

Judicial Process Dynamics

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Abstract

Becker (1968) posits that criminals respond, like any rational agent, to the benefits and costs of their activities. From this notion follows the deterrence hypothesis: the idea that judicial policies can reduce crime through an increase in the expected costs of illegal activities. Yet, despite implementing the suggestions implied by this hypothesis, many countries undergo large crime escalations. In this research we explore institutional failures in the implementation of deterrence policies. We use a dataset of relevant judicial figures for one country. The data are used to calibrate a System Dynamics model. We find that, contrary to what would be expected, criminals tend to be punished not exclusively on the basis of their behavior, but in terms of other institutional variables. Our data show that judges are prone to dismiss cases when the backlog to be processed exceeds a threshold, in a manner that much corresponds to the archetype "Shifting the Burden To." The effect of judges' decision rules, which result in potential criminals being acquitted without apparent reason, is that of creating incentives for people to engage in criminal activities, thus causing crime rates, and the backlog of cases, to increase even further.

Introduction

Crime threatens the fabric of society. It affects the well being of people and institutions, and it drains the benefit created by productive activities. Investors looking for projects to generate long-term prosperity will avoid working in places where they have to worry about assault, burglary, or kidnapping. As a consequence, the more pervasive crime is in a country or region, the more difficult it will be to attract and generate investments, create jobs, and maintain social stability, possibly leading to more crime.

Crime is particularly troublesome in the less developed regions of the world, where it becomes an obstacle to development, it greatly compromises efforts to reduce poverty and inequality, and it hinders economic growth. In an interconnected global economy, crime can outweigh a country's workforce productivity advantages or any other source of comparative advantage. Costa Rica is a good example. The country, which has had a stable democracy and a strong social foundation embedded into its institutional system, appears to be seriously threatened by insecurity and crime. In this country crime and insecurity have started to reach disquieting levels. The country has gone, in less than twenty years from a per capita murder rate of approximately 4 per 100,000 people, to almost 12. Burglary, assault, and other crimes against property are on the rise. Insecurity has become the main concern among the general population. This has, in turn, triggered cries, for the government to use repressive measures to harshly and quickly put an end to the problem. Political parties are starting to seek power on "no tolerance" and "hard hand" platforms. Although intuitively, such ideas might look like good solutions, it could very well be that exacerbated repression may actually create more incentives to commit crime, with a consequent further deterioration of the situation and even louder cries for more repression, which would, in turn, induce the commission of more crime.

Public officials and decision makers should not give in to such demands for repressive measures unless sound analysis warrants them. They should approach the problem from a broad and objective perspective. Their mission is to design and implement realistic, balanced, and effective strategies to contain and reduce crime and insecurity.

From an academic standpoint crime, as a subject, is still, notwithstanding decades of research, poorly understood. Progress in decoding the complex causal relations

that underlie the occurrence of crime has been slow. In this work we do not try to unravel such a complex issue. Rather, we focus on a seemingly simpler and trivial, at least at first sight, component of the criminal system: the sequence of stages through which legal disputes must go within the judicial system for justice to be provided. We examine this structure and how it interacts with other variables within the judicial system, and do so in systematic manner. The result of this exploration is somewhat surprising. We find that, contrary to what would be expected, criminals tend to be punished not exclusively on the basis of the gravity of their illicit acts, but also in terms of other, apparently irrelevant, variables. One such variable is the size of the backlog of cases judges happen to have when alleged criminals stand trial.

This paper is structured as follows: In the first section we present a very concise literature review of what we have learned, mainly from an economic standpoint, about crime. We also mention some theoretical and empirical advances present in the literature concerning purported interactions between the economics of crime and the institutional structure of the judicial system. We then provide data for the case of Costa Rica. Our data are composed of longitudinal series of crimes in the Costar Rican judicial system from 1990 to 2007. We use these data to formulate dynamic hypotheses. In the fourth section we use a simulation model to explore our dynamic hypotheses and provide policy suggestions.

Literature Review

It was Becker (1968) who first raised the possibility of criminal activity being subject to cost-benefit analysis. Applying this same idea, Priest and Klein (1984) considered that economic agents involved in judicial activities (i.e., criminals) have learned that the decision to litigate, resolve conflicts, and commit criminal acts is a function of forecasted benefits. This viewpoint presents individuals rationally deciding whether or not to take on criminal activities by comparing the return of illicit work to that of legitimate work. Thus, embracing illicit activities has benefits and costs, just as taking up any legitimate work would. The costs associated to illicit acts are those incurred if the criminal behavior is discovered and brought thereupon to the justice system. Cooter and Rubinfeld (1989) mention four main factors affecting the probability of somebody committing a criminal act: a) The likelihood that the crime will be detected by the victim and a complaint will be brought up to an authority, b) the cost-benefit ratio of what is in dispute, c) the uncertainty about the outcome of the dispute between the parties, and d) the costs of any solution relative to the cost of bringing the matter to a judicial trial.

Following this line, it is possible to imagine an extreme scenario: an individual who contemplates committing a crime will probably do so if: a) the crime is unlikely to be detected or, if detected, the probability that the victim will file a complaint is very small, b) the opportunity cost of committing the criminal act is very small, so that what the individual can obtain through legal work is only a small fraction of what he can get, with a similar effort, doing illicit activities, c) the person who committed the illegal action, even if captured and processed in the judicial system, is not punished; or d) there is a possibility that an agreement can be reached with the victim, at a very low cost for the person who committed the crime.

Thus, most economic literature portraying the rational model of crime (e.g., Ehrlich, 1981, 1996) will depict a person's decision to engage in illegitimate behavior as determined by:

- w_i : The expected payoff per offense
- c_i : The cost incurred to acquire an illegitimate payoff w_i
- w_l : The payoff from alternative legitimate activities
- p_i : The probability of being arrested and convicted
- f_i : The penalty if convicted

Thus, in the traditional economic literature on crime, an individual would engage in illegitimate activities if the net return per offense, Π_i , is positive, where

$$\Pi_i = w_i - c_i - w_l - p_i f_i \quad (1)$$

$$\Pi_i > 0$$

Risk preferences, moral values, and the individual's proclivity for violent behavior can also be incorporated into these analyses. Ehrlich (1996) assumes, for instance, that individuals are risk neutral and their moral stances can be modeled, mainly for simplicity and brevity, as constant. If so, individuals would not engage in illegitimate activities when $\Pi_i > 0$, but when it exceeds some threshold "moral" level m ($\Pi_i > m$).

Despite the plausibility and, to some extent, the intuitive appeal of the arguments outlined above, empirically verification in the economic literature is still work in process. Though examination of the data sheds light on the determinants of crime, the econometric approach shows so far that correlations are often contrary to what should be expected from the above standard model. This model suggest that increasing the costs associated to the commission of crime, would serve as a

deterrent, what is known as the deterrence hypothesis. Empirical verification of the deterrence hypothesis is not robust when it comes to generalize to different contexts and to consider extended periods of time. So far, no multivariate approach has succeeded in showing the “right” correlations in most cases. On the contrary, many studies show empirical inconsistencies. Cameron (1988), for instance, reviewed several studies that tried to determine whether the number of police (or, in general, resources to apprehend and deter) had an effect upon crime. None of the studies finds a significantly negative relationship (and some find a positive one).

This is recognized in the economic literature. For instance, Dills, Miron, and Summers (2008:1) argue, for the US case, the following:

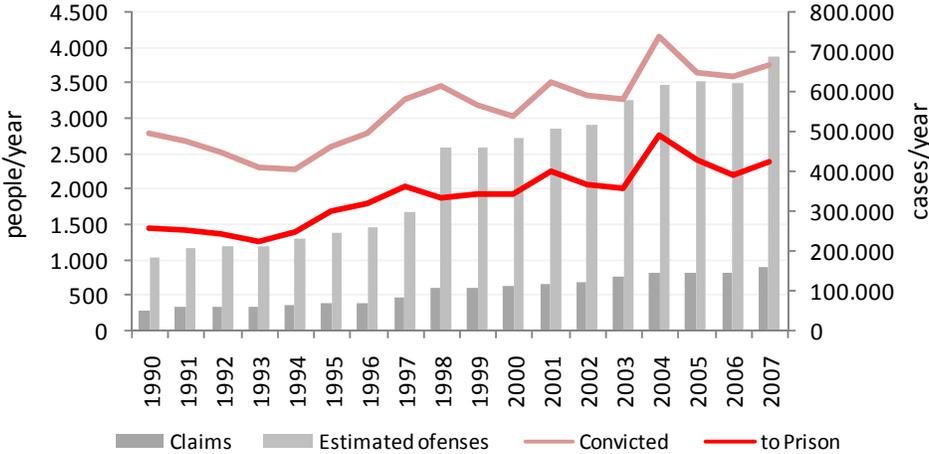
(...) we argue that economists know little about the empirically relevant determinants of crime. This conclusion applies both to policy variables like arrest rates or capital punishment and to indirect factors such as abortion or gun laws. The reason is that even hypotheses that find some support in U.S. data for recent decades are inconsistent with data over longer horizons or across countries.

In other words, although the deterrence hypothesis might appear to have a sound intuitive basis, when it comes to see if the variables thought to deter crime actually do so, the evidence is controversial. This does not mean, necessarily, that the deterrence hypothesis is wrong. But it could mean that there are other intervening variables at play. One such consideration could be that the institutions in charge of dispensing justice do so inefficiently. This could signal the need to carefully understand the architecture of the criminal justice system, and to know how such structure may influence the behavior of key deterrence variables. Blumstein and associates (Blumstein and Cohen, 1973; Blumstein and Graddy, 1982; Blumstein and Larson, 1969; Blumstein and Nagin, 1978) shed light on these issues using operation research techniques to model, among other things, the effects of variables that discourage criminal behavior. Their work focused much more sharply on system characteristics, and showed how system limitations, such as incarceration maximum limits, determine optimum policies to deter crime. In the System Dynamics literature, McCold (1993) carefully studied felony offender processing in the New York court system. This author showed that the number of observed prison admissions could be explained by changes in system capacity (police, prosecutors, court resources), and not necessarily by the offense itself.

