LEGAL RESERVE REQUIREMENTS IN BRAZILIAN FORESTS: PATH DEPENDENT EVOLUTION OF *DE FACTO* LEGISLATION

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Abstract
Why would a poor and largely pro-developmental country such as Brazil, that has so much of its territory covered in forest, adopt one of the most restrictive land use requirements in the world when it comes to cutting the forest to give way to other economic uses? We describe the evolution of legal reserve legislation in Brazil, which currently requires that 20% of the area in a property (80% in the Amazon) be left in forest or its native vegetation. This legislation was put into place in 1934 with the objective of assuring the supply of wood for fuel. Over time this objective has become irrelevant, but the legislation remained in place, though non-constraining, until the late 1980s when growing environmental concerns led to increasing levels of enforcement. We show how the path dependent nature of the legislation interacted with the changing *de facto* impact of the law to create a situation where environmental interests were able to ratchet up changes in the laws that could never have been achieved if the point of departure had been the complete absence of legislation.

Resumo
Por que um país relativamente pobre e com forte viés desenvolvimentista como o Brasil, que possui tanto de seu território coberto de florestas, adotaria uma das mais restritivas regulamentações do uso da terra no mundo, dificultando a remoção da cobertura florestal para dar lugar a usos econômicos? Este trabalho descreve a evolução da legislação de reserva legal no Brasil, que atualmente requer que 20% da propriedade (80% na Amazônia) seja deixada com cobertura florestal ou da respectiva vegetação nativa. Esta legislação teve sua gênese em 1934 com o objetivo de assegurar a provisão de madeira e lenha. Ao longo do tempo este objetivo se tornou menos importante, porém a legislação permaneceu, sem restringir, até o final da década de 1980, quando interesses ambientais levaram a maiores níveis de monitoração e policiamento. Este trabalho mostra que a evolução temporal (*path dependence*) da legislação interagiu com o impacto *de facto* destas regras para criar uma situação onde os interesses ambientais da sociedade conseguiram gradualmente mudar a implementação da legislação até um ponto que não poderia ter sido alcançado caso a lei já não estivesse estabelecida.

Palavras chave: Reserva legal, *de facto* vs. *de jure*, meio ambiente,Amazônia.
Key words: Legal reserve, *de facto* vs. *de jure*, path dependence, environment, Amazon.

JEL: K32, Q15, R14.

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Legal Reserve Requirements in Brazilian Forests: Path Dependent Evolution of *De Facto* Legislation

I. Introduction

Brazil has one of the most draconian rural land use regulations in the world. In addition to being prohibited from removing the vegetation from areas along rivers and other water bodies as well as steep slopes and hilltops, private landowners are obligated to keep 20% of their land in native forest, with the restriction increasing to 80% in the Amazon forest and 35% for savannah in the northern region. This preserved area, known as the legal reserve (*reserva legal*), must be recorded in the land title and the location of the preserved area cannot be subsequently altered. The restriction must be maintained even if fractions of the land are sold. Parcels that have already violated the restriction – which is the rule rather than the exception – must recover the forest at the owner's expense. Sustainable economic use of the legal reserve is only allowed after a detailed management plan drafted by a forest engineer is approved by a state or federal environmental agency, requiring at least two field inspection which must be periodically renewed.[1] Although many other countries have similar restrictions on the use of private land, the legal reserve restrictions are exceptional not only for the levels involved (80% of a property in the Amazon) but also because the costs are to be borne solely by the landowner although the benefit has public good qualities. This is much different from the concept of easements involving direct compensation or tax breaks to the landowner. An efficient frontier analysis of the impact of legal reserve requirements in the state of Paraná (legal reserve of 20%) by Padilha Junior and Berger (2005) calculated an average loss to landowners of US$465 per acre per year and an increase in risk to their business of 25%.

As Brazil holds the largest area in tropical forests in the world with the greatest amount of plant biodiversity, it may seem natural and fitting that such strict legislation should be in place. However, if one considers that Brazil is a relatively poor country (GDP per capita of US$9,108 -68th rank - compared to US$43,444 for the USA) it seems puzzling that such strong constraints on the use of natural resources would have been chosen. It is true that although these constraints are stringent in the letter of the law, their actual implementation and enforcement are typically extremely deficient. Nevertheless they are far from innocuous, imposing costs even when they are evaded, and the puzzle remains why a poor country striving to develop and raise the level of well-being of its population would voluntarily create laws that could have the effect of hindering the use of forest resources, one of the most obvious early avenues towards those very goals. After all – as Brazilians are fond of pointing out – most of today's developed nations depleted much of their forest resources in the process of becoming rich.[2] The problem is compounded if one considers the jealousy with which Brazilians have guarded their right not to be told what to do with the

[1] Hirakuri (2003) collected detailed data on the costs involved for issuing forest managment permits in the Amazon and calculated a total cost for a 1500 hectare parcel of US$3,094.03 taking approximately 170 days on average, plus a cost of approximately US$2,400 incurred by the environemental protection agency for follow-up inspections. These cost strongly discourage sustainable economic projects for use of the legal reserve.

[2] For example, in October 2006, when the news came out that the deforestation rate in the Amazon had fallen by 30%, President Lula stated 'They (the developed countries) have little to teach us about taking care of the environment. They only found out that it was necessary to take care after they cut down their whole territory.' (Agência Brasil, 2006).

Amazon and its resources.[3] What is stranger still is that these laws did not originate in the fairly recent period when environmental concerns have started to emerge in the national and global context, but rather can be traced as far back as 1934 when the first Forest Code declared that forest were of "common interest" of all Brazilians and first placed limits on how much private landowners could clear their properties.

In this paper we analyze the evolution over time of legal reserve requirements in Brazil and provide an explanation for the emergence of legislation with such strongly environmental characteristics in a country that is so eminently pro-developmental.[4] The argument is based on the path dependent nature of the evolution of *de facto* as opposed to *de jure* legislation. We show how rules that are created for unrelated objectives, or which are ineffectual for long periods of time, can affect future outcomes by becoming a binding reversionary point in the political negotiations for policy change.[5] In this way, legislation which would never normally be approved, given the balance of power among interest in society, can unexpectedly become the status quo. This possibility is more general than the case of legal reserve requirements in Brazil. All legislation has a path dependent nature and a gap between their *de jure* and *de facto* impacts. In a fast changing world rules that were intended for one set of objectives, or rules that at one point are non-binding, can suddenly play an important role in the process by which future rules are chosen. Examples of this are the myriad rules and regulations that are currently being adopted in response to the recent growth in concern over carbon emissions and global warming. A survey in The Economist (2007) on the recent reaction of business and governments to these issues provides dozens of examples, across the globe, of restrictions that are imposed on firms and individuals with the objective of changing behaviour in specific ways and reducing carbon emissions. It stands out how many of these cases end up having unintended or smaller impacts than was expected. An example is Britain's Renewables Obligation that requires that:

> …a set proportion of the electricity that power distributors buy must come from renewable sources; if they fail to meet their obligation, they must put money into a pot to be shared among renewables providers. The system is complex and the resulting price uncertain; which, along with planning constraints, explains why so much capacity has been planned and so little built. One consequence … is that Britain will not meet its target of producing 10% of its electricity from renewables by 2010. That's one reason why, in its energy white paper … the government proposed a radical revision of the scheme. (The Economist, 2007).

