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## Crime and Poverty:

# Evidence from a Natural Experiment\*

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### Abstract

This paper investigates the relationship between poverty and crime. Following a disputed presidential election, fuel supply to the highlands of Madagascar was severely curtailed in early 2002, resulting in a massive – if temporary – increase in poverty. Using original survey data collected in June 2002 at the height of the crisis, we find that crime increases with poverty. Our most conclusive results are for crop theft. We also find that an increase in law enforcement personnel reduces cattle theft which, in Madagascar, is a form of organized crime. Theft appears to be used by some of the rural poor as a risk coping strategy. Increased transport costs led to a rise in cattle and crop theft, suggesting that isolation raises crime.

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## 1. Introduction

There has long been a suspicion that poverty favors criminal activity, but hard evidence of this relationship is difficult to come by. There are several reasons for this state of affairs, all having to do with the joint causality between poverty and crime (Ehrlich 1973). First, the prevalence of crime in an area discourages business, hence contributing to poverty. Secondly, high crime areas may also attract criminals because they find it easier to elude detection or because these areas constitute focal points for customers – think of prostitution or of the drug trade, for instance (Freeman, Grogger and Sonstelie 1996). Finally, individuals with a high predisposition for crime are likely to have unobservable traits (e.g., lack of discipline) that make them less employable and thus would make them poorer even if they did not resort to crime. For all these reasons, analyses of the relationship between crime and poverty are often regarded with skepticism (e.g. Bourguignon 2000, Fajnzylber, Lederman and Loayza 2001).

Efforts to bypass these problems have focused on natural experiments such as income transfers (e.g. Imrohoroglu, Merlo and Rupert 2000, Rephann 1999). At this juncture, the conclusion from the empirical literature is that poverty has little effect on crime (e.g. Dreze and Reetika 2000, Krueger and Pischke 1997, Doyle, Ahmed and Horn 1999, Morgan 2000, Blau and Blau 1982, Jarell and Howsen 1990, Freeman 1996). The available evidence, however, is largely if not exclusively based on data from rich countries – predominantly the U.S. – where much crime is related to the drug trade (Newman 1999). We know very little about how poverty affects crime in poorer countries, in spite of the fact that crime represents a major welfare issue. In a rare intercountry comparison, Fajnzylber,

Lederman and Loayza (1998) show that many developing countries have crime rates equal to or higher than that of developed countries.

This paper revisits this issue by taking advantage of a natural experiment in Madagascar. Following a disputed presidential election, fuel supply to the central highlands of the country was severely curtailed in early 2002, resulting in a massive – if temporary – increase in poverty. This situation, however dramatic it was for the population, enables us to ascertain the immediate effect of poverty on crime. Using data on crime and poverty before and during the crisis in a number of locations or *communes*, we examine whether locations where poverty increased more also experienced a higher increase in crime. The originality of this approach is that it controls for many of the factors that plague cross-section or panel analysis, since the shock was too swift to enable reverse causation to manifest itself. Moreover, because fuel prices skyrocketed, there was no massive relocation of population over the time period considered. The large magnitude and unpredictable nature of the shock also are advantages relative to studies that focus on increments in transfers.

Results indicate that the crisis resulted in an increase in certain forms of criminal activity, but had little or no effect on others. We find that the reported increase in one type of crime – crop theft – is systematically related to increases in poverty, even after we control for changes in law enforcement. Other forms of crime such as burglaries and homicides show less systematic relationship with poverty. These findings suggest that a strong relationship exists between poverty and only certain forms of crime.

