Crime, Isolation, and Law Enforcement*

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Abstract

This paper investigates the relationship between criminal activity and geographical isolation. Using data from Madagascar, we show that, after we control for population composition and risk factors, crime increases with distance from urban centers and decreases with population density. In Madagascar, crime and insecurity are associated with isolation, not urbanization. This relationship is not driven by placement of law enforcement personnel which is shown to track crime but fails to reduce feelings of insecurity in the population. Other risk factors have effects similar to those discussed in the literature on developed countries. We find a positive association between crime and the presence of law enforcement personnel, probably due to reporting bias. Law enforcement personnel helps solve crime but appears unable to prevent it.

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1. Introduction

Insecurity affects human welfare in many ways. There is the direct cost of crime on victims and the ricochet effect on their friends and relatives. There is also the sense of fear with which people must live even if they have not been victims of crime. In addition to the direct cost of crime, insecurity generates potentially large economic losses: business and trade are diverted, investment and savings are reduced, and resources are wasted protecting property rights and ensuring personal safety. Insecurity also induces populations to vote for and support strong men who promise security, even at the expense of personal freedom and civil rights. Concerns for security are on the rise everywhere, and most countries saw increases in crime rates in the 1990s (e.g. Newman 1999, Fajnzylber, Lederman & Loayza 1998). Expenditures on private security personnel and protection equipment are increasing in many countries (Fajnzylber, Lederman & Loayza 2000). As the rich seek to protect themselves and their assets, the poor too often end up bearing the brunt of insecurity (Pradhan & Ravallion 1999).

In both developed and developing countries, the focus has long been on urban crime. Urbanization is thought to drive increases in crime (e.g. Glaeser & Sacerdote 1999, Dilulio 1996, Clinard & Abbott 1973). In Ghana, for instance, much of the increase in crime rates has been attributed to urbanization Barak (2000). Cities are often ideal places for crime because criminals have a larger number of potential targets and a lower risk of detection than in a small community (Freeman 1996). Crime is frequently found to be correlated with poverty, unemployment, and inequality– both common features of large cities in developing countries (e.g. Ehrlich 1973, Ehrlich & Brower 1987, Fajnzylber, Lederman & Loayza 2000, Bourguignon 1999, Hull 2000). Furthermore, most crime is committed by young men, and since young men account for a large proportion of migrants to cities, one would again expect increases in crime rates there Clinard & Abbott (1973). Finally, cities in poor countries harbor a large foot-loose population freed from

the social pressure found in many small, rural communities, and hence more prone to express its criminal tendencies (e.g. Glaeser, Sacerdote & Scheinkman 1996, Sah 1991, Lederman, Loayza & Menendez 2000). One exception is cattle rustling,which is more likely in rural areas where cattle are raised.

The focus on urban crime leaves one to believe that such problems are few or even non-existent in rural areas. Little has been written on rural crime and insecurity in Africa. Gugler (1991), for instance, argues that Nigerian parents living in large cities often send their children back to the village to be raised where it is safer. The plight of the rural poor is thought to be more easily bearable because whatever little property they have is safe. In this context, guerilla activity, which normally takes place in remote areas, is seen as an aberration, as a spill-over of political conflicts between urban elites (Bayart 1989). Claims by national governments that guerilla fighters are nothing but 'bandits' are seen as a ploy to dismiss the political objectives of armed opposition (Collier & Hoeffler 1998).

The purpose of this paper is to investigate the relationship between crime and isolation. Using a commune census undertaken in Madagascar immediately prior to the 2001 presidential election, we examine the incidence of various types of crime – cattle theft, burglary, homicide, and rape – as a function of population density and distance to the nearest major city. We test whether crime is primarily an urban phenomenon driven by proximity to other people and favored by ease of transportation.

The rate of homicides in Madagascar is as high as in the US, and probably underestimated. Contrary to the US, however, crime is negatively related with population density and positively related with isolation, even after we control for risk factors. All four categories of criminal activity recorded in the commune census are more prevalent in areas with low population density and a long way from the nearest town. We also find that the incidence of crime increases less

than proportionally with population. Relatively speaking, there is more crime in isolated, low density areas. Dahalo is the word the Malagasy use to describe organized rural crime. What our work suggests is that dahalos are not but a folk legend. They are the sad reality of rural life.

An analysis of crime would be incomplete without factoring in the role of law enforcement (Becker 1968). The incidence of crime is affected by the presence and effectiveness of the police (e.g. Ehrlich 1996, Rasmussen, Benson & Sollars 1993, Barak 2000, Levitt 1997, Levitt 1998). While not much is known about police and crime control in Africa, police forces are generally urban and under-funded Hills (2000). To the extent that law enforcement personnel prefers to be posted in cities where amenities are better, or are posted there to protect government or political interests, the concentration of police in and around cities may reverse the relationship between urbanization and crime: if law enforcement personnel are reluctant to live in isolated rural villages, their absence may result in higher crime incidence. It is therefore essential to control for police presence before drawing firm conclusions regarding the effect of isolation on criminal activity.

Our findings are not due to a bias in policing. As anticipated, results show that law enforcement personnel tend to locate in communes that are close to schools and hospitals and have electricity and running water. But after we correct for endogeneity in police placement, our main finding remains: crime incidence is higher is isolated, less populated communes, even when they have more law enforcement personnel. Contrary to expectations, we find that police presence raises crime incidence. This is probably due to a reporting bias: more crimes are reported in areas where law enforcement personnel are present and active, perhaps because rural dwellers fear reprisals from dahalos. This suggests that the actual incidence of rural crime is likely to be even higher than reported.

We also investigate subjective rankings of insecurity made by commune residents, an indicator that is free from law enforcement reporting bias. This subjective indicator is strongly correlated with crime incidence. Results again show that feelings of insecurity are highest in low population density, isolated areas. We find that law enforcement personnel tends to locate near crime but their presence has no significant effect on people's subjective feelings of insecurity. Although police presence is not sufficient to make people feel secure, it helps solve crime: communes with more gendarmes have a higher proportion of stolen cattle recovered and a higher proportion of captured murderers.

The paper is organized as follows. Section 2 is a brief introduction to the conceptual framework. The data is presented in Section 3, together with descriptive statistics. Simple regressions on crime incidence are discussed in Section 4. Police placement and its effect on crime are examined in Section 5. Regression results using subjective measures of insecurity are presented in Section 6.

2. Conceptual framework

Crime is a natural tendency of human beings (e.g. Becker 1968, Ehrlich 1973). In any population, some people are predisposed to crime. If the conditions are 'right', this predisposition expresses itself and crime occurs. On the basis of this simple observation, we expect the average number of crimes $E[C_i]$ committed in location i to be roughly proportional to population P_i at that location.

Different segments of the population have different propensities toward crime. Men, for instance, especially young men, are more prone to violent crime (e.g. Grogger 1997, Clinard & Abbott 1973). Consequently, we expect $E[C_i]$ to increase with the share S_{Mi} of men in the population of location i. Similarly, we expect migrants S_{Ii} to be more crime prone because they

live outside the boundaries of social control: crime is less likely to be noticed by neighbors and relatives, and less likely to result in social sanctions (e.g. Glaeser, Sacerdote & Scheinkman 1996, Sah 1991, Lederman, Loayza & Menendez 2000). In contrast, because the sedentary nature of agriculture favors social sanctions, we would expect the proportion of men engaged in farming S_{Ai} to reduce crime. The only exception is when social customs call for young men to prove their courage by stealing cattle or, as in the case of the Afars in Ethiopia, by killing another man.

Crime incidence also depends on the intensity of social interaction. Child upbringing matters. Glaeser & Sacerdote (1999), for instance, show that there is more crime in US cities with a larger proportion of female-headed households H_{i}. If we regard the criminal as a predator and the victim as the prey, the number of committed crimes should increase with the number of encounters between a prospective criminal and his or her potential victims. For this reason, we expect crime to increase with population density D_{i}: the less dense population is, the fewer opportunities for theft, rape, and murder (Hull 2000). For the same reason, we expect road links R_{i} to increase crime because they facilitate human interaction and thus create a greater likelihood of an encounter with the violent and the criminally inclined. This is, for instance, the interpretation given by Rephann (1999) who finds that US rural counties closer to highways have more crime. For all these reasons, we expect isolated populations to be less subjected to crime.