This work shows that there are intervening variables that could render the policy implications of the deterrence model ineffective. The legal system plays a key role in the functioning of markets. It shapes and constrains human interactions (with laws, constitution, jurisprudence, etc.). It, therefore, influences the efficiency with which transactions take place and the returns people obtain from them. Market efficiency requires low transaction costs (Coase, 1960). Market actors, hence, must not only have objectives but know the right way to achieve them. This is possible only through a learning process with information feedback. Thus, if individuals seek criminal objectives, the actors who enforce the rules should promptly send signals to correct deviant behavior so as to align it with socially desirable norms and principles. But institutions do not necessarily work promptly and well to correct behavior. Crime may be the result of an institutional arrangement that allows or even encourages its very occurrence.

An example of this is Costa Rica. Figure 1 shows the evolution of admitted complaints to this country's judicial system from 1990 to 2007. Figure 1 also shows total convictions prison sentences. The data in Figure 1 are only approximations. The true number of crimes is higher than what court statistics show. One estimate is that only 23% of criminal events are reported to the authorities (INEC, 2008). This could mean that all crimes may have increased from approximately 180,000 actual cases per year (48,000 reported complaints per year) in 1990 to almost 685,000 cases/year (157,400 reported cases/year) in 2007. While the true extent of crime is unknown, the behavior is suggestive of how quickly criminal activities have increased in the last two decades. The data, of course, also signals the need of developing policies to change this trend.

Figure 1. Costa Rica: Recent evolution of crime and punishment



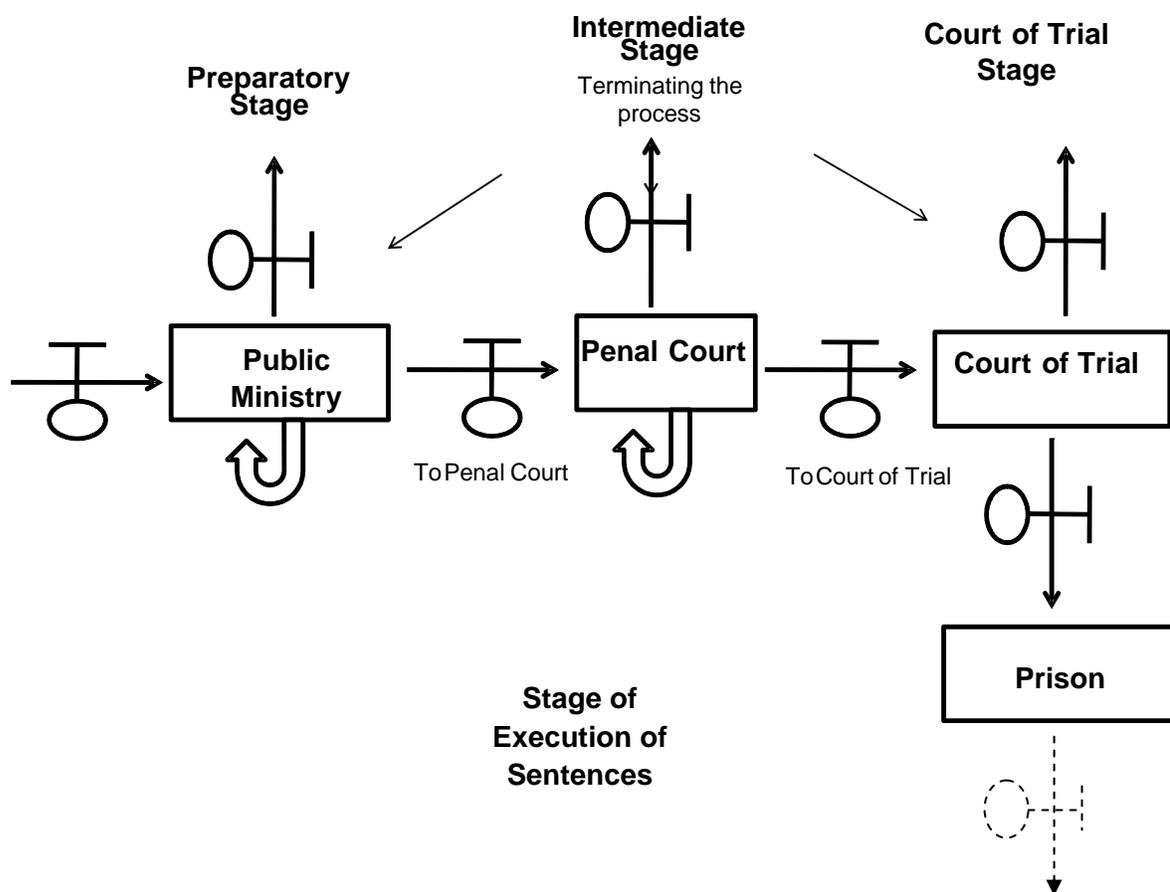
Source: The authors with data from Judiciary Statistics.

The structure of the judicial system of Costa Rica

*The Criminal Process*¹

The ordinary criminal procedure instituted in the Criminal Procedure Code of Costa Rica has 5 steps: a) preparatory, b) intermediate, c) view, d) sentence challenge, and e) implementation. For modeling and analysis purposes only the first three phases and the last one are considered here. The challenge phase is omitted because only a small fraction of the total number of records processed goes through it, and because the execution of any imposed penalty is not suspended when a challenge is invoked. Figure 5 illustrates the system. The limit of the model was set at the prison admission stage.

Figure 5: Ordinary Criminal Procedure in the Penal Code of Costa Rica

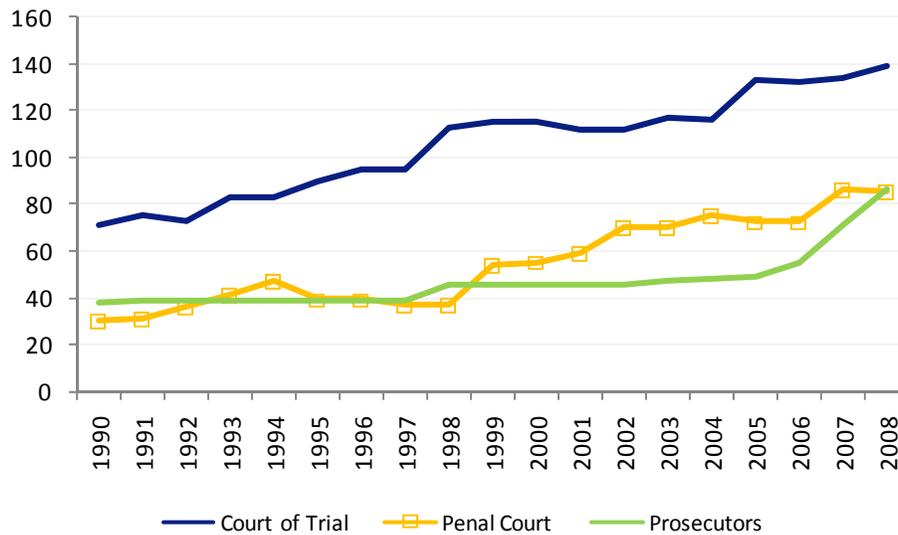


¹ This work is based on information collected by the authors from the following sources: a) interviews with specialists and experts, b) the Planning Department of the Judiciary, c) the Library of the Supreme Court, d) the Department of Analysis and Information Processing of the Ministry of Public Security, e) the Directorate General of Social Rehabilitation at the Ministry of Justice.

Personnel Dynamics of the Judiciary

Court and prosecution capacity are assessed in terms of the number of judges and prosecutors who formally belong to the Judiciary of the State in its criminal jurisdiction or territory, as shown in Figure 6 for the period 1990-2007. We can see, in Figure 6, that processing capacity has increased significantly through the period under scrutiny. Personnel in the court of trial, for instance, almost doubled. This notwithstanding, the number of cases in stock in each stage has increased more than proportionally. Figure 7 compares stocks and flows for three different years, 1990, 1998, and 2007. As Figure 7 shows, all stocks and flows are on the rise².

