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The impact of agricultural shocks on households growth performance in rural Madagascar

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THE IMPACT OF AGRICULTURAL SHOCKS ON HOUSEHOLDS GROWTH PERFORMANCE IN RURAL MADAGASCAR

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ABSTRACT

This paper tests if agricultural and climatic shocks have persistent impacts on consumption growth in 7 rural areas from Madagascar.
The empirical framework is inspired by a standard Solow growth model. Shocks are introduced directly in the reduced form model as controls for factor productivity and investment level. This model is estimated on a panel of 6175 households observed each year between 1999 and 2004. Fixed effects are introduces to control for unobserved heterogeneity. We use idiosyncratic shocks on agricultural fields due to plant illness or predators and a covariate climatic shock measured by village rainfall deviations from long term means. Growth is measured by consumption growth. We use household total consumption, household per capita consumption, household total food consumption and household per capita food consumption.
Estimation results indicate that covariate (rainfall) and idiosyncratic shocks on rice fields have persistent impacts on growth whereas idiosyncratic shocks on other crops than rice have no persistent impact. These average impacts are however not the same along income distribution. Estimation by income quintile shows that idiosyncratic shocks decrease future growth of poor household whereas rich household growth performance is protected against idiosyncratic shocks. Surprisingly, covariate shocks have persistent impact on rich household consumption growth but not on poor household consumption growth.

Keywords: risk, poverty, growth, insurance

RESUME

Cet article teste si les chocs agricoles et climatiques négatifs ont un effet persistant sur la croissance de la consommation des ménages dans 7 observatoires du Réseau des Observatoires Ruraux (ROR) à Madagascar. Autrement dit, on examine si un choc négatif sur la production agricole réduit les performances de croissance futures des ménages.
Un modèle de croissance néo-classique de type Solow est mobilisé afin de spécifier la relation entre croissance de la consommation, caractéristiques du ménage et chocs. Ce modèle est estimé sous forme réduite sur un panel de 6175 ménages malgaches interrogés chaque année de 1999 à 2004. L'introduction d'effets fixes permet de contrôler pour l'hétérogénéité non observée. Les chocs sont introduits directement dans l'équation comme des variables qui déterminent la productivité des facteurs et le niveau d'investissement. Les chocs étudiés comprennent des chocs idiosyncratiques sur les cultures tels que les maladies des plantes et les destructions par des prédateurs et un choc climatique covarié mesuré par les déviations des précipitations par rapport à leurs moyennes de long terme village par village. Quatre agrégats sont utilisés pour mesurer la croissance : la croissance de la consommation totale du ménage, la croissance de la consommation par tête, la croissance de la consommation alimentaire totale du ménage et la croissance de la consommation alimentaire par tête.
Les résultats d'estimation indiquent que les chocs covariés (précipitations) et les chocs idiosyncratiques sur les parcelles de riz réduisent durablement la croissance des ménages. Par contre, les chocs idiosyncratiques sur les autres cultures (maïs, tubercules, autres) n'ont pas d'impact persistant sur la croissance de la consommation. Ces effets moyens ne sont cependant pas homogènes sur toute la distribution des revenus des ménages. Les estimations réalisées par quintile de revenus montrant que les chocs idiosyncratiques ont un impact négatif persistant sur la croissance de la consommation des ménages pauvres tandis que les riches semblent protégés. De manière étonnante, les chocs covariés (précipitations) ont un impact persistent sur la croissance des ménages les plus riches mais pas sur celle des plus pauvres.

Mots-clés : risque, pauvreté, croissance, assurance

JEL Code: O12, D90, R20, Q12

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1 Introduction

High exposure to risk is a constraint often faced by households in developing countries that could explain part of the gap in growth between developing and developed countries. It has been observed that probability of crop failure, price volatility and morbidity are higher in the rural African context than elsewhere (Collier and Gunning, 1999). Moreover, the combination of a high proportion of covariate risk and remotness prevents the emergence of insurance so that households are not well protected against risk. Increasing evidence attests from the cost of risk in term of efficiency and growth performance at both household and agregate levels (Rosenzweig and Binswanger, 1993; Collier and Gunning, 1999; Morduch, 1999; Dercon, 2004).

The causality between risk and low growth however is not straightforward. At the household level, the impact of risk on household growth performance is largely linked to the available risk management strategies. Risk management strategies are usually divided in two groups as proposed by Alderman and Paxson (1992). We distinguish between *ex post* and *ex ante* strategies. *Ex post* strategies are taking place after the shock happens. It involves mobilizing savings, selling assets, receiving transfers from formal or informal insurance or other organizations, borrowing from credit market, shifting labour to other activities. On the opposite, *ex ante* risk management strategies are engaged before the shock happens. They include revenue diversification and technology choices. *Ex post* strategies may often need *ex ante* planning. It is the case for assets that need to be accumulated or mutual insurance for which households must organize a network beforehand.

In developing countries, the choice of strategies is limited. Most of the time, neither formal insurance nor credit markets are available, especially for the poorest households. Remaining strategies may hinder growth and accumulation. Reducing risk exposure through diversification and production or technology choices *ex ante* usually implies the choice of low risk and low return activities. Non profitable production choices driven by the fear of risk may keep households in poverty. Dercon and Christiaensen (2007) show, for instance, that the fear of a defavorable shock prevents Ethiopian rural households from using fertilizer. Reducing risk *ex ante* is often made necessary by the limited access to *ex post* strategies, especially for the poor. Poor households who have very few assets are basically left, *ex post*, with selling productive assets, shifting labour or withdrawing children from school. Using the same database as the one used for this paper, Gubert and Robilliard (2008) show, for example, that child labour is used as a risk coping strategy in Madagascar. Likewise, loss or selling of productive assets like animals or land to maintain consumption above an acceptable level hinders further the productive capacity of households. From these examples, we can see the causality between risk and poverty persistence. Uninsured risks and shocks are likely to have persistent effect on household's welfare growth, especially for poorer households. It may thus contribute to poverty persistence.