This work fits within a growing economic literature on crime and conflicts. While economic analysis of criminal activity in developed countries is well developed (e.g. Becker

1968, Morgan 2000, Krueger and Pischke 1997, Imrohoroglu et al. 2000, Doyle et al. 1999), research elsewhere in the world is still in its infancy. Fajnzylber, Lederman and Loayza (2000) provides cross-country comparisons and concludes that differences in crime rates across countries is related to growth and poverty and partly driven by demographic factors. There is a growing recognition among development economists that crime and conflicts take a heavy toll on the welfare of the poor (e.g. Bourguignon 2000, Stewart, Humphreys and Lea 1997). Pradhan and Ravallion (1999), for instance, show that poor families have a greater desire to improve public safety than do rich people. Using cross-section data from South Africa, Demombynes and Ozler (2002) shows that local inequality is strongly correlated with both property crime and violent crime. A similar relation was found in cross-country studies (Fajnzylber et al. 2001). Dreze and Reetika (2000) on the other hand show that murder rates in India show no relation with urbanization or poverty. In Madagascar, Fafchamps and Moser (2002) find that crime is higher in isolated, less populated areas, not in urban areas as is common in rich countries. This suggests that the geographical pattern of crime in poor countries might be quite different from that in rich countries. Programme ILO (2002) provides evidence that security is one of the major concerns among the Malagasy people. In 2001, security conditions in the country were perceived to be bad or very bad by two thirds of rural households. When asked whether security is important to improve living conditions, 83% of the country's rural households stated that security was important or very important. Security in general and crime in particular thus were at the top of citizens' concerns, even before the political crisis that would unfold in the first half of 2002.

The paper is organized as follows. The conceptual framework is introduced briefly in

Section 2. The data is presented in Section 3. Empirical analysis appears in Section 4.

## 2. Conceptual framework

As starting point for our investigation, we begin by positing a relationship between crime, population, and law enforcement. Let  $C_{it}$  denote crime in location  $i$  at time  $t$  and let  $P_{it}$  be total population. Similarly, let  $D_{it}$ ,  $R_{it}$ , and  $L_{it}$  denote the number of poor, non-poor, and law enforcement personnel in location  $i$  at time  $t$ . By construction,  $P_{it} = D_{it} + R_{it}$ . Fafchamps and Moser (2002) have shown that, in Madagascar, crime increase with isolation. Let  $T_{it}$  denote the travel cost from location  $i$  to the nearest major town. We posit the relationship:

$$E[C_{it}] = (R_{it} + \gamma D_{it})^\alpha L_{it}^{-\tau} T_{it}^\beta e^{\lambda_i + \sigma_t} \quad (2.1)$$

where  $\lambda_i$  is a location-specific effect capturing all time-invariant determinants of crime and  $\sigma_t$  is a common time effect. The parameters we are interested in are  $\alpha$ ,  $\tau$ ,  $\beta$ , and  $\gamma$ .

Equation 2.1 essentially says that expected crime is an increasing function of population and travel cost and a decreasing function of law enforcement. We expect  $\alpha$  to be positive and close to 1, i.e., we expect crime to be roughly proportional to population. If law enforcement is effective at deterring crime,  $\tau$  should be significantly positive. If crime increases with isolation,  $\beta$  should be positive. Parameter  $\gamma$  captures the effect of poverty on crime: if the poor and non-poor have the same crime rate, then  $\gamma$  should be unity. In contrast, if crime is more prevalent among the poor, we expect  $\gamma$  to be larger than one.

To facilitate estimation, equation 2.1 can be transformed into:

$$E[C_{it}] = \left( P_{it}(1 + (\gamma - 1)\frac{D_{it}}{P_{it}}) \right)^\alpha L_{it}^{-\tau} T_{it}^\beta e^{\lambda_i + \sigma_t} \quad (2.2)$$

which, after taking logs, is approximately equal to:

$$\log E[C_{it}] \simeq \alpha \log P_{it} + \alpha(\gamma - 1)\frac{D_{it}}{P_{it}} - \tau \log L_{it} + \beta \log T_{it} + \lambda_i + \sigma_t \quad (2.3)$$

Testing whether poverty affects crime boils down to testing whether  $\gamma \neq 1$  and thus whether the coefficient of  $\frac{D_{it}}{P_{it}} \neq 0$ .