Figure 6. Costa Rica: Evolution of the Personnel in the Judiciary System

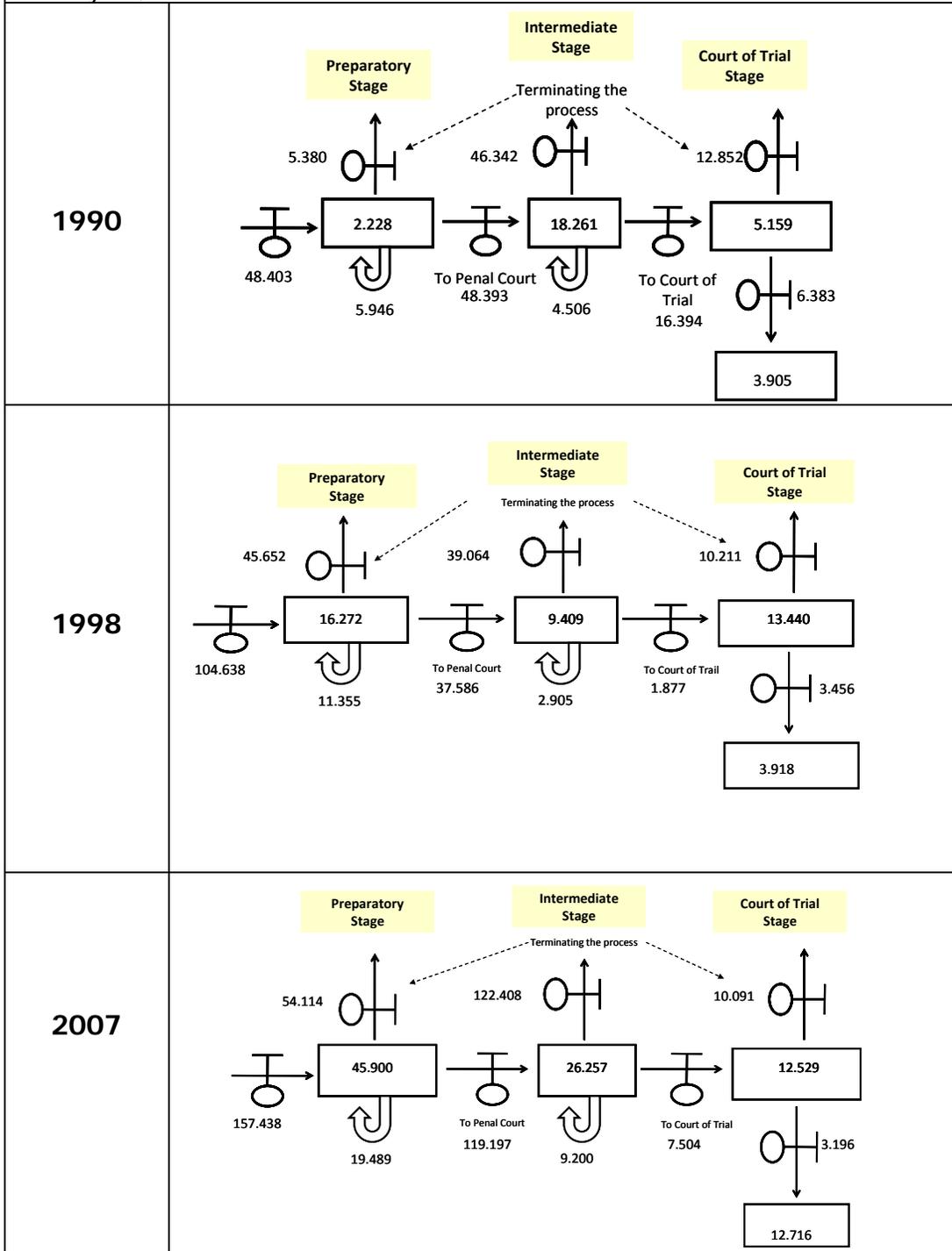


Source: The authors with data from the Planning Department of the Judiciary

Figure 7 shows also that some numbers fluctuate. It is worth noticing the large increase of cases in stock at the preparatory stage and the intermediate stage. The court of trial has remained relatively stable despite an increase in the intake. This apparently results in more people being sent to prison. The number of cases thrown out in the intermediate stage appears also to have gone up sharply. We now examine each phase in detail.

² In Figure 7, the numbers for 1990 have been approximated through some simplifying assumptions, so as to make them as comparable as possible to the other two years. This is because the structure of the system changed in 1998 with the introduction of a new Penal Code.

Figure 7. Values of stocks and flows for three different years. Flows in cases/year; stocks in cases.



Phases of the Criminal Process

I. Preparatory stage

The purpose of the preparatory phase is to determine whether there is a basis for trial. This stage is carried out by the Public Ministry with assistance of the Judicial Police. The Judicial Police gathers evidence to substantiate the accuser's allegation, or the defense of the accused. In this phase prosecutors look at the facts and determine if a crime can be attributed to somebody. The activities undertaken by the Public Ministry are summarized in Figure 8. Once cases enter the Public Ministry, there are two main paths: they are either thrown out or brought up to Criminal Court. A third possibility is to remove the case from the pool for lack of a formal, technical, or legal requirement. One can look at this as if the case reenters the stock. Figure 9 summarizes the data pertinent to this stage.

Figure 8: Structure of the Preparatory Phase

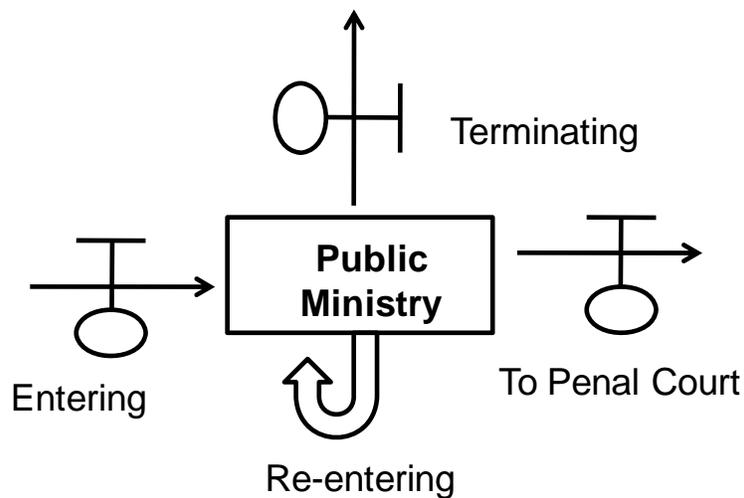
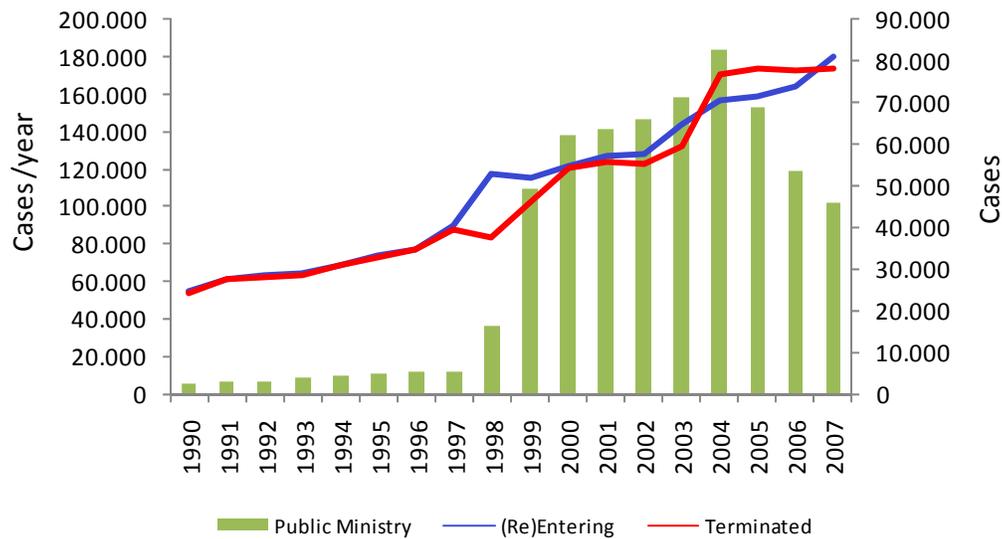


Figure 9. Costa Rica: Stock and Flows of Cases in the Public Ministry



Source: The authors with data from the Planning Department of the Judiciary

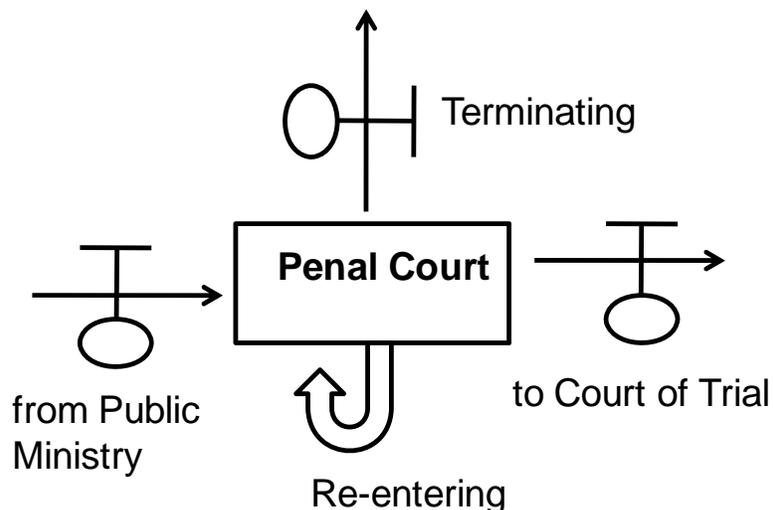
If we look at the stock of cases, the green columns in Figure 9, in the Public Ministry, there are two well-delineated stages: before and after 1998. At this point there was a new Criminal Procedure Code implemented. This new code mandated that all cases, which, up to that point, had been processed to a large extent by lesser courts (known as fiscal agencies) had to go through the Public Ministry. Thus, before 1998 the stock of cases was small compared to the number reached in the next decade. Between 1990 and 1997 fiscal agencies had on average fewer than 5,000 cases (right axis). Beginning in 1998, with the centralization of the preparatory stage in the prosecution, this number rose to nearly 63,000 (about 14 times more). The situation changed with the new Judicial Code because the Public Ministry received the many cases that up to that point were in the hands of lesser courts. The Public Ministry was thereupon required by law to prosecute all complaints and to give each case a more professional and formal treatment than it had been given before. This doubled the entry of new complaints from less than 50,000 cases per year in 1990 to more than 100,000 new cases per year in 1998. The new situation is partly reflected in the graph that shows where one line, entries plus re-entries (blue line, left axis), exceeds the cases that exited the pool (red line, left axis). The two lines differ significantly from the year 1998 on, reaching an initial difference of 12,000 cases/year. It only in 2004 when the red line, that of cases terminated, temporarily exceeded the intake.

II. Intermediate Stage (The Criminal Court)

This phase aims to capture the activity of judges who may be involved in the process that takes place before the first-instance criminal trial. The judges of the intermediate stage guarantee that due processes are followed so as to protect the individual rights of the accused during the investigation, as it is carried out by the prosecution.

