INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

UMI
A Bell & Howell Information Company
300 North Zeeb Road, Ann Arbor MI 48106-1346 USA
313/761-4700  800/521-0600
FOOD INSECURITY AND THE EVOLUTION OF INDIGENOUS RISK-SHARING INSTITUTIONS IN THE SAHEL

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By

Thi-Dieu-Phuong Geneviève Nguyen,
D.A.G. (E.N.S.A., France), D.A.T. (E.S.A.T., France), M.A.

The Ohio State University

1998

Dissertation Committee:
Dr. Douglas H. Graham, Adviser
Dr. Claudio Gonzalez-Vega
Dr. Mario J. Miranda

Approved by

Dr. Douglas H. Graham
Adviser
Department of Agricultural Economics
ABSTRACT

In semi-arid Africa, income fluctuations pose a critical problem of food security for rural households. In the absence of complete insurance markets, households have developed a broad range of market and non-market institutions to smooth their consumption.

Standard neoclassical economic theories predict that in the presence of a complete market for state-contingent claims, transfers are made across individuals so that individual consumption responds to aggregate income shocks only. A formal test of the perfect risk-sharing was conducted using household panel data from Burkina Faso. The null hypothesis of perfect risk-sharing was rejected at the 5 percent significance level.

Further statistical analyses were undertaken to classify households along a consumption scale. Results also showed that extended households offer better insurance coverage than nuclear households by state-contingent contracts and intertemporal transfers, and that family labor and the size of livestock herd are positively correlated with the household's level of food consumption. Starting from a situation where all nuclear households are organized in extended households, the current picture of agro-pastoral economies displays an apparent dysfunctional social insurance scheme.

A static stochastic semi-cooperative model of an extended household was derived to show that the extended household viewed as a risk-sharing institution is not sustainable for
certain conditions. Simulation results suggested that nuclear households improve their welfare by participating in the household risk-sharing scheme, but that large aggregate shocks and unequal endowments of labor and assets reduce significantly the space of feasible insurance contracts.

A dynamic version of the same household model was then developed and solved using the Chebychev polynomial projection method to capture the time dimension of consumption smoothing. When households are heterogeneous, unequal endowments of labor and assets and unequal redistribution of common surpluses give the better-endowed member an incentive to either leave the household or to shirk by accumulating less resources in the long run and consuming more today.

The decline of traditional insurance institutions is a critical issue due to the individualized effects of this disappearance on household welfare, in an environment where well functioning markets and public interventions are rare.
Dedicated to my family, friends, professors,

and the villagers of Banh
ACKNOWLEDGMENTS

I wish to express my sincere gratitude to my adviser, Dr. Douglas H. Graham for his intellectual support and enthusiasm during my Ph.D. program, and for the time he spent discussing with me various aspects of my research and editing all my writings. His expectations of me learning to conduct a rigorous applied research and his confidence in me have helped me to keep my focus and to achieve this dissertation.

I also wish to thank Dr. Gonzalez-Vega for his constructive and challenging questions during my dissertation and for his careful editing of my dissertation. I am deeply grateful to Dr. Mario Miranda for his guidance in some of the most difficult steps of my research and for providing me with all of the programming subroutines. He has also introduced me to one of the most exciting quantitative analysis approach, as namely computational economic dynamics. I would also like to extend my gratitude to Dr. Patricia Reagan and Dr. Cameron Thraen for their precious help at an early stage of the dissertation.

Many other professors have made this dissertation possible. I would like to thank Dr. Carlos Cuevas for introducing me to the Rural Finance Program at The Ohio State University. I would also like to express my gratitude to Dr. Michel Benoit-Cattin and Dr. Konrad Ellsasser for granting me the opportunity to conduct my field research in Burkina Faso. Many thanks to Dr. Luther Tweeten and Dr. Frederick Hitzhusen, who have shared with me their
teaching experience, knowledge and expertise about the interrelationships among food security, demographics and the environment. Many thanks to Barbara Lee, Judy Petticord, Karlene Robison, Betty Wampflet, and Joan Weber for helping me with all the paper work and for their encouragement during my dissertation.

Thanks to the Rural Finance Program and the Department of Agricultural Economics at The Ohio State University for the financial support during my entire Ph.D. program. Thanks to the Centre de Recherche et de Cooperation Internationale pour le Developpement (Montpellier, France) for the financial support at the early stage of my research in France and Burkina Faso.

I cannot thank my family and friends enough for their love, patience, understanding, and confidence in me. They were always there when I needed the most. This dissertation was far more than an academic challenge. It was a great emotional challenge for an international student like me who had to be away from loved ones for many years. I am deeply in debt to my parents, sisters, brothers in-law, my nephew, and nieces, who provided me with great love and strength.

To my dear roommates, Shu-Tai Wang and Yi-Mei Sun, I would like to express my sincere gratitude for their daily warm and loving care during my stay in Columbus. Many thanks to my big sisters Koro Ouattara and Damitha De Zoysa, who gave me precious advice and restored my self-confidence every time it was shattered. To my senior colleagues, Mayada Baydas, Hyma Gollamudi, Gheeta and Shiva Makki, and Yira Mascaro, thanks for providing me with the Ph.D survival kit.
Many other people have shared with me their true friendship, trust in one another, and faith, including, first and foremost, my classmates, Dony Azdan, Bernard Bashaasha, Veronica De Allende, Ivonne Diaz, Darcy Hartman, Janina Leon, Harriet Nannyonga, Julia Paxton, Jorge Rodriguez-Meza, and Mark Schreiner; and my dearest friends, Joe Angerer, Sylvie and Maousse Assa, Bruno and Mireille Barbier, Dave Chen, Leah Dieh, Cecile Lapenu, Rebecca Nannyonga, Steven Pao, Marianne and Chris San-Ching, Yumiko Shiga, Ada and Louis So, Wendy Tsai, Maria and Dan Villareal, and Jin Yang. All these people have created an affectionate environment that I will never forget.

Finally, I would like to express my sincere gratitude to all the people I have met during my field work in Bangladesh, Burkina Faso, and Mali. These people have shared their lives and knowledge with me, allowing me to gain a better understanding of the economics of the household. They have enlarged my horizon and have helped me to be more open-minded.

To all these people, who have helped me through this academic and emotional journey, I dedicate my dissertation.
# VITA

<table>
<thead>
<tr>
<th>Year(s)</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 8, 1967.</td>
<td>Born - Saigon, Viet-Nam</td>
</tr>
<tr>
<td>1992-1993.</td>
<td>Graduate Research Associate, Département des Systèmes Agraires Ruraux, Centre de Recherche et de Coopération Internationale pour le Développement, Montpellier, France</td>
</tr>
<tr>
<td>1995.</td>
<td>M.A. Department of Economics, The Ohio State University, Ohio</td>
</tr>
<tr>
<td>1993-1997.</td>
<td>Graduate Teaching and Research Associate, Department of Agricultural Economics, The Ohio State University, Ohio</td>
</tr>
</tbody>
</table>

**FIELDS OF STUDY**

Major Field: Agricultural Economics

Minor Field: Rural Finance
# TABLE OF CONTENTS

ABSTRACT ................................................................................................................ ii
DEDICATION ......................................................................................................... iv
ACKNOWLEDGMENTS ............................................................................................. v
VITA .................................................................................................................... viii
LIST OF TABLES .................................................................................................... xv
LIST OF FIGURES ................................................................................................... xvii

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHAPTER 1: Introduction</td>
<td></td>
</tr>
<tr>
<td>A. Problem Statement</td>
<td>1</td>
</tr>
<tr>
<td>B. Objectives of the Dissertation</td>
<td>9</td>
</tr>
<tr>
<td>C. Organization of the Dissertation</td>
<td>12</td>
</tr>
<tr>
<td>CHAPTER 2: Risk and Household Consumption Smoothing in Northern Burkina Faso</td>
<td></td>
</tr>
<tr>
<td>A. Introduction</td>
<td>15</td>
</tr>
<tr>
<td>B. Context of the Study</td>
<td>15</td>
</tr>
<tr>
<td>1. Institutional Background and Initial Motivations</td>
<td>15</td>
</tr>
<tr>
<td>2. Food Insecurity in Burkina Faso</td>
<td>18</td>
</tr>
<tr>
<td>3. The Region Studied</td>
<td>19</td>
</tr>
</tbody>
</table>
CHAPTER 3: Do Households Fully Share Risk? A Formal Test of The Perfect Insurance Model And A Closer Look At Inequalities in Household Consumption Smoothing

A. Motivations ............................................................................................. 67

B. Exploratory Analyses of Variations in Household Ability to Smooth Consumption ........................................................................................................... 69
1. Individual Interactions and the New Institutional Economics 107
2. Endogenous Theories of Institutions and The study of Informal Insurance Institutions 109
   a. Transaction Costs, Asymmetric Information, and Collective Action 109
   b. Agrarian Institutions, Risk, and The Economic Rationale of Extended Household Formation 111
3. Implications of the NIE For The Modeling of Household Insurance Arrangements 115
   C. The Static Semi-Cooperative Model of Household Risk-Sharing 116
      1. Modeling The extended Household as An Indigenous Insurance Institution 116
         a. The Extended household In Burkina Faso 116
         b. Models of Intrahousehold Resource Allocation 118
      2. The Static Version of the Semi-Cooperative Model of Household Risk-Sharing 124
         a. Formulation of The Model 124
         b. Parameterization of The Model (Base Case) 134
         c. Simulation Results 136
            (i) Effects of Inequalities in Labor Supply and Assets on the Contract Space 136
            (ii) Effects of Income Shocks on The Contract Space 141
   D. Conclusion; Inequalities, Risk and The Dynamics of Capital Accumulation 141

CHAPTER 5. Redistribution of Resources Under Uncertainty and The Dynamics of Indigenous Risk Sharing Institutions

A. Introduction 150
B. From " Allocative Efficiency-Improving Institutions to "Redistributive
Institutional Changes*: A Review of Theories and Empirical Studies of Institutional Changes ......................................................... 152

1. The Theoretical Debate ................................................................. 152

2. Lessons from Existing Empirical Studies on Institutional Changes ... 153

C. The Extended Household Viewed As A Stochastic And Dynamic Non-Cooperative Game of Risk and Resource Redistribution ......................................................... 156

1. Formulation of the Model ............................................................... 156

2. The Nash Equilibrium ................................................................... 158

3. The Numerical Approach for Solving the Model ......................... 160

D. Simulation Results ........................................................................ 161

1. Choice of the Parameters ............................................................... 161

2. Equilibrium Investment/Saving Strategies of Nuclear Families Under the Sharing Rule A ......................................................... 163

3. Steady-State Savings and Consumption Within the Extended Household Under the Sharing Rule A ......................................................... 176

4. Resource Redistribution Rules and the Shirking Behavior of Members of the Extended Household ......................................................... 181

5. Individual Decision to Stay In or Exit the Extended Household Risk-Sharing Scheme ......................................................... 188

E. Conclusion: Wealth Inequalities, Resource Redistribution Schemes, and The Sustainability of Indigenous Risk-Sharing Institutions .............................. 194

CHAPTER 6: Conclusion

A. Summary of the Research Findings ............................................. 196

B. Policy Implications ....................................................................... 201

1. Effects of Risk, Wealth Inequalities, and Poverty on Food Security ......................................................... 201

2. The Importance of Public Interventions ......................................... 202
3. The Sustainability of Development Programs Based on
Indigenous Institutions .......................................................... 204

C. Limitations and Implications For Further Research .................. 205

1. Problems From the Use of Collective Household Approach
and the Study of Dynamic Processes ........................................... 205

2. Directions For Further Theoretical and Empirical Research on
Intra-Household resource Allocation and the Dynamics of Institutions 207

LIST OF REFERENCES ................................................................. 210

APPENDIX A: Results of Three-Stage Least-Square Estimation of the Perfect
Insurance Model ........................................................................ 223
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1.</td>
<td>Stratified Random Sample Drawn in 1991</td>
</tr>
<tr>
<td>2.2.</td>
<td>Eight Different Distributions of Expenditures and Income in a Crop Deficit Year and Crop Surplus Year</td>
</tr>
<tr>
<td>2.3.</td>
<td>Descriptive Statistics of Household Annual Harvest and Consumption of Cereals</td>
</tr>
<tr>
<td>2.4.</td>
<td>Direct Transfers Across Households in Years of Good and Bad Harvest</td>
</tr>
<tr>
<td>2.5.</td>
<td>Average Demographic and Economic Characteristics of Extended Households in the Sample</td>
</tr>
<tr>
<td>2.6.</td>
<td>Correlation Matrix of Activity Returns</td>
</tr>
<tr>
<td>2.7.</td>
<td>Distribution of Households by Size, Labor, Size of Herd of Livestock, and Level of Food Consumption</td>
</tr>
<tr>
<td>2.8.</td>
<td>Sources of Household Financial Services and Indicators of Household Financial Transactions</td>
</tr>
<tr>
<td>2.9.</td>
<td>Local Markets of Cereals and Livestock: Weekly Inflows and Outflows of Cash</td>
</tr>
<tr>
<td>3.1.</td>
<td>Average Characteristics of Households Grouped in Ten Clusters</td>
</tr>
<tr>
<td>3.2.</td>
<td>Results of the Principal Component Analysis Using Orthonormal Rotations</td>
</tr>
<tr>
<td>3.3.</td>
<td>Results of the Principal Component Analysis Using Oblique Rotations</td>
</tr>
<tr>
<td>3.4.</td>
<td>Results of the Three-Stage Least-Square Estimation of the Perfect Insurance Model Using the Sample of Extended Households</td>
</tr>
<tr>
<td>Section</td>
<td>Title</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>3.5</td>
<td>Results of the Three-Stage Least-Square Estimation of the Perfect</td>
</tr>
<tr>
<td></td>
<td>Insurance Model Using the Sample of Nuclear Families Organized Into</td>
</tr>
<tr>
<td></td>
<td>Extended Households</td>
</tr>
<tr>
<td>4.1</td>
<td>Structure of Agricultural Income Shocks in Burkina Faso</td>
</tr>
<tr>
<td>4.2</td>
<td>Household Risk-Sharing Contracts: Simulation Results of the Base Case</td>
</tr>
<tr>
<td>4.3</td>
<td>Household Risk-Sharing Contracts: Simulation Results for Higher</td>
</tr>
<tr>
<td></td>
<td>Frequencies and Magnitudes of Income Shocks</td>
</tr>
<tr>
<td>4.4</td>
<td>Household Risk-Sharing Contracts: Simulation Results for Higher</td>
</tr>
<tr>
<td></td>
<td>Frequencies and Magnitudes of Income Shocks, and Higher Levels of</td>
</tr>
<tr>
<td></td>
<td>Endowments in Labor and Capital</td>
</tr>
<tr>
<td>5.1</td>
<td>Model Parameters for Four Different Scenarios Under the Sharing Rule</td>
</tr>
<tr>
<td>5.2</td>
<td>Steady-State Means and Variances of Stock of Resources and</td>
</tr>
<tr>
<td></td>
<td>Consumption of Members of the Extended Household</td>
</tr>
<tr>
<td>5.3</td>
<td>Nuclear Family 1’s Decision to Participate or Not to the Extended</td>
</tr>
<tr>
<td></td>
<td>Household Risk-Sharing Scheme A in Scenario 1</td>
</tr>
<tr>
<td>5.4</td>
<td>The Poorer Nuclear family 1’s Decision to Participate Or Not to</td>
</tr>
<tr>
<td></td>
<td>the Extended Household Risk-Sharing Scheme A in Scenario 3</td>
</tr>
<tr>
<td>5.5</td>
<td>Decision of the Nuclear Family With the Smallest Share of Pooled</td>
</tr>
<tr>
<td></td>
<td>Consumption to Participate or Not to the Extended Household Risk-</td>
</tr>
<tr>
<td></td>
<td>Sharing Scheme A in Scenario 4</td>
</tr>
<tr>
<td>A.1</td>
<td>Results of the Three-Stage Least-Square Estimation of the Perfect</td>
</tr>
<tr>
<td></td>
<td>Insurance Model Using the Sample of Extended Households</td>
</tr>
<tr>
<td>A.2</td>
<td>Results of the Three-Stage Least-Square Estimation of the Perfect</td>
</tr>
<tr>
<td></td>
<td>Insurance Model Using the Sample of Nuclear Families Organized Into</td>
</tr>
<tr>
<td></td>
<td>Extended Households</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1.</td>
<td>Map of the Region of Study</td>
<td>20</td>
</tr>
<tr>
<td>2.2.</td>
<td>Rainfall Variability in Norther Burkina Faso</td>
<td>29</td>
</tr>
<tr>
<td>2.3.</td>
<td>Idiosyncratic Component of Agricultural Shocks or Harvest Variability Across Households Measured as the Percentage Deviation from the Average Over All Households</td>
<td>31</td>
</tr>
<tr>
<td>2.4.</td>
<td>Variability of Food Consumption Across Households Measured as the Percentage Deviation From the Average Over All Households</td>
<td>37</td>
</tr>
<tr>
<td>3.1.</td>
<td>Distribution of Households Sampled in Ten Clusters and According to the Percent Deviation from mean Consumption in 1990-1991</td>
<td>73</td>
</tr>
<tr>
<td>3.2.</td>
<td>Simultaneous-Equations Model of Perfect Risk Sharing</td>
<td>91</td>
</tr>
<tr>
<td>3.3.</td>
<td>Estimated Simultaneous-Equations Model of Perfect Risk Sharing</td>
<td>97</td>
</tr>
<tr>
<td>4.1.</td>
<td>Classification of Collective Household Models and Underlying Assumptions</td>
<td>119</td>
</tr>
<tr>
<td>4.2.</td>
<td>Solution to the First-Stage Bargaining Problem</td>
<td>131</td>
</tr>
<tr>
<td>4.3.</td>
<td>Conflict Outcome of the Extended Household’s Joint Decision</td>
<td>133</td>
</tr>
<tr>
<td>4.4.</td>
<td>Space of Household Risk-Sharing Contracts: Simulation Results of the Base Case and for Initial Levels of Labor and Capital twice the Levels in the Base Case</td>
<td>137</td>
</tr>
<tr>
<td>4.5.</td>
<td>Space of Household Risk-Sharing Contracts: Simulation Results of the Base Case and for Higher Frequencies and Magnitudes of Aggregate Shocks</td>
<td>143</td>
</tr>
</tbody>
</table>

5.1. Equilibrium Investment/Saving Strategy of Nuclear Families in Scenario 1 .......................................................... 165

5.2. Equilibrium Consumption of Nuclear Families in Scenario 1 .......................................................... 166

5.3. Shadow Price of Individual Stock of resources in Scenario 1 .......................................................... 167

5.4. Equilibrium Investment/Saving Strategy of Nuclear Families in Scenario 2 .......................................................... 168

5.5. Equilibrium Consumption of Nuclear Families in Scenario 2 .......................................................... 169

5.6. Equilibrium Investment/Saving Strategy of the Poorer Family in Scenario 3 .......................................................... 171

5.7. Equilibrium Investment/Saving Strategy of the Richer Family in Scenario 3 .......................................................... 172

5.8. Equilibrium Shadow Price of the Richer Family's Stock of Resources in Scenario 3 .......................................................... 173

5.9. Shadow Price of Resources of the Family with the Smallest Share of Current Pooled Consumption in Scenario 4 .......................................................... 174

5.10. Shadow Price of Resources of the Family with the Smallest Share of Current Pooled Consumption in Scenario 4 .......................................................... 175

5.11. Individual Expected Consumption Path in Scenario 1 .......................................................... 177

5.12. Individual Expected Consumption Path in Scenario 2 .......................................................... 178

5.13. Equilibrium Investment/Saving Strategy of the Family With the Smallest Contribution in Scenario 4 and Under the Sharing Rule B .......................................................... 186

A. PROBLEM STATEMENT

In semi-arid Africa, seasonal and interannual income fluctuations pose a critical problem of food security for a large majority of rural households. In the absence of complete insurance markets, household survival and welfare depend on the ability to anticipate and to cope with income shocks. A broad range of market and non-market mechanisms have been developed through time and effectively used by rural households to maintain a given level of consumption despite adverse shocks such as drought and disease.