This example and others like it are similar to the case of the legal reserve in Brazil in that limits are placed by legislation on what property owners can do. The similarity continues in that the legislation's *de facto* impact was quite different than the *de jure* letter of the law, eventually leading the government to pass new legislation to try to bring the actual impact to

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[3] A survey in 2005 found that 75% of those asked believed that there was a real threat that the country could be invaded by a foreign power for its natural resources (Ibope, 2005).

4 Drummond and Barros-Platiau (2006) argue that "there was in Brazil a deep and lasting social consensus in favor of economic growth, at any and all costs, and that such an attitude was supported by a quite similar global consensus. This agreement crossed social, economic, and ideological boundaries throughout periods as distinct from each other as the civilian dictatorship of Getúlio Vargas (1930–45), the 1945–64 civilian "experiment in democracy," the 1964–85 military dictatorship, all the way up to the eve of the 1992 Rio environmental summit. "Developmentalism" was a national unanimity for almost 60 years. The widely accepted goal was to turn Brazil into a major world power, at the expense of political liberty and of the natural resource endowment, not to mention "social justice."

[5] A reversionary point is what will become the status quo if all proposed changes to the current status quo fail, see Cox and McCubbins (2001).

that which is intended by policymakers. The argument that we make in this paper points out that when this revision comes to be negotiated and voted upon in the country's political system, the reversionary policy, which has a major influence in each political actor's calculus, is the *de facto* restriction which the current policy implies. This means that in many cases (which vary because the outcomes are dependent on the specific voting rules and the balance of power) the current *de facto* policy will influence which new policies emerge. In Section 4 we present a spatial model that shows how this can lead to policy being adopted that is apparently incompatible with the country's balance of power.

Another contribution of this paper is to increase our understanding on the process through which countries change their environmental (and other) policies as they develop. The literature on the environmental Kuznets curve predicts an inverted-U relationship between environmental quality and income (Grossman and Kruger, 1995; Deacon and Norman, 2006; Levinson, 2000, among many others). This literature is large, diverse and disputed, however, the empirical strategies typically involve large cross-country econometric analyses which may or may not capture the way environmental quality changes in response to income, but typically do not provide much insight to the mechanism through which these changes operate. In this paper we look closely at the evolution of a specific environmental regulation over time – the legal reserve in Brazil – and highlight the complex process through which changes in income, together with changes in other variables, determine the changes in environmental impacts. This analysis provides insights into what goes on in the black box of observed environmental Kuznets curve relationships, that is, the political and institutional constraints and incentives that determine a society's motivation to increase its level of environmental protection and the factors that hinder or help that transformation.

In the next section we describe the evolution of legal reserve legislation in Brazil from its inception in 1934 to the present day. Section III then provides some data and tests to determine to what extent the legislation is being applied and what affects its *de facto* enforcement. A spatial model is presented in Section IV that spells out our argument on how the evolution of the *de facto* policy has a crucial effect on future changes that are made to the policy. Section V expounds on the generalizabilty of the argument to other policy areas and concludes.

Section II - The Evolution of Legal Reserve Legislation

In this section we provide a brief overview of how the notion of legal reserve arose and evolved in Brazil.[6] More than the specific details of the myriad changes that have been made over time we want to stress the dynamic nature of the legislation, which varies in purpose and in content following changes in social and economic circumstances as well as shifts in the balance of power among different groups. This section thus provides information on the path dependent aspect of the legislation while the next section address the issue of *de facto* versus *de jure* impacts. Subsequently these two strands will be linked to explain why the current legal reserve restrictions came to be.

In 1934 Brazilian President Getúlio Vargas created by decree its first Forest Code inspired by the New Deal and its high levels of government regulation of economic activity. The

[6] A more detailed description of the changes in this legislation can be found in Oliveira and Bacha (2003) and Hirakuri (2003). The dozens of changes to Law 4,771 (The New Forest Code) can be explored in detail through hyperlinks at the government's site: http://www.planalto.gov.br/ccivil/leis/L4771.htm .

Code established that each farmer must retain at least 25% of his land in forest, including the area along any body of water. The purpose of the Forest Code was to ensure that farmers retained a sufficient amount of land in forest to provide an adequate fuel supply. The forest in turn provided habitat for wildlife which in depressed economic conditions could be hunted to provide subsistence. For thirty years the law remained in effect but not enforced and therefore it did not impinge on the amount of cleared land for agricultural production.

In 1965 the recently empowered military government passed Law No. 4,771 which came to be known as the New Forest Code. The legislation now distinguished three areas in all properties. The first were areas of permanent preservation which simply could not be cut down or used economically. These include the margins of rivers and other bodies of water, steep slopes, top of hills and mountains, among others. The second area was the legal reserve, with new limits being set at 20% of the property in the south and southeast region of the country and 50% in the north region (Amazon) and the northern part of the centre-west, with no limits for the northeast. At this point only forests were protected and not other types of vegetation, such as savannahs. The area in the legal reserve could be explored without removing the forest, but this required authorization from the forestry service. The third area was the remainder of the land and this could be used freely.

The 1965 Forest Code is still in place and encompasses most of the forestry legislation in Brazil, though it has been and continues to be greatly amended. Hirakuri (2003) collected data on the number and content of changes to the initial legislation and found over 140 instances only at the federal level. She shows that from 1965 to 1985 there were on average 3.1 changes per year most of them "related to economic development of forest based industries." The major motivation of the government in this period was not environmental, but rather to support the accelerated development of the country and to assure sovereignty over Brazilian territory, both of these major concerns of the military

Kirakuri (2003:16) argues that in the second half of the 1980s the near total depletion of forests in several southern states and the alarming levels of deforestation in the Amazon, led to an increased demand for new legislation bringing the average number of changes up to 10 per year. At this point the changes are increasingly related to environmental aspects. In 1989 for example it became required that the area and location of the legal reserve be registered in the land title and notarized. This change also prohibited the loophole of separately selling of the legal reserve so as to create a new property that could then be partially cleared (Oliveira and Bacha, 2003). In 1991 new legislation was passed requiring landowners who no longer had the legal reserve stipulated by law to replant each year at least $1/30^{th}$ of the total legal reserve area. In 1996 a major change took place motivated by the alarm over increased levels of deforestation in the Amazon. For land in regions of the Amazon where forests are the predominant vegetation, legal reserve requirements were increased to 80% and in those areas where other vegetation predominated (savannah in the Amazon fringes) the limit was set at 50%. Note that now the motivation and the objective are exclusively environmental. In 1997 properties below 100 hectares in the Amazon were excluded from the 80% limit.[7]

A careful examination of the changes to the legislation, especially in the period since 1996, shows that there is a distinct contest between environmental interests and those of landowners and farmers. The changes alternate leading to occasional gains to one group and then to the other, indicating that there is, if not a clear balance of power among these groups,

[7] Presumably we do not see more subdivision of land into 100 hectare plots because of lax enforcement.

at least not a distinct predominance of one over the other. Most of the changes in legislation are instituted by presidential decree, which at the time – and only slightly less today – was the main instrument through which legislation is created in Brazil (Alston, Melo, Mueller and Pereira, 2005). The President had high levels of discretion to pass decrees which could be reedited almost infinitely, with many of the changes taking place in the reedited versions of original decrees.[8] This discretion, which essentially circumvents Congress, does not mean that the preferences of the different groups are not taken into consideration when the changes are decided.[9] Rather the Executive is the force that mediates among these interests and the decrees simply express the Executive's attempt to set the legislation so as to maximize its net support in this divisive situation.

