison)[1]: the middle-class and the poor.

These groups do not necessarily need to be voters, but I assume that they have an impact on developmental policies – one or both groups provide the basis for governmental support and, depending on their strategic moves, can promote or hinder development,

[1] This division has been used elsewhere in comparative studies as a way to simplify groups in order to study their interaction. See, for example, Boix (2003).

responding to incentives created by government and the market. For each of these groups OSS can have a different impact.

(1) *The poor* – The poor can gain indirectly from the OSS policy. They can get more access to computers (as the middle class) through subsidized low-cost computers or from the use of computers in the public education system, since the overall price of the computer tends to fall because the government does not have to negotiate prices for operating systems or software running in them. They may also benefit in the long term if the demand for technical jobs is increased over time. Since the "visible" part of OSS tends to target the poor, this could increase their chances of computer literacy. Again, OSS is not a salient issue for poor supporters of the government, unless it is connected to access to computers.

(2) *The middle-class* – The middle-class may have the most to gain from governments' implementation of an OSS policy. The middle-class gets two kinds of benefits: more access to computers and, potentially and more importantly, more access to jobs. The OSS policy can facilitate the consumption of computers by lowering their final cost and can generate demand for training in technical jobs. In developing countries, the middle-class is much less mobile than the wealthy. Their capacity for relying on the private sector for secure jobs is lower than public sector jobs.[2] Usually, the middle-class is a product of industrialization – where the state has been able to grow and invest, a middle-

[2] It is therefore not surprising that the middle-class has been one of the loudest groups against privatization in developing countries, especially in Latin America. See, for example, Lora and Panizza (2003) and Baker (2003).

class was created to support it (Huntington 1968; Evans 1995; Kohli 2004). For the middle-class, the costs of this policy are small: as long as it does not represent a threat to either job security or to the education system, it can benefit from the policy.

It is important to point out that the middle class will only support a policy of technological change if it can see the benefits of training in a particular environment. If the technological opportunities are seen as insufficient or risky, they tend to prefer stability over change.

2.3. Strategic Interaction and the Effects of Liberalization

As previously argued, both *autonomy* and *development* play a central role in the adoption of OSS in developing countries. These two concepts, both of which can be connected to individual preferences, help explain why developing countries have taken the lead in this initiative and why the role of the national government is seen as central to make the policy work. The pursuit of this policy is a function of a constrained set of options, limited both by the domestic political process and international conditions.

When I refer to *autonomy*, I mean *the ability to avoid long-term commitments and dependency by maximizing the control of information.*[3] The basic principle behind autonomy is the need to reduce the costs of changing policies in the unknown future. As

[3] When I refer to "control of information," I am not implying any kind of media censorship or the like. I refer here to the ownership of the tools and *know-how* for development.

the costs of uncertainty are increased (especially in the case of developing countries), the need to avoid commitments also increases. This rationale applies in many cases: for example, if a country bases its agricultural exports in a sole product, its whole economy can collapse if market conditions change in the future or if the product becomes a commodity; if a worker is only trained to perform a certain kind of work, he/she can find him/herself out of work if the market changes and his/her abilities are easily found elsewhere. Control of information (i.e., know-how and diversification of production in the first case or multiple abilities in the second) can guarantee that the costs in the future will not be as high if change is needed. As Keohane and Nye show, for example, this is a clear case of *sensitivity* to changes in policy (Keohane and Nye 2001: 10-11). More autonomy means more negotiating power and less dependency on outside uncontrollable forces. The fewer resources a country has, the more vulnerable it can become in the face of changing conditions. Having a big internal market, for example, may help shelter countries during a crisis.

When I refer to *development*, I mean *the ability to upgrade industrial capacity, upgrade human resources and innovate*. Development does not automatically mean growth -- although growth is a necessary condition, it is not sufficient. Growth may be the result of policies that have little to do with long-term development, in activities of resource extraction, for example. In order to produce development, it is necessary to have both state capacity and the establishment of an equilibrium that can generate positive externalities. Development has to do with how well institutions can complement each

other to create the possibility of reaping the benefits of long-term investment, be it in terms of infrastructure or human capital. In the case of developing countries, in order to grow, a functioning market must be supported by a broader set of policies that only the state can provide (Wade 1990; Amsden 2001, 2007; Rodrik 2003). By the state, I mean the state apparatus (i.e., the bureaucracy), which can have longer-term horizons than the politicians in countries where institutions keep changing and the "rules of the game" are usually fluid.

Despite the differences in specific and local histories and institutional configurations, countries tend to cluster in one specific aspect: they present certain institutional equilibria that hinder or stimulate divergent development paths. The way in which institutions interact and complement each other generates ideal-typical varieties of capitalism that are sustained through time (Soskice 1999; Hall and Soskice 2001). These configurations have a broad range of influence on how capitalism is organized – specific characteristics, that range from how firms are organized to the shape of the financial sector and labor market, vary sharply in coordinated market economies and liberal market economies. While these varieties of capitalism have been studied in advanced industrial democracies, there has been little work so far regarding developing countries.

For the past century, the developing world has been resorting to a number of techniques in order to break away from its cycle of underdevelopment and guarantee more leeway in terms of policy implementation. States require both the capacity to implement policies

(i.e., some degree of bureaucratic competency) and the technologies to effectively bolster production (i.e., the ideas and tools for economic development). These two "capacities" are deeply connected to what I call *autonomy* and *development* – it is both necessary to have the means of implementation as well as the technological tools to achieve the goal of development.

Developing countries have certain equilibrium configurations that tend to hinder development and perpetuate the *status quo*. Because of the institutional complementarities existing in such countries, patterns of (under)development tend to endure – when institutions embody a certain kind of capitalism, they tend to reinforce it, constraining choices and creating incentives for the society at large to stick to that equilibrium. Therefore there is no *single* problem for governments to address – solving just one problem at a time may not be enough to overcome an underdevelopment equilibrium; even if governments have the political support and will to make an effective change, understanding the prevalent equilibrium in a given society *as a whole* is the only way to address the developmental bottlenecks. In addition, the international system tends to reinforce these patters of institutional complementarities because it traditionally offers developing countries little opportunities for technological upgrading – technology being at the center of comparative advantages of developed countries (Gerschenkron 1962; Wade 1990; Amsden 2007).

One of the attempts to achieve both autonomy and development has been to rely on protectionist policies and to isolate the bureaucracy into technocratic unaccountable groups expecting that they could steer developmental policies (Schneider 1993; Geddes 1994). Both *developmentalism* and autarky were prevalent in great part of the so-called "Third World" during the 20th century. These policies had many benefits in terms of creating industrial conditions in countries that previously had none (Evans 1995). In some of these cases, this developmental moment was also essential for the creation of a stable middle-class, for example (de Ferranti et al. 2003; Kohli 2004).

However, with the acceleration of the technological and liberalizing forces of the 1990s and the increasing costs of closeness, the previous developmental model became hard to sustain. Beginning in the 1980s and continuing throughout the next two decades, there has been a progressive opening of economies in the developing world (Keohane and Milner 1996; Simmons and Elkins 2004; Milner and Kubota 2005). For some developing countries, especially in Latin America, liberalization meant a hard blow to the established middle-classes, as the state could not sustain its own growth anymore and countries could not compete with the technological innovation from abroad merely from closing their markets and expecting that innovation would happen endogenously without the incentives to upgrade their industries (Amsden 2007: 127-135). Responses to this ISI crisis were not the same across the developing world nor did they happen simultaneously – reforms were a function of how countries were affected and how policymakers perceived the degree of success of previous experiences with industrialization.

Usually faced with macroeconomic crises, countries that decided to liberalize markets were faced with the dilemma of "economics versus politics" (or "state vs. market"), i.e., trying to define the degree to which the state could regulate and impose itself on market forces. I argue that in order to understand the balance of forces inside countries and to understand the paths of OSS adoption, we need to focus on how countries embraced the liberalizing process and what kind of institutional configurations these choices generated. In the next section, I identify three of these configurations, (or "paths") that gave way to different policy results in terms of further IT policy and OSS adoption in particular.

2.4. The Three Paths of OSS Adoption

When talking about the OSS implementation, there are three major paths that may lead to three different outcomes: (1) The Market Path; (2) The State Path; and (3) The Pendulum Path. These "paths" are all connected to previous experiences of industrialization in each country and the subsequent liberalization of the 1980s, 1990s and 2000s. Each one presents a stylized model of how the state interacted with market forces and re-shaped each model of capitalism in developing countries. These responses to liberalization led to different incentives for social groups, the state and firms. I will explain the logic behind each of the three paths and how these paths generated each approach to the OSS policy.

(1) The Market Path

When countries choose the "market path," the state willingly gives up most of its ability to impose itself on the market. It is the market and not the state that is able to steer development and to assure its *de facto* independence from the state apparatus. The economies of these countries rely heavily on market discipline and the reduced capacity of the state to restrict market transactions.

For developing countries, the market path usually comes about when the state and economic elites perceive previous experiences with industrialization as failures. These perceptions are usually associated with sharp crises or collapses that impelled policymakers to revert previous protectionist policies and to rely on open markets for development, in effect abdicating of the possibility of directly intervening on market forces. This "victory" of economics over politics marks a sharp turn against the concept of autonomy and the belief that only the market can correctly allocate resources for development. Decisions about economic development are not decided at the government level, but are decided by decentralized market forces. In this "path," governments are inherently skeptic of "industrial policies" of any kind, since they automatically involve some kind of intervention.

Developing countries that rely on the market path are very unlikely to adopt OSS policies. The main thrust of technology production (if any) will be based on market

forces – which means the government will make no efforts to implement OSS from top down; proprietary software will prevail given the overall strength of business compared to the state. In the market path, governments have no incentive to interfere with business. Market forces also tend to weaken bureaucracies – they are less coherent, present less job security and have shorter-term horizons. The middle-class cannot rely on the state for jobs or training and needs to go into the private sector counting on what the market can offer. Skills are usually non-specific and there is little incentive to learn OSS, since the basis of the information technology sector heavily relies on proprietary software.

This basic causal mechanism for the market path is summarized in Figure 2.1:

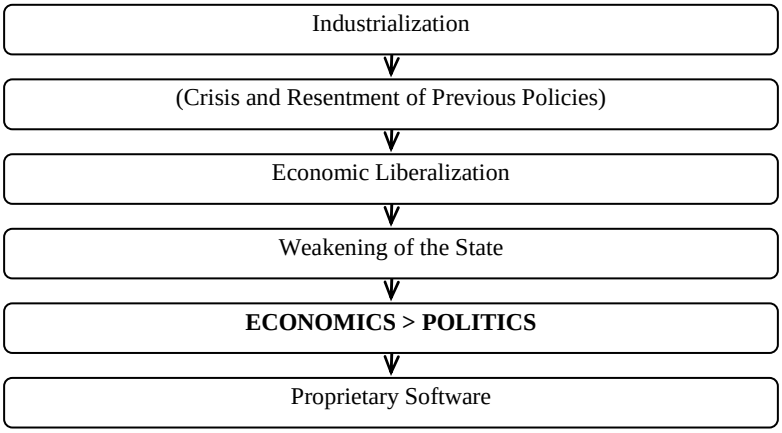


Figure 2.1: The Market Path

In countries where economics trumps politics -- where business is stronger than the state – we would expect to see no OSS adoption.

(2) The State Path

The state path represents the opposite side of the market path. Here, the state, even though it might have opened its economy to foreign investment, never gives away the power to regulate, interfere with, and direct market forces. The state here remains strong, in some cases even authoritarian. Even though market forces might play a role, the state has the prerogative over the market – it might change the rules when it decides, and its bureaucracy has a strong say in the direction the economy should go. Market forces are subject to state discipline, not the other way around, which means that the state selects which sectors it needs to promote and then create incentives for market forces to act.

For developing countries, the state path appears in two cases: when the state had the capacity to resist liberalization or when previous experiences with industrialization were perceived as successful by the state and economic elites. The state structure remained intact and isolated from the market, keeping bureaucrats focused on long-term goals and state policies, rather than shrinking the state and relying on market forces. This represents the "victory" of politics over economics, where industrial policy is seen as an essential function of the state and where market forces need to remain controlled.

Developing countries that rely on the state path are very likely to implement OSS, either because it makes sense in terms of developmental policy and autonomy concerns or because it does not have any support of the market. These countries are more likely to implement OSS decisively, relying on the strength of the bureaucracy to carry it out. In these countries, governments will try to set the standard of OSS to business, and bureaucrats have strong incentives to implement OSS because they can effectively maximize control. The middle-class has an incentive for training in OSS because it knows it can either credibly rely on the state for jobs or go to the private sector that is adapted to the state discipline. Relying on the state means that the middle-class can acquire more specific skills and guarantee that it can be employed no matter where it decides to go.

This basic causal mechanism for the state path is summarized in Figure 2.2:

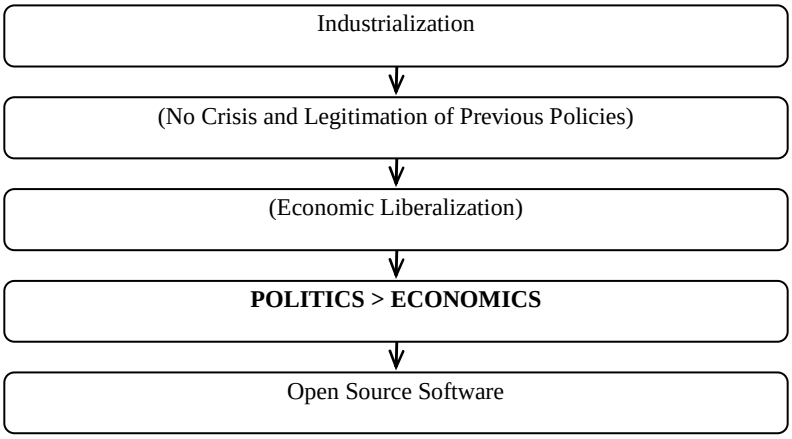


Figure 2.2: The State Path

In countries where politics trumps economics – where the state is stronger than business, I would expect to see strong OSS adoption.

(3) The Pendulum Path

The pendulum path is the middle ground between the two other paths. It happens when there is no clear predominance of either market forces or the state. Two main forces create a tension with each other: the power of legacies and the necessity to change. For the countries on the pendulum path, liberalization was never the first option among political elites – liberalization was either delayed or unenthusiastically adopted. Although market forces tend to be powerful, the state still maintains part of its power to influence industrial policy and promote development. Because of the perception of "successful" past experiences with the previous developmental model, liberalization was never completed and positions "swing" according to political forces. Like a pendulum, it oscillates between moments of more liberalization and setbacks to previous practices. Autonomy and development are defined contextually, depending on the feasible alternatives available to policymakers.

For developing countries, the pendulum path can take place in two scenarios: either countries experienced limited liberalization of the state since the need for change or they experienced fast but unsuccessful liberalization and had subsequent setbacks. In those

cases, the state structure is not isolated from market forces, but it presents a resilience that prevents drastic changes. Bureaucrats still have some discretionary power and constantly struggle for more control. These countries usually present "lock-in" politics – i.e., groups that attempt to consolidate a certain policy for a more extended time-horizon. Because of that, political struggle and lobbying usually take place inside bureaucracies, not on the usual political battleground. With the pendulum path, there is no clear "victory" of either politics or economics – they are in constant struggle for control.

On this path, countries are likely to experience difficulties with OSS implementation – either struggles inside the government, strong differences between local and national patterns of adoption, or only partial implementation of OSS. In these countries, governments still have an incentive to implement OSS because of autonomy and development, but they are more aware of bureaucratic problems and political in fighting. Business has a strong incentive to pressure the bureaucracy to avoid change, while the bureaucracy tries to gather support for its own form of implementation. The middle-class still has the incentive to acquire skills in OSS if the government is able to offer jobs and guarantee job security and mobility.

This basic causal mechanism for the pendulum path is summarized in Figure 2.3:

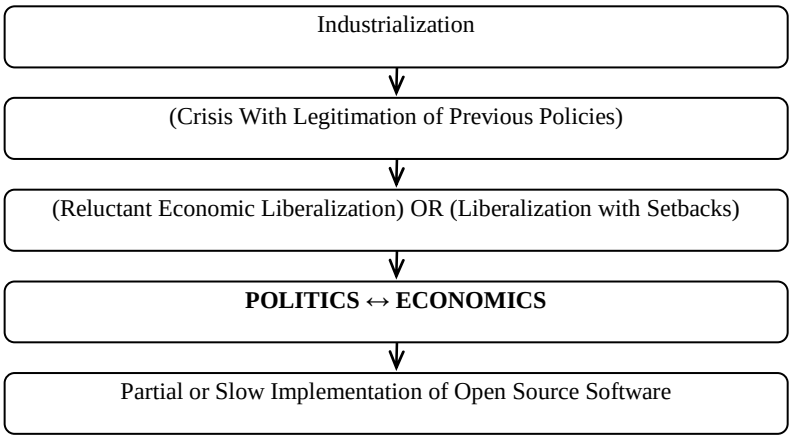


Figure 2.3: The Pendulum Path

In countries where there is no clear winner between politics and economics – where the state struggles with market forces for control – I would expect to see either partial or slow adoption of OSS.

In the next chapter, we will see how well the paths translate into the empirical record by examining the cases in developing countries that adopted or not OSS and their subsequent experiences with the process. I apply a grading system to measure both the *centralization/decentralization of adoption* (central governments initiating the program of OSS migration or not), and the *progress of adoption* (how fast and integrated is the process itself).

3. The Determinants of Open Source Software Adoption

3.1. Introduction

In the last chapter, I made the theoretical connection between countries' responses to liberalism and open source software adoption. The main idea proposed was that countries that chose a certain "path" to development (the market path, the state path, or the pendulum path) would produce a certain set of incentives and constraints for the actors involved. In turn, these equilibria would favor or hamper open source software (OSS) adoption and actors would respond accordingly. The paths are ideal-types created to highlight the connections between incentives and outcomes, which I argued help explain why certain countries are or have been adopting OSS while others were not, and how the process is being carried out in the countries that adopted OSS.

Given that the paths were approximations of a more complex reality, how do they translate into countries' real adoption experiences? In this chapter, I will make the connection between the theoretical paths and data from a newly collected data-set on governmental efforts throughout the world to implement OSS, pointing out both the differences and similarities between them. In order to compare different experiences, I create a measure of OSS adoption.

As I have argued in chapter 2, the logic of OSS adoption differs sharply between developed and developing countries. Public policies toward OSS in the former depend on where they fall on the Varieties of Capitalism dimension (Hall and Soskice 2001). For reasons discussed above, LMEs prefer proprietary software whereas CMEs prefer open source.