Equation 2.3 is estimated in Section 4. Two estimation methods are used. The first adds zero-mean errors to equation 2.3 and estimates it using standard fixed and random effect estimators to eliminate  $\lambda_i$ . The second regards the number of crime incidents  $C_{it}$  as following a Poisson process with mean given by:

$$E[C_{it}] = e^{\alpha \log P_{it} + \alpha(\gamma - 1)\frac{D_{it}}{P_{it}} - \tau \log L_{it} + \beta \log T_{it} + \lambda_i + \sigma_t} \quad (2.4)$$

Equation 2.4 is estimated using a conditional fixed and random effect Poisson regressions to eliminate  $\lambda_i$ .

We expect different types of criminal activity to respond differently to changes in poverty. Certain categories of crime can be seen as a desperate response to poverty, as when someone steals food to feed himself and his family. We expect these types of crime to rise when poverty increases. Other crimes are largely affected by the demand for illegal commodities and services such as drugs and prostitution. In this case, an increase

in poverty would increase the supply of criminals but at the same time reduce demand from illegal products. The combined effect on crime may be an increase or a decrease, depending on the relative strength of the two effects. Finally, certain criminal activities may take place within well organized networks and other mafias that restrict entry in crime, at least in the short run. Because the poor cannot enter these activities easily, we expect organized crime not to respond to poverty shocks, or at least not immediately.

In Madagascar, cattle theft is a serious endemic problem that plagues specific parts of the country and is facilitated by geographical isolation (Fafchamps and Moser 2002). According to Rasamoelina (2000) and Razafitsiamidy (1997), cattle thieves are well organized groups that often operate with the complicity of local authorities. Because this form of organization is likely to restrict entry, we expect cattle theft to be relatively insulated from poverty shocks. However, as commune residents are hit by a major shock, they may sell (part of) their livestock to smooth consumption (e.g. Rosenzweig and Wolpin 1993, Fafchamps, Udry and Czukas 1998). So doing, they also reduce their exposure to cattle raiders. If cattle sales are sufficiently large, this may reduce cattle theft as there is less livestock to steal.

In contrast, burglaries and crop theft are expected to increase with poverty as people turn to crime to mitigate the effect of the shock on their lives. What remains unclear is whether these forms of crime respond more to an increase in deep poverty – e.g., chronic lack of food – or whether it is the moderately poor who temporarily turn to crime as a consumption smoothing strategy. Some empirical evidence to this effect is provided in Section 4. Regarding homicides, we have no strong expectations one way or another. Poverty may increase desperation and hence violence. But if homicides are primarily

driven either by idiosyncratic events (e.g., family feuds) and by organized crime (e.g., cattle theft), the number of homicides may respond little to changes in poverty.

In Madagascar, there is no drug trade to speak of and we have no data on prostitution, which is illegal but widely tolerated. We cannot therefore document types of crime that may decrease as poverty increases.

### **3. The data**

We estimate the model using data collected in rural Madagascar.<sup>1</sup> What makes these data unique is the very unusual set of circumstances under which they were gathered.

In December 2001, the first round of a presidential election witnessed the success of the former mayor of the capital city over the incumbent and long-time president of the country. Two independent vote counts gave the challenger an absolute majority and declared him the winner. But the official ballot count gave the challenger less than 50% of the votes and called for a second round. Suspecting that official results had been rigged, the challenger disputed the official ballot count.

What followed were six months of rampant conflict between the two candidates. The challenger reinforced his control over the capital while the incumbent retreated to Toamasina, the major port city. Rallying under his banner the governors of most provinces except the central highlands, the incumbent then proceeded to blast key road bridges and to blockade the capital city and its hinterland. The immediate consequence was a sixfold increase of gasoline prices in the highlands and a doubling of transport costs. The

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<sup>1</sup>Similar data were collected in urban areas, but questions on poverty could not be answered by focus groups. Urban data is ignored in the analysis presented here.

ensuing disruption of the economy raised havoc among farmers who could no longer sell their surplus to the market, as well as among urban dwellers who faced sharp increases in food prices. As a result, the country experienced a dramatic – but hopefully temporary – increase in rural poverty. Fortunately, the political conflict did not degenerate into an all-out civil war. By the Summer most of the army had rallied the challenger’s cause and the incumbent president fled the country in late June. On June 26, the US government recognized the new government. Three days later, France followed suit. The crisis was over.