Alderman and Paxson (1992) have classified these consumption smoothing mechanisms into two groups on the basis of the underlying economic theories of portfolio choice, intertemporal allocation of resources, and state-contingent contractual arrangements. The first group includes ex ante risk-management strategies such as diversification of crops and activities, fragmentation of fields, and migration. Strategies smoothing consumption over time (such as saving and borrowing in general and storing) and those smoothing consumption across households (risk pooling) are classified into the second group of ex post risk-coping strategies.
During the past decade, economists have made important theoretical and empirical contributions in this area. These contributions have produced new insights on the role of consumption smoothing mechanisms. Important topical areas, however, such as the dynamics of non-market institutions built around these mechanisms and the issue of efficiency versus equity, which have long fascinated researchers in the field of development economics and anthropology, still raise many questions. Difficulties stem, on the one hand, mostly from controversies around theories of institutional change and conceptual models of individual interactions and, on the other hand, from the lack of appropriate means to empirically test or simulate the latter (Bardhan, 1989; Besley, 1995; Haddad et al., 1997).

Standard economic theories of consumption smoothing predict that transfers are made across individuals at a certain point in time as well as over time in order to perfectly insure individuals against idiosyncratic and transitory components of income shocks. Many empirical studies, including those undertaken by Cochrane (1991) using data from the United States, Townsend (1991, 1996) with data from Thailand and India, and Paxson (1992) with data from Thailand, rejected, however, the hypothesis of perfect insurance. These studies concluded that consumption does vary across households and over time with respect to idiosyncratic and transitory components of income shocks.

There is thus a clear gap between the predictions from standard theories of insurance and the real facts, which economists have been trying to elucidate since. In response, a growing literature started to question the neoclassical paradigm in contexts where markets and information are imperfect. This literature led to the development of new approaches that emphasize property rights and incentive and information problems, and which view
interactions among individuals as endogenously created nonmarket institutions. Indeed, social control within an isolated and organized community has been long known by anthropologists to play a predominant role in the use and allocation of common property (land, forests, and water) and of pooled resources (labor, agricultural and non-agricultural output) necessary for individual survival (Dalton, 1971; Riesman, 1974; Enswinger, 1992).

There is, nowadays, a growing interest centered around the modeling of socially-articulated contractual arrangements across households or within an extended household (informal lending, stored resources, sharecropping, and other informal risk-pooling arrangements) as major substitutes for incomplete insurance markets (Rozensweig, 1988; Bardhan, 1989; Udry, 1990; Agarwal, 1991; Hayami and Otsuka, 1993).

Meanwhile, the erosion of community insurance has been observed throughout traditional economies (Dreze, 1989; Platteau, 1995). Started in the late eighteenth century under the influence of Islam, the partition of traditional communities in the Sahel seems to have accelerated in the last two decades due to the combination of rapid population growth, more frequent periods of severe crop deficit, and the transition to a market economy (Riesman, 1974; Ford, 1982). Although no formal demonstration has been provided, Binswanger et al. (1989), Meillassoux (1981), and Platteau (1991) have discussed how informal insurance mechanisms based on state-contingent contracts can be affected by population growth and the introduction of external trading opportunities within the village economy.

On the one hand, population growth puts pressure on the use of scarce resources within a closed economy, thus lowering the effectiveness of local community insurance
schemes to cope with shocks having a relatively large aggregate component. On the other hand, the opening of isolated villages to the rest of the world, followed by the development of trading opportunities and better information, enlarge the opportunity set of households. Individual strategies based on market transactions such as sales of labor outside the community, sales of assets, and formal deposits and borrowing become available, which can either be complementary to community-based consumption smoothing strategies or compete with the latter in terms of cost-effectiveness (Ehrlich and Becker, 1972).

Stylized facts from Burkina Faso suggest that the ability to cope with income shocks not only varies across households within the same village but that it is also strongly correlated with household demographic and economic characteristics. Among households that succeeded in maintaining a certain level of consumption despite severe adverse income shocks are those large extended households with sufficient labor force and wealth. As theories of economic behavior under uncertainty predict, these households can engage into portfolio diversification in order to maximize expected income while minimizing its variance. Nuclear families with low dependency ratios and high levels of assets count also among the better off. In contrast, losers are composed of the majority of poor nuclear families with high dependency ratios. Surprisingly, a few extended households also experienced food deficit. Yet, community insurance is known to be an efficient strategy for smoothing consumption in Sahelian economies. So why these traditional institutions cannot be sustained? Or why do we observe seemingly inefficient insurance institutions?

The decline of socially-articulated insurance arrangements and institutions raises interesting questions about the household’s moral and economic behavior. According to
Carter (1997), a rural household in the Sahel, if socially and economically isolated, would annually face a 21 percent probability of falling below the food subsistence level. This probability decreases to 16 percent when reciprocal social sharing is involved. Rosenzweig (1988) also confirmed the critical role an extended household plays in insuring consumption against adverse income shocks.

Do Carter and Rozensweig's results imply that individuals, assumed to be risk averse, behave in an irrational manner by abandoning the community insurance? Furthermore, the break-up of an extended household goes against Scott's claim that rural communities are organized around norms of conduct and moral principles of reciprocity (Scott, 1972). Such a moral community guarantees subsistence as a "moral claim." Are new generations of individual households more selfish (in Popkin's sense, 1979) than their ancestors?

In an environment where a majority of households affected by relatively frequent and important income shocks strive to meet their basic needs, one could effectively argue that household choice of the most cost-efficient insurance scheme is guided by pure economic factors rather than dictated by any seemingly selfish behavior or other non-economic factors. A household may choose to leave the community if its utility under the autonomous regime is higher than its utility under the community regime. Frequent droughts associated with an exhaustion of resources at the community level not only create internal tensions but also force households to seek mechanisms that can provide the relatively isolated village with flows of resources from the rest of the world.

Researchers in the fields of geography, sociology, and anthropology, who have observed and studied traditional African economies in detail, suggest that centrifugal
tendencies come, on the one hand, from the fragile equilibrium between family size and its physical capital on the one hand and, on the other hand, from conflicts caused by individual claims over the ownership of resources in hard times (Hopen, 1958; Dalton, 1971; Riesman, 1974; Ford, 1982). Development of impersonal market exchanges opens individuals to new opportunities that may alter the initial distribution of economic power and risks within a community, thereby causing changes in interactions among individuals.

While many economic studies have stressed the role of market insurance strategies, little attention has been given to the importance of non-market insurance institutions operating within a rapidly changing environment. Few studies have tried to integrate market and non-market strategies from the point of view of household insurance choices. Indeed, most studies are piecewise analyses of the effects of one or a group of consumption smoothing strategies on household consumption in developing countries. Only a few have explored the determinants of changes in traditional insurance institutions or, more generally, the dynamics of household choice of the most efficient insurance arrangements with respect to their whole opportunity set.

Household strategies are often so complex that significant and practical conclusions can hardly be drawn by using traditional household models and estimation techniques. From a theoretical standpoint, Besley (1995) and Haddad et al. (1997) show how the modeling of individual interactions in an imperfect world lies in the midst of much confusion. Empirically, models of nonmarket organizations varying across time and space call for highly sophisticated treatments. Zimmerman (1994), for example, has addressed the issue of structural change in rural African economies by building a sophisticated multi-agent programming model. Using
data from Burkina Faso for the parameters, his simulations showed that community-based insurance arrangements are not sustainable in the present context of rural West Africa. The econometric study by Foster (1988) based on a non-zero stochastic game framework and data from rural India, led, however, to weaker evidence compared to Zimmerman's study of a decline in traditional risk-sharing schemes in primitive economies. According to Foster (1988), no general statements could be made about the effects of modernization and development on the use of community-based mechanisms versus self-insurance by rural Indian households.

Still today, any attempt to objectively test the hypothesis of institutional change using traditional quantitative methods appears to be quite an unreasonable goal. The estimation techniques and data required are either poor or unavailable. As a result, the dynamics of institutions built for smoothing consumption in developing economies are not well understood and documented. What determines people's choice of one set of contractual arrangements versus another? How does this choice evolve through time and with respect to changes in the economic environment? How does it affect household welfare?

A better understanding of the household's resource allocation process and of its economic causal determinants is crucial for formulating appropriate development policies and projects and for evaluating those already existing. Is it cost-effective to implement community-oriented development projects in an environment where the importance of social control has declined? Shall one adopt drastic recommendations drawn from the pessimist Malthusian point of view or, on the contrary, prefer a more optimistic scenario in which trade
at the scale of the global economy would serve as a foundation for improving the welfare of small communities?

This dissertation does not presume to draw any normative or definitive conclusions about how consumption smoothing strategies in developing economies have changed through time, and about what the right actions are to undertake such strategies. As Townsend (1996) argued, variations in household responses to risk suggest that there exists potential for Pareto improvements. In addition, one of the main neoclassical results, namely the separability of efficiency and equity, does no longer hold under the assumption of market incompleteness and imperfect information. Any efficiency-oriented policy reform or development project will, thus, carry important redistributive effects (and vice-versa). It is important to evaluate these effects. This can be accomplished if household initial positions or welfare ranks are known.

Therefore, this dissertation primarily seeks to contribute to an understanding of the dynamics of non-market insurance institutions and their welfare implications by reviewing existing theories, developing a model of social insurance contracts and empirically simulating the latter in order to evaluate hypotheses formulated within the specific context of rural Sahelian areas. Conclusions drawn here should be taken as a basis for discussing policies and development programs more adapted to current household strategies and their long-term evolution. It will not be possible to precisely estimate long-term changes in the households’ choices with respect to structural changes in their economic environment. By analyzing the causal determinants of their actual choices of strategies combining traditional insurance arrangements with new opportunities for risk coping, this dissertation hopes, nevertheless, to be able to provide meaningful insights on past trends and future patterns.
B. OBJECTIVES OF THE DISSERTATION

The main objective of this dissertation is to explore the reasons behind the decline of traditional risk-sharing institutions and the effects on household consumption smoothing. Two major stages characterize the research undertaken here. First, using a panel data of households collected from 1991 to 1994 in rural Sahelian Africa, an empirical analysis is carried out to evaluate the effectiveness of community risk-sharing and the effects of endowments and exogenous factors, such as the access to labor and formal financial markets, on the household's food consumption. The purpose of this analysis is to classify households according to their ability to smooth consumption and to identify the determinants of food security at the household's level.

Second, simulation and dynamic programming analyses of household institutional responses to income shocks in rural Sahelian areas are conducted to explore the effects of changes in the economic environment on the household’s choice of either community risk-sharing or self-insurance and, in turn, on household welfare. The approach adopted here will also make it possible to investigate the issues of institutional change and of the trade-off between equity and efficiency.

Due to a lack of panel data over a sufficient long period of time and satisfactory estimation techniques, it will not be possible to estimate the household's choice of an insurance arrangement and to test the hypothesis that new patterns of household institutional responses have been observed following a dramatic increase in population along with the drought-related exhaustion of local resources and following the emergence of new markets.
This dissertation will, however, develop a framework to generate a scenario of changes in household institutional responses to income shocks with respect to changes in the economic environment. Welfare implications will be investigated by analyzing the differences among households that rely only on traditional community-based insurance schemes and those choosing to develop only individual market strategies.

Traditional insurance arrangements will be defined as mechanisms calling for risk-sharing through the pooling of resources by all members of a community, which is defined here as an extended family or a village. Examples of such arrangements in rural Sahelian Africa are transfers within a community and informal labor and credit contracts within a network of closed relatives and acquaintances. Market insurance is defined, in contrast, as risk-coping mechanisms based on external trading opportunities offered by the markets for labor and agricultural commodities or as those provided by formal financial institutions (deposit and credit programs launched by non-governmental organizations or commercial banks).

Although qualitative studies have reported the coexistence of traditional insurance institutions and market insurance strategies within a community, much of the existing literature has emphasized only one or the other mechanism. In general, studies have focused only on one aspect of consumption smoothing and most of them have assumed that household preferences can be aggregated. This is insufficient. Providing a more complete view of household responses to income shocks requires one to consider both the cross-sectional and the intertemporal dimensions of consumption smoothing, and hence, to integrate the two frameworks of risk-sharing and intertemporal choice into one.
Furthermore, it is important to go beyond the simplistic unitary household model and explore the collective approach since stylized facts suggest that property rights, bargaining power, and resource allocation across individuals matter. As Haddad et al. (1994) stressed in their review of models of intra-household resource allocation, the dynamics of community formation and dissolution have not received much attention although they are important for improving existing conceptual models and formulating appropriate policies. Importance will, therefore, be given to the modeling of the short-term dynamics of the intra-household resource allocation process.

Major conceptual and data problems arise, however, when the time dimension of consumption smoothing mechanisms at the household level and uncertainty are incorporated into the framework. Existing conceptual and empirical models of consumption smoothing and of the household are either unsatisfactory, because of their static features, or intractable from an estimation point of view.

From a conceptual point of view, a semi-cooperative model of intra-household resource allocation, where an extended household is represented as a contractual arrangement between two decision-making nuclear families, is used here to show that:

(1) conflicts and non-cooperative behavior are likely to arise when a resource-constrained community is subject to important income shocks. Frequent income shocks within a context of resource scarcity tend to weaken cooperative behavior among individuals.

(2) The payment an individual receives for his contribution or the premium paid for community insurance are affected by decisions made by the other member of the extended household. Given the institutionalized rules guiding the allocation of scarce
resources within an extended household, cooperation may not always be the outcome due to an unbalanced endowment of labor and assets across nuclear families or a resource redistribution scheme perceived as unfair.

Meanwhile, as Sen (1995) has argued, the problems of food insecurity and in general of household welfare find their roots in unequal distributions of endowments and in the failures of "exchange entitlement mappings" and acquisitions. If, in the past, Pareto optimum could be achieved through the pooling of risk and resources within a community, the progressive decline of social risk-sharing leads to Carter's (1997) one-to-one mapping between an individual's risk exposure and his endowment, enlarging existing consumption smoothing inequalities.

The framework of intra-household resource allocation under uncertainty developed here yields losers, which are households unable to buy community insurance or capture market opportunities.

C. ORGANIZATION OF THE DISSERTATION

The organization of the dissertation is as follows. Chapter two describes the context of the study, i.e. its institutional background and the geographic area of interest. This is followed by a descriptive analysis of the data collected to illustrate the types and magnitudes of income shocks, their effects of these latter on household utility, and the strategies used by households to maintain a given level of consumption in face of adversities. This descriptive
analysis underscores the pervasiveness of traditional insurance institutions and points out to the rising importance of self-insurance strategies based on market exchanges. At the same time, the different concepts of household, community-based insurance arrangements, and market insurance are defined for the specific context of the Sahel with reference to the literature on economic anthropology and geography. A multi-disciplinary approach is helpful for defining concepts and for understanding individual behavior in unfamiliar contexts and, thus, for avoiding misleading hypotheses and modeling.

Chapter three provides a brief review of theoretical and empirical studies in the mainstream neoclassical economics of consumption smoothing. The primary objective of this chapter is to answer the question whether households within a community share risk perfectly. Therefore, the chapter includes a formal test of the benchmark situation of perfect insurance, using data collected in Burkina Faso. Discussion of the test results serves as a basis for developing a model of risk-sharing contractual arrangement using concepts from institutional economics, which go beyond standard theories of consumption smoothing. Statistical exploratory analysis of the Burkina Faso data, including cluster and factor analyses, provide additional stylized facts and insights about differences in household's ability to develop efficient consumption smoothing strategies.

Chapter four reviews recent contributions of the New Institutional Economics in the modeling of intra-household resource allocation. Emphasis is placed on discussing the apparent contradiction between standard theoretical predictions and results drawn from empirical studies and on the necessity of considering alternative approaches. This underscores the rationale for studying household choice of consumption smoothing strategies in the
context of the Sahelian economy in transition. This literature review is then followed by a static model of risk-sharing contractual arrangements. This model, numerically solved, is used to explore the space of potential contracts and the effects of increasing uncertainty, resource scarcity, and unequal distribution of resources on informal risk-sharing institutions.

Chapter five extends the static model of social risk-sharing to a two-person dynamic non-cooperative game in order to capture the dynamics of informal institutions and of capital accumulation within an extended household. Finally, chapter six offers a summary and conclusions with policy implications for addressing the problem of food insecurity in the Sahel.
CHAPTER 2

RISK AND HOUSEHOLD CONSUMPTION SMOOTHING STRATEGIES IN
NORTHERN BURKINA FASO

A. INTRODUCTION

Using household data collected in Burkina Faso from 1991 to 1994, a descriptive analysis is conducted here to:

(1) evaluate the nature and magnitude of income shocks faced by households;
(2) measure the extent of consumption smoothing across households; and
(3) describe household risk-management strategies and village insurance institutions.

In addition, qualitative information from the anthropological literature is reviewed to gain a better understanding of the structure and evolution of traditional insurance institutions in West Africa.

B. CONTEXT OF THE STUDY

1. Institutional Background and Initial Motivations

In response to the request of the Projet de Promotion du Petit Crédit Rural (PPPCR), a savings and credit program operating in Burkina Faso, the Centre de Coopération
Internationale en Recherche Agronomique pour le Développement (CIRAD), a French research center, launched in 1991 a study to evaluate the economic impact of the program. Concerned with cost efficiency and local development issues, one crucial question asked by the PPPCR was whether the provision of their services responds to household demands for financial services not already satisfied by existing mechanisms and institutions. To answer this question effectively required a good understanding of household economies and of their demand for financial services.

The study was launched in 1991 in the Province of Yatenga (North West of Burkina Faso). To determine the flows of goods and services within and across households, the CIRAD conducted in-depth surveys on a limited panel of households in one village and two Fulani camps located in the territory of the same village. Furthermore, the CIRAD monitored key agricultural product markets on a weekly basis to completement the household survey. Given the difficulties of an impact study (David and Meyer, 1983; Von Pischke and Adams, 1983), the first step was essentially to describe household consumption, production, and savings patterns with a farming systems approach and a social accounting matrix technique (Colliot and Nguyen, 1993).

This dissertation was motivated by the unexpected questions raised by the pilot study. These questions pertain to household behavior with regard to the use of traditional insurance organizations which pool risk versus self-insurance strategies associated with the penetration of markets for agricultural products, labor, and financial services.