OSS adoption—and in particular government attitudes and policies toward OSS—follow a different logic in developing countries. Among developing countries, too, my theoretical argument leads me to expect a marked difference regarding OSS adoption. Not all developing countries are alike, but it is not the LME-CME distinction that matters here (if it is applicable to developing countries at all). Rather, the main difference among developing countries, I have hypothesized, concerns their states' efforts to build and maintain technological policies geared towards development. The countries that had a significant experience with industrial policies, and continue to do so, are those referred to as "middle-powers", "regional powers" or "whale countries". The majority of these countries have invested heavily in state-led (but not necessarily state-controlled) development, using the advantages of the scale of their own markets and labor force to "jump stages" of development (Chang 2002).

If the theory is correct, we expect to observe that (1) developed countries adopt OSS according to the Varieties of Capitalism logic; (2) developing countries vary among themselves -- while the "middle-powers" tend predominantly to adopt OSS, less-

developed countries with no previous ISI experience or technological/industrial policies tend to refrain from adopting OSS (or for that matter, even having a software policy); and (3) differences within the "middle-powers" can be explained by the strength of the government vis-à-vis the market actors.

3.2. The Data

3.2.1. Refining the Dependent Variable: the Adoption Index

One of the greatest challenges to this research is finding empirical measures of open source software adoption, which are sufficiently differentiated to allow me to test the theoretical argument, yet also sufficiently general to be valid measures across all countries. Measuring the success or failure of such policies is not easy for several reasons. First and most importantly, government data on software usage by public bureaucracies simply does not exist beyond a few countries. This lack of data has a simple practical reason: as my field research in Brazil showed[1], software purchase decisions are decentralized and uncoordinated even in quite centralized state bureaucracies. In most countries, each government agency has traditionally decided its own software purchases, with little or no oversight over what is bought and why. In fact, I have argued that the bureaucratic patterns that cause the lack of data create one of the incentives for OSS adoption. Decentralized and uncoordinated software adoption has led

[1] For details, see Chapter 4.

to inefficiencies, including buying different pieces of software to perform the same functions. These choices have tended to be made by each successive administration, leaving bureaucrats with little or no control over what got installed. The adoption of OSS thus came to be seen by some as a way to rationalize the structure of installed software and to guarantee consistency throughout the whole system of computers in state agencies.

Another problem for gathering data on OSS adoption is that the technology is still very new, and any policies regarding OSS therefore have to be are all fairly recent. The Brazilian case again illustrates the problem: Despite being one of the first countries to create an OSS policy for software adoption, the announcement of the Brazilian policy was only made in 2003 and its implementation is still underway. Other countries, even if faster in implementation, still have little to show in terms of the consequences that OSS might generate. It is too early to assess if an OSS policy will be resilient enough to undergo changes in governments and the coalitions supporting them. Focusing on longer-term consequences of OSS policy such as whether it yields the hoped-for increased economic development would have to take into account several dimensions that are beyond the scope of this research, such as diverse macroeconomic variables and controls for many other factors. The debate on the causes of economic growth is multifaceted to the point of confusion.[2]

[2] From the size of nations (Alesina and Spolaore 2003) to religion (Barro 2002), from language fragmentation (Easterly and Levine 1997; Easterly 2001) to political competition (Bueno de Mesquita et al. 2001), the proliferation of variables seems hardly conducive to a consensus in the short-term.

Given the lack of resources to pursue an up-to-date assessment of success or failure of OSS adoption, the main strategy of measurement of the dependent variable is not to focus on *results* but to focus on *attempts*. Trying to implement a policy is visible and generates a trail – groups inside countries have found many ways to push forward OSS adoption or to block it. These efforts show a great degree of variation and detailed accounts of those efforts are available for many countries from the work of James A. Lewis (2006). To examine my hypotheses systematically, I have built an original dataset of OSS adoption policies in both developed and developing countries. Specifically, I have encoded several quantitative variables, which measure various aspects of OSS adoption policy and can be analyzed statistically, thus allowing a panoramic view of the process on a global scale.

164 countries are included in the data-set. The data collection from Lewis is merely descriptive. I coded his narratives of OSS policies into three indicators, which will serve as the key dependent variables:

- **local**: Number of local initiatives, i. e., how many attempts to implement OSS at the local level (in regions, provinces, states or cities); if a city, province or state has tried to implement legislation regarding OSS adoption or has promoted research regarding OSS, it is counted here;

- **national**: Number of national initiatives, i. e., how many attempts to implement OSS at the national level; if the central government or the national Legislature has tried to

implement legislation regarding OSS adoption or has promoted research regarding OSS, it is counted here;

- **oss_action (composite index)**: This is an ordinal variable trying to measure the level of OSS adoption by a country. It ranges from 0 to 6 and its formula is:

  1 point if only local adoption;

  2 points if only national adoption;

  3 points for both local and national;

  PLUS

  1 point if proposal is R&D and/or Advisory;

  2 points if proposal is Preference and/or Mandatory on Local Level;

  3 points if proposal is Preference or Mandatory on National Level;

In order to get these last points, the proposal must have been approved by Legislatures and/or sanctioned by the central administration. National decisions have more importance than local decisions in the final score in order to make sure that the number of local adoptions does not overpower the number of national attempts (a country can only have a few national attempts but can have many local attempts.).

This variable is created to give us a rough measure of adoption attempts across cases. The distribution of points for each country gives weight to local adoption first, then national adoption and to both national *and* local adoption if possible. This is

complemented by a distribution of points for the importance of the proposals (one point if the proposal is only about research and development or advisory, and more points if open source software is preferred or imposed on the local and the national levels). So, if a country has never attempted to use OSS, it gets zero points. If, for example, it only tried to adopt OSS at the national level and this proposal was for the mandatory use of OSS, it gets 2 points plus 3 points, and its *oss_action* rating is 5. A country with the maximum number of points (6 points) must have both local *and* national attempts and the national attempt must be either preference or mandatory use of OSS.

Although these are simple variables, they allow us to see results in several ways according to the local/national differences and to rank countries according to their adoption of OSS. There is an inherent difficulty when constructing an adoption index that is not completely ordinal, but the index is able to capture a magnitude of importance given to adoption attempts, both at the local and national levels. Some simple descriptive statistics of these variables will be shown below.

3.2.2. Refining the independent variables: definitions and measurements

My theoretical framework suggests that (1) there are stark differences between developing countries and developed countries, as well as differences in the group of developing countries ("middle powers" vs. "the rest"), that (2) there are differences within developed countries – these differences can be explained by a Varieties of

Capitalism logic, and that (3) the differences within “middle-countries” can be explained by the strength of the state vis-à-vis the market.

To test these propositions, I first need to identify the samples (developing vs. developed countries, the middle powers). After discussing my choices regarding the samples, I will turn to the discussion of the operationalization of the key independent and control variables.

As argued in the last chapter, developing countries had different experiences when faced with the pressures of liberalization. As some readily embraced the process of reforming the state and pursuing orthodox economic policies, others chose to remain in control of the market, by establishing industrial and technological policies of their own. In the middle, a group of countries were not able to complete or engage thoroughly in the reforms – the balance of power between the state and market forces pushed for discontinuous policies and "stop-and-go" liberalization.

There are two important points to be made regarding liberalization. The first one is the concept of liberalization I employ. For the developing world, liberalization came mostly as an exogenous force – in Latin America in the 1980s and Asia in the 1990s, due to a series of strong financial and economic crises connected to the international system these regions were presented with stark choices for their development models (Stallings and Kaufman 1989; Haggard and Kaufman 1992; Kahler 1992). In this sense, I treat

liberalization as a constraining factor on developing countries – each country calculated its costs and benefits of implementing liberal reforms according to its strength, its political forces at the moment and, more importantly, the perception of elites regarding previous experiences with industrialization.[3]

The other important distinction to be made regarding liberalization is the more political nature of the concept I use. While usual indicators of liberalization such as the reduction of tariffs or the opening of the financial sector to foreign capital are commonly used to describe liberalization, these indexes do not give us a satisfying picture of the role of the state in the economy -- they are incapable of capturing the weight of the state in the economic realm or, in other words, incapable to show precisely *to what extent the state defines economic goals instead of the market*. This definition is central because this balance is precisely what sustains certain development paths instead of others. Moments where the state redefines its role *vis-à-vis* the market are rare[4] – they can be triggered either by external crises that change the structure of costs and benefits for the domestic

[3] It is important to point out that this dissertation does not see liberalization as imposed, but as a set of constraints offering costs and benefits to countries, much in the way Keohane and Milner use the term "internationalization" (1996). There are different views in a broader debate, exemplified by Simmons and Elkins (2004), about how liberalization spreads from country to country, painting a different picture than the view of "imposed liberalization" presented in many analyses of the role of the IMF and World Bank conditionalities – see, for example, Stiglitz (2002).

[4] These changes are even rarer in advanced industrial democracies – institutions are firmer and more resilient through time, while the political struggle concentrates around issues instead of the rules of the game. It is not coincidentally that it is easier to establish clusters of "varieties of capitalism" for the OECD countries than for the developing world.

political forces or because of internal substantial changes in the political balance of power.

Given this definition of liberalization, it is difficult to find "pure" cases of either total liberalism or total state control empirically, as this would mean either complete anarchy or no market. However, as previously argued, theoretically countries can be positioned within the three major paths that are reflective of their experiences with liberalization.

To measure the independent variables, I use several variables from the World Development Indicators (WDI) database of the World Bank and other sources. To measure the strength of the state vis-à-vis the market, I use a variable called *total tax rate (% of profit)* -- which is the total amount of taxes payable by businesses (except for labor taxes) after accounting for deductions and exemptions as a percentage of profit. While clearly only a proxy, this variable picks up the actual level of involvement of the state in the economy. Alternatively, I employ a rough and aggregated measure of market liberalization: the Heritage Foundation scores for freedom around the world, ranging from 2000 to 2005.

Regarding control variables, my data-set includes a host of measures that can be expected to drive a country's adoption of OSS. I will discuss all variables and the rationale for including them in more detail below. But for the sake of the big picture, let me preview by saying the control variables relate to countries' technological development (*broadband*

subscribers (per 100 people), *research and development expenditures* (as % of GDP), and a measure of *international Internet bandwidth* (in bits per person); all from WDI).

In order to test the argument that the adoption of OSS correlates with the need to curb software piracy, I included a measure of *software piracy rate* from the Annual Business Software Alliance and IDC Global Software Piracy Study, which gets crime related statistics from most countries regarding software piracy. If the software piracy theory is correct, we would expect to see a strong correlation between OSS adoption and software piracy.

I also include several control variables that are important to the study. In the sample, I control for the size of industry, GDP per capita, Internet users (per 100 people), personal computers (per 100 people), and finally, information and communication technology expenditure (as % of GDP).

3.3. The Results

3.3.1. Descriptive Statistics on the Dependent Variables

Given that my data-set is the first to provide a systematic snap-shot of OSS policies across the world, a few descriptive statistics are warranted to familiarize the reader with the data. Table 1 breaks down the four key dependent variables described above, by

region (OECD countries, “middle powers”, developing world). The differentiation between (rich) OECD countries and “developing” countries is fairly straightforward; the identifications of “middle powers” are not. Later in this chapter, I will offer a detailed justification of my coding decisions. But for now, I simply want to take it as given and present some descriptive data.

Most of the activity on OSS adoption is done in the developed world (i.e., OECD countries), but middle powers come fairly close. As can be seen from the first row in Table 1, all measures of OSS adoption policies are – on average – highest in OECD countries. For example, the average number of local initiatives in OECD countries is 2.96 (with a range from zero to seventeen), while the same number is only 1.27 for “middle powers” and close to zero for all other developing countries. We see similar patterns if we look at simple descriptive statistics with respect to national initiatives (second column), the overall intensity of OSS activity (third column), and the mere presence of OSS activities (last column). 87% of OECD countries and 67% of “middle powers” have some sort of OSS activity (last column). Only 21% of all other 125 developing countries pursue some sort of OSS action.

These simple descriptive statistics confirm a first key prediction of my theoretical framework: that OSS activity will be qualitatively different in developed countries, “middle power” countries, and poor countries – while in the first we will find a "bottom up" local ad hoc approach to OSS adoption, in the second we will find a "top to bottom"

industrial policy approach to OSS adoption. As for poor countries, we will observe almost no OSS activity.

Table 3.1: OSS activities in different regions of the world

	Number of local initiatives [local]	Number of national initiatives [national]	Intensity of OSS activity [oss_action]	Presence of OSS activities [oss_presence]
OECD countries (N=24)	2.96 (0/17)	3.52 (0/9)	4.04 (0/6)	0.87 (0/1)
Middle powers (N=15)	1.27 (0/9)	2.93 (0/10)	3.20 (0/6)	0.67 (0/1)
Rest of World (N=125)	0.02 (0/1)	0.41 (0/7)	0.75 (0/6)	0.21 (0/1)

Notes: Displayed are average levels for each of the four measures of presence and intensity of OSS activities, over each variable's (minimum/maximum). See text for definition of variables.

Figure 3.1: Distribution of OSS activities in different regions of the world

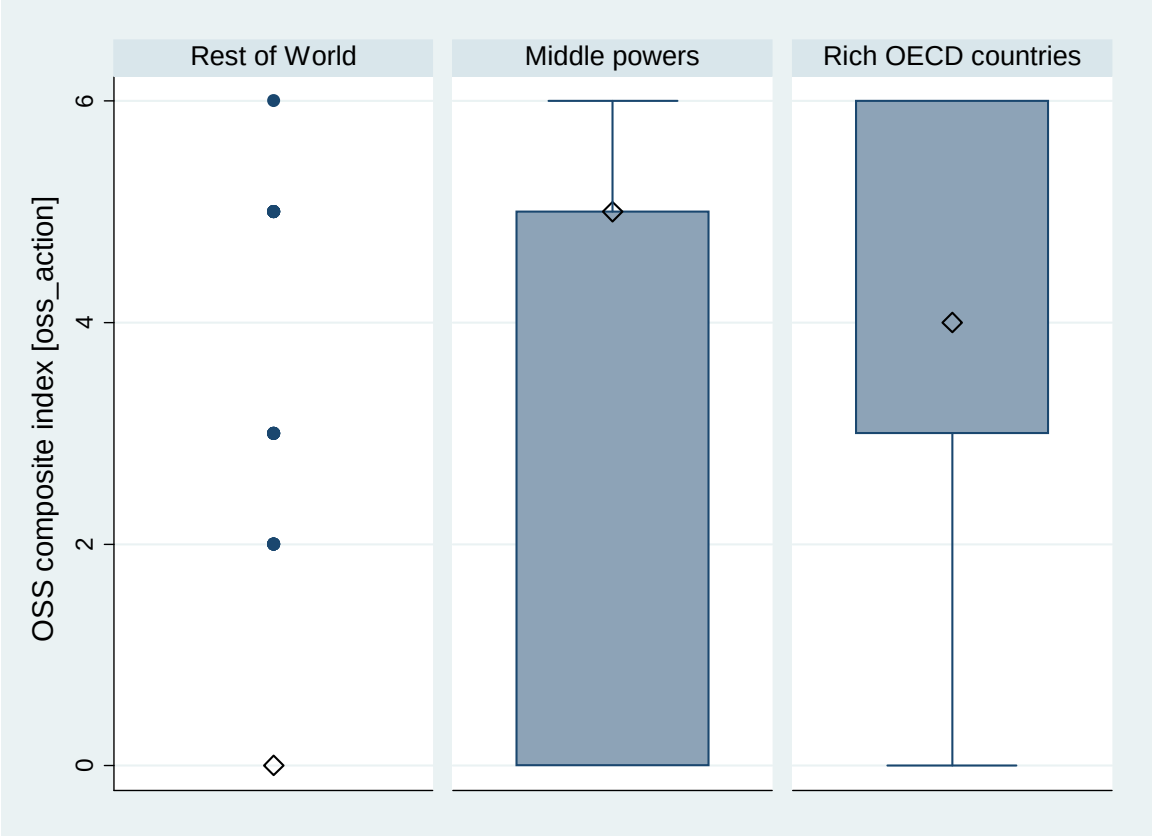


Figure 1 presents some more information on the distribution of OSS activity across the three regions. The Figure draws a vertical box plots (also known as whisker diagram). As is common, the box plot for each region indicates five numbers of the distribution: the smallest and largest 'non-outlier' observation (zero and six in each region) are indicated by the bottom and top-whisker, respectively. The lower and upper quartiles (25^{th} and 75^{th} percentile) are indicated by the filled box. In the residual category (rest of world), that box is collapsed to the point zero; in the middle powers box plot are, the interquartile range goes from zero to five, while it reaches from three to six in rich OECD countries. The fifth point of the distribution indicated by a hollow diamond in the Figure is the median value. It is zero, five, and four, respectively. The box plot for the residual category also indicates outliers by filled circles.

The box plots confirm the impression from Table 1, but add further information to it. The single-most OSS common outcome in the 'rest of world' sample is zero. Most OSS activity happens in rich OECD countries, although – interestingly – the median OSS activity is higher in the middle powers countries.

While the averages across a large number of countries already enable me to draw some conclusions, they also hide a lot of interesting variation within each of the three regions I distinguish. My theoretical framework not only makes predictions about different levels across different 'types' of countries, but also offers conjectures about the relationship of OSS and a number of (different) variables inside OECD and "middle power" countries.

The next two Tables, therefore, disaggregate the data for these two sets of countries to set the ground for exploring the logic of adoption both among developed countries, as well as the adoption among "middle powers". Table 2 shows the data for the OECD countries.

Table 3.2: OSS activity in OECD countries

	Number of local initiatives [local]	Number of national initiatives [national]	Intensity of OSS activity [oss_action]	Presence of OSS activities [oss_presence]
Australia	8	3	5	**1**
Austria	1	1	5	**1**
Belgium	2	6	**6**	**1**
Canada	0	1	3	**1**
Denmark	0	5	5	**1**
Finland	1	3	4	**1**
France	3	**9**	**6**	**1**
Germany	6	**9**	**6**	**1**
Greece	0	0	0	0
Iceland	0	1	5	**1**
Ireland	0	1	3	**1**
Italy	7	7	**6**	**1**
Japan	2	5	3	**1**
Luxembourg	0	0	0	0
Netherlands	3	3	4	**1**
New Zealand	0	0	0	0
Norway	2	4	**6**	**1**
Portugal	0	3	5	**1**
Spain	10	**9**	**6**	**1**
Sweden	0	2	3	**1**
Switzerland	2	1	4	**1**
United Kingdom	4	6	4	**1**
United States	**17**	2	4	**1**

Note:
Maxima are highlighted in **bold**.