In this paper, we aim to test for the persistent effect of risk on growth at the household level. We use a Solow-inspired reduced form econometric model of growth where we introduce shocks directly as proposed by Dercon (2004). In other words, we study persistence by testing if past shocks still have an impact on current growth rate when we control for welfare level and household characteristics whatever the underlying mechanism is.

This model is tested on panel data coming from surveys carried out in rural Madagascar between 1999 and 2004. Madagascar is an obvious settings for studying the impacts of shocks on poverty. Malagasy households are indeed confronted with many different types of shocks, especially in rural areas. Farm households are subject to production risks, both covariate risks (e.g., typhoons, drought, flooding) and idiosyncratic risks (e.g., farm specific crop and livestock damages by diseases and predators) in a context where credit and insurance are missing. For example, half of rural Malagasy household have declared damages linked to environnement and climate in 2004 and 2005 (INSTAT, 2005). Types of shocks vary across regions of Madagascar. For example, typhoons are more prominent in the Eastern regions whereas droughts are more frequent in the Southern regions.

This paper has two main contributions. First, it studies consumption growth at the household level using an exceptionally rich panel database of Malagasy rural households observed from 1999 to 2004. The study of growth in living standards using household-level data is not that common. Growth models have been tested against data mainly through cross-countries regressions. These cross-countries analyses are not fully satisfying because their results are often subjected to econometric and data problems (Ravallion, 2001; Rodriguez and Rodrik, 2001). Moreover, studying distributionnal issues at agregate country level is not really informative. The relevance of cross-countries evidence for policy formulation is thus limited. Investigating the determinants of growth at household level is more promising. Second, the paper quantifies the impact of shocks on consumption growth at the household level. The relation between shocks and poverty is well established in the literature (Dercon, 2005) but the quantification of the relation between shocks and welfare growth itself is seldom available. In particular, few papers study persistent effects of risk on growth performance at the household level. Empirical quantification of this relation are found in Elbers, Gunning, and Kinsey (2003) and Dercon (2004)'s work. Elbers and Gunning (2003) use simulation-based econometric methodology to estimate the structural form of a micro model of household investment decisions under risk. They find that risk has a negative effect on asset accumulation: the mean capital stock of Zimbabwean sampled households is 46 percent lower than in the absence of risk . Dercon (2004) uses a reduced form econometric approach to show that lagged rainfall has a significant impact on current growth rate and that famine severity in 1984-85 is also a determinant of growth rate in the nineties in rural Ethiopia. This paper draws largely from Dercon's 2004 work.

The following section describes the empirical framework. Section 3 elaborates on data and empirical specification. Section 4 presents the results from regressions and section 5 discusses the findings.

2 Empirical Framework

To put some structure in the empirical analysis, we borrow the empirical framework proposed by Dercon (2004). This framework is inspired by the Solow (1956) growth model and its development with human capital accumulation like in Mankiw, Romer, and Weil (1992). In this type of model, sources of growth in per capita output are technological progress and capital accumulation. Technological progress is assumed to rise at a constant exogeneous rate. When this parameter is fixed, growth level thus depends on capital accumulation determined by investment level and factor productivity, i.e., the production function, given population growth rate and capital depreciation rate. The key assumption in this model is the decreasing marginal return to factors accumulation so that growth rate is even slower since we are close to the steady state. A testable implication of this model is given in an equation where consumption growth rate is associated to an initial level of consumption and a number of variables that determine total factor productivity and the steady state including investment in physical and human capital. In the context of panel data of per capita income c of H households h , the growth rate from period *t-1* to t can be written as follows:

$$\ln c_{ht} - \ln c_{ht-1} = \alpha + \beta \ln c_{ht-1} + \delta x_{ht} \tag{1}$$

where c_{ht} is household income per capita, α is a common source of growth across households, x_{ht} is a vector of time varying household characteristics. According to this theoritical framework, these variables determine investment in human and physical capital and factor productivity. This empirical model can be used as a starting point to investigate a set of questions.

A standard question in growth empirical analysis is whether convergence in per capita living standards exists between countries. At the household level, this question translates into the following one: do incomes of the poor households grow as fast as those of the rich households after controlling for variables that determine the steady state? In other words, we examine if the growth rate is roughly what is predicted once differences in investment rate and productivity are accounted for. A negative estimate for β would suggest convergence. To go further, we can disaggregate the consumption at *t-1* between the village average consumption at *t-1* and the difference between this average and the household consumption level as in equation (2), with the v subscript standing for the village:

$$\ln c_{ht} - \ln c_{ht-1} = \alpha + \beta_1(\ln c_{ht-1} - \ln c_{vt-1}) + \beta_2 \ln c_{vt-1} + \delta x_{ht} \tag{2}$$

If β_1 is not equal to β_2, it would imply that convergence between villages and between households in a village occur at different speed.

Shocks have *a priori* no explicit role to play in this formulation. Often, shocks are accounted for by introducing a stationary error term in the regression. Dercon (2004) argues that this approach is short of accounting for neither persistence nor the accumulation of shocks. As mentioned in the introduction, it is most likely that uninsured shocks have a structural effect on the behavior of poor households. If we assume that a multiplicative risk affects the technological parameter of the implicit Cobb-Douglas technology in the Solow model, it is then possible to introduce shocks directly in the specification after linearization. To evaluate persistence in the impact of shocks on consumption growth, we introduce contemporaneous and lagged shocks on growth rate in the growth model as follows:

$$\ln c_{ht} - \ln c_{ht-1} = \alpha + \beta_1(\ln c_{ht-1} - \ln c_{vt-1}) + \beta_2 \ln c_{vt-1} + \delta x_{ht} + \theta_0 s_{ht} + \theta_1 s_{ht-1} \tag{3}$$

with s_{ht} and s_{ht-1} the intensity of the shock in period t and $t-1$ respectively. If past shocks matter for current growth, it indicates persistent effect of shocks.