The data used here were collected during the month of June 2002, just before road-blocks were lifted between the major port city of Toamasina and the rest of the country. The survey focuses on three of the worst affected regions of the country – the two provinces of Antananarivo and Fianarantsoa located in the central highlands where the majority of the population lives, and the coastal province of Mahajanga which depends on the highlands for supply of consumer goods and outlet for its agricultural surplus. A stratified sampling frame was set up in such a way to be as representative as possible of the situation in these three provinces. Districts (*fivondronanas*) were divided into six strata depending on the distance to the provincial capital and on the availability of a tarred road. In each strata, one district or *fivondronana* was selected for every province. In each district, four communes were then selected at random, resulting in a total sample of 72 communes. The small size of the sample is primarily driven by the heroic conditions under which the survey was undertaken, i.e., in the midst of a serious and volatile political crisis that made vehicle transport difficult and movements of enumerators costly and dangerous.

Data collection was undertaken by the USAID-funded Ilo project in collaboration with

INSTAT and FOFIFA.<sup>2</sup> This project has a long experience collecting data in Madagascar and had just completed a census of all communes in the country before the December elections. The census could thus be used as sampling frame for the survey discussed here.

Via interviews with key informants and focus groups – typically local administrators, public servants, traders, and farmers – the survey collected detailed information on crime incidence in the April-May 2002 period immediately preceding the survey, as well as on the April-May 2001. Given the high seasonality in incidences in crime (Razafitsiamidy 1997) and in poverty (Minten and Zeller 2000), data were gathered for comparable periods during the year. Respondents were also asked to evaluate the proportion of the population experiencing difficulties feeding themselves during the same period, as well as the number of law enforcement personnel operating in the commune.

Answers are summarized in Table 1, together with *t*-tests for the difference between 2001 and the corresponding period in 2002. We see that crime rates remained broadly constant over time, with the possible exception of crop theft which went up – but the *t*-statistic is not significant.

We report two distinct poverty lines: the percentage of commune residents who face difficulties feeding themselves throughout the year, and the percentage of those who face occasional difficulties feeding themselves. We call the first the chronically food insecure and the second the temporarily food insecure. By construction, the second category includes the first. Table 1 shows that both measures of poverty went up significantly with the crisis. The magnitude of the effect is quite large, especially on temporary poverty.

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<sup>2</sup>INSTAT is the statistical institute of the Ministry of Economy and Planning. FOFIFA is a the agricultural research institute within the Ministry of Scientific Research.

We also report the proportion of commune residents who face chronic and occasional difficulties paying for health care and school fees, respectively. Survey results display a similar pattern, with a large and significant increase in the share of the population experiencing occasional difficulties paying for health and education.

The next section of Table 1 reports changes in law enforcement personnel between 2001 and 2002. The figures show no change over time, albeit there are changes across communes between the two years. In contrast, transport costs rose dramatically due to the blockade and lack of fuel for transport. The difference is strongly significant.

#### **4. Empirical results**

We are now ready to turn to our estimates of equation 2.3. To avoid losing zero observations, we add one to the dependent variable and to the number of law enforcement personnel before taking logs. Regressions include the two measures of poverty reported in Table 1. Since, by construction, the chronically insecure are included in the temporary insecure, the coefficient on the temporarily food insecure should be interpreted as the effect of poverty in general, while the coefficient of the chronically food insecure measures the *additional* effect of severe poverty. A 2002 year dummy is included to control for the possible presence of a common shock, e.g., lawlessness induced by the deleterious political climate.

Table 2 report regression estimates using commune fixed- and random-effect estimators. A Hausman test is also provided to compare the fixed and random effect results. Except in the case of cattle rustling, we fail to reject the random effect model.

Results show that an increase in poverty is associated with a rise in burglaries and crop theft but has no significant effect on homicides or cattle theft. These results are in agreement with expectations: theft increases with poverty while homicides and organized crime (cattle theft) are insensitive to changes in poverty.<sup>3</sup> Results indicate that it is our broad definition of poverty that is associated with burglaries and crop theft, not the number of chronically poor. Crime therefore appears as a consumption smoothing strategy by the not-so-poor as they seek to protect their standards of living against a shock.