We can observe that the overwhelming majority of OECD countries have had experiences with open source software adoption. As an example, the United States has had 17 local experiences with OSS adoption. However, the OECD countries as a whole do not give us the complete picture. Below, I will explain the observed differences among them using a Varieties of Capitalism approach.

With the countries I call "middle powers" the experience is a bit different. Table 3 has the data:

Table 3.3: OSS activity in middle powers

	Number of local initiatives [local]	Number of national initiatives [national]	Intensity of OSS activity [oss_action]	Presence of OSS activities [oss_presence]
Argentina	4	2	**6**	**1**
Brazil	**9**	**10**	**6**	**1**
China	1	8	**6**	**1**
Egypt	0	0	0	0
India	5	4	5	**1**
Indonesia	0	2	5	**1**
Iran	0	1	3	**1**
Mexico	0	0	0	0
Nigeria	0	0	0	0
Poland	0	1	2	**1**
Russia	0	0	0	0
South Africa	0	3	5	**1**
South Korea	0	**10**	5	**1**
Turkey	0	0	0	0
Vietnam	0	3	5	**1**

Note:
Maxima are highlighted in **bold**.

Table 3 shows that the logic of adoption is fairly uniform across middle powers, yet some differences remain and beg for explanations. Very few among these countries refrained from experiencing open source software and almost no countries from this list (apart from Argentina, Brazil, China, and India) have had any local experiences with OSS adoption. Most of the adoption occurs at the *national* level. Before we turn to a more detailed analysis of the middle power experience, I will discuss the differences among OECD countries in some detail in the next section.

3.3.2. Varieties of Capitalism

One of the major questions regarding OSS adoption is: what are the reasons (if any) for developed countries to apply these policies? If my reasoning is correct, we should see differences between Coordinated Market Economies and Liberal Market Economies regarding the adoption of OSS. The division established by Hall and Soskice (2001) presents a persuasive theoretical case for these groups of countries' different approaches to software policies. I have argued above that LMEs should favor a market-driven proprietary software approach to government policy, whereas CMEs should see in OSS a good mechanism of coordination between different levels of government and a holistic policy regarding the rationalization of software usage, given their institutional advantages of coordination via the state. CMEs have a strong incentive to invest in open source software in order to reap the benefits of OSS adoption. According to this logic, we would expect to see CMEs not only adopting more, but also adopting more at the *national level*,

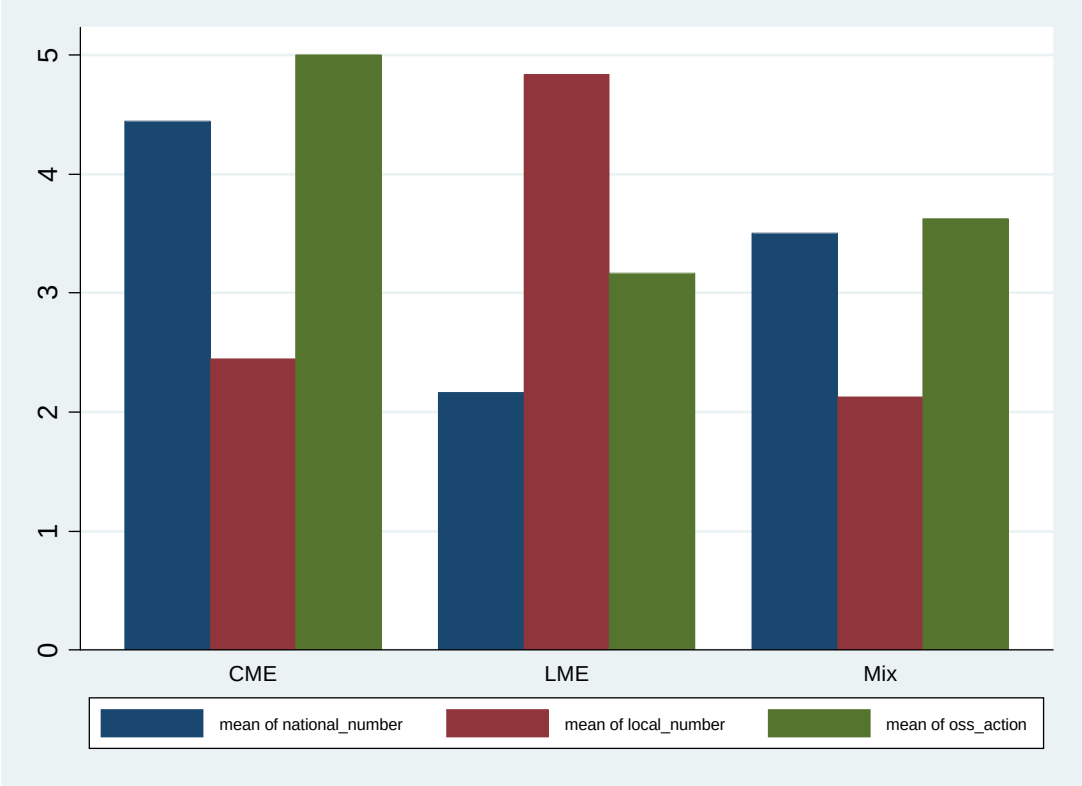
as a national government policy. Table 4 shows that that these hypothesized patterns turn out to be fairly accurate:

Table 3.4: Varieties of Capitalism and OSS adoption

countries	VoC	national_number	local_number	oss_action	oss_presence
Austria	CME	1	1	5	1
Belgium	CME	6	2	6	1
Denmark	CME	5	0	5	1
Finland	CME	3	1	4	1
Germany	CME	9	6	6	1
Italy	CME	7	7	6	1
Netherlands	CME	3	3	4	1
Norway	CME	4	2	6	1
Sweden	CME	2	0	3	1
Australia	LME	3	8	5	1
Canada	LME	1	0	3	1
Ireland	LME	1	0	3	1
New Zealand	LME	0	0	0	0
United Kingdom	LME	6	4	4	1
United States	LME	2	17	4	1
France	Mix	9	3	6	1
Greece	Mix	0	0	0	0
Iceland	Mix	1	0	5	1
Japan	Mix	5	2	3	1
Luxembourg	Mix	0	0	0	0
Portugal	Mix	3	0	5	1
Spain	Mix	9	10	6	1
Switzerland	Mix	1	2	4	1

The overall composition of OSS adoption in developed countries shows that there is confirmation for the theoretical ideas expressed. In the sample, the countries that do not correspond specifically to the CME-LME categories are represented as mixed. If we chart the results, we can have a better picture of adoption:

Figure 3.2: CMEs, LMEs, "mixed" countries and OSS adoption



Even if we exclude the countries that are usually not in the VoC-literature samples (Greece, Iceland, Portugal, Spain, Switzerland) and classify the “mixed” countries as CMEs, the results still hold. By running t-tests to see whether these differences are statistically significant, and using the data from the figure below (LMEs and CMEs only, with "mixed" countries as CMEs), it turns out that most of the differences in the figure are statistically significant, both at the *national* and *local* levels (CME>LME, significant at 5%) and with *oss_action* (CME>LME, significant at 10%).

The logic seems to hold for the division established by Hall and Soskice (2001). OSS adoption seems to fit well with coordination at the national level. One additional piece of evidence is that the state's involvement with the economy and the institutions it uses to regulate is qualitatively different in Coordinated Market Economies and Liberal Market Economies. The economies that are better positioned to take advantage of the economies of scale that OSS adoption has to offer are CMEs and they are being able to capture these advantages.

Although this logic seems to hold for developed countries, in the case of developing countries the picture is subtler.

3.3.3 Middle Powers

According to the logic spelled out in the theoretical chapter, I point towards a substantial difference among developing countries regarding OSS adoption. When breaking

countries into the binary categorization of developing/developed, we tend to leave aside some differences that matter greatly for the explanation not only of OSS adoption, but also for differences in industrial policy in general. In the developing world, there is strong evidence that some characteristics matter when we group these countries, even to the point that goals and strategies for development differ profoundly and even antagonistically.

Although these divisions are very common theoretically, they have proven to be difficult to develop empirically. There is a strong disagreement by theorists of who should be included in an "intermediary" list between developing and developed countries. These countries correspond loosely to what Wallerstein (1979) referred to as the "semi-periphery" of the world capitalist system, being connected both the "core" countries (the ones that are most dynamic in the production of technology) and the "periphery" (which are countries that basically produce commodities and raw materials for export). Not only is his categorization outdated, he has also difficulties when presenting a coherent list (1979: 100). In his list, he mentions countries that hardly compose a "semi-periphery" now (countries such as Portugal, Spain, Canada, and Australia, for example) and that cannot be classified as "developing."

Wallerstein also ignores an important characteristic that also marks the importance of some developing countries over others -- a modicum of regional importance, both economically and politically. As Keohane (1969: 295) pointed out, there are some states

that do not qualify as "system-determining" states, but need to be taken into account as "system-affecting" states. Again, although the differentiation makes intuitive sense, it is hard to create an effective list of countries that correspond to it.

Almost by accident, a new type of classification has become the center of attentions, even theoretically. The investment bank Goldman Sachs came up with a list of major developing countries in terms of GDP and predicted that, by 2050, these countries will have a larger combined GDP than developed countries (O'Neill et al. 2005). This list only involves four countries (Brazil, Russia, India, and China) with thoughts of including another one: Mexico (O'Neill et al. 2005: 4).

Apart from discussions about a precise list of "middle powers" or "regional powers," there is something different, at least theoretically, about these countries that needs to be captured for my purposes.

My list of "middle powers" takes into account a combination of three major criteria for inclusion: a high GDP, significant population, and political-economic importance in their regions. A high GDP roughly corresponds to the BRICs (Brazil, Russia, India and China) criteria, while significant population means that there is the possibility of building economies of scale in their internal markets, presenting an incentive to invest heavily and coordinate production inside the country. Taking these criteria, I classify the following countries as "middle powers":

- Brazil
- Russia
- China
- India
- South Africa
- Argentina
- Mexico (even though it belongs to the OECD)
- Turkey
- Iran
- South Korea (even though it belongs to the OECD)
- Indonesia
- Nigeria
- Egypt
- Vietnam
- Poland (even though it belongs to the EU)

Exploring the determinants of OSS activity in the "middle powers" empirically is not easy. A key problem is the small number of observations with available data (a maximum of 15), making causal inferences based on statistical work difficult. This is one reason why I also conducted case studies (see chapters 4 and 5).

For the middle power countries, my theoretical framework suggests that it is a government's primacy over the private sector that makes development strategies relying on OSS more likely. On the one hand, this is a concept which shies away from empirical operationalization. On the other hand, it is also a concept which has "taxation" written all over it - in particular, taxation of business. Therefore, the main variable I use to measure the presence of the state in the economy is called *total tax rate (% of profit).* This is a

measure of a government's actual capacity of taxing profits as a proxy for the concept in question.

There are at least two downsides that are specific to this variable. First of all, the WDI does not report data-points for this variable before 2005. Therefore, the values on this variable refer to 2005, i.e. a few years later than the other control variables - and potentially a little bit after the dependent variable. Fortunately, the available data-points suggest a high degree of stationarity, therefore making it less problematic to effectively extrapolate the values backward. Second, one of the observations in my sample (Argentina) reports a value of more than 100% on this variable. Given that governments can tax state owned companies beyond unity (usually in order to hide debts), a value beyond 100% on the "Total tax rate (% of profit)" variable isn't too surprising. However, since this variable reports the mean across all companies, more than a 100% is problematic. I therefore run every model in three incarnations: (1) using the unchanged WDI-variable "Total tax rate (% of profit)"; (2) using the same variable, but dropping Argentina; (3) using the same variable, but top-coding it (effectively: Argentina) at 100%. Fortunately, it turns out that these choices make little difference. The results reported below refer to option 2, i.e. dropping Argentina from the sample of middle countries.

Having elaborated on the key explanatory variable let me discuss some potentially important control variables. Before doing so, however, let me stress that there is no

literature I can rely on to justify my choices of control variables. So, here I have to pay tribute to the novelty of my approach. However, it is not particularly challenging to come up with off-the-shelf variables that scholars might want to suggest as alternatives.

To economize on space, I will only elaborate on four control variables. I ran my models with many other control variables as well, with fairly similar results. I believe that four factors can be easily suggested as potentially important explanatory variables when it comes to a country's OSS adoption. Interestingly, I find it somewhat difficult to predict the direction of the impact of each variable. All these variables correspond to data from 1997 to 2000, which is previous to the experience with OSS adoption.

(1) A country's economic well-being, as measured by its "GDP per capita in 2000 US$, in thousands". As just mentioned, it is difficult to predict the direction of the relationship of a country's wealth and its proneness to adopt OSS. On the one hand, one could expect that rich countries are taking licensing issues more seriously and are therefore more likely to switch to OSS (so, we would expect a positive relationship between OSS and a country's wealth). On the other hand, it also seems perfectly reasonable to conjecture that governments of poorer countries have massive incentives to push their country to adopt OSS. Overall, it is difficult to formulate a simple hypothesis regarding a country's GDP per capita and its OSS activity. But these issues are, by and in themselves, worth exploring empirically.

(2) Secondly, OSS activity might simply be a function of a country's involvement in the Internet. To account for this, I include a variable called "Internet users (per 100 people)" into my multivariate analysis. Again, it is somewhat difficult to come up with clear-cut predictions regarding that variable. Do individual users want to be participants - even if this means using illegal software - , or do they rather want to be "legal for free", and opt for an OSS alternative? Hard to tell. As with (1), this is an empirical question which will be explored below.

(3) A country's commitment to OSS may have little to do with the factors I propose in my theoretical framework; rather, they may simply relate to a country's involvement into promising technologies, which I measure by a country's "information and communication technology expenditure (% of GDP)." But, once again, it's not straightforward to predict the direction of the relationship between this explanatory variable and my dependent variable.

(4) For the reasons exposed before, it is important to include a measure of "Industry, value added (% of GDP)" in order to see if the presence of industry influences the results. Again, it is difficult to formulate firm expectations regarding the direction of the relationship.

Tables 5, 6, and 7 contain the results for three different dependent variables: OSS adoption at the national level (Table 3.5), OSS adoption at the local level (Table 3.6), and the OSS composite index (Table 3.7). Each of the Tables contains six models. All of them include the key explanatory variable (total tax rate as % of profits). Models (2) to

(5) add one and only one of the four control variables, while Model (6) contains all variables at the same time.

Overall, the results are reasonably supportive of the hypotheses developed above – they are particularly strong when it comes to OSS adoption at the local level. When consuming the regression results, the reader is reminded of the very small sample size (14 observations). The purpose of the regression analysis is to explore the correlations between potentially relevant important variables and OSS adoption.

Table 3.5 shows that the total tax rate variable is significant in more than half of the models – most importantly in the most complete model including all control variables (Model 6). In that model, the significant coefficient of size 0.145 suggests that changing the total tax rate from the minimum value in the sample (about 30) to the maximum value in the sample (about 82) increases the predicted level of national OSS initiative by about 7.5 – a very substantive effect given that the national OSS initiative variable ranges from 0 to 10.

However, it is somewhat worrisome - but given the sample size not entirely surprising – that the results in Table 3.5 are fairly unstable. The goodness of fit measure (adjusted R2) bounces around quite a bit, and two of the control variables (GDP per capita and Internet users) are significant when added separately, but insignificant in Model (6).

Overall, then, the results displayed in Table 3.5 are encouraging, but cannot fairly be taken as a very strong confirmation of the hypothesis.

Table 3.5: Regression Estimates for National as the Dependent Variable

	National					
	(1)	(2)	(3)	(4)	(5)	(6)
Total tax rate (% of profit), <100	0.0537	0.0649	0.0970*	0.100**	0.0677	0.145**
	[0.0519]	[0.0542]	[0.0473]	[0.0418]	[0.0524]	[0.0464]
Industry, value added (% of GDP)		0.126				0.264
		[0.151]				[0.154]
GDP per capita (constant 2000 US$ in thousands)			0.826**			1.052
			[0.342]			[0.918]
Internet users (per 100 people)				0.405***		-0.041
				[0.128]		[0.379]
Information and communication technology expenditure (% of GDP)					0.403	0.506
					[0.340]	[0.283]
Constant	0.232	-4.679	-4.203	-3.558	-2.414	-18.63*
	[2.851]	[6.555]	[3.028]	[2.464]	[3.582]	[8.482]
Adjusted R2	0.00541	-0.0204	0.291	0.433	0.0381	0.493
Observations	14	14	14	14	14	14
Note: Standard errors in brackets, * p<0.10, ** p<0.05, *** p<0.01						

This is different when it comes to the results in Table 3.6, which has the local OSS initiative variable as dependent variable. The key explanatory variable is highly significant in all models, and the coefficient is quite stable. Also, the control variables are consistently insignificant, and the adjusted R2 measure behaves well. The substantive effect when looking at a change from the minimum to the maximum sample value on the tax rate variable is an impressive (almost) 4.9 (the dependent variable ranges from 0 to 9).

Table 3.6: Regression Estimates with Local as the Dependent Variable

	Local					
	(1)	(2)	(3)	(4)	(5)	(6)
Total tax rate (% of profit), <100	0.0841** [0.0301]	0.0748** [0.0304]	0.0957** [0.0327]	0.0892** [0.0333]	0.0881** [0.0319]	0.0941* [0.0416]
Industry, value added (% of GDP)		-0,105 [0.0848]				-0,041 [0.138]
GDP per capita (constant 2000 US$ in thousands)			0,221 [0.237]			0,522 [0.823]
Internet users (per 100 people)				0,0443 [0.102]		-0,155 [0.340]
Information and communication technology expenditure (% of GDP)					0,116 [0.207]	0,12 [0.254]
Constant	-3.263* [1.656]	0,821 [3.680]	-4.452* [2.094]	-3.678* [1.962]	-4.022* [2.180]	-3,801 [7.603]
Adjusted R2	0.343	0.37	0.336	0.295	0.303	0.202
Observations	14	14	14	14	14	14
Note: Standard errors in brackets, * p<0.10, ** p<0.05, *** p<0.01						

The results in Table 3.7, which has the composite index as a dependent variable, are quite disappointing. None of the variables turns out to be significant (although the total tax rate variable fails to be significant in Model (6) only by a small margin).