Other risk factors, such as alcohol or drug consumption, are also expected to play a role (Grogger & Willis 1998). Although we cannot measure consumption directly, we suspect it is correlated with the presence of bars and, thus, of electricity V_{i}. Ethnic diversity is also expected to increase crime if it reduces social bonds and guilt (e.g. Glaeser, Sacerdote & Scheinkman 1996, Easterly & Levine 1997). Using international comparison of country-level data, Fajnzylber,

Lederman & Loayza (2000) find a strong effect of ethnic diversity on crime. We therefore expect more crime where ethnic fractionalization F_i is more acute. Certain types of criminal activities, such as cattle theft, are by definition more likely in areas with abundant livestock (Smith, Barrett & Box 2001). To summarize, we expect the following:

$$E[C_i] = f(P_i, H_i, D_i, F_i, R_i, V_i, S_{Mi}, S_{Ii}, S_{Ai}) \tag{2.1}$$

or, in log form:

$$\begin{aligned} \log C_i \quad = \quad & \alpha \log P_i + \phi \log H_i + \beta \log D_i + \upsilon \log F_i + \gamma \log R_i + \\ & \eta \log V_i + \theta_M \log S_{Mi} + \theta_I \log S_{Ii} - \theta_A \log S_{Ai} + \mu_R + u_i \end{aligned} \tag{2.2}$$

where μ_R is a region or ethnic group effect capturing various location specific factors, including thieving customs, and u_i is a residual. We expect crime to be proportional to population, that is, $\alpha = 1$.

The above reasoning does not allow for law enforcement personnel. In general, we expect the police to catch and punish (some of the) criminals (e.g. Levitt 1997, Levitt 1998, Fajnzylber, Lederman & Loayza 1998). Let the punishment be J_i and let the probability of being caught be an increasing function of the number of law enforcement personnel $p(L_i)$: The gain from crime is written G_i; it is enjoyed only if not caught. The expected gain from crime is $p(L_i)J_i + (1 - p(L_i))G_i$. Since $p(L_i)$ increases in L_i, we see that police presence reduces the expected gain from crime. To the extent that criminals weigh punishment against the instant gratification crime provides, we expect L_i to have a deterrent effect on crime: the higher L_i is, the higher G_i must be to make crime profitable (Becker 1968). Of course, the deterrence effect of police presence assumes that criminals are rational.

If G_i varies across locations – for instance because of population density – then achieving a similar level of criminal activity requires a higher level of policing. Let $g(L_i)$ be the threshold level of G_i required to induce crime when law enforcement personnel is L_i. In any population, some proportion of individuals have a $G_i > g(L_i)$ and thus commit crime. This means that the expected number of crimes $E[C_i]$ is a decreasing function of L_i:

$$\begin{aligned} \log C_i &= -\tau \log L_i + \alpha \log P_i + \beta \log D_i + \gamma \log R_i + \eta \log V_i + \\ &\quad \theta_M \log S_{Mi} + \theta_I \log S_{Ii} - \theta_A \log S_{Ai} + \mu_R + u_i \end{aligned} \tag{2.3}$$

where parameter τ measures the deterrence effect of police presence.

Estimating equation 2.3 is the object of this paper. For this to be done consistently, we must account for the possibility that government locates more law enforcement personnel where G_i is highest. In this case, regressing crime on police presence would yield spurious results: L_i is correlated with G_i and thus with u_i, unobserved factors that affect crime incidence also affect police presence. It is therefore necessary to instrument police presence. To this effect, we need factors that affect police presence but have no anticipated effect on crime. Because law enforcement personnel are skilled civil servants, they probably wish for their families to be located reasonably close to schools and health facilities, to face a reasonably low cost of living, and to enjoy some basic amenities such as electricity and running water. These factors are thus likely to affect police placement without having direct effects on crime – at least the types of criminal activity on which we have data. In poor communes, the difference in standards of living across counties is likely to be quite large – large enough to serve as instrument. Once police placement has been properly instrumented, we expect its effect on crime to be negative or, in case of no deterrence effect, zero.

So far we have reasoned that isolation and low population density reduce crime incidence. It is also conceivable that they encourage crime. Lack of roads makes it difficult for law enforcement personnel to pursue criminals. Low population density makes it hard to find witnesses. Put differently, it is possible that bad roads and dispersed human settlements reduce $p(L_i)$ and the deterrence effect of police presence. If this effect on deterrence is strong enough, it would generate a lower τ in isolated and less densely populated areas. But it would not, by itself, generate a negative relationship between crime and isolation in equation 2.2 where we do not control for L_i.

For such a relationship to arise, some other assumptions are required. One possible assumption is that low population density reduces the probability of detection by anyone to the point where any form of punishment – legal or informal – is unlikely. In this interpretation, social sanctions are actually lower in isolated areas, contrary to what happens in developed countries. Another possibility is that isolation breeds antisocial behavior. Isolation may foster identification with a small group but relatively conflictual relations with the rest of the world. When people from different and normally isolated groups come into contact, the likelihood for conflict and crime may increase. In this context, we would expect violence to erupt at the boundary between neighboring groups who do not respect each other in the absence meta-order institutions that can ensure peace. This is consistent with findings in the northern Kenyan and southern Ethiopian rangelands, where households living closer to the boundaries with hostile ethnic groups had higher risk assessments (Smith, Barrett & Box 2001). If these alternative assumptions are correct, rural areas need not be the idyllic place where 'traditional communities unspoiled by civilization live in harmony with their environment and each other'. Rousseau's 'good savage' parable may be a fallacy. The 'state of nature' may very well be a violent one.

Having clarified our conceptual framework and testing strategy, we now turn to empirical

implementation.

3. The data

The data for this study come from two sources: a commune-level survey conducted in 2001 and the 1993 national population census. Our unit of analysis is the commune, a geographically defined administrative unit in Madagascar, roughly equivalent to a county. Madagascar has six provinces (or faritany), which are divided into fivondronana. The fivondronana are made up of communes – the smallest administrative units with direct representation from the central or provincial government. Rural communes are further divided into fokontany, which essentially represent individual villages. Each commune has a locally elected mayor and a délégué appointed by the province. As of late 2001, there were approximately 1390 communes in Madagascar, but the exact number remains unclear due to the existence of conflicting "official" lists. This confusion is the result of changes in the boundaries and composition of some communes in the mid-1990s. This means that approximately 20 percent of the communes surveyed in 2001, did not have an exact equivalent in the 1993 census.

The commune survey used in this research was conducted over a three-month period in 2001 in a collaboration between Cornell University, Oxford University, and the Malagasy agricultural research institute (FOFIFA). The remoteness of some communes and the general lack of national data on certain subjects meant that little was known about the spatial distribution of public goods and services, economic activity, or crime prior to this study. The commune survey gathered some statistics, such as the number of gendarmes and police, crime figures, and educational enrollment, from the relevant government offices in the commune. More subjective questions, such as those concerning local prices, transportation, access to various goods and services, major economic activities, and community perceptions of existing conditions, were answered by a focus

group composed of residents of the commune. The survey was conducted at the commune's administrative center. A total of 1385 communes were surveyed, all but 9 currently functioning communes.[1]

The 1993 population census is the most recent government census currently available in Madagascar. Information from this census includes population figures by gender and various age groups, literacy rates, employment figures, and percent of the population with amenities such as electricity and running water. Because this information is available by commune based on the 1993 territorial divisions, we are only able to match 86 percent of the communes in the population census with the 2001 commune survey. After combining the two data sets and eliminating observations with missing data, we are left with roughly 1000 observations.

A map of Madagascar with provincial and communal boundaries is shown in Figure 1. Population density is depicted in shades of grey. We see that population is densest in the Central highlands around the main cities of Antananarivo (the capital city) and Antsirabe. The Eastern highlands and coast between Toamasina and Fianarantsoa are also heavily populated. This largely reflects climate patterns that make these areas more productive for agriculture. Other major cities such as Toamasina, Mahajanga, Toliara, and Antsiranana are coastal port cities with a small rural hinterland surrounding them. The Western and Southwestern parts of the country are more arid and much less populated.

Descriptive statistics on crime and law enforcement personnel from the commune census are presented in Table 1. All figures are reported per 100,000 inhabitants. Crime statistics are averages over the three year period 1999-2001. Of the five types of criminal activity recorded in the commune survey, cattle rustling is the most common. An average of 80 or so head of cattle are stolen on average each year in each commune – an average of 1500 or so heads of

[1] The 9 communes in question were missed in the first round of surveys, but the political crisis following the 2001 presidential elections made the work impossible to complete.

cattle per 100,000 inhabitants. This figure is influenced by a number of a small number of very large outliers where cattle rustling takes place at an 'industrial' level. But the median is still 62 heads of cattle reported stolen each year per 100,000 inhabitants. On average, one third of the stolen cattle are found and returned to their owner. The high incidence of cattle rustling may be related to traditional practices of certain ethnic groups. The Bara,one of the dominant ethnic groups in Southwestern Madagascar, are known cattle thieves because young men are supposed to prove their manhood by stealing cattle . When they have done so, they are ready to get married (Ramiarantsoa 1995). The Sakalava have similar customs. cattle rustling is more common in the western part of the island. This largely reflects the fact that this drier part of the island is most suitable for extensive livestock production, which naturally facilitates cattle rustling (Smith, Barrett & Box 2001).

Burglaries are the next most common type of crime, with some 43 burglaries on average per year per 100,000 inhabitants. The average number of reported homicides is roughly similar to the US national average: 8.5 homicides per 100,000 inhabitants. This number is of the same order of magnitude as the 1994 national average of 6.4 intentional homicides reported in Fajnzylber, Lederman & Loayza (1998). The median number of homicides is much lower, again suggesting that crime is concentrated in certain communes. The geographical distribution of murder rates is shown in Figure 2. We see that the highest rates are by and large found in less densely populated areas.

