Commune Shocks, Household Assets, and Economic Well-Being in Madagascar

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Abstract
Madagascar is an island-economy characterized by very high rates of poverty. Households on the island are also buffeted by various environmental, social, health and economic shocks that increase household vulnerability to poverty. This paper provides an empirical vignette of the frequency, spatial distribution, and temporal persistence of commune level shocks to household well-being in Madagascar. The association between such shocks, community and household assets, and household levels of economic well-being, poverty and vulnerability is also explored. The results suggest that reported commune environmental and human health shocks, as measured, play a relatively minor role in determining high current rates of poverty and household vulnerability to poverty. Households do, however, commonly sell livestock assets in the face of shocks and this consumption-smoothing response is likely increase their future vulnerability to poverty. By contrast, household human capital assets and commune social and market infrastructure appear to play substantial roles in determining current levels of well-being. In communes with low social and market infrastructure, both low household asset levels and low returns on assets must be addressed to reduce extremely high rates of chronic poverty. While in more densely populated high infrastructure areas, where 70 percent of chronically poor households are found, investments in household assets like secondary school attendance may substantially reduce chronic poverty.

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1. Introduction

Madagascar is an island-economy characterized by low levels of economic well-being and high rates of poverty. Low levels of economic well-being are particularly acute in rural areas. Further, households on the island are buffeted by a variety of shocks that influence well-being. The most common types of shocks that impact communes in Madagascar are listed in figure 1. Environmental and climatic shocks like cyclones, floods, and droughts frequently hit sections of the island. Such shocks may be particularly important in determining household well-being in rural areas that depend of agriculture. A number of serious human diseases like Malaria, Tuberculosis and Cholera are also present on the island. These human health shocks may have major impacts on household well-being due to loss of income earners time, costs of medical care, and emotional trauma. As shown by the political crisis of 2002, social and political insecurity may also have a major impact on household economic well-being. While the political situation on the island has stabilized, many of the island's communes continue to face high incidences of crime, particularly cattle theft in remote areas (Fafchamps and Moser). Macro-economic shocks like falling terms of trade and exchange rate changes impact the relative price of goods and also have an indirect impact on production and employment. Employment shocks, in turn, directly affect household income streams and consumption.

Many shocks like floods and human or livestock diseases show strong spatial or temporal correlations. The spatial and temporal dependence of shocks can have important implications for households' abilities to mitigate negative shocks and smooth household consumption. Common shocks over large geographic areas reduce the effectiveness of local mutual insurance networks by putting all members under similar pressure (Fafchamps). On the other hand, shocks that tend to be strongly correlated over years reduce the efficacy of precautionary savings as a self-insurance strategy (Dercon, 1998). Different types of shocks are often also related, e.g. flooding and closure of roads. This can amplify the impact that the separate shocks have on household well-being. The spatial and temporal persistence of shocks can also greatly complicate the analysis of the relative importance of specific shocks on household well-being and the design of appropriate assistance strategies to mediate shocks.

A household's ability to ameliorate the impact of negative environmental, social, and economic shocks depends on a number of factors. Well-integrated markets are of primary importance. Local negative shocks often create shortages in basic foods and other essential goods. In poorly integrated markets, prices for these items will rise to reflect such shortages. Well-integrated markets can efficiently move resources to areas of scarcity and reduce the associated variability in prices.[1] Well-developed credit markets and labor markets can also enable households to smooth consumption in the face of negative shocks. However credit and labor markets are often thin, particularly in rural areas (Eswaran and Kotwal).[2] Necessary conditions for integrated markets are well developed transportation and communication infrastructure. The construction and maintenance of such infrastructure is an on-going challenge in Madagascar, particularly in light of the geography and climatic conditions. Social infrastructure, like medical facilities, judicial courts, and agricultural and veterinarian facilities can also play an important role in the short-term amelioration of negative shocks to household well-being. Thus, commune market and social infrastructure can be important assets for protecting household well-being.

[1] On the other hand, well-integrated markets will transmit a greater portion of external price shocks to the local area households (Barrett and Dorosh).
[2] Although Udry (1995) provides evidence that functional credit markets can exist in rural sub-Saharan Africa.

Similarly, forward looking social protection strategies that assist households and communities to develop their asset bases can increase resilience to future shocks. In fact, household and commune assets play a crucial role in determining household relationships to two important concepts of poverty: chronic poverty and vulnerability to poverty. In this paper chronically poor households are defined as households with such low asset endowments that, given the their returns on assets, the household is expected to reside consistently below the poverty line. Vulnerable households face a significant probability of being poor in future periods due to their asset levels and exposure to shocks. [3]

A recent poverty assessment (World Bank) emphasizes the role that the low level of assets (including human capital), low returns, and high population pressure have in perpetuating chronic poverty. Even if household assets are sufficient to yield returns that would raise the household above the poverty line, covariate or idiosyncratic shocks may still make households vulnerable to future spells of poverty. The accrual of household assets may be an effective strategy to reduce households' long-term vulnerability to poverty. Physical and financial assets allow for self-insurance against consumption declines in the face of negative shocks, thus making households less vulnerable to poverty. However, physical and financial assets are unlikely to fully insure households against declines in consumption in the face of negative shocks, as they may be depleted in the face of multiple or repeated shocks. Similarly, human capital assets, by allowing household to better understand and respond to shocks, may reduce vulnerability to poverty (Schultz).

This paper provides an empirical vignette of the frequency and spatial distribution of commune level shocks in Madagascar and identifies the association between such shocks, community and household assets, and levels of economic well-being and chronic poverty.[4] The rest of the paper is structured as follows. The next section describes the data. Section 3 then examines the incidence of shocks (including bundling and spatial – temporal correlations) in Madagascar, while section 4 describes measures of market and social infrastructure and household assets that mediate or amplify shocks. Shocks and asset measures are then related to a per-capita expenditure measure of household well-being in section 5. The contributions of low asset bases and shocks to chronic poverty are examined in section 6. The empirical mapping of the shock – asset – well-being nexus is then used to makes recommendations for reducing both Malagasy household poverty and vulnerability to poverty in the concluding section.

2. Data

Study data come primarily from two sources. The 2001 ILO/Cornell Commune Level Survey provides information from key informants on the presence of commune level shocks from the weather and the environment, commune insecurity, and human disease over the three year period from 1998 to 2000. In Madagascar communes are the smallest administrative unit with direct representation from the central government. Rural communes may contain several villages. Each commune has an elected mayor and

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[3] The definitions of vulnerability to poverty and chronic poverty follow the general approach outlined in the literature (Chaudhuri, Chaudhuri and Christiaensen; Chaudhuri, Jalan and Suryahadi; Christiaensen and Subbarao; Dercon (2001); Heitzmann, Canagarajah and Siegel; Holzmann; and Holzmann, and Jorgensen) in which vulnerability is defined as the ex-ante probability of being poor in the next *n* periods and chronic poverty as the probability of always being poor. However, due to data constraints more emphasis is placed on expected outcomes based on the current level of endowments and exposure to shocks than on the dynamic aspect of well-being.

[4] Economic well-being is measured by per-capita consumption expenditures, recognizing that well-being has many other dimensions.

appointed central government representative. In 2001 there were approximately 1,390 communes, of which 1,385 were enumerated in the commune survey.

Information on household exposure to shocks comes from the 2001 Enquete Aupres Des Menages (EPM). The EPM is a comprehensive survey of 5,080 households conducted by the Madagascar Institut National de la Statistique. This study uses EPM data on household characteristics, employment and health related shocks, household asset holdings, and household per-capita expenditures. Descriptive statistics on household level variables are weighted based on survey weights to be nationally representative. Similarly, weighted least squares regression methods are used in the regression analysis in section 5 to adjust for both household weights and survey clusters in order to obtain unbiased parameter estimates and heteroskedasticity robust standard errors.

Some of the limitations of the data used in the study should also be explicitly noted. Most importantly, there is no panel component to the household dataset. This makes it impossible to document changes in individual household well-being and how such changes are related to exposure to shocks by the household. Instead, the analysis estimates the influence of shocks from the cross-sectional variation in household well-being. This reliance on cross-sectional variation gives rise to potential problems of unobserved heterogeneity, specifically the possibility that correlations between shocks and economic well-being are actually due to a third factor that is associated with both household economic well-being and presence of shocks. The reliance on cross-sectional data also prohibits the direct examination of the impact that household asset disbursement and accumulation strategies have on smoothing changes in household well-being over time. These issues will be addressed further in section 5.

The other major limitation of the data is the measure of shocks employed. Specifically, all commune level environmental and health shocks are measured based on recall from a key informant on whether the shock occurred in the commune during the previous calendar year. Such measures have several limitations. First, it is subjective and provides no indication of the intensity of the shock. For example, one key informant may feel that a drought occurred in the commune in the previous year, while another key informant in the same commune might feel that rainfall was not sufficiently feeble to be characterized as a drought. For future work, data with objective measures of the intensity of environmental shocks would greatly strengthen the analysis.

Second, the impact of shocks on households is likely to vary widely within communes. For example, flooding may have a devastating impact on the well-being of one household, while actually improving the well-being of another household by insuring adequate rainfall for agricultural production. Thus, the commune level data on shocks really provides an indicator of household propensities to experience shocks. Some commune-wide shocks like cyclones are likely to be widely felt, while others like indicators of human diseases in the commune probably only indicate a small increase in the propensity for specific households to experience the health shock. Future data collection efforts aimed at understanding the impact of shocks on household well-being need to also include some indicator of the intensity of shocks experienced by individual households.

These limitations do not, however, mean that associations drawn between measures of shocks in the current dataset and household economic well-being are not meaningful for the design of social protection policies. Subjective, commune-level, indicators of shocks are often the most common type of monitoring information available to social protection agencies. The analysis provides an indication of the strength of the association between such reports and the likelihood that households experience low levels of economic well-being and chronic poverty.

3. Major sources of shocks

The commune incidence, spatial scope, and temporal persistence of shocks are analyzed under four broad types: weather and the environment, social, health, and economic.

a. Weather and environment

Most households in Madagascar, particularly the 77 percent located in rural areas, are exposed to a wide array of weather and environment related shocks. Six climate related shocks, four plant diseases or pests, and six livestock diseases are examined under this heading. Table 1 presents the frequency of commune reported shocks, along with the estimated number of people in communes exposed to shocks and the correlation across years for each shock. Relatively few communes reported being impacted by a Cyclone in 2000 (7.1 percent). But the incidence of Cyclones is higher in the two previous years. As a result, only around 1.25 million people out of a total estimated population of around 15.5 million, live in communes hit by Cyclones in the year 2000. Cyclones and most other shocks also seem to be evenly distributed over high and low density population areas, as the commune incidence of shocks is roughly equal to the incidence of exposed persons in communes. Commune reports of Cyclones also show only a small correlation across years (also see table 1). Flooding and the closure of bridges and roads were more commonly reported shocks, with 28.5 and 32.5 percent of communes reporting exposure to these shocks, respectively, in 2000. Correspondingly, over 4.5 million people live in communes reporting impassible bridges and roads and 3.7 million live in communes reporting flooding. As with cyclones, both flooding and closure of bridges and roads appear to be less prevalent is 2000 than in previous years. Flooding and particularly the closure of bridges and roads show a much stronger correlation across years than do Cyclones, suggesting these shocks are recurrent problems in many communes.