Table 3.7: Regression Estimates with the Composite Index (oss_action) as the Dependent Variable

	Composite Index					
	(1)	(2)	(3)	(4)	(5)	(6)
Total tax rate (% of profit), <100	0,0335 [0.0359]	0,0426 [0.0371]	0,0412 [0.0401]	0,0486 [0.0379]	0,0456 [0.0350]	0,0709 [0.0435]
Industry, value added (% of GDP)		0,102 [0.103]				0,139 [0.145]
GDP per capita (constant 2000 US$ in thousands)			0,147 [0.290]			0,0579 [0.861]
Internet users (per 100 people)				0,131 [0.116]		0,0727 [0.355]
Information and communication technology expenditure (% of GDP)					0,347 [0.227]	0,393 [0.266]
Constant	1,271 [1.974]	-2,701 [4.485]	0,483 [2.563]	0,0415 [2.231]	-1,008 [2.391]	-7,71 [7.953]
Adjusted R2	-0,0099	-0,0122	-0,0766	0,0136	0,0917	0,0553
Observations	14	14	14	14	14	14
Note: Standard errors in brackets, * p<0.10, ** p<0.05, *** p<0.01						

The correlation and regression exercise in this chapter then provides a mixed picture. The developed hypotheses have mixed support, depending on which of the three dependent variables is employed: OSS adoption at the local level, at the national level, and the OSS composite index. While the results for the OSS composite index are disappointing, they are encouraging for the national OSS adoption, and very strong for the local OSS adoption variables.

Given the small sample sizes and the challenging operationalization problems on both sides of the regression equations, we cannot make too much of the bi- and multivariate findings for the middle-countries anyway. Even the supportive evidence (mainly found in Table 5 and, especially, Table 6) just displays correlations and does not guarantee causation. To trace causalities (Büthe 2002), the next chapters will present case studies of Brazil and Mexico.

3.4. Conclusion

Three major conclusions can be drawn from the data results. These numbers tell us about the logic operating in regards to OSS adoption.

(1) Advanced industrialized countries tend to follow "Varieties of Capitalism" (VofC) logic when deciding whether to adopt or not. It is important to remember that for all of them it is not a matter of saving money or fighting

software piracy that are the major drivers of the results. For developed countries, it matters greatly if the institutions that underline their economic and political model are best suited to "capture" the gains of adopting open source software. The United States present an excellent case of comparison. Most of the development of OSS came from the US – not only the concept of creating software from this model, but also the further contributions to its spread (Weber 2004: 20-25). Despite having major proprietary software companies, the US also has some of the larger open source software companies, that rely on the "software as a service model" made possible by the advent of OSS. Despite that, its experience in OSS adoption at the national level has been negligible, and the fact that its whole system of training and coordination is based on market forces actually tends to create better incentives for the production of proprietary software and solutions. A further analysis that could be pursued in future works is to understand the connection between centralization/decentralization regarding political systems and OSS adoption. On the other hand, countries that are Coordinated Market Economies tend to overwhelmingly adopt OSS and tend to do it at the national level. This pattern is what the logic of the theory leads us to expect. It is important to mention that there is no automatic connection between being a CME country and actually adopting OSS, but their incentives are geared towards making use of the scalability and rationalization of systems provided by the top-to-bottom adoption of OSS. They are better able to re-train

personnel and to reap the benefits of contracting people to maintain it, rather than buying the software itself.

(2) "Middle Powers" tend to adopt OSS, and almost all of the ones that adopt it, do it primarily at the national level. The prediction of the theory is that they have major incentives to do it, since they have the capital to invest, internal markets that are sufficiently sophisticated to reach the technological/informatics sector, and last but definitely not least, they have the drive to implement these policies. The important question that remains is that not all of them follow this logic despite the prediction of the theory – Mexico and Russia are excellent examples of deviant cases. Why is that the case? In the next chapters, I will analyze both a "successful" case (Brazil) and a "non-event" case (Mexico) to spell out the differences between them. But it is important to point out right away that their differences are not due to potential (both countries could well implement these policies if they so chose to do it) but a matter of strategy.

(3) The great majority of countries (which comprise most of the developing world) do not adopt OSS at all. Why is that the case? According to the same logic spelled out regarding the case of "middle powers," countries that fall below a certain threshold of GDP-power-population and/or have not had previous experiences with industrialization, will have a hard time adopting OSS or even having coherent industrial/technological policies. The incentives

> for adoption are stacked against them: either they have small internal markets (which would dictate a more pressing need for openness and reliance on free markets) (Katzenstein 1985) or they have institutional complementarities that are not conducive to coordination at either the local or the national levels. This also comes to show that OSS adoption is hardly a silver bullet or a recipe for development – these results show that in order to implement OSS, some preconditions, usually regarding the equilibrium between state and market, must be met.

In the next chapter, we will see qualitatively how the experience of Brazil corresponds to the numbers and we will try to understand the rationale and the process of adoption itself.

4. The Case of Brazil: Changing the Development Paradigm

4.1. Introduction

Many open-source software advocates cite Brazil as an example of successful implementation. Brazil has been using OSS for some time in several areas -- from ministries to schools, with different results. The decision to fully change the state of software in the Brazilian government officially started with Luis Inácio Lula da Silva's administration in 2003, though there had been some previously localized experiences throughout the government. To have an "official" software policy was new; not only was it extremely difficult to have such a policy for logistic and bureaucratic reasons, but there were also no previous experiences of system-wide changes for software implementation in Brazil. Predictably, the move generated controversy and opposition from both outside and inside the government.

Why promote a change that was difficult and costly? I will argue that the main reasons were autonomy and development – motivations that were not new to the Brazilian state apparatus, but often present in different permutations according to opportunities in the international system and the internal configuration of the state in particular junctures. The Brazilian decision to adopt OSS can be seen as a *feasible strategy of development* – not necessarily because it presents "*the best*" path of development (this issue will be

discussed in the concluding chapter), but because it was *available* as an option, given a restricted set of choices.

Brazil's investment in OSS promotion from the top level of government has not come out of a vacuum. The Brazilian state has a long tradition of attempts of creating technology that began with the ISI experience in the 1930s and continued with variations throughout the 20th century (Vigevani 1995: 73). In the realm of computers, the experience with the "informatics" industry, promoted by the state during the 70s, represented a bold attempt to create autonomous technological capacity (Evans 1995). These efforts to develop autonomous technology were inseparable from the goals that sustained a consensus about the developmental model Brazil should pursue.

This consensus persisted until the late 80s, when it became clear that the model was exhausted and could not be sustained with resources from the Brazilian government. At that point, being a closed economy represented a major setback for Brazil, since the country did not have available capital for the research and development of new technologies, neither the resources to buy the technologies from abroad, or even the proper incentive structure to attract foreign investment in applied technological research. Despite having created a sizable informatics industry from scratch (as well as other sophisticated industries, such as the aeronautics industry or the petrochemical industry), Brazil's computer program -- sustained with great losses and at the cost of diplomatic

disputes with the United States in the 80s -- was terminated during Fernando Collor de Mello's administration in 1992 (Vigevani 1995; Evans 1995: 207-209).

Acquisition of technology became a major hurdle for developing countries in the 1990s, especially those that struggled with transitions to free-market economies. With the increased presence of TNCs in the global economy, the autarkic model of complete independence from foreign capital/technology/trade could not be sustained. While the goals of autonomy and development were never abandoned, renouncing the increasing internationalization became costly, especially for intermediary countries like Brazil, with a perennial fiscal crisis and the difficulties to directly finance production (Keohane and Milner 1996; Evans 1992). The decade was marked by a progressive retreat of the state in the creation of indigenous technology both directly or through coordination with firms.[1]

Despite the changes in the international system, Brazilian society still had some of the problems that the *técnicos* (engineers or technically-trained people) identified in the late 70s – a dearth of qualified technical jobs for the middle class, which was still symbiotically connected to the state, an underdeveloped sector of indigenous creation of technology, and the always apparent need to "jump stages" and go from the export of agricultural products or commodities to the export of technologically sophisticated goods.

[1] There were a few notable exceptions such as Embrapa (which develops applied research for agriculture), Petrobras (the oil state company) and the financing of pure science in universities.

Open source software presented the Brazilian state with a renewed opportunity to focus on the creation of a technology policy by using tools that were simply not available at the time of the creation of the "informatics" policy. Three major shifts allowed for this opportunity. First, the landscape of the computer industry had dramatically changed, moving the focus from hardware to software. Hardware became commodified as Moore's law predicted -- computers progressively became more powerful while prices became lower. This time, software pushed the computer industry in the realm of ideas and information, creating a major shift in production processes.

Second, protectionism became too costly a strategy. After being retaliated against by the United States in the mid-80s for protecting the computer industry, by the early 90s Brazil was a constituent part of the push for liberalization in the WTO and had significantly opened its economy. The country could not sustain the costs of closure both internally and externally. There was simply very little capital to invest in an area that requires constant openness in order to thrive. Defying both the world and Brazilian society by closing the informatics industry again would have been politically impossible, even for a leftist government.

Third, OSS signified that the battle for software would not be fought along the intellectual property frontier, as was the case with the pharmaceutical industry and the long battle in the WTO for the creation of generic drugs, for example. Open source software presented the Brazilian state with a public good that was reliable, flexible and

worked with no strings attached. Moreover, the policy could be "translated" into the language of electoral politics: by promoting "inclusion" and a "computer for everyone", the administration made sure that this opportunity could be converted into political cash.

In the next sections, I present the Brazilian experience with computer policies, in two distinct moments – a first effort (from the 1970s to 1980s) to create autonomous technology through a native computer industry and the recent moment of OSS implementation (in the 2000s). Both experiences reflect a persistent willingness to promote policies based on the ideas of *autonomy* (trying to avoid industrial and technological lock-ins) and *development* (trying to expand the base of technically trained workers and to create and sustain a viable middle-class). These experiences, however, are constrained both by the opportunities offered by the international system at each particular time, as well as the domestic possibilities.

4.2. The Challenge of the "Informatics" Policy (1974-1985)

By the late 60s, it was unlikely Brazil would ever build a computer industry (Evans 1995:107). Despite growth rates of almost 10% a year, the country seemed poised to import the computer power that it needed – which, at the time, was basically composed of mainframe machines. According to the logic of comparative advantage, Brazil had very little incentive to invest in an area in which it had no distinct advantage. Building computers, as the argument goes, was clearly economically inefficient – much needed

resources would be channeled into an area already dominated by several major international players (including the greatest of all, IBM) and in which Brazil had very little expertise.

Despite the gloomy economic predictions, up until then the Brazilian experience with ISI was considered to be a major success among part of the Brazilian elites and the nationalistic sectors (Kohli 2004: 167-168). Both the steel industry (*Companhia Siderúrgica Nacional*) and the oil industry (*Petrobrás*) could be seen as examples of a struggle to create industrial capacity where previously there was none, and at both instances despite having been denounced as a folly by classic economic theory (Bielschowsky 2000; Vigevani 1995: 87). The military dictatorship was more than willing to promote the increasingly interventionist state in order to reap the benefits of growth and continue to foster state production in several areas. The first oil crisis in 1973 did not diminish the government's enthusiasm for ISI, because the legitimacy of the regime was by then tightly connected to Brazil's economic performance. President Geisel's second National Development Plan (II PND) and second Basic Plan of Scientific and Technological Development (II PBDCT) incorporated the call for the creation of an autonomous computer industry (Vigevani 1995: 84).

From the beginning, the goals of the group that pushed for the creation of a Brazilian computer industry were multiple (Evans 1995: 107-109). Known as the *barbudinhos* (young bearded men), this group of recent PhDs in Computer Science from American

universities (mainly from Stanford and Berkeley) was returning to Brazil with little hope to get the jobs they wanted. Developing computers in Brazil was an impossibility given the lack of research and development from TNCs inside the country or the lack of Brazilian firms that developed native technology. The best jobs one could hope to have were in sales (usually for IBM), assembly plants, or processing data for the Brazilian government (Evans 1995: 107). Despite the wish to create a sizable number of *técnicos,* the industry simply did not exist by the early 70s, apart from the presence of the already mentioned IBM, which sold imported computers to the Brazilian market.

The *barbudinhos* also saw this lack of qualified jobs in the computer industry as a major problem for the growth of a middle class. They knew right then that lack of opportunity to work with technology was translated into "brain drain" – no incentives to stay in Brazil meant no investments, perpetuating a vicious circle. For them, talent required jobs, even if a whole sector had to be created from nothing (Evans 1995: 107-108).

Moreover, the group was preoccupied with the development of native technology. For them, it was not enough to simply have a computer industry with no Brazilian solutions – Brazil had to possess "autonomous technology" (Evans 1995: 108). That argument resonated heavily with the military, which were already investing in a state-owned weapons industry and related fields, with a significant export role – an offshoot of this investment was Embraer, created to produce military aircraft with Brazilian technology and later an example of a privatized firm turned to civilian aircraft.

"Autonomous technology" at that time meant two things: state involvement and trade protection. The *barbudinhos* (and soon the Brazilian government) believed that the way to develop the computer industry was to protect it and to create incentives to generate Brazilian computer firms from the inside, with Brazilian capital. That meant heavy state financing, and by 1974, two companies were created with state funds: COBRA (Computadores e Sistemas Brasileiros S.A.) and Digibrás (Empresa Digital Brasileira S.A.) in order to first produce computer "clones" of the existing machines and develop their own technology from there (Vigevani 1995: 85). It was specifically demanded that, in order to guarantee protection, there could be no alliances or joint ventures with TNCs, a policy that created a powerful internal lobby for its continuation (Vigevani 1995: 85; Evans 1995: 118-119).

The model chosen to develop the computer sector in Brazil was a combination of state financing and private companies. The government would protect and finance anyone who wished to invest in the creation of Brazilian technology, and invested an agency inside the Ministry of Planning with the responsibility of promotion and policing (the Commission for the Coordination of Electronic Processing Activities, or CAPRE). Evans refers to this strategy as "midwifery" (1995: 116). As he puts it,

> *CAPRE became the home of the "frustrated nationalist técnicos" and their vision of what Brazil needed to become a participant in the world of informatics, a vision that went far beyond rationalization of government usage. (…) Since no one, including IBM, could manufacture a computer in Brazil without imported*

> *components, CAPRE had the power to decide not only what should be imported, but also what computers would be manufactured locally, and by whom." (Evans 1995: 117)*

With backing from the Brazilian National Development Bank (BNDE) – which created a working group to oversee the creation of a local computer sector – CAPRE was favored by the military government, which liked the idea of having computers with cryptographic capabilities produced internally. Despite their government support, the *barbudinhos* were distrusted by the government, which identified their ideals with the left (Evans 1995: 118). Although the policy was correct according to the government, the people in command of it were not.

By 1979, the new Brazilian government of President Figueiredo decided that CAPRE should be transformed into another agency, with better military oversight and more in tune with the official line (Vigevani 1995: 95). The resulting agency was the Special Secretariat for Informatics (SEI), created by decree in 1979 with personnel recruited from the National Intelligence Service (SNI) and directly subordinated to the National Security Council and the Presidency (Evans 1995: 118; Vigevani 1995: 91). Even though by this time there were Brazilian banks investing in the computer companies, and a significant computer industry, there was little discussion and input from business (Vigevani 1995: 91; Schneider 2004: 108-112). There was also a small but vocal constituency for the industry (composed from engineers and the firms already established in the Brazilian market), which pushed for more protection from the government, but resented the militarization of CAPRE – its main representative, ABICOMP (Association of the

Brazilian Computer and Peripherals Industries). Despite the demise of the original CAPRE, its defenders widely believe that at least the main goal of creating a national computer industry had been achieved (Vigevani 1995: 93-95).

4.3. Struggle, Retaliation and Retreat (1985-1992)

By the 1980s, all the signs pointed to a mixed result for the original *barbudinhos*. Even after being able to push their goals from inside the bureaucracy, some of the first objectives turned out fairly differently than they had expected. Although the jobs they wanted were partially there,[2] they were maintained through protectionism and required very little involvement in research and development of new technologies, apart from a few short-lived exceptions.[3]

The development of the Brazilian computer industry would reach another level with the passing of the National Informatics Law in 1984. Voted by Congress and sanctioned by President Figueiredo in October of that year, the law enshrined the policy of market

[2] The total number of university-trained technicians in the Brazilian informatics industry rose from 4,052 in 1979 to 24,113 by 1989 (Evans 1995: 162).

[3] Peter Evans (1995: 128-129) tells the story of how Brazilian engineers from COBRA were able to create from scratch a Brazilian operating system compatible with the proprietary UNIX system from AT&T called SOX. COBRA did it without reverse engineering, and SOX was the first operating system to pass an independent verification test offered by X-OPEN, a consortium of British and American computer companies. The certificate meant that they could operate in any market without the fear of being accused of intellectual property infringement. Ironically, that proved to be too late – it was already 1989 and COBRA was losing money by then. As Evans points out, "one indication of the magnitude of what COBRA was attempting is the fact that when IBM, Digital, and other major U.S. firms decided to develop a challenger to AT&T's UNIX, they felt it necessary to join together, forming the Open Software Foundation" (1995: 272).

protection and government control. The law had a defensive nature. Despite being though of as unnecessary by almost all of the players involved in regards to content, with the imminent transition to democracy in sight, transforming the policy into law was clearly a move to lock it in given the uncertainties of the new regime (Vigevani 1995: 96-97).

Unlike other countries in Latin America (like Mexico, for example), Brazil did not begin to liberalize in the 80s. Despite feeling the effects of the 1982 Latin American debt crisis such as hyperinflation, growing external debt and fiscal crisis, the country held as much as it could to the model of development based on ISI and market-protection. Powerful internal lobbies had already formed for protection in all areas where the state guaranteed protection and, in the case of the computer industry, the story was the same.

Against the odds, José Sarney, the first civilian president after 21 years of military rule, attempted to follow through with ISI and plainly endorsed the informatics policy. His government, based on a loose coalition of center-right parties, had little stomach to promote deep changes in policy or to upset its political support.[4] The government suffered from the effect of several economic "packages," a series of unsuccessful measures to curb inflation through price and wage controls, changes in the Brazilian

[4] It is important to notice that José Sarney only came to power because the chosen coalition president, Tancredo Neves, died a few days before being officially sworn in. Sarney, as Neves' chosen vice-president, had to struggle with a cabinet not of his choosing and with the fact that for a long time he was part of military government's party, ARENA, a fact that put in question his commitment to change.

currency and finally defaulted on the external debt in 1987. It was hardly a scenario where a computer industry could grow, but it still had governmental backing.