An increase in law enforcement personnel is associated with a drop in cases of cattle theft. The effect is reversed in the random effect model, but the fixed-effect results are preferred since the Hausman test rejects the random effect model. This result suggests that prevention and deterrence is highest for organized crime. It is also conceivable that cattle thieves, who operate over a large territory, simply shift their operations to other communes in response to movements in law enforcement personnel. This issue deserves more investigation. Law enforcement has a significant positive sign in the random-effect burglaries regression. We do not know what accounts for this result. It may be due to crime reporting bias. The 2002 dummy and the transport cost variables are not significant in any of the regressions, suggesting that lawlessness did not systematically increase over and above the effect of poverty and law enforcement.

Because crime remains a rare event, ordinary least squares is not the most efficient estimator. Arguably a more accurate representation of the data generation process is

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<sup>3</sup>These results confirm the findings of Dreze and Reetika (2000) in India and Morgan (2000) in the US as they do not find a significant relationship between poverty and homicides either.

to assume that crime follows a Poisson distribution process. We now estimate Poisson regressions in which the expected crime incidence rate is modeled by equation 2.4. To the extent that the Poisson assumption is a reasonable approximation of the data generation process, this specification should be more efficient. Once we control for commune fixed effects, however, this need no longer be the case. The reason is that, like the fixed-effect logit estimator, the fixed-effect Poisson estimator is a conditional estimator, meaning that all observations in which the dependent variable is unchanged are not used for estimation purposes. Throwing away observations reduces efficiency. For this reason, we report both random and (conditional) fixed effect Poisson regressions.

Table 3 report estimates of the results.<sup>4</sup> We see that, in the case of fixed effects, the loss of observations is highest for burglaries and homicides, where coefficients are identified on the basis of less than 25 observations. It is therefore no surprise that none of the coefficients are significant in the burglaries and homicides fixed effects Poisson regressions.

For the other two regressions, we have more observations and hence more significant results. As in Table 2, we find that temporary poverty has a significant positive effect on crop theft and burglaries. Law enforcement has a significant negative effect on cattle theft. Extreme poverty raises cattle theft in both models while temporary poverty has a negative effect – which is significant in the random effect regression.<sup>5</sup> One possible explanation is that commune residents sold livestock to deal with a temporary shock,

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<sup>4</sup>Unlike in the case of standard fixed and random effect models, we cannot use a Hausman test to compare the two Poisson models. This is because the fixed effect Poisson estimator is conditional, that is, uses only observations for which the dependent variable changes over time.

<sup>5</sup>Chronic poverty has a positive effect on cattle theft in the random effect regression. But by analogy with the standard fixed effect model, we suspect that the random effect model is not appropriate in this case, so we discount this result.

hence reducing the number of animals that could be stolen. At the same time, chronically poor households may have turned to cattle theft out of desperation. We again find that law enforcement has a positive effect on the incidence of burglaries in the random effect regression.

Unlike in Table 2, Poisson regressions suggest that isolation – measured by transport costs to the nearest major town – has a positive effect on rural crime, principally cattle and crop theft. This is particularly strong in the fixed-effect regression. This is consistent with the results reported by Fafchamps and Moser (2002) who show that crime in rural Madagascar increases when roads are washed out by hurricanes.

To check the robustness of these results, we repeat the analysis with alternative poverty measures, namely chronic and temporary difficulties paying for health care and school fees (see Table 1). The correlation coefficient between the two measures of temporary poverty is 0.56. Regression results are presented in Table 4 for the Poisson model.<sup>6</sup>

We find that our alternative definitions of poverty is a slightly less good predictor of crime. Inability to pay for health and education expenditures is positively associated with crop theft and homicides, but chronic money problems are negatively significant in the cattle theft regressions. As in Table 2, this may be due to the fact that people sold livestock to pay for school fees and medical expenses. Results regarding transport costs are unchanged.