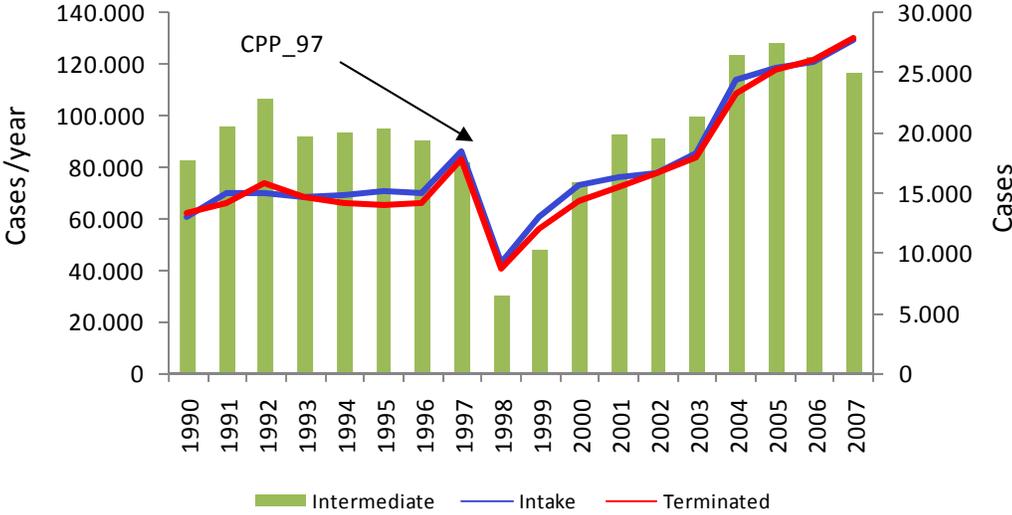
In the intermediate stage a procedural solution is adopted and a course of action is set. This step serves to define the objective fact of indictment, and to accurately determine the person against whom the charge is being brought up. This stage is carried out by the Judge of the Intermediate Stage and begins with the accusation of the Public Ministry or with the application of one of the alternatives to criminal prosecution. The court will convene a preliminary hearing, almost informal. After the hearing, the court will decide whether the case is brought up to trial, terminated, or sent back due to technical flaws. See Figure 10.

Figure 10. Structure of the Intermediate Stage



As in the previous stage, the Criminal Court data show a sharp discontinuity in 1998, when a new Criminal Procedure Code was put into practice. As shown in Figure 11, during the nineties the stock of cases remained stable at around 20,000 cases. Similarly the flow of cases filed was relatively constant, close to 70,000 cases per year. It is from the year 1998 and on that the entry and exit of cases varies in size and slope. Case intake went from about 60,000 cases per year in 1998 to 130,000 cases per year in 2007. These have, in turn, surpassed the outflow of cases in most years during the decade 1998-2007, although it, similarly, increased from 62,000 to over 130,000 cases per year. The stock of cases in the criminal court has grown at a declining rate.

Figure 11. Costa Rica: Stock of Cases in the Penal Court.

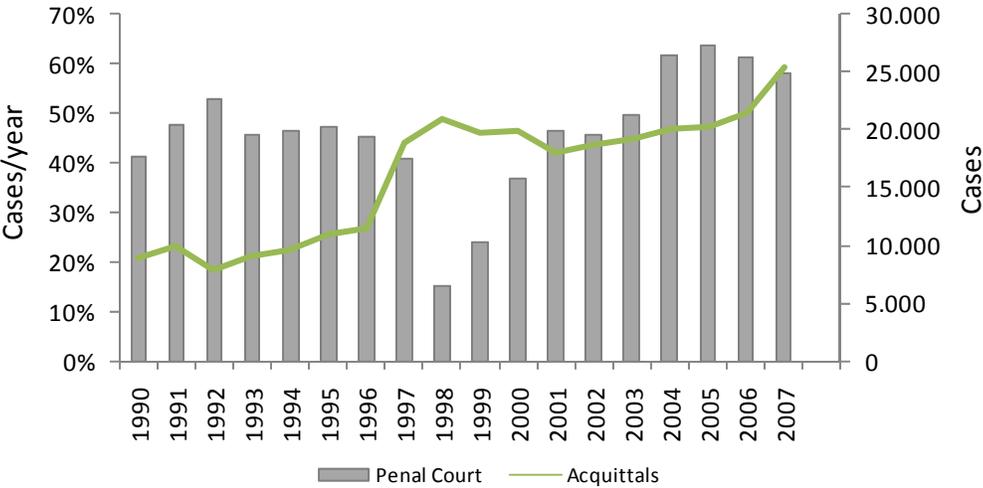


Source: The authors with data from the Planning Department of the Judiciary

An important issue is shown by the cases that were terminated. A breakdown of this outflow permits to observe that the percentage share of rejections, that is cases where the prosecution decided not to proceed with the investigation, with the approval of the Criminal Court, had a strong rebound starting in 1998. Looking at this series in Figure 12, it is possible to see that its percentage tripled from 20 percent in 1990 to 60 percent in 2007. In 1996-1997 this indicator increased from 27% to 46%. The cases submitted to trial decreased from 26% to 6% over the same period. If we overlap this information with the stock of cases, the data

suggest that the number of cases that were not pursued further, and thus rejected, increased in the presence of a growing stock of cases. In other words, the series suggests that prosecutors and judges with an (un)expected growth in the intake of cases, perhaps at a rate that exceeded their processing capacity, rejected a higher proportion of them (i.e., they took the cases out of circulation, or removed them, "no matter what"). The final effect, however, seems to be contrary to expectations and counterintuitive: with a greater number of cases dismissed, the pool of cases, the stock that is, has increased. This point will be discussed later.

Figure 12. Rejections in the Penal Court

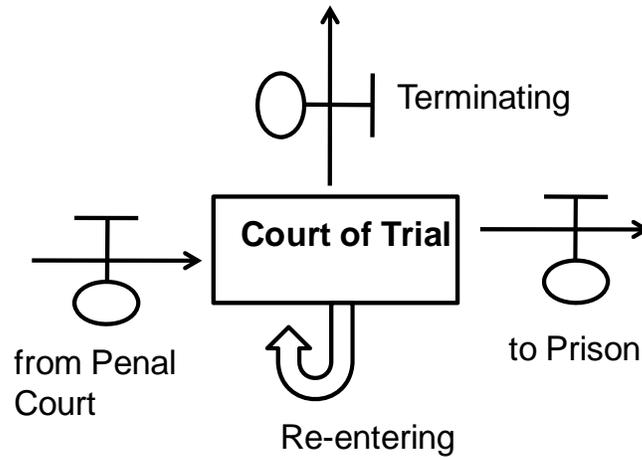


Source: The authors with data from the Planning Department of the Judiciary

III. Trial Stage

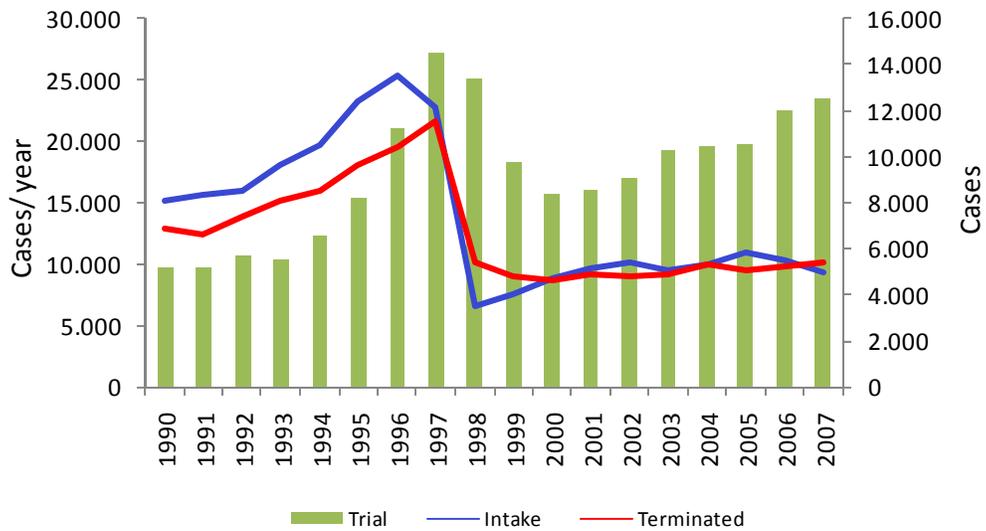
The court of trial is the crucial phase of the criminal proceedings because the victim receives a response to what it considers a violation of his rights. It is at this stage that the behavior of the accused is judged. The trial ends with the judge's decision, whether it is a conviction or an acquittal. The structure of this stage is shown in Figure 13. It is similar to the structure we have described in the two previous stages. Our data covers the period between 1990 and 2007.

Figure 13. Structure of Trial Stage.



Unlike the previous stages, with the new Penal Code the number of cases entered declined sharply. The stock seems to find a new steady state with a lower level than in the 1990s (Figure 14). As in previous stages, the year 1998 shows an abrupt change in the data series.

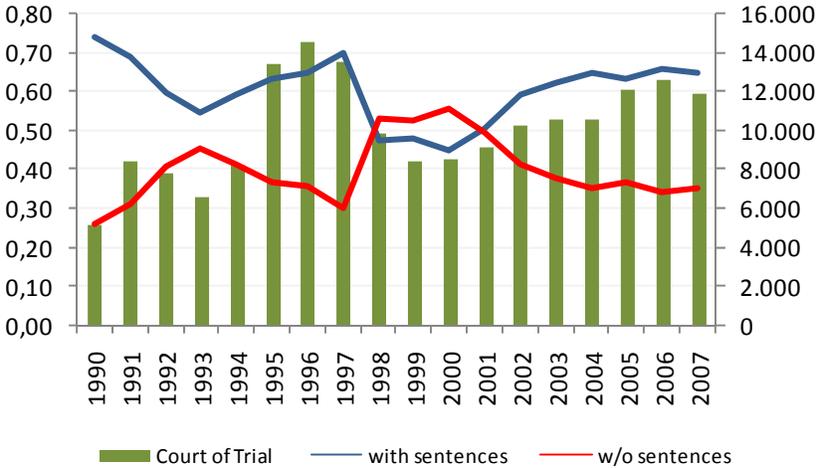
Figure 14. Costa Rica: Evolution of Cases in the Court of Trial



Source: The authors with data from the Planning Department of the Judiciary

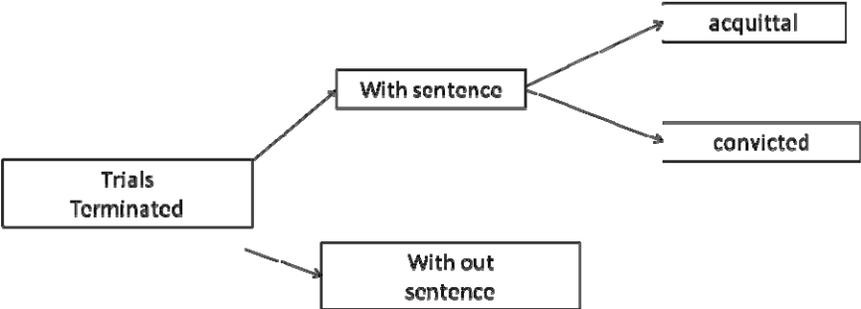
For the outgoing cases, it turns out that starting in 1998 there was an unusual increase in acquittals and abbreviated processes. After 1997, terminated cases that did not provide a response to the claimant were on the rise (Figure 15). For the first time in two decades the proportion of cases without sentence exceeded those with conviction, even on a temporary basis. This is because the criminal courts were strengthened with additional staff to perform more trials and thereby offset the higher inflow of cases to the trial stage. Then the cases without sentence went back to its historical 30 percent, similar to that of the early 1990s, albeit with a larger stock.