In 1985, the Brazilian computer industry was by international standards fairly developed, although by no means comparable with the United States, for example (Evans 1995: 160-168). Although Brazil could competently produce hardware, it could not compete with the latest technology (Luzio 1996: 121). With backing from major banks and entrepreneurial groups, the country could boast about having computers and about making them, but it could not claim that the technology was national. PC "clones" assembled in Brazil dominated most of the market for personal computers with practically no native technology employed; Brazilian firms had a clear incentive to free ride on the national policy of protection and reverse-engineer foreign technology, while using this protection in order to export. Moreover, in order to reap the benefits of the Brazilian market, foreign companies were more than willing to ally with national companies in joint ventures as minority partners (Evans 1995: 185-190). Regarding software, the law was ambiguous – although it nominally protected the copyright of software, the mechanisms for enforcement were spotty at best (Vigevani 1995: 104-105).[5]

In attempts to regain a strong footing in markets that were previously lost to protectionist measures, President Ronald Reagan, pressured by some American firms that still could

[5] However, it is important to remember that just at that time software was beginning to get the importance it had later, and questions of intellectual property regarding its creation and protection were also fluid for the American market.

not enter the Brazilian market, threatened to retaliate with trade sanctions (Section 301 of the 1974 Trade Act) if Brazil did not reverse the informatics law, since it heavily restricted the import of American computers. President Reagan's threat was meant not only for Brazil but it was intended to make Brazil an example for a tougher trade policy (Evans 1989: 222-223). The announcement was made (coincidently or not) on September 7th, 1985, Brazil's Independence Day – a symbolism that was not lost on Brazilian officials (Evans 1989: 207).

The American threat created a full-blown diplomatic struggle that lasted until the next Brazilian administration (Fernando Collor de Mello) and the dismantling of the informatics policy. The negotiation with the United States could not happen in a more turbulent context: apart from the macroeconomic problems already mentioned, Brazil was drafting its new Constitution and negotiating other issues, such as pharmaceutical drugs and intellectual property in the Uruguay Round of the GATT. However, instead of accelerating the demise of the law, for some years after Reagan's speech, the informatics policy was defended inside Brazil as a way to resist the pressures for change.

In spite of the Brazilian officials' resistance of the American retaliation, by the late 80s, it was becoming increasingly difficult to gather internal steam in support of the market reserve for the computer industry. The informatics law was hardly defensible, even by some groups that supported it at first, such as the Brazilian scientists represented by the Brazilian Association for the Progress of Science (SBPC – Associação Brasileira para o

Progresso da Ciência) – by the end, the incentives for production were so misguided that Brazil lagged technologically in terms of "autonomous technology", had to clone most of the technology it consumed and the "official" industry was giving way to an enormous black market of computer parts (Luzio 1996: 121-124).

The companies that truly produced Brazilian technology, like COBRA, for example, were positioned in the worst of two worlds – consumers perceived COBRA, which defended the informatics policy, to be an impediment to new foreign technology, while COBRA itself could not compete with companies that were free-riding on the policy and just producing PC clones.

When Fernando Collor de Mello started his presidency in 1990, there was little public support for the continuation of the informatics policy. When the law expired in the same year, Collor made sure not to renew it.[6] By then, the computer industry was already internationalized. Brazilian companies were bought by or were allies with foreign companies, producing computers designed outside Brazil. Although the country had the capacity to manufacture and assemble computers and computer parts, these companies were mainly interested in the Brazilian internal market, which was hungry for automation in the services sector and in the personal computer market.

[6] The informatics law was created with a defined period for market protection, with an option to renew it in case it was necessary; this structure was chosen in order to comply with GATT regulations (Luzio 1996: 14).

Over the course of the next decade, with more or less emphasis depending on the administration, the Brazilian state abandoned the protection for technology companies. The major Brazilian telecommunication company for example (Embratel), once seen as an important part of the state, was privatized with clear effects for the both the market and consumers. If that meant that Brazil would not invest to create a "Brazilian cell phone," at least the possibility to have *a* cell phone was not far away. As the decade progressed and the Internet became more ubiquitous, the possibilities of closing an industry such as computers from foreign competition (and at that point, innovation) became unthinkable. Not only had it become unwise trade policy, but it also became a barrier from new technologies and sure way to stagnation.

What about software? There were some lessons of the experience with the informatics policy that would be incorporated somewhat in the following years regarding the handling of technology by the government and the Brazilian market in general, especially years later in the open source software policy. But many things changed until then, and different contexts allowed for different solutions.

4.4. Implementing Open Source Software: Reasons and Opportunities[7]

It is said that ten years of computer development is an eternity – after all, computers were only invented during the Second World War – not much time if we ponder how they

[7] This section is based on interviews conducted by the author with current administration officials and bureaucrats involved with the open source software adoption policy at different levels and offices. Some of them asked for anonymity when they were voicing their own opinions about policy and other people involved with it.

changed until now. However, the 1990s were particularly revolutionary for computers and their usage: they were the years of both the explosion of the Internet and the prevalence of software over hardware. Costs in communication dropped abruptly, while millions of people became integrated in the World Wide Web. The "New Economy" was hailed by pundits and analysts as the way to move forward and promised wonders for connected markets and people. Some even went forward to announce a fundamental change in the outlook of governments for the 21st century (Friedman 1999: 101-110).

Brazil was not immune to these changes. As both an industrializing country and a participant in the world economy, it had to deal with the new realities of the Internet and the changing role of software. Differently from the previous informatics industry that had become commodified, the software industry went to the heart of high-value added production – software is an idea written in code. It involves a highly qualified labor force, not only able to copy, but also to create and improve upon previous work.

Some of the problems the *técnicos* identified in the 70s still remained. First, there were still few jobs for the middle class. Although by now Brazil had a computer industry, the private sector still could not provide the technical jobs that meant so much for the goals of the informatics policy, twenty years before. The bulk of the middle class in Brazil still relied heavily on the state for jobs, and most import of all, for long-term job security. Brazil had never made the structural transition to an economy based on technical production, much less one that could rely on a software industry or even a full computer

industry. The incentives for a middle class university student were skewed towards state jobs (good careers are usually associated with the Judiciary, the bureaucracy or public companies, usually Petrobras (the state-owned oil company) or Banco do Brasil (a federal bank)).

Second, the ideal of creating indigenous technology was stunted by the logic of the market. The bulk of software production and the IT industry were still greatly concentrated in the OECD countries (OECD 2006: 86).[8] It is not very difficult to grasp the reasons for this – OECD countries have a better-educated and trained labor force and have to concentrate the high-value added parts of commodity chains inside their countries, especially in the electronics industry (Gereffi et al. 2005: 94-96). For TNCs, outsourcing computer manufacturing is not a problem; outsourcing computer design or software production is. Brazil could hardly rely on a pool of software designers to compete with this new international division of labor.

While these problems persisted and, in some cases, were accentuated by globalization, some new developments presented windows of opportunity for a different policy in Brazil. The most important change happened in the computer industry itself – the main focus turned from hardware to software. After Microsoft licensed its DOS and Windows Operating Systems to any manufacturer of hardware, machines became mostly commodities competing for prices. For a country such as Brazil, which aimed to create

[8] It is important to notice that this trend is beginning to be altered according to the latest OECD Information Technology Outlook Report (OECD 2006: 86).

an industry based on technological autonomy, investing in computer clones did not seem to provide any edges in technology; the challenge was not to build the machine, but the programs running it.[9]

Policymakers in Brazil took some time to notice the rise of Open Source Software (OSS) as an alternative to the proprietary model of software production. After years of the demise of the informatics policy, state involvement with questions of computer development was dormant at best. Moreover, as the need for foreign direct investment grew, privatization and de-regulation were the policies to be followed in order to grow, and supposedly leave the state to concentrate on other issues, such as poverty alleviation programs.

When the Workers' Party (PT) got to power in 2003 with President Luis Inácio Lula da Silva, there was no clear central software policy in the Brazilian government. Software was always bought on a case-by-case basis by every state agency, with great decentralization and little overall knowledge and coordination of the systems used.[10] Some government agencies had already been using OSS for some time before President

[9] American companies, such as Intel, still mostly design the main component of hardware, the microprocessor chip, for example. But just like other machine components, after it is designed, it can be produced in different places with lower costs (Gereffi et al. 2005).

[10] This is consensual among both defenders and attackers of the OSS policy.

da Silva's administration, such as Serpro (Serviço Federal de Processamento de Dados), which is one of the two major data processing backbones of the Brazilian government.[11]

The experience that provoked the federal government into thinking about the adoption of OSS was local. The Workers' Party previous administration of the state of Rio Grande do Sul is usually cited by the actors involved in the national policy as one example of an authoritative decision involving adoption of OSS (Kim 2005: 56). The decision to migrate to OSS was connected with the Open Source activists, which had ties with the World Social Forum in Porto Alegre (the state capital). Although the activists had a stake in promoting an ideological agenda in regards to OSS, the major reason given by the government was still cost-effectiveness (Kim 2005: 54). The other local experience that predated the national policy of OSS and greatly influenced the national government was the adoption of OSS in the state of Paraná, another southern state. Paraná's policy faced some skepticism from critics when it began, but received less attention because of its limited scope and impact.

With this previous experience orienting the new PT federal government, the thought of applying it to the national level seemed reasonable enough. From the beginning, however, the top level knew that the policy would not be without controversy from the

[11] While Serpro is connected to the Ministry of Finance, and is responsible for the Brazilian income tax data, the other agency is DataPrev (Empresa de Tecnologia e Informações da Previdência Social) connected to the Ministry of Social Security and responsible for gathering and organizing the social security data. Both agencies, due to the heavy load of processing needed, had previously used open source software solutions for severs and other needs. DataPrev even created its own software, CACIC – later "open-sourced" (see section 4.5 below).

outside – what was not known then were the difficulties from inside the government itself. The decision to transition from proprietary software to open source software began at the top: the agency in charge of officially coordinating the transition was the Institute of Information Technology (ITI)[12], connected directly to the Secretary of Casa Civil (the Brazilian equivalent of "Chief of Staff") José Dirceu. ITI was responsible both for the migration to OSS inside the government, for the handling of public keys for cryptography (electronic certification) and for headlining the *Governo Eletrônico* project[13] (e-government), which involved the establishment of a set of goals to harmonize the electronic standards and rationalize the Brazilian state, known as *e-PING* (Padrões de Interoperabilidade de Governo Eletrônico).[14]

Dirceu was the political coordinator of the government and the liaison from the Executive to the Legislative and the bureaucracy. A former president of the Workers' Party, Dirceu started as the "über-minister" responsible for making or breaking deals with political parties and implementing the projects the Presidency deemed a priority. Within this structure, the open source software policy became, from the beginning, a pet project of the Presidency. Sérgio Amadeu, a vocal advocate of open source software, headed ITI. The order was apparently simple: think of a plan, set a schedule, and define the first targets and deadlines. Coming from the top and empowered by the key players in the

[12] http://www.iti.gov.br

[13] http://www.governoeletronico.gov.br

[14] All versions of this document (previous and most recent) can be found at http://www.eping.e.gov.br (accessed on December, 2009).

Presidency, it was thought that ITI could manage the transition alone. Migration inside the Executive branch would be the example needed to push the policy forward in other areas of government and in public companies.

Transition had to be operated through different levels of the government: changing the software of bureaucracies connected to the Executive branch requires less red tape than changing the software inside a public company (such as Banco do Brasil or Caixa Econômica Federal, two Brazilian state banks, or Petrobras, the oil company, for example). Public companies have a greater degree of autonomy inside the government and have their own technicians and needs. Although they had more leeway to implement the OSS policy, public companies realized that harmonizing systems with the government would not only be critically important in the long run, but they also were in a position to create their own internal expertise in handling the transition for their needs.

The decision to migrate all governmental software to open source software had many justifications, among which was the question of cost-effectiveness, publicly used from the beginning in order to explain the move. In fact, OSS overcame several of the difficulties the old informatics policy had:

(1) Technology was now a public good – contrary to the informatics policy of the 70s, the technology of OSS was readily available. In fact, as Weber points out, one of the main strengths of OSS is the special nature of this public good:

the more it is used, the better it gets, thanks to Linus' Law (Weber 2004). OSS had also reached a scale in terms of network effects that made it safe for governments to adopt it (Varian and Shapiro 2003). IBM, for example, could no longer threaten to withdraw its technology from the country if the government did not meet its demands like it did in Brazil during the 70s; now, the technology was simply there for the taking. As one bureaucrat from the Ministry of Science and Technology puts it, "in the end, we adopted because it was there." The bargaining power of the government had increased significantly.

(2) Intellectual property issues could now be legally bypassed – Another issue that truly preoccupied Brazilian policymakers was the question of intellectual property and its possible international impact. The most apt comparison in terms of policy is the previous fight between President Fernando Henrique Cardoso's administration and the pharmaceutical industry regarding the prices of the AIDS/HIV drugs. While pharmaceutical companies were increasing the prices, the Brazilian government was having difficulties to maintain its policy of offering free drugs and treatment for any AIDS/HIV patient. In order to credibly threaten the drug companies, the government argued in the WTO that in cases of national emergency such as the AIDS/HIV epidemic, it had the right to break patents and manufacture the drugs itself, for lower costs, which it subsequently did backed by the WTO. While the country's position

was not against patents, it was against their abuse. Breaking patents is increasingly costly and problematic, and it is becoming one of the key issues of international trade, with countries both strengthening their internal legislations to protect copyrights and patents, while fighting externally to enforce them (Chang 2002; Lessig 2001). Both open source software and the GLP could, by their very nature, spare the country of prolonged battles to develop its own software. Again, the fact that the government could open and modify the source code guaranteed increased bargaining power.

(3) A way to bypass protectionist policies – one of the advantages of OSS is that it takes free market politics to the extreme – all kinds of software appear in the market (the Internet allows for extremely low barriers to entry) and the best survive or evolve. The Brazilian government was not blind to the possible repercussions of going back to the protectionist policies of ISI – there would be a political backlash both internally and externally, while it would undermine the Brazilian position in the WTO, openly favorable to the developed world's dismantling of subsidies for agricultural products. Moreover, as stated before, the production and diffusion of OSS go against the logic of protection; in fact, the more protection a software gets, the less effective and tested it is. Embracing the openness of the software market (especially the not-for-profit software) would pose no problems in regards to liberal orthodoxy.

(4) A visible side to the policy with direct credit claiming – unlike the informatics policy of the 70s, in which subsidies would go straight to producers, the OSS policy could reach more people and be more visible. Instead of receiving a backlash for "closing the market" the government would "help" the market. The visible counterpart to OSS migration inside the government would be the "PC Conectado" program (later renamed "Computador Para Todos" – "computers for all," in a clear allusion to a much repeated government goal, "digital inclusion").[15] This program would guarantee tax breaks and public loans for any private company that sold computers with a certain government-defined configuration. This configuration would favor a basic computer, with a top price already defined, with the ability to access the Internet and with general productivity applications such as a word processor and a spreadsheet program; and more important than those characteristics, the computer should run Linux, in Portuguese, independent of the distribution. That meant, in practice, that the government was directly subsidizing computers for the lower and middle-income groups, and indirectly "subsidizing" the usage of Linux (Comino and Manenti 2005: 228).[16]

[15] http://www.computadorparatodos.gov.br

[16] One of the intended objectives of the "Computador Para Todos" program was to diminish piracy – a problem that the United States has usually acused Brazil (as well as other countries) of not doing enough to curb. A poll conducted by Abes (Associação Brasileira de Empresas de Software, available on http://www.abes.org.br/computadorparatodos.pdf) later showed, much to activists' dismay, that the majority of computer buyers of the CPT program (73%) would erase Linux soon after buying the computer and 50% of these would install pirated versions of

It was believed that the supposed advantages of the adoption of OSS and the apparent political centralization to implement it spelled success for the policy. However, the migration proved difficult and problematic – although the process never fully stopped, it was significantly slowed down by the government's own mistakes and inexperience, and by both external and internal pressures.

4.5. Implementing Open Source: Opposition and Infighting

Most people involved with the policy inside the government spontaneously identify two distinct phases of implementation of open source software in the Brazilian government – the first phase was headed by Sérgio Amadeu and a strong ITI, while in the second phase, the process slowed down and the responsibility was shared by many.[17] When José Dirceu was weakened by a corruption crisis involving his direct secretary, Waldomiro Diniz, in a case unrelated to the OSS migration, the policy was suddenly left to a subsequently weakened ITI and Amadeu, responsible for dealing with the opposition to the policy. While ITI was in charge of setting the *goals* and *strategies* for the migration, the Ministry of Planning (Ministério do Planejamento) became involved with the *logistics*

Microsoft Windows and Office, readily available in street stands for less than US$ 5. What is remarkable, however, is that if the numbers are correct, 23% leave Linux as the default operating system – much more than the statistical international usage of Linux (no more than 5% of the market).

[17] Corinto Meffe, interview with the author, September 2006.

of transitioning – the department in charge of establishing the change was the SLTI (Secretaria de Logística e Tecnologia da Informação).

Sérgio Amadeu, the head of ITI, was a firm believer in open source software. For him, there was little question of what the problem was or how to solve it. He was both an "energizer" for his followers and the people working with him, but he personified several traits that were a lightening rod for the opposition to the policy. Some of the goals Amadeu set in the beginning for the migration to OSS were, at best, unrealistic in the view of some people that had previously worked in many different areas of the government and had "bureaucratic expertise."[18] The government stipulated that most of the Ministries would transition to OSS within a year, to set an example for other government agencies and public firms. As of 2005, three years later, the Ministries were still in migration, with some success stories, but also some problems. Amadeu was out after resigning. Why was the process so morose according to the goals set by Amadeu?

Some problems appeared early on in the process. Although the idea for the migration seemed straightforward enough, anyone with experience with the Brazilian bureaucracy knows that the state is so balkanized that it is a nightmare to issue any communications from the top to the bottom. The Brazilian state resembles a series of "feudal territories", with particular loyalties, lords and internal regulations. Students of the Brazilian state also know that due to its fragmented electoral system of open list proportional

[18] Ministry of Planning employee, interview with the author, September 2006.

representation, in order to assure support in Congress, the President governs through "Coalition Presidentialism," dividing both the Cabinet and the top to mid-levels of government among its many political allies (Ames 2001). This fragmentation assured that the OSS policy needed real political support among the bureaucrats if it was to succeed.

Moreover, and most importantly, there was absolutely no quantitative study about software usage in the Brazilian government, which meant that the government was clueless in regards to what was used by whom. The purchase of software was decentralized for each agency – which assured that there was plenty of duplication, inefficiency, and sometimes corruption in the purchase of government software.[19] At some Ministries (and even the Presidency), it was not uncommon to have several different pieces of software that performed the same functions – with each change of personnel there would be a new acquisition of software.[20] Previous versions would be incompatible with new ones, which would make sure that the new user would be locked in the new software until the next one arrived.