On the one hand the landowners and agricultural interests are a major productive sector on which the economy depends not only for agricultural products but also for foreign exchange. Furthermore this group is well represented in Congress by a well articulated inter-party coalition (known as the *bancada ruralista*) whose capacity to deliver votes on crucial proposals makes it particularly effective at extracting policy concessions from the Executive (evidence to this effect will be shown below). On the other hand, the environmental interests are a more amorphous and diffuse force, which is nevertheless equally capable of influencing the President's choices. This involves a large and diverse set of NGOs and grass-roots movements, many of which are very organized, motivated and well-funded. Brazilian legislation provides several mechanisms through which they and other social movements can participate in the policymaking process, such as seats in CONAMA, the federal environmental council. It involves as well public prosecutors, which are independent from the Executive and have the motivation, resources and legal instruments to punish governmental inaction or transgression towards protecting the environment (Mueller, 2007). Furthermore there is a public sentiment among Brazilians, perhaps due to the fact that the country harbours the world's largest tropical forest, that protecting the environment is important.[10] A World Values Survey for 2000 on international attitudes towards the environment, which asked people if they would agree to an increase in taxes if the extra money were used to prevent environmental pollution, had Brazilians as the top country in terms of people choosing 'strongly agree', with 42% versus Sweden at 28.2% and Denmark at 22% in second and third and the US last at 4.0%.[11] We are not arguing that these responses are truthful and that such a policy would actually get implemented in Brazil. The point is to argue that there is a strong preference for environmental issues among the electorate and that the President must heed this fact.

The balance of power between environmental and agricultural interests can be seen explicitly in a well publicized event that took place in May 2001 in a mixed (House and Senate) committee that discussed a proposal to reduce the legal reserve requirements in the

[8] From 1996 to 2001 the decrees related to legal reserve requirements were reedited 67 times (Oliviera and Bacha, 2003).

[9] It is not that Congress has no power, but rather that the Executive is generally able to garner the support of a clear majority coalition which assures that very few decrees get overturned or blocked (Alston and Mueller, 2006).

[10] As noted in an article in The Economist (2001) "Another encouraging change arises because Brazil, though not exactly a rich country, is no longer a poor one. A conservationist movement is stirring among the new middle classes, and beginning to win some battles. One gram of patriotic pressure is often worth a tonne of well-meaning foreign meddling."

[11] The World Values Survey data is available at http://www.worldvaluessurvey.org/ .

Amazon from 80% to 50%. The committee was dominated by the *bancada ruralista* – 11 out of 14 -and the project sought additionally to loosen many of the most stringent restrictions in the legislation. Before the proposal could be voted on, a word of mouth campaign started by environmental groups and soon amplified by local and international media, transformed into a blitz of emails sent to the Brazilian Congress and President protesting about what was seen as legislation allowing the deforestation of 50% of the Amazon. The political magnitude of this protest led the president to maintain the previous levels of forest reserve requirements (80% in the Amazon) in a decree in June 2001, and to explicitly recognize, for the first time in the legislation that the legal reserve is "… necessary for the sustainable use of natural resources, for the conservation and rehabilitation of ecological processes, for the conservation of biodiversity and for the protection of native flora and fauna." Since then the struggle to alter legal reserve legislation has not ceased, rather emphasis has shifted towards creating mechanisms through which properties can compensate not meeting the legal requirements by purchasing those rights from other land owners.[12] Although there are great efficiency gains to be had from such schemes, at least in theory, both sides have been ambivalent. Land owners because they would still have to pay the entire cost of the public service; and environmentalists because they fear that if the schemes are not implemented properly they will just amount to a loophole through which existing legal reserve forest will be legally cut down.

Another important instances in which legal reserve requirements were negotiated in the political sphere was during the final vote in Congress for the Environmental Crimes Law of 1998 which sought to assemble and standardize all the diverse legislation which previously established fines and sanctions for violations related to the environment, thereby making evasion harder and enforcement more effective. This law was initially proposed in the House in Congress in June 1991 by the Executive with the purpose of "establishing penal and administrative sanctions to which will be subject those who break the legislation that protects the flora and fauna."[13] The initial project had 9 articles and was approved only in April 1995 with 27 articles. It was then sent to the Senate where in July 1997 it was approved with 90 articles. In the final stages of the process, in 1998, most portions of the proposal had been negotiated and were unanimouly accepted leaving just four controversial points left to be voted on seperately. One of these points was an article establishing it to be a crime against the flora "to set on fire, burn, fell, destroy, damage or cut trees in forest, woods or permanent preservation vegetation, even if it is still in formation, of legal reserve, or situated in conservation unit, even if it is still in formation, without authorization or license: Sentence: two to four years and fine." The point of contention was whether the legal reserve should be included in this article.[14] That is, the issue was whether misuse of the legal reserve would be explicitly considered a crime by the law.

When it came to the vote, the Senate version of the article (containing the reference to the legal reserve) was defeated by 177 yea to 267 no, and 4 abstentions. Given that the roll call was close we can analyze the determinants of the legislators' votes with a logit regression to

[12] See Chomitz (2004) for a description of how these schemes might work and an exercise for the state of Minas Gerais showing its viability.

[13] Note that this occurs in the period when Brazil was preparing for Eco-92.

[14] The alternative proposal was to substitute this article with the following: "... to destroy or damage forest considered to be of permanent preservation, even if still in formation, or to use it against the preservation norms: Sentence: from one to three years, or a fine, or both."

gain insights into the mechanisms through which political disputes over legal reserve requirements took place. The dependent variable equals 1 if the legislator voted for keeping the text that explicitly makes it a crime to cut down the legal reserve without permission, and equals 0 if she voted for the new text that does not make reference to the reserve legal. The explanatory variables are:

(i) an index of loyalty to the government which reflects the percentage of times the legislator voted according to the governments recommendation in previous years;

(ii) a dummy variable that indicates if the legislator is a member of the *Bancada Rural* (Rural Block), the inter-party group of deputies that defends rural interests;

(iii) a dummy variable that indicates if the legislator is a member of the *Bancada Evangélica (*Evangelical Block), also a multi-party group of representatives of the fast growing Universal God of Christ. In the 2002 election they gained 60 seats in Congress. They are included as an explanatory variable because they strongly opposed the noise pollution articles of the Environmental Crime Law, as their cults are noisy and tend to create conflict with neighbors.