3 Data and Empirical Specification

The database is assembled from annual surveys conducted by the *Réseau des Observatoires Ruraux* (ROR) in several rural areas of Madagascar. The ROR is a joint project of the Malagasy National Statistical Institute (INSTAT) and the Institut de Recherche pour le Développement (IRD). This data collection scheme is specific from Madagscar. It was experimented in 1995 in four areas by the MAdagascar, Dial[1],INSTAT, Orstom[2](MADIO) project and extended in 1999. The ROR runs annual surveys on a panel of about 500 rural households. In 1999, 13 areas were part of ROR, 17 in 2000 and 2001, 15 in 2002 and 2003, and 14 en 2004. These areas are not randomly selected but are chosen to illustrate different facets of the Malagasy rural economy. The household sample is thus not statistically representative of the country. The areas strongly differ from each other in terms of soil quality, rainfall pattern and population density. Within each area, households are randomly chosen from an exhaustive list. Households that have moved or are unwilling to be interviewed are substituted by new households with similar characteristics from the same area. The annual survey collects data on household housing, socio-demographics, education, income sources, agricultural production (landholding, crops, husbandry, farm technology, inputs, stocks), expenditures in food as well as non-food items and agro-climatic shocks. A panel of rural households from 1999 to now is thus available. A common methodology of sampling, survey methodology, training of pollsters and supervisors and data inputting is used in the different areas. Data inputing and treatment are administered at the ROR headquarter in Antananarivo. Data obtained thus allow to make comparisons between areas from the whole country. This feature make this database unique and very useful to follow poverty and living conditions for a long period of time and in a wide range of agro-geographic conditions, at least compared with what is usually available in developping countries. In this paper, we use a panel of 6175 households from seven areas surveyed each year between 1999 and 2004.

The basic empirical specification is drawn from the empirical growth

[1]Developpement Institutions et Analyse de Long terme, Paris

[2]former name of the french Institut de Recherche pour le développement

model presented in section 2:

$$\ln c_{ht} - \ln c_{ht-1} = \alpha + \beta \ln c_{ht-1} + \delta x_{ht} + \theta s_{ht} + \theta_1 s_{ht-1} + u_{ht} \tag{4}$$

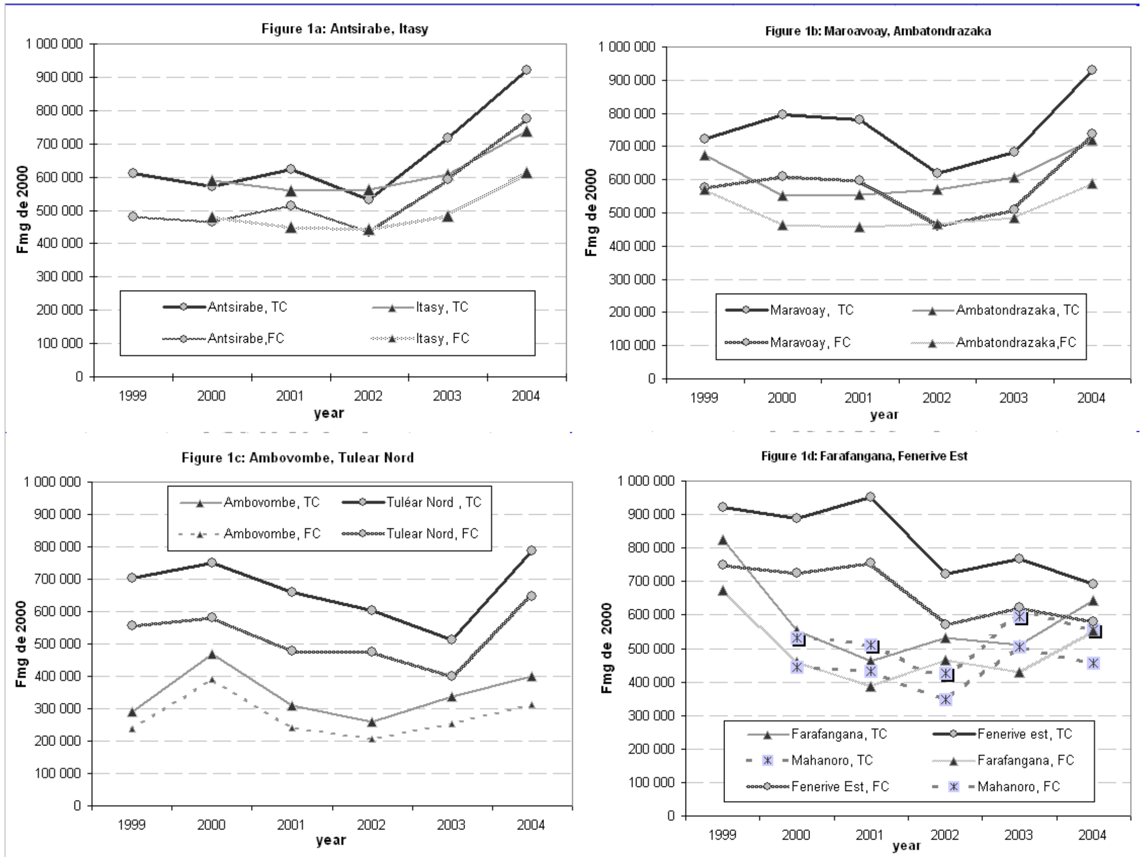
or, after disagregating, past consumption between the difference between this average and the household consumption level and the village average consumption at *t-1*:

$$\ln c_{ht} - \ln c_{ht-1} = \alpha + \beta_1(\ln c_{ht-1} - \ln c_{vt-1}) + \beta_2 \ln c_{vt-1} + \delta x_{ht} + \theta s_{ht} + \theta_1 s_{ht-1} + u_{ht} \tag{5}$$

The dependent variable $\ln c_{ht} - \ln c_{ht-1}$ is the annual growth rate in total consumption of household h in year t. Total consumption is the sum of food and non food consumption. The measure of food consumption includes cash expenditures on food and the imputed value of home consumption. The measure of non-food consumption includes expenditures on clothing, health, housing, education, recreation, transportation and rituals. Because the Malagasy economy is subject to a high inflation rate, the consumption agregate is deflated trough a national price index of consumption[3] for lack of a local price index.