Changing and installing software in big organizations entail the knowledge of the architecture of the network and the rationalization of administrators and users. A system administrator must know the needs of the users and plan accordingly, granting

[19] Ministry of Planning employee, interview with the author, September 2006.

[20] Ministry of Planning employee, interview with the author, September 2006.

permissions and securing the whole system. Without the overall picture of what is wanted, the system cannot function properly and security is compromised (Schneier 2000). According to system administrators, it is impossible to start migration of any kind without starting from the top and going down the hierarchical computer structure. Desktops are usually the last to be changed.[21]

In the Brazilian case, not only was the architecture not known, it was *designed* to be so.[22] Piracy was rampant – employees would simply buy (or copy) a pirated version of Microsoft Windows Operating System and install it himself/herself in his/her own desktop computer in order to work. This would lead to periodical breakdowns and virus infestations, not counting the fact that it would make the Brazilian government an accomplice in piracy – not flattering if the country is also trying to convey the image of a supporter of intellectual property laws.

Soon enough, the government also discovered that it had no guidelines for migration. Both ITI and SLTI employees realized that more than the will to change, what was needed was a concrete plan of action, with specified logistics and support for the overall change. It was defined that the process of migration itself was supposed to come at the

[21] SLTI team, interview with the author, September 2006.

[22] When asked if there were already any studies available after almost four years of implementation, an employee answered that not only there were none, but everybody inside believed that if any studies were to surface, they would prove to be a major embarrassment for the government. Ministry of Planning employee, interview with the author, September 2006.

end of an elaborate plan, not before.[23] It was also discovered that the government needed to enroll the open source community as an ally to help ease the way to the transition, offering immediate support through online forums and encouraging the switch of long-time proprietary software users. If the transition was to happen smoothly, the first thing that was needed was concrete documentation explaining and directing these changes. The product of these discussions with the open source community resulted in a document (*Guia Livre* – Free Guide)[24] with all the guidelines for change – the document itself an impressive piece of collaborative work among government employees *and* the OSS community.[25] Together with the *e-PING*, which defined the technical standards, the Guia Livre suggested concrete migration strategies to all levels of government (including local government if they wished to migrate), from simple offices to highly complex workstations, presenting some initial case studies of limited migrations already underway inside the government. It took almost a whole year to prepare it.[26]

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[23] Ministry of Planning employee, interview with the author, September 2006.

[24] http://www.softwarelivre.gov.br/publicacoes/guia-livre-referencia-de-migracao-para-software-livre. The Guia Livre is available for free in electronic format and it was issued under a Creative Commons/GPL license (accessed on December 2006).

[25] The creation of the Guia Livre was cited with evident pride by the SLTI team that structured it – the guide was released one month before (in version 0.99), especially for the OSS community that had participated. Major names were invited to a ceremony in Brasília and presented with a free copy of the guide (SLTI team, interview with the author, September 2006).

[26] Ironically, the Guia Livre started as a tentative translation of a freely available EU document called "The IDA Open Source Migration Guidelines" from October 2003. This is a very small document, produced by the EU Information Technology bureaucracy as a suggestion for system administrators. Brazilian officials soon realized that the EU guide was not enough for their needs, and the idea to "open-source" the writing of a new guide was born.

This year of preparation of the Guia Livre exposed the administration to the difficulties of implementing policies through fiat. The tone of the guide is very different than the "mandatory-implementation" tone from the year before, and it takes into account the cultural differences that appear when approaching a new way of organizing information for work. It recommends a step-by-step approach, trying first to win "hearts and minds" of employees to the importance of switching to OSS by immediately installing readily available open-source alternatives that run on Windows (such as the Mozilla Firefox browser and the OpenOffice productivity suite), for example, in order to ease the transition to a full-OSS based workstation and desktop. The guide emphasizes *suggestions,* stressing that there can be no "one-size-fits-all" migration logistics for the whole government.

Most important among the problems faced by ITI and SLTI during the migration process was opposition inside the government itself. The Ministry of Development, Industry and Foreign Trade (Ministério do Desenvolvimento, Indústria e Comércio Exterior) became the main vocal opposition hub to the policy, formed right after it was announced. The Minister, Luiz Fernando Furlan, was chosen for being one of the most successful CEOs of a Brazilian firm and having connections with the business sector. Furlan was CEO of Sadia, a producer of poultry and ham and one of the success stories of Brazilian exports, exporting to more than 92 countries. Although Furlan had no connections to the Workers´ Party, he was chosen as credible sign to the business sector of the continuation

of economic policy in the Lula administration, as well as the commitment to bolster Brazilian exports.

The MDICE was opposed to the inclusion of OSS in the computer configuration of the "Computador Para Todos" program. Although the Ministry was eventually defeated in the subsequent discussions, and only OSS was included in the guidelines, the fight marked the open animosity towards the favorable outlook of the Brazilian government in regards to the OSS policy in general. Therefore, it was no accident that the arm of the policy that dealt with providing lines of credit and stimulating the economy to produce services and solutions involving OSS for the private sector would be assigned to the Ministry of Science and Technology (through SEPIN, Secretaria de Política de Informática) and not the MDICE. Although small in terms of resources, the program provided a different form of promoting OSS – helping parts of the Brazilian software industry adapt to the model of services implied by the open source production paradigm.[27]

The government conducted the creation of a program that would stimulate the private sector into accepting OSS and would change the pattern from software sales to services. Although the Brazilian software industry was not negligible in its lobbying capabilities, the power of the government backing the OSS policy was the main conductor of the

[27] A cited study, produced together by the MCT, Unicamp (University of Campinas) and Softex (a NGO created to promote Brazilian exports in software), tries to estimate the impact of the OSS policy for the Brazilian private sector, available on http://www.softex.br/portal/_publicacoes/publicacao.asp?id=808.

process. This stimulus to the private sector was never meant to destabilize the industry – according to the study conducted by the MCT, 51.3% of open source developers in Brazil also develop some kind of proprietary software (Softex 2005: 24) – OSS is not meant to replace proprietary software, but to complement it, on the one hand offering a new kind of business model for some and raising the bar for the production of proprietary software on the other.[28] It was known that this transition was meant to be smooth, although necessary to the future of the OSS in Brazil.

The OSS migration was also slowed down by efforts of TNCs with direct interest in selling software to the Brazilian government. Bureaucrats always cite the insistence with which TNCs' employees would lobby high-ranking officials for slowing down the implementation of OSS. Lobbying in Brazil usually happens through the bureaucracy, instead of Congress – bureaucrats can derail policies if they present any threats to their control. The example cited by officials was the implementation of OSS in the Brazilian Congress; started with great enthusiasm for the change, it was rolled back after a series of meetings among Congress staff and representatives of TNCs.[29]

The teams inside the migration process committed to OSS realized that rationalizing the system might not be a sufficiently important reason to avoid reversal of adoption. In an

[28] This number is almost the same in Europe, where 52% of open source developers also develop some kind of proprietary software (Softex 2005:24).

[29] MCT employee, interview with the author, September 2006.

effort to thwart attempts to roll back the policy, they created a strategy of institutional sticking – the migration group made sure that every step in implementation was accompanied by the creation of a virtual community of users, moderated by the group and welcoming to new users. As the users became acquainted with the forums and felt safe enough to ask questions and search for answers, the group realized that they were much less likely to prefer a reversal of policy and adoption of proprietary solutions. One engineer in the migration group referred to the process as "helping the users help themselves" – winning "hearts and minds" by entrenching your position is a fundamental step inside bureaucratic structures. Communities that had barely a few messages per week, in a short period of time, increased by hundreds, getting to the point where the migration group answered fewer questions by themselves – the community was already self-replicating the knowledge of problem-solving.[30]

The Ministry of Planning also created seminars in which they would directly train employees in the use of OSS, answer questions and socialize with those that were using the software. These meetings were called "Semanas de Capacitação do Software Livre," or OSS Training Weeks. The team tried to replicate the feeling of the Linux user groups, which is a concept well known among Linux users – the local user communities usually promote "install parties" in which they install, solve problems and socialize with old and new Linux users. This builds trust and a sense of community, creating networks that help both promote and test software, thus increasing the Linux base. In the case of the

[30] Ministry of Planning employee, interview with the author, September 2006.

Brazilian government, it created internal networks of users across ministries, which also built awareness towards OSS.

One interesting experience that came of the OSS policy of the Federal government was the release of CACIC ("Configurador Automático e Coletor de Informações Computacionais") and the concept of *public software* (Meffe 2006).[31] DataPrev originally created this piece of software as an internal solution to a problem – the diagnosis of internal computer systems and networks – for which there was no proprietary software available. Although Brazilian law stipulates that anything created by the Brazilian government has to acquire a patent belonging to the state, in this case SLTI pushed for licensing a release using the GPL license, thus opening the code and making the software publicly available for download. Not only have other parts of the Brazilian government access to this software now, but also other governments, including Argentina's Federal government. A community of users is already established and functional, while improving upon the software. And finally, after the code was released, Brazilian private companies started providing service and support for CACIC, in practice supporting the use of software for usage by other private companies. The software is *public* because it was created by the state and then released as *free software*.

[31] http://www.softwarepublico.gov.br/ver-comunidade?community_id=3585

4.6. Using the State as Leverage

Notwithstanding the successes, the policy proceeded slowly during the rest of President Lula's first term. Migration inside the government continues, with the lessons of opposition learned and attempts to build a more collaborative process instead of simply commanding the governmental machine to change all of a sudden. Differently from ITI's original intentions of fast migration, there was the discovery that the Brazilian state is a beast that "runs by itself" – several inside groups fight strongly not only for budget, but for control of processes implemented. Change is often difficult and painful, but seasoned infighters know that policies can always be changed; what matters most is how to entrench certain procedures and outcomes in order to make them as permanent as possible or prohibitively costly to change.

For the advocates of OSS inside the government (just like in the Linux world) this was about creating communities. As they see it, communities entrench users into accepting and enjoying the use of certain tools, while making them more productive and more self-reliable/self-sustainable. This resembles the process in which institutions are created and become embedded through time (Pierson 2004) and shows much about bureaucratic infighting. The actors involved knew the whole time what was involved – what they still do not know is whether this strategy will pay off in the long term.

For Lula's administration, the visible part of the OSS policy – the "Computador Para Todos" Program – is seen as a success. There is more access to computers for lower income families, there is an overt attempt to establish OSS nationally and inside homes of maybe future developers of software, and finally, a way of fighting piracy by default – letting the established base of users use its legal Linux copy instead of going to the trouble of de-installing it and installing a pirated version of Microsoft Windows.

Although the pressure from TNCs against the policy is intense, there seems to be an already established critical mass of OSS development to sustain governmental needs for years to come (Varian and Shapiro 2003: 20). Even though the Brazilian state can always rollback its policies, by now there is a growing trend of OSS adoption throughout the world – a pool of know-how Brazil would miss by withdrawing. The more Brazil follows the path of OSS adoption, the more rationalization is achieved in terms of the way information is organized, maintained and shared. One of the key benefits of the migration is surely the unintended (but beneficial) consequence of starting to know how the government employs IT and how it can improve upon it. As IT becomes more relevant, the need for rationalization of systems becomes even stronger. The more opaque a system in which a government operates is, the more do opportunities for errors (in the best case scenario) and corruption (in the worst case scenario) increase.

Several questions remain: given the fragmented nature of the Brazilian state and problems to implement policy changes from the top to the bottom, is the open source

policy sustainable in the long term – or as one Brazilian bureaucrat wondered: is it state policy or an administration policy?[32] Can it produce "spillovers" and generate a developmental process as intended by policymakers? And finally: can the Brazilian experience provide any lessons or guidelines for other implementations of open source software in other countries and contexts?

Despite all the logistics involved in changing systems and the day-by-day infighting, the main lesson learned was one about the role of the state in a new international political economy and the feasibility of policies. This was a computer policy a lot different from the one the *barbudinhos* tried to implement, although the goals were very similar. Autonomy and development have been recurrent themes for the Brazilian state, with mixed results. In an age in which less state involvement seems to be thought as always the best course, the challenge is to identify the forms the state can and should act and where it can produce the most efficient impact. The forms autonomy and development take in each generation and the strategies employed to achieve them may be important to take into account.

[32] Ministry of Science and Technology employee, interview with the author, September 2006.

5. The Case of Mexico: Organization, Market Forces and State Retreat

5.1 Introduction

As Ortega y Gasset once famously said, “we are ourselves and our circumstances.” Although he was referring to the condition of men and their histories, we could very easily apply the same logic to developmental strategies: they depend strongly on circumstantial conditions. Technology is not something that any country, regardless of their structural and internal conditions, can easily obtain and use. It is not enough that a technology is available at a price that can be paid. As seen in the previous chapters, being a very poor country does not help to create the conditions to capture even a technology that is supposed to be a public good. Moreover, being a country in the group that I call "middle-powers" also does not guarantee adoption – as we are going to see in the case of Mexico, there are both problems of internal strategies and its structural position that help to explain its experience with Open Source Software adoption.

Mexico has been a curious case regarding Open Source Software (OSS) adoption. Despite being one of the most vibrant economies of Latin America, having a considerable regional presence in political and economic terms, and having previously implemented Import Substitution Industrialization (ISI), the country has lagged other countries in its adoption of OSS. According to the theory constructed in the previous chapters, Mexico

presents all the major variables that would indicate a widely adoption of OSS as a governmental policy, but in practice, little has been done in order to implement it. The question that this chapter tries to answer is why has Mexico lagged? Why, despite having the "right" theoretical conditions to implement this technology, has the country still been reluctant to do it?

Mexico is similar to Brazil in many ways, but most importantly, it has shared with Brazil the historical ambition of autonomy, which it has pursued with tenacity and using its own strategies. This has often been translated as economic nationalism and protectionism, as seen by the experience with the national oil company, *Petróleos Mexicanos* (Pemex) and its reluctant and uneasy economic relations with the United States.

As we have previously seen in chapter three, Mexico – along with Brazil and several others – is included in a category that I call "middle-powers," or countries that are neither fully developed, nor completely poor. This category of countries is important to the analysis because these countries have substantial experience with industrial policies of different kinds, have large internal markets and throughout the 20th century, they have developed functional and stable bureaucracies, which give them a reasonable modicum of what Peter Evans called "state capacity" (Evans 1994: 141-142; Evans 1995: 70-73). For many countries in that category, industrialization meant a great degree of state intervention, since the private sector had initially little incentive to invest given the absence of important factors such as a trained workforce or the infrastructure to produce.

According to a free market logic, it would not only be dangerous to invest money in more sophisticated products because of huge risks, but some would insist it would not even be desirable given the comparative advantages usually skewed towards commodities or very basic manufacture (Evans 1995: 22-25; Wade 1990).

In the case of Latin America as a whole, the timing is very similar across cases and the challenges to development each country faced were also comparable. The differences, however, had and still have many impacts on their current attempt to continue with the development process – the strategies these countries adopt are affected by previous choices and institutions. If all these structural problems defined the responses from these countries, we would observe almost similar patterns of development and results. That is not the case and, in fact, the differences among them can be highly illuminating of the process as a whole. Even, sometimes, under similar structural constraints, governments made choices and set strategies. Some worked and some did not. But in the case of Mexico and its lack of progress in the open source software adoption, we can see broader patterns of development, not necessarily wrong or right, but different.

This chapter will argue that there are main reasons why Mexico has lagged: first, its business associations were, from the beginning of the industrialization process to the present day, very strong and highly coordinated. With broad liberalization in the 1990s, business gained even more power to steer both industrial and technological policies, which were hardly geared toward software development. The second reason behind the

lack of OSS adoption was the effect of reforming the state throughout almost two decades: the dismantling of state capacity and the decrease of the resources to initiate or provide economies of scale for the adoption of software. Finally, the progressive connection between the United States' and Mexico's economies created deep disincentives to change the pattern of software adoption and training in Mexico, as long as the US continued to support proprietary solutions for the majority of its businesses and government.

The first part of the chapter is a historical account of ISI implementation in Mexico. Relying on Schneider (2004) and Gereffi (1990), I will show that the first difference between Brazil and Mexico is the way ISI was implemented in each country. Despite having a stable party rule for so long -- which could indicate a clear governmental direction for development -- Mexico's development was firmly based on very strong and few corporatist associations. The corporatist associations in Mexico practically ran the economy with the government, insisting on a much larger role for the private sector than in the case of Brazil. My first argument is that the historical structure of firms was substantially different in Mexico and it presented a much larger role for the private sector in establishing industrial policy.

In the second part of the chapter, I will show how the liberalization process happened in Mexico. Having been hit much earlier and much deeper by the debt crisis, Mexico started liberalizing earlier than other countries in Latin America (with the exception of

Chile). This process, helped by the position occupied by the private sector, was also deeply connected to the American economy, which both the private sector and the government saw as complementary to the Mexican economy (Babb 2001). In the Brazilian case, the government was forced to liberalize much later, and both the Brazilian government and its bureaucracy still retained great leverage to set and implement state-led industrial policy strategies. The Brazilian bureaucracy did not see the American economy as complementary but rather as competitive (as I have shown in the fourth chapter). My second argument is that the Mexican response to the debt crisis was rather different than Brazil's, not only giving more power to the private sector, but weakening the bureaucracy and connecting the Mexican economy even more to the American economy.

The third (and final) part of the chapter deals with the opportunities for OSS adoption in Mexico. I will show that both the industry and the government did not see the production of IT as something Mexico could (or should) pursue given the country's proximity and connection to the American IT industry and, mostly and more importantly, why strong business coordination did not push the government to invest in open source software. It is important to stress that when the economy is highly liberalized and the public sector loses the ability to steer industrial policy like the case of Mexico:

> (1) The government has little incentive to implement an open source software policy because it lacks both the "state capacity" to implement it (capable and

trained professional bureaucracy plus the actual scale to implement OSS to make any difference in the economy)[1] and because it is able to anticipate that, because of this, its results are not going to be significant in the long term.

(2) The private sector has a coordination problem and a traditional network effect: each individual IT firm owner has an incentive to stay with the software that the majority does – in this case, proprietary software – and would only deviate if two steps were taken *at the same time*: strong government adoption throughout a large state bureaucracy *and* (again, in the case of Mexico) an important market shift towards open source software; which would also need to include the US market.