The pilot study launched by the program indicated that the primary objective of rural households is to ensure family basic needs and in particular food consumption against
frequent and severe income shocks. As expected, numerous patterns of risk-management and risk-coping strategies involving the informal sector were observed. Meanwhile, large variations in the effect of income shocks across households within the same village were recorded.

Contrary to expectations from standard insurance theories and previous empirical studies (Wade, 1988; Udry, 1990), well-known kin-based arrangements such as direct transfers and informal credit transactions appeared to be relatively more important during years of good harvest than years of bad harvest. In periods of crop deficit, disavings and transactions in the labor and formal financial markets seemed to prevail.

Moreover, villagers reported that break-ups of extended households and traditional reciprocity networks have been more frequent since The Last Famine, a major drought between 1963 and 1973 that devastated all the Sahelian countries and that led to the loss of at least 100,000 lives and 75 percent of the livestock in the region (Marchal 1974; Sheets and Morris, 1976; Ford, 1982).

From a policy standpoint, it was clear that I had to focus my attention on understanding why households differ in their ability to smooth consumption and the reasons why traditional insurance institutions are not as effective as one could expect. In this chapter, I will provide a detailed description of the stylized facts that are at the origin of my study on food insecurity and the evolution of traditional insurance institutions.
2. Food Insecurity in Burkina Faso

With a per capita GNP of US$ 290 in 1991, Burkina Faso ranks among the poorest countries in the world. The agricultural sector, mainly of a subsistence nature, counted for 44 percent of GDP, but it absorbed 88 percent of the total labor force. Located in the semi-arid tropics South-West of the Sahara, the country suffers of high rainfall variability and frequent harvest deficits. The average annual increase in food production of 2.5 percent was based on an extensive conversion of forests and pastures into cropland and on important flows of development assistance. This increase in food production was not, however, sufficient to cover the food demand of a population that was rapidly increasing at an average annual rate of 2.8 percent.

Like many other developing countries, Burkina Faso experiences balance of payments deficits due primarily to a swollen public sector, the country’s high dependence on imports of machinery, the absence of strong comparative advantages, and a non-competitive government-controlled industrial sector. Poverty and high external debts do not enable the country to secure the basic needs of a rapidly growing population and to invest in sustainable development programs. The current economic growth rate is close to zero and Burkina Faso encounters significant food insecurity as the per capita average calories available remains at less than 100 percent of the minimum required to maintain a normal life (World Resource Institute 1994).

In January 1994, already under the structural adjustment program, Burkina Faso underwent, along with the other West-African countries of the Monetary Union of West-
Africa, a 50 percent devaluation of their common currency, the Fcfa, in order to promote their exports and control their balance of payments.

3. The Region Studied

The Province of Yatenga, a name derived from the name of its founder Yadega and the word tenga, meaning earth and community, is located on the southern border of the Sahelian agro-climatic region of Burkina Faso (Figure 2.1). Its Sahelo-Sudanian climate is characterized by one long dry season from October to May, followed by a rainy season from June to late September. The region receives rainfall of between 600 and 700 mm annually. The sub-region of interest called Foi, occupies the northern part of the Yatenga. Ford (1982) described the Foi as a region on the outer limit of the rainfed agricultural zone in West Africa, where severe desertification and population growth occur, with an economy characterized by its transition from a pure subsistence to a market economy. Fulani herders and former slaves Rimaaybe (officially emancipated in 1927), who are sedentary cultivators, form the dominant ethnic groups. While the Fulani were traditionally pure transhumant pastoralists, they have slowly adopted the sedentary farming life of the Rimaaybe after the dramatic Kitenga famine of 1914. More than elsewhere, food insecurity is particularly acute in this region of Burkina Faso due to high rainfall variability, rapid population growth, and poor infrastructure.
Figure 2.1. Map of the Region of Study
C. HOUSEHOLD SELECTION, SURVEY PROCEDURES, AND DATA COLLECTED

The data for the dissertation come from an existing data base jointly constructed by the CIRAD and the PPPCR in North Yatenga. Among other information, the data include household and market panel data.

1. Household Panel Data

a. Definition of An Extended Household

Following Gastellu (1978) and Meillasoux (1989), an extended household is defined as a group of people who share the same granary, the product of their common labor, and who eat together over a full year. Seasonal and permanent migrants whose incomes contribute to the household expenditures are also included in the extended households. Indigenous people clearly identify this production-consumption unit as the *Djom-Faînde*, meaning the cooking pot in the Fula language. A *Djom-Faînde* is composed vertically of nuclear families of different generations and horizontally of siblings. Resource allocations within each *Djom-Faînde* are under the control of a household head, who is usually the eldest male member of the household, the father or the eldest brother.

b. Sample and Survey Procedures

*Banâ*, the capital of the *Foï*, was chosen as a survey village because it is the most populous village in the region with approximately 200 extended households in 1991. Another
reason for the choice was that households in Banh participate in newly-developed formal financial markets.

The procedure followed to select the panel consists of a stratified random sampling. Previous studies by Ford (1982), Ehret (1988), and Djibo (1990) distinguished eight different types of households based on the ethnic group and the size of the herd. These studies indicated that there is a significant correlation between these two criteria and the type of production system of the household. It was assumed that the household's economic behavior is influenced by their belonging to an ethnic group and by the household's level of assets. Using the resulting stratification, eight samples of households, one from each strata, were randomly drawn (lottery method) from the village population (Table 2.1).

Following this procedure, a final sample of 42 to 51 out of approximately 200 extended households in the Banh village were selected and surveyed between May 1991 and September 1994, at approximately six-month intervals. In each household, in addition to the household's head, every economically productive member was surveyed. The total number of persons interviewed varied at each visit since most of the activities are seasonal and the allocation of family labor to cash-income activities is dependent on the level of expenditures. On average, 90 people from the 42 to 51 households were surveyed at each visit, and among these participants approximately two-thirds had received at least one loan.

---

1 The survey started in May 1991 with an initial sample size of 50 households chosen with respect to time and budget constraints. After the first visit, 8 households were dropped due to their unwillingness to participate in the panel. Nine new Djom-Fainde were formed during the time of the survey from the partial and complete dissolution of five initial extended households.
<table>
<thead>
<tr>
<th>Extended household types</th>
<th>Percentage in the village (n=200)</th>
<th>Percentage in the sample (n=42)</th>
<th>Number of extended household surveyed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fulani without cattle</td>
<td>15</td>
<td>12</td>
<td>5</td>
</tr>
<tr>
<td>Fulani with &lt;10 cattle</td>
<td>10</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>Fulani with &lt;20 cattle</td>
<td>15</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>Fulani with &gt;20 cattle</td>
<td>9</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Rimaibe without livestock</td>
<td>13</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>Rimaibe without cattle</td>
<td>25</td>
<td>21</td>
<td>9</td>
</tr>
<tr>
<td>Rimaibe with &lt;10 cattle</td>
<td>13</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Rimaibe with &gt;10 cattle</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100</td>
<td>100</td>
<td>42</td>
</tr>
</tbody>
</table>

Table 2.1. Stratified Random Sample Drawn in 1991
from both semi-formal (non-governmental organizations) and formal financial institutions, mainly commercial banks and post office banks.

Detailed information pertaining to on-farm consumption and monetary and non-monetary transactions is collected approximately every six months, while general information regarding household composition and seasonal allocation of labor is recorded during interviews with the head of household once a year. The questionnaire was carefully designed to record individual transactions while ensuring the accuracy of the responses. Questions range from those concerning expenditures to later questions about the sources of income to finance household expenditures. Households engaged in the reported transactions were also surveyed to identify the type of transaction (informal transfers or market exchanges) and the direction of the resource flows. Information on quantities of grains harvested, stored, and consumed collected during the interviews was double-checked by measuring the effective quantities stored in granaries and withdrawn for each meal. Finally, herd size was estimated by counting the number of animals parked in the camps in the evening belonging to each owner. For the following analyses, the data have been aggregated by nuclear family (in total 89 to 95 nuclear families), or by extended family (in total 42 to 51), and by year (4 years).

---

2
Six new nuclear families were formed with the marriage of sons or brothers of the household head.

3
A year is defined from harvest to harvest instead of from January to December.
2. Data on Cereals and Livestock Markets

Local retail market data for the two agricultural products, cereals and livestock, were collected to complement the household survey. In an economy in transition such as Banh, an important flow of products and factors do not go through the market defined as an institution where exchanges occur with explicit prices. Villagers still practice barter when transactions do not require money as a medium of exchange. The absence of cash reserves has been well documented by Ancey (1983) and Pieroni (1989), who argued that the demand for cash corresponds to a future demand for goods and that it never exceeds the latter. Collecting data on the flows of cereals and animals and on the sellers and buyers in these markets helps to evaluate the barter transactions, and it provides complementary information on household production and consumption in relation to the rest of the economy. Since June 1991, the most important retail market for cereals and livestock in the survey area has been monitored on a weekly basis.

The market information collected includes:

(1) volume of transactions (inflows and outflows) and prices; and
(2) characteristics of sellers and buyers (ethnic group, home, motivation, sources of cash and revenue uses).

---

4 The local currency is the Fcfa. The exchangerate before the 1993 devaluation was approximately of US $ 1 for 250 Fcfa.
D. DESCRIPTIVE ANALYSIS OF HOUSEHOLD RESPONSES TO INCOME SHOCKS

1. Agricultural Risks, Income Shocks, and the History of Famines

After living among and conversing with the villagers of Banh for a year's time, Ford learned the following:

"Food scarcity or harvest failures resulting from climatic, social-political, or economic disrupt in the normal subsistence cycle have been a fact of life in Yatenga as far back as anyone can remember." (Ford, 1982: 536)

Located between the 500 mm and 700 mm isohyets, the Yatenga Province theoretically receives sufficient rainfall to permit extensive agriculture. The longstanding traditional production system of mixed herding and farming, described as a climate spatial adaptative mechanism by Gallais (1974), Monod (1975), Ford (1982), and Bonte (1986), characterizes the region's economy. Cropping systems based on millet and sorghum produce the staple diet, while cattle raising activities provide households with milk and manure.

Furthermore, livestock represents the predominant form of household wealth along with women's jewelry. In these areas, social status is directly correlated to herd size. There was traditionally a strict ethnic division of labor between the Fulani herders and their slaves Rimaaybe, who used to practice sedentary farming and to supply their masters with cereals in exchange for animal by-products and physical protection. Believed to be "rational" and "ecologically stable under the low density of population of precolonial time" (Ford, 1982), this symbiotic relationship between transhumant herders and sedentary farmers has failed to
meet the needs of the rapidly growing population since the beginning of this century (Marchal, 1977; Ford, 1982; Bonte, 1986). Sahelian agro-pastoral societies have recently become more exposed to food deficiency risks.

Since the Great Zogore Famine of 1831-39, which led to the desertion of most of the villages in the northern Sahel and to out migration toward the West and the East, Marchal (1974), Sheets and Morris (1976), and Ford (1982) have reported two other major famines, the Kitanga famine in 1914 and the Last Famine in 1972-74. They have also reported at least four other severe crop deficits. In 1914, the Kitanga famine caused a second wave of migration to the South and forced the Fulani herders to abandon their nomadic lifestyle and to begin cultivating the land. More dramatic by its effects, the Last Famine in 1972-74 meant the loss of hundreds of thousands of lives and more than one-half of the livestock in the Sahelian region. This event further weakened the fragile equilibrium between population and natural resources. Nevertheless, in 1982-84 and 1989-90, despite mediocre harvests, many households were able to ensure a minimum level of consumption by travelling to Mali or to the south of Burkina Faso to buy cereals in villages with grain surpluses.

Using annual data from 1921 to 1987 on rainfall, production, food consumption, and population, the Office Régional de Développement (the Burkina Faso government agency for development) has estimated that the probability of a deficit year in cereals is 26 percent for the Province of Yatenga. Using the cumulative density functions of per-hectare yield, Carter (1997) demonstrated that the probability for a rural household in Northern Burkina Faso to fall below the subsistence level is within the same range.
The production of millet and of sorghum are strongly weather dependent. Deficit years are usually either caused by a lack of rainfall or by an uneven distribution of rainfall throughout the cultivation season. In general, reported famines and periods of food shortfalls correspond to years when annual rainfall was below 550 mm. Annual rainfall data over the 1921-93 period for Northern Yatenga indicate that the probabilities for rainfall to be below the average of 646 mm and below 550 mm are, respectively, 49 and 23 percent (Figure 2.2).

If positive correlations between food deficits and lack of rainfall are observed, the fit is, however, imperfect. Other factors such as severe locust attacks (1928-35 and 1989), a low-yielding production technology, poor infrastructure and inappropriate policies (taxation and levies) may affect the supply of cereals as well (Marchal, 1974; Ford, 1982; Bonte, 1986; Platteau, 1995). Concerning the effects of rainfall, Bonte (1986) concluded that the severity of the Last Famine of 1973 was not related to a random drought that hit the Sahel, but to a more or less normal lack of rainfall that was associated to a new socio-economic post-colonial environment.

Carter (1991) further extended the notion of agricultural risk by making the exposure to risk an endogeneous variable simultaneously determined with the individual’s resource endowment. In the absence of a social risk-pooling mechanism, an individual becomes more exposed to risk as his resource endowment declines. A household with a sufficient amount of labor, for example, can practice the well-known field scattering tactic (Blarel et al., 1992) and reduce risk exposure by 15 percent in the Sahelian context of Burkina Faso (Carter, 1991).
Figure 2.2. Rainfall Variability in Northern Burkina Faso
This method is included in the group of risk management strategies in Alderman and Paxson's classification (Alderman and Paxson, 1992), which combined with risk coping strategies (those undertaken after the realization of the stochastic event) determine both the household's willingness to pay and ability to protect itself against risk. Carter's endogenization of risk follows Garcia and Spitz' (1986) analysis in which drought is qualified as an in-built regulator provided that the precolonial agro-pastoral societies were in equilibrium. Drought has ceased, however, to adequately play this role with colonial disjunctions and has become since a disturbance the environment is unable to absorb (Garcia and Spitz, 1986).

As expected, the realization of risk through negative production shocks differs across households (Figure 2.3). Indeed, any production shock can be decomposed into two components, an aggregate component, defined as the deviation from the average output over time, and an idiosyncratic component, defined as the deviation from the average output over all households within a community in a given year. From a per capita average production of 204 Kg over the four survey years, the aggregate component of production shocks in percentage deviation from the average were -75, 31, 15, and 29 for the 1990, 1991, 1992, and 1993 harvests, respectively. Even though the 1990 harvest experienced a relatively important aggregate negative production shock, not all households suffered from it. Figure 3 clearly shows that the idiosyncratic component can account for a large part of the drought's effects on household production.

---

Dugue (1989) gives a per capita average production of 190.48 Kg based on extensive surveys of farmers in the Yatenga and on agronomic experimentations.
Figure 2.3. Idiosyncratic Component of Agricultural Shocks or Harvest Variability Across Households Measured as the Percentage Deviation from the Average Over All Households
Frequent production shocks and a growing population have dramatically increased in recent years the households’ dependence on cereal markets. The Province of Yatenga is, currently, a net importer region of cereals from the south of Burkina Faso and Mali. Since expenditures on food represent on average 70 percent of the household’s annual budget, any variation in cereal production will affect household income, and it should translate into cereal price variations in local markets where supply is constrained by monopolistic behavior and technological problems (Dejou, 1987; Egg and Martinet, 1988; Dione, 1989). Between the harvests of 1990 and 1991, the variance in cereal prices was 826, whereas between 1991 and 1992, the variance was only 13.

Moreover, these variances are positively correlated with the interannual variations in rainfall and production. The 1990 drop in rainfall followed by an explosion of the cereal prices suggests that in 1991 the majority of households experienced a severe negative income shock. In addition to rainfall, variances in cereal prices constitute a good indicator of adverse income shocks.

2. What Do Households Smooth?

In situations where crop failures and deprivation of basic needs occur frequently, a primary concern is to ensure the household reproductive capability by maintaining a minimum level of food consumption (cereals, milk, and kola nuts) necessary for basic human activities. Therefore, consumption smoothing must be considered as an asymmetric phenomenon associated with any negative deviation from the average, whereas in developed countries it would affect the overall variance.
Table 2.2 also suggests that the study of consumption smoothing must be restricted to the fulfilment of basic needs as defined by food and health-related expenditures. In years with good harvests, household expenditures effectively shift from food to social consumption (clothes, baptisms, weddings, funerals and gifts) to strengthen kinship relations. To meet specific cash needs during good harvest years, households usually sell part of their agricultural production, although not necessarily the whole surplus, after the harvest time around October. They also develop cash income activities during the dry season from November to April or occasionally deplete their livestock. In the latter case, households do not behave like livestock sellers but rather purchase liquidity services from traders. Ignoring this phenomenon will likely increase the chances of rejecting the hypothesis that consumption is smooth with respect to adverse agricultural income shocks.

Although income and consumption smoothing are closely interlinked, as Morduch (1995) argued, the latter appears to be predominant in Sahelian transition economies. Indeed, income flows tend to follow consumption patterns. Households in rural areas engage in income generating activities only to cover future expenditures. Stable income flows are far from being typical; instead, income flows are correlated to variations in expenditures. This justifies the emphasis on consumption smoothing, income generation being only a solution to achieve the latter and not an objective in itself.
<table>
<thead>
<tr>
<th>Expenditures (%)</th>
<th>Income (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>Social</td>
</tr>
<tr>
<td>Harvest 1990 - Harvest 1991 (severe crop deficit year)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>83</td>
</tr>
<tr>
<td>2</td>
<td>69</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>95</td>
</tr>
<tr>
<td>5</td>
<td>83</td>
</tr>
<tr>
<td>6</td>
<td>93</td>
</tr>
<tr>
<td>7</td>
<td>67</td>
</tr>
<tr>
<td>8</td>
<td>51</td>
</tr>
<tr>
<td>Harvest 1991 - 1992 (average crop surplus year)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>33</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>64</td>
</tr>
<tr>
<td>4</td>
<td>26</td>
</tr>
<tr>
<td>5</td>
<td>70</td>
</tr>
<tr>
<td>6</td>
<td>44</td>
</tr>
<tr>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>8</td>
<td>16</td>
</tr>
</tbody>
</table>

Table 2.2. Eight Different Distributions of Expenditure and Income in a Crop Deficit Year and Crop Surplus Year
The Burkina Faso and several empirical studies suggest that the concept of utility smoothing may be more relevant than that of consumption smoothing. In these studies, utility is defined with respect to the two standard arguments of consumption and leisure. In periods of abundance, when one may expect all households to engage in an active capitalization process, it has been observed that time normally devoted to income earning activities is shifted to strengthen social ties. As the anthropologist Riesman explained, the Fulani society should be viewed as a society where energy, if not for the production of basic needs, is used to maintain and strengthen the kin-based insurance capital (Riesman, 1974). Due to a lack of precise data on family labor allocation and our concern for the insurance issue, however, emphasis is placed here on the consumption dimension of utility rather than on leisure.