[3]We use the Concumption Price index given by INSTAT, http://www.instat.mg

Figure 1: Evolution of average total (TC), food (FC) and non-food (NF) consumption by area 1999-2004



Source: ROR data, Average values calculated on the balanced panel

Average per capita consumption follows an upward trend in the two areas of Antsirabe and Itasy located in the highlands (see figure 1). The computation of the Gini coefficient show that the consumption distribution is becoming slightly less equal in Antsirabe and slightly more equal in Itasy. The large rice producing zones of Maravoay and Ambatondrazaka, and the two south areas of Ambovombe and Tulear show stagnant per capita consumption during the period. The areas on the East Coast display stagnant or downard trend in per capita consumption. At the household level, the per capita consumption paths are quite heterogeneous. Quintile transition matrices shows that some areas like Ambovombe display less mobility at the bottom of the distribution suggesting poverty traps. The food consumption follows the same trends as total consumpation. The non-food consumption is more stable across time.

Rainfall is critical at different points during the season as fields are hardly irrigable and thus very dependent on rainfalls. An excess of rain could cause flooding whereas a deficit of rain could cause hardship for the plant. Rainfall data come from the the National Aeronautics and Space Administration-Goddard Space Flight Center, Laboratory for Atmospheres (NASA\ GSFC). This source gives monthly rainfall data from 1995 to 2004[4]. Rainfall data are presented in Table 1 as deviations from their long term averages. The first three years 1999, 2000 and 2001 have been less rainy than the three last years 2002, 2003 and 2004. The areas differ regarding regularity of rainfalls. Ambatondrazaka, Farafangana, Maravoay and Tulear Nord exhibit more variable pattern of rainfall than the other areas. Rainfall shocks are computed as changes in a rainfall deviation measure. The rainfall deviation measure is the average of monthly deviation from the long term mean squared, from September of the preceding year and September of the current year. This harvest period is linked to consumption in year t because the interviews take place between September and December. Squaring monthly deviation allows us to give more importance to larger deviations from the long term mean. Introducing rainfall shocks as changes in deviations between $t-1$ and t allows to control for shocks in consumption growth rate between $t-1$ and t. A negative sign is expected for the parameter θ_0 associated to the current rainfall shock. The parameter θ_1 associated to lagged rainfall shock is expected to be negative in case of persistence but positive if the household catch up after the shock.

Idiosyncratic crop shocks are represented by annual indices of crop dam-

[4]Monthly ground measures on rainfall are available for 4 observatories but are missing for the other. Correlations between these measure and those provided by NASA vary between 0,85 and 0,94 depending on the observatory.

Table 1: Rainfall shocks between 1999 and 2004 by area reported as the sum over a year of monthly deviation from the long term monthly average, in percentages

year	Antsirabe	Farafangana	Ambatodrazaka	Fenerive Est
1999	-11%	-6%	-15%	-5%
2000	-11%	-15%	-3%	-6%
2001	-4%	-8%	-3%	-4%
2002	14%	32%	8%	4%
2003	15%	-6%	20%	16%
2004	1%	19%	-3%	4%
year	Maravoay	Ambovombe	Tuléar Nord	
1999	-13%	-3%	-18%	
2000	-14%	-11%	-15%	
2001	-12%	-0,3%	-14%	
2002	25%	-5%	25%	
2003	12%	16%	17%	
2004	7%	13%	4%	

source: author's calculations on NASA/GSFC rainfall data

ages lying between 0 (no damages) and 3 (harvest reduced to nothing) on rice, maize, tuber and other crops. Crop damages results from degradation by men, predators or diseases. Although their agro-climatic environment differ, all households in the sample face high levels of risk. Between 3 and 80% of the households, depending on the area and the year, experience shocks on their rice fields. Mean proportion of households experiencing a shock on rice fields in a given year is 32% on the whole sample but proportions vary depending on the area. The frequence and intensity of schocks are larger in Farafangana, Fenerive Est and Maravoay. Farafangana, Fenerive Est and Tulear Nord seem to be more prone to extreme event because the proportion of households exepriencing heavy losses is higher than in the other areas. Around 25 to 39% of households are subject to a heavy loss in one year at least during the survey period. Shocks on maize fields are much less frequent in all the areas except in Ambovombe. Indeed, maize is mainly cultivated in the south of the country with more than one third of the households experiencing a shock on their maize fields whatever the year in Ambovombe.

Changes in household demographics are also included to control for life cycle and other demographic effects. We introduce the change in the number of babies, children, youngs, adults and elders in every empirical specification.

Equations (4) and (5) are estimated using a fixed effect (FE) regression. It is indeed likely that unobserved heterogeneity persists after controlling for household characteristics. Parameters determining utility and production functions of households could surely not be fully taken into account by the available data. The error term u_{ht} takes the following form:

$$u_{ht} = e_h + v_{ht} \tag{6}$$

where v_{ht} is assummed independent and identically distributed with zero mean. The unobserved individual effect e_h is certainly correlated with the explanatory variables. The unobserved ability of the producer is correlated with characteristics of the households. FE techniques needs to be used to obtain consistent estimates.

We must recognize that the lagged per capita consumption is likely to be endogenous. Time invariant heterogeneity is removed by the FE regression but time varying unobserved characteristics potentially correlated with lagged growth remain in the error term. Potential candidates to instrument lagged consumption must be sufficiently correlated with consumption at $t-1$ and be uncorrelated with the error term of the structural specifications. One potential instrument is consumption lagged twice but using it drops observations from the first period 1999-2000. We choose to use per capita or total capital stock at $t-1$ proxied by the number of person at working age and the area owned. This choice allows to have a limited number of well correlated instruments. The Hausman test that compares Ordinary Least Square (OLS) versus 2 Stages Least Square (2SLS) estimates indicates that instrumentation is necessary.