(3) The individual worker has little incentive to get training in open source software because both government *and* the market are geared towards proprietary software. In the case of Mexico, his market skills have an additional burden: they have to be in line with both the Mexican market *and* the US market. If the IT worker is highly skilled, he can be hired by the higher end of the IT industry which is the US. If not, he still can be employed in Mexico not as a producer of technology but as a user. This situation also points in the direction of a continuous structural disincentive for the production of higher end IT technology in Mexico itself.

[1]On "middle-powers," see Hurrell 2000, 2006.

The third argument of the chapter is that as the American and Mexican markets become more integrated, the less incentive there is for the government to implement open source software in Mexico and retrain its workforce, the less incentive there is for the private sector in Mexico to implement OSS, and finally, the less incentive there is for the worker to get training in OSS.

5.2. ISI and Mexico

Just as some other countries in Latin America, like Brazil and Argentina, Mexico started its industrialization process as a result of foreign investment. By the beginning of the 20th Century, these countries had built reasonable infrastructures relying mainly on British and French investments. They built railroads, ports and urban works, which were believed by mostly liberal governments in the region to be the main conductor of development (Babb 2001: 6-7). In Mexico, this was the main feature of the *Porfiriato Era* – the period from 1877 to 1910 in which President Porfirio Díaz built and expanded the role of the administration while leaving most of Mexico's population without proper representation and with high levels of inequality (Camín and Meyer 1993). The main government directive of Díaz, according to him, would be "less politics, more administration," which he would pursue with the help of foreign investors and an incipient national entrepreneurial class (Villegas 1974: 129). Although this brought considerable growth to the economy, it ensured that Mexico would remain a producer of

raw materials and agricultural products for export, given its comparative advantages (Babb 2001: 7).

Despite the long experience with Porfirio Díaz economic liberalism, there was still little economic incentive for capital owners to invest in areas other than land ownership. The highly unstable 19th Century in Mexico assured one major development for national capital owners: it generated the need to organize and put pressure on the government to act in their favor. Instability meant that individual entrepreneurs had little incentive to "go-it-alone" – organizing seemed to be a sensible strategy, given that any government could ensure very little in the long term. The *porfiriato* represented for them a period of stability – as long as government assured the rules and left them alone, there would be support (Camín and Meyer 1993).

That was no to last the second decade of the new century. The Mexican Revolution that started in 1910 represented a watershed moment in Mexican history and another long period of instability for Mexico's elite. Not only the state and its role were transformed, but also the relationship between the state and social classes was altered. As soon as 1917, with the promulgation of the new Constitution, the state was in desperate need of re-arranging the productive sector, devastated by the revolutionary interregnum (Schneider 2004: 61). The model to follow was based on state corporatism: the state would include both entrepreneurs and workers to generate momentum for economic development and a measure of control. For entrepreneurs, that would be achieved by the

creation of "chambers of commerce" organized by the entrepreneurs themselves. Despite some initial pitfalls, the overall structure of Mexican business associations would only be complete by the 1930s (Schneider 2004: 62-63).

The Mexican experience with industrialization could only get consolidated after its revolutionary process. Until the *Partido Revolucionario Institucional* (PRI) re-structured the Mexican state in the 1930s, the country was heavily rural and had a deep concentration of wealth (Camín and Meyer 1993; Levy and Bruhn 1999). In the 1930s, with its power already consolidated, the PRI government could reliably invest in creating both a middle class and a nascent industry, which would guarantee political support from both unions and capital holders. In order to do that, the government had a strong voice in how business should be run.

For most of the period between the 1940s and the 1970s, the Mexican government supported business associations that could reliably provide support for its policies. It did the same with unions, which also had very strong connections to the state and were directly organized by the PRI. In this period, there was a consensus that development meant industrialization, and industrialization meant protectionism and government subsidies to industries, in accord to the widely held views on the ISI strategy, based on the United Nations Economic Commission for Latin America (ECLA) ideas (Babb 2001: 7-8; Bruton 1998). It is also from the same period the increasing connectedness of the Mexican economy with the American economy: according to Camín and Meyer, from the

1940s onwards, 60 to 70% of Mexican international economic transactions had the US as the origin or destination of its products (1993: 165).

It is important to recall that development could be implemented in two major ways: first, it could be built by creating state industries and directly involving the state in the production process or, second, it could be achieved by promoting joint-ventures and attracting the private sector (usually domestic, but in many cases foreign). In the case of Mexico, according to Gereffi, the main orientation was to promote joint-ventures whenever possible (most of the time with domestic capital in order to keep business associations in line with the government of the time) (1990: 92). This was markedly different, from the beginning, with the Brazilian experience, which gave much more importance to the creation of state companies, especially during the military dictatorship, as seen in the last chapter (Gereffi 1990: 95).

While this preference for domestic firms guaranteed a significant amount of control for the government in terms of selecting firms, it also made industry somewhat static. According to Gereffi, transnational corporations (TNCs) would only come in when absolutely necessary and would fill a certain void and create a new market. The logic would be that in certain areas (automobiles and petrochemicals, for example), the state would authorize the presence of foreign firms, while certain niches would remain protected (like textiles or food-processing, for example) (Gereffi 1990: 99). This meant

that domestic firms had a strong influence inside the government to maintain certain market conditions and to regulate tariffs.

Although this arrangement did not promote much competition, it was extremely important for building industrial capacity. Mexico was able to create and maintain industries in many areas, especially because it made use of a resource that Brazil did not have at the time: oil. Mexico's oil production assured the possibility of financing its industry and of exporting part of the production. Mexico was never a member of OPEC, but had a significant role to play after the oil shock in the 1970s.

According to Ros, the implementation of ISI in Mexico had two major phases – one that goes from the end of the Second World War to the sixties, and one that goes until the 1980s (1993: 4-6). In the first phase, the Mexican government invested in expanding the industrial base and making sure it had the basic industries of durable goods. The 1960s brought increasing consumer demand for other goods, which Mexico was able to provide through the creation of the "maquiladoras" – industries that relied on a low-skilled labor force. The "maquiladoras" served a double purpose: they could supply the domestic market with cheaper goods than those imported, while they created jobs and a possible access to the US market.

While this progressive need for new goods brought new TNCs to Mexico, it also assured that the domestic entrepreneurs would have a strong position inside the country. Now,

because of the need of joint-ventures and of local support, TNCs were glad to unite forces with domestic capital, the most famous case being that of the automobile industry (Gereffi 1990; Bennett and Sharpe 1979). That had the effect of giving the business associations a power that they did not have: they became intermediaries between the government and the TNCs: they could train workers while sharing part of the profits made by selling in the protected internal market, as well as share part of the profits in the eventual case of exports.

In the 1960s, business created a powerful organizational tool: the *Consejo Mexicano de Hombres de Negocios* (CMHN). Schneider points out that the CMHN became one of the most important business associations in Mexico, even serving as a "meta-association" bringing together other groups under it and helping coordinating them (2004: 76). From the 1960s on, CMHN grew in power and influence inside the government, with a constant presence inside the Mexican government (Schneider 2004: 79). According to Schneider,

> *"Beyond the intrinsic value of these various coordinating activities, it has been the contact with government that has held the CMHN so tightly together. (…) Ministers and presidents in Brazil and Argentina sometimes established regular, informal meetings with a dozen or two top capitalists. However, what is notable about these groups is that they disappear once government invitations stop. (…) Since the mid-1980s, very close cooperation and communication between government and the CMHN has maintained the high value of membership and active participation in the CMHN." (Schneider 2004: 80-81)*

The other main business association in Mexico with power to influence government was the *Consejo Coordinador Empresarial* (CCE). The CCE has also been very influential,

but for different reasons than the CMHN: its reach of more than 900,000 member businesses and its representation of practically every branch of businesses assured that that CCE has a powerful voice in the government (Schneider 2004: 81). It was able to overcome collective action problems because from its beginning, the government promoted the CCE as an interlocutor and because the bulk of its expenses was covered by major players as the Monterrey group and bankers (Schneider 2004: 83). While the CMHN worked behind the scenes, the CCE presented a very public display of strength for business. And how did these associations become so strong? Again, according to Schneider, it was the importance government gave to business associations that determined their lasting presence.

For workers, until the 1960s, the situation was mixed. Great part of the appeal of the Revolution and its incarnation in the PRI was its popular nature – the idea that the state should serve first and foremost the poor and the masses. One consequence of the revolutionary process and the PRI's emphasis on ISI was the creation of a new class of industrial workers and a middle class. Mexico (and several other countries in the region) started to become more urban, while these new workers slowly developed new demands and political power. The creation of these classes meant training them for a new economic reality – the Mexican government invested in new education programs and incipient vocational training (Ferranti et al, 2003).

For workers, the incentives were connected to the role of joint-ventures in the Mexican economy. Even if the government were involved in steering the economy and assuring that investments would go in a certain direction, it would still pay to train for the industry in the cities. For the middle class, there were two paths open: either train in managerial jobs inside the industries or go for the public sector as a bureaucrat or lawyer. That also meant that the middle class in Mexico had rely much more on the business associations than in the case of Brazil, where they could safely and constantly rely on the state for jobs and training.

By the end of the 1960s, this process was consolidated and a whole generation of workers and the middle class had been integrated. This was also possible because of external and structural conditions. At the time, credit was abundant and there was an incentive for countries in the region to spur development with long-term international loans. Although this was to prove disastrous later on, in the short-term governments could easily finance state programs and create the conditions for almost full employment. However, these conditions were affected by a series of events and the situation would become more acute as the 1970s developed. This would point to a whole re-organization of production, and would give even more power to the private sector, while profoundly weakening the state.

5.3. Liberalization and Market Structure

The 1970s and 1980s had an enormous impact in the world political economy. Both oil shocks, in 1973 and 1979, for example, led to forceful changes in how countries

organized their economies and how the state was organized after that. The subsequent debt crisis generated different responses from governments and usually some form of liberalization. This was exactly what Gourevitch once called a process of "second-image reversed," in which an international shock causes different responses and force governments to create different domestic institutional arrangements in order to cope with its effects (1978). Although these were international shocks with global effects, countries reacted differently. Each had its own institutions and state capacity to confront the problems and, consequently, responses varied. Both developing and developed countries had to devise different strategies, and this was also the case in Latin America.

For Latin America, the oil shocks, the subsequent tightening of credit and the spike in interest rates for long-term loans meant that it became much harder to finance the import substitution industrialization strategy with foreign loans. Countries that relied heavily on these sources for finance had, suddenly, a much harder position to sustain. Governments had to take into account several factors: which reforms were necessary and which were not? Were the reforms politically feasible at that moment? If so, which sectors needed to be reformed the most?

As we have seen in the Brazilian case, the government had major difficulties steering the course. The first difficulty lied in the way the regime was legitimized. The military dictatorship that started in 1964 and strengthened its powers after 1968 used economic growth as a way of legitimizing its rule. The period, known in Brazil as "the economic

miracle," presented for several years in a row GDP growth of 8-10%, making the regime widely successful with the middle class and the poor. Growth was financed with foreign loans at very low interest rates. In this sense, the oil shock came literally as a shock to the regime.

In order to remain in power, Brazilian President Ernesto Geisel decided on a two-pronged strategy. Since Brazil needed both the capital *and* the oil, instead of economic liberalization, the regime chose to keep on borrowing while deepening the process of ISI. The state increased its role in the economy by creating several state-owned companies, while investing in alternative sources of energy and diversifying its economic relations with other countries. President Geisel was also able to see that he had to start the political liberalization while the regime still had some power to shape the post-transition period. For the Brazilian government of the time, the political calculus was clear: the longer the country could hold with ISI, the longer the military could remain in power.

Mexico had a similar situation economically. Beset with inflation and a deepening of a trade balance deficit, the only thing that Mexico could rely on to proceed with the ISI strategy was its ability to be an oil exporter. Although this could remedy some of the effects for some time, it helped masked the structural problems created by the long-term development strategy. Mexico needed to expand its internal market, but had no more capital to invest, since the powerful business lobby increased demands for protection of the internal market. Even its attempts to increase its market by cooperating with other

Latin American countries were unsuccessful in a climate of protectionism and panic (Camín and Meyer 1993: 169-170). As resources for the private sector started dwindling, business groups started pressuring the government to increase its subsidies to the national industry, by increasing its expenditures (Krause 1997: 750). As Camín and Meyer show as way of comparison, "by 1971, the foreign debt of the public sector was substantial: $4,543.8 million, which would be four times larger five years later: $19,600.2 million" (1993: 170).

However, instead of using the increased public debt to reform its economic structure, the Mexican government had a struck of good luck: in 1977, Pemex found new oil reserves that served to bolster Mexico's oil exports. The money made from these reserves solved two major problems: it worked both as a cushion for appeasing the middle class through subsidies and as a temporary relief for the payment of interest rates of foreign debts (Camín and Meyer 1993: 171). This, however, meant that the new government of José Lopez Portillo felt no need to reform at all, while increasing public spending and giving even more power to the private sector (Krause 1997: 758-759). This strategy was entirely based on the premise that oil prices would remain high for a long time and that this could, by itself, finance the restructure of Pemex and the continuation of production on the same levels (Camín and Meyer 1993: 171-173).

This firm belief in the oil export development model blinded the need for reforms. Despite having increasing signs of the need for devaluation of the peso, President López

Portillo insisted on borrowing – according to Krause, "between July and August of 1981, $9 billion [dollars] left the country" (1997: 760). This protracted period of uncertainty about the peso eventually took its toll – as more and more people exchanged their pesos for dollars while the government kept on declaring that the economic situation was sound, the greater the market pressures for devaluation became. In February 1982, the Mexican government devalued the peso in "the worst devaluation in Mexican history" (Krause 1997: 760). The peso went from 22 to 70 per dollar and kept going down progressively (Krause 1997: 760). In August of the same year, the government finally announced that it could not fulfill its external debt-service obligations (Atkins 1995: 268).

This devaluation and the subsequent default on Mexican debt triggered a regional "perfect storm" (Mahon Jr. 1996; Findlay and O'Rourke 2007: 496-497). As U.S. interest rates were high at the time due to the Federal Reserve's policy of strengthening the dollar, a sudden uncertainty about Latin American markets progressively spread internationally. Given that many other countries in the region had also contracted massive debt in the 1970s, a sudden shock in one country – and as big a country as Mexico – had a chilling effect on the ability to raise credit in the region and the conditions to pay the service of the debt (Atkins 1995: 268-269). As these debts were mainly from governments, that meant that countries in the region were *de facto* bankrupt.

As countries faced devaluation and economic crises, it became increasingly difficult to keep on relying on ISI as a developmental strategy. Not only governments could not find more credit, they also had to print more money to pay their internal debts, which practically forced them to halt or to dismantle several long-term public policies. This "crisis of the state" was felt throughout Latin America both politically and economically. The crisis was so severe that countries in the region tried to find a multilateral way of negotiating their debt – the Cartagena Group (Atkins 1995: 269).

Politically, the crisis was a turning point for the whole region. Unable to legitimate the regimes based on economic growth, several military dictatorships collapsed in the 1980s – Argentina in 1982[2], Brazil and Uruguay in 1985, and Paraguay in 1989, among others, were major examples of failure in the political sphere and, consequently, middle-class support rapidly and sharply declined. The conditions for implementing radical state intervention had faded fast and were seen as more misguided authoritarianism. Different groups, both economic and social, demanded more representation in the government and made sure that their positions were heard. The balance of power shifted away from the government and favored both civil society and the market.

This shift in power did not mean however that it was the same situation in every country of the region. As we have seen, both institutions and social groups differed, creating different sets of circumstances and incentives for both policymakers and market forces.

[2]It is important to remember that in the case of Argentina, the debt crisis coincided with the defeat in the Falklands/Malvinas War, which greatly undermined any attempts to sustain the regime.

Economically, the crisis had a major impact in the power governments had to steer developmental policies. Although each country faced different circumstances, it was clear that from that point on, governments had to negotiate even more if they wanted to have any impact in economic strategy.

For countries that had weaker business associations like Brazil, the government could still insist on a set of developmental policies and still had some means to implement it. That usually meant later and milder liberalization processes than countries like Argentina or Mexico, for example. In Mexico, President Miguel de la Madrid, which came to power in 1982 just as the crisis was set, had to instantaneously begin to liberalize its economy (Krause 1997: 769). Both economically and politically, ISI was seen as a failure at that point, giving the government practically no choice but to deepen the integration of Mexico's economy with the US (Babb 2001; Krueger 1997). Unsurprisingly, the main interlocutors of the Mexican government during the process of liberalization were the CCE and, especially, the CMHN (Schneider 2004: 85; Teichman 2001: 144-146). President Miguel de la Madrid knew that in order to open Mexico's markets, he had to bring business to the negotiating table and give them more power. That step was indispensable to any strategy of economic integration with the US.

There was also an external process that greatly contributed to set the roots for the liberalization that would take place in the 1990s in the region as a whole – the Uruguay Round of the GATT. Starting in 1986, the 8th round of negotiations of the GATT tried to

reduce and eventually phase out tariffs for services and agriculture. It was supposed to be an all-encompassing round of negotiations, discussing the issues still pending in international commerce, especially between developed and developing countries (Gilpin 1987: 199-200). This new round of negotiations brought the question of intellectual property to the forefront of the international discussion, as some developed countries (especially the United States and Japan) tried to establish more stringent rules for the protection and enforcement of these rights (Gilpin 1987: 200). Since technological development and the services sector were already merging at the time, the United States forcefully made the case against protectionism of industry and of the services sector.

Liberalizing the state in Mexico meant reforming and downsizing its bureaucracy. Paradoxically, the goal was to drastically reduce the Mexican state and its role in the promotion of development and industrial policy. This process, that span almost ten years, had a tremendous impact in state capacity – between 1982 and 2000, for example, the number of state firms decreased from 1,155 to 202 (MacLeod 2004: 71; Teichman 2001). According to MacLeod, this process had three phases, roughly corresponding to the presidencies of de la Madrid (1982-1988), Salinas de Gortari (1988-1994), and Ernesto Zedillo (1994-2000), spanning the 1980s and 1990s (2004: 71). De la Madrid leaded the first round of privatizations by implementing a whole range of legal reforms that allowed the government to further the process and the Constitution was changed.

While de la Madrid initiated and liberalized the Mexican economy, Salinas deepened and consolidated the process (Teichman 2001). He redefined Mexico's legislation on financial markets, deregulated most of Mexico's labor laws, and created a bureaucracy at the top to oversee the downsizing of the state – the Unit for the Divestiture of Parastate Entities (UDEP) (MacLeod 2004: 80-81). Most importantly, by liberalizing Mexico's economy, Salinas did not create more competition, but less: according to Teichman, "the most important privatized companies fell into the hands of the most important industrial/financial conglomerates; by 1992, the country's most important financial, industrial, and service activities were in the hands of four conglomerates." (2001: 146).