(iv) a dummy variable if the legislator belonged to the government's coalition, that is the parties PSDB, PFL, PMDB, PTB, PPB.

(v) the proportion of agricultural land in the state that is covered in natural or planted forest or woods (1996 IBGE agricultural census);

(vi) the average number of years of schooling for the population over 10 years in the legislator's state. (1998 IBGE Aunário Estatístico).

(vii) the proportion of area in the legislator's state in farms over 500 hectares (1996 IBGE agricultural census);

(viii) GDP per capita in 1997 in the deputy's state (IBGE 1998 Contas Nacionais);

(ix) the proportion of rural population in the legislator's state (IBGE Censo Demográfico 2000).

Table 1 shows the results of the logit regression.

[Table 1 here]

Before analyzing the regression results it is important to note this vote involving the legal reserve was the only issue in the entire proposal that had to be decided by vote rather than negotiated.[15] Given that the Environmental Crimes Law encompasses all environment-related issues, from pollution to erosion to biodiversity to CO_2 to fishing to noise, etc., this fact is revealing about the level of controversy and the balance of power among interest concerning legal reserve.

In order to understand the regression results it is important to consider that the Executive positioned itself against the proposal.[16] This does not mean that Executive sided exclusively with the agricultural and against the environmental interest. In trying to maximize its net support from both these groups this was merely a marginal adjustment. It had already supported tougher legal reserve legislation, as evidenced in several decrees it had recently passed, such as the 1996 increase in legal reserve requirements in the Amazon from 50% to 80%. However the Executive did not want to go as far as making it a crime to cut the

[15] In the end a compromise was reached on the three other disputed points and they were approved almost unanimously.

[16] In Brazil the Executive always officially announces its position on a roll-call vote, which makes it easier for coalition members to know how they are expected to vote.

reserve. It is in this context that the regression results can be understood. They show that members of the government's coalition, members of the Rural Bench and of the Evangelical Bench voted significantly against making a crime of cutting the legal reserve. Similarly, the more loyal the legislator was to the government the higher the probability of voting against criminalization. The Executive thus used its extensive legislative powers and control of pork to block the change which it percieved would bring more opposition from agricultural interest than it would bring support from the environmental side (Alston and Mueller, 2006). Another interesting result is that legislators from those states with more forest had a higher probability of voting against criminalization. This indicates that those states with more forests had more developmental than conservationist preferences and did not want to lose the option of cutting them down. Equivalently this means that states with less forest coverage tended to have more environmental preferences relative to the more forested states and thus represented a force towards toughining legal reserve legislation. Perhaps surprisingly, legislators from more educated states voted, *ceteris paribus*, against criminalization, however, those richer states supported tougher standards. Land ownership concentration and rural population did not turn out to be statistically significant determinants of legislators' votes.[17]

What this section has shown, besides describing the content of the legislation, is that the legal reserve is a salient issue that undergoes a continuous and charged evolution over time involving resonably well balanced interest. In Section IV we present a spatial model that shows how these characteristics determine the legal reserve legislation that emerges over time. Before that, however, Section III provides some data on the actual impact that the legislation had on the landowners' choices.

Section III – *De Facto* Impacts of Legal Reserve Requirements

Anyone familiar with the Brazilian countryside knows that in general legal reserve requirements are far from being respected. In principle it is not necessary to go to the data to assert that there is a wide gap between what the legislation imposes and the *de facto* situation. This section will nevertheless explore the little data that is available so as gauge the size of that gap and its evolution, and also to analyze its determinants. In the process we argue that the fact that the legal reserve legislation is so widely disrespected is not equivalent to saying that it is absolutely not binding and imposes no costs on landowners. The fact that they dedicate so much effort to sway changes in the legislation, described in the previous section, reflects the recognition that the legislation creates current and potential costs.

Oliveira and Bacha (2003) analyzed the extent to which legal reserve requirements are respected in Brazil using data from the cadastre held by INCRA (the federal land reform agency) and conclude that less than 10% of the properties declare having a legal reserve and even those that do have less than the required area. Officially every rural property should be registered in this cadastre, which explicitly collects information on the area of legal reserve. However, it is well known that the cadastre is a poor reflection of reality. Not only do landowners have incentives to withhold or distort information, given that it may be used for tax and land reform purposes, but also because INCRA has not been very diligent over the years in its maintenance and expansion. The landowners also have an incentive to

[17] Presumably part of the explanatory power of these variables is captured in the variable measuring the rural bloc in Congress.

underreport the existence of forested area as not having a legal reserve only brings with it the obligation of having to replant over a 30 year period, whereas cutting down an existing forest implies much stiffer sanctions. Remember that for states in the North region the legal reserve should cover at least 80% of the property and in the rest of Brazil 20%. If we count only those farms that do indicate having a legal reserve, which are less than 5% in the North (except Pará), the area covered is on average 45%. The value when we use all the registered farms falls to below approximately 12% on average in the North. For the other states the level of compliance is similarly low.

Given the problems with the INCRA data we turn to the agricultural census, which has universal coverage and is much more credible. The three main problems with this data are that the last census was in 1996 (a new one is currently in the works but results will only be available in 2008), the numbers are not disclosed at household level but only at municipio level and it does not ask respondents explicitly about legal reserve. It does however have data on the total area of the properties, and of the area under various uses, including natural and planted forest and land that is unusable. Note that what is actually being measured is not really the extent to which legal reserves actually exist, but rather whether the state (or the municipio in subsequent analysis) has enough forest on average across its farms to meet the legal reserve requirements. In reality it may be that some farms are completely deforested and others have large stocks of forest. One way of thinking about it would be to consider if the state or municipo has enough forest so that a system of tradable compensations would be feasible (Chomitz, 2004). The data shows that, under this interpretation, none of the Northern region states meet the 80% requirement but that 13 out of 21 other states are above the required 20%.[18]

In order to have a less aggregated look at the data Figure 1 plots the proportion of forested area relative to total farm area at the municipio level in 1985 and 1996, ordering the observation from lowest to highest and separating the North from the other regions.[19] The first point that stands out is that the muncipios span the entire range from 0% in forest to nearly 100%. The disaggregated data provides a better picture of the distribution of municipios along that range. If trading schemes were restricted to be implemented within a single municipio, a majority would not have a large enough stock of land.[20] In 1985 in the North, 79.8% of the municipios had less than 80% in forest and in 1996 that number increased to 90.8%. In the other regions the number of municipios below the required 20% of our proxy level of legal reserve actually decreased slightly from 62.7% in 1985 to 57.3%

[18] This data is more than 10 years old and the situation today must surely have deteriorated. Note however that the data include only the area in actual farms and not public land. In the North region there is abundant public land beyond the frontier that is constantly being incorporated. Much of this land is covered in forest and may increase the measure when they are added to the universe of farms.