A high proportion of perpetrators of homicides are found, with a median probability of 67%. The mean is lower, however, suggesting that finding murderers is more difficult in communes where the number of homicides is high. The incidence of rape appears low, with less than three reported cases on average per 100,000 inhabitants. This is most probably due to under-reporting bias. Vehicle theft is extremely rare, reflecting the low number of personal vehicles on the island

and the fact that few people know how to drive.

The summary statistics on law enforcement personnel are presented in the second half of Table 1. Law enforcement personnel are divided into three categories in Madagascar: gendarmes, police, and quartiers mobiles (literally, 'mobile quarters'). Gendarmes and police are responsible for public security (Ministere de la Justice 1999). The former are primarily posted in rural communes while the latter are posted in urban areas. Both deal with major crimes like the ones discussed in this paper. The police are under the State Secretary while the gendarmes are part of the Ministry of the Armed Forces. The majority of communes have neither gendarmes nor police and must rely on law enforcement assistance from neighboring communes. Quartiers mobiles are more numerous and more broadly distributed but their mandate is focused on smaller crimes and misdemeanors. They nonetheless may play an important preventive role. Regular army units sometimes assist the gendarmes in the pursuit of bandits or cattle thieves. The data shows that military forces are extremely concentrated geographically.[2]

Figure 3 shows the geographical distribution of law enforcement personnel per 100,000 inhabitants. Except for a large pocket of low law enforcement density in the Southwest, there does not seem to be strong evidence that law enforcement is concentrated in and around cities.

Table 2 provides information on the make-up of Malagasy communes in terms of population, isolation, public services, and risk factors. The population variables (Table 2, Part A) as well as the percentage of households with running water, electricity, pump water and toilet (Table 2, Part B) are from the 1993 census data. The remaining variables are from the commune survey.

We see that median population density is low – 26 inhabitants per square Km. The proportion of migrants in the male population is high – 12% on average. Most active males are involved

[2] In some areas, groups organized at the village level enforce traditional laws called dina (U.S. State Department 2002). In our analysis, we also experimented with a dina dummy, but its effect on crime and insecurity is never significant. These results are omitted here.

in agriculture. Overt unemployment is essentially non-existent. The proportion of female-headed households is quite high, with an average of 19%. The literacy rate is our measure of education (Ehrlich 1975). The average is 57%, a moderately high rate by African standards.

The average travel time to a major city is high: 29 hours, with a median of 14 hours. This includes travel time as well as waiting time for public transportation, and is an average of dry and rainy season. This measure is a more useful measure of isolation than either cost or distance, which fail to account for the often long distances that must be covered on foot to reach a road with public transportation. A third of surveyed communes are located 6.5 hours or less from a major city; one third is located 25 hours away or more. The average commune is located 5 hours from the nearest hospital and 2.4 hours from the nearest secondary school. Medians, however, are much smaller. The percentages of households with electricity or running water are quite low. Less than one fourth of households have a toilet. We also report the average beer price in the communes. Malagasy beer is produced at a single location in the central highlands, near the city of Antsirabe, and is transported from there to all parts of the country. We use it as a yardstick to measure the cost of living in terms of manufactures.

Risk factors and other characteristics are listed in the third panel of the Table. Crime may go up when climatic events force people to abandon their homes. The occurrence of cyclones is fairly high: over the three year period 1999-2001, on average, communes experienced a cyclone 0.6 years. This means that in any single year, the probability of being hit by at least one cyclone is 20%. The likelihood of bridges and roads being washed out during at least part of the year is twice as high, with a 40% probability in any single year. Such occurrences constitute another measure of isolation as it hinders movements by law enforcement personnel.

Using the data at hand, we construct an index of ethnic fractionalization. The literature has indeed suggested that conflicts of all nature – including crime – may be related to ethnic

diversity (e.g. Easterly & Levine 1997, Collier & Hoeffler 1998, Smith, Barrett & Box 2001). Let the share of ethnic group j in the population of commune i be written σ_{ij}. The fractionalization index F_i is but a Simpson index based on the population shares of various ethnic groups:[3]

$$F_i \equiv 1 - \sum_{j=1}^{20} \sigma_{ij}^2$$

The fractionalization index is also the polarization index proposed by Duclos, Estaban & Ray (2002), equation (6), with their parameter $\alpha = 1$. If the whole population belongs to the same ethnic group, $F_i = 0$. If the population is equally divided into many tiny groups, F_i tends to 1. The average index is 0.32, which corresponds to a moderate degree of fractionalization. We also record the presence of Bara or Sakalava in the commune. As discussed earlier, these two ethnic groups have a tradition of cattle rustling. One fourth of the communes have some Bara or Sakalava.

Other risk factors include a history of political violence. Crime and violence indeed tend to display a fair degree of inertia (Blume 2002). Some 6% of communes have experienced riots or looting since independence. We suspect these communes to be less secure as the population might be against the authority and more willing to harbor criminals. The mining of precious stones and minerals and the presence of non-native residents provide easily identifiable targets for crime. We follow Rephann (1999) and include tourism as a possible draw for criminals and risk factor. The presence of large numbers of livestock in the commune similarly may attract cattle theft. We see that Madagascar is well stocked in zebu cattle, with a median of 2500 heads of cattle per commune. Variance is quite large, and some communes have massive herds. The

[3] The survey records ethnicity into 19 distinct categories. Like all definition of ethnicity, these categories are based on a somewhat arbitrary combination of phenotype, dialect, and place of origin. There is also a residual category 'other'. For the sake of constructing the index, we assumed that the 'other' population is divided equally into three distinct ethnic groups.

number of sheep and goats is smaller but also heavily concentrated geographically.[4]

To summarize, the variables listed in Table 2 cover essentially all major determinants of crime identified in the literature: proportion of males and of migrants in the population; crime opportunities measured by the number of livestock, the mining of precious stones, tourism, and the percentage of non-Malagasy population (Becker 1968); labor participation measured by the unemployment rate and the proportion of population engaged in agriculture and livestock (e.g. Ehrlich 1973, Tauchen, Witte & Griesinger 1994); literacy as a proxy for education (Ehrlich 1975); the percentage of female-headed households (Glaeser & Sacerdote 1999); the history of violence and criminal inertia measured by the riot dummy (Glaeser, Sacerdote & Scheinkman 1996); social interactions measured by ethnic fractionalization (e.g. Dilulio 1996, Lederman, Loayza & Menendez 2000, Glaeser, Sacerdote & Scheinkman 1996); and social practices measured by the Bara/Sakalava dummy. We also have data on law enforcement personnel (e.g. Fajnzylber, Lederman & Loayza 1998, Levitt 1997).

In addition to these standard explanatory variables, we have information about distance to the nearest town and the incidence of cut roads. Together with population density, these three variables constitute our measures of isolation. The main objective of the remainder of this paper is to ascertain whether isolation has an effect on crime independent of all the standard explanations for crime.

4. Empirical analysis of crime incidence

Now that we have a better idea of the area under study, we turn to the determinants of criminal activity. We begin with regression analysis of crime incidence. Estimates of equation 2.2 are presented in Table 3. To account for censoring while allowing for heteroskedasticity, the esti-

[4] concentration of small ruminants can be explained by certain local or regional customs which forbid raising or eating these animals.

mator is censored least absolute deviation (Buchinsky 1998). Standard errors are obtained by boostrapping with 100 replications (Buchinsky 1995). Similar results are obtained using tobit.

Contrary to expectations, none of the crime measures is found to be proportional to total population. For cattle theft, this is not too surprising: the dependent variable is primarily a function of the livestock present in the commune. The other three crime categories are increasing functions of population, but in all cases we can confidently reject the hypothesis that the coefficient $\alpha = 1$. This is our first evidence that the concentration of population is not driving crime in Madagascar.

Many of the standard explanatory variables are significant. Communes with proportionally more men and more migrants suffer from higher rates of homicides and cattle theft. Burglaries are more frequent where unemployment is higher. As Glaeser & Sacerdote (1999) find in US cities, a higher percentage of female headed households is associated with higher crime – in our case, more cattle rustling, homicides, and rapes. Risk factors behave largely as anticipated. Cattle rustling is higher with more men in agriculture and more livestock. Communes with tourism have more crime. Electricity is associated with more burglaries and rapes. Cyclones favor burglaries and homicides. Ethnic fractionalization has a positive effect on cattle rustling and rape while the presence of Bara and Sakalava is associated with more crime except burglaries. We also find strong differences across provinces. In general, many of the forces driving crime elsewhere in the world are also at work in Madagascar.

Turning to our main result of interest, we find that, even when we control for all these variables, the effect of isolation on crime is strong and completely contrary to the current literature. Travel time to the nearest major city has a significantly positive coefficient in all regressions. Population density is negative in all regressions, significantly so in two. The number of years in which roads or bridges were cut by weather conditions has a positive significant effect in the

burglaries and homicide regressions. Crime is thus more prevalent in areas with low population density, located further away from a major city, and with a higher incidence of cut roads.[5] Combined with the finding that $\alpha < 1$, these results suggest that, in the case of Madagascar, crime is associated with low population and rural isolation, not with urbanization.