The detailed sampling scheme is given in Appendix (Table 5). Because of a high attrition rate, we have to envisage an attrition bias. We have first to mention some exogeneous changes in the sample: in the area of Antsirabe in 2003, a exogeneous change of the area surveyed occured so that some households have been dropped from the panel and others entered. This change explains the small number of households in the balanced panel in the area of Antsirabe. Small changes in the area surveyed also occurred in Ambatondrazaka and Farafangana in 2004 and in 2003 respectively. To test for an attrition bias, we apply the method suggested by Verbeek and Nijman (1992). In a fixed effect context, attrition is only a problem if attrition is related to idiosyncratic error. We consider an attrition indicator a_t equal to zero when the household is observed at t and equal to one when the households is not observed at t. A lead of the indicator a_{t+1} is added as an explanatory variable in specification (4). It switches for zero to one during the last period during which the household is observed. Under the null hypothesis of no correlation between the attrition indicator and the idiosyncratic error at any period, attrition in the following period should not be significant in the equation at time t. If the coefficient of the selection indicator is not significant, attrition can be ignored. The results in appendix (Table 6) indicate that attriting at $t+1$ is not significant in the equation at t. Attrition should not bias our estimation.

4 Econometric Results

Table 2 shows the results of a FE regressions of household total, per capita, total food and per capita food consumption growth on the lagged level of correponding consumption aggregate, idiosyncratic crop shocks and covariant rainfall shocks while controlling for change in demographic variables as in specification (4). Disaggregation of individual lagged consumption between average village consumption and the difference between household's consumption and village average consumption as in specification (5) leads to the results presented in Table 3.

Estimation results in Table 2 point to a process of convergence indicating that consumption of poorer households grow faster than consumption of richer ones after controlling for variables determining the steady state. The estimates obtained are around -0.3, i.e., closed to those obtained by Dercon (2004). Hausman test shows that instrumentation is necessary for lagged consumption in every specification.

The convergence process within villages is confirmed when disaggregating individual lagged consumption between average village consumption and the difference between household's consumption and village average consumption (Table 3). Households with consumption below mean village consumption have higher growth rates whereas households with consumption above mean village consumption have lower growth rate. Some convergence is also observed between villages because, for a given household lagged consumption level, households experience a lower growth rate in village with a higher mean consumption. A *Chi2* test reject the hypothesis of equality between β_1 and β_2 indicating that convergence within and between villages occur at different speed.

Demographic control variables introduced are the changes in the number of babies, children, young adults and elder. We find that an increase in the size of the households, whatever the age of the additional household member, decreases per capita growth rate. This positive relation between poverty and household's size is often observed in developing countries.

Contemporaneous rainfall shocks clearly matter and appear with a significant negative sign suggesting that deviation from the long term mean rainfall negatively affects consumption growth. The one-year lagged rainfall shock has a significant impact on current consumption growth. This suggests some persistence of rainfall shocks on consumption growth or, at least, that past rainfall shocks matter for current consumption growth. The level of the parameter of rainfall shock are difficult to interpret because rainfall shock is computed as average of monthly deviation squared. A 10% increase in this measure of rainfall shock reduces total per capita consumption by about 1% for both lagged and current rainfall shock. Moreover food consumption growth rate seem to suffer more from rainfall shocks than total consumption growth rate.

Contemporaneous and past shocks on rice fields appear with a significantly negative sign as expected as the shock is coded from 0 to 3 in ascending order of the shock intensity. Idiosyncratic shocks are thus not completely insured by the household's risk managment mechanisms like formal or informal insurance and mobilization of savings, and, have an impact on living standards. The impacts on total and food consumption are similar. Lagged rice fields shocks also matter and negatively impact consumption growth indicating some persistence of the shock. Current shocks on maize and tuber fields are not significant. Lagged shocks on maize fields appear with a significantly positive sign that could indicate catch up after the shock. These results may suggests that shocks on these crops have little impact on household welfare. Rice is the main crop for most of households and also the main source of their incomes. Tuber and maize shocks could probably be better insured as they represent a smaller source of the household income.

We then run the same regression by quintile of income to test whether the poorer households are more vulnerable to shocks. Results in Table 4 indicate that idiosyncratic shocks hurt more the poorest. Current and lagged idiosyncratic shocks on rice fields do not impact significantly on the growth rate of the richest twenty percent of the population whereas it has a negative and significant impact on the poorest forty percent. The impact is even larger for the poorest twenty percent. Moreover, lagged rice fields shocks have a significantly negative impact on the poorest but not on the richest indicating that these shocks have a persistent effect on poorer households but not on richer ones. Current and lagged shocks on maize and tuber fields have no significant impact on most of the households sampled. Only lagged shock on maize fields appear with a positive negative sign for the two poorest quintiles. It could indicate catch up after the shock on maize like in the regression on the complete sample. The results for rainfall shocks are surprising. Current rainfall shocks have a negative and significant impact on the consumption growth rate of all quantiles except the poorest one.

Current rainfall shock has indeed an unexpected positive effect on poorest quintile consumption growth rates. Lagged rainfall shocks matter only for the three richer quintiles indicating that persistence is only observed for these richer quintiles. Turning to demographic control variables, as observed before, a increase in the number of household members decreases per capita consumption. It may be worth to note that the change of the number of baby and elder appear with a significant negative sign for the poorest quintile and insignificant for the richest quintiles. The cost of adding one more dependant member, i.e. a baby or an elder, to the household is thus higher for poor families than for rich families.

Table 2: Results of fixed effect regression with the basic specification (4)