Consumption data for the 42 initial households in Banh provide clear evidence of consumption smoothing (Table 2.3). If deviations from the average harvest ranged from -100 percent to +500 percent in 1990 and from -100 to +200 percent in the remaining years, deviations for average food consumption ranged only from -60 to +100 in 1990 and from -50 to +60 in all other years (Figure 2.4). Moreover, the effect of the 1990 aggregate adverse shock on consumption was five times less than the effect on harvest.

Compared to a per capita annual average consumption of 204 Kg (the FAO norm is equal to 200 Kg per capita per year), the percentage deviations from the average consumption over the four years are -15, -1.9, 13, and 3, respectively, for 1990, 1991, 1992, and 1993. However, important variations in food consumption across households represented in Figure 2.4 reveal that households in the same village do not suffer shocks equally.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HARVEST</td>
<td>Mean (Kg/person/year)</td>
<td>50.26</td>
<td>267.38</td>
<td>235.09</td>
</tr>
<tr>
<td></td>
<td>Median (Kg/person/year)</td>
<td>32.00</td>
<td>231.77</td>
<td>237.50</td>
</tr>
<tr>
<td></td>
<td>Standard Deviation</td>
<td>53.43</td>
<td>171.02</td>
<td>156.94</td>
</tr>
<tr>
<td></td>
<td>Variance</td>
<td>2854.80</td>
<td>29248.32</td>
<td>24632.25</td>
</tr>
<tr>
<td></td>
<td>Minimum (Kg/person/year)</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>Maximum (Kg/person/year)</td>
<td>272.73</td>
<td>671.43</td>
<td>687.50</td>
</tr>
<tr>
<td>CONSUMPTION</td>
<td>Mean (Kg/person/year)</td>
<td>176.60</td>
<td>202.93</td>
<td>233.93</td>
</tr>
<tr>
<td></td>
<td>Median (Kg/person/year)</td>
<td>180.00</td>
<td>206.49</td>
<td>234.00</td>
</tr>
<tr>
<td></td>
<td>Standard Deviation</td>
<td>41.34</td>
<td>43.62</td>
<td>26.39</td>
</tr>
<tr>
<td></td>
<td>Variance</td>
<td>1709.11</td>
<td>1903.52</td>
<td>696.71</td>
</tr>
<tr>
<td></td>
<td>Minimum (Kg/person/year)</td>
<td>105.00</td>
<td>102.30</td>
<td>126.00</td>
</tr>
<tr>
<td></td>
<td>Maximum (Kg/person/year)</td>
<td>360.00</td>
<td>328.57</td>
<td>281.25</td>
</tr>
</tbody>
</table>

Table 2.3. Descriptive Statistics of Household Annual Harvest and Consumption of Cereals
Figure 2.4. Variability of Food Consumption Across Households Measured as the Percentage Deviation from the Average Over All Households
Differences in food consumption across households result from both variations in production and the household’s ability to smooth out crop deficits. These results seem to contradict the Pareto optimum outcome predicted by standard insurance theories.

3. Consumption Smoothing Mechanisms and Their Institutional Organizations

I have classified consumption smoothing strategies existing in the Sahel into two major groups according to the nature of the institutions involved or, in other words, whether they pertain to the community or the market spheres. Both groups include mechanisms consisting in transfers across states of nature (i.e. across households) or across time.

a. Traditional Community-Based Insurance Institutions

(i) Transfers Within the Village Community and Extended Household

Two systems of kin-based contractual arrangements are found in the Northern Yatenga. These arrangements serve the purpose of ensuring both the household’s and the community’s reproductive capabilities. Evolving in a risky environment, these systems possess an important built-in insurance component that, first, relies on the long-lasting subordinate relationship between the Fulani and the Rimaaybe and, second, relies on the extended household formation process.

In the agro-pastoral economy of Northern Yatenga, gold, livestock, granaries, and children have traditionally been the main stores of value (Riesman, 1974; Ford, 1982; Bonte 1986; Reardon, Matlon, and Delgado, 1988). Wealth accumulation from household production and institutionalized reciprocal transfers serve the purpose of constituting
precautionary reserves for the household and of providing members of a community with a means to tie social relations. In this economy, interaction patterns between the Fulani cattle herders and their slave Rimaaybe cultivators were spatially adapted to the cultural ecology of the Sahel and based on production specialization and barter transactions across kinship spheres.

In equilibrium and able to absorb any agricultural shocks, these symbiotic relationships were disrupted with the arrival of Islam in the region in the mid-eighteenth century (Riesman, 1974; Ford, 1982) followed by the French colonial regime in 1895 (Ford, 1982; Langlois, 1983; Bonte, 1986). In contrast to the indigenous animist religion, Islam introduced centrifugal forces in the agro-pastoral society. Currency was introduced by the French administration to account for the payment of taxes. This forced the Fulani and the Rimaaybe to sell livestock and grains to passing traders, which induced the erosion of the reciprocal ties between the two communities.

The 1914 and 1974 droughts accelerated the transformation of the traditional agro-pastoral economy leading to a situation where complementary production specialization was replaced by a polarizing diversification process. On the one hand, the Fulani began breeding goats in addition to raising cattle and to cultivating millet, but encountered problems of a labor constraint and of low productivity due to a lack of knowledge about risk-reducing cropping techniques and a disregard for their former slaves’ activities. The average productivity of cereals output per Fulani laborer is two to three times lower than a Rimaaybe’s productivity depending on the quantity of manure the fields receive, which in turn depends on the size of the herds (Dugue, 1989; Colliot and Nguyen, 1993). On the other
hand, the Rimaaybe introduced cattle raising in their production systems, which afforded them a complete economic independence from their masters (Langlois, 1983; Ford, 1988; Ellsasser, 1990).

Today, despite internal disjunctions in the structure of the agro-pastoral society, transfers of products and labor between the former master and slave communities still occur in Banh but at a smaller scale and take the forms of gifts and state-contingent credit contracts instead of tributes. Informal credit contracts without well-defined terms (duration and interest rate) are typically negotiated between household-consumers and household-shopkeepers living in the village. Mutual help exists, but it is more frequent in the Fulani community due to the need to optimize movements of herds and the management of communal pastures, whereas, within the Rimaaybe community, reciprocal networks are marginal because of the long-lasting subordinate ties linking Rimaaybe households to their masters (Ford, 1982; Riesman, 1992). The data collected from the 1990 and 1993 agricultural seasons indicate that although in-kind and monetary transfers across households are more important in their size (but not necessarily in their frequency) in years of good harvest, they still account for only a marginal part of household total transactions (Table 2.4).
### Direct Transfers Across Sample Households

<table>
<thead>
<tr>
<th>Year</th>
<th>In cash</th>
<th>In kind</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1990-91 (severe harvest deficit)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number of transfers</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Average size of transfer (Fcfa)</td>
<td>10976</td>
<td>12765</td>
</tr>
<tr>
<td>Percent of total transactions made as direct transfers</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>1991-92 (good harvest)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number of transfers</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>Average size of transfer (Fcfa)</td>
<td>40577</td>
<td>54611</td>
</tr>
<tr>
<td>Percent of total transactions made as direct transfers</td>
<td>1.3</td>
<td>1.2</td>
</tr>
<tr>
<td><strong>1992-93 (average harvest)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number of transfers</td>
<td>17</td>
<td>6</td>
</tr>
<tr>
<td>Average size of transfer (Fcfa)</td>
<td>27935</td>
<td>42275</td>
</tr>
<tr>
<td>Percent of total transactions made as direct transfers</td>
<td>1.3</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Table 2.4. Direct Transfers Across Households in Years of Good and Bad Harvest
Within an extended household, resource allocation decisions are made by the head of the household. In the Fulani society, children become economically productive at the age of seven. Girls are responsible for herding goats and for helping their mother in domestic activities, such as grounding grains and collecting fire wood, whereas boys have to watch over cattle herds and cultivate during the rainy season. Girls leave their father’s home after their marriage, whereas boys can claim their independence upon having their own sons of herding age. At this point, they can self-sustain their own families with the herds they are entitled to at their births. Similarly, in Rimaaybe households, younger members have to work on the family fields from sunrise to 4 p.m. during the entire cultivation season. They are permitted to cultivate personal fields only after 4 p.m., but if needed, the household head could requisition personal granaries.

Respected head of household are those who can keep their elder sons from leaving in order to maintain a large family with a large herd (Riesman, 1992). Following the Chayanov tradition, Stenning (1958) established that there exist a lower and an upper limit to the size of the herd that is determined, respectively, by family needs, labor force size, and the amount of pasture resources. Since both his reputation and the reproductive capabilities of his household and of the community depend upon the size of the extended household, the Fulani household head’s objective is to maintain the family cohesion.

---

6 Fulani women do not cultivate, limiting hence the family labor availability during the rainy season.
In the agro-pastoral society of Northern Yatenga, the household head has full authority over the use of labor and the products of labor of non-emancipated members (Hopen, 1958).

This is common especially in times of emergency since the essence of such an organization is to "create lifelong organic relations" among members of the domestic group (Meillassoux, 1981). From his study of village organizations in South India, Wade (1988) actually found that ingenious institutions with built-in insurance schemes tend to emerge more often as the environment becomes riskier. Moreover, Binswanger, McIntire, and Udry (1989) suggested that ownership of family labor and common stores of assets clearly provide the household head with a "powerful means of extracting cheap labor" and "might enable the household to accumulate faster than it would otherwise." Despite the control the household head has over their labor and assets, younger members may remain within the extended household in order to benefit from the household head's insurance services financed through the redistribution of commonly stored products (granaries and livestock) and transfers across nuclear families.

Table 2.5 summarizes household average demographic and economic characteristics as well as some correlations between these characteristics. From two to five nuclear families and six to 37 people form an extended household in the area of study. On average, an extended household counts 3 nuclear families and 10 persons. Household livestock averages 241 goats, but the distribution is skewed as 50 percent of the extended households have less than 63 goats. Grain harvest from common fields averages 1891 Kg, which is sufficient to feed approximately ten adults. In addition to their labor participation in the cultivation of
common fields, each nuclear household contributes to the common pot an equivalent of 473 Kg of grain. This pot is usually used to invest in livestock or it is saved in case of emergency. Correlation coefficients in Table 2.5 show, as expected, that the household’s major physical asset (i.e. livestock) and off-farm income are positively correlated with household size. In addition, the correlation matrix, in Table 2.6, supports the hypothesis that alternative activities are less than perfectly positively correlated. Activity diversification combined with field scattering techniques within an extended household can constitute effective risk management strategies.

The proposition that households are traditionally organized into large units for insurance purposes does not explain, however, why nuclear households with food deficiencies are observed. A breakdown of households by size (nuclear and extended) and food consumption level along with labor force and asset characteristics are shown in Table 2.7.

Households made up of one unique nuclear family experiencing food deficit (i.e. having a level of food consumption lower than the WHO-defined quantity of food required to have a normal life) represent on average 27 percent of all households. Compared to food sufficient or food surplus extended households, which represent 33 percent of the total, these food deficit nuclear families have, as expected, a high dependency ratio and only a few livestock. A comparison of food deficit nuclear families with the 23 percent of nuclear families that are food surplus suggests that high asset levels can effectively compensate for the high dependency burden.
### Table 2.5. Average Demographic and Economic Characteristics of Extended Households in the Sample

<table>
<thead>
<tr>
<th>Household Characteristics</th>
<th>Mean</th>
<th>Median</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of nuclear families in an extended household*</td>
<td>3.30</td>
<td>3.00</td>
<td>1.58</td>
</tr>
<tr>
<td>Number of people in a household</td>
<td>11.74</td>
<td>10.50</td>
<td>49.75</td>
</tr>
<tr>
<td>Household livestock (in equivalent number of goats)</td>
<td>241.09</td>
<td>62.50</td>
<td>15.01 e(^{-4})</td>
</tr>
<tr>
<td>Household grain harvest (in Kg)</td>
<td>1,890.91</td>
<td>1,556.00</td>
<td>26.98 e(^{-5})</td>
</tr>
<tr>
<td>Household off-farm income (FCFA)</td>
<td>96,334.05</td>
<td>46,025.00</td>
<td>21.05 e(^{-9})</td>
</tr>
<tr>
<td>Contribution to common pot from each nuclear family (in equivalent Kg of grain)</td>
<td>473.09</td>
<td>324.00</td>
<td>10.82 e(^{-5})</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Correlation coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of nuclear families and number of household members</td>
</tr>
<tr>
<td>Number of nuclear families and asset level</td>
</tr>
<tr>
<td>Number of nuclear families and harvest</td>
</tr>
<tr>
<td>Number of nuclear families and off-farm income</td>
</tr>
</tbody>
</table>

* There are 23 to 20 extended households in the sample in 1990 and 1993 respectively.
<table>
<thead>
<tr>
<th></th>
<th>Cropping</th>
<th>Breeding</th>
<th>Labor contract</th>
<th>Off-farm activities</th>
<th>Migration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cropping</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breeding</td>
<td>-0.248</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labor contract</td>
<td>-0.213</td>
<td>0.034</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Off-farm activities</td>
<td>-0.053</td>
<td>-0.152</td>
<td>-0.185</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>Migration</td>
<td>0.187</td>
<td>-0.195</td>
<td>0.041</td>
<td>0.030</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Table 2.6. Correlation Matrix of Activity Returns
<table>
<thead>
<tr>
<th>Household size</th>
<th>Percent of H.H and labor and asset indicators</th>
<th>Level of food consumption:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Food deficit</td>
</tr>
<tr>
<td>Nuclear household</td>
<td>1. Percent of households in total sample</td>
<td>26.79</td>
</tr>
<tr>
<td></td>
<td>2. Average dependency ratio (^2)</td>
<td>2.10</td>
</tr>
<tr>
<td></td>
<td>3. Livestock (equivalent number of goats (^1))</td>
<td>34.69</td>
</tr>
<tr>
<td>Extended household</td>
<td>1. Percent of households in total sample</td>
<td>17.26</td>
</tr>
<tr>
<td></td>
<td>2. Average dependency ratio</td>
<td>2.57</td>
</tr>
<tr>
<td></td>
<td>3. Livestock (equivalent number of goats)</td>
<td>323.43</td>
</tr>
</tbody>
</table>

1. Food deficit (surplus) households are defined as households having a level of food consumption inferior (superior) to the WHO-defined minimum food consumption required to maintain a normal life, which is equivalent to 550 grams of grains per person per day.

2. The average dependency ratio is defined as the average of all the ratios total number of household members over number of members who are economically active.

3. Herds of cattle, sheep and goats have been converted into herds of goats according to the terms of exchange practiced by local populations in order to facilitate household comparison.

Table 2.7. Distribution of Households By Size, Labor, Size of Herd of Livestock, and Level of Food Consumption
The possession of livestock is not, however, a sufficient condition for food sufficiency as illustrated by the differences between food deficit and food surplus extended households. Achieving consumption smoothing requires either an optimum combination of labor and assets, that the majority of extended households in Banh have achieved, or a minimum level of livestock associated with an optimum management of the resources commonly held by food surplus nuclear households. A closer look at the latter requirement is necessary to derive hypothetical explanations for a household's success in consumption smoothing.

(ii) Role and Importance of Informal Finance

In the rural Sahelian part of Burkina Faso, informal and formal finance are built around two institutions, one relying upon socially organized networks and the other one on market transactions. Eboue (1988) discussed three factors that have induced the development of informal financial institutions in Africa. These factors are the reciprocity nature of social organizations, the flexibility of collective action, and the importance of solidarity in traditional societies. Informal financial transactions, including saving, borrowing, and lending, serve the main purpose of helping each other. Indeed, the idiosyncratic nature of income shocks allows households to engage in intertemporal state-contingent exchanges and pool and redistribute risk.

The importance of informal finance in Sahelian economies which includes savings and borrowing as well as insurance instruments, has been widely studied (Lelart, 1985; Servet, 1987; Adams, 1994) and empirically estimated (Udry, 1990; Deaton, 1992; Ouattara, 1993). Its very diverse and flexible features arise from the matching process of borrowers with
lenders according to their characteristics (Foster, 1988). Many institutions have been described in detail, but the most frequently cited are the spatially and intertemporally organized networks of relatives and traders to transfer currencies and commodities (Graham, 1994), and the rotating savings and credit associations created to either channel funds for consumption or accumulate investment capital (Bouman, 1983; Lelart and Gnansounou, 1994).

There are mixed conclusions, however, when researchers evaluate the importance of financial intermediation (defined as the channelling of funds from surplus to deficit households) relative to other income and consumption smoothing mechanisms in the recent history of Sahelian agrarian economies. Using data collected in 1985-86 over a sample of 400 households in rural Niger, Graham (1994) found that informal credit represents 17 percent of household agricultural income. Christensen (1989), Reardon and Mercado-Peters (1992) reported a much smaller share of informal borrowing/lending activities to total budget size in Burkinabe households during the same period. Any comparison across studies must be interpreted with caution because survey procedures, variable measures, and ethnic groups sampled are usually different. Christensen (1992) argued, however, that the absence of a general tendency in household use of informal intermediation suggests that the predominant role of informal financial intermediation is yet to be established. Like any other community-based institutions, factors such as asymmetric information, the increase in covariate risks, and the development of insurance alternatives seem to have created an environment unfavorable to the reproduction of informal financial institutions in agrarian economies (Foster, 1988; Platteau, 1991; Christensen, 1992; Townsend, 1996).
In the North Yatenga, it is important to distinguish between non-financial saving (livestock and granaries) and borrowing. If the level of savings is high across all households and years, credit activities involve fewer households and are observed preferentially during years of bad harvest such as 1990-91 (Table 2.8). Livestock is the most preferred form of non-financial savings because of its social value for agro-pastoral societies and its high rate of return from the animal production of calves, milk and manure. It could be shown that Fulani herders manage their herds as a portfolio of assets having different expected rates of return and variances. Goats and sheeps are used as short-term savings, which are depleted in case of emergency, whereas cattle constitute long-term savings and are sold only to cover important expenditures.

Despite frequent drought and disease outbreaks, risks of mortality for the livestock are only of 4.7, 19.7, and 17.7 percent for cows, sheeps, and goats, respectively (Colin de Verdiere; 1988). The estimated rate of return of a herd on 57 equivalent goats (the terms of exchange fixed by Fulani herders is approximately one cattle for 20 goats) is on average equal to 38 percent. This form of savings, which represents 30 to 95 percent of household liquid wealth in our sample and 54 percent in Christensen’s sample (Christensen, 1989), plays an important ex ante and ex post role in insuring a household against income shocks.
<table>
<thead>
<tr>
<th></th>
<th>Borrowing from projects</th>
<th>Borrowing from informal sources</th>
<th>Informal lending</th>
<th>Non-financial savings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1990-91 (severe harvest deficit)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of households in total sample</td>
<td>21.19</td>
<td>23.81</td>
<td>7.14</td>
<td>42.86</td>
</tr>
<tr>
<td>Average size of cumulative financial transaction (FCFA)</td>
<td>26,541</td>
<td>11,750</td>
<td>20,000</td>
<td>18,453</td>
</tr>
<tr>
<td><strong>1991-92 (good harvest)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of households in total sample</td>
<td>11.91</td>
<td>14.28</td>
<td>7.00</td>
<td>66.67</td>
</tr>
<tr>
<td>Average size of cumulative financial transaction (FCFA)</td>
<td>16,000</td>
<td>8,975</td>
<td>21,667</td>
<td>130,008</td>
</tr>
<tr>
<td><strong>1992-93 (average harvest)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of households in total sample</td>
<td>7.11</td>
<td>16.67</td>
<td>26.19</td>
<td>77.16</td>
</tr>
<tr>
<td>Average size of cumulative financial transaction (FCFA)</td>
<td>20,433</td>
<td>40,600</td>
<td>15,618</td>
<td>10,860</td>
</tr>
</tbody>
</table>

Table 2.8. Sources of Household Financial Services and Indicators of Household Financial Transactions
On the one hand, gifts made to newborn babies and traditional reciprocal exchanges of animals (Langlois, 1983), although sometimes perceived as debt, help to strengthen social ties. On the other hand, livestock is often used like any other asset as a major buffer stock even if households never completely deplete their savings in order to fully offset income shocks. This is probably due the household’s expectation of future income and consumption streams (Czukas, Fafchamps, and Udry, 1995).