As discussed in Section 2, the negative relationship we find between crime and isolation may be due to insufficient law enforcement effort. To investigate this possibility, we turn to equation 2.2 and include the number of law enforcement personnel as an additional regressor. Because of possible endogeneity between law enforcement L_i and unobservables u_i in the crime regression, we instrument L_i using variables measuring the attractiveness of the commune to police personnel and their family. Instruments are listed in Table 2. They include: distance to nearest school and hospital; percentage of households with running or pump water; percentage with a toilet; and average beer price (an indicator of cost of living for manufactures). These variables are likely to affect the placement of law enforcement personnel, but should not have a direct effect on crime.

Results are presented in Table 4 using as measure of L_i the (log of the) sum of all law enforcement personnel (i.e., gendarme, police, and quartiers mobiles). Similar results are obtained if we use gendarmes or police only. Contrary to expectations, we find that law enforcement has a significant positive effect on crime in two of the regressions. The only exception is cattle theft where the coefficient is negative but not significant. One possible explanation is that police presence has a strong effect on the reporting of crime but little or no effect on crime itself. As a result, more crime is reported where law enforcement personnel is present.[6] We come back to this issue below.

[5] Results are even stronger and more significant when we use tobit.

[6] A cynical view of policing may ascribe excess criminality to the presence of ill-disciplined law enforcement personnel. Although lack of discipline has been documented in a few cases (Ministere de la Justice 1999), it is extremely unlikely that the very small numbers of law enforcement personnel be responsible for very large increase in crime implied by the coefficients.

Including law enforcement has little effect on other coefficients. If anything, the relationship between crime and total population becomes even weaker. Travel time to the nearest town remains strong and positive for cattle theft and homicides. Population density retains a negative and significant coefficient for two of the four crime categories, the main exception being burglaries where the coefficient becomes non-significant. The incidence of cut roads remains significant for burglaries and homicides.

If under-reporting is the correct explanation for the positive association between police presence and crime, then the fact that more isolated, less densely populated areas are more crime prone cannot be due to under-reporting: if anything, isolation and low population density should reduce crime reporting. The fact that isolation variables by and large remain significant suggests that the association between isolation and crime is not an artifact of incorrect reporting.

5. Subjective insecurity

The results presented thus far indicate that law enforcement personnel have no identifiable effect on crime prevention. One possible explanation is that Malagasy law enforcement is ineffective. This claim is made, for instance, by Ministere de la Justice (1999), Root (1993), and The World Bank (1999) who argue that Malagasy law enforcement personnel are unmotivated and corrupt. A gentler interpretation is that the beneficial effect of law enforcement is entirely obscured by crime under-reporting in communes without policing. To investigate this possibility, we turn to a subjective measure of insecurity collected in the commune census.

Respondents to the census questionnaire – a focus group of commune residents – were asked to rank the level of insecurity in their commune on a scale from 1 to 5.[7] Half the communes were ranked as average; 19-20% were ranked either moderately bad or moderately good, and

[7] If we regress the insecurity variable on (instrumented) crime statistics, we find that insecurity responds mostly to cattle theft (t-ratio of 6.32) and burglaries (t-ratio of 2.82).

the rest were ranked as either very bad or very good. A high ranking means the commune is very insecure. The geographical distribution of the subjective rankings suggests that Western communes with low population density feel the most insecure.

Although subjective, this ranking offers the advantage that it is not subject to crime under-reporting. We regress it on the same set of regressors as in Table 4. Ordered probit results are reported in Table 5. Results show no relationship between the presence of law enforcement personnel in the commune and the feeling of insecurity of residents. This is true whichever law enforcement category we use. This seems to confirm that law enforcement personnel has little or no effect on crime prevention.

Regarding population and isolation variables, results are consistent with earlier findings. Travel time to the nearest town has a strong positive effect on insecurity while population density has a negative effect. The cut roads variable has the right sign but is slightly below traditional levels of significance. This further confirms that isolation and low density are strongly associated with a deep sense of insecurity.

Total population has no effect on subjective insecurity; this was anticipated since, unlike crime statistics, the dependent variable is not expected to be proportional to population. But, as before, the proportion of men in the population and the proportion of migrants among males are strong determinants of insecurity. The presence of Bara or Sakalava in the commune also raise insecurity.

Strangely, we find that communes with a high literacy rate feel more insecure, possibly because literacy makes people long more for security. Another possible explanation is failed expectations. Literacy raises expectations, especially among young people. When these raised expectations are not met by real economic opportunities, some turn to crime. Yet another possible interpretation is that literacy is correlated with income and higher incomes attract

more crime. This issue deserves more investigation.

6. Law enforcement and crime

Having ascertained what factors affect crime, we now examine the factors that determine placement of law enforcement personnel and its effectiveness in fighting crime. Table 6 summarizes the factors affecting police placement. Because of censoring at 0, we again rely on censored least absolute deviation as our estimator. Crime incidence is instrumented to control for possible endogeneity bias. Instruments include: the proportion of males in the population; the proportion of migrants, unemployed, and agricultural workers in the male population; the proportion of female headed households; and various risk factors such as livestock, tourism, gem mining, ethnic fractionalization, and the presence of Bara and Sakalava. These variables are thought to affect police placement only through their effect on crime. Two political factors are included in the regression: a history of riots in the commune and the proportion of non-Malagasy in the population (e.g. Blanchy 1995, Fafchamps & Minten 2001).

Although instrumented crime variables are jointly significant in all regressions, results show little systematic relationship between crime and the placement of law enforcement personnel. Some signs are positive while others are negative. Burglaries raise the number of quartiers mobiles while cattle rustling raises the number of gendarmes but reduces the number of quartiers mobiles. Law enforcement presence is an increasing function of population, albeit as in the case of crime we can reject the hypothesis of proportionality between the two. Population density has a negative effect on both gendarmes and quartiers mobiles. This implies that communes with a lower population density have a larger number of law enforcement personnel per inhabitant.

Attractiveness variables (our instruments) are jointly significant in all cases. The percentage of people with toilets and running water are significant with the expected sign in 4 cases out of 8.

Distance from the nearest city has a negative effect in all regressions except for gendarmes, who by nature are supposed to be posted in remote areas. For all law enforcement personnel combined, the effect of distance is negative and significant. Beer prices show a positive relationship with the presence of quartiers mobiles, instead of a negative relationship as anticipated. The two political factors we control for are not significant. Regarding province effects, we find that communes in Fianarantsoa have significantly more quartiers mobiles than in all other provinces. To summarize, we find that the placement of law enforcement personnel bears little systematic relationship with the incidence of crime, with the possible exception of burglaries for quartiers mobiles and of cattle rustling in the case of gendarmes.

Perhaps the placement of law enforcement personnel responds not to actual crime but feelings of insecurity. To investigate this possibility, we repeat the analysis controlling for the sense of insecurity instead of crime. As before,insecurity is instrumented to control for endogeneity. The list of instruments is the same as for crime. Results are presented in Table 7. We see that the placement of gendarmes is quite responsive to feelings of insecurity. But gendarmes prefer being posted near a school and in a commune with electricity and toilets. Law enforcement personnel in general, however, tends to be located in areas that are more secure.

With the possible exception of gendarmes, we have seen that law enforcement personnel does not locate where they are most needed to fight crime. We have also seen that their deterrent effect on crime itself is non-existent and their effect on feelings of insecurity is not significant. Does this mean that Malagasy law enforcement personnel is completely ineffective?

To investigate this possibility, we examine whether policing has an effect on crime resolution. Our two measures are the proportion of recovered cattle and the proportion of captured murderers. Given that these two measures are only available in communes where a crime was perpetrated, we estimate a Heckman selection model. The variables affecting the occurrence of

crime are those reported in Table 4. We are primarily interested in the effect of law enforcement on the probability of resolution, conditional on a crime having taken place.

Some of our results are shown in Table 8; others are omitted to save on space. We find that the effectiveness of law enforcement varies between the different branches. The presence of quartiers mobiles has no effect on the resolution of cattle theft and murder. These findings are consistent with their subsidiary role. Police and gendarmes help solve homicides. Only gendarmes have an effect on the recovery of stolen cattle. Law enforcement personnel is thus not entirely useless: it apprehends some of the criminals. However, we find no evidence that law enforcement personnel either deter criminals or increase the sense of security among residents.

7. Conclusion

Insecurity is an important dimension of human welfare. Using data from a commune census in Madagascar, we investigate whether crime incidence is driven by urbanization or isolation. Theory predicts that areas of large human concentration should have more crime because of more potential victims and more opportunities to gain from crime. For similar reasons, areas with better transport to urban centers should suffer more crime. A few forces operate in the opposite direction, however, such as the capacity to avoid detection and the lack of trust among neighboring communities that results from being insulated from the rest of the world.