Growth rate in:	Total cons.	Per cap. cons.	Total food cons.	Per cap. food cons.
Past consumption:				
Lagged total consumption	-0.336***			
	(-5.55)			
Lagged per capita consumption		-0.635***		
		(-10.04)		
Lagged total food consumption			-0.352***	
			(-5.83)	
Lagged per capita food consumption				-0.671***
				(-10.39)
Demographic control variables:				
Nb of baby (less than 1)[1]	-0.0286	-0.0300*	-0.0298	-0.0300*
	(-1.94)	(-2.36)	(-1.92)	(-2.28)
Nb of children (1-5)[1]	0.0963***	-0.0401**	0.109***	-0.0284*
	(6.68)	(-3.27)	(7.10)	(-2.26)
Nb of children (6-14)[1]	0.0360***	-0.110***	0.0352**	-0.107***
	(3.39)	(-11.61)	(3.16)	(-10.94)
Nb of young (15-19)[1]	0.118***	-0.120***	0.131***	-0.105***
	(8.73)	(-9.78)	(9.14)	(-8.35)
Nb of adults (20-64) [1]	0.304***	-0.223***	0.293***	-0.224***
	(12.84)	(-11.84)	(12.03)	(-11.39)
Nb of elder (more than 64)[1]	0.157***	-0.154***	0.150***	-0.152***
	(5.84)	(-6.66)	(5.35)	(-6.29)
Covariate shocks:				
Current rainfall shock	-0.164***	-0.0976***	-0.193***	-0.121***
	(-7.59)	(-5.43)	(-8.42)	(-6.43)
Lagged rainfall shock	-0.201***	-0.101***	-0.253***	-0.150***
	(-9.05)	(-5.52)	(-10.75)	(-7.88)
Idiosyncratic shocks: from 0= no damages to 3= harvest reduced to nothing				
Current idiosyncratic shock on rice fields	-0.0835***	-0.0520***	-0.0910***	-0.0539***
	(-8.24)	(-5.96)	(-8.30)	(-5.68)
Lagged idiosyncratic shock on rice fields	-0.0631***	-0.0443***	-0.0649***	-0.0437***
	(-6.98)	(-5.77)	-6.76)	(-5.41)
Current idiosyncratic shock on maize fields	0.00789	0.00933	0.0115	0.0153
	(0.61)	(0.84)	(0.85)	(1.33)
Lagged idiosyncratic shocks on maize fields	0.0237*	0.0258*	0.0262*	0.0298**
	(2.01)	(2.55)	(2.11)	(2.85)
Current idiosyncratic shocks on tuber fields	0.00157	0.0131	0.00263	0.0150
	(0.15)	(1.45)	(0.24)	(1.60)
Lagged idiosyncratic shocks on tuber fields	0.00648	0.0180*	0.0116	0.0223**
	(0.69)	(2.26)	(1.18)	(2.69)
Constant	4.929***	8.371***	5.085***	8.696***
	(5.65)	(10.08)	(5.94)	(10.44)
Number of observations	14028	14028	14027	14027
Number of households	4382	4382	4382	4382
Hausman test(Prob Chi2)	0.000	0.000	0.000	0.000

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

[1] change in the log of

Table 3: Results of FE regressions with specification (5)

growth rate in:	Total cons.	Per cap. cons.	Total food cons.	Per cap. food cons.
Difference to the village average consumption	-0.338***			
	(-5.64)			
Village average consumption	-0.952***			
	(-29.41)			
Difference to the village average per cap. consumption		-0.648***		
		(-10.47)		
Village average per capita consumption		-1.035***		
		(-36.20)		
Difference to the village average food consumption			-0.340***	
			(-5.56)	
Village average food consumption			-0.956***	
			(-28.62)	
Difference to the village average per cap. food cons.				-0.672***
				(-10.52)
Village average per cap. food consumption				-1.049***
				(-35.86)
Nb of baby(less than 1)[1]	-0.0285*	-0.0300*	-0.0307*	-0.0308*
	(-1.97)	(-2.40)	(-1.99)	(-2.35)
Nb of children (1 to 5)[1]	0.0941***	-0.0394**	0.107***	-0.0287*
	(6.67)	(-3.26)	(7.09)	(-2.30)
Nb of children (6 to 14)[1]	0.0416***	-0.103***	0.0458***	-0.0986***
	(3.92)	(-11.47)	(4.04)	(-10.66)
Nb of young (15 to 19)[1]	0.115***	-0.120***	0.128***	-0.106***
	(8.68)	(-9.88)	(9.11)	(-8.46)
Nb of adults (20 to 64)[1]	0.292***	-0.225***	0.285***	-0.227***
	(12.84)	(-12.00)	(11.99)	(-11.53)
Nb of elder (more than 64)[1]	0.148***	-0.158***	0.147***	-0.154***
	(5.66)	(-6.88)	(5.29)	(-6.43)
Current rainfall shock	-0.0826***	-0.0524**	-0.102***	-0.0707***
	(-4.08)	(-3.01)	(-4.73)	(-3.87)
Lagged rainfall shock	-0.171***	-0.0865***	-0.216***	-0.132***
	(-8.03)	(-4.81)	(-9.57)	(-7.02)
Current shock on rice fields	-0.0543***	-0.0325***	-0.0585***	-0.0331***
	(-5.91)	(-4.17)	(-5.91)	(-4.00)
Lagged shock on rice fields	-0.0497***	-0.0341***	-0.0514***	-0.0342***
	(-5.75)	(-4.64)	(-5.58)	(-4.44)
Current shock on maize fields	0.0157	0.0150	0.0220	0.0227*
	(1.24)	(1.38)	(1.64)	(2.00)
Lagged shock on maize fields	0.0332**	0.0295**	0.0406***	0.0365***
	(2.86)	(2.96)	(3.29)	(3.50)
Current shock on tuber fields	0.0247*	0.0297**	0.0311**	0.0344***
	(2.37)	(3.28)	(2.80)	(3.61)
Lagged shock on tuber fields	0.0145	0.0243**	0.0215*	0.0293***
	(1.58)	(3.06)	(2.20)	(3.52)
Constant	13.91***	13.68***	13.76***	13.61***
	(29.55)	(36.15)	(28.82)	(35.89)
Number of observations	14028	14028	14027	14027
Number of households	4382	4382	4382	4382
Test $\beta_1 = \beta_2$ (Prob Chi2)	0.000	0.000	0.000	0.000

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

[1]change in the log of

Table 4: Results of fixed effect regression by income quintile with the basic specification (4)