Informal credit transactions represent less than 5 percent of the village total income, confirming the results cited by Christensen (1989) and Reardon and Mercado-Peters (1992). These transactions include loans occasionally contracted with relatives primarily for consumption purposes, in-kind loans given by wholesalers (usually large merchants from big cities) to detailed traders (small shopkeepers selling in villages or local markets), and pawnbroking practiced by village shopkeepers.

Two types of networks can be observed based on the characteristics of the partners and the nature of the transactions. The first type of network is composed of socially-linked households. Lending in this network acts as a device to create and strengthen long-lasting social ties. The second type of network matches consumer-borrowers to lender-traders, and it is motivated by profit maximizing behavior. In this second case, the distinction between barter transactions and strictly-defined informal loans appears ambiguous. Indeed, due to the absence of cash reserves and the poor circulation of cash within the village, this form of informal credit transaction is often used by households as delayed cash payments.

Despite the numerous examples of ROSCAs described by Servet (1987) in Senegal, Graham (1994) in Niger, and Ouattara (1994) in the Gambia, no such organization was
observed in the village of Banh. Nevertheless, several women reported that they have
attempted to create a *tontine* with their neighbors, but all the experiences failed after two to
three cycles due to interruptions in the off-farm activities of one or more members. Several
explanations are offered for the low level of informal credit transactions, which come from
the demand side (self-rationing), the supply side (quantity and price rationing) or both
(absence of matching opportunities). In the context of transitional agrarian economies, high
uncertainty makes it more difficult for both lenders and borrowers to commit. Income shocks
and uncertainty about future loans increase the risk of default on the borrower’s side, whereas
lenders may not be able to service the potential demand due to limited funds and asymmetric
information problems. As Platteau argued “one can never be sure that the costs imposed by
the need to control moral hazard problems” (from both sides of the transaction) “will be offset
by the risk-pooling benefits, given covariate yield or incomes” (Platteau, 1991: 140).

b. The Development of Market Transactions

(i) Definition of Market-Based Insurance Mechanisms

Market insurance strategies are defined as mechanisms that do not require socially
organized institutions such as reciprocal networks and extended households but that on the
contrary rely upon explicitly priced transactions with anonymous partners. Citing Gregory
(1982) and Williamson (1985), Platteau (1991) considered that market exchanges can be
fully characterized by “the rule of contract and private property.” “Private property means
that a person has exclusive and alienable rights over the things that he or she owns” while “the
rule of contract presupposes that relations can be established between agents, that is, between
parties who are free and independent in the sense of being fully emancipated from all kinds of non-economic constraints” (Platteau, 1991: 118-19). In this sense, insurance schemes based on market exchange correspond more closely to the Arrow-Debreu type of transaction, which ideally matches individuals with respect to a set of characteristics resulting in a Pareto optimum.

Furthermore, self-insurance will be defined in contrast to community risk pooling as a strategy developed by a household independently of others. This includes risk management and risk coping strategies such as a sale of assets and family labor to the rest of the world. While the commonly used risk management strategies (field scattering and activity diversification) are in general limited by the availability of family labor, risk coping opportunities require the existence of labor and key agricultural markets.

(ii) Role of Markets for Agricultural Products and Labor

Market exchange of agricultural products and labor were introduced in the region in the eighteenth century along with the introduction of money supplied by traders visiting the region from Mali and the southern part of Burkina Faso. A native Fulani interviewed in 1994 reported having seen 57 years ago his father sell a cow for the first time to a cattle trader coming from the southern part of the country to earn money to pay taxes imposed by French settlers. This trader was himself supplied with cash from cultivating cotton and groundnuts in Southern Burkina Faso where these crops were developed under the French influence. Rimaaybe were similarly selling their crops, reducing their tributes to their masters. Since that
time, the size of agricultural markets has rapidly increased to a current level of more than half of the total monetary and non-monetary transactions (Ancy, 1983; Pieroni, 1989).

During the 1990-91 crop deficit period, market exchanges of agricultural products and labor represented between 13 and 55 percent of all transactions made by households in Banh. In contrast, social transfers across households (gifts and informal loans) accounted for only 1 percent (Colliot and Nguyen, 1993). Similar results are reported by Christensen (1989) and Reardon and Mercado-Peters (1992), who found that net transfers (gifts and informal loans) across households represent only a small part (no more than 7 percent) of household total income.

Emerging labor markets include the sale of local labor and seasonal and long-term migration. The rapid economic development in South West African countries in the 1950s and 1960s led to an important migration wave from Burkina Faso to Ghana and Ivory Coast, which has slowed down since the 1980s. Seasonal migration occurs during the dry season between December and June, and it reflects movements of villagers to gold mines located in Southern Yatenga or to the large cities of Ouahigouya and Ouagadougou. Total revenues from migration can represent on average upwards of 30 percent of a household’s total income, of which irregular remittances from long-term migrants represent about one-third of income.

The local labor market is limited to seasonal cropping activities for which the daily wage is on average equal to 350 to 500 Fcfa plus one meal, and herding activities which consist in the guarding of wealthy cultivators’ herds by poor Fulani in exchange for animals...
and milk. These transactions constitute only an embryo of the labor market because labor was traditionally a vital commodity exchanged only in reciprocal and redistributive spheres (Dalton, 1971). There is a negative correlation of -0.24 between the level of assets and labor income, suggesting that only poor households tend to sell family labor. In contrast, households possessing a large herd of livestock tend to deplete their savings in order to cover consumption expenditures. However, the disaving rate declines as herd size increases because rich households are forced to deplete proportionally less than poorer households.

Figure 2.5 shows the weekly cash inflows and outflows associated with the sale of livestock and cereal purchases in the local market. Cash inflows tend to follow a regular pattern corresponding to the household’s seasonal demand in cash whereas cash outflows are clearly correlated with seasonal and interannual crop deficits. Indeed, successive severe droughts over the last decades have increased the household’s dependence on the cereal markets. In years of bad harvests like 1990, food consumption represents up to 80 percent of household total expenditures (Table 2.2).

---

7 The exchange rate was prior to the 1994 devaluation 250 Fcfa for one US dollar.
Figure 2.9. Local Markets of Cereals and Livestock: Weekly Inflows and Outflows of Cash
In years of good harvest, the demand for cash remains at a high level due to the shifts in household expenditures from food consumption to social consumption for events such as weddings and baptisms that were postponed to a period of abundance. Readon and Mercado-Peters (1992) reported similar household expenditure patterns. Using data from an extensive household survey conducted by the ICRISAT in Burkina Faso between 1981 and 1984, they showed that household cash demand is substantial in years of crop deficit (40 percent of cereals consumed are purchased) as well as in years of good harvest, contradicting the traditional view of subsistence rural households.

Finally, it is important to mention that until recently, in Northern Yatenga, land remains the only commodity that is not exchanged in the market. This contrasts with many other parts of the country, where the penetration of a market economy via the establishment of large plantations along with rapid population increases have led to the creation of a land market. Fulani families own the majority of the land in the region, even if land tenure patterns ensure to the Rimaaybe lines the usufruit of the land “given” to them by their masters. Ancey (1983) argued that the absence of a market for land deprives the traditional power in place of gaining effective means to balance the economic control of the younger generations. Moreover, Zimmerman’s conclusion of how risk can induce the emergence of land markets among Burkinabe farmers seeking to smooth consumption does not hold in our Sahelian context (Zimmerman, 1994).
(iii) Development of Formal Finance

The deterioration of the Sahelian agro-pastoral economy during the last two decades has brought many development projects into the region, with three of them having a more or less important financial component. Two Burkinabe-sponsored projects 6S and UCODEB, launched in the mid 1980s, provide farmers with two types of in-kind loans: potato seeds (repayment after the harvest in cash equivalent of the seed value borrowed) and carts (five yearly repayments of 5,000 Fcfa without interest).

The third project, Projet de Promotion du Petit Crédit Rural (PPPCR), is a French-financed credit project implemented by a Burkinabe NGO, Sahel Action, in 1988. Following the Grameen Bank's principles, this project offers small loans to groups of five borrowers, mostly women, in order to support the development of microenterprises. Individual loan sizes vary from 5,000 Fcfa for a one-year loan with weekly repayments to 10,000 Fcfa for a six-month loan with one repayment targetted on sheep fattening. The interest rate is about 24 percent per year. In addition, there is a compulsory saving scheme that represents five percent of the total loan used to build up the borrower’s capital share in the forthcoming financial institution.8

The distribution of formal and informal loans among the different types of households in Banh tends to be concentrated among medium income households. The percentage of households having multiple loans also outnumbers the percentage of single-loan households.

Of the total number of household borrowers, 78 percent have an average of 3 loans. Formal loans provided by the various development programs seem to complement informal credit whenever the latter cannot satisfy demand.

Similarly, household lenders tend to be wealthier than the average person, suggesting that lending and borrowing activities are more frequent among the better-off households. Surveys do confirm that poorer households self-ration themselves, preferring other types of consumption smoothing mechanisms over credit. On the lenders' side, creditworthiness combined with other requirements such as collateral, which is inevitable in the case of pawnbroking, or mandatory savings and permanent settling in the case of the PPPCR, are often used as a screening criteria. If client selection is quite apparent in the informal lending world, it is not clear whether the screening process practiced by loan officers and bank workers objectively targets certain categories of the population.

The fungible nature of money prevents the follow-up of loans uses. However, in an economy in transition where money can be scarce in periods of high consumption, it is possible to trace to a limited extent the use of loans by asking borrowers how they allocated their loans or how their expenditures have been financed. Similar to informal borrowing, formal loans serve for financing both productive investment and final consumption with, as expected, an emphasis on final consumption in years of bad harvest. In 1990-91, a majority of the loans disbursed by the PPPCR actually financed food expenditures.

In fact, beyond the nature of the contracts involved, the main difference between informal borrowing and formal borrowing lies in the characteristics of the parties. If the lenders are from the village's social networks, informal transactions can take place and usually
involve in-kind exchanges. In contrast, if the lenders are, for example, cereal traders from outside the village, informal borrowing viewed as a state-contingent transfer cannot take place. In this case, monetary exchanges are possible and households will choose to use formal credit if it is available. Therefore, the matching phenomenon can explain the presence of multiple loans. The majority of medium-income households indicate that their principal motivation for borrowing from formal sources to cover consumption expenditures is to substitute formal loans for livestock depletion because the present borrowing costs are lower than the expected future income stream from keeping the animals. There is clearly a trade-off between informal and formal finance, and the relative attractiveness of each one depends upon the circumstances.

4. The Decline of Traditional Insurance Institutions

I have already discussed the importance of two institutionalized informal consumption smoothing strategies, which are the extended household and, at a larger scale, the village community. Transfers of resources across states of nature as well as capital accumulation at the household level have long served as major insurance substitutes in an environment where no formal insurance or any kind of public safety net exist.

However, anthropologists have reported a significant decline of traditional insurance institutions in Sahelian agrarian economies (Dreze, 1989; Platteau, 1991). Starting in the late eighteen century under the influence of Islam, the partition phenomenon of traditional communities in the Sahel seems to have accelerated in the last three decades due to successive periods of severe crop deficit in conjunction with other demographic and economic factors.
(Riesman, 1974; Ford, 1982). Wade (1988) described the endogeneous creation of insurance institutions in risky environments and indicated that these might not be sustainable. Similarly, Stiglitz (1989) argued that changes in the environment underlying the emergence of alternative insurance strategies can explain the pervasiveness as well as the decline of traditional risk-sharing institutions such as sharecropping.

In the sample, 13 out of 42 households had experienced, before the survey period, a partial or complete break-up due to conflicts around the distribution of the common harvest in periods of food deficit. During the four-year survey, nine new nuclear and extended households were created from the dissolution of five initial extended households.

Raynaut (1973), Binswanger et al. (1989), Meillassoux (1981), and Platteau (1992) have discussed how traditional insurance institutions can be affected by population growth and the introduction of alternative market-based insurance strategies. Population growth puts pressure on the use of scarce resources within a closed economy, lowering the effectiveness of risk-sharing to smooth out shocks having a relatively large aggregate component. A household or a village community can be viewed as a governance structure which has a comparative advantage in supplying certain services such as insurance, since family ties and personal relationships facilitate the monitoring of individual participation in the insurance scheme. As such, population growth can affect traditional insurance institutions by increasing the opportunity for moral hazard behavior. In addition, there is an issue of equity regarding the amount of contribution one has to provide as compared to how much he could receive in exchange. This issue has been raised by Farmer and Tiefenthaler (1995) who analyzed behavior of heterogenous households in environments characterized by resource scarcity. In
particular, equity could be critical in the Sahelian context where households with low
dependency ratios (defined as the total number of family members over the number of
economically active members) have to care for households with relatively high dependency
eratio.

The opening of isolated villages to the rest of the world may, on the one hand, enlarge
the opportunity set of households. Individual strategies based on market exchanges such as
the sale of labor outside of the community, the sale of assets to anonymous traders, and
formal saving and borrowing, become available. These strategies can then either be
complementary to traditional community-based consumption smoothing strategies or compete
with them in terms of cost-effectiveness. One consequence of market penetration into the
traditional agro-pastoral economy of Northern Yatenga is the development of cash income
activities within the household sphere. These activities are pursued to either satisfy the
demand for new commodities or to avoid transaction costs associated with the barter system.
This work is predominantly seasonal due to labor constraints during the cultivation season.
Furthermore, cash generating activities such as shopkeeping, trading, handicrafting, food
processing, and animal fattening are very diverse in nature, profitability, and capital
requirements.

Successive years of crop deficits have increased household dependence on markets
and thereby the importance of these activities not only for men, who are traditionally
responsible within the household for the supply of food and other basic needs, but also for
women, who occasionally have to complement their husband's earnings. During the 1990-91
period, female contribution to cereal purchases represented on average 22 percent of total
food expenditures, giving women additional power in the household decision making process. It is important to mention that in normal circumstances cash income is not pooled automatically within a household. Pooling occurs only when the household head expresses the need for a transfer and personally supervises the redistribution between the household members. Since their returns are less than perfectly correlated with returns on agricultural production, cash-generating activities can improve the effectiveness of a risk-reducing portfolio of activities. The degree of portfolio diversification depends, however, on the availability of family labor and investment capital. Again, correlation coefficients (Table 2.5) report a positive correlation between off-farm income and indicators of family labor force.

On the other hand, anthropologists argue that the penetration of market economies in traditional societies does create room for opportunistic and free-riding behavior (Ensminger, 1992). There are reported cases in the Orma society in Kenya of free-riding behavior on behalf of young men, who sold household assets without elders’ authorization (Enswinger, 1992). In a study of intrahousehold budget allocation in Burkina Faso, by studying the decision making process and income disparity within a sample of households, Ancey (1983) found a mismatch between the social power traditionally enjoyed by the elder and the new economic power acquired by the younger economically active members of the household engaged in cash earning activities. Therefore, to maintain family cohesion, some household heads limit or even forbid participation in these activities.

More important than the disappearance of indigenous insurance institutions are the effects the disappearance of social insurance has on household welfare. In the absence of well-functioning markets, Carter (1991) has demonstrated that the disappearance of social
insurance will lead to a one-to-one relationship between individual risk exposure and resource endowments. Using the ICRISAT Burkina Faso database, Zimmerman (1994) simulated the functioning of social risk-sharing. His results show that, in an environment where opportunities for asset concentration are developing, about one-third of the participants in a risk-sharing scheme drop out immediately: "Because the cost of participation is positively related to one's asset base, and the benefits negatively related to it, it is clear that it is the wealthier agents who withdraw from the scheme earliest, leaving at last only those who are best only slightly above subsistence as members of the scheme."

E. CONCLUSION: From Traditional Community-Based Insurance Institutions to Market Oriented Self-Insurance Strategies

In summary, traditional insurance arrangements are based on socially well-established reciprocal relationships rather than on anonymous contingent exchanges. Institutionalized arrangements include complementary transfers, which take the forms of tribute-disguised gifts and loans between the Fulani and their former slaves Rimaaybe and transfers within an extended household. Transfers can either be state-contingent transfers across nuclear families permitted by risk-sharing strategies or transfers across generations through savings.

Despite their importance, stylized facts suggest that the future of indigenous insurance institutions is open to question due to rapid changes in the environment in which they have emerged. Starting from a situation where individual households are grouped in large socio-economic units insuring each other by state-contingent contracts and intertemporal transfers,
the current picture of Sahelian agro-pastoral economies displays an apparent disfunctional community-based insurance scheme.

The decline of traditional insurance institutions, however, is not in itself a critical issue. The problem comes from the individualized effects of this disappearance on household welfare, in an environment where well functioning markets and public interventions are rare. Forty-four percent of the households in the village of Banh, among which more than half are nuclear families with small endowments of physical and human resources, are experiencing chronic food deficit. A food self-sufficient community will not necessarily be food secure, if food security is defined as the continuous access by all the population to sufficient quantities of food. I argue that these observations provide strong support for examining in more detail and more rigorously the determinants of the decline of traditional insurance and its effects on household welfare.
CHAPTER 3

DO HOUSEHOLDS FULLY SHARE RISK?
A FORMAL TEST OF THE PERFECT INSURANCE MODEL AND A CLOSER
LOOK AT INEQUALITIES IN HOUSEHOLD CONSUMPTION SMOOTHING

A. MOTIVATIONS

The descriptive analysis of household consumption smoothing in Chapter 2 has shown evidence that households in rural Burkina Faso develop relatively complex strategies and institutions to smooth out consumption after important income shocks. These strategies can be classified into two categories according to whether they involve exchanges over time (i.e., savings and borrowing) or state-contingent exchanges (i.e., transfers across households). Extended households and the village community at a larger scale represent two ubiquitous agrarian organizations known to have incorporated those two dimensions of consumption smoothing. In the absence of formal insurance markets, these institutions were also known to be the most efficient in supplying insurance services to households until recent signs of break-down and ineffectiveness.

Before going further in the study of traditional risk-sharing institutions, it is important, on the one hand, to identify households which experience chronic food deficits and, on the
other hand, to evaluate the extent to which the village community and extended households are insuring individuals against income shocks. Although stylized facts from Burkina Faso underscore the role of the village community and extended households in supplying social insurance, they do not provide any clear evidence to support the claim that informal risk sharing is perfect.