[19] There are 5572 muncipios in the data for 1996 and 4266 for 1985 as subdivisions occur over time. To make data comparable over time we use the 'minimum comparable areas' available at www.ipeadata.com.br , which reduces the number of observations to 3659.

[20] Most proposals for compensation scheme allow trades across muncipios but generally within the state. One avenue that is allowed in legislation but that has not yet been fully implemented in any state is the concept of ecological zoning whereby a large study is made of the state's geography, flora and fauna and different areas are assigned to different uses. The zoning would indicate which areas would be allowed in trades. One advantage of zoning and trading is to create a large continuous legal reserve, rather than unconnected islands of forest where biodiversity cannot thrive. Many environmentalist fear that zoning will simply amount to a license to deforest entire areas.

in 1996, though it is still the case that a vast majority of municipios are below the required limit.

A question which might arise is whether there is some kind of inverted Kuznets curve dynamic at play whereby as income rises legal reserve limits are initially increasingly disrespected but after a point they start to become binding. In the previous section we showed that in the past decade environmental interests have experienced significant growth in size, exposure and influence in Brazil. This phenomenon might be a reflection of this very dynamic as well as a mechanism through which it works. In order to take a first look at the influence of income growth on legal reserve compliance, we plotted municipios according to the variation in the fraction of forested area from 1985 to 1996. This showed that in fact there are more municipios where the area in forest increased than there are municipios were it decreased. In absolute terms there was a net increase of about 1 million hectares in forested area out of the total of 353 million hectares in farms in the country in 1996.[21] A difference in means test between the average GDP per capita in those municipios where potential legal reserve area increased and where it decreased yielded a t-statistic of 7.11, which rejects at a 1% level of statistic significance that both groups of municipios have the same average GDP per capita. As the muncipios where forested area increased had higher average income, some evidence is found that increases in income might eventually lead to higher compliance with legal reserve requirements.

In order to test this more rigorously, we regressed the fraction of forested areas in each municipio, that is, the legal reserve potential, against a series of control variables as well as agricultural GDP per capita including a squared term. The other explanatory variables are:

i) average size of farm in the municipio (IBGE, 1996);
ii) area in farms divided by total municipio area, which can be seen as a measure of availability of frontier land (IBGE, 1996);
iii) investment per hectare in constant Reais of 2000 (IBGE, 1996);
iv) rural population density(IBGE, 1991);
v) percent of total population that is rural (IBGE, 1991);
vi) Distance to state capital (Ipeadata);
vii) Longitude and latitude of municipio centre (Ipeadata)

The regression results are shown in Table 2. The first column in Table 2 shows the OLS regression for 1996 data where the dependent variable is the fraction of farm area in the municipio that is in forest. The results show a statistically significant non-linear relationship between income and forested area. Figure 2 plots this estimated relationship together with the actual observed data. Clearly the bulk of the municipios lay in the region where predicted income is negatively related to GDP per capita, nevertheless the effect becomes weaker as income grows and several municipios lay in the positive part of the curve. This evidence is compatible with the existence of an incipient inverted Kuznets curve, though clearly more evidence would be necessary to make a stronger claim to this effect.
The other variables in the regression also provide important information on the determinants of proportion of forested area. Muncipios with larger average farm areas tend to have more

[21] Total area in farms in the entire country actually decreased 5% from 1985 to 1996. The area in forest in the same period grew by 1%. Typically, land that is incorporated into the stock of farms is frontier land that is usually more covered in forest than those already in the stock. This would explain an increase in forested land when total area in farms is falling.

farms. This may be due to the fact that farms in more frontier regions, especially the North, tend to have more forest and larger farms. However, the effect remains positive and significant when state dummies are added so it may also reflect a greater disposition of larger farms to hold more forest.

[Table 2 here]

[Figure 2 here]

The variable that measures the fraction of the total geographical area of the municipio that is covered by farms, which proxies in a way for 'frontierness', was found to have a negative and significant impact on legal reserve potential. More developed muncipios are more fully occupied and have less forest coverage. As expected greater investment per hectare and greater population density also reduce forested area. Rural population (%) on the other hand is found to have a positive and statistically significant effect of legal reserve potential. Possibly this variable measures more the backwardness of the economy in a muncipio than it does the intensity of agriculture. The distance of the muncipio to the state capital is found to have a have a non-linear effect on forest coverage, first decreasing and then increasing. As one moves away from the capital there will typically be intensive agriculture and less forest, but as some point transportation costs will increase and extensive agriculture and pasture will start to dominate as well as increased forest area. Longitude and latitude simply control for geographic and climatic effects. The large size of the sample leads to highly significant relationships in this regression and the R-squared shows that nearly 30% of the variation in legal reserve potential was explained.

In the second column of Table 2 we repeat the same regression using a panel which includes data for 1985 and 1996.[22] The panel was estimated with a random effects estimator and thus includes only variables which vary over time. The results for this estimation are similar to the 1996 cross-section, with all variables showing the same sign and significance but always a smaller effect. The inverted-U relationship between income and legal reserve was found to be robust. In addition this estimation allows for a time dummy which confirms that over time the area in forest did in fact grow.

In the third column of Table 2 we regressed the percent increase in legal reserve area (potential) in each municipio against the 1985 level of some of the variables. This is in the spirit of growth regressions that test whether there is convergence of poor to rich countries by regressing growth rates on initial income levels (Barro, 1991; Sala-i-Martin, 1996). The coefficient for the level of legal reserve in 1985 was found to be negative and statistically significant. The interpretation for this is that municipios with more forests in 1985 will tend to have greater reductions in forest by 1996. If you take two identical municipios except that one has 10% more area in forest than the other in 1985, this result implies that the reduction of the forested area would be 17% percentage points lower in the first. This indicates that there are probably increasing costs to clearing forests, which may be due to geographical as well as legal reasons as farms move from more accessible and legally cleared land to more margin and protected land.

Agricultural GDP per capita in 1985 is found to be negatively related to increases in legal reserve area, with no quadratic effect found in this case. Once again the effect of average farm area is found to be positive, with muncipios that have larger farms on average tending to have more growth (or less reduction) in forest cover. Additionally, higher

[22] As a subdivision of many municipios occurs over time, we use 'minimum comparable areas' to make the panel compatible.

investment levels in 1985 were found to reduce growth in forest area and higher rural population percentage was found to reduce them, consistent with the cross-section and panel results.