Growth rate in:	Total consumption					Per capita consumption				
Income quintiles	(20% poorest)	(20%)	(20%)	(20%)	(20% richest)	(20% poorest)	(20%)	(20%)	(20%)	(20% richest)
Lagged consumption	-0.363	-0.333**	-0.391**	-0.491***	-0.484***					
	(-1.90)	(-2.71)	(-3.10)	(-4.63)	(-5.01)					
Lagged per capita						-0.743***	-0.759***	-0.619***	-0.540***	-0.807***
consumption						(-5.06)	(-4.89)	(-5.44)	(-3.90)	(-7.71)
Nb of baby(less than 1)[1]	-0.0889	-0.0375	-0.0366	0.00662	-0.00500	-0.0918*	-0.0364	-0.0410	0.00686	-0.00618
	(-1.96)	(-1.10)	(-1.41)	(0.25)	(-0.18)	(-2.43)	(-1.31)	(-1.77)	(0.26)	(-0.25)
Nb of children (1-6)[1]	0.152***	0.140***	0.0938***	0.0257	0.0661*	-0.000267	-0.0258	-0.0363	-0.0901***	-0.0242
	(3.48)	(4.40)	(3.40)	(0.98)	(2.46)	(-0.01)	(-1.02)	(-1.56)	(-3.43)	(-1.02)
Nb of children (6-14)[1]	0.0579	0.0616*	0.0201	0.00811	0.0181	-0.121***	-0.102***	-0.120***	-0.112***	-0.0802***
	(1.69)	(2.50)	(1.00)	(0.44)	(0.98)	(-4.58)	(-4.36)	(-6.61)	(-5.66)	(-4.60)
Nb of young (14-19)[1]	0.0501	0.245***	0.105***	0.0533*	0.129***	-0.223***	-0.0200	-0.124***	-0.161***	-0.0690***
	(1.13)	(7.28)	(4.36)	(2.19)	(5.64)	(-5.62)	(-0.76)	(-5.42)	(-6.25)	(-3.39)
Nb of adults(20-64)[1]	0.254***	0.289***	0.274***	0.301***	0.302***	-0.269***	-0.252***	-0.255***	-0.179***	-0.162***
	(3.60)	(5.82)	(5.84)	(6.87)	(7.22)	(-5.39)	(-6.14)	(-6.50)	(-4.40)	(-4.71)
Nb of elder(64)[1]	0.109	0.0738	0.118*	0.231***	0.177***	-0.271***	-0.249***	-0.149***	-0.0273	-0.0638
	(1.51)	(1.21)	(2.42)	(4.39)	(3.32)	(-4.06)	(-5.09)	(-3.38)	(-0.58)	(-1.38)
Current rainfall shock	0.386***	-0.219***	-0.228***	-0.172***	-0.253***	0.303***	-0.105*	-0.134***	-0.147***	-0.186***
	(4.21)	(-3.76)	(-5.11)	(-5.00)	(-6.96)	(3.88)	(-2.21)	(-3.48)	(-4.46)	(-6.11)
Lagged rainfall shock	-0.0429	-0.157**	-0.196***	-0.217***	-0.233***	0.0160	-0.0360	-0.0859*	-0.149***	-0.168***
	(-0.42)	(-2.63)	(-4.49)	(-6.31)	(-6.56)	(0.20)	(-0.76)	(-2.24)	(-4.58)	(-5.67)
Current idiosyncratic	-0.241***	-0.0660**	-0.0508**	-0.0515**	0.00969	-0.145***	-0.0383*	-0.0282	-0.0340*	0.0108
shock on rice fields	(-4.65)	(-3.04)	(-2.88)	(-3.18)	(0.60)	(-3.66)	(-2.17)	(-1.82)	(-2.14)	(0.78)
Lagged idiosyncratic	-0.219***	-0.0556**	-0.0264	-0.0234	0.00526	-0.176***	-0.0300	-0.0212	-0.0137	0.00827
shock on rice fields	(-6.47)	(-2.69)	(-1.57)	(-1.50)	(0.33)	(-6.49)	(-1.77)	(-1.44)	(-0.89)	(0.61)
Current idiosyncratic	0.00103	-0.00508	-0.0240	0.0260	0.0178	0.00596	-0.0158	-0.0215	0.0308	0.0375
on maize fields	(0.04)	(-0.17)	(-0.89)	(0.99)	(0.61)	(0.25)	(-0.66)	(-0.91)	(1.20)	(1.49)
Lagged idiosyncratic	0.0686*	-0.0716*	-0.0196	-0.00876	0.00447	0.0637**	-0.0584**	-0.0149	0.00138	0.0283
shock on maize fields	(2.39)	(-2.58)	(-0.81)	(-0.39)	(0.17)	(2.69)	(-2.60)	(-0.71)	(0.06)	(1.21)
Current idiosyncratic	0.0328	0.0235	-0.00454	0.0255	-0.00517	0.0342	0.0258	0.0117	0.0288	0.00929
shocks on tuber fields	(1.15)	(1.01)	(-0.23)	(1.29)	(-0.24)	(1.44)	(1.37)	(0.67)	(1.49)	(0.49)
Lagged idiosyncratic	0.0231	0.00577	-0.00872	0.00962	-0.0478*	0.0270	0.00974	-0.000480	0.0176	-0.00232
shocks on tuber fields	(1.02)	(0.27)	(-0.48)	(0.52)	(-2.27)	(1.43)	(0.57)	(-0.03)	(0.97)	(-0.13)
Constant	5.073	4.795**	5.721**	7.255***	7.329***	9.482***	9.920***	8.166***	7.173***	10.90***
	(1.95)	(2.75)	(3.15)	(4.66)	(5.04)	(5.11)	(4.90)	(5.46)	(3.90)	(7.71)
Number of observations	2574	2721	2831	2968	2934	2574	2721	2831	2968	2934

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

[1] change in the log of

5 Discussion

In this paper, we evaluate the impact of agricultural and climatic shocks on consumption growth performance in some rural areas of Madagascar. We test for persistent effects of past shocks on growth rates. Using a reduced form econometric model inspired from the growth litterature, we find that both covariate and idiosyncratic shock entail costs in term of consumption growth. In the areas under concern, risk reduces growth on the overall income distribution.