The descriptive analysis conducted in Chapter 2 shows that not all households are able to smooth their food consumption in the face of adversities. There is, however, no strong evidence of significant dysfunctioning within the village community or extended households that would lead to imperfect risk-sharing. The objective of this third chapter is, therefore, to characterize households according to their ability to insure their food consumption and to test the insurance first-best outcome, where households within the village community and nuclear families within an extended household are perfectly sharing risk with each other.

The standard full-insurance model is adapted to the present problem and estimated using my small Burkina Faso panel data. I believe the neoclassical theory of perfect insurance provides a useful benchmark to study the nature and causes of departures from the first-best insurance outcome. However, the standard model of perfect insurance is not expected to provide any insight into understanding the rationale behind social risk-sharing, its structure and effectiveness.

First, an exploratory analysis of variations in consumption smoothing across households is performed using cluster and principal component approaches. In the light of the descriptive analysis of household consumption strategies in Chapter 2 and studies conducted by Eswaran and Kotwal (1989), Carter (1991), and Zimmerman (1994), I have the
hypothesized that the structure of the household economy is critical to the understanding of observed inequalities in household ability to smooth consumption. This exploratory analysis should help to identify associations between the household’s ability to smooth out income shocks and household characteristics. It should also help to select the set of exogenous variables that could best explain household food consumption.

The chapter then reviews the neoclassical theory of perfect insurance and summarizes findings of major empirical studies. The perfect insurance hypothesis will then be tested with the Burkina Faso data, based on a modified version of the test developed by Mace (1991). The estimation results will then serve as a basis for discussing alternative approaches for the study of the evolution and effectiveness of indigenous insurance organizations.

B. EXPLORATORY ANALYSIS OF VARIATIONS IN HOUSEHOLD ABILITY TO SMOOTH CONSUMPTION

Large variations in food consumption are observed across households within the village despite the existence of well known community insurance strategies (Figure 2.4). The descriptive analysis in Chapter 2 found food deficit households among both extended households and nuclear families within the village. It also suggested, on the one hand, a negative correlation between the dependency ratio and household food consumption and, on the other hand, a positive correlation between household assets and food consumption. A more detailed analysis can classify all the households along a food consumption scale according to their economic characteristics. To do so, I conducted two types of multi-variate
analysis, cluster and principal component analysis, using the 1990-1991 data. This year is characterized by a major crop deficit making it an ideal test for studying a household's revealed ability to insure food consumption against income shocks.

1. Cluster Analysis Results

A cluster analysis, using the centroid hierarchical method was performed to separate the 42 households into groups on the basis of 13 variables describing their demographic characteristics (number of nuclear families, total number of members within the extended household, dependency ratio) and their economic situation (deviation from average production, deviation from average consumption, number of cattle, number of goats, rate of disavings, labor income, off-farm income, remittances, formal outstanding credit, informal outstanding credit). This is known to be the most robust method for outliers. The method identified ten clusters with respect to the combination of the 13 variables. Results are reported in Figure 3.1 and Table 3.1.

a. Unequal Distribution of Wealth and Income and the Importance of Market Penetration

Several general patterns revealed by the cluster analysis deserve focused attention as they illustrate, on the one hand, the highly unequal distribution of income and of physical and human capital across household clusters and, on the other hand, the importance of market penetration in this formerly isolated village.
In contrast to the conventional view of an egalitarian village in rural Sub-Saharan Africa, households in Banh and other villages in the region exhibit a highly unequal distribution of wealth, a concept used here as a proxy for household ability to smooth consumption. My definition of wealth goes beyond the conventional definition that defines wealth in terms of financial and physical assets only. The availability of labor force is a good indicator of household ability to engage in risk-diversification strategies. This should be included in the definition of household wealth. Physical assets represent, in turn, a good indicator of the household's ability to smooth consumption over time through savings and of household ability to develop off-farm activities requiring start-up capital.

The average number of cattle and goats in a household cluster goes, respectively, from 0 to 27 and from 0 to 124, while household average size ranges from 4 to 17 people (Table 3.1). Clusters A, B, and C suggest that, on average, households having a large herd tend to be large extended households (households with more than one nuclear family) with a relatively high dependency ratio. Their disavings rates are smaller relative to those of households having a smaller herd of livestock (clusters F, H, and G). There exists, however, extended households in the village with just a few animals (cluster G). These are, in general, households which experienced dramatic losses during the 1970 and 1984 droughts. Elders reported that during these severe droughts, households with a large herd of cattle had to migrate to regions infested by the tze-tze flies in Southern Burkina. Due to their lack of resistance, many cattle died and these households lost their highly ranked social status to the benefit of formerly poorer households as they returned to their native villages (Ellsasser, 1990).
In contrast to these extended households are small households (clusters D, F, H, I, and J) composed mostly of one nuclear family and holding a relatively small herd of livestock. These small households result from the break-up of extended households, principally following conflicts among brothers after the death of the patriarch or the desire of a married son to become independent. When households break up, the patriarch or eldest brother keeps the household’s common assets inherited from one generation to the other, but loses control over the nuclear families’ personal assets accumulated over their life time. Regardless of their size, this is probably the major reason why nuclear households have a relatively small herd.

Similarly to wealth, large variations in income are observed across the ten household clusters. Household sources of income in the region are principally agricultural production, off-farm activities, remittances and wages. Household demographic and economic characteristics, access to risk management and risk coping strategies, preferences for a portfolio of activities, and idiosyncratic shocks are all possible causes of these variations. The effects of each one of these factors on income variations are, however, difficult to identify and isolate based on the information given by the cluster analysis.
Figure 3.1. Distribution of Households Sampled in Ten Clusters and According to the Percent Deviation from Mean Consumption in 1990-1991
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. nuclear families</td>
<td>2.1</td>
<td>2.9</td>
<td>2.7</td>
<td>1.0</td>
<td>1.8</td>
<td>1.6</td>
<td>3.0</td>
<td>1.5</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Total members</td>
<td>15.5</td>
<td>12.1</td>
<td>17.0</td>
<td>4.5</td>
<td>11.0</td>
<td>11.4</td>
<td>11.0</td>
<td>7.5</td>
<td>7.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Dependency ratio</td>
<td>2.1</td>
<td>2.9</td>
<td>2.0</td>
<td>1.6</td>
<td>2.8</td>
<td>2.3</td>
<td>1.7</td>
<td>1.6</td>
<td>1.2</td>
<td>4.0</td>
</tr>
<tr>
<td>Dev. from mean prod.</td>
<td>38.6</td>
<td>43.2</td>
<td>-66.9</td>
<td>-75.1</td>
<td>5.6</td>
<td>-31.8</td>
<td>-60.1</td>
<td>15.0</td>
<td>-64.47</td>
<td>-100.0</td>
</tr>
<tr>
<td>Dev. from mean cons.</td>
<td>-4.8</td>
<td>6.1</td>
<td>-0.3</td>
<td>-37.3</td>
<td>30.7</td>
<td>-5.3</td>
<td>3.7</td>
<td>-21.49</td>
<td>1.92</td>
<td>1.9</td>
</tr>
<tr>
<td>No. cattle</td>
<td>9.2</td>
<td>26.6</td>
<td>16.0</td>
<td>0.0</td>
<td>0.4</td>
<td>2.6</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>No. goats</td>
<td>42.1</td>
<td>113.3</td>
<td>124.2</td>
<td>0.0</td>
<td>10.0</td>
<td>28.0</td>
<td>4.0</td>
<td>12.0</td>
<td>0.0</td>
<td>33.0</td>
</tr>
<tr>
<td>Disaving rate</td>
<td>28.1</td>
<td>29.7</td>
<td>22.2</td>
<td>0.0</td>
<td>0.0</td>
<td>49.0</td>
<td>0.0</td>
<td>81.0</td>
<td>0.0</td>
<td>79.0</td>
</tr>
<tr>
<td>Labor income</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>32,900.0</td>
<td>0.0</td>
<td>6,100.0</td>
<td>10,250.0</td>
<td>192,000.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Off-farm income</td>
<td>161,661.5</td>
<td>0.0</td>
<td>350,150.0</td>
<td>0.0</td>
<td>171,200.0</td>
<td>129,400.0</td>
<td>33,600.0</td>
<td>38,500.0</td>
<td>10,800.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Remittances</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>43,000.0</td>
<td>0.0</td>
<td>2,500.0</td>
<td>0.0</td>
<td>172,000.0</td>
<td>3,250.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Formal credit</td>
<td>23,807.7</td>
<td>6428.6</td>
<td>35,000.0</td>
<td>0.0</td>
<td>34,460.0</td>
<td>18,500.0</td>
<td>22,500.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Informal credit</td>
<td>5,846.1</td>
<td>785.7</td>
<td>3,750.0</td>
<td>0.0</td>
<td>0.0</td>
<td>5,700.0</td>
<td>3,750.0</td>
<td>0.0</td>
<td>0.0</td>
<td>25,200.0</td>
</tr>
</tbody>
</table>

Table 3.1. Average Characteristics of Households Grouped in Ten Clusters
The other important patterns revealed by the cluster analysis illustrate the importance of market penetration in the village of study. First, off-farm income, which includes incomes from activities such as trade of agricultural products, cottage industries, and handicrafts, is, by far, the most important source of income a household can derive after the sale of livestock (clusters A, C, E, F, G, and I). The scale of these activities has significantly increased after exchanges became monetized and regional markets were created in order to accommodate traders from neighboring regions.

The regional market closest to the village of Banh has been operating since 1984. Approximately 5,000 to 10,000 people living within 20 kilometers from the market depend on it for the supply of food and other essential goods. Located at equal distance between the border with Mali and Burkina Faso's second largest city, this market has become one of the most important platform for trading livestock and grains. Before the development of market exchanges, households practiced cottage industries and handicrafts, but their production was limited to personal consumption and a few barter exchanges with close neighbors.

Currently, a minimum investment in the stock of consumption goods and other inputs is required in order to launch most off-farm activities. Only households that can afford this investment can engage in profitable off-farm activities. These are households with assets or households which have access to external sources of funding such as formal and informal borrowing (cluster A, C, E, F, and G). However, having access to the financial market does not mean that loans are used to finance an activity. Due to the fungibility of money, one cannot distinguish among the many uses of borrowed money. Households can use loans for productive purposes as well as consumption. The cluster analysis only suggests a correlation
between the household’s access to financial markets, on the one hand, and the importance of off-farm income in the household’s budget, on the other hand.

For the other households, the primary source of income is the sale of labor principally during the agricultural seasons. However, the monetized labor market remains limited to exchanges involving partners who are not well acquainted to each other or exchanges involving village informal groups. These village informal groups are initially formed with the objective of helping each other in difficult gender-specific tasks such as the harvest of common fields and the construction of wells. Nowadays, villagers can benefit of the groups’ services in exchange for a daily wage of about FCFA 500 (US$ 1) and compensations in kind (lunch and tobacco). Villagers who work for others and earn wages usually belong to households who have a labor surplus (or equivalently a low dependency ratio) and at the same time cannot engage in more profitable off-farm activities (clusters D and H).

The importance of formal lending relative to informal lending in 6 out of 7 household clusters with positive loan amounts constitute the second most important pattern observed here (clusters A, B, C, E, F, and G). This goes against conventional wisdom which underscores the role and size of the informal sector in low-income rural Africa. In Chapter 2, I have discussed some of the reasons why informal finance is limited in an economy in transition characterized by high information costs, high uncertainty and imperfect markets. Moreover, informal finance is built upon indigenous organizations such as networks of family members and friends, where information is costless and risk can be shared. If it is true that major traditional institutions such as the extended household are disappearing, then one should observe, in parallel, the decline of informal financial organizations. At the same,
abundant amounts of money were brought into the region after the 1984 drought, with the distribution of subsidized loans by three major development projects: 6S, UCODEB and the Projet de Promotion du Petit Crédit Rural. The first two projects benefit principally households that are engaged in farm activities while the last one targets women who are developing off-farm activities.

b. Characteristics of Food Deficit Household Clusters and Food Surplus Household Clusters

The first cluster, A, consists of 13 households with no labor income nor remittances. This means that these households do not work for other households within their village or neighboring villages, nor do members of these households migrate to cities. Within this cluster, there are households who were able to maintain a minimum level of food consumption despite the severe harvest deficits and some who were not.

Households A1 and A2 at the bottom of the consumption smoothing scale (Figure 3.1) are unit nuclear households with low levels of livestock, whereas households A11 and A12 from the same cluster but at the top of the scale have more than one nuclear family, a low dependency ratio and a relatively high level of livestock holdings. The first two Fulani households, A1 and A2, were formed after the actual household heads married and left their father's home upon his request. The children in these households are still too young to efficiently work in the field. Moreover, their herds were not sufficiently large to compensate for the losses and sales occurring during the severe drought of 1984.
In contrast, households in the second group at the top of the consumption smoothing scale are relatively rich in terms of assets and labor force. Composed of more than one nuclear family, these households could develop more elaborate divisions of labor and diversify their portfolios of cash-earning activities during the dry season. These households also share the common trait that the actual household head, an eldest brother, succeeded in maintaining the extended household cohesion after the father’s death. As a consequence, the family’s herd that had accumulated over time was not split among the various families. This second group of households do not differ in their propensity to borrow from formal versus informal sources.

The analysis above suggests that the group of households A has relied essentially on disavings and off-farm income (trading, handicrafts, construction, and cottage industries) to smooth their consumption. Some were more successful than others depending on the number of economically productive members and the household’s level of assets. The former factor allows the household to diversify in order to maximize expected income for a given variance of income. The second factor simply provides a means with which to cope directly with income shocks. Other clusters, such as C and F, show similar patterns but they differ in their combined activities. Households without labor income and informal credit form cluster C, while those without remittances are gathered in cluster F.

Finally, a brief comparison of clusters B, E, G, I, and J, restricted to household consumption, suggests that households with a level of consumption above the mean but without a labor force large enough to permit a diversification strategy can still meet their food consumption needs by depleting their savings and by borrowing (clusters B and J). Two common features among the majority of these households, along with livestock size, are their
ethnic background and the extended household size of three or more nuclear families. These features are characteristic of traditional Fulani herder households where livestock is passively accumulated and transferred from one generation to the next as long as families stay together. Conversely, households without savings but with an abundance of labor can efficiently cope with income shocks by diversifying their portfolio of activities (clusters E, G, and I). These are primarily sedentary farming households that pool resources with as many economically productive members as they can mobilize at any time. At the other extreme, clusters D, F, and H, primarily contain households with negative deviations from the average consumption level. Households in these clusters can be characterized by their smaller size, the absence of assets and credit, and few sources of income.

2. Results of Principal Component Analysis

A principal component analysis with orthonormal and oblique rotations was conducted to identify factors that could explain the observed variance across households. These statistical procedures should provide additional information on possible correlations among the 13 variables. The principal component analysis using orthonormal rotations and the Mineigen criterion identified five factors that explain up to 67 percent of the observed variance (Table 3.2).

The first factor is, as expected, strongly correlated with the variables indicating the size of the household (number of nuclear families and number of members) and the level of assets (number of cattle and number of goats). Factors two through five are, however, more difficult to interpret. For example, factor three is positively correlated with the dependency
ratio and asset level and negatively correlated with any use of formal credit. This suggests that variance across households can be explained by a high dependency ratio, a higher level of assets, and a low level of outstanding formal credit. In other words, large households who deplete their savings are not likely to borrow and vice versa. This is consistent with results from the cluster analysis. The method of orthonormal rotation was then completed with a principal factor procedure using oblique rotations that do not assume non-correlation among the factors. Oblique rotations were tried using only two factors that account for 36 percent of the explained variance (Table 3.3). The results are slightly different from those determined by orthonormal rotations. The first factor includes not only the household characteristics (size and asset level) but also the degree of disavings.
<table>
<thead>
<tr>
<th>Factors</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor pattern</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(correlation coef.):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of nuclear</td>
<td>0.71*</td>
<td>0.44</td>
<td>0.03</td>
<td>0.18</td>
<td>0.09</td>
</tr>
<tr>
<td>families</td>
<td>0.62*</td>
<td>0.56*</td>
<td>-0.04</td>
<td>-0.06</td>
<td>-0.19</td>
</tr>
<tr>
<td>Number of members</td>
<td>0.16</td>
<td>0.06</td>
<td>0.49*</td>
<td>-0.46*</td>
<td>0.40*</td>
</tr>
<tr>
<td>Dependency ratio</td>
<td>0.28</td>
<td>-0.59*</td>
<td>-0.20</td>
<td>-0.16</td>
<td>0.13</td>
</tr>
<tr>
<td>Production deviation</td>
<td>0.35</td>
<td>-0.47*</td>
<td>-0.35</td>
<td>-0.35*</td>
<td>0.03</td>
</tr>
<tr>
<td>Consumption deviation</td>
<td>0.71*</td>
<td>-0.38</td>
<td>0.42*</td>
<td>0.20</td>
<td>0.08</td>
</tr>
<tr>
<td>Number of cattle</td>
<td>0.77*</td>
<td>-0.20</td>
<td>0.40*</td>
<td>0.24</td>
<td>-0.07</td>
</tr>
<tr>
<td>Number of goats</td>
<td>-0.37</td>
<td>0.19</td>
<td>0.39</td>
<td>-0.26</td>
<td>-0.45*</td>
</tr>
<tr>
<td>Disavings rate</td>
<td>-0.51</td>
<td>0.12</td>
<td>0.06</td>
<td>0.59*</td>
<td>0.11</td>
</tr>
<tr>
<td>Labor income</td>
<td>0.44</td>
<td>-0.03</td>
<td>-0.15</td>
<td>0.29</td>
<td>-0.55*</td>
</tr>
<tr>
<td>Off-farm income</td>
<td>0.13</td>
<td>0.24</td>
<td>-0.34</td>
<td>0.37*</td>
<td>0.54*</td>
</tr>
<tr>
<td>Remittances</td>
<td>0.35</td>
<td>0.23</td>
<td>-0.72*</td>
<td>-0.23</td>
<td>-0.10</td>
</tr>
<tr>
<td>Formal credit</td>
<td>0.19</td>
<td>0.61*</td>
<td>0.15</td>
<td>-0.33</td>
<td>0.17</td>
</tr>
<tr>
<td>Informal credit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Eigenvalues</strong></td>
<td>2.99</td>
<td>1.81</td>
<td>1.57</td>
<td>1.30</td>
<td>1.08</td>
</tr>
<tr>
<td><strong>Variance explained</strong></td>
<td>0.23</td>
<td>0.37</td>
<td>0.49</td>
<td>0.59</td>
<td>0.67</td>
</tr>
<tr>
<td>(cumulative)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3.2. Results of the Principal Component Analysis Using Orthonormal Rotations
<table>
<thead>
<tr>
<th>Factors</th>
<th>Two factors rotated</th>
<th></th>
<th>Three factors rotated</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Factor pattern</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(correlation coef.):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of nuclear families</td>
<td>0.73*</td>
<td>0.32</td>
<td>0.45*</td>
<td>0.81*</td>
</tr>
<tr>
<td>Number of members</td>
<td>0.80*</td>
<td>0.43</td>
<td>0.52*</td>
<td>0.85*</td>
</tr>
<tr>
<td>Dependency ratio</td>
<td>0.42</td>
<td>0.06</td>
<td>0.48*</td>
<td>0.11</td>
</tr>
<tr>
<td>Production deviation</td>
<td>-0.08</td>
<td>0.26</td>
<td>0.01</td>
<td>-0.17</td>
</tr>
<tr>
<td>Consumption deviation</td>
<td>0.05</td>
<td>0.53*</td>
<td>0.02</td>
<td>0.07</td>
</tr>
<tr>
<td>Number of cattle</td>
<td>0.72*</td>
<td>0.19</td>
<td>0.73*</td>
<td>0.34</td>
</tr>
<tr>
<td>Number of goats</td>
<td>0.52*</td>
<td>-0.31</td>
<td>0.69*</td>
<td>-0.01</td>
</tr>
<tr>
<td>Disavings rate</td>
<td>-0.33</td>
<td>-0.43*</td>
<td>-0.21</td>
<td>-0.35</td>
</tr>
<tr>
<td>Labor income</td>
<td>0.44</td>
<td>0.64*</td>
<td>-0.11</td>
<td>0.60*</td>
</tr>
<tr>
<td>Off-farm income</td>
<td>0.43</td>
<td>-0.07</td>
<td>0.38</td>
<td>0.30</td>
</tr>
<tr>
<td>Remittances</td>
<td>-0.08</td>
<td>0.54*</td>
<td>-0.36</td>
<td>0.42*</td>
</tr>
<tr>
<td>Formal credit</td>
<td>-0.01</td>
<td>-0.35</td>
<td>0.04</td>
<td>-0.09</td>
</tr>
<tr>
<td>Informal credit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eigenvalues</td>
<td>2.96</td>
<td>1.69</td>
<td>2.96</td>
<td>1.69</td>
</tr>
<tr>
<td>Variance explained</td>
<td>0.23</td>
<td>0.36</td>
<td>0.23</td>
<td>0.36</td>
</tr>
<tr>
<td>(cumulative)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3.3. Results of the Principal Component Analysis Using Oblique Rotations
The larger the household, the larger is its livestock herd, and the more it disaves. The first factor alone explains up to 23 percent of the variance. The second factor associates non-formal credit with formal credit, deviations from the consumption mean, and labor income. Correlations with the first three variables are positive whereas they are negative with the last variable. An interpretation of this occurrence is that as deviations from the average consumption become positive, outstanding credit increases and labor income declines.