Results show a strong positive association between crime, the feeling of insecurity, isolation, and low population density. Communes that are the least populated and furthest away from major cities harbor the most criminal activity. This finding stands in stark contrast with the common perception that urbanization drives crime (e.g. Glaeser & Sacerdote 1999, Grogger & Willis 1998, Fajnzylber, Lederman & Loayza 2000). They fly in the face of Rousseau's 'good savage' parable that still influences so much of the popular psyche about the idyllic nature of

so-called traditional societies. As far as Madagascar is concerned, isolation appears to nurture distrust among different groups and provide safe harbor and passage for criminals. These findings also invite researchers to question the nature of guerilla uprisings and their relationship with crime and isolation (Collier 2000). The recent examples of Maoist insurgency in Nepal and FARC warlords in Colombia spring to mind, together with countless historical examples of banditry and guerilla activity in remote areas. This issue deserves further research.

Regarding other determinants of crime, our results largely confirm findings obtained using either US data or international comparisons. The presence of males and migrants in the population increases crime. So does the proportion of female-headed households (Glaeser & Sacerdote 1999). Ethnic fractionalization is associated with more crime as well (e.g. Fajnzylber, Lederman & Loayza 2000, Dilulio 1996, Glaeser, Sacerdote & Scheinkman 1996). Crime opportunities, such as tourism or a large livestock population, raise crime. Rephann (1999) finds a similar effect of tourism in US counties.

We have also investigated the relationship between crime and law enforcement. We find that the presence of law enforcement personnel has a positive effect on reported crime. We attribute this effect to under-reporting of crime in communes without police presence. The more professional members of the law enforcement apparatus have a positive effect on crime resolution, solving the majority of homicides, for instance. But law enforcement has no effect on perceptions of insecurity and little effect on crime prevention. Why this the case is unclear and calls for further research, albeit some authors have suggested that law enforcement in Madagascar is particularly ineffective (e.g. Ministere de la Justice 1999, Root 1993). Our work suggests that urbanization and the construction of roads to remote areas should reduce crime and insecurity in Madagascar, not the contrary.

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Table 1. Descriptive statistics on crime and police

All figures reported per 100,000 inhabitants

A. Crime incidence (average 1999-2001)	**Mean**	**Median**	**Std. dev.**
Number of stolen cattle	1496.0	62.0	5754
Number of stolen cattle found	323.2	6.1	1074
Proportion of recovered catte (if stolen)	33%	22%	38%
Number of stolen vehicles	0.2	0.0	2
Number of burglaries	42.8	7.9	97
Number of homicides	8.5	2.1	20
Number of murderers found	7.0	0.0	27
Proportion of murderers found (if murder)	56%	67%	44%
Number of rapes	2.9	0.0	10
B. Law enforcement personnel			
Gendarmes	46.2	0.0	105
Police	12.9	0.0	83
Quartier mobiles	478.1	362.9	609
Total	537.1	413.7	613
Military	25.0	0.0	271

Table 2. Characteristics of communes

A. Population characteristics	**Mean**	**Median**	**Std. dev.**
Total population	10532	7873	23965
Population density	131	26	754
Percentage of men in total population	50%	50%	1%
Percentage of migrants in male population	12	8	11
Percentage of men in agriculture or livestock	70	75	19
Percentage of unemployed in male population	0	0	1
Percentage of female headed households	19	18	6
Literacy rate	57	58	25
B. Isolation and public services			
Travel time to nearest city (in hours) (*)	28.7	14.0	45.0
Travel time to nearest hospital (in hours)	5.3	2.0	10.3
Travel time to nearest secondary school (in hours)	2.4	0.0	8.3
Percentage of households with electricity	2.4	0.0	7.8
Percentage of households with running water	0.9	0.0	3.6
Percentage of households with pump water	5.6	0.2	12.9
Percentage of households with toilet	22.7	7.4	28.4
Average beer price (an indicator of cost of living)	5244	5000	1317
C. Other characteristics			
Number of years with cyclone in last three years	0.6	0	0.8
Number of years road was cut in last three years	1.2	1	1.3
Ethnic fractionalization index	0.32	0.29	0.25
Presence of Bara or Sakalava	24%	0%	
Commune had riots since independence	6%	0%	
Precious stones or gold mined in commune	20%	0%	
Tourist attraction present in commune	43%	0%	
Percentage of non-Malagasy population	0.06%	0.01%	0.29%
Number of zebu cattle	6644	2588	31974
Number of sheep and goats	1718	6	8615
D. Province			
Antananarivo	21%		
Fianarantsoa	27%		
Toamasina	14%		
Mahajanga	13%		
Toliara	16%		
Antsiranana	10%		
Number of observations	1008		

(*) Travel time to nearest urban center includes waiting time. Average of dry and wet season times.

Table 3. Determinants of Crime

(estimator is censored least absolute deviation)		Cattle theft		Burglaries		Homicides		Rapes	
Population	**Unit**	**Coef.**	**z-stat.**	**Coef.**	**z-stat.**	**Coef.**	**z-stat.**	**Coef.**	**z-stat.**
Total population	log	-0.152	-0.84	0.310	**2.91**	0.371	**4.98**	0.517	**5.69**
Percentage of men in total population	%	43.628	**4.14**	-1.551	-0.17	16.445	**3.81**	11.835	1.47
Percentage of migrants in male population	%	0.034	**3.51**	0.014	1.37	0.020	**3.60**	-0.001	-0.09
Percentage of men in agriculture or livestock	%	0.015	**1.89**	0.002	0.41	0.001	0.40	-0.007	**-1.83**
Percentage of unemployed in male population	%	0.027	0.18	0.114	1.46	0.039	0.66	-0.003	-0.04
Percentage of female headed households	%	0.031	1.45	0.003	0.16	0.016	**1.84**	0.041	**2.59**
Literacy rate	%	0.021	**2.92**	0.006	1.30	-0.001	-0.25	-0.006	-1.20
Isolation									
Travel time to nearest major city	log	0.148	**1.73**	0.121	**1.91**	0.113	**2.96**	0.221	**4.68**
Population density	log	-0.156	-1.56	-0.013	-0.15	-0.087	**-2.08**	-0.105	**-1.89**
Number of years road was cut in last 3 years	# years	0.080	1.22	0.142	**2.60**	0.071	**2.35**	-0.016	-0.34
Risk factors									
Number of zebu cattle	log	0.779	**6.10**	-0.045	-0.97	-0.001	-0.06	-0.018	-0.62
Number of sheep and goats	log	0.084	**2.20**	0.064	**2.27**	0.026	**1.69**	0.016	0.75
Precious stones or gold mined in commune	yes=1	-0.106	-0.40	0.152	0.98	0.034	0.36	0.178	1.20
Tourist attraction present in commune	yes=1	0.316	**1.66**	0.240	1.60	0.129	1.58	0.067	0.68
Percentage of non-Malagasy population	%	0.046	0.11	-0.295	-0.65	0.066	0.18	-0.179	-0.49
Commune had riots since independence	yes=1	0.055	0.17	0.321	1.26	-0.035	-0.21	-0.435	**-2.00**
Percentage of households with electricity	%	-0.003	-0.16	0.050	**3.44**	0.014	1.36	0.041	**3.95**
Number of years with cyclone in last 3 years	# years	-0.064	-0.53	0.156	**1.73**	0.093	**1.86**	0.089	1.03
Ethnic fractionalization index	index	1.254	**3.05**	0.056	0.14	0.151	0.74	0.368	1.21
Presence of Bara or Sakalava	yes=1	0.484	**2.17**	-0.174	-0.91	0.268	**2.45**	0.340	**2.44**
Province dummies (Fianarantsoa is omitted category)									
Antananarivo	yes=1	-1.385	**-4.75**	0.052	0.20	-0.397	**-3.10**	0.732	**2.39**
Toamasina	yes=1	-2.485	**-7.01**	1.250	**5.12**	-0.273	**-2.08**	1.012	**3.68**
Mahajanga	yes=1	-0.059	-0.21	0.581	**2.00**	-0.435	**-3.01**	0.786	**3.28**
Toliara	yes=1	-0.262	-0.64	-0.149	-0.56	-0.461	**-2.86**	-0.858	**-2.50**
Antsiranana	yes=1	-2.874	**-9.34**	1.907	**7.66**	-0.447	**-2.90**	0.930	**3.43**
Intercept		-26.366	**-4.76**	-2.148	-0.45	-11.333	**-4.94**	-11.204	**-2.60**
Pseudo R-squared		0.337		0.195		0.129		0.190	
Quantile used in estimation		0.587		0.629		0.655		0.754	

The dependent variable is log(# crimes over last three years +1)

Table 4. Determinants of crime, controlling for the presence of law enforcement personnel