We are well aware that our approach suffers from several limitations. Results are however informative. Our approach includes shocks directly in a reduced form of a Solow-inspired growth model. With this modelisation, we implicitly assume shocks as controls for the steady state growth rate. In other words, past and current shocks are introduced in an *ad hoc* manner like others factors, in addition to lagged consumption, that could influence growth rate. According to Solow's assumptions, it would imply that shocks influence total factor productivity or investiment and saving rate. This implication has weak behavioural foundations. Discussions on risk and growth imply much more complex mechanisms. But we are still convinced that this approach is useful. First, the panel structure of our data makes it possible to control for a number of time invariant variables including heterogeneity in the production function. Second, it is an attempt to measure the overall welfare impact of uninsured risk. Except for Dercon (2004) in Ethiopia and Elbers, Gunning, and Kinsey (2003) in Tanzania, risk consequences are usually studied in term of coping strategies developed by households. Authors distinguish between strategies that conduce to impoverishement (loss of assets, human capital, etc) and strategies that prevent negative impacts from risk. But the overall impact on welfare is often not evaluated because several strategies are taking place simultaneously.

One interesting result is that both idiosyncratic and covariate shocks impact consumption growth performance. It is in agreement with most of the work on consumption smoothing such as Townsend (1994) who stresses that existing risk-related institutions do not completely protect households against shocks. Further work is needed to evaluate the relevance and the distributionnal impact of existing risk sharing institutions versus other insurance schemes. But our results support the fact that existing risk sharing institutions are not sufficient to adequately protect households against risk. Moreover, we give evidence for persistent effects of negative shocks on consumption growth. Presence of uninsured risks has thus not only a welfare cost but also an efficiency cost. We do not bring information about the mechanisms at stake but from other work (Gondard-Delcroix and Rousseau, 2004;

Gubert and Robilliard, 2008) we know that some risk management strategies are responsible for losses in household productive capacity. These strategies can lead to lower welfare growth and poverty traps. Intervention towards better insurance for rural households are thus not only supported by an equity motive but also by efficiency considerations. The debate goes beyond a conflict between growth versus pro-poor measures: insuring risk may promote growth at the individual and agregate level and be pro-poor because poor seem less well protected against risk. As stated by Dercon (2003), there is no trade-off between equity and efficiency when intervening towards better protection against risk.

Concerning distributional considerations, two results are worth discussing. First, idiosyncratic shocks hurt more the poorest quintile of the wealth distribution. It suggests that intervention in favour of insurance could help make the growth pro-poor. We also find evidence of convergence in consumption trends within a village. We can link these results to a broader discussion on the distributive impact of aggregate growth. Is aggregate growth due to growth of the already more productive households or to growth of the less productive ones catching up? The convergence findings would suggest that catching up occurs within a village. It is in agreement with most household surveys analyses. Generally more productive households do not grow much faster than less productive ones (Collier and Gunning, 1999). We need to be cautious when using the Solow framework for explaining microeconomic behaviors. But, the interpretation could be that more productive households have reached their steady state growth rate. In the Solow framework, steady state growth rate is determined by total fator productivity and investment rate. Households may be unable to reach a higher steady state growth rate because of the characteristics of their environnement. Market imperfections, for example, may prevent increase in total factor productivity. More productive households may be unable to purchase enough land to allow higher returns to size. Low investment rate may also be maintained because cash is not an enough safe asset. Accumulating cash at home may be to risky for example. Impossibility of sparing safely in liquid forms may thus limit investment capacities.

6

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7 Appendix

Table 5: Sample scheme, ROR data, 1999-2004

year	Antsirabe	Farafangana	Ambatodrazaka	Fenerive Est	Maravoay	Ambovombe	Tuléar Nord
Number of households surveyed:							
1999	599	520	501	544	519	501	500
2000	600	519	503	552	517	502	501
2001	600	518	501	548	518	501	501
2002	601	518	503	544	518	501	502
2003	517	518	497	549	505	501	502
2004	515	516	486	550	503	501	501
Number of households in the balanced panel:							
1999	66	278	232	282	238	296	303
2000	66	278	232	282	238	296	303
2001	66	278	232	282	238	296	303
2002	66	278	232	282	238	296	303
2003	66	278	232	282	238	296	303
2004	66	278	232	282	238	296	303
Proportion of attriters (%):							
1999-2000	9%	16%	5%	18%	8%	12%	11%
2000-2001	10%	13%	10%	5%	9%	11%	10%
2001-2002	7%	9%	12%	13%	9%	10%	11%
2002-2003	85%	13%	26%	8%	8%	8%	24%
2003-2004	8%	10%	18%	17%	34%	8%	15%

source: ROR data, author's calculations

Table 6: Test for an attrition bias

growth rate in:	Total cons.	Per cap. cons.
Lagged consumption	-0.337***	
	(-5.53)	
lagged per cap. consumption		-0.749***
		(-13.25)
Age	0.0127*	-0.00362
	(2.55)	(-0.88)
Age squared	-0.0000744	0.0000357
	(-1.60)	(0.94)
Change in the log of	-0.0298*	-0.0272*
the nb of baby	(-2.02)	(-2.25)
Change in the log of	0.0994***	-0.0351**
the nb of children less than6	(6.89)	(-3.01)
Change in the log of	0.0396***	-0.103***
the nb of children less than 14	(3.71)	(-11.61)
Change in the log of	0.118***	-0.109***
the nb of young	(8.75)	(-9.48)
Change in the log of	0.302***	-0.208***
the nb of adults	(12.66)	(-11.70)
Change in the log of	0.133***	-0.148***
the nb of elder	(4.77)	(-6.32)
Current idiosyncratic	-0.0824***	-0.0449***
shock on rice fields	(-8.16)	(-5.49)
Lagged idiosyncratic	-0.0625***	-0.0407***
shock on rice fields	(-6.93)	(-5.58)
Current idiosyncratic	0.00903	0.0109
shock on maize fields	(0.70)	(1.03)
Lagged idiosyncratic	0.0239*	0.0240*
shock on maize fields	(2.02)	(2.49)
Current idiosyncratic	0.00289	0.0141
shock on tuber fields	(0.27)	(1.63)
Lagged idiosyncratic	0.00851	0.0178*
shock on tuber fields	(0.91)	(2.33)
Current rainfall shock	-0.161***	-0.0893***
	(-7.44)	(-5.25)
Lagged rainfall shock	-0.198***	-0.0974***
	(-8.88)	(-5.59)
Attrition indicator	-0.0214	-0.0267
	(-1.06)	(-1.63)
Constant	4.539***	9.951***
	(5.09)	(12.93)
Number of observations	14028	14028

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$