Figure 15. Trial: Proportion of cases with Sentences



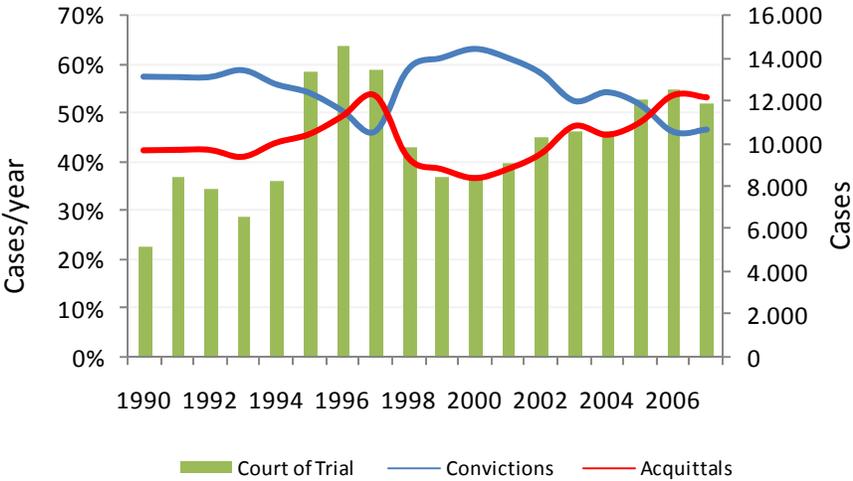
Source: The authors with data from the Planning Department of the Judiciary

Figure 16. A penal case in the Court of Trial



At this stage, similarly to what happens in the previous cases, the data show that when there is a backlog, the courts try to reduce the stock, first issuing fewer sentences, and, second, acquitting more people as a way of reducing the current case load. Acquittals tend to track the movement of files in circulation (in stock). It is worth expanding a little more on this point.

Figure 17. Sentences in the Court of Trial



Source: The authors with data from the Planning Department of the Judiciary

Figure 17 shows how the percentages of acquittals and convictions behave. It is shown overlapped with movements in the stock of cases in the Trial Court. For example, the 1990s had a little over 40% of acquittals, while in 1996 this level reached 55%. This coincides with a period in which the stock tripled, from 5,000 cases to nearly 15,000 units. In the following years, until 2000, the stock of cases experienced a substantial decline, reaching 8,000 units with a corresponding decrease of acquittals below 40%. The decreasing trend in the stock is reversed from 2000 to 2007 and reached 12,000 units, while the total number of acquittals rises to over 50% of all trials.

As was the case with the intermediate stage, this behavior may be due to cases that do not warrant a trial reaching the Criminal Court because elements to convict the accused are lacking. Though a plausible alternative explanation, it is doubtful, as it appears in different years, and, hence, would show some change in the way cases are processed over time. It is also possible, although not necessarily

exclusive of the above, that the judge or judges observe that there is more work than is feasible to process and, hence, dictate more acquittals than "normal" as a way of reducing the backlog of cases in a manner that least compromises their observed performance.

IV. Stage of Execution of Sentences

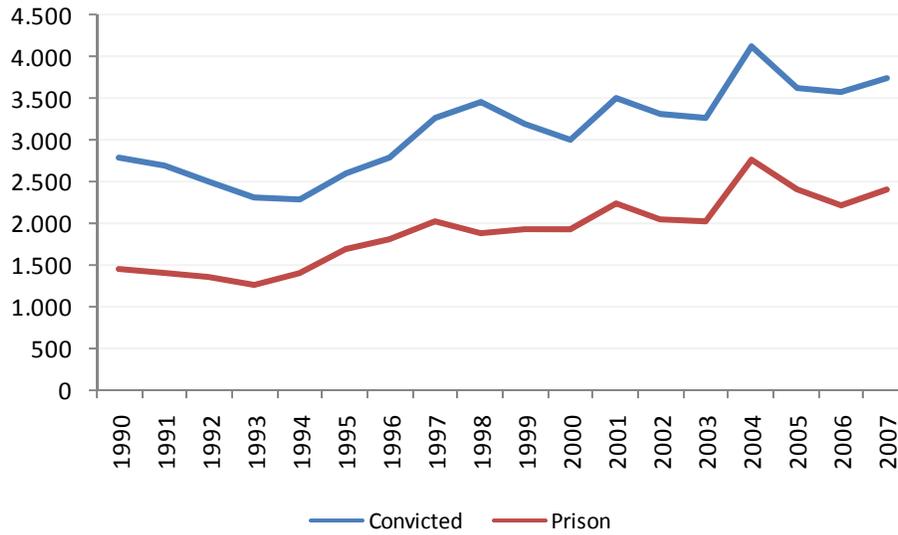
The implementation phase is the last stage of the criminal proceedings. This is where the judge's ruling is implemented. From a model's perspective, the outflow of the judicial system represents the main product that generates the criminal justice system as a means to punish and incapacitate the individual who actually committed a fault and to discourage those planning to do so in the future³.

Figure 18 shows the behavior of the series on those convicted and those who were actually sent to prison. The difference relates to other alternatives to prison convictions, such as fines or conditional execution of the sentence. The trend shows a steady increase throughout.

Two aspects of these data are interesting. First, the fraction that is sent to prison moves closely with the behavior of the stock of cases at the trial stage. The greater the amount of raw files in stock, the greater the number of convicts sent to prison. See Figure 19. Second, the proportion of convicted and sentenced to prison are a low proportion of the total number of cases entered for prosecution. This fraction has declined considerably. In 1990, in a hundred complaints entered into the court, six ended with conviction. By 2007, this proportion had fallen steadily to reach three percent. Here probably lies much of the discontent of citizens with regard to the effectiveness of the country's justice system. The actual probability of being punished is shown in Figure 20.

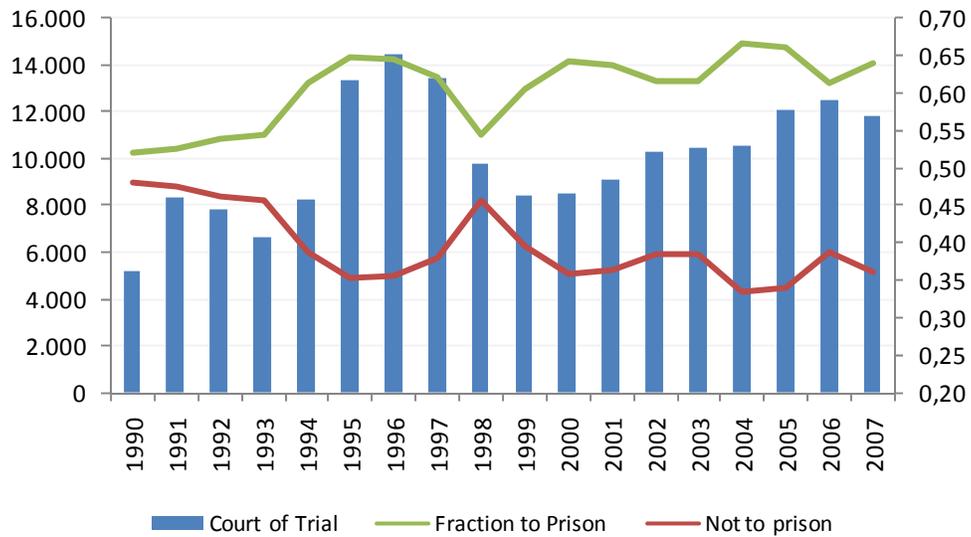
³ Clearly there is a debate about imprisonment having or not a deterrent effect. Some argue that it might actually cause offenders to increase their criminal technological and social capital (by, for instance, forming a criminal network of contacts within prison which can later be used to commit more crime). However, when modeling this effect, particularly because we still do not have recidivism data, it was assumed that the latter possibility is more than compensated by the deterrent effect prison has when a potential criminal is making the decision to enter the active offender population.