The overall picture that emerges from the regressions in Table 2 is of a standard frontier process that evolves in response to economic rents leading more land to be incorporated into production, both by expanding the area of farms as well as the amount of the farm area that is put into use, which is done often by clearing forest. The results showed as well that there are signs that as income grows the pressure to remove forests tends to decrease and may even revert and lead to increased conservation, though by 1996 this effect was still weak. It will be interesting to see whether this effect will be confirmed in the 2007 agricultural census, which captures a period when land stopped being used for hedging against inflation and when returns to agriculture increased sharply.

Above we presented primary data (INCRA cadastre and IBGE agricultural census) to show that compliance with legal reserve requirements is highly deficient. In addition to this data there are several case studies of specific experiences that provide additional information on the extent of legal reserve legislation compliance in different contexts. An interesting case is that of the monitoring system put into place in Mato Grosso, a state that has experienced an intense growth in agricultural production, especially soy beans, in the past decade, including in areas that are part of Legal Amazonia and subject to the 80% legal reserve restricition. This state set up a monitoring system known as SLAPR (Environmental Licensing System for Rural Properties) which uses satellite imagery and GPS (Global Positioning System) technology to provide easily accessible and frequently updated information on the forest cover on agricultural properties. Landowners much register their land and register what area in their farm will be the legal reserve. The system monitors all forest clearing by satellite and matches that information with registered legal reserve data. If at any point the landowner cuts down part of his legal reserve, the monitoring system will quickly sense it and the proper authorities will be notified. This is an interesting situation because it removes many of the physical and logistical impediments to the enforcement of legal reserve legislation so that remaining shortcomings can be traced to political and institutional as well as financial causes. Interestingly the governor of the state is known as the 'Soybean king' and is one of the world's largest producers. Nevertheless, the system was put in place during his two terms and office, and it is not clear whether to what extent his government is championing the system or holding it back, perhaps consistent with the notion of an inverted Kuznets curve dynamic.

Lima (2005) sets out to examine the images generated by the system for 6,116 registered properties, covering a total area of 15.32 million hectares (17% of the state) by 2004. They found that in a single year (2004) the level of deforestation in areas registered in the system was 3.21%, higher even than in properties not in the system where the rate was 2.15%.[23] Of the total amount of deforestation that took place in the properties registered in the SLAPR monitoring system, 31% was done in areas that had been registered as legal reserve. In other terms, 8% of the deforestation in the state in 2004 was undertaken in registered legal reserve area, which by law could not be cut down. The study shows that not only did clearing occur in the legal reserve areas but those areas that entered the system already below the legal limit, and thus had the obligation of recomposing the area, continued to deforest. Lima (2005) concluded that the SLAPR monitoring system has not been

[23] This excludes parks and conservation areas, Indian reservations and land reform settlements.

effective at reducing legal reserve abuses and point out that given the rate of deforestation, the state will soon reach a point where there will not even be enough of a forest stock to allow a system of legal reserve trading to be set up.[24] These facts corroborate the main point of this section, which is to show that the *de facto* impact of legal reserve legislation is significantly lower than the *de jure* impact. However, the case of Mato Grosso also substantiates the important point that although the legislation is not fully observed it is nevertheless far from innocuous and imposes costs on landowners that they are willing to try to reduce by further affecting legislation.

Section IV – The Political Economy of Legal Reserve Requirements

In Section II we showed the way in which legal reserve requirements, which were created for a different purpose, became strong environmental restrictions on the use of land. Furthermore, we showed the way in which this legislation has been constantly evolving in a continual and balanced contest between environmental and agricultural interest. Then in Section III we showed that although the restrictions are strict, enforcement is lax and the actual levels of legal reserves maintained by landowners are, as a rule well below mandated levels. In this section we bring these threads together to provide an understanding of the determinants and consequences of the dynamic political process through which changes in legal reserve legislation and implementation take place. This will provide a explanation to the paradox of a relatively poor and generally pro-developmental country like Brazil having chosen to put in place such restrictive legislation.

In order to model the political process behind the evolution of legal reserve evolution, we simplify the issues involved into just two dimensions, so as to allow the preferences and policy points to be plotted on a two dimensional graph. The first dimension, measured horizontally in Figure 3, captures the strictness of the legislation. It can be thought of as the percent of total area that must be kept in forest in a given region according to the law. Points more to the left represent lower levels and points to the right approximate the 100% level where no forest can be removed. The second dimension, measured vertically, reflects the severity of the penalties for violations of the levels required by the legislation. These can range from warnings and mere exhortations to replant, in the lower regions of the graph, to hefty penalties, incarceration or expropriation in the higher regions. Clearly, legal reserve legislation, as any other issue, has several other dimensions, such as the extent to which it actually impacts the environment – for example protecting biodiversity –or the extent to which it provides for flexibility through economic incentives such as compensation schemes. Nevertheless, simplifying to two dimensions allows us to make our argument more clearly and without loss of generality.

In Figure 3 we focus on the preferences of two specific groups, environmentalists and landowners or agricultural interests. We argued above that both are currently well organized in Brazil and are able to pressure government for policy changes. We argued also that the balance of power among these groups is sufficiently balanced that neither completely dominates. In this model the preferences of government are not made explicit, rather it is assumed that the President's main goal is to maximize net support and policy choices are made in response to the levels of support and opposition that each group provides as in the Stigler/Peltzman approach to economic regulation (Stigler, 1970; Peltzman 1976).

[24] It is important to point out that Lima (2005) is not an academic publication but a report by an environmental NGO so reader should be on guard for potential biases in the analysis.

The preferred point of the landowners, *L*, is plotted in Figure 3 at the lower left-hand corner, on or close to the point where there are no legal reserve restrictions and no penalties. Conversely, the environmental interest's preferred point, *E*, is on the upper right-hand region of the graph, where restrictions are tight and penalties are tough. The line connecting both of these points is the contract curve, that is, points where there are no Pareto improvements for both sides. For all points not on the contract curve there is always a non-empty set of points that both sides would prefer to the status quo.

The analysis starts with the Forest Code of 1965, which reaffirmed previous legislation (the 1934 Forest Code) in requiring that landowners should leave 20% of their property in forest or native vegetation (50% in the Amazon) subject to three months to one year in prison or a fine equal to one to one-hundred times the monthly minimum wage. The point on the graph that corresponds to the situation depicted in the 1965 legislation is labeled SQ_{65}^{jure} and is placed reasonably high and to the right given that it establishes a relatively strict set of standards. The actual impact of this legislation was, however, much more modest than the letter of the law, so that the corresponding *de facto* point on the graph, SQ_{65}^{facto} is significantly down and to the left. This situation of relatively little constraint over landowners persisted until the end of the 1980's when environmental concerns started to emerge and slowly organized as groups that pressure for the law to be better enforced. This process intensified over time and led to a major revision in the law in 1996 (smaller changes are made before that) which increased the legal reserve restriction in the Amazon from 50% to 80% with slight stiffening of the penalties for non-compliance. This change shifted the *de jure* status quo point from SQ_{65}^{jure} to SQ_{96}^{jure} in Figure 3. Simply changing the law does not necessarily mean it will be more enforced, but this case the effect was to move the *de facto* status quo to the right as it gave the legal backing for increased pressure by environmental groups for better enforcement. One example of this is the satelite-based monitoring system (SLAPR) described above. Another institutional mechanism through which enforcement improved was the legal backing which the modified law gave to public prosecutors. Mueller (2007) argues that public prosecutors in Brazil have the independence, financial and human resources, legal instruments and the motivation to actually pursue environmental compliance, not so much by cracking down on perpetrators directly, but rather by pursuing those governmental agents whose mandate it is to do so, such as federal and state environmental protection agencies'.