Taken together, these findings confirm that poverty has an effect on crime. Our most robust results are the positive effect of temporary poverty on crop theft and the negative

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<sup>6</sup>The new poverty measures are non-significant in nearly all the standard fixed and random effects regressions and the results are not reported here.

effect of law enforcement on cattle theft.

## 5. Conclusion

In this paper we use data from a natural experiment to investigate the relationship between crime and poverty in rural Madagascar. This paper is one of very few efforts to understand criminal activity in poor countries. What makes the investigation unique is the timing of data collection: right in the middle of a serious and volatile political crisis that led to a blockade of the heartland of the country. Disruption to road transport and agricultural production was massive and it resulted in a dramatic – if only temporary – increase in poverty. Because the political crisis was resolved with little bloodshed, there was no refugee crisis and the damage is nearly exclusively economical. This unusual sequence of events provides us with a unique way of assessing the effect of poverty on crime while keeping other crime determinants unchanged. The large magnitude of the shock compensates for the small size of the sample.

Fixed-effect regressions are estimated for a least squares and a Poisson model. Two alternative sets of poverty measures are used. Results suggest that crime increases with poverty. Our most conclusive results are for crop theft where poverty is shown to have a significant effect with both poverty measures in Poisson regressions and in the standard fixed and random effect models with food insecurity as measure of poverty. We get encouraging if less robust results regarding other categories of crime: for all crime categories except cattle theft, there is at least one set of regression results showing a positive association between crime and poverty. Contrary to expectations, it is not chronic poverty

that has the strongest effect on crime, but temporary poverty. This suggests that some households use crime – primarily crop theft – as a consumption smoothing device. This conclusion, however, is reversed for cattle theft where temporary poverty decreases crime while an increase in extreme poverty increases it. We also find that an increase in law enforcement personnel reduces cattle theft, possibly because thieves move their activities elsewhere. In agreement with Fafchamps and Moser (2002), we find that locations which became more isolated – i.e., experienced a higher increase in transport costs – incurred more crime. Finally, the Poisson regression results suggest that poverty may reduce cattle theft as households liquidate livestock to generate much needed funds.

Results presented here provide evidence that crop theft is used by some of the rural poor as a risk coping strategy. Because criminal activity is often local in nature, other people affected by similar shocks bear the brunt of crime. For this reason, we expect the poor to bear much of the welfare cost of crime and of the associated distortions and waste of resources in crime avoidance. The relationship between poverty and crime is thus likely to be important, especially in isolated rural areas (Fafchamps and Moser 2002). These issues deserve more research.

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Table 1: Descriptive statistics

Item	Unit	April/May 2001		April/May 2002		Paired t test	
		Mean	Median	Mean	Median	t-value	P>t
<b>Incidents of crime</b>							
Zebu theft	Number per month per commune	27.03	1.50	33.90	0.50	-0.458	0.647
Burglary	Number per month per commune	0.13	0.00	0.14	0.00	-0.174	0.862
Muders	Number per month per commune	0.14	0.00	0.18	0.00	-0.401	0.689
Crop theft	Number per month per commune	1.85	0.00	2.65	1.00	-1.146	0.254
<b>Measures of poverty</b>							
Definition 1							
Poor	% of population that face temporary problems to find enough to eat	44.12	40.00	58.25	70.00	-2.735	<b>0.007</b>
Extreme poor	% of population that face chronic problems to find enough to eat	11.69	5.00	15.90	10.00	-1.603	0.111
Definition 2							
Poor	% of the population that face temporary problems to pay for health care/schools	40.34	35.00	57.34	60.00	-3.941	<b>0.000</b>
Extreme poor	% of the population that face chronic problems to pay for health care/schools	13.19	10.00	18.82	12.50	-2.330	<b>0.021</b>
<b>Law enforcement personnel</b>							
	Number per commune	54.04	44.00	54.34	43.00	-0.041	0.967
<b>Transport costs</b>							
	Transport costs of a person one way to a major city (Fmg)	26687	20000	52979	37500	-3.991	<b>0.000</b>
	Transport costs of a bag of 50 kg one way to a major city (Fmg)	8973	6750	16778	13750	-4.735	<b>0.000</b>
Number of communes in the survey=72							