Drought conditions were on the whole only slightly less prevalent than flooding, affecting over half of all the communes in the survey at some point in the three year period and communes with a total population of 3.3 million in 2000. Drought conditions also persist across years, with a correlation coefficient between 1999 and 2000 of 0.57. The late arrival of rain was a slightly more frequent commune level shock than drought, effecting over two-thirds of the communes at some point in the three year period. Pest and disease shocks to agriculture are also prevalent. Rice infestations are experienced by over one-third of communes in any year and are very persistent across years. Coffee rust displays a more limited overall incidence among all communes, but is very prevalent and persistent in coffee growing communes. Over half of the communes, containing almost 8 million persons, reported other phytosanitary problems in any year, again with a very strong persistence in commune level reports across years. Locusts showed a limited incidence in 2000, but were more prevalent in previous years. Livestock diseases (particularly Fasciolosis and Newcastles) are endemic to many areas. Over 81 percent of communes, containing 10.9 million people, reported Fasciolosis among cattle, while 87.6 percent reported outbreaks of Newcastles among poultry, and 61.5 percent reported Blackleg among sheep and goats. These livestock diseases also show a very strong persistence across years.

Factor analysis is undertaken on shocks in the year 2000 to explore the covariance structure.[5] The results (table 2) suggest that shocks are bundled into the three groups. Group one is plant and livestock

[5] Analysis of count data for shocks between 1998 and 2000 yielded similar results.

pests and diseases (rice pests, Locusts, Fasciolosis, Blackleg, and Anthrax). Group two is low rainfall events (drought and late rains). Note that shocks from plant diseases and pests are also correlated with low rainfall events, reflecting biotic stress. Group three is high rainfall events (cyclones, impassible bridges and roads, and flooding). However, only the first grouping has an Eigen value above 1.0; a common cut-off point in determining the importance of factor groupings. This suggests that there is only weak co-variation among shocks in the second and third factor groupings. Commune specific scores for the groupings are then generated based on factor loadings and the results are displayed in figure 2. Shocks from plants and livestock diseases and pests are most prevalent on the western side of the island. High rainfall events are most prevalent in the east central portion of the island, while low rainfall events are prevalent at the Northern and Southern tips, but also in the eastern – lower central portion of the island.

The magnitude of the spatial and temporal correlation of shocks, along with the correlation across types of shocks, is further explored by estimating the marginal effects on the probability of 2000 commune shocks from the incidence of the same type of shock in adjacent communes, the presence of the shock in the commune in the previous two years, and the presence of other types of shocks in the commune in the same year (see appendix table A1 for results).

For most shocks the incidence of the same shock in adjacent communes has a significant influence of the probability of the shock in the commune. However the magnitude of this influence varies widely by type of shock. Among shocks associated with high rainfall, a 10 percent increase in the incidence of impassible bridges or roads in adjacent communes results in a 4.3 percentage point increase in the probability of impassible bridges or roads in the commune. A similar increase in the incidence of adjacent communes with flooding results in a 4.0 percentage point increase to the probability of flooding in the commune. Interestingly, a 10 percent increase in the incidence of reported cyclones in adjacent communes has a much smaller (less than one percent increase in probability) influence on the probability of a cyclone in the commune. This suggests that the impact of cyclones, at least as recalled by key informants in the survey, is not widely felt among adjacent communes. Again, it is worth noting that only 7 percent of communes reported cyclones in 2000.

For shocks associated with low rainfall, a 10 percent increase in the incidence of drought in adjacent communes increases the probability of drought in the commune by 2.7 percentage points, while a similar increase in the incidence of late rain in adjacent communes increases the probability of late rain in the commune by 6.0 percentage points. Rice disease, locusts, Fasciolosis, Blackleg, Newcastles, and 'other livestock' diseases all show small marginal affects from increases in diseases in adjacent counties. But 'other plant diseases', Anthrax, and African Swine Fever all show marginal effects between two and four percent, with a ten percent increase in the shock in adjacent communes.

Consistent with the correlations results, many shocks also show very strong temporal persistence. For shocks associated with high rainfall, the presence of flooding in the commune in the previous year increases the reported probability of flooding in 2000 by 45.2 percentage points. Similarly flooding two years prior increases the probability of reported flooding in 2000 by 31.1 percentage points. Impassible bridges or roads and early rain show somewhat weaker temporal persistence, while the influence cyclones in the previous two years on reported cyclones in 2000 is very small. Among low rainfall events, a drought in the previous year increases the probability of a drought in 2000 by 28.9 percentage points, similarly late rain in the previous year increases the commune probability of late rain in 2000 by

30.3 percentage points. Temporal persistence is very high for most plant and livestock pests and diseases. For example reported rice disease in the previous year increases the probability of disease in the commune in 2000 by 56.7 percentage points and the presence two years prior increases the probability by 35.9 percentage points. For livestock diseases, the probability of the disease generally increases between 60 and 80 percent in 2000 with the reported presence of the same disease in the previous year. Estimated cross-shock effects largely confirm the results of the factor analysis. Large cross-shock effects are found within plant and livestock diseases. More moderate cross shock effects are found among shocks within high rainfall event and low rainfall event groups.

The spatial and temporal correlations among the shocks detailed above may put additional strains on household coping mechanisms. Spatial correlations reduce the efficacy of mutual assistance networks by spreading a common shock over a wide geographic area. Temporal correlations increase the probability a household will not be able to smooth consumption through precautionary savings or asset depletion. Households often show a greater loss of household well-being following the second year of a shock, when assets have been depleted (Dercon and Krishnan). An important factor for designing social protection strategies, the magnitude of the impact of various shocks on household well-being, has yet to be examined. But, spatial and temporal patterns may help guide social monitoring and protection strategies. For instance, shocks with broad spatial impacts like flooding and late rains are best mitigated through regional monitoring and assistance. Most plant and livestock diseases, on the other hand, have more site specific impacts that may require site specific monitoring and mitigation. It is also worth noting that some shocks, like Cyclones, receive significant news coverage, but actually impact relatively few households. Other shocks, like Newcastles among poultry are endemic to most communes and cause significant economic losses, but receive relatively little news coverage.

b. Social and political security

After the disputed presidential election in December 2001, Madagascar suffered from a serious social and political crisis. For six months, the country had two parallel governments, each with its own central bank and administration. Clashes between the two parties led to the destruction of key infrastructure, and claimed about a hundred of lives. Domestic instability also led to the isolation of the economy, freezing of Madagascar's assets abroad, a suspension of the foreign exchange trading and a closure of the T-bills market for several months. The lower bound estimate of the cost of the political crises alone rises to 11 percent of GDP and many public social services were also discontinued (CAS, 2002). The shock also had a powerful negative impact on employment and income. However, the current data pre-date the crisis and do not allow a detailed analysis of its impact.

Other indicators of insecurity can, however, be examined with the data. Criminal activities also add to the climate of insecurity on the island. In fact, Madagascar has established a 'Zone Rouge' (ZR) to delineate communes where criminal activity is particularly high. The commune census indicates that 29.9 percent of communes were in the ZR. This designation appears to be a good general predictor of both perceived levels of insecurity and crime statistics (table 3). Over 63 percent of communes in the ZR reported commune security to be bad or very bad and 44.2 percent indicated that security had declined in the past five years. For communes not in the ZR, only 12.8 percent reported bad or very bad security in the commune and 24.0 percent reported a decline in security in the last five years. Crime statistics appear to support these perceptions. Gunfights between gangs and security forces since independence were reported in 48.6 percent of ZR communes compared to 11.8 percent on non-ZR communes. Reported thefts of cattle, homes and shops ransacked, and murder rates per-capita were also much higher in the ZR. The ZR also tends to encompass communes in isolated areas. Fafchamps and Moser (2002) find that the incidence of criminal activity tends to increase with isolation, with cattle rustling being particularly endemic in some isolated regions. Fafchamp and Moser also suggest that crime statistics may be subject to significant reporting bias, as crimes are more likely to be reported in areas with greater police presence. These same areas are also likely to have higher levels of infrastructure and economic well-being.

Consistent with commune level assessments of high levels of insecurity, 49.8 percent of households reported security conditions to be bad or very bad. Again, perceptions of security are significantly worse in the ZR; where 62.6 percent of households reported security as being bad or very bad, versus 46.7 percent of households outside the ZR. These security concerns likely increase household vulnerability by increasing the risks associated with asset holding and, thereby, reducing asset holdings, particularly for large livestock.

c. Human Health

Madagascar faces serious human health concerns from Malaria, Tuberculosis, Typhoid, and Cholera. Over 90 percent of communes reported cases of Malaria in 2000 and 55 percent reported cases of Tuberculosis (table 4). Many communes also reported cases of Typhoid (30 percent) and Cholera (14 percent) in 2000. The human diseases show strong temporal persistence within communes. Malaria, Tuberculosis, and Typhoid all show intertemporal correlations in commune incidence of over .80 between 1999 and 2000. These diseases also appear to be spatially clustered. Malaria is present in almost all the communes on the island in every year. Tuberculosis is found in the western, southern, southeastern, and central parts of the island. Typhoid is largely limited to the western part of the island, particularly central and southern portions, while Cholera is found on the northern and southern tips, and southern portion of the west side of the island.

Person level incidences of illness or accidents in the previous two weeks are also reported in table 4. In the two weeks prior to the survey, 13.8 percent of all persons reported a sickness or accident. Fever was the most common reported ailment (6.6 percent). Interestingly, adults appear as impacted by sickness and disease as young children, with 15.2 percent of adults 16 to 65 years of age reporting an ailment versus 14.9 percent of children under 6. When person level illnesses are aggregated to the household level, however, the potential impact of illnesses is magnified, as 32.6 percent of all households are impacted by a sickness or accident. Again, fever is the most commonly reported ailment, affecting 20.1 percent of households. The data also indicate that the economic losses associated with illness and accidents may be significant. Over 37.1 percent of all persons reporting sickness or disease in last 2 weeks saw their activities interrupted (for on average of 5.1 days). Among adults age 16 to 65, 45.6 percent saw their activities interrupted (for on average of 5.2 days).