As the pressure for compliance increases, the *de facto* status quo point starts drifting to the right. It is in this context that the presidential decree that instituted the changes in the law undergoes an intense process of minor changes. These take place each time that the decree is renewed, a total of 67 times between 1996 and 2001. We interpret these sequential marginal changes as the process through which environmental and agricultural interest dispute the terms of the legislation as mediated by the Executive, rather than being discussed in Congress.[25] The effect of this process in Figure 3 is denoted as the shift in the *de facto* legislation to SQ_{96}^{facto} on the contract curve as it represents a point where all negotiations have been realized.

[Figure 3 here]

[25] An analysis of the merits and weaknesses shifting the political process to this realm is an interesting topic for future work.

The narrative we have produced thus far to explain how a moderately restrictive set of requirements over the use of private land emerged in Brazil can now be contrasted with a counterfactual so as to highlight the importance of the path dependent nature of the legislation's evolution. This counterfactual is a situation where there is no previous legislation requiring a limit on the clearing of forests on private property, as one would expect to be the case in most forest abundant poor countries. In this scenario, even if an influent environmental interest group were eventually to emerge, as long as the balance of power with the agricultural interest were not completely lopsided, one would not expect high levels of legal reserve requirements to find their way to the letter of the law. The reason for this is that in this situation the status quo, which acts as the reversionary point which will prevail if no deals are struck, is much different than that which the 1965 Forest Code imposed, even if the intention in that legislation was not environmentally driven, but rather stemming from a concern over fuel security. The status quo in this counterfactual situation is simply the inexistence of legislation limiting forest clearing, represented by point SQ^{NoLaw}. This status quo is *de facto* by default and either coincides with the landowners preferred point or is slightly above and to the right if there are limits on land use stemming from other sources such as local rules or custom. In this case the status quo point anchors the scope for subsequent changes in the law through the political system and at most a nearby compromise such as SQ_{New}^{NoLaw} is reached. This contrasts sharply with SQ_{96}^{facto} that was actually achieved. What made the difference was the previous existence of the legislation, that though dormant for a long period, gave the environmental interests a point of departure.

The story, naturally, does not end in SQ_{96}^{facto}. Since then there has been a continuous process of marginal changes in the legislation with a few larger changes along the way, such as the presidential decree in 2001 (MP 2,166) described in Section II, which arose in response to the uproar against proposed changes reducing legal reserve requirements by a landowner-dominated committee in Congress. In actual fact, the process has continued actively in the past few years and is sure to continue to do so in the future.[26] Clearly the outcomes of this process will depend on the relative power of the opposing groups, which may very well change over time, although there is no expectation that any dramatic shift will take place.[27] As long as that balance is maintained, our analysis suggests that what will take place is a series of new legislative adjustments in response to *de facto* changes in the enforcement of the legislation. This process is depicted in Figure 4, where a drift in the *de facto* status quo, brought about by technological changes in monitoring technology or by

[26]In 2006 legal reserve rules were slightly modified in the context of a 2006 law which seeks to regulate the sustainable private use of public forests. Currently in 2007 there are new modifications being discussed in committees in Congress.

[27] The flagship program of President Lula's second term in office in 2007 is a set of measures that seeks to accelerate economic growth (known as the Growth Acceleration Program - PAC). One of the stated instruments towards this end is the removal of several impediments to economic projects in the form of environmental legislation. The most prominent of these are legal problems involving the construction of new hydroelectric dams and roads. Legal reserve legislation has not yet been considered in this context but the stage is set. President Lula has restructured IBAMA, changing staff and reshuffling powers and functions. At the same time deference has been shown by the President to the Ministry of Environment which is dominated by environmental interests and no attacks have been made to its power. Corroborating this, Brazilian society (and even business) has been accompanying the world wide trend of the past few years of increased environmental concern.

increase public pressure on enforcement authorities, changes the previous status quo, SQ_{96}^{facto} to SQ_{drift}^{facto}. This leads to a situation where both sides are willing to agree on further changes in the legislation that consequently lead to new *de facto* impacts at SQ_{New}^{facto}.

[Figure 4 here]

Section 5 - Conclusion

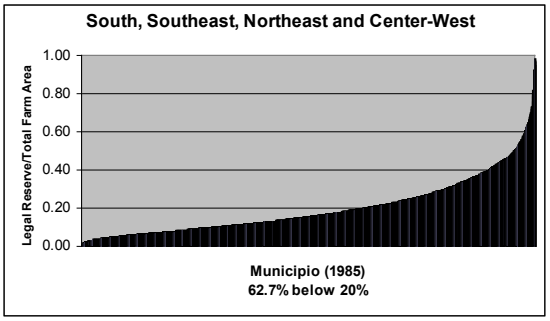
The dynamics of legislative change described in this paper is more general than the case of forest reserve in Brazil. It is very common for legislation to be passed with one set of purposes but end up not having the desired impact. Changing circumstances can create situations where dormant legislation will start to be constraining, often in unexpected ways, leading to *de facto* effects that thereon become the reversionary point for negotiations to change the legislation. Although not exclusively, this is very common with environmental regulation that establishes rules and restrictions that are often difficult or impossible to be monitored or enforced. Over time, changes in technology and public sentiment can lead to better enforcement, creating *de facto* situations, often unrelated to the initial intention of the law, which result in outcomes that would not be achieved if no legislation had been in place. As regulation imposing environmental restrictions is likely to grow considerably in the future throughout the world, this is an important point to take into account.