(estimator is censored least absolute deviation)		Cattle theft		Burglaries		Homicides		Rapes	
Law enforcement (instrumented)		**Coef.**	**z-stat.**	**Coef.**	**z-stat.**	**Coef.**	**z-stat.**	**Coef.**	**z-stat.**
Number of law enforcement personnel	log	-0.285	-0.65	0.872	**3.26**	0.069	0.38	0.511	**1.75**
Population	**Unit**								
Total population	log	0.142	0.46	-0.202	-1.07	0.310	**2.48**	0.220	1.15
Percentage of men in total population	%	46.933	**4.09**	0.322	0.04	16.443	**4.55**	4.012	0.47
Percentage of migrants in male population	%	0.028	**2.32**	0.022	**2.61**	0.022	**4.23**	0.000	0.02
Percentage of men in agriculture or livestock	%	0.015	**1.91**	0.005	1.07	0.001	0.49	-0.013	**-2.32**
Percentage of unemployed in male population	%	0.164	1.02	0.102	1.41	0.034	0.63	0.024	0.29
Percentage of female headed households	%	0.035	1.27	0.014	0.95	0.018	**2.29**	0.046	**2.62**
Literacy rate	%	0.018	**2.42**	0.003	0.62	-0.001	-0.34	-0.011	**-1.90**
Isolation									
Travel time to nearest major city	log	0.173	**1.97**	0.104	1.23	0.111	**3.12**	0.074	1.12
Population density	log	-0.232	**-2.05**	0.051	0.60	-0.074	-1.64	-0.167	**-2.04**
Number of years road was cut in last 3 years	# years	0.019	0.28	0.189	**3.26**	0.071	**2.04**	0.047	0.87
Risk factors									
Number of zebu cattle	log	0.591	**4.50**	-0.050	-1.17	-0.001	-0.03	-0.073	**-2.27**
Number of sheep and goats	log	0.109	**2.93**	0.092	**3.57**	0.026	**1.77**	0.049	1.64
Precious stones or gold mined in commune	yes=1	-0.009	-0.03	0.003	0.02	0.026	0.22	0.069	0.42
Tourist attraction present in commune	yes=1	0.367	**2.01**	0.273	**1.90**	0.126	**1.65**	0.052	0.43
Percentage of non-Malagasy population	%	0.072	0.14	-0.385	-0.71	0.063	0.20	-0.295	-0.84
Commune had riots since independence	yes=1	-0.061	-0.18	0.302	1.23	-0.036	-0.23	-0.084	-0.34
Percentage of households with electricity	%	-0.011	-0.54	0.053	**3.52**	0.010	1.04	0.035	**3.28**
Number of years with cyclone in last 3 years	# years	0.050	0.39	0.182	**2.19**	0.101	**2.10**	-0.070	-0.75
Ethnic fractionalization index	index	1.376	**3.29**	0.362	1.11	0.127	0.65	0.604	1.54
Presence of Bara or Sakalava	yes=1	0.527	**2.40**	-0.183	-0.98	0.257	**2.02**	0.414	**2.47**
Province dummies (Fianarantsoa is omitted category)									
Antananarivo	yes=1	-1.039	**-2.71**	-0.239	-1.12	-0.431	**-2.50**	1.769	**2.61**
Toamasina	yes=1	-2.592	**-6.58**	1.669	**6.94**	-0.233	-1.53	2.435	**3.97**
Mahajanga	yes=1	0.012	0.03	0.232	0.87	-0.422	**-2.57**	1.453	**2.78**
Toliara	yes=1	-0.546	-1.10	0.195	0.63	-0.358	-1.42	0.286	0.35
Antsiranana	yes=1	-3.125	**-9.51**	1.885	**7.25**	-0.404	**-2.30**	1.938	**3.25**
Intercept		-28.012	**-4.76**	-2.026	-0.51	-11.116	**-6.00**	-5.884	-1.26
Pseudo R-squared		0.339		0.201		0.127		0.167	
Quantile used in estimation		0.587		0.629		0.655		0.754	

The dependent variable is log(# crimes over last three years +1)

Table 5. Determinants of sense of insecurity, controlling for law enforcement
(Estimator is ordered probit)

		Coef.	z-stat.
Law enforcement (instrumented)			
Number of law enforcement personnel	log	0.142	0.81
Population			
Total population	log	-0.020	-0.17
Percentage of men in total population	%	8.786	**1.94**
Percentage of migrants in male population	%	0.016	**3.00**
Percentage of men in agriculture or livestock	%	0.005	**1.78**
Percentage of unemployed in male population	%	-0.072	-1.48
Percentage of female headed households	%	0.005	0.51
Literacy rate	%	0.006	**2.18**
Isolation			
Travel time to nearest major city	log	0.146	**4.03**
Population density	log	-0.116	**-2.63**
Number of years road was cut in last 3 years	# years	0.048	1.57
Risk factors			
Number of zebu cattle	log	-0.018	-0.73
Number of sheep and goats	log	-0.003	-0.23
Precious stones or gold mined in commune	yes=1	-0.065	-0.69
Tourist attraction present in commune	yes=1	0.007	0.09
Percentage of non-Malagasy population	%	-0.132	-1.04
Commune had riots since independence	yes=1	0.146	0.97
Percentage of households with electricity	%	0.005	0.64
Number of years with cyclone in last 3 years	# years	-0.015	-0.32
Ethnic fractionalization index	index	0.124	0.66
Presence of Bara or Sakalava	yes=1	0.346	**3.33**
Province dummies (Antananarivo is omitted category)			
Fianarantsoa	yes=1	-0.098	-0.64
Toamasina	yes=1	-0.024	-0.16
Mahajanga	yes=1	0.189	1.27
Toliara	yes=1	0.282	1.36
Antsiranana	yes=1	0.188	1.16
Pseudo R-squared		0.065	
Number of observations		988	

The dependent variable is a subjective ranking of insecurity ranging from 1 (very safe) to 5 (very insecure)

Table 6. Presence of law enforcement officers, controlling for crime
(Estimator is censored least-absolute deviation)

		Gendarmes		Quartiers mobiles		Police		All three	
Crime (instrumented)		**Coef.**	**z-stat.**	**Coef.**	**z-stat.**	**Coef.**	**z-stat.**	**Coef.**	**z-stat.**
Cattle theft	log	0.262	**2.37**	-0.105	**-2.41**	-0.094	-1.42	-0.066	**-1.91**
Burglaries	log	-0.113	-0.44	0.374	**2.70**	0.242	1.54	0.317	**2.73**
Homicides	log	0.453	1.55	-0.170	-0.84	-0.185	-0.55	-0.030	-0.20
Rape	log	-0.156	-0.32	-0.578	-1.64	0.613	**2.01**	-0.058	-0.23
Population									
Total population	log	0.851	**5.47**	0.639	**9.53**	0.487	**3.59**	0.582	**9.42**
Population density	log	-0.261	**-1.97**	-0.136	**-2.41**	-0.123	**-1.80**	-0.113	**-2.33**
Attractiveness									
Travel time to nearest major city	log	0.125	1.38	-0.041	-0.79	-0.084	-1.20	-0.069	**-1.77**
Travel time to nearest hospital	log	-0.047	-0.39	0.072	0.94	-0.171	**-2.15**	0.071	1.05
Travel time to nearest school	log	-0.160	-1.18	-0.062	-1.22	0.073	1.21	-0.048	-1.23
Percentage of households with electricity	%	0.062	**3.01**	-0.019	-1.63	0.011	0.42	-0.016	-1.64
Percentage of households with running/pump water	%	0.014	**1.85**	-0.009	-1.41	0.023	**2.21**	0.001	0.19
Percentage of households with toilet	%	0.012	**2.87**	-0.000	-0.11	-0.005	**-1.80**	0.001	0.46
Average beer price (an indicator of cost of living)	log	-0.165	-0.33	0.741	**2.43**	0.666	**2.14**	0.635	**2.80**
Number of years with cyclone in last 3 years	# years	0.044	0.50	-0.016	-0.32	0.099	1.44	-0.028	-0.58
Number of years road was cut in last 3 years	# years	0.126	1.64	-0.067	**-1.76**	0.010	0.28	-0.003	-0.10
Political factors									
Commune had riots since independence	yes=1	0.227	0.82	0.090	0.52	0.334	0.88	0.048	0.30
Percentage of non-Malagasy population	%	0.244	0.41	0.137	0.28	0.160	0.20	0.125	0.75
Province dummies (Antananarivo is omitted category)									
Fianarantsoa	yes=1	0.246	0.76	0.354	**3.57**	-1.467	**-1.94**	0.279	**2.58**
Toamasina	yes=1	-0.222	-0.41	-1.275	**-5.10**	0.051	0.22	-1.135	**-5.14**
Mahajanga	yes=1	0.039	0.11	-0.013	-0.07	-0.331	-1.18	-0.013	-0.11
Toliara	yes=1	0.457	1.38	-0.714	**-3.19**	-0.518	**-2.10**	-0.474	**-3.23**
Antsiranana	yes=1	-0.372	-0.54	-1.045	**-3.54**	-1.689	**-2.90**	-0.900	**-3.68**
Intercept		-5.945	-1.42	-7.677	**-2.94**	-8.558	**-2.75**	-6.458	**-3.06**
Pseudo R-squared		0.197		0.129		0.193		0.133	
Quantile used in estimation		0.718		0.536		0.739		0.518	
Joint test of crime variables		**F stat.**	**p-value**	**F stat.**	**p-value**	**F stat.**	**p-value**	**F stat.**	**p-value**
		3.10	0.0089	3.23	0.0067	2.63	0.0230	2.88	0.0138