Finally, it is worth noting that no statistically significant association is found between health status of individuals in the previous two weeks and the previously generated aggregate health and environmental shock indices. This may be, in part, due to the short period of recall in the individual data and to the seasonality associated with the presence of most of the diseases identified in the commune data. But, as previously noted, commune level indicators may have a particularly weak impact on the propensities for households in the commune to actually experience a health shock.

d. Economic
Economy-wide shocks, regional economic shocks, and local economic shocks all influence household employment choices. The two datasets do not contain information on commune-level economic shocks. Employment status is, however, observed. Basic employment statistics are generated to document the potential importance of labor market shocks like unemployment and underemployment for persons 6 years of age and older, as well as by age cohort (table 5). The data reveal that, overall, 63.5 percent of people are working. As expected, this rate varies by age, rising from 26.3 percent among persons 6 to 15 years of age to 74.0 percent among those 16 to 25, and then peaking at 88.7 percent among those 26 to 50 years of age. Work rates then decline slightly to 83.3 percent among for those 51 to 55 and more rapidly to 58.6 percent among those 66 years of age old older.

The incidences of unemployment (0.9 percent overall) and persons temporarily not working (0.9 percent) are very low. Those not actively seeking to participate in the workforce (34.8 percent overall) represent the vast majority of persons not working. The major reason for not seeking to work is that the individual is a student, 66.6 percent overall. As expected, students as a percentage of those not seeking to work declines by age cohort; among those 6 to 15 years of age 82.4 percent are students, while among those 16 to 25 60.0 percent are students. Among those 26 to 50 years of age, 80.4 percent of those not seeking to work cite other reasons mostly related to labor market conditions. Persons 51 years of age and older cite being too old as the main reason for not seeking work. Overall, only a small share of people cite being handicapped as a reason for not working, but the share does rise with age and reaches 8.4 percent among those not working in the 51 to 65 years of age cohort.

The high labor market participation rates suggest that most individual, who are willing and able, do work. Labor market shocks associated with the loss of formal sector employment and frictional unemployment associated with the search for formal sector positions may not be a major concern. This does not, however, mean that the intensity of work and level of remuneration are satisfactory. Underemployment does appear to be a concern as 24.3 percent of households are without a full-time workers (1,750 hours per year), and 10.8 percent are without one full-time or two part-time (875 hours per year) workers.

4. Assets and Household Coping Mechanisms

As mentioned, households use both their own assets and commune assets to store wealth, buffer shocks, and reduce vulnerability to poverty. The households own assets include human capital and physical assets. Commune assets include social infrastructure like schools, health facilities, and courts to provide social services and transportation and communication infrastructure to support markets. These household and commune assets are described in this section. The association between physical asset sales and shocks is also explored.

Household assets
The most readily obtained measure of human capital is an individual's level of schooling. In Madagascar the average level of education in very low (table 6). Among persons 6 years of age and older, 24.9 percent are currently in school, 26.6 percent never attended school, 34.2 percent attended school up to the primary level, 12.8 percent attended up to the secondary school level, and only 1.5 percent attended up to the university level. Again, some variation in schooling is seen among age cohorts. Among children 6 to 15 years of age, 27.0 percent have never attended school. This high level

of children having never attended school is in part due to the late entrance of some children to school, as the average age of entrance among those enrolled was 5.8 years. However, the portion of individual 16 to 25 years of age who never attended school is only slightly lower at 23.6 percent. Similarly, 24.0 percent of individual 26 to 50 years of age never attended school. Thus, roughly one-quarter of individuals in their prime working years have no formal education. As expected, the portion of individuals with no formal education increases rapidly for the oldest age cohorts (37.8 percent for those 51 to 65 and 49.4 percent for those 66 years of age and older.

Also as expected, school attendance drops by age cohort. In the 16 to 25 age cohort, only 15.4 percent of individual are still in school. This is because most people do not continue education beyond the primary level. For instance, in the 26 to 50 years of age cohort, 46.6 percent had attended primary school, but only 25.7 percent had attended secondary school, and 3.5 percent had attended a university. Thus, even among those who have been exposed to formal education, the majority do not go beyond primary school. In fact 21.3 percent of household have no member 16 years of ages or older who has attended and completed some level of formal schooling. The returns that households can expect to receive on schooling, in terms of increased per-capital expenditures, will be explored in the next section. Gender differences in educational attainment are smaller than might be expected. Overall, 25.1 percent of males and 28.1 percent of females six years of age or older never attended school. The average age of initial attendance of school also varies only slightly by gender, with males entering at 5.8 years of age on average and females at 5.9 years of age. The variance of the distribution of first year of attendance does, however, appear to be slightly higher for females than for males. Females are also slightly less likely to currently be in school and more likely to leave school during the primary grades.

Almost all households (96.8 percent) have also accumulated physical assets like land, houses, durable goods, and livestock that have some value. The average estimated total per-capita value of physical assets is 1,267,476 Fmg. This is roughly one-quarter more than the average per-capita expenditures of a household per annum. The variance in the distribution of asset holdings is also quite large. Land is an important household asset (with 58.4 percent owning rice land and 60.3 percent owning other land), but sales of land are a very rare in Madagascar. In fact, only two percent of those that own land have sold any amount in the last 10 years. There are several reasons for this, including the facts that most people do not have a legal title. Thus, land is unlikely to be a useful household asset for consumption smoothing in the face of shocks.

Livestock holding represent 40.9 percent of total per-capita asset holding. Large herds of cattle and to a lesser extent goats, sheep, and poultry represent ways to save and store wealth for households. However, the previously outlined diseases and security concerns suggest that households face significant risks in these holding. Sales of livestock assets are also a significant source of revenue for households. Sales of cattle contribute to 169,000 Fmg per capita per annum on average to household income, while goats and sheep, hog, and poultry sales contribute 203,000 Fmg, 122,000 Fmg, and 21,000 Fmg, respectively.

Use of household transfers and livestock assets to cope with shocks

Private transfers also represent an important source of income and a smoothing mechanism for many households in Madagascar, with about 23 percent of the households receiving transfers in a year. These households receive, on average, 227,000 Fmg per capita per year, of which almost 90 percent is in the form of cash.

Receipt of transfers and sale of livestock assets may be important mechanisms to mitigate the impacts of negative shocks on household economic well-being. Table 7 provides correlation coefficients between household exposure to major commune level shocks and the level of transfer received, as well as correlations between shocks and the sale of various types of livestock. Correlations that are statistically significant at the *p=0.05* level are presented in bold type. The level of transfers received by the family shows small negative, but statistically significant, correlations with impassible bridges and roads, flooding, rice pests, severe heat, and the livestock disease index. This suggests that there is a slight tendency for households to receive small levels of transfers in the face of these shocks. On the other hand, all commune level shocks, except impassible bridges and roads, show a significant positive correlation with household sale of cattle. Many shocks also show positive, but usually smaller, correlations with the sale of poultry and of sheep and goats. Thus, the sale of livestock, particularly cattle, appears to be an important strategy for households to cope with commune level shocks. Better-off households are the most likely to own livestock, thus they are also more likely to be able to maintain consumption in the face of shocks. Poorer households, by contrast, generally have fewer livestock assets with which to mitigate shocks.

Commune level assets
Social service infrastructure varies significantly across communes (see appendix table A2). While 98.2 percent of communes have a health center, only 25.3 percent have a hospital. Similarly, secondary schools are found in most communes (77.4 percent), but only 30.7 percent of communes contain a Lycee. Judicial courts are found in only 14.9 percent of communes, while agricultural extension and veterinary centers are found in 42.3 and 45.2 percent of communes, respectively. A social infrastructure index for the presence of these institutions in the commune is generated based on factor analysis (table A2). The index suggests that there is significant correlation in the location of these social institutions. A map of the index shows that social infrastructure is concentrated in the central portion of the island and in urbanized areas (figure 3).

A similar set of descriptive statistics are provided for measures of market infrastructure in appendix table A3. Transportation infrastructure is perhaps the most important component of market infrastructure. Many areas have little transportation infrastructure. Approximately one-third of the communes are serviced by a national road; 40.8 percent are serviced by a provincial road; 27.8 percent require travel by foot to enter the commune. Carts never or rarely pass through 37.5 percent of the communes and trucks never or rarely pass through 38.1 percent. Perhaps most striking, the average travel time to a central urban place is 26.6 hours.

Market institutions are also sparse in many communes; as only 29.2 percent of communes have a seasonal market. Similarly, 29.2 percent have a livestock market. Wholesalers are found in only 12.3 percent of the communes and storage facilities are found in only 19.4 percent of the communes. The average distance to a daily market is 3.4 kilometers and the average distance to a market for agricultural inputs is 6.2 kilometers. Accessible credit markets can be a very important market institution for smoothing household negative income shocks. But, as mentioned, credit markets are often thin or missing in many parts of Africa. This also appears to be the case in Madagascar. Only 7.5 percent of communes report having a formal bank, 20.5 percent report having a saving society, and 5.3 percent reported having a development project that included the provision of credit as a component. Household knowledge of, and access to, credit appears to be similarly low. Almost half (46.0 percent) of households did not know of a credit establishment and 53.1 percent reported that no credit establishments operated in the Fivondronana. Similarly, only 7.5 percent had ever demanded credit from an establishment or person.

A market infrastructure index is generated based on factor analysis of the presence of markets institutions and the transportation access measures (table A3). Like the social infrastructure index, the market index suggests that there is significant correlation in the location of specific market and transport infrastructure assets. Figure 3 also provides a map of the index and shows that market infrastructure is concentrated in the central portion of the island and in urbanized areas.

The correlation between the market infrastructure and social infrastructure indexes is also very high (0.80), suggesting market and social infrastructure also tends to be located in the same communes. Cluster analysis is performed on the data using the discrete indicators for market and social infrastructure. Two clusters, high infrastructure (=1) and low infrastructure (=2) are estimated. Figure 2, again, provides a map of cluster locations. While 42.6 percent of communes are grouped in the low infrastructure cluster, population density in these communes is relatively low and only 22.5 percent of the population is estimated to live in the low infrastructure cluster.

5. Outcomes

In this section we first examine the distribution of household well-being, as measure by per-capita expenditure. Household and commune shocks and assets are then related to per-capita expenditure in a multivariate regression. Per-capita expenditure regressions are also run separately for households in the high and low infrastructure clusters. The results of these regressions are used to decompose large infrastructure cluster differences in household per-capita expenditures into the portions associated with cross-sectional differences in exposure to shocks, differences in asset levels, and differences associated with the relationship (parameter estimates) between shocks and assets and per-capita expenditures.