Figure 18. . Number of convictions in the Court of Trail



Source: The authors with data from the Planning Department of the Judiciary

Figure 19. Convicts sent to prison



Source: The authors with data from the Planning Department of the Judiciary

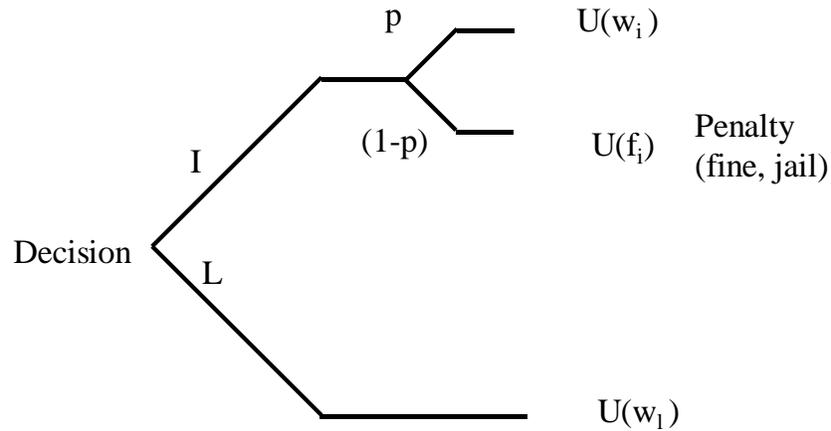
Figure 20. Probability of punishment (cases entered into the legal system/convictions)



Modeling the Judicial System

Our model builds upon the ideas developed by Becker (1968) and Sah (1991). According to Becker (1968), criminal behavior is the result of a cost-benefit assessment made by the potential offender who is choosing between performing licit or illicit activities (Figure 21). But, given the strong institutional component that, as we have reviewed, is in play, we have added an additional component to this scheme by incorporating the structure of the Costa Rican criminal process system. This structure consists of the series of linked stages we already reviewed through which the offender population goes through when they are caught in their criminal activity.

Figure 21. Crime according to Becker (1968)



Will engage in illegal activities if

$$p_t U(w_{it}) + (1-p_t) U(f_{it}) > U(w_{lt})$$

Let us consider a dynamic version of Becker's model. In each period, individuals choose between a life of legal activities (which receives a benefit w_{lt}) or illegal activities and their consequences. If in period t^* the person chooses to commit criminal activity, he or she will be arrested and prosecuted with probability $(1-p_t^*)$, which will report a utility $U(f_i)$ where f_i is the penalty in terms of imprisonment or fine. However, with probability p_t^* the crime committed will go unnoticed or will not result in conviction after the criminal trial, and she receives a utility $U(w_i)$, where w_i is the benefit of a criminal act. Then, in each time period t , the individual commits a crime if and only if $p_t U(w_{it}) + (1-p_t) U(f_i) > U(w_{lt})$, where $w_{it} > w_{lt} > f_i$. Equivalently, he will choose to commit a crime if and only if the probability of impunity is greater than a "reservation probability", given by

$$p(t) = \frac{U(w_i) - U(f_i)}{U(w_i) - U(f_i)}$$

A key outcome of this approach is that an increase in the expected cost of criminal activity (increase in $U(w_t)$) or a decrease in the benefits of crime (smaller $U(w_t)$) could discourage such behavior because the probability p would fall below the reservation probability p .

The actual probability of committing a crime and not be penalized, $p(t)$, is a direct result of the judicial system (one minus the probability depicted in Figure 20). But what the individual actually uses in making his decision to engage in illicit activities is the "estimated" probability of being punished as derived from personal experience. This is done when comparing the total number of known people who commit crimes and go unpunished to those known criminals who have actually been punished. All those who go through the judicial system without punishment are assumed to reflect prevailing impunity.

In each period, potential criminals "collect" information from the active population, observe how many criminal cases enter the criminal process, and determine what fraction ends up not being punished⁴. Thus, an increase in $p(t)$ means that an individual is more likely to find a larger amount of active criminals who have not been punished for their behavior, and this influences his decision to commit crime. This probability is the same for all individuals⁵.

The value of p (the actual probability of punishment) is not instantly available to these individuals. Instead they use the perception of impunity, called p^* , which reflects the weighted values of previous values of p and is then influenced by the observations accumulated to date by the individual. The individual perceived probability (p^*) governs the individual's participation in criminal activities for period t . This is summarized in the following relationship

$$\text{Fractional rate of crime } t = h_t \{ \text{Individual perception } (p^*(t)) \}$$

Where h_t is a value between 0 and 1

⁴This probability is defined as (1 - fraction of the number of cases that go into the system divided by the total number of cases entered).

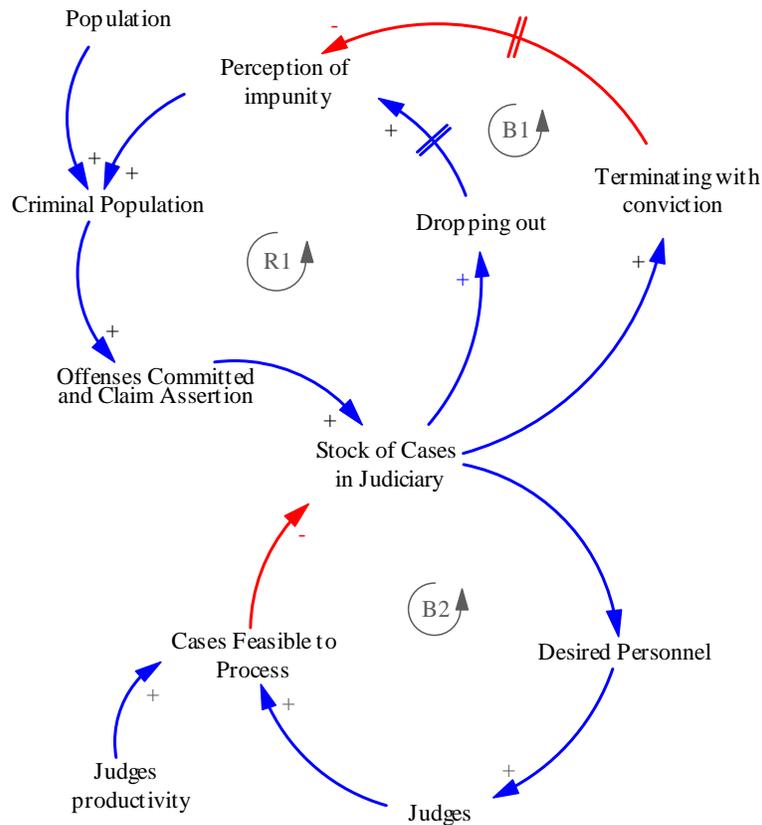
⁵ Some assumptions about the nature of this information are: Information relevant to the individual is limited to data from his past experience or that of his acquaintances. (b) The individual has information available, whether relevant or not, but do not use it for reasons or cognitive limitations. (c) The individual does not adjust his perceptions instantaneously.

Perceptions relate to a formulation based on expectation formation as individuals gradually update their observations of impunity (Sah, 1991). In other words it is a first order information delay.

$$P^* = (\rho_{t-1} + \rho_{t-2} + \dots + \rho_{t-s})/s$$

where s is the time needed to adjust the perception of the real value of the probability of impunity (or punishment). This parameter has a value $s = 4$ years in this particular case. That is, individuals use information from the past four years to form their expectations of the probability of getting out free from their illegal activities. Figure 22 shows a causal loop diagram based on the above.

Figure 22: Causal loop diagram of the model



Aside from the perceptions associated to the probability of being punished, the structure of the judicial system requires resources as cases go through. In each stage capacities have been modeled using available empirical assessments of actual capacity.

Prosecutors

In the first stage, the Public Ministry which is in charge, supervised by a judge, of evaluating each case and, should criminal behavior be established, to bring it up to court alongside the required evidence. The Public ministry staff, the “fiscales” or prosecutors, have varied workloads. A 2004 study shows that the workload varies from a minimum of 367 to a maximum of 1092 cases per prosecutor. In our model we use a value of 733 cases per prosecutor per year.

The formulation of the stock of Public Ministry Prosecutors follows a common approach found in the System Dynamics literature. Capacity varies depending on the amount of current cases and new cases admitted to the prosecution, with some lag (2 years in this case). In very general terms, this parameter represents the average time required to close the gap between actual and desired capacity and reflects administrative delays and delays in recruiting, train, and getting incoming personnel up to speed. Similarly, prosecutors leave the stock after an average of 25 years of judicial career.

Judges

The analysis of workload and staffing requirements provides a monthly average of cases entered per judge at the intermediate stage. It is assumed that this value is similar among different offices. The comparison is made on the assumption that the average monthly number of cases entered by judges and judicial assistants, obtained from the workload generated in prior periods, will remain at levels similar to the period used.

Having the number of cases entered and terminated, we determined a ratio to what would reflect the performance level of Criminal Court judges. If the ratio of cases in and out is greater than 1, court efficiency is positive. It means that during the period more cases left than entered and, therefore, the stock diminished. If the ratio is 1, the court is balanced during that period. If the ratio

is less than one, the intake exceeded the outflow and, hence, the stock increased. When this happens, an application is forwarded to the relevant personnel department for a capacity increase. With these data we were able to determine a productivity parameter for judges in the intermediate stage of 100 to 105 solved cases each month or approximately 1,200 cases per judge per year.

The staffing adjustments are then based on workload level and average productivity. But this adjustment is not immediate, courts can maintain workloads of 50% to 100% higher than the mean of 100 monthly cases, which has been documented by internal studies and confirmed in interviews, but when this happens on a recurring basis for several years, then new personnel is assigned to the court so that the workload regresses to the mean. The model assumes an average of five years for this purpose, similar to the preparatory stage, so that administrative delays and delays in new staff reaching the productivity levels of the most experienced judges is considered.

In the final stage we have trial judges. These are the judges that must decide if the evidence warrants a conviction in the trial court. It is difficult to assign a point value to the productivity of a court judge. From interviews with experts we determined that with good logistics a judge can reach a value of 6 sentences per month, about 72 per year.

Simulation and Results

The simulation model was built based on the causal diagram of Figure 22. There are three loops, two of which are negative or balancing, and one positive or self-reinforcing. These loops form the cause and effect structure of the judicial process in Costa Rica. In the terminology of System Dynamics, this representation corresponds, to some extent, to the archetype "Shifting the Burden To".

Loops B1 and B2 are the dominant ones for all levels in the different stages during the 1990s, before the new Criminal Code went into effect. Because of the relatively small input of new cases, the different phases of the process maintained low levels in the stocks. This resulted in smaller staff requirements. Fractions of cases dismissed and acquitted were less than 25% and slightly above 40%, respectively. The effect of R1 in this period, corresponding to the output of cases in the judicial system without penalty, was very low, although not completely zero. Exhibit 1 shows simulated behavior for the system before the introduction of the new Code.