The dependent variable is log(# law enforcement personnel+1)

Table 7. Police placement and sense of insecurity

(Estimator is censored least absolute deviation)		Gendarmes		All law enforcement	
Insecurity (instrumented)		**Coef.**	**z-stat.**	**Coef.**	**z-stat.**
Perceived insecurity	rank	1.142	**4.30**	-0.253	**-2.12**
Population					
Total population	log	1.005	**6.15**	0.629	**12.05**
Population density	log	-0.406	**-3.16**	-0.123	**-3.34**
Attractiveness					
Travel time to nearest major city	log	0.068	0.95	0.018	0.48
Travel time to nearest hospital	log	-0.008	-0.07	-0.030	-0.49
Travel time to nearest school	log	-0.256	**-1.71**	-0.036	-0.76
Percentage of households with electricity	%	0.054	**3.64**	0.003	0.63
Percentage of households with running/pump water	%	0.008	1.18	-0.001	-0.32
Percentage of households with toilet	%	0.010	**1.79**	0.004	**2.33**
Average beer price (an indicator of cost of living)	log	-1.214	**-1.92**	0.984	**4.43**
Number of years with cyclone in last 3 years	# years	0.036	0.39	0.034	0.86
Number of years road was cut in last 3 years	# years	0.134	**1.74**	0.015	0.50
Political factors					
Commune had riots since independence	yes=1	0.216	0.85	0.184	1.14
Percentage of non-Malagasy population	%	0.762	1.58	0.084	0.62
Province dummies (Antananarivo is omitted category)					
Fianarantsoa	yes=1	0.154	0.45	0.283	**2.71**
Toamasina	yes=1	-0.904	**-2.33**	-0.719	**-4.10**
Mahajanga	yes=1	-0.015	-0.04	0.075	0.63
Toliara	yes=1	0.367	1.17	-0.542	**-3.67**
Antsiranana	yes=1	-1.378	**-1.66**	-0.294	**-2.34**
Intercept		-9.816	-1.63	-7.197	**-3.70**
R-squared		0.179		0.130	
Quantile used in estimation		0.718		0.518	
Number of observations		988		988	

The dependent variable is log(# law enforcement personnel+1)

Table 8. Solving crimes

(estimator is maximum likelihood Heckman selection model)		Recovering stolen cattle		Finding murderers	
A. Proportion of cases solved		**Coef.**	**z-stat.**	**Coef.**	**z-stat.**
Number of gendarmes	log	0.044	**1.67**	0.099	**2.43**
Success factors					
Total population	log	0.046	**1.75**	0.010	0.23
Population density	log	-0.012	-0.82	0.003	0.13
Travel time to nearest major city	log	-0.002	-0.13	0.021	1.18
Commune had riots since independence	yes=1	0.023	0.45	-0.001	-0.02
Percentage of non-Malagasy population	%	0.045	1.08	0.111	1.21
Percentage of households with electricity	%	-0.004	-1.41	-0.001	-0.23
Number of years with cyclone in last 3 years	# years	-0.016	-0.96	0.006	0.22
Number of years road was cut in last 3 years	# years	0.004	0.37	0.026	1.49
Province dummies (Antananarivo is omitted category)					
Fianarantsoa	yes=1	-0.107	**-2.51**	-0.114	**-1.70**
Toamasina	yes=1	-0.102	**-1.93**	0.199	**3.05**
Mahajanga	yes=1	-0.099	**-2.03**	0.043	0.61
Toliara	yes=1	-0.081	**-1.92**	-0.007	-0.10
Antsiranana	yes=1	-0.067	-1.35	0.183	**2.46**
Intercept		-0.006	-0.03	0.171	0.44
B. Selection equation					
Total population	log	-0.001	-0.01	0.266	**3.44**
Percentage of men in total population	%	22.270	**3.67**	17.415	**3.21**
Percentage of migrants in male population	%	0.009	1.21	0.014	**2.41**
Percentage of men in agriculture or livestock	%	0.008	**1.95**	-0.003	-0.83
Percentage of unemployed in male population	%	0.036	0.57	0.021	0.37
Percentage of female headed households	%	0.015	1.26	0.013	1.25
Literacy rate	%	0.004	1.06	0.001	0.28
Isolation					
Travel time to nearest major city	log	-0.004	-0.08	0.126	**2.98**
Population density	log	0.038	0.64	-0.055	-1.04
Number of years road was cut in last 3 years	# years	0.135	**3.15**	0.064	**1.80**
Risk factors					
Number of zebu cattle	log	0.109	**3.35**	0.012	0.45
Number of sheep and goats	log	0.086	**3.84**	0.017	0.94
Precious stones or gold mined in commune	yes=1	-0.298	**-2.29**	0.025	0.23
Tourist attraction present in commune	yes=1	0.313	**2.90**	0.206	**2.30**
Percentage of non-Malagasy population	%	0.069	0.34	-0.025	-0.16
Commune had riots since independence	yes=1	0.304	1.36	0.208	1.13
Percentage of households with electricity	%	-0.015	-1.41	-0.004	-0.42
Number of years with cyclone in last 3 years	# years	-0.115	**-1.76**	0.008	0.14
Ethnic fractionalization index	index	-0.081	-0.32	0.234	1.05
Presence of Bara or Sakalava	yes=1	0.201	1.32	0.064	0.54
Province dummies (Antananarivo is omitted category)					
Fianarantsoa	yes=1	0.403	**2.17**	-0.191	-1.22
Toamasina	yes=1	-0.444	**-2.77**	-0.079	-0.53
Mahajanga	yes=1	0.861	**3.13**	-0.256	-1.50
Toliara	yes=1	-0.216	-1.02	-0.325	**-1.77**
Antsiranana	yes=1	-0.399	**-1.94**	-0.339	**-1.84**
Intercept		-12.870	**-4.00**	-11.651	**-3.99**
Number of observations		992		994	
of which uncensored		725		523	

The dependent variable is the number of cattle (murderers) found over the number of cattle stolen (murde