Per-capita expenditure

The mean per-capita expenditure level of Madagascar households is 980,774 Fmg.[6] The distribution, however, has an extended upper-tail and the median income is 629,700 Fmg. This median is below the per-capita poverty line of 990,404.6 FMG per year, leaving 69.9 percent of the population in households classified as poor. Figure 4 presents the distribution of the log of per-capita expenditures, with the log of the poverty line indicated by the vertical line.

Average per-capita expenditures vary notably in the high and low infrastructure communes identified by the cluster analysis. For households in the high infrastructure cluster the mean and median per-capita expenditures are 1,102,983 Fmg and 707,007 Fmg, respectively. The corresponding poverty rate in the high infrastructure cluster is 64.6 percent. For households in the low infrastructure cluster per-capita expenditures are very low, with mean and median per-capita expenditure levels of 560,759 Fmg and 445,446 Fmg, respectively. The corresponding poverty rate in the low infrastructure cluster is 87.9 percent. The distributions of household per-capita expenditures in high and low infrastructure clusters are also shown in figure 4.

[6] These are person-weighted household estimates.

Determinants of per-capita expenditure

In order to understand the associations of shocks and assets with per-capita expenditures, the log of per-capita expenditures is regressed on the indicators of the previously discussed major commune level shocks in 2000; a bridge or road that became impassible, a cyclone, a flood, a drought, rice infestation, and an index for the presence of major livestock diseases (fl1). Discrete measures of household involvement in agricultural and livestock (cattle and pig) production are also included in the regression, as these households may show different base levels of economic well-being. Households involved in agricultural production may also be differentially impacted by weather related shocks. Thus, interaction terms for households in agricultural activities and flooding (agflood) and drought (agdrought) are also included in the specification.

Measures of reported theft of cattle per-capita (pczebu) and burglary of shops and homes per-capita are included as measures of commune insecurity. The number of commune cattle per-capita (commcattpc) is also included in the per-capita expenditure equation, both as a measure of community wealth and to control for the fact that cattle theft is likely to be more rampant in cattle abundant communes. Commune level health shocks are measured by the reported presence of tuberculosis (tuber), typhoid, and cholera in the commune in 2000.[7] Commune social and market infrastructure assets are captured through the previously documented social infrastructure (socindex) and market infrastructure (tranindex) indexes. Measures of household asset also included in the per-capita expenditure regression are; an indicator for if the household has no member working, an indicator for if the household has no member working full-time, number of family members 16 years of age and older with primary, secondary, university, or no education by gender, total household size, and indicators for residence in a rural area and a secondary urban center (with a primary urban center as the base).

The per-capita expenditure regression results are reported in table 8. Most of the parameter estimates for environmental shocks are not statistically significant. However, a reported impassible bridge or road is associated with a 12 percent decrease in household economic well-being and a one standard deviation increase in the livestock disease index is associated with an 8 percent decrease in well-being.[8] Again, care must be taken in inferring that these shocks directly cause decreases in household economic well-being. A third unobserved factor that is related to both the shock and declines in economic well-being can not be ruled out without panel data observations of household well-being before and after the shock. For example, households with lower levels of economic well-being may be clustered in areas where bridges and roads are poor maintained. These bridges and roads are, in turn, more susceptible to becoming impassible due to flooding. The results for cyclones provide another good example. A reported cyclone in 2000 is associated with a 25 percent increase in economic well-being. It is, however, unlikely that cyclones actually increase household economic well-being. On further examination, cyclone activity in 2000 appears to have been concentrated in the relatively well-off center portion of the island. Flooding and drought are found to have no significant association with household well-being, even among those engaged in agricultural production. Even without a structural estimation of the causative association between shocks and changes in household economic well-being due to data deficiencies, the results are useful for the targeting of social assistance programs. The reported presence of shocks like impassible bridges and roads following flooding and the presence of livestock diseases indicate that households in the commune are likely to have low levels of economic well-being, while

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[7] The reported presence of malaria is excluded because it is endemic to most communes.

[8] For discrete variables the percent change is exp(*B*)-1.

other commune shocks are not a good indicator of the presence of households with low levels of economic well-being.

Turning to measures of commune level insecurity, both per-capita cattle theft and burglary measures also have positive and statistically significant coefficients. This result suggests, somewhat counter-intuitively, that even after controlling for the number of livestock (cattle and pigs) per-capita, higher levels of crime are associated with higher levels of household economic well-being. When analyzing crime statistics in Madagascar, Fafchamps and Moser (2002) find a similarly counter-intuitive result that higher numbers of law enforcement personnel are associated with higher rates of crime. They attribute this relationship to reporting bias in criminal activity, i.e., crime is much more likely to be reported in areas with law enforcement personnel. Similarly, the observed positive relationship between crimes and economic well-being may arise because law enforcement personnel are located in relatively well-off communes and criminals may be more likely to operate in these areas. Again, the result suggests that reported crime rates are not particularly useful for identifying households with low levels of per-capita expenditures. As expected, higher levels of cattle per-capita are also associated with high levels of per-capita expenditure. For human health shocks, indicators of the presence of major diseases in all communes all have negative parameter estimates, with Typhoid significant at the $p=0.10$ level.

In terms of community assets, both the social infrastructure and the market and transport infrastructure index estimates have positive and statistically significant parameter estimates at the $p=0.10$ and $p=0.05$ levels, respectively. The parameter estimates suggest that one standard deviation increases in the social and transport infrastructure indexes are associated with increases in household economic well-being of 7 percent and 11 percent, respectively.

Household levels measures generally show strong associations with household per-capita expenditures. While having no employed adult in the household does not show a significant association with per-capita expenditure, having underemployed adults (no member working full-time and no two members working part-time) is associated with a 25 percent decrease in per-capita expenditures. Household human capital assets show a particularly strong association with household well-being. The quadratic specification of household size suggests that per-capita expenditures decrease with household size, but at a decreasing rate. Female and male adults 16 years of age or older with no formal education and female adults with primary education have no additional impact on education, beyond the impact of reducing per-capita expenditures as additional family members. An additional male with a primary school education increases per-capita expenditures by only 3 percent, while additional female and male adults in the family with secondary school education are associated with approximately 22 percent and 19 percent increases in per-capita expenditures, respectively. University education has an even larger impact. An additional adult female family member with a college education results is associated with 47 percent increase in per-capita expenditure, while an additional male is associated with a 64 percent increase.

Even after controlling for human capital, community assets, and commune level shocks, households involved in agricultural activities still show markedly lower (36 percent) per-capita expenditures, while households involved in livestock production show 17 percent higher expenditures. Households located in secondary urban areas show 13 percent lower per-capita expenditures than those in primary urban areas, after controlling other variables. On the other hand, the parameter estimate for the rural areas indicator is not significant. This is somewhat surprising given the significantly lower mean per-capita expenditure levels found in rural areas. But most rural households are involved in agricultural activities and this may account for the gap. Next we estimate separate per-capita expenditure regressions for low and high infrastructure clusters in order to understand the nature of the per-capita expenditure gap in these areas (table 8). Specifically, how much of the gap is due to differences in exposure to environmental, health, and security shocks and how much is due to differences in household assets.

An F-test indicates that the parameter estimates of the low and high infrastructure cluster equations are, as a group, significantly different. Several differences in the parameter estimates of specific variables are also worth noting. Impassible bridges and roads have a very large negative (34 percent) association with per-capita expenditures in the low infrastructure cluster and a more moderate negative (15 percent) association in the high infrastructure cluster. Cyclones have an extremely large positive association with per-capita expenditures in the low-infrastructure cluster, again this may be due to the presence of cyclones in a few relatively well-off remote communes in 2000. On the other hand, the livestock disease index is found to have a significant negative association only in the high infrastructure cluster. The positive association between burglaries per capita and economic well-being is now found to hold only in the high infrastructure cluster. Again, this is consistent with the suspected reporting bias of crimes in areas with higher levels of police presence and economic well-being.

The large negative impact of household involvement in agriculture is also concentrated in the high infrastructure cluster, which in not surprising since nearly all households in the low infrastructure cluster are involved in agriculture. Livestock production, on the other hand, has a positive impact on per-capita expenditures in both the low and high infrastructure clusters. Underemployment, while significant in both clusters, has a larger negative impact in the high infrastructure cluster. It is also worth noting that the return on male adults secondary and higher levels of education is lower in the low infrastructure cluster than in the high infrastructure cluster, while returns on females secondary and higher levels of education is actually lower in the high infrastructure cluster.[9] The intercept terms also suggest that base levels of well-being are much lower in the low infrastructure cluster.

The low – high infrastructure cluster per-capita expenditure gap is decomposed under two different sequences in table 9. The first sequence starts with low infrastructure cluster average per-capita expenditures and the second starts with high infrastructure per-capita expenditure. For each sequence the decomposition then has five components. The first component is the difference associated with low and high infrastructure cluster regression parameter estimates. Starting in sequence one with low infrastructure cluster parameters and means and then substituting high infrastructure cluster parameter estimates explains 25.5 percent of the low – high infrastructure cluster gap in per-capita expenditures, while under the second sequence substituting low infrastructure cluster parameters for high infrastructure parameters explains 78.4 percent of the gap. Thus, parameter differences as a whole explain a significant share of the observed gap in per-capita expenditures in the two clusters.

The second component of the decomposition then transposes cluster means for the incidence of environmental shocks. The results show that neither replacing low infrastructure cluster means with high infrastructure cluster means under sequence one nor replacing high infrastructure cluster means with low infrastructure cluster means under sequence two contributes to the observed gap in cluster per-

[9] Note, a separate indicator for university education is not included because no males in the data possess a university education in the low infrastructure cluster.

capita expenditures. A similar result holds for the third component of the decomposition that transposes the incidence of major human diseases in the two clusters.

The fourth component in the first sequence replaces the high incidence of household involvement in agriculture in the low infrastructure cluster with the lower incidence of involvement in agriculture in the high infrastructure cluster. This substitution explains 23.5 percent of the observed per-capita expenditure gap. However, under the second sequence the substitution of high infrastructure cluster for low infrastructure cluster household involvement in agriculture has no impact on the gap. The different results from the two sequences stems from the fact that the evaluation in the second sequence is based on low infrastructure parameter estimates for household involvement in agriculture, which are close to zero. The final component of the decomposition substitutes household employment and education asset means. In this case, the two decomposition sequences yield a similar result; employment and educational asset differences account for about 40 percent of the observed gap in economic well-being in the low and high infrastructure clusters. Thus, a good portion of higher per-capita expenditures in high infrastructure zones appear to stem from both higher levels of, and returns to, household assets.