Loop R1, however, takes force with the change in the Penal Code, perhaps due to expectations of an increase in the inflow of new cases, and the consequent increase in backlogs, when the Public Prosecutors were required to perform a complete review and thorough analysis of each and all complaints.

The same archetype shown in Figure 22 can be used to explain the change brought up by the new Penal Code. By combining these three loops with the two structures of the criminal justice system of Costa Rica (before and after the change) it is possible to replicate the evolution of this system during the period 1990-2008, as shown in Figures B2 of Exhibit 2. During 1998 the system is dominated by loop R1. At this point, each stage is trying to process as many cases as possible. However, production capacity is always below demand at each time t , i.e., there is a stock of files (backlog) positive and increasing in most of the stages (on a permanent basis). As the production capacity of the judicial process is always to the limit and the data suggest that prosecutors and judges react to an expected and continued growth in case input when it is above its processing capacity, they tend to drain a higher than normal proportion of cases. We have added this to the model (Exhibit 2, Figure B2).

This decision rule appears to have counterintuitive effects. If judges and prosecutors, in getting cases out, were able to deter the criminal from re-offending, then getting cases out in a proportion higher than "normal" could have a positive outcome in terms of reducing the overall incidence of crime in the country. But the result apparently moves in the opposite direction.

If we analyze this decision rule, but now in the light of the feedback loop depicted in Figure 22, criminals (in other words a fraction of those cases which were not prosecuted or which were acquitted without apparent reason) will re-offend, and will become active criminals with a higher (subjective) probability of impunity than the probability they had before they were processed. This in turn creates an incentive for them and others to engage in criminal activity. It is likely, then, that judges' behavior is causing that the stock of cases increases in the next period, because they are, themselves, encouraging a larger intake of cases, an intake that is larger than the number of cases they get out of circulation in a futile attempt to lower the backlog.

It is also possible that the recruitment of more judges and prosecutors to process a larger number of files in stock will not have the desired effect if the new judges and prosecutors go by what appears to be an institutional policy of dismissing

cases at a higher rate when the stock of cases pending increases beyond their processing capacity.

The simulation results show a very low probability of punishment. The modeled probability is in line with the data collected which show that only 3% of cases that enter the system actually end up in a conviction. This is not surprising. Sah (1991) reports that probabilities of punishment are generally very small. It is worth emphasizing, however, that during the period between 1990 and 1997 the probability of punishment was higher than that experienced during the next decade (see Exhibit 2, Figure B1, and Figure 20 for the actual probability of punishment). This is the byproduct of a natural event: the change of the Penal Code in 1997. It is thus possible that an individual's propensity to commit crime is actually greater in the decade of 1998-2008 than in the preceding one, and the perception of impunity that criminals have is the result of a very slow rate of change of that (perceived) probability over time

With the assumed adjustment time between the real and the perceived probability of punishment (or impunity), the perceived probability of punishment is still transitioning towards its long-term value. Because of the adjustment lag to a downward trend, the perceived probability of impunity, the figure criminals use to decide if they will embark in criminal activity, decreases more slowly than the actual probability. Hence, even when taking steps to correct an observed change of impunity in the judicial system, its effects will only be visible after long periods, periods that may even encompass decades (see Figure B4 in Exhibit 2).

Several policy measures could be tested to address these problems. For example, one could experiment with limiting the entry of new cases to the system to those really important and with a high probability of being satisfactorily resolved. Such policy tests are left for further research.

Conclusions

Since Gary Becker's pioneering article on the economic model of crime (1968), economists have tried to establish empirical validity to its claims, but with mixed results. Becker's and subsequent research upholds the notion that criminals respond, like any other rational agent, to the benefits and costs of their activities. That's why an important focal point is the hypothesis of "deterrence", the idea that judicial policies can help reduce crime through an increase in expected costs of

illegal activities. Yet despite the implementation of the many deterrence policies such models suggest, more and more countries undergo large escalations of criminal activities. It is therefore necessary to broaden the perspective and include other analytical schemes. One alternative view has been raised in this paper: the possibility that institutions do not necessarily work in the direction of reducing criminal behavior, and could even encourage it.

The case of rising crime in Costa Rica seems to show this institutional failure. While it is possible that exogenous variables are at work on increasing crime in the country, a brief look inwards appears to show that there is a non-trivial endogenous component, ascribable to the unforeseen consequences of a change in the penal code, and to judges' behavior associated to feedback control of backlogs, which bears a part on the country's crime escalation.

One key point of this institutional paradox is the apparent increased dismissal of cases at various stages of the system when the stock of cases increases. This may affect the assessment of the probability of punishment that potential criminals make, and thus influence the propensity to commit crimes, which leads to greater accumulation of cases, which in turn increases the rates of unwarranted dismissals. This is a vicious cycle that creates direct and indirect costs to society and that, most likely, will not reduce crime rates.

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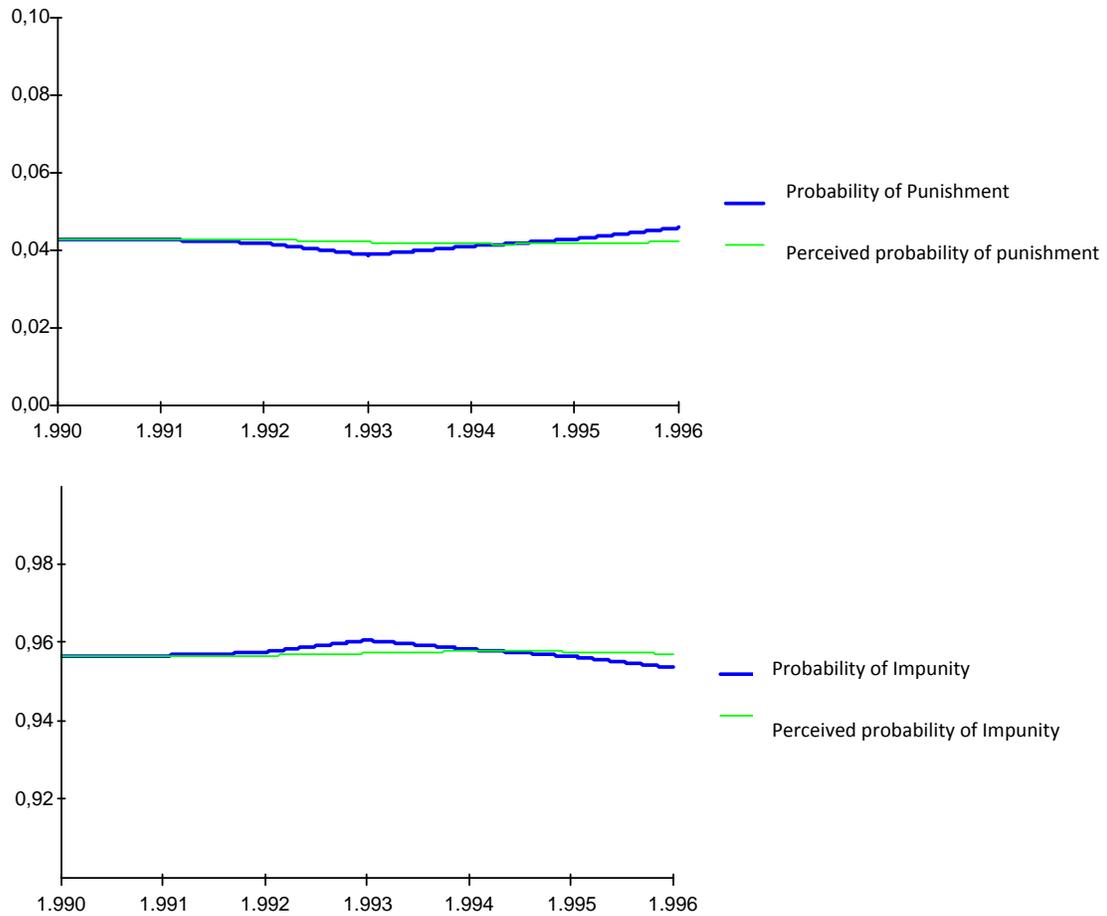
Exhibits

Exhibit 1

Costa Rica's judicial system under the previous penal code (pre-1998)

Figure A1

Probabilities of punishment and probability of impunity, actual and perceived



Source: Authors' simulation model

Figure A2
Evolution of stock of cases in main stages of process

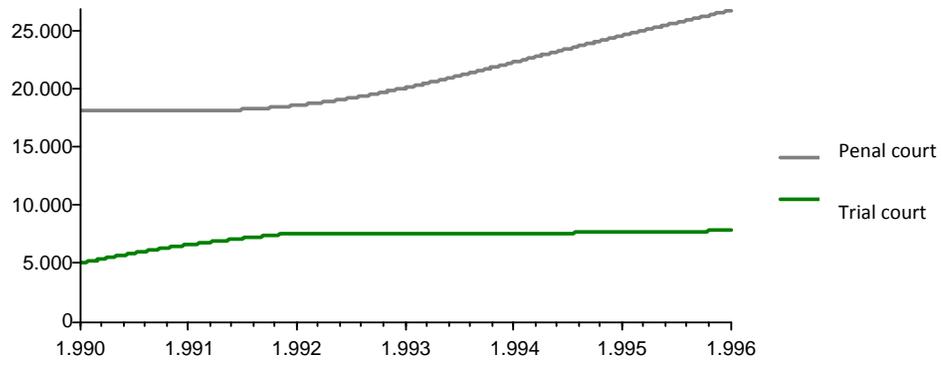


Exhibit 2. Simulation model results for 1990-2008

Figure B1

Natural experiment change of penal code from 1973 to new code in 1996

Probabilities of punishment and impunity, actual and perceived.