Table 2: Link of crime and poverty - fixed effect and random effect regression

Determinants	Unit	Dependent variable (log (Number of incidences per month per commune+1))					
		Zebu theft	Burglary	Murders	Crop theft	Coefficient	t-value
<b>Fixed effect model</b>							
law enforcement personnel	log+1	-3.812	-0.147	-0.370	-1.033	-1.150	
poor (temporary food problems)	% of pop.	-0.001	0.004	-0.003	0.013	<b>3.200</b>	
extreme poor (chronic food problems)	% of pop.	0.006	0.360	-0.002	-0.005	-0.520	
transport costs to major city	log(Fmg)	-0.070	-0.180	0.059	0.429	2.000	
time dummy	2002=1	0.173	0.480	0.030	-0.305	-1.550	
intercept		16.240	<b>2.230</b>	1.037	-0.147	-0.040	
sigma_u		3.856	0.284	0.416	1.385		
sigma_e		0.818	0.192	0.247	0.449		
rho		0.957	0.687	0.739	0.905		
number of observations		142	141	142	142		
F(5,66)		1.29	1.17	0.91	3.37		
Prob>F		0.28	0.33	0.48	0.01		
<b>Joint test if 2 poverty categories diff. from 0</b>							
F(2,66)		0.06	2.75	1.26	5.17		
Prob>F		0.94	0.07	0.29	0.01		
<b>Random effect model</b>							
law enforcement personnel	log+1	0.430	0.073	0.042	0.091	0.770	
poor (temporary food problems)	% of pop.	0.003	0.570	0.000	0.010	<b>3.530</b>	
extreme poor (chronic food problems)	% of pop.	-0.003	-0.270	-0.003	-0.009	-1.520	
transport costs to major city	log(Fmg)	0.227	1.450	0.021	0.034	0.450	
time dummy	2002=1	-0.124	-0.630	0.009	0.031	0.310	
intercept		-2.392	-1.250	-0.261	-0.343	-0.370	
sigma_u		1.521	0.162	0.115	0.721		
sigma_e		0.818	0.192	0.247	0.449		
rho		0.776	0.416	0.178	0.721		
number of observations		142	141	142	142		
Wald chi2(5)		4.95	11.17	4.38	17.14		
Prob>chi2		0.42	0.05	0.50	0.00		
<b>Joint test if 2 poverty categories diff. from 0</b>							
F(2,67)		0.33	7.84	2.49	12.48		
Prob>F		0.85	0.02	0.29	0.00		
<b>Hausman test</b>							
Chi2(5)		13.06	2.14	5.30	6.65		
Prob>chi2		0.02	0.82	0.38	0.25		

Table 3: Link of crime and poverty - fixed effect and random effect Poisson regression

Determinants	Unit	Zebu theft		Burglary		Murders		Crop theft	
		Coefficient	z-value	Coefficient	z-value	Coefficient	z-value	Coefficient	z-value
<b>Fixed effect model</b>									
law enforcement personnel	log+1	-5.440	<b>-9.260</b>	31.452	1.020	-20.591	-1.260	-2.055	-1.320
poor (temporary food problems)	% of pop.	-0.004	-1.490	0.020	1.290	-0.036	-0.910	0.018	<b>3.660</b>
extreme poor (chronic food problems)	% of pop.	0.022	<b>2.090</b>	-0.043	-0.220	-0.346	-1.380	0.012	0.700
transport costs to major city	log(Fmg)	1.080	<b>6.220</b>	0.087	0.060	0.224	0.140	1.668	<b>3.500</b>
time dummy	2002=1	-0.294	<b>-1.850</b>	-0.672	-0.440	1.932	1.060	-1.369	<b>-3.000</b>
number of observations		92		24		22		78	
Wald chi2(5)		273.61		2.27		6.03		25.18	
Prob>chi2		0.00		0.81		0.30		0.00	
<b>Joint test if 2 poverty categories diff. from 0</b>									
Chi2(2)		5.71		1.70		3.47		14.26	
Prob>chi2		0.06		0.43		0.18		0.00	
<b>Random effect model</b>									
law enforcement personnel	log+1	-3.340	<b>-5.470</b>	1.143	<b>2.260</b>	0.466	0.880	0.213	0.710
poor (temporary food problems)	% of pop.	-0.005	<b>-1.860</b>	0.024	<b>2.130</b>	0.005	0.360	0.010	<b>2.700</b>
extreme poor (chronic food problems)	% of pop.	0.041	<b>3.880</b>	-0.050	<b>-1.860</b>	-0.082	-1.670	-0.005	-0.400
transport costs to major city	log(Fmg)	1.141	<b>7.170</b>	-0.112	-0.450	0.409	1.500	0.278	1.530
time dummy	2002=1	-0.483	<b>-3.350</b>	-0.174	-0.320	0.373	0.710	-0.065	-0.310
intercept		7.189	<b>2.060</b>	-6.011	<b>-1.950</b>	-7.497	<b>-2.050</b>	-3.190	-1.380
number of observations		142		141		142		142	
Wald chi2(5)		213.57		9.11		5.98		17.64	
Prob>chi2		0.00		0.10		0.31		0.00	
<b>Joint test if 2 poverty categories diff. from 0</b>									
Chi2(2)		16.27		5.64		2.95		7.31	
Prob>chi2		0.00		0.06		0.23		0.03	