6. Poverty Simulations

General poverty rates are predicted using the per-capita expenditure regression parameters in table 8. The predicted rate of persons in households below the poverty line is 75.7 percent, higher than the measured rate of 69.9 percent in the sample. This difference in the predicted and measured rates stems from the facts that the mean level of per-capita expenditures is well below the poverty line and that the regression has a natural tendency to predict towards the mean. In other words, the unexplained variation of the per-capita regression actually reduces poverty because, with such a high overall rate of poverty, many of the households with observed per-capita expenditure above the poverty line have expected per-capita expenditures below the poverty line.[10] As mentioned in the introduction, households that are expected to consistently fall below the poverty line given their situation and assets are termed chronically poor.

Poverty rates are also predicted separately for low and high infrastructure clusters using the low and high infrastructure expenditure regression equations reported in table 8. In the low infrastructure cluster 95.2 percent of persons are in households where predicted per-capita expenditures fall below the poverty line (table 9). In other words, living in the low infrastructure cluster almost guarantees that the household resides in chronic poverty. By contrast, the high infrastructure cluster shows a predicted rate of poverty that is roughly equal the observed rate for the island as a whole (69.3 percent).

The impacts of cross-sectional variations in environmental and health shocks, as well as education levels and intensity of employment, on household predicted poverty status are then simulated for the high and low infrastructure clusters. The first simulation sets environmental and health shocks to zero for all communes. The results in table 10 indicate that reducing environmental and negative human health shocks in affected communes is likely to result in a moderate reduction in chronic poverty in the high infrastructure cluster, but have no impact on chronic poverty in the low infrastructure cluster. Thus, cross-sectional differences in economic well-being associated with variations in commune environmental and human health shocks explain little of the observed differences in poverty status in

[10] Assumptions of homoskedastic and symmetric error terms maintained.

low and high infrastructure clusters.[11] The separate impact of giving all adults 16 to 65 some primary school education is then simulated. The simulated increase in education has little impact on predicted poverty in either the high or low infrastructure clusters due to the fact that for both males and females the returns on some primary school education in terms of increased per-capita expenditures are not very different from the returns to a household of adults with no education. Thus, ensuring at least some schooling among the total population is unlikely to influence the high rates of chronic poverty.

Ensuring attendance of secondary school, on the other hand, is likely to have a major impact. If all adults are given some secondary school education the rate of chronic poverty drops dramatically to 35 percent in the high infrastructure cluster.[12] The impact in the low infrastructure cluster of ensuring all adults attended secondary school is still large, but less dramatic, as the rate of chronic poverty drops to 60 percent. This difference in the impact that secondary education has on predicted poverty in low and high infrastructure clusters is due, in part, to lower returns on male secondary education in the low infrastructure cluster. However, adult females actually see a higher return on secondary education in the low infrastructure cluster. Also contributing to the difference is the fact that most households in the low infrastructure cluster lie farther away from the poverty line. Thus, a similar percentage increase in per-capita expenditures is more likely to leave low infrastructure cluster households below the poverty line than high infrastructure cluster households. A separate simulation also examines the impact on chronic poverty of eliminating underemployment. As with the simulation of universal primary education, the elimination of underemployment has little impact on predicted poverty rates in either the low or high infrastructure clusters.

The three separate simulated changes in environmental and health shocks, secondary education, and employment are then combined. This combined simulation also shows a markedly different impact on high and low infrastructure zones. The combination of remediating environmental and health shocks, assuming universal attendance of secondary school, and eliminating underemployment generates a very low predicted poverty rate of 20 percent in the high infrastructure zone. However, in the low infrastructure zone the same combination yields a predicted poverty rate of 58 percent. Thus even after controlling for cross-sectional variations in commune level environmental and human health shocks and markedly improving education levels, most households in the low infrastructure zone remain chronically poor. The final set of simulations examines the role that low returns on assets plays in the high rates of chronic poverty in the low infrastructure cluster. Specifically, the predicted rate of poverty for the low infrastructure cluster is calculated when households' assets and shocks in the cluster are combined with high infrastructure cluster per-capita expenditures regression parameters for the same asset and shock variables. The results indicate that these generally higher rates of returns on assets would result in a small reduction in the rate of predicted poverty to 93 percent. However, when the same regression parameter transformation is applied to household shocks and assets from the combined simulation of eliminating environmental and health shocks, assuming universal attendance of secondary school, and eliminating underemployment, then the rate of predicted poverty appears to decline markedly to 32 percent. Thus, given the very low level of per-capita expenditures found in most households in the low infrastructure cluster, a combination of marked improvement in household asset bases and structural

[11] Again, simulation results are based on the assumption that cross-sectional variations are indicative of the changes in economic well-being that can be expected from reductions in shocks.
[12] This assumes that such a massive increase in secondary school education levels would not lower the return on this level of schooling.

improvement in the returns that household can receive on those assets will be required to bring most household out of chronic poverty.

7. Conclusions and Policy Implications

Both a commune level census and a household survey are used to explore the frequency, spatial distribution, and temporal persistence of commune level shocks and their association with household well-being and chronic poverty. Given the availability of only one round of household data and the lack of information on the intensity of shocks at the household level, the analysis remains subject to all of the standard limitations associated with the inference of factors influencing economic well-being from cross-sectional data.

Despite these deficiencies, several important implications for targeting and ameliorating poverty in Madagascar can be drawn. First, many shocks, particularly environmental shocks, do not show the significant association with economic well-being that might be initially expected. This may be in part due to the previously discussed deficiencies in the survey measures of commune shocks. However, many shocks like cyclones and drought, that are likely to receive significant media attention, appear to impact relatively few households. Other shocks like many livestock diseases receive far less attention, but are more widely spread across communes containing a far greater share of the population. Efforts to mitigate these less dramatic shocks are likely to result in greater aggregate gains in household economic well-being. Another reason that some shocks may show insignificant impacts on household well-being is that households use livestock asset sales to smooth per-capita expenditures in the face of shocks. Such self-insurance strategies against shocks have notable limitations however. As household assets are depleted through such sales, household vulnerability to poverty in the face of future shocks is increased. Further, livestock and particularly cattle are disproportionately owned by wealthier households. Thus, the poorest households are the least likely to have access to this form of self-insurance and are more vulnerable to consumption shortfalls in the face of negative shocks.

Second, for targeting purposes low levels of social infrastructure and market and transport infrastructure can be clearly linked to low levels of economic well-being. In the low infrastructure cluster almost the entire population is exposed to chronic poverty. Further, the analysis of chronic poverty in low infrastructure clusters reveals that neither dramatic increases in household asset bases or increasing returns on assets to levels found in high infrastructure areas are by themselves likely to move a significant share of these households out of chronic poverty. Thus, a combination of initiatives aimed at building assets and increasing structural returns on assets is required. On the other hand, the isolation (and insulation) of these low infrastructure communes appears to also reduce the impact that negative commune level shocks have on household well-being. Communes in the low infrastructure cluster, by definition, currently have little in the way of social service infrastructure and market and transport infrastructure to be disrupted by environmental shocks, and this may mute the impact of shocks.

Recommendations for reducing endemic chronic poverty in the low infrastructure clusters are hard to specify. It is easy to recommend public investments to transform communes in these clusters into high infrastructure communes, particularly through investments in market infrastructure that show a strong positive association with economic well-being. But these are remote communes with low population densities; such infrastructure investment may not be economically feasible or justifiable, given that less than 30 percent of the chronically poor live in the low infrastructure cluster. Isolated and insulated, most low infrastructure communes appear to be in a low level equilibrium, with little public infrastructure, low levels of household assets, and low returns on those assets. Still, most communes do have primary and secondary schools. Efforts to increase primary and secondary school access and retention may be warranted, but the rate of return on education needs to be increased for it to be profitable for households to make educational investments through secondary school and then for young adults with secondary school education to remain in the commune. In terms of delivery of social assistance, the high rate of chronic poverty in the low infrastructure cluster suggests that minimal effort need be devoted to screening potential aid recipients to exclude the non-poor, since this is effectively done by the geographic isolation of these very poor households.

Even though chronic poverty rates are significantly lower in the high infrastructure cluster than in the low infrastructure cluster, over 70 percent of persons in chronically poor households live in the high infrastructure cluster. Given the relative accessibility of these areas and their large shares of chronically poor, targeted efforts to reduce environmental shocks and increase asset bases may have particularly cost effective impacts on chronic poverty. On the other hand, lower rates of chronic poverty suggest that social protection programs in the high infrastructure cluster will need mechanisms to exclude non-poor from receiving benefits. The high infrastructure cluster also shows particular scope for reducing chronic poverty through investments in household assets due to the higher estimated return on these assets. Efforts are needed to foster continued investments in household assets, particularly secondary education which shows a high rate of return in terms of increased per-capita expenditure.

Two areas for further data collection and research come to light from the current analysis. First, the commune and household level surveys contain little information on social protection mechanisms that are in place to assist poor households. The spatial distribution of chronically poor households could, however, be compared to a future analysis of the spatial distribution of government and (as available) NGO expenditures on social protection mechanisms in order to better target assistance. Second, as noted, future data collection efforts need to include more information on household exposure to shocks in order to better map the relationship between the intensity of household exposure and household economic well-being. It is also tempting to suggest that Madagascar also implement a panel survey in order to better document household responses to shocks and to formally establish linkages between those responses and vulnerability to poverty. Panel data surveys are, however, very difficult to conduct effectively. Such a recommendation should be reviewed within the context of Madagascar's existing priority needs for socio-economic data and the current capacity for data collection.