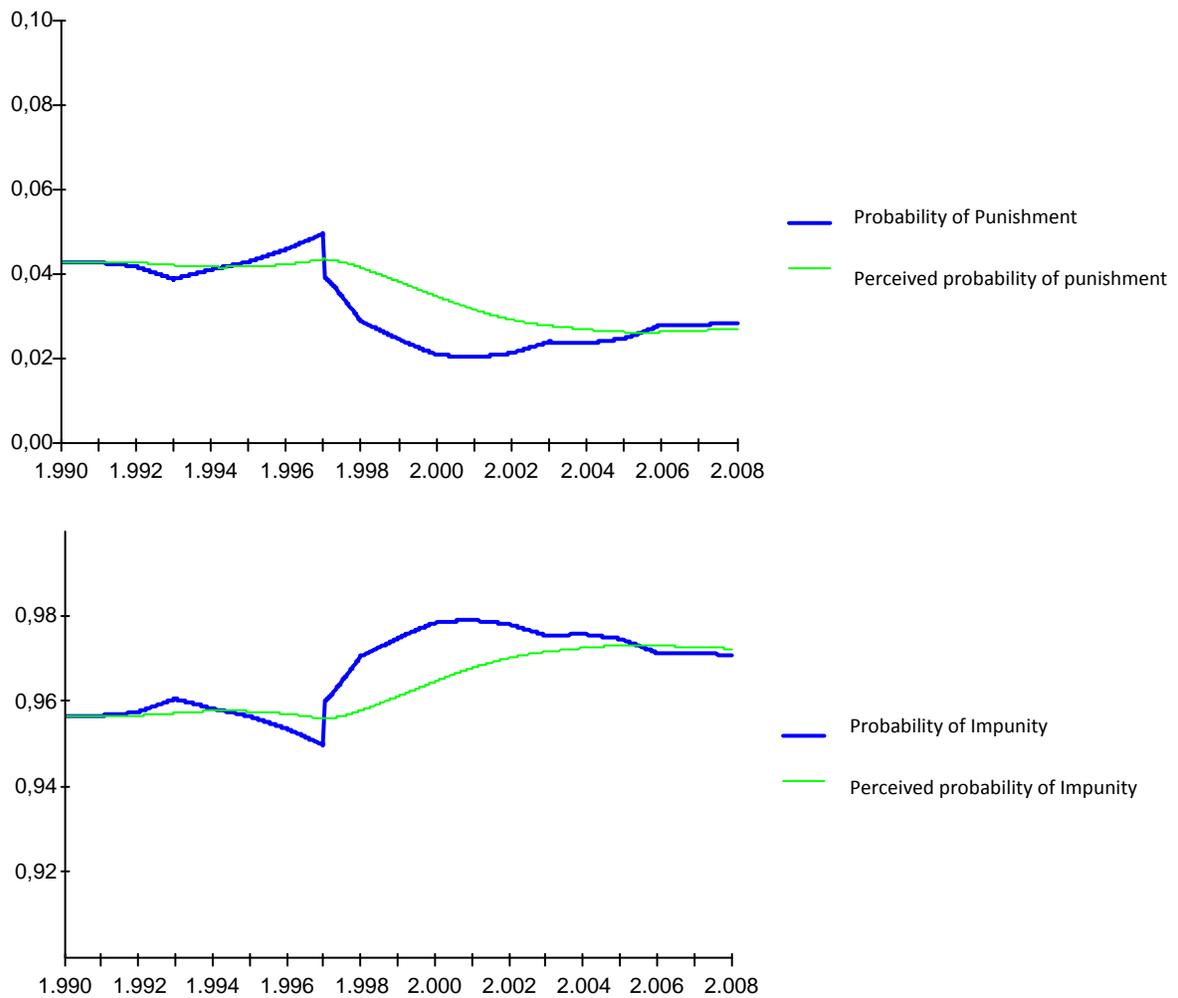
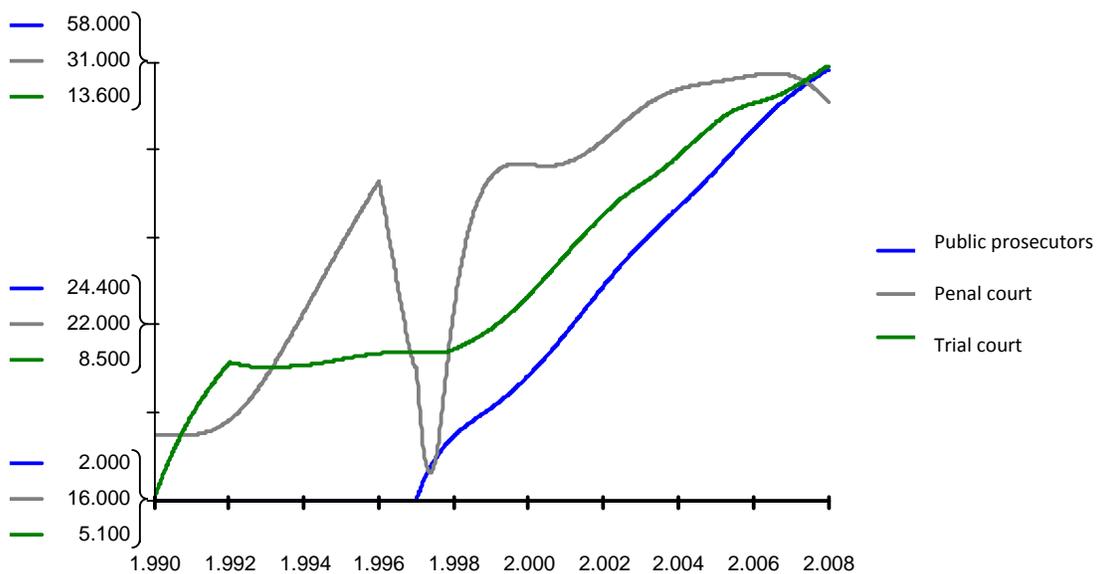
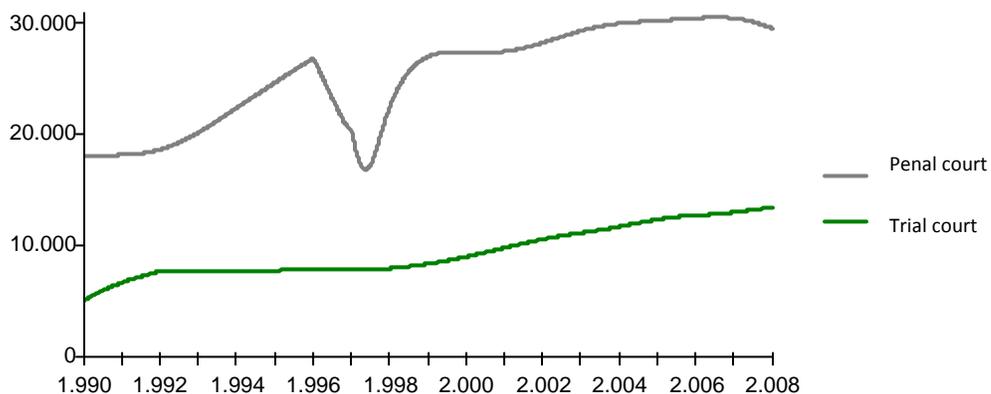


Figure B2. Evolution of stock of cases in main stages of process



*Normalized scale

Figures B3. Simulation Base Scenario 1990-2020. Cases in all stages

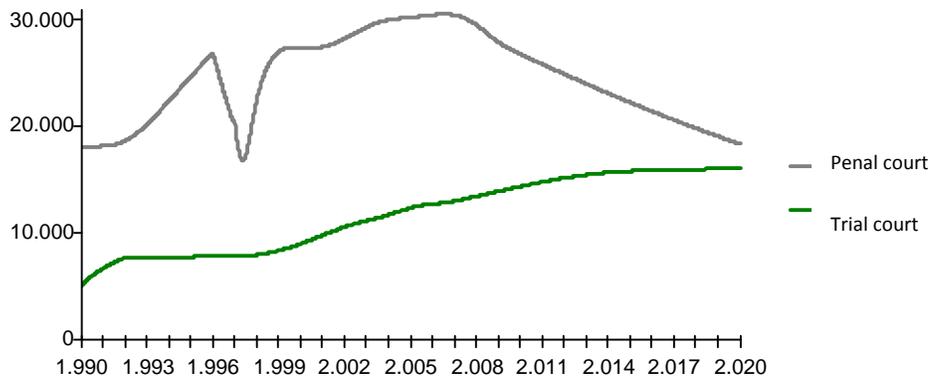
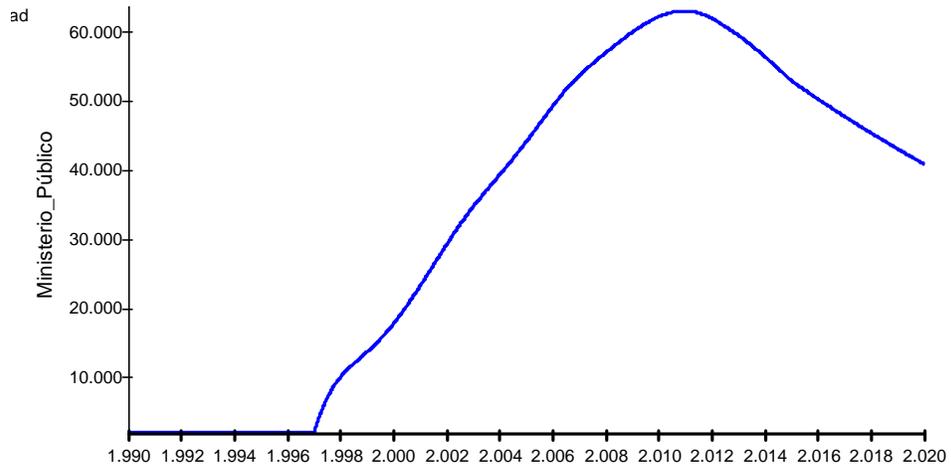


Figure B4. Simulation of probability of punishment over 50 year time horizon