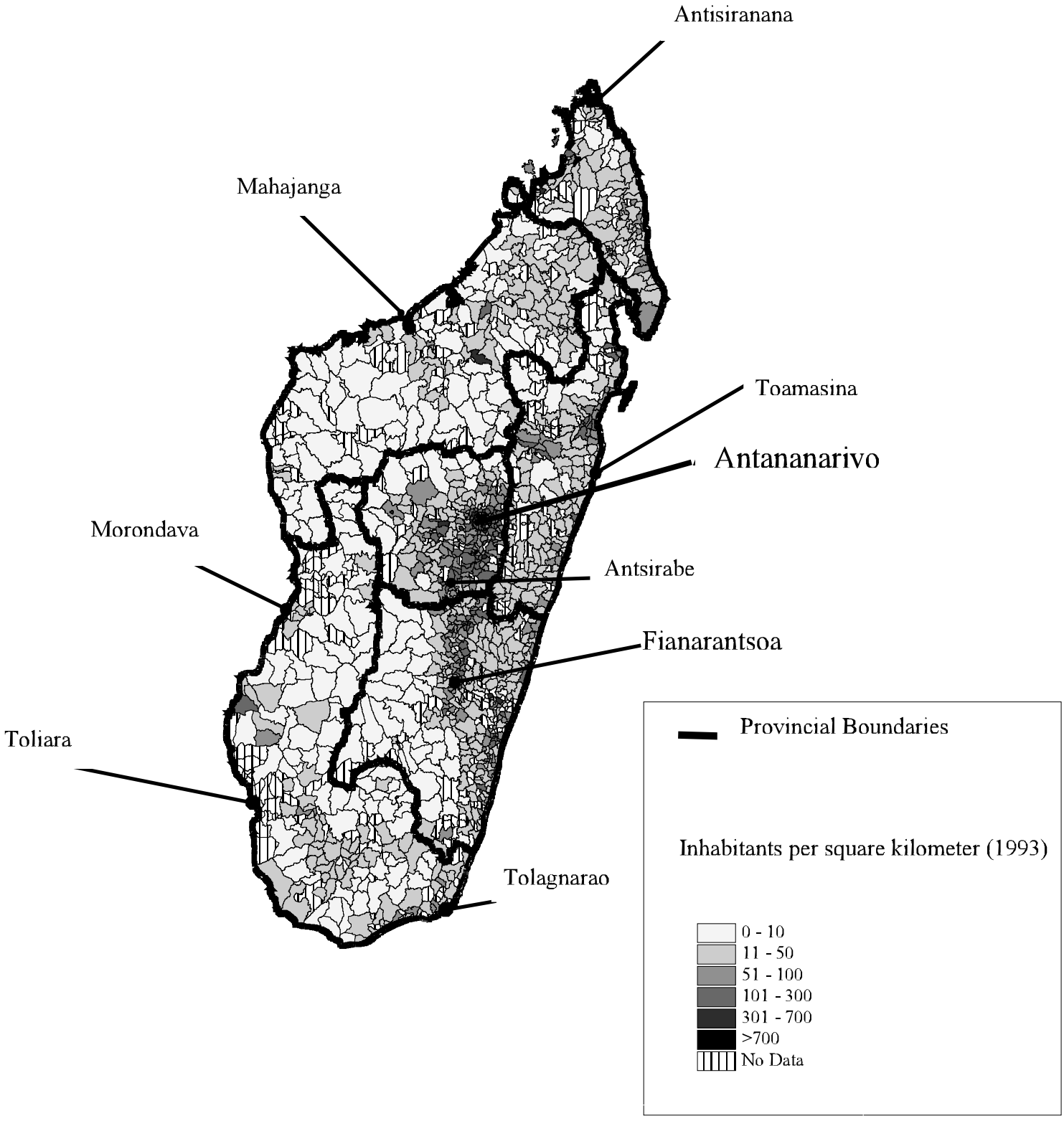

Figure 1. Population density and major cities of Madagascar

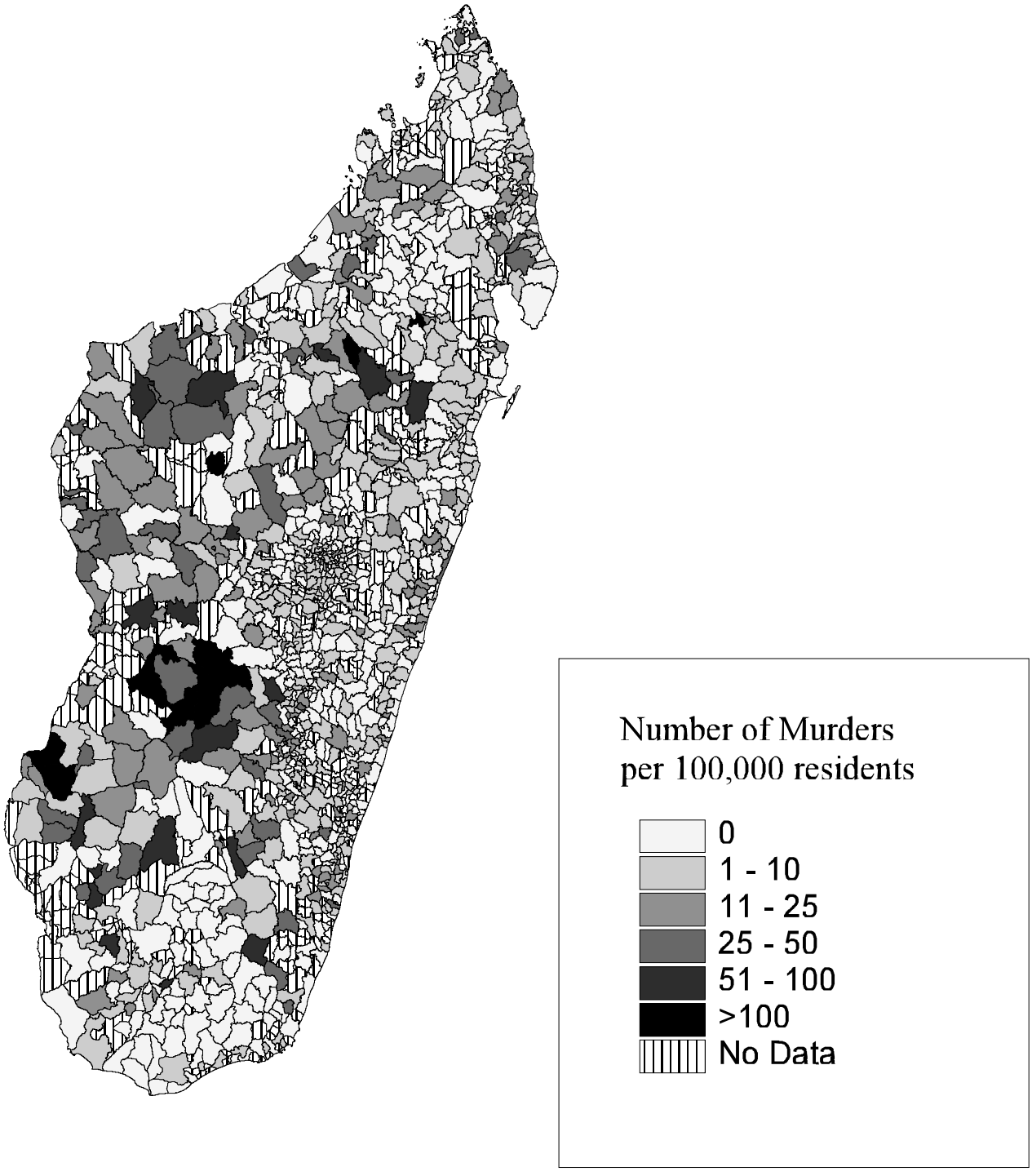

Figure 2. Average Number of Murders per 100,000 inhabitants 1999-2001

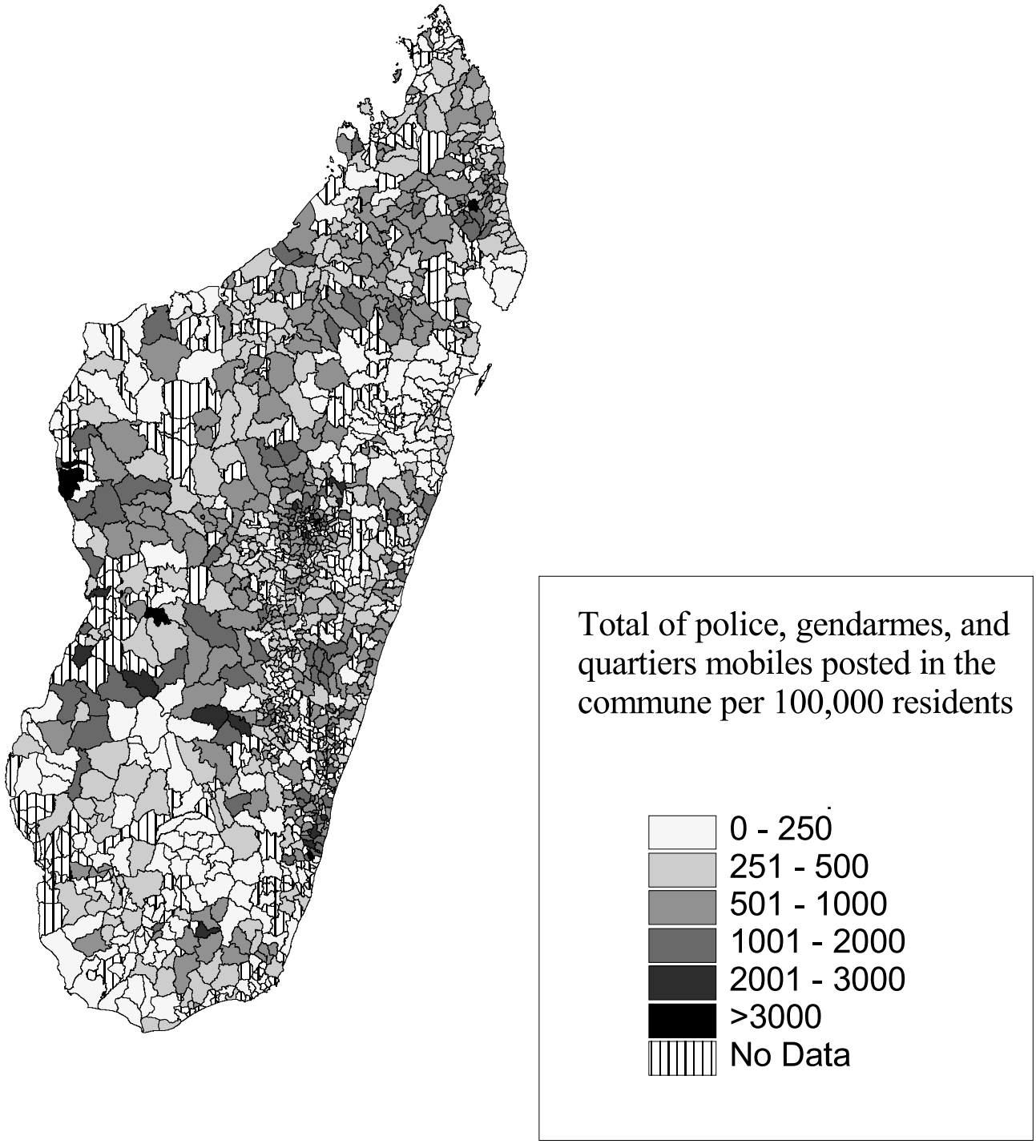

Figure 3. Number of law enforcement personnel per 100,000 inhabitants