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Table 1: Incidence of covariate shocks reported by communes

Shock	Incidence by commune				Number of persons affected	Commune Correlation across years		
	2000	1999	1998	Any	2000	2000/ 1999	1999/ 1998	2000/ 1998
Cyclone	7.08	26.23	29.55	46.68	1,266,093	0.25	0.17	0.20
Impassable bridge or road	32.51	42.85	42.34	52.89	4,612,081	0.70	0.67	0.65
Flooding	28.54	44.51	43.42	61.27	3,721,745	0.52	0.46	0.42
Early rain	13.58	17.12	10.62	28.03	2,206,863	0.47	0.54	0.49
Drought	24.87	38.54	41.40	54.41	3,337,916	0.57	0.51	0.51
Late rain	33.53	49.93	52.53	69.65	4,700,424	0.48	0.42	0.40
Severe heat	8.74	16.84	17.77	25.87	1,553,000	0.51	0.51	0.46
Forte attaque de poux- Rice	34.54	38.80	40.39	45.56	4,423,433	0.84	0.81	0.78
Forte attaque de rouille - Coffee	8.67	8.74	8.96	9.89	1,530,382	0.93	0.93	0.91
Other plant disease	54.99	57.66	56.94	61.66	7,964,317	0.88	0.88	0.84
Locusts	8.53	22.40	47.47	54.84	1,357,253	0.58	0.38	0.32
Distomatose/fasciolose (bovin)	81.23	83.83	84.19	85.99	10,857,785	0.89	0.87	0.85
Charbon bacteridien (beary)	40.07	43.68	43.39	47.80	5,204,652	0.87	0.88	0.83
Charbon symptomatique (besoroka)	61.52	65.99	65.92	72.06	7,745,466	0.82	0.80	0.75
Swine flu	44.62	60.22	59.28	70.04	6,628,051	0.63	0.65	0.59
Newcastles	87.65	89.82	90.61	91.55	12,883,310	0.85	0.89	0.80
Other livestock disease	23.83	23.75	22.38	27.00	4,327,099	0.88	0.89	0.85

Table 2: Factor analysis of commune level shocks - Rotated factor loadings for 2000 shocks

Variable	**Factor 1**	**Factor 2**	**Factor 3**	**Uniqueness**
Cyclone	-0.01	-0.02	**0.47**	0.77
Impassable bridge or road	-0.02	0.00	**0.51**	0.72
Flooding	0.09	0.17	**0.34**	0.79
Early rain	0.04	0.08	0.14	0.90
Drought	0.06	**0.51**	0.03	0.67
Late rain	0.01	**0.53**	-0.05	0.66
Severe heat	0.09	0.08	**0.27**	0.85
Rice pests	**0.34**	**0.38**	0.12	0.65
Coffee rust	0.00	**0.32**	0.12	0.81
Other plant disease	**0.25**	**0.30**	0.15	0.73
Locusts	0.19	**0.27**	-0.04	0.81
Distomatose/fasciolose (bovin)	**0.39**	0.04	0.04	0.82
Charbon bacteridien (beary)	**0.57**	0.03	0.01	0.66
Charbon symptomatique (besoroka)	**0.57**	0.09	-0.03	0.62
Swineflu	**0.27**	-0.17	0.10	0.81
Newcastles	**0.22**	-0.12	0.09	0.86
Other livestock disease	**0.22**	0.04	0.05	0.92

Table 3: Perceptions of commune security and crime statistics

	Communes in "Zone Rouge"	Communes not in "Zone Rouge"	Total
Portion of communes reporting (percent)			
Poor Security	63.5	12.8	27.9
Deteriorating security in last 5 years	44.2	24.0	30.0
Post-impendence Gunfights with Gangs	48.6	11.8	22.8
*Crime Statistics (per-capita*1,000)*			
Cattle stolen	26.0	2.7	9.6
Homes or shops	0.3	0.3	0.3
Murders	0.1	0.0	0.1
Percentage of Communes	29.9	70.1	100.0

Table 4: Human diseases

	in 2000 (%)	Anytime in 1998-2000(%)	Correlation 2000 -1999	Correlation 1999 – 1998	Correlation 2000 -1998
Communes reporting					
Malaria	91.3	93.4	0.88	0.88	0.80
Tuberculosis	54.6	632	0.81	0.81	0.80
Typhiod	29.8	38.4	0.81	0.84	0.79
Cholera	14.1	33.6	0.44	0.34	0.24
Fever	7.5	15.5	0.64	0.66	0.63
Persons reporting	(%)	(%)			
Fever	6.61	20.1			
Diarrhea	1.57	5.74			
Mouth/eye infection	1.45	4.61			
Accident	0.85	2.31			
Other	3.28	10.78			
Cost of sickness/disease					
All persons					
Percent with activities interrupted	37.13				
Average number of days	5.10				
Adults 16 through 65					
Percent with activities interrupted	45.57				
Average number of days	5.22				

Table 5: Basic employment statistics

	Worked 1+ hours last 7 days	Not employed did not search in last month	Reason for not employed and not searching			
			Student	Too old	Handicapped	Other
Individuals	(%)		(%)			
All 6+	63.5	34.76	66.56	5.84	2.28	25.32
6 to 15	26.28	72.86	82.39	0	1.29	16.26
16 to 25	73.97	23.17	59.99	1.4	2.72	37.16
26 to 50	88.65	9.39	3.25	10.73	5.61	80.4
51 to 65	83.28	15.5	0.29	71.52	8.44	19.75
66+	58.55	41.08	3.71	79.95	5.84	10.5

	All Households
Average total hours worked per year	2021
Average number of household full-time workers (1,750 hours per year)	1.64
Average number of household part-time workers (875 hours per year)	0.71
Percent of households without full-time worker	24.32
Percent without 1 full-time or 2 part-time workers	10.84

Table 6: Education levels by age cohort and gender

	Never attended	Currently in school	Out of school, last attended		
			Primary	Secondary	University
Age cohort					
All	26.62	24.87	34.19	12.84	1.48
6 to 15	27.04	60.35	12.38	0.23	0.00
16 to 25	23.64	15.43	46.47	13.75	0.71
26 to 50	24.04	0.24	46.56	25.68	3.47
51 to 65	37.84	0.00	44.53	15.21	2.42
66+	49.43	0.86	40.91	8.03	0.76
Gender					
Male	25.13	25.59	33.74	13.56	1.98
Female	28.06	24.18	34.62	12.14	1.00

Table 7: Correlation of transfers and sale of livestock assets with commune level shocks

Variable	Transfers	Sales of livestock: Cattle	Pigs	Poultry	Sheep & Goats	Other
Cyclone	-0.014	**0.041**	0.012	**0.033**	0.012	-0.003
Impassable bridge or road	**-0.028**	-0.004	0.013	0.027	-0.020	-0.009
Flooding	**-0.052**	**0.063**	0.009	**0.053**	0.020	-0.007
Drought	-0.023	**0.074**	-0.009	**0.069**	**0.095**	0.000
Rice pests	**-0.070**	**0.096**	0.013	**0.036**	0.015	-0.010
Severe heat	**-0.039**	**0.165**	0.006	**0.055**	**0.102**	-0.004
Locusts	0.016	**0.073**	**-0.028**	-0.014	**0.032**	-0.008
Late rain	-0.024	**0.085**	**-0.028**	**0.056**	**0.067**	-0.012
Early rain	-0.013	**0.038**	0.009	0.015	0.013	-0.006
Livestock disease index	**-0.067**	**0.065**	0.022	**0.037**	**0.037**	-0.019

Note: Bold indicates statistical significance at the $p=0.05$ level.

Table 8: Log per-capita expenditure regressions

	All		Low Infrastructure		High Infrastructure	
Variable	Coeff. Est.	Std. Err.	Coeff. Est.	Std. Err.	Coeff. Est.	Std. Err.
Commune bridge or roads impassible	-0.125	0.068 *	-0.412	0.147 ***	-0.167	0.073 **
Commune hit by cyclone	0.225	0.103 **	0.696	0.257 **	0.188	0.127
Commune hit by flooding	-0.040	0.096	-0.198	0.152	0.046	0.081
Flood & household in agriculture	0.009	0.108				
Commune hit by drought	-0.016	0.102	-0.018	0.114	-0.077	0.082
Drought household in agriculture	-0.050	0.105				
Commune hit by rice pests	0.044	0.060	0.124	0.097	0.022	0.067
Commune index of livestock diseases	-0.080	0.035 **	0.066	0.068	-0.145	0.040 ***
Commune cattle per-capita	0.122	0.054 **	0.456	0.122 ***	0.077	0.061
Commune theft of cattle	0.001	0.000 ***	-0.001	0.001	-0.002	0.004
Per-capita ransacking of houses/shops	0.131	0.057 **	-0.054	0.093	0.179	0.068 ***
Tuberculosis reported in commune	-0.041	0.064	-0.258	0.099 **	-0.015	0.071
Typhiod reported in commune	-0.096	0.056 *	-0.082	0.131	-0.090	0.061
Cholera reported in commune	-0.066	0.071	0.156	0.270	0.013	0.064
Social infrastructure index	0.066	0.041 *				
Transportation infrastructure index	0.109	0.050 **				
Household involved in agriculture	-0.443	0.067 ***	-0.069	0.119	-0.550	0.056 ***
Household has cattle or pigs	0.159	0.040 ***	0.168	0.062 ***	0.129	0.047 ***
No employed member of household	-0.103	0.070	-0.112	0.111	-0.067	0.085
Underemployed household members	-0.225	0.051 ***	-0.176	0.092 *	-0.253	0.061 ***
Number of members 16+ years of age:						
male with primary school	0.033	0.019 *	0.011	0.045	0.037	0.022 *
male with secondary school	0.192	0.040 ***				
male with university	0.640	0.062 ***				
male with secondary or university			0.142	0.102	0.255	0.040 ***
male with no education	0.020	0.027	-0.026	0.045	0.006	0.027
female with primary school	0.011	0.021	0.021	0.034	-0.012	0.025
female with secondary school	0.222	0.027 ***				
female with university	0.471	0.051 ***				
female with secondary or university			0.382	0.087 ***	0.246	0.029 ***
female with no education	-0.034	0.026	-0.039	0.040	-0.055	0.039
Total household size	-0.237	0.017 ***	-0.241	0.038 ***	-0.235	0.020 ***
$Size^2$	0.009	0.001 ***	0.011	0.003 ***	0.009	0.002 ***
Secondary urban area (=1)	-0.121	0.069 *				
Rural (=1)	0.015	0.117				
Constant	14.465	0.128 ***	14.041	0.202 ***	14.698	0.089 ***
Number of observations	5078		558		4520	
R^2	0.527		0.440		0.487	

Table 9: Low and high infrastructure cluster per-capita expenditure decompositions

	log(per-capita expenditure)	Share of gap (%)
Mean low infrastructure cluster	13.03	
Add:		
High infrastructure parameter estimates	13.16	25.5
High infrastructure environmental shocks	13.17	2.0
High infrastructure health shocks	13.17	0.0
High infrastructure involvement in ag. and livestock	13.29	23.5
High infrastructure employment and education	13.49	39.2
Mean high infrastructure cluster	13.54	
Add:		
Low infrastructure parameter estimates	13.14	78.4
Low infrastructure environmental shocks	13.17	-5.9
Low infrastructure health shocks	13.20	-5.9
Low infrastructure involvement in ag. and livestock	13.20	0.0
Low infrastructure employment and education	12.99	41.2

Table 10: Simulated poverty rates in low and high infrastructure cluster

	High	Low
Measured base	64.3	87.9
Predicted base	69.3	95.2
Variable changes		
Environmental and health shocks set to zero	62.0	96.7
All adults (16 to 65) have some primary education	68.6	93.5
All adults have some secondary education	34.8	60.3
No underemployed households	68.7	95.0
Combined	19.7	58.3
- environmental and health shocks set to zero		
- all adults have some secondary education		
- no underemployed households		
Parameter changes		
Low infrastructure clusters have high cluster returns on assets and shocks		93.4
Combined variable changes and high cluster returns on assets and shocks		32.2

Figures

Figure 1: Link between shocks, market and public infrastructure, household assets and vulnerability