Table 4: Link of crime and alternative measures of poverty - fixed effect and random effect Poisson regression

Determinants	Unit	Dependent variable (Number of incidences per month per commune)							
		Zebu theft		Burglary		Murders		Crop theft	
		Coefficient	z-value	Coefficient	z-value	Coefficient	z-value	Coefficient	z-value
<b>Fixed effect model</b>									
law enforcement personnel	log+1	-6.927	<b>-12.270</b>	17.852	0.610	-16.554	-1.010	-1.235	-0.790
poor (temporary money problems)	% of pop.	0.008	<b>2.730</b>	0.002	0.070	-0.119	-1.270	0.014	<b>2.550</b>
extreme poor (chronic money problems)	% of pop.	-0.040	<b>-3.340</b>	0.099	0.870	0.223	1.600	0.060	<b>2.290</b>
transport costs to major city	Log(Fmg)	1.062	<b>6.270</b>	-0.404	-0.240	-1.509	-0.750	1.700	<b>3.290</b>
time dummy	2002=1	-0.183	-1.170	-0.266	-0.190	1.507	0.740	-1.528	<b>-2.970</b>
number of observations		92		24		22		78	
Wald chi2(5)		287.94		1.50		5.44		25.71	
Prob>chi2		0.00		0.91		0.36		0.00	
<b>Joint test if 2 poverty categories diff. from 0</b>									
Chi2(2)		12.33		0.97		2.59		15.37	
Prob>chi2		0.00		0.61		0.27		0.00	
<b>Random effect model</b>									
law enforcement personnel	log+1	-5.236	<b>-9.130</b>	0.971	<b>1.990</b>	0.425	0.760	0.195	0.660
poor (temporary money problems)	% of pop.	0.007	<b>2.380</b>	0.018	1.450	-0.034	-1.650	0.007	1.640
extreme poor (chronic money problems)	% of pop.	-0.024	<b>-2.060</b>	-0.028	-1.030	0.068	<b>1.920</b>	0.009	0.600
transport costs to major city	log(Fmg)	1.156	<b>7.180</b>	-0.089	-0.350	0.336	1.140	0.277	1.450
time dummy	2002=1	-0.367	<b>-2.490</b>	-0.091	-0.170	0.249	0.430	-0.061	-0.260
intercept		16.305	<b>4.660</b>	-5.478	<b>-1.740</b>	-6.648	-1.690	-3.097	-1.300
number of observations		142		141		142		142	
Wald chi2(5)		218.51		6.02		6.70		14.73	
Prob>chi2		0.00		0.30		0.24		0.01	
<b>Joint test if 2 poverty categories diff. from 0</b>									
Chi2(2)		6.46		2.21		3.80		4.04	
Prob>chi2		0.04		0.33		0.15		0.13	