At this stage of the analysis, one should not conclude that households can be distinguished on the basis of their use of credit as a substitute for labor income in order to smooth consumption. Finally, oblique rotations were conducted with three factors. Again household size, asset level, and borrowing activities enter into the structure of the three factors which all together explain 48 percent of the variance observed across households.

3. Conclusion

Despite well-known weaknesses inherent in explanatory multi-variate analyses (in particular, the fact that all variables are considered to be independent), results from these methods indicate that there is, in general, a strong correlation between the household’s ability to smooth consumption and its level of physical and human assets.

Cluster analyses separated households into groups according to the combination of income activities. A comparison of households across and within cluster groups suggests that households consuming above the average level despite negative income shocks are those that either have sufficient labor to engage into activity diversification or have sufficient savings that could be mobilized in case of emergency. Factor analyses confirm these results and
augment them by underscoring the importance of credit in explaining the variance observed across households. The first and second factor patterns identified by the principal component analysis reveal that household cohesion and family labor availability allow for risk reducing strategies such as field scattering and activity diversification and at the same time prevent the dissociation of family assets accumulated through generations.

These results support Stenning's findings that agro-pastoral agrarian economies can be characterized by the equilibrium between the extended household size (estimated by the number of nuclear families, the total number of economically active members, and the dependency ratio) and the size of livestock herds (number of cattle and goats). Better-off households have a large labor force and herds. This result should not be surprising since it simply reflects the Tchayanovian household life-cycle. It does not, however, explain the existence of inefficient nuclear families in a situation where households traditionally form large extended units.

C. THE NEOCLASSICAL MODEL OF PERFECT INSURANCE

1. From State-Contingent and Time Exchanges to Perfect Insurance Markets

In any society, individuals do interact with each other. Consumption smoothing not only takes place within an intertemporal choice framework but also involves state-contingent exchanges. The Arrow-Debreu competitive exchange model provides the foundation for studying the role of the market in allocating state-contingent claims among individuals under uncertainty.
Assuming a complete market for state-contingent claims and risk aversion, a Pareto optimum outcome can be achieved under two conditions. First, marginal rates of substitution should be equal across individuals and, second, no other feasible allocation exists that can make one individual better off without making other worse off (Arrow and Debreu, 1954; Arrow, 1971). Following Mace's (1991) notation, the optimum allocation results from the maximization by a social planner of the sum of weighed individual utilities (equations 3.1 and 3.3) subject to an aggregate resource constraint (equation 3.2):

\[
\text{Max} \sum_j w_j \sum_i \beta_i \Pi(s_{st}) U[c_i'(s_{st}), b_i'(s_{st})]
\]

\[
\sum_j c_i'(s_{st}) = \sum_j y_i'(s_{st})
\]

\[
y_i'(s_{st}) = \tilde{y}_i' + \eta_i'(s_{st}) + \epsilon_i'(s_{st})
\]

Lifetime utility is expressed as a function of consumption \( c \) and a preference shock \( b \). Each individual \( j \) is exogenously endowed with a consumption good \( y \) (equation 3.3), which is composed of a deterministic component \( \tilde{y} \) and both an aggregate \( \eta \) shock (i.e. average income over all individuals) and an idiosyncratic \( \epsilon \) shock (i.e. deviation to the average over all individuals). \( \Pi \) denotes the probability of the event \( s \), while \( \beta \) is the discount factor. The first-order condition of the maximization problem simply states that the distribution of aggregate resources is chosen such that weighed marginal utilities are equalized across individuals (Equation 3.4):
This implies that individual consumption will respond only to the aggregate resource endowment or, equivalently, to aggregate consumption.

In a simple model with two states and two agents, different situations can arise depending on the aggregate endowment in each state and on each agent's degree of risk aversion. The model yields perfect insurance when aggregate endowments are the same in both states, \( i.e., \) individuals are effectively pooling risks and redistributing their purchasing power across states, or when one of the two agents is risk neutral and, thus, willing to bear all the risk. This last situation describes an actuarially fair insurance and, in this case, the risk-averse agent is always willing to pay a premium equal to the probability of realization of the bad event in order to completely insure himself. Under a competitive equilibrium, the price ratio that clears the contingent market is, hence, equal to the ratio of the agents' subjective probabilities. Conversely, a Pareto outcome will not be achieved when the aggregate endowment is smaller in one of the two states (Laffont, 1995). In other words, perfect insurance occurs when individual consumption responds to aggregate shocks only.

It is important to mention that, according to Mace (1991), the perfect insurance model can also be interpreted as an extreme case of the Permanent Income Hypothesis (PIH), which is traditionally used to capture the time dimension of consumption smoothing. Friedman's PIH, which is a special case of the theory of intertemporal choice, states that income can be decomposed into a permanent (\( i.e., \) average income over time) and a transitory (\( i.e., \) deviation to the average income over time) component. The major implication of the PIH is that
consumption responds proportionally to permanent income only (Friedman, 1957). Commodities are basically traded over time via mechanisms such as saving or investment and borrowing. The model initially assumes the existence of perfect financial markets. Individuals will make decisions so as to equate their marginal utility of consuming today with their marginal utility of consuming tomorrow.

The perfect insurance model is related to the PIH in the sense that the idiosyncratic component of income shocks can be decomposed into permanent and transitory idiosyncratic shocks. The PIH predicts that households optimize their consumption plan according to their expectations of permanent income only, while the perfect insurance model makes this outcome as a special case. The generality of the perfect insurance model combined with the fact that it is empirically easier to separate aggregate from idiosyncratic shocks than to separate the permanent component of income shocks from its transitory component make the model more attractive for examining community risk sharing.

2. The Perfect Insurance Hypothesis and Findings from Major Empirical Studies

Using respectively the US Panel Study of Income Dynamics and the US Consumer Expenditure Survey, Mace (1991) and Cochrane (1991) provided a formal test of the perfect insurance hypothesis. Under the assumptions of perfect markets and perfect information, the null hypothesis is true whenever individual consumption is orthogonal to individual income changes or, in other words, when individual consumption is sensitive to aggregate income shocks only. When preferences are specified as exponential utility functions, the test consists
simply in regressing changes in individual consumption on changes in aggregate consumption and changes in individual income:\footnote{See Mace (1991) for the detailed derivation of the empirical model of perfect insurance.}

**Ho: Individual consumption = \( f(\text{aggregate consumption only}) \)**

\[
\Delta c_i' = \beta_1 \Delta c_i'' + \beta_2 \Delta y_i'' + u_i'
\]  
\[ (3.5) \]

where \( \beta_2 = 1 \) and \( \beta_2 = 0 \)

Mace and Cochrane's studies exhibit mixed results. Full insurance is rejected when utility is specified as a power function in the case of Mace (1991) and when idiosyncratic shocks are large and unanticipated in the case of Cochrane (1991). The latter also found that health-related shocks and job loss, in particular, are not insured. On the other hand, the null hypothesis cannot be rejected when Mace uses exponential utility. Based on the latter results, she argued that there is evidence that households do insure each other against idiosyncratic shocks by developing numerous informal and formal mechanisms including insurance contracts and family transfers. Udry (1990) and Ouattara (1993) developed a model of informal saving and borrowing based on the Arrow-Debreu general equilibrium framework to show that informal finance is used by households to smooth consumption. Their results support Mace's claim but they did not formally test the effectiveness of informal finance in smoothing consumption. Mace also added that it is not clear whether market imperfections play or do not play a major role in resource allocation under uncertainty.
Townsend (1991) conducted a similar test but using the ICRISAT Indian panel data set. In contrast to Mace and Cochrane, who were constrained by the nature of their data, Townsend was able to run both cross-section and time-series regressions. His results show that transitory income does impact consumption but to a limited extent. Significant co-movements in individual consumption are observed, suggesting that markets work but are not complete.

Several conclusions can be drawn from these previous studies of perfect insurance. First, none of them strongly supports the hypothesis of perfect risk sharing. Meanwhile, there is no complete rejection of the hypothesis. The nature of the income shocks does matter, since households seem to insure each other better against certain income shocks and not others. Due to these mixed results, only a formal test of perfect risk-sharing can justify more in-depth analysis of the causes of failure of traditional insurance institutions. Finally, as Townsend argued (1991), it is important to know the source of error terms in the regression equations in order to derive a formal test of the risk-sharing hypothesis. The use of either pooled cross-section and time-series data or pure panel data allows for richer analyses, but it also requires one to consider the fact that dependent variables may be measured with errors that are correlated over time or across individuals.
D. TESTING THE PERFECT INSURANCE HYPOTHESIS WITH LIMITED
HOUSEHOLD PANEL DATA FROM BURKINA FASO

1. Adapting the original Model of Perfect Insurance to Account for Income
   Endogeneity and Individual and Time Fixed-Effects

   a. Income Endogeneity and the Choice of Regressors

   Following the work of Mace (1991), Cochrane (1991), and Townsend (1991), I have
derived an empirical model to estimate the extent to which nuclear households within an
extended household and households in a village community fully co-insure each other.
Whenever risk sharing is perfect, one can state that market imperfections, if they exist, do not
impact household consumption smoothing and that strategies developed by households are
efficiently allocating scarce resources across states of nature and to a certain extent across
time.

   In contrast to many models testing for consumption smoothing, the model I developed
for this dissertation endogenizes income. In other words, the model treats income from the
sale of livestock and off-farm activities as important decision variables. In general, the
tendency is to apply least squares to a single equation with the assumption that explanatory
variables are truly exogenous variables. For Sahelian households, income and consumption
decisions are jointly determined by households. Rural households in Burkina Faso decide
about how many animals to sell and how many hours to allocate to off-farm activities based
on the level of crop deficits and levels of food consumption. Off-farm activities and animal
sales are expected to increase as food deficit is more pronounced. Meanwhile, incomes and assets determine how much a household can consume. Household surveys confirm the fact that in years of bad harvests, households experiencing labor and liquidity constraints do lower their consumption of food. Failing to endogenize income from the sale of livestock and off-farm activities would lead to biased and inconsistent least-square estimates because of the interdependency between the dependent variables and their regressors.

In turn, I do not treat crop income as endogenous because in the area under study, risk-averse households do not plant according to their food needs but according to the availability of the labor force. Since two endogenous variables, income from livestock and off-farm activities, appear on the right-hand side of the original consumption equation, a system of three simultaneous equations is needed to describe the economic phenomena (Figure 3.2):

\[
\begin{align*}
\text{Individual consumption} &= f(\text{Aggregate component of income shocks, Off-farm income, Livestock income, Crop income, Loan, Expenditures on health care}) \\
\text{Off-farm income} &= g(\text{Aggregate component of income shocks, Individual consumption, Crop income, Luxury expenditures, Labor force}) \\
\text{Livestock income} &= h(\text{Aggregate component of income shocks, Individual consumption, Crop income, Labor force, Loan, Asset})
\end{align*}
\]

Figure 3.2. Simultaneous-Equations Model of Perfect Risk Sharing
It seems reasonable to consider various sources of individual annual income, such as livestock income, crop income, off-farm income, and informal loans, as indicators of idiosyncratic shocks. Another indicator of idiosyncratic shocks used is expenditures on health care. If risk sharing is perfect among households within the village community and, similarly, among nuclear families of extended households, it is expected that variations in these various sources of individual incomes do not significantly affect individual food consumption. Several indicators of aggregate shocks can be used such as the village's average level of consumption, variance in rainfall, or variance in the market price of cereals or even household crop income. This is equivalent to using two year-dummies to each equation in the case of three-year panel data. The perfect risksharing hypothesis states that the dummies' regression coefficients for the first equation should be significantly close to one in order to accept the null hypothesis that individual consumption covaries with aggregate shocks only.

In addition to individual consumption and indicators of aggregate shocks, several variables are added to explain the level of off-farm and livestock incomes. Sahelian households are accustomed to allocate specific incomes to specific expenditures. As a consequence, luxury expenditures on clothes and social events tend to raise the effort and the level of off-farm income in order to service these expenditures and events. In contrast, an increase in crop income is expected to affect negatively off-farm income and livestock sales, since households tend to substitute crop income for the latter. Incorporating labor force (i.e., number of family members who are economically active) as a variable controls for changes in household demographics. This responds to Cochrane's (1991) comment that changes in household demographics may significantly affect changes in individual consumption.
However, I did not add labor force to explain individual consumption since there are not significant changes in household demographics over a three-year period. Rather, the availability of household labor force does determine activity diversification and, by extension, the level of off-farm and livestock incomes. Household assets are also expected to impact positively livestock income, while access to informal credit should discourage the depletion of household livestock.


The original risk-sharing model derived by Mace (1991) and Cochrane (1991) has also been adapted to the use of panel data, which allows one to capture both the time and cross-sectional dimensions of risk sharing. One difficulty when using panel data is the presence of either time-invariant or individual-invariant variables or both, at the same time. Ignoring the fact that intercepts and slopes of the regression lines may vary through time or across individuals leads to biased estimates since they are potential sources of correlation between regressors and residuals (Hsiao, 1986).

In the case of the model studied, the aggregate shock is, for example, an individual-invariant time-variant variable. This means that at a given point in time, this variable takes the same value for all households. Considering a single equation, these particular variables need to be taken into account. Otherwise, the matrix of explanatory variables will be singular and least square estimation cannot be applied. Two possible models could be used to get around this problem of specific-effect variables: a fixed-effect or a random-effect model. They are different in the way they treat the specific-effect variables. The fixed-effect model, also called
Least Squares Dummy Variable (LSDV) model, assumes that differences across time can be captured through differences in the constant term:

\[ y_{it} = \alpha_i + \gamma Y_{it} + \beta X_{it} + u_{it} \]  

(3.6)

The error term \( u \) contains the effects of the omitted time-invariant and/or individual-invariant variables. In turn, the random-effect model considers the specific constant term as a random variable \( e_t \), in the sense that it is randomly distributed across time:

\[ y_{it} = \alpha + \gamma Y_{it} + \beta X_{it} + e_t + u_{it} \]  

(3.7)

The choice between the two models depends primarily on the structure of the data. The fixed-effect model is usually chosen when the number of individuals, \( N \), is large and, the number of observations in time, \( T \), is small and the focus is on those specific time observations. When the sample randomly chosen from the population is large, the random-effect is said to be more appropriate. Hsiao (1986) as well as Greene (1993) argue, however, that there is no real fundamental difference between the two models when the data set is sufficiently large. The choice between the two should rather be based on the consideration whether the specific-effect variable is correlated or not to the other explanatory variables. The fixed-effect model allows for correlation whereas the random effect model assumes no correlation between the time-variant variable and the regressors. Using the random-effect model when there is correlation leads to inconsistency.
Hausman (1978) derived a test to check for orthogonality of the random effects and the regressors. For my consumption smoothing model, there are good reasons to think that indicators of the time-variant variable for the aggregate component of income shock are correlated with indicators representing the idiosyncratic component of the same shock. Moreover, the small size of my panel data does not a priori justify the use of a random-effect model, but rather a fixed-effect model. In a context of limited information, the choice of a fixed-effect model versus a random-effect model is critical since it can lead to significant differences in the results.