Risks and Shocks	**Mediated/ amplified through**	**Impacts**
	Static	
- Environmental & climatic - Human health & Social - Economic - Price - Employment	- Market infrastructure - Public infrastructure - Social protection mechanisms - Assets o Human capital o Physical	- Household well-being - Consumption level - Level of assets and reserves
	Dynamic	
- spatial correlation - temporal correlation - bundling	- Infrastructure and social protection investment - Consumption smoothing o Asset savings/ dis-savings	- Vulnerability

Figure 2: Livestock and Plant Disease, High Rainfall Events and Low Rainfall Events

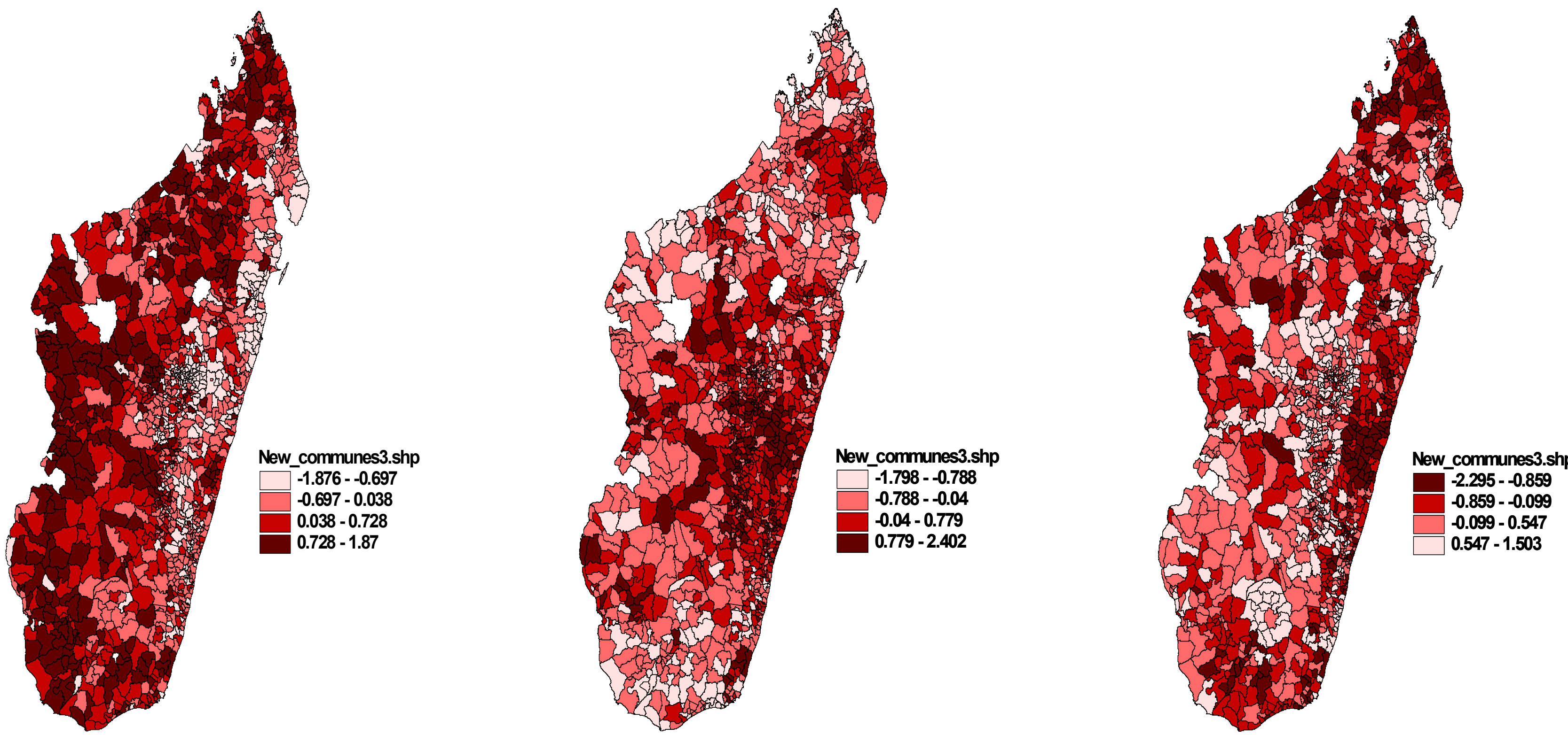


Figure 3: Index for infrastructures. Social Infrastructure index, Market and Transport Index and High and low Infrastructures

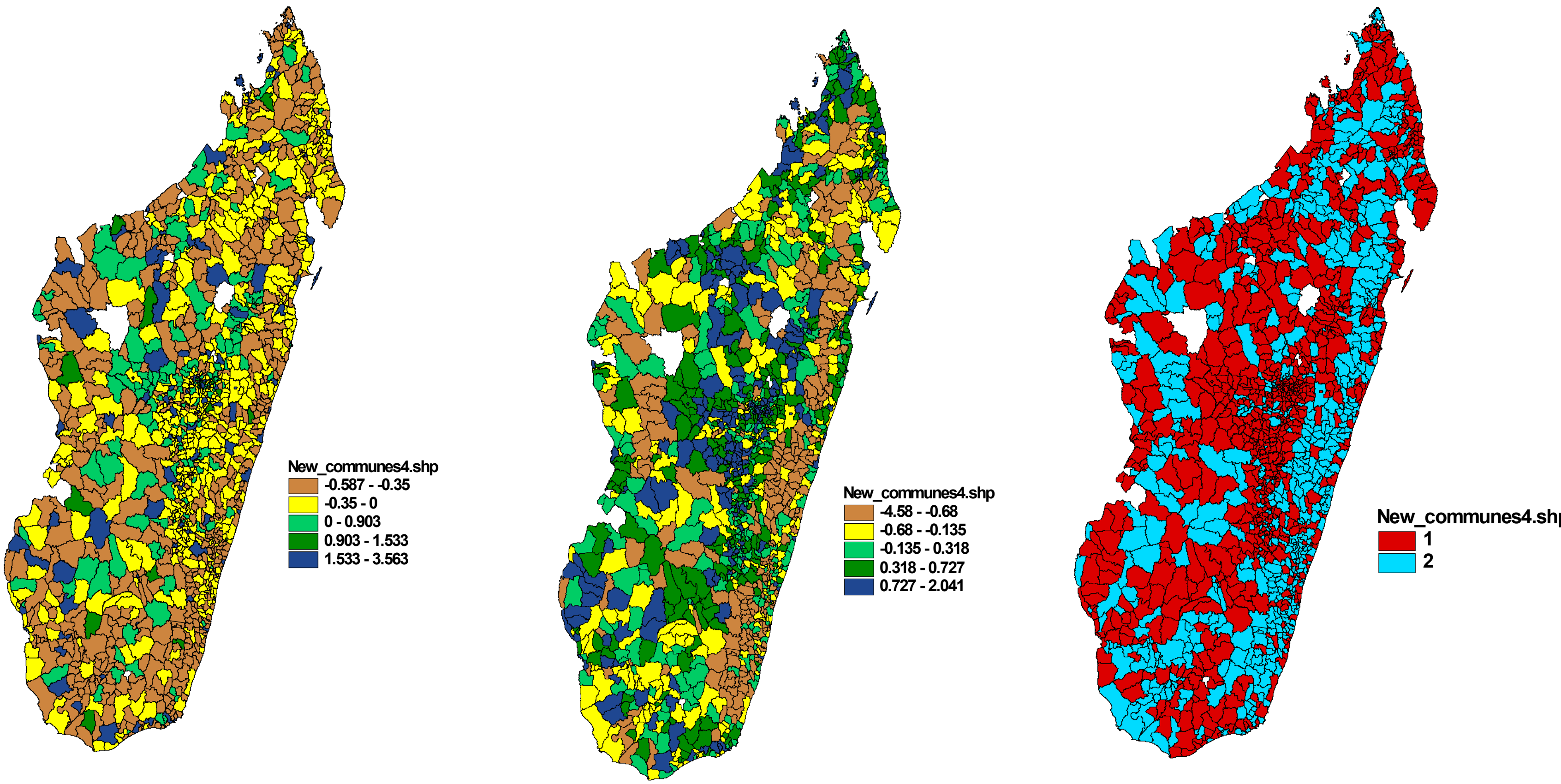
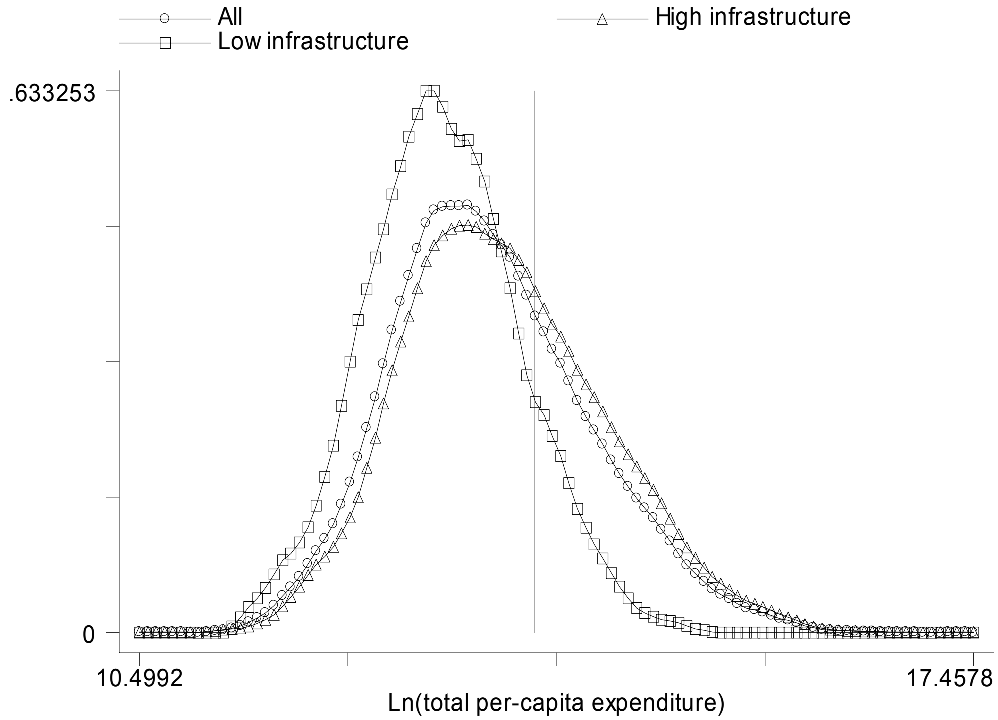


Figure 4: Distribution of per-capita expenditure in low and high infrastructure communes