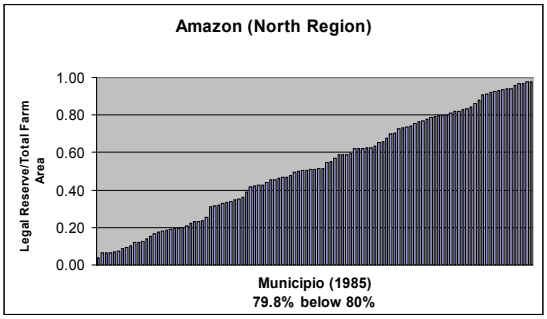
Table 1 – Determinant of Legal Reserve–Related Votes in Environmental Crimes Law

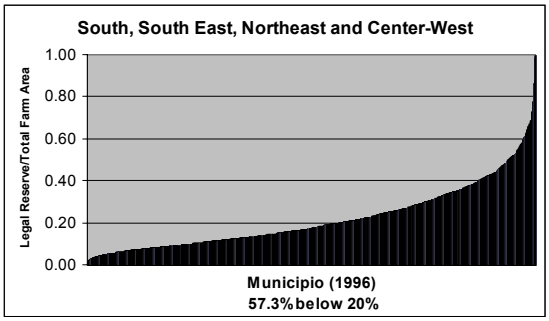
	Votes to Strengthen Legal Reserve Penalties
Loyalty to Government	-2.77***
	(-4.25)
Rural Interest dummy	-0.97**
	(-2.02)
Evangelical dummy	-2.76**
	(-2.31)
Coalition dummy	-2.27***
	(5.64)
% Forest	-4.46***
	(-3.17)
Education	-1.38***
	(-2.47)
Land Ownership Concentration	0.002
	(1.47)
Rural	-5.00
	(-1.44)
GDP per captia	0.0003*
	(1.69)
Constant	11.27***
	(3.62)
Method	Logit
Observations	436
Log-likelihood	-201.099
Log-like. restricted	-292.856
Chi-squared	183.513
Significance level	0.0000

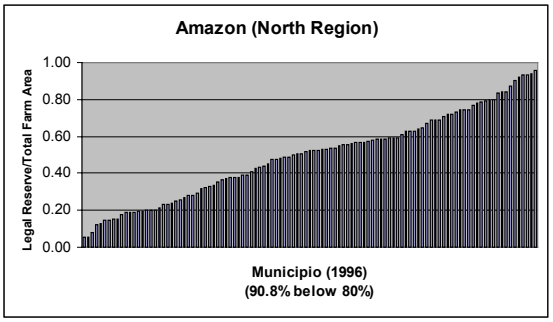
T-stats in parenthesis. *=10%, **=5%, ***=1% level of statistical significance.

Figure 1 – Potential Legal Reserve by Region









Source: IBGE. 1996. Agricultural Census.

Figure 2 – The Effect of Income on Legal Reserve Potential (1996).

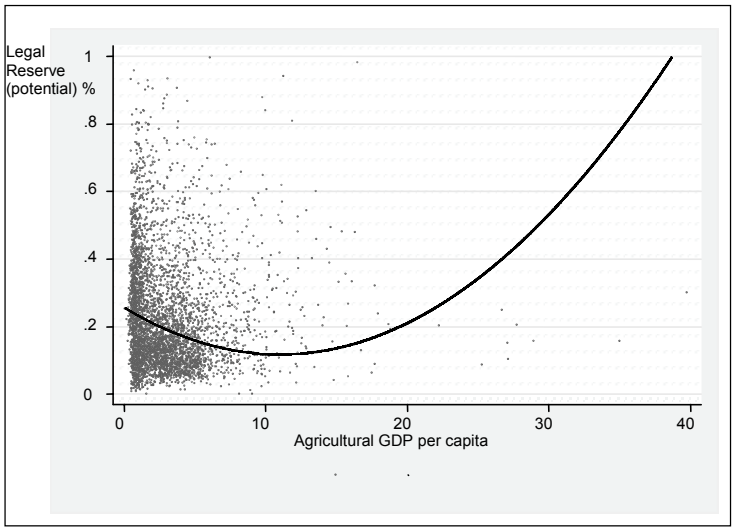


Table 2 – Determinants of Legal Reserve Potential.

	(1) Legal Reserve (Potential) 1996	(2) Legal Reserve (Potential) Panel 1985-1996	(3) Variation in Legal Reserve (Potential) 1985 - 1996
Legal Reseve % in 1985			-1.773***
			(-12.23)
Agricultural GDP per capita	-0.024***	-0.015**	-0.074***
	(-8.85)	(-8.52)	(6.45)
Agricultural GDP per capita squared	0.001***	0.0007**	
	(6.03)	(6.39)	
Average size of farm	0.0001***	0.0001***	0.0003***
	(5.10)	(6.91)	(2.65)
Farm area over municipio area	-0.002***		
	(-17.46)		
Investment (per hectare)	-0.121***		-0.002***
	(-3.23)		(-3.09)
Rural population density	-0.0007***	-0.0003**	
	(-5.08)	(-2.36)	
% Rural population	0.129***	0.066***	0.334***
	(11.80)	(6.98)	(4.51)
Distance to state capital	-0.0001***		
	(-3.83)		
Distance to state capital squared	1.05×10^{-7} *		
	(1.82)		
Longitude	0.007***		
	(10.98)		
Latitude	0.002***		
	(4.22)		
Time dummy (1996)		0.025***	
		(11.10)	
Constant	0.107***	0.153**	0.555***
	(4.9)	(18.75)	(11.90)
Method	OLS Robust Std. Errors	Panel data Random effects	OLS Robust Std. Errors
Observations	4207	N=3632, T=2	3626
R-squared (adjusted)	0.293 (0.291)	within = 0.022 between = 0.077 overall = 0.066	0.073 (0.071)

T-stats in parenthesis. *** = 1%, ** =5% and * =10% level of statistical significance.

Figure 3 – Political Bargaining Over Legal Reserve Regulation

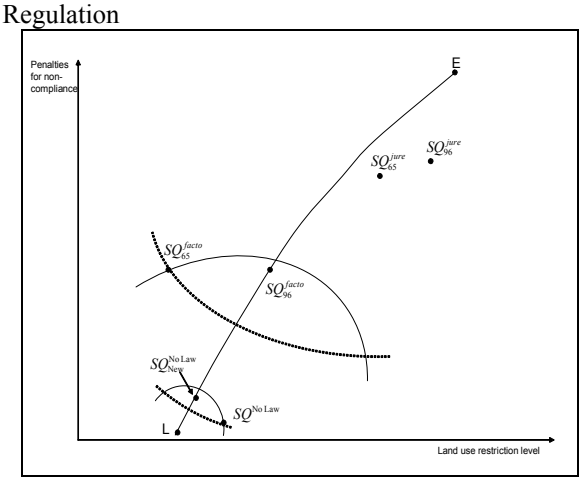
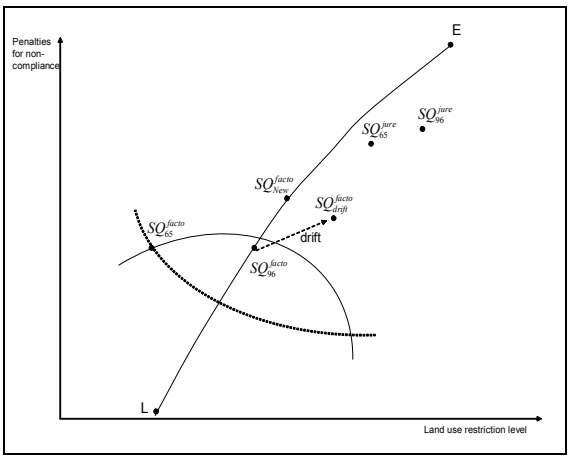


Figure 4 – The Impact of Changing *de facto* Enforcement.



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