For Mexico, liberalization has meant increased integration with the United States economy. The biggest feat of Salinas' government was the negotiation of the North American Free Trade Agreement (NAFTA) with the United States and Canada, which was bitterly fought over in all signatory countries (Mayer 1998). Integration made it much harder to fully separate the Mexican development process from growth (or recession) in the United States and, at the same time, it made it much harder for future governments to reverse the reforms (Teichman 2001: 177). Even when considering that labor markets were never fully integrated with the same scope as trade, it is impossible to ignore the effects of training and acquiring skills in Mexico independent of the US market (MacLeod 2004). The task of implementing the reforms demanded by the integration process fell to President Ernesto Zedillo, which was responsible for putting NAFTA in place.

These changes in the structure and reach of the state had an even greater impact in the Mexican IT industry and strengthened the position of business regarding the government. As the computer industry grew in the 1990s and the Internet became prevalent, all of these structural and political conditions provided very little incentive for both government and business to adopt open-source software.

5.4. Open Source in Mexico: Resistance and Irrelevance

The fifteen-year period of reforms in Mexico transformed its economy and its state structure. Now, instead of relying on import-substitution industrialization and protection for its industry, the Mexican government downsized the state and relied on business and the market to steer its economy. This reform did not mean that the state completely abdicated of its role in defining industrial policy, but its participation declined sharply and to a greater extent than other Latin American countries. As Rodrik points out, it is impossible to completely separate the state from the market, especially in a country that had so many years of ISI and a heavy presence of the state in production (Rodrik 2007: 109-110). However, the character of Mexico's liberalization and its previous institutional structure created many disincentives for its possible use of open source software and/or training the workforce to use it.

Mexico has not been apart from the technological changes that were developed in the last forty years. Mostly as a consumer of the U.S. computer industry, the country has yet managed to invest strongly in the production/assembly of hardware, especially through the creation of the *maquiladoras*. These were companies that did not have as a main goal the creation or even the development of new technologies, but were only part of production chains that connected Mexico to the wider network of the technology industry. This is still one of the strongest areas of Mexico's export promotion and, by 2000, still figured among the top 5 Mexican export items, with an annual value of 6,411 million dollars (Rodrik 2007: 110).

If the computer hardware industry is strong in Mexico, despite its lack of technological development, Mexico's IT industry is extremely dynamic but also lack in the production and development of native technology. There are strong reasons for that and they are mostly connected to the disincentives of both business and governmental to implement changes in the system. Moreover, these very disincentives contribute to a lack of middle-class youth that is willing to invest both time and money to train for a different system than the one already set by the Mexican IT industry.

For the most part, there is a strong consensus among both analysts and producers of open-source software that Mexico is very far from the standard adoption of OSS in industry in general, and the government in particular. The leader of OpenOffice Latin America, Alexandro Colorado – which is one of the main open source productivity suits used to

substitute for Microsoft's proprietary Office – has stated that Mexico is by far, one of the least friendly countries in OSS adoption in Latin America, especially regarding government adoption.[3]

According to the theory proposed in chapter 2 and the empirical results in chapter 3, Mexico had all the main attributes to have a program of open source software adoption at the national level, since it plainly qualifies for the category of a middle power. Its experience with ISI and its previous preoccupation with autonomy should indicate a strong probability of OSS adoption. Its results, however, have been meager: apart from an incipient attempt to adopt OSS in the capital (Mexico, DF), governed by the main leftist party and the opposition to the national government, Mexico has not developed the studies or the means to implement OSS. The question remains: what can explain Mexico's lack of OSS adoption?

There are three main reasons that help explain why Mexico has lagged. Although, these explanations are coherent with the overall framework of the political economy of OSS adoption, they stress the importance of institutional factors and the coordination of business and government when defining both industrial and technology policies. Given the institutional framework where decisions may be taken, it is understandable that Mexico has not pursued more vigorously the opportunity to invest in OSS. As previously argued, adopting OSS may not be a feasible strategy in some cases, as Mexico shows.

[3]Alexandro Colorado, "Sobre Software Livre en Gobierno Mexicano", on http://jza.posterous.com/sobre-software-libre-en-gobierno-mexicano, accessed on 07/28/2009.

These reasons for the lack of OSS adoption are also complementary: as business associations became stronger and a central part of the liberalization process and state bureaucracy was reformed, these effects were compounded by a traditional "network effect" – as integration with the United States economy grew, the less feasible became, both for the Mexican private and public sectors, to adopt a different technology than its main market for goods, services and labor. We will then try to see how these connections can be made between the individual incentives of major groups: business associations, the government (and its bureaucracy) and workers.[4]

The first reason for Mexico's lack of national experiences with OSS is the composition of business and the role it plays in the economy, especially after the deep reforms of the 1990s. As the reforms took form in the decades after the debt crises debacle, Mexican business associations actively came to the forefront of the development process. These reforms and the progressive liberalization of the economy greatly coincided with the software revolution in technology, in the 1980s and 1990s. Just when hardware stopped being the main component of technological innovation in the computer industry, Mexico's industry found little support from the government to invest in this area.

From the point of view of business, it makes little sense to invest in open source software in Mexico. In this case, the comparisons with the Brazilian case make it clearer why this

[4]The assumptions I make here are compatible with the discussion about collective action problems, since (1) business associations are strong and motivated; (2) the bureaucracy lost most of its capacity to influence the government in technological issues, as we will see, and left the Presidency the power to implement policy in this area, and (3) the lack of an independent institutional arena to push forward technological policy.

developed in this way. As we have seen, Brazil had an informatics policy in the 1970s promoted by the military dictatorship and designed from the top to overcome what was perceived as a bottleneck for development. This program in Brazil had established a consensus between governmental goals and the scientists that were supposed to steer the process. Unlike Brazil, Mexico never experimented with developing know-how in this area. Heavily influenced by the oil boom in the 1970s, the Mexican state was not able (or willing) to develop a long-term project for building the ability to create indigenous technology in hardware or software. Even as it struggled with the effects of the oil shocks (and in some degree because of them), Brazil insisted with the funding and the creation of an autonomous industry, even if riddled with inefficiency and bureaucracy.

In Mexico, business never supported such a project, even because there was no market for it then. In the 1970s, business did not want to invest in this area given such a risk of failure and the lack of basic resources. It was the same in Brazil, but the state was in a much stronger position to force the informatics program, start the production process and assume the risks of the enterprise. As the business associations in Mexico were much more powerful, business never pressured the government for such a program. Nationalism meant oil, not computers.

Investing in computers only made sense if they could compete with the US market, which they could not. Given the progressive access to the US market, Mexican business saw (rightly) that they would be in deep trouble in they competed with one of the most

dynamic sectors in the US economy at the time. The strategy was to simply import the technology and, as a consumer, not a producer, just adapt it to their eventual needs. By the same token, the software industry never fully developed, mirroring the problems of creating hardware (OECD 2006: 47). If, in the case of Brazil, software was created because of the need to overcome licensing issues and to power the computers created domestically, in the case of Mexico, since business rarely invested in creating autonomous technology, there was no need to invest on a parallel software industry – it was simpler to import the pre-packaged and proprietary solutions created mostly in the United States.

With the software revolution in the 1980s and 1990s, why business did not turn to OSS? It was not considered because (1) they never fully developed an industry or a domestic market in the area, and (2) government could not and would not give any support. Apart from the *maquiladoras* -- which mainly reproduced turn-key technologies from abroad and only assembled machines – Mexico's experience with the creation of technology in the informatics sector was highly problematic. Instead, most of the energy and political capital was invested in developing Mexico's auto-industry, which for a long time was a major source of its fights for technological access (Evans 1995: 263; Gereffi 1990). It is important to remember that given these structural issues, there were no individual incentives for firms to invest in the software business as an indigenous producer of technology.

In the Brazilian case, we could observe that the role of the government in helping to create these industries was essential for such a dynamic market. The government is not only able to provide the initial investments and bear the risks that prevent individual firms or institutions to invest, but it can also provide the economies of scale in the adoption of a certain technology (Evans 1995). These examples are almost the definition of creating radically new technologies from scratch, as the United States case in the 20th century also shows us – military technology and research wholly funded by the government was the only way to develop a whole range of technologies, from laser to the Internet (Chang 2002).

In Mexico, the government never got involved in fully promoting the domestic production of computer technology. If during the 1970s, it may have chosen to invest in oil production, it probably could not afford the political costs of going against the major business associations wishes. In subsequent decades, it was not a matter of strategy anymore – as the state got weaker and the bureaucracy shrank, the government could do even less to invest in computer technology in the mold of Brazil. Not only it delegated to the private sector the main strains of economic development, but also it dismantled the tools to implement any widespread industrial-technological policy of its own. It is also telling that Mexico never created a National Secretary or Ministry for Science and Technology, which could serve as an inducer of policies.

As the 1990s approached, Mexican strategy regarding its development became completely dependent on promoting free trade and liberalizing its economy by celebrating free trade agreements with several different countries and locking in its institutional reforms. The goal of autonomy was now subordinated to a liberalization strategy of development – neither the President nor the Legislative had any individual incentives to push for a governmental program that might involve trade disputes or any protection from the government.

However, the greatest impediment to OSS adoption in the Mexican case, apart from the lack of individual incentives to support such a policy, was the combination of a traditional network effect. As Mexico pushed forward with its development strategy through liberalization in the 1990s, it became even more involved and intertwined with the American economy. The more this process matured, the less reasons Mexico had to radically alter its technological policies in relation to its major market.

Integration with the US economy had two major effects: the first effect was the consolidation of an incentive structure that was completely tied with the US market. Unlike Brazil, where the government could (theoretically) create the economies of scale to change the technological pattern of software and steer the training of the work force towards open source software and later create a market of its own, Mexico could not apply the same solution. As the private sector entrenched proprietary solutions directly from the US market, the workforce and the middle class had no incentives to train in any

other system than the proprietary one. Its success in the market was directly tied to their performance in the system used not only in Mexico, but also in the US. By learning the skills of proprietary software, this workforce could work in Mexico, and in the case of talented programmers, eventually go to the United States.[5]

For a middle class young person, training in the IT industry in Mexico means (1) competing in a foreign-based market, mostly composed of subsidiaries of American companies or Mexican companies that use foreign technology, usually turn-key; and (2) withering the effects of a highly unstable and dynamic environment which yesterday's technology may become obsolete in a matter of a few years, sometimes months. As we have previously seen, these characteristics mostly fit countries with a dynamic and liberal market economy, and discourage the adoption of OSS nationally or on a large scale. This is clearly the case where structural conditions and market forces create a path that highly discourages the adoption of OSS and its use by the government.

The second effect of the integration of the Mexican and American economies was the institutional lock in of the reforms regarding state capacity (Teichman 2001). In order to liberalize, Mexico had to accept common rules and regulations in regards to intellectual property and the structure of trade. Moreover, in this process, starting with the Salinas

[5]The exception that proves the rule is the case of Miguel de Icaza, the main programmer behind the GNOME interface for the GNU/Linux Operating System. Icaza, a very talented programmer, was born in Mexico and is one of the most recognized names in the open source community internationally. He tried individually in 2003 to convince the Mexican government to use OSS but his attempts were in vain. He currently lives in the US and works for Novell, a major open source software company provider.

administration and continuing throughout the subsequent ones, the presidency had to quell the opposition inside the bureaucracy and make sure that it could not reverse the process (Babb 2001; Teichman 2001). In order to do that, it guaranteed that its bureaucracy would not challenge any major change and would only fulfill the role of managers in policy execution, usually regulating competition from the private sector.

5.5. Conclusion: Some Lessons

Regardless of its lack of OSS adoption (or even because of it), the case of Mexico can provide some lessons for the adoption of technologies in the developing world. On a more normative sense, was Mexico's strategy correct? Although it is hard to use counterfactuals, the change to OSS was not a feasible strategy for the country, since it had neither the structure nor the incentives to apply it. In this case, adopting OSS, even though it is a public good and freely available, meant disturbing the developmental path adopted since the 1980s. It made no political or economic sense. Despite having a deep and long history of ISI and having all the attributes of a middle power, Mexico would not and could not adopt OSS in this form.

Adopting open source software is not a panacea for development. In the right circumstances, it can be of great help to train the workforce, provide a new platform for development and lower the barriers to entry for people that want to acquire the skills and invest in innovation. As we have previously seen, in order to “capture” these gains and

reap its benefits, the state has to possess the structural and institutional conditions for such. Not only because a public good is available is it necessarily the case that everybody will benefit equally from it, even wanting to do it. As the case of both Mexico and Brazil show us, state strategies of development usually mean "being in the right place, at the right time."

6. Some Tentative Conclusions: Designing Development

Development is not easy. After all these years, we are still trying to gasp what or what combination of factors makes countries richer, happier, and fulfilled. The lineage of writers that were committed to find a recipe or a solution has stacked libraries since the dawn of time. For the last 500 years, with the ascension of Europe and its creation, the state, we have had a wonderful canvas to study.

How this state should be organized has always been a matter of deep disputation. A series of normative questions were put forth: who should it favor? An elite? Everyone? The individual? The problem with any normative question is, unfortunately, always the same: we first need to have an understanding or theoretical map of how the world works before we can present solutions (or attempts at solutions) of what we think needs fixing. That is the goal of both Political Theory and Political Science, of asking the questions of need and focusing on the practical matters of how.

The major discovering, however, is that humans have an incredible potential for change. Technology is always evolving and thriving, although we are still baffled by the unpredictable nature of these changes and of our understanding of where it should go. For generations, the international system has been the locus of intense fighting and deep divisions. Conditions for change were scarce. In general, they still are. But as technology advances, new opportunities arrive that may offer profound change. Let us

take as an example the first steam engine -- an iconic machine: the invention and use of James Watt's machine changed the world, although not as we are accustomed to perceive.

Not everybody could benefit from the marvelous invention in the same way. Although simple, not everyone could afford or operate one. Certainly, possession of a steam engine meant power, sometimes literally military power. The steam power was also used, involuntarily, to divide men, as the social characteristics of the 19th Century clearly demonstrated. But, in the end, it revolutionized the world, launching an Empire in its wake. The opportunity was always there, as these are all creations of men.

A steam engine, alone, is not much. In order to exist it needs nurturing -- social, political and economic nurturing. Its creation depends on institutions also created by men. If it ever reaches a state where it shows some promise, it may be fought over by individuals, firms, bureaucracies, interest groups, and even social classes, if, of course, they manage to overcome collective action problems. The opposition to the steam engine may also arise -- as we know, the nature of technologies is disruption.

Developing countries need technology more than most. Their problems are multiple and deep. But the great inequality inherent in the international system has usually prevented this and, in a way, still does. Technology transfers are difficult and rare. Depending on the technology, the very nature of several uses prevents those who have it to give it (or sell it) to those who do not. Moreover, in the interdependent world where we live today,

it become even more unclear what exactly "autonomy" means. Technology to improve lives does not necessarily coincide with autonomy, which especially developing countries treasure.

We have gone very far in this understanding these connections. Political Science and International Relations are slowly revealing the patterns that explain patterns of development and relating those to real needs and, more importantly, making sure we pay attention to strategies of development. In a world in crisis, this need is amplified, and paradoxically, it can offer some enlightenment for developed countries too. In the last decade, we came to understand that capitalism is not the same everywhere, but it is not random either. It presents different sets of institutions that complement each other and affect long term patterns of development and the possibilities of policy creation, implementation and change.

The role of the state has never been more important. The state does not need to intervene to succeed, but the right combination of institutions does need to be taken seriously by those in charge. Radical changes are usually difficult and fraught with dangers both from within and from without. As both the Brazilian case and the Mexican case showed us, most of the time public policies work very different when applied then when they were first designed. Intentions are different than results and even the very idea of implementing a particular policy depends in great measure on politics.

A fundamental lesson from the case studies is the degree to which state capacity matters. Political will is not enough to formulate and implement policies. Without a solid base of bureaucrats and resources, combined with the knowledge of the strategic interaction between state, firms and social classes, there is little a country can do – even if it has, for free, a technological advance. While Brazil was able to turn old experiences into new policies using state capacity as leverage, the Mexican state became too weak (as compared to its private sector) to even find the advantage in implementing these OSS policies. Even worse: according to the logic spelled in the previous chapters, it would be very unlikely that OSS adoption would even work in Mexico as a tool for a developmental upgrade.

It is getting harder also to understand politics without understanding the very fabric of society – education and training. It affects everything and everybody in a polity, from who works to who demands the work, from those who consume to those who produce. As this reality is very present in the practical life of the majority of people, surprisingly it is still much unexplored in Political Science and especially in International Relations. This robust connection must become the next frontline of study in the area if, of course, the intention is to use research for improving the life of people.

This is what this dissertation tried to understand for developing countries. As the patterns presented by the data and the analysis of the cases shows us first is that there is hardly one just way of promoting some technology, even if it is widely available and offers a

new way not just to create but to consume technology. Open Source Software is not a panacea. Its future is uncertain and it may prove to be unsustainable in the long run. But all the signs point to a direction of great promise in revolutionizing the way whole countries relate to technology and possibly offering a future for people that never imagined operating or even being near to a computer. Again, getting one billion people out of the one dollar a day poverty trap is not easy. But now, differently than previous times, it is starting to show a lot more promise.

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Biography

Bruno de Moura Borges was born in Rio de Janeiro, Brazil, on November, 2nd, 1976. He completed his Bachelor's degree in Social Sciences at the Pontifícia Universidade Católica of Rio de Janeiro (PUC-Rio) on September, 1998, and completed his Master's Degree in International Relations at the same University on July, 2001.

He published the entries “Tratado de Cooperação Amazônica” and “Celso Amorim (as a co-author)” for the *Dicionário Histórico-Biográfico Brasileiro* produced by the CPDOC of Fundação Getúlio Vargas (1998) and an article called “Uma Teoria de Instituições em Declínio: Reavaliando *Saída, Voz e Lealdade* de Hirschman para as Instituições Internacionais”. *Contexto Internacional*, Vol. 26, n. 2, pp. 249-285 (2004).

He received scholarships by both CAPES and FAPERJ for the whole completion of his Master's degree and received a full scholarship for Ph.D. work by CAPES. He currently lives in Rio de Janeiro, is married, and is an Assistant Professor of International Relations at Universidade Cândido Mendes (UCAM) and an Adjunct Assistant Professor of Political Science at the Catholic University of Rio de Janeiro (PUC-Rio).