Appendix

Table A1: Marginal effects from probit models for spatial scope and temporal persistence of shocks

Variable	Cyclone		Impassible Bridge or Road		Flooding		Early rain		Drought		Late rain	
Own shock effects	Marginal Effect	Standard Error	Marginal Effect	Standard Error	Marginal Effect	Standard Error	Marginal Effect	Standard Error	Marginal Effect	Standard Error	Marginal Effect	Standard Error
Incidence in adjacent communes	0.090	0.023	0.426	0.047	0.405	0.056	0.291	0.041	0.272	0.042	0.597	0.053
Presence previous year (1999)	0.042	0.014	0.318	0.029	0.452	0.035	0.179	0.034	0.289	0.031	0.303	0.030
Presence two years ago (1998)	0.048	0.013	0.203	0.030	0.311	0.038	0.164	0.042	0.217	0.030	0.216	0.031
Other shocks in same year												
Cyclone			0.463	0.068	0.137	0.072	0.064	0.042	-0.005	0.043	-0.014	0.060
Impassable bridge or road	0.082	0.017			0.262	0.042	0.026	0.021	0.048	0.029	0.001	0.035
Flooding	0.022	0.010	0.179	0.031			0.031	0.019	0.051	0.026	0.046	0.034
Early rain	0.022	0.015	0.044	0.040	0.056	0.046			0.020	0.033	-0.164	0.031
Drought	0.007	0.011	-0.009	0.033	0.033	0.038	0.000	0.021			0.247	0.039
Late rain	-0.007	0.008	-0.040	0.029	-0.017	0.033	-0.063	0.017	0.228	0.031		
Severe heat	0.032	0.019	0.112	0.054	0.025	0.057	0.025	0.033	0.047	0.045	0.013	0.056
Rice pests	0.000	0.009	-0.066	0.028	0.020	0.034	0.012	0.020	-0.001	0.025	0.090	0.036
Coffee rust	-0.013	0.008	0.035	0.050	-0.016	0.050	0.034	0.034	-0.018	0.035	0.090	0.059
Other plant disease	0.003	0.008	0.015	0.028	-0.010	0.032	0.008	0.018	0.015	0.024	-0.038	0.032
Locusts	-0.002	0.014	0.057	0.063	0.107	0.066	0.025	0.033	0.077	0.046	0.114	0.063
Distomatose/fasciolose (bovin)	0.006	0.009	-0.090	0.037	-0.083	0.046	-0.011	0.024	0.030	0.028	0.042	0.037
Charbon bacteridien (beary)	-0.003	0.008	0.019	0.030	-0.015	0.033	-0.020	0.019	-0.052	0.024	-0.041	0.034
Charbon symptomatique (besoroka)	-0.018	0.010	-0.016	0.030	0.049	0.033	0.011	0.019	0.040	0.025	-0.036	0.035
Swineflu	0.013	0.008	0.017	0.026	-0.037	0.030	-0.019	0.018	-0.014	0.023	0.012	0.031
Newcastles	-0.007	0.014	0.070	0.035	-0.034	0.046	0.000	0.025	-0.028	0.035	-0.036	0.047
Other livestock disease	0.017	0.011	0.030	0.032	0.039	0.036	-0.011	0.019	-0.044	0.023	0.009	0.036

Table A1: Marginal effects from probit models for spatial scope and temporal persistence of shocks (Continued)

Variable	Severe heat		Rice disease		Coffee disease		plant disease		Locusts		Distomatose	
	Marginal Effect	Standard Error	Marginal Effect	Standard Error	Marginal Effect	Standard Error	Marginal Effect	Standard Error	Marginal Effect	Standard Error	Marginal Effect	Standard Error
Own shock effects												
Incidence in adjacent communes	0.070	0.022	0.196	0.060	-0.014	0.014	0.324	0.093	0.092	0.022	0.165	0.053
Presence previous year (1999)	0.155	0.033	0.567	0.043	0.586	0.172	0.710	0.041	0.145	0.026	0.814	0.065
Presence two years ago (1998)	0.101	0.026	0.359	0.047	0.204	0.118	0.535	0.054	0.001	0.006	0.532	0.096
Other shocks in same year												
Cyclone	0.037	0.025	0.043	0.080	-0.004	0.005	-0.051	0.103	0.005	0.013	0.069	0.027
Impassable bridge or road	0.022	0.012	-0.039	0.039	0.005	0.007	0.046	0.060	0.008	0.009	-0.010	0.031
Flooding	0.016	0.010	0.061	0.038	0.005	0.007	-0.019	0.057	0.001	0.006	-0.012	0.029
Early rain	0.014	0.016	-0.010	0.046	0.000	0.007	0.022	0.075	0.012	0.010	0.019	0.036
Drought	0.015	0.012	0.048	0.044	-0.003	0.005	0.131	0.065	0.017	0.009	-0.024	0.036
Late rain	-0.009	0.009	0.094	0.041	0.008	0.008	0.138	0.059	0.011	0.008	0.036	0.028
Severe heat			0.119	0.075	0.007	0.015	0.143	0.087	0.024	0.016	-0.039	0.055
Rice pests	-0.007	0.008			0.009	0.008	0.242	0.053	0.027	0.010	-0.021	0.032
Coffee rust	-0.015	0.009	0.109	0.075			0.098	0.096	-0.013	0.005	-0.053	0.054
Other plant disease	0.020	0.009	0.120	0.034	0.006	0.006			0.000	0.006	0.010	0.028
Locusts	0.074	0.033	0.129	0.073	-0.001	0.008	0.029	0.104			0.062	0.031
Distomatose/fasciolose (bovin)	-0.011	0.013	0.001	0.049	0.009	0.005	0.012	0.068	0.009	0.006		
Charbon bacteridien (beary)	0.010	0.010	-0.013	0.037	0.000	0.005	-0.048	0.057	0.004	0.007	0.043	0.029
Charbon symptomatique (besoroka)	-0.001	0.009	0.039	0.038	-0.008	0.007	-0.067	0.058	0.000	0.007	0.102	0.034
Swineflu	0.005	0.008	-0.003	0.035	-0.005	0.005	-0.017	0.053	-0.006	0.006	0.009	0.026
Newcastles	-0.014	0.016	0.015	0.050	0.001	0.006	0.159	0.072	0.004	0.007	0.077	0.048
Other livestock disease	-0.001	0.009	-0.019	0.037	-0.006	0.004	-0.033	0.057	0.004	0.007	-0.003	0.031

Table A1: Marginal effects from probit models for spatial scope and temporal persistence of shocks (Continued 2)

Variable	Beary		Besoroka		Swineflu		Newcastles		O. Livestock Disease	
	Marginal Effect	Standard Error	Marginal Effect	Standard Error	Marginal Effect	Standard Error	Marginal Effect	Standard Error	Marginal Effect	Standard Error
Own shock effects										
Province level incidence	0.135	0.074	0.324	0.073	0.436	0.060	0.081	0.030	0.077	0.058
Presence in previous year (1999)	0.690	0.041	0.654	0.040	0.476	0.031	0.690	0.096	0.644	0.059
Presence two years ago (1998)	0.355	0.059	0.345	0.053	0.337	0.036	0.256	0.100	0.441	0.074
Other shocks in same year										
Cyclone	-0.063	0.076	-0.103	0.089	0.079	0.073	0.013	0.019	0.008	0.053
Impassable bridge or road	0.009	0.049	-0.024	0.048	-0.041	0.039	0.015	0.012	0.037	0.035
Flooding	-0.028	0.044	0.086	0.044	0.015	0.039	0.005	0.013	-0.017	0.031
Early rain	-0.030	0.057	0.012	0.059	-0.024	0.052	-0.011	0.019	-0.010	0.039
Drought	-0.096	0.047	-0.023	0.054	-0.021	0.043	-0.011	0.017	-0.002	0.036
Late rain	0.005	0.050	0.083	0.048	0.060	0.041	0.031	0.012	0.020	0.034
Severe heat	0.015	0.072	-0.074	0.075	-0.059	0.057	-0.026	0.031	0.122	0.062
Rice pests	-0.044	0.047	-0.010	0.050	0.005	0.041	-0.002	0.014	0.050	0.036
Coffee rust	0.050	0.077	-0.026	0.076	0.010	0.065	-0.019	0.026	0.026	0.057
Other plant disease	0.045	0.044	0.059	0.043	-0.023	0.037	0.017	0.013	-0.014	0.031
Locusts	0.105	0.089	0.013	0.087	0.002	0.068	0.027	0.013	0.030	0.059
Distomatose/fasciolose (bovin)	0.104	0.048	0.159	0.056	0.076	0.043	0.008	0.015	-0.001	0.039
Charbon bacteridien (beary)			0.207	0.041	0.049	0.040	0.002	0.013	-0.039	0.030
Charbon symptomatique (besoroka)	0.146	0.043			0.110	0.038	0.029	0.016	0.031	0.031
Swineflu	0.040	0.043	0.069	0.042			0.058	0.013	0.054	0.029
Newcastles	0.190	0.041	0.104	0.063	0.196	0.044			-0.011	0.045
Other livestock disease	0.027	0.049	0.003	0.048	0.065	0.040	-0.040	0.020		

Table A2: Availability and factor analysis for social infrastructure

Variable	Percent of communes with	Rotated Factor Loadings Factor 1	Uniqueness
Hospital	25.30	**0.8105**	0.3053
Clinic	98.19	0.0977	0.9546
Secondary school	77.39	**0.4171**	0.7220
Lycee	30.71	**0.8051**	0.3145
Court	14.87	**0.5763**	0.6230
Agric. Extension	42.33	**0.4867**	0.6708
Veterinarian center	45.18	**0.6604**	0.5198

Table A3: Availability and factor analysis for market infrastructure

Variable	Percent of communes	Rotated Factor Loadings Factor 1	Uniqueness
National road	33.79	**0.4778**	0.7717
Province road	40.79	0.3311	0.8904
Seasonal market	29.24	0.1372	0.9812
Cattle market	29.17	0.2160	0.9534
Wholesalers	12.27	**0.4437**	0.8031
Processor	42.02	**0.4752**	0.7742
Storage facility	19.42	0.2469	0.9390
Slaughter facility	7.36	0.3529	0.8755
Foot travel required	27.80	**-0.5409**	0.7074
Carts pass through commune		0.3309	0.8905
Never	26.35		
Rarely	11.12		
Seasonally	3.90		
Always	58.63		
Trucks pass through commune		**0.6247**	0.6097
Never	19.64		
Rarely	18.48		
Seasonally	15.81		
Always	46.06		
	Hours		
Time to central urban place	26.56	-0.3601	0.8703
	Kilometers		
Distance to daily market	3.36	**-0.5640**	0.6819
Distance to ag. input market	6.22	**-0.5929**	0.6485