Both time and the individual fixed-effects are accounted for in the model of perfect risk sharing used here. Two year dummies are introduced as regressors in each of the three simultaneous equations to represent the aggregate component of income shocks and to control for the time fixed-effect. The error terms may contain, in addition, unobserved individual fixed-effects associated with unobservable household characteristics such as managerial capacity. More specifically, the individual fixed-effect can be taken care of by replacing individual observations by their deviations from time-means. This procedure, also called the least-squares dummy-variable approach, is equivalent to replacing the N-1 (N being a large number) dummies needed to control for the N individual-invariant effects by instruments chosen from “within” equation instead of “without” equation, as is usually done. It has been applied by Hausman and Taylor (1981) to take care of unobserved time-variant individual effects in their simultaneous-equations model. Since variables are replaced by their deviations from time-means, the estimated equations do not contain an intercept term.
Due to over-identification of the entire model, Three Stage Least-Squares (3SLS) is applied to derive consistent and asymptotically efficient estimates. This approach is also known as a full information approach because it uses information contained in all equations to estimate coefficients for each equation. The estimated simultaneous-equations model adapted from the original perfect insurance model is shown in Figure 3.3. First, the estimation is conducted with a first sample of 42 extended households in order to test for perfect risk sharing among the village community. To capture the degree of risk sharing within an extended household, the estimation is then performed with the sub-sample of 68 nuclear families belonging to the extended households surveyed. A measure of goodness of fit for the entire system is computed following the formula devised by McElroy (1977). In contrast to the conventional weighed R-squared, McElroy R-squared (Equation 3.8) is bounded below by zero and above by one. The later is constructed based on the residuals $\bar{e}$ in stacked form and the covariance matrix $\sum$ of the Two Stage Least-Square regression.

$$R^2 = 1 - \frac{\bar{e}'(\sum^{-1} \otimes I)\bar{e}}{Y'(\sum^{-1} \otimes D_N)Y}$$ (3.8)

$$0 \leq R^2 \leq 1$$

---

2 The 3SLS estimation procedure was performed with GAUSS.
C\(_i\) = \(\gamma_1 L_{it} + \gamma_2 L_{it} + \beta_{12} HC_{it} + \beta_{13} H_{it} + \beta_{14} B_{it}\) + \(\theta_{11} D90 + \theta_{12} D91 + u_{1it}\)

\(L_{it} = \gamma_{21} C_{it} + \beta_{23} H_{it} + \beta_{24} CO_{it} + \beta_{25} F_{it}\) + \(\theta_{21} D90 + \theta_{22} D91 + u_{2it}\)

\(L_{it} = \gamma_{31} C_{it} + \beta_{33} H_{it} + \beta_{34} B_{it} + \beta_{35} F_{it} + \beta_{37} A_{it}\) + \(\theta_{31} D90 + \theta_{32} D91 + u_{3it}\)

\(I = i^{th}\) household

\(t = t^{th}\) year \(t = 1, 2, 3\)

**Endogenous variables:**

- **C**: Consumption of cereals (Kg per capita)
- **I**: Labor income from off-farm activities (Fcfa per capita)
- **L**: Livestock profits (Fcfa per capita)

**Exogenous variables:**

- **HC**: Household's expenditures on health care (Fcfa per capita)
- **H**: Crop income (market value of millet harvest, in Fcfa per capita)
- **B**: Dummy variable indicating whether the household has any loan (=1) or not (=0)
- **CO**: Luxury expenditures (Fcfa per capita)
- **F**: Demographic variable (Number of persons in charge per economic activity)
- **A**: Level of asset (number assigned from 1 to 5 according to the herd's size)
- **D90**: Dummy for year 1990 (=1) or otherwise (=0)
- **D91**: Dummy for year 1991 (=1) or otherwise (=0)

**Figure 3.3. Estimated Simultaneous-Equations Model of Perfect Risk Sharing**
Testing for perfect risk sharing within the village community or the extended household will then consist of deriving the F-ratio for the following null hypothesis:

\[ H_0 : \sum_j (\gamma_j + \beta_j) = 0 \text{ and } \theta = 1 \]

This is equivalent to imposing on the first equation a set of restrictions of the form:

\[ H_0 : R \Phi = \Phi \]

The corresponding F statistic (Greene, 1993) is then as follows:

\[ F[J,(N-K)] = \frac{(R\Phi - \Phi)'[R(X'X)^{-1}R']^{-1}(R\Phi - \Phi)}{e'e/(N-K)} \quad (3.9) \]

2. Estimation Results

The 3SLS regression results including the sign of the coefficients, their significance, McElroy measures of goodness of fit for the entire system and the F statistic for the null hypothesis are reported in Tables 3.4 and 3.5. Values of the estimated coefficients, standard errors, and t-statistics are in the appendices.

Results in Table 3.4 from the regression run with the sample of 42 households suggest that risk sharing within the village community is imperfect. Since the F-value for the joint test of perfect insurance is larger than the critical F-value, the null hypothesis is rejected at a 5 percent significance level. The test is set up in such a way that, unfortunately, the source of rejection of the null hypothesis cannot be formally identified. It is reasonable, however, to conclude that the rejection results from the significance of the coefficients representing the effects of idiosyncratic income shocks.
<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Equation one: Household consumption</th>
<th>Equation two: Household off-farm income</th>
<th>Equation three: Household livestock accumulation or sale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household consumption</td>
<td>(+) ***</td>
<td>(-) NS</td>
<td>(-) ***</td>
</tr>
<tr>
<td>Household off-farm income</td>
<td>(+) ***</td>
<td>(-) **</td>
<td>(-) ***</td>
</tr>
<tr>
<td>Household livestock</td>
<td>(+) ***</td>
<td>(-) ***</td>
<td></td>
</tr>
<tr>
<td>Household crop income</td>
<td>(-) NS</td>
<td>(-) **</td>
<td>(-) ***</td>
</tr>
<tr>
<td>Household borrowing or lending</td>
<td>(+) ***</td>
<td>(-) ***</td>
<td></td>
</tr>
<tr>
<td>Household health expenditures</td>
<td>(-) NS</td>
<td>(-) ***</td>
<td></td>
</tr>
<tr>
<td>Household luxury expenditures</td>
<td>(+) ***</td>
<td>(-) **</td>
<td>(-) ***</td>
</tr>
<tr>
<td>Household labor force</td>
<td>(-) **</td>
<td>(-) ***</td>
<td></td>
</tr>
<tr>
<td>Household level of asset</td>
<td>(+) ***</td>
<td>(-) ***</td>
<td></td>
</tr>
<tr>
<td>Dummy for 1990</td>
<td>(-) ***</td>
<td>(-) **</td>
<td>(+) ***</td>
</tr>
<tr>
<td>Dummy for 1991</td>
<td>(-) ***</td>
<td>(+) NS</td>
<td>(+) ***</td>
</tr>
</tbody>
</table>

A/ Goodness of fit of the system: McElroy R-squared = 0.524

B/ Ho : \( \sum_j (Y_j + \beta_j) = 0 \) and \( \theta = 1 \)  
F-value = 93.694

(·) sign of the coefficient
* significant at 10%; ** significant at 5%; *** significant at 1%; NS not significant

Table 3.4: Results of Three-Stage Least-Square Estimation of the Perfect Insurance Model Using the Sample of Extended Households
### Three Simultaneous-Equations Model
(Number of observations = 68 nuclear families * 3 years)

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Equation one: Household consumption</th>
<th>Equation two: Household off-farm income</th>
<th>Equation three: Household livestock accumulation or sale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household consumption</td>
<td>(⁺) ***</td>
<td>(⁺) ***</td>
<td></td>
</tr>
<tr>
<td>Household off-farm income</td>
<td>(⁺) NS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household livestock accumulation or sale</td>
<td>(⁺) NS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household crop income</td>
<td>(⁻) *</td>
<td>(⁺) NS</td>
<td>(⁺) ***</td>
</tr>
<tr>
<td>Household borrowing or lending</td>
<td>(⁺) ***</td>
<td></td>
<td>(⁻) ***</td>
</tr>
<tr>
<td>Household health expenditures</td>
<td>(⁺) NS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household luxury expenditures</td>
<td></td>
<td></td>
<td>(⁻) NS</td>
</tr>
<tr>
<td>Household labor force</td>
<td>(⁺) ***</td>
<td></td>
<td>(⁻) NS</td>
</tr>
<tr>
<td>Household level of asset</td>
<td></td>
<td></td>
<td>(⁻) NS</td>
</tr>
<tr>
<td>Dummy for 1990</td>
<td>(⁻) ***</td>
<td>(⁻) NS</td>
<td>(⁺) **</td>
</tr>
<tr>
<td>Dummy for 1991</td>
<td>(⁻) ***</td>
<td>(⁺) NS</td>
<td>(⁺) ***</td>
</tr>
</tbody>
</table>

A/ Goodness of fit of the system:

- McElroy R-squared = 0.289
- F-value = 115.781

(. ) sign of the coefficient

* significant at 10%; ** significant at 5%; *** significant at 1%; NS not significant

**Table 3.5: Results of Three-Stage Least-Square Estimation of the Perfect Insurance Model Using the Sample of Nuclear Families Organized Into Extended Households**

100
Income from off-farm activities such as trading and handicrafts, sales of livestock, and the access to informal loans have a significant positive impact on individual food consumption. In contrast, income from selling crop harvested on personal fields and health expenditures do not impact household food consumption, probably because of their marginal shares in the overall household budget.

As expected, household consumption does co-vary with the aggregate component of income shocks approximated by the two year-dummies. Household consumption is, indeed, significantly lower in 1990 (bad harvest year) and 1991 (average harvest year) than in 1992 (relatively good harvest year). Household consumption positively impacts, in turn, household off-farm income and livestock sales. Households tend to increase significantly the number of hours worked off-farm to cover their expenditures of food and non-food commodities (health and luxury items). Signs of the coefficients of household crop income and borrowing in the second and third equations are, as expected, negative indicating a certain degree of substitution across sources of income. Households tend to work less off-farm and to avoid depleting their livestock when they can have access to informal loans or when their harvest of personal fields is good and part of it can be sold.

Livestock holdings traditionally serve as a buffer against income shocks. However, as the village opens to the market economy, households develop off-farm activities in order to keep their livestock, because the latter is also used to define the household's social status within the village. This explains why household off-farm income and livestock sales are significantly higher in 1990. Despite the growing importance of off-farm activities as a consumption smoothing strategy, there seems to be a threshold on how much income a
household can get from off-farm activities. This is related to household size. More precisely, per capita income is positively correlated to the number of economically active people within a household. Similarly, income from livestock sales is positively correlated to household asset accumulation. Estimated coefficients in the second and third equations illustrate the insurance role of the horizontally and vertically extended household; the former allows for activity diversification while the latter permits a faster rate of savings.

Table 3.5 exhibits shows from the regression that uses the sub-sample of nuclear families forming the extended households. Similarly to the results obtained with the sample of households in the village, the null hypothesis of perfect insurance within an extended household is rejected at a 5 percent significance level. However, in contrast to the first regression, it is not clear what causes the rejection of the null hypothesis. Results of the estimated first equation are consistent with which we would expect if the null hypothesis cannot be rejected. In addition to health expenditures, off-farm income and livestock sales are not significant in explaining the nuclear family's consumption. The effects of the dummies are significant, as expected from variables representing the effects of aggregate shocks. This rejection of the null hypothesis indicates, therefore, that nuclear families are sharing risks but to a certain extent only. While other variables have similar effects to those found in the first regression, crop income, luxury expenditures, and dummies in this second regression are not significant in explaining the level of off-farm income.

In summary, results from both regressions rejected the null hypothesis of perfect insurance at a 5 percent significance level. There is evidence of risk sharing that is reinforced by activity diversification and livestock depletion, but risk sharing is, in general, present but
imperfect within both the community village and the extended household. In addition to the aggregate component of income shocks, idiosyncratic incomes such as off-farm income, livestock sales and informal borrowing affect significantly the household level of food consumption.

E. CONCLUSION: Limits of the Neoclassical Model of Perfect Risk-Sharing

The model of three simultaneous equations with individual and time-specific effects confirms the fact that households do share risks through activity diversification and savings in order to smooth their consumption. Risk-sharing is, however, not capable of providing perfect insurance when the income shocks have a relatively strong aggregate component. Idiosyncratic shocks do affect household consumption of food. This is especially true at the village level. Indeed, the extended household apparently offers a better protection against idiosyncratic shocks than the village community. Nevertheless, the null hypothesis of no effect of idiosyncratic shocks on consumption is rejected at the 5% significance level.

While the full insurance model can be utilized as a useful benchmark, it does not offer any insights on the nature of the risk-sharing arrangements involved. Neither does it allow one to identify the factors leading to violations of the model's assumptions. Violations of the basic assumptions and deviations to the optimum outcome also result from other problems such as incomplete or non-competitive state-contingent markets, transaction costs, and asymmetric information. According to Mace (1991), the effects of imperfect markets and asymmetric information must be offset by the existence of numerous forms of informal insurance so that
they cannot lead to a strong rejection of the null hypothesis. The major problem with Mace’s and Cochrane’s models is that they do not give any hints on the type of insurance arrangements involved, whether idiosyncratic shocks have been insured or not.

Based on the Arrow-Debreu state-contingent model, Udry (1990) and Ouattara (1993) showed, in turn, that informal credit arrangements in West Africa substitute for missing insurance and capital markets and thereby bring the economy close to the ideal situation of perfect insurance. Similarly, in the West African context or in Thailand, risk diversification within a household through interregional migration also constitutes an efficient instrument to mitigate the effects of idiosyncratic shocks (Paulson, 1993; Lambert, 1994).

While all of these studies tend to support the full-insurance hypothesis, Townsend’s results for Thailand led to frequent rejections of the hypothesis, due to income growth associated with occupational disparity (Townsend, 1994), on the one hand, and imperfect information (Townsend, 1996) on the other hand. His first finding is quite puzzling since a richer economy is expected to exhibit higher insurance than poor economies. Townsend (1994) did not, unfortunately, provide any explanation of this phenomenon, which one can probably attribute to the predominance of informal arrangements in more primitive economies (i.e., the Sahel) rather than in economies in transition like Thailand. Information asymmetry may, furthermore, limit the emergence and enforceability of insurance arrangements in some regions and villages of Thailand (Townsend, 1996).

Following Deaton’s path (1990), Townsend’s most important conclusion in both studies is based on the existence of significant unobservable village and regional effects which cause the rejection of the full insurance hypothesis and that suggest that differences in village
functioning and institutional organizations are more prevalent and critical for the development of efficient insurance mechanisms than one might expect.

Numerous studies have attempted to address the problems of transaction costs and asymmetric information in insurance markets, but few have formally analyzed the conditions of the existence and the types of insurance arrangements operating under a Pareto-constrained environment where major markets are missing. It is only recently that researchers in the field of development economics have gone beyond the frontier of neoclassical paradigms to study the pervasiveness of market failure and the resulting complexity of agent interactions (Bardhan, 1989; Nabli and Nugent, 1989; Besley, 1995).
CHAPTER 4

DOMAIN OF EXISTENCE OF SOCIAL RISK-SHARING CONTRACTS
IN SUB-SAHARAN TRANSITION ECONOMIES: SIMULATION RESULTS OF
A STATIC SEMI-COOPERATIVE MODEL OF HOUSEHOLD RISK-SHARING

A. INTRODUCTION

Chapter 3 of the dissertation provided a formal test of the perfect risk-sharing hypothesis. The results show that risk is not optimally shared across households and point out to the limits of the perfect risk-sharing model. The ideal model of perfect risk-sharing also implies the existence of complete contingent contracts. Deviations from it are signs that conflicts exist regarding the allocation of strategic resources within an extended household or a larger community.

In addition, the exploratory analysis of the Burkina Faso data reveal large variations in household food consumption. The data also suggest that, while living in the same environment, households do not have the same ability to develop efficient risk-sharing arrangements, and that this ability is highly correlated with household size and level of assets. To explain variations in household consumption smoothing requires a view of the traditional family structure as an institution, organized according to the distribution of property rights
over strategic resources among members of a household and according to the rules defining individual behavior with respect to the use of these resources.

In turn, recent studies on intra-household resource allocation strongly reject the unitary household framework, which considers the household as a single decision unit or an aggregation of identical utility functions. These studies underscore the existence of multiple decision centers, which are defined according to the allocation of property rights over resources shared by different members of a household. Recognizing that aggregating preferences cannot always be justified allows one to better understand observed heterogeneity in individual economic behavior as well as inequality in resource allocation among a group of individuals.

The objectives of Chapter 4 are, first, to review recent contributions of institutional economics to the modeling of informal contractual arrangements and intra-household resource allocation. Second, a static model of social risk sharing is developed in order to identify conditions under which nuclear households organize themselves into an extended household in order to manage risk. This model not only draws upon the risk-sharing dimension, but it also includes economies of scale as a second dimension of extended household formation.

B. RECENT CONTRIBUTIONS OF THE NEW INSTITUTIONAL ECONOMICS TO THE STUDY OF INDIGENOUS INSURANCE INSTITUTIONS

1. Individual Interactions and the New Institutional Economics

Neoclassical Economics considers economic agents as identical and studies their behavior by making reference to a hypothetical representative individual, assuming that
individual preferences can be aggregated. The New Institutional Economics (NIE) rejects the assumption of identical preferences and a single decision maker and defines two concepts, namely *institution* and *organization*, which are at the basis of insightful frameworks used for the study of individual interactions. The NIE finds its inspiration and working tools principally in the modern theories of industrial organization and game theory. Although the two terms are often used in the literature in a confusing way, economists of the NIE school make a clear distinction between institution and organization.

The concept of *organization* is used to define the collective behavior of a group of people, who get together in order to perform certain tasks and to achieve common goals (Khalil, 1995). It tries, in particular, to answer the question of “how the behavior of a group can be explained by the supposed pre-constituted strategies (defined by individual utility and constraints) of the members” (Khalil, 1995). The concept of organization recognizes that there are some costs to collective action. The study of an organization is, therefore, concerned with property rights, agency theory, mechanism design, and transaction costs (Williamson, 1990). A team of workers, a union, a bank are examples of organizations.

In comparison to the concept of organization, the definition of an *institution* is broader. Citing Uphoff (1986) and Ruttan and Hayami (1984), Nabli and Nugent (1989) point out the two central pillars constituting an institution, namely rules and norms of behavior. Uphoff (1986) stressed the role of norms of behavior and defined institutions as “complexes of norms of behavior that persist over time, by serving collectively valued purposes.” In comparison to Uphoff, Ruttan and Hayami (1984) defined institutions as “the rules of a society or of organizations that facilitate coordination among people by helping them form
expectations which each person can reasonably hold in dealing with others.” North (1989) reconciled the two perspectives by defining institutions as “rules, enforcement characteristics of rules, and norms of behavior that structure repeated human interaction.” Families, married couples, schools, the State, the Indian system of caste are examples of institutions. One major implication of this concept is that it ultimately restricts the set of choices available to economic agents as defined by neoclassical theories (North, 1989). The concept of institutions also allows one to explore the issue of the persistence of seemingly inefficient human behavior (Akerlof, 1976).

In the section 3 that follows, I will discuss how the two concepts are equally useful for my study of indigenous insurance contractual arrangements in rural Sub-Saharan Africa.

2. Endogenous Theories of Institutions and the Study of Informal Insurance Institutions

a. Transaction Costs, Asymmetric Information, and Collective Action

Recent studies focusing on the analysis of agrarian institutions are articulated around two major approaches, namely transaction cost cum asymmetric information and collective action. While the first approach tries to explain the emergence of institutions as an efficient outcome of a cost minimization problem (North, 1981; Stiglitz, 1989), the second underscores the distributional implications of the behavior of groups and conflicts among individuals with different interests to explain the existence of seemingly dysfunctional institutions (Olson, 1965; Akerlof, 1976).

109
Within the first approach, Bardhan (1989) made the distinction between the transaction cost and imperfect information schools. Works from economists such as Coase, Williamson, and North formed the body of the first school, which states that institutions emerge and evolve over time in order to minimize transaction costs. Bardhan (1989) listed among transaction costs those associated with information collection, negotiation, monitoring, coordination, and enforcement of contracts.

Bardhan also argued that the definition of property rights is critical in determining the type of institution, but that "the basic source of institutional change is fundamental and persistent changes in relative prices, which lead one or both parties in a transaction to perceive that they could be better off under alternative contractual and institutional arrangements." His argument supports many economic-anthropologists' observations that population growth accompanied by an increasing scarcity of vital resources and market penetration are having profound repercussions on indigenous institutions.

The second school of endogenous theory of institutions, developed around the work of principally Akerlof and Stiglitz, focuses its attention on the impact of information on contract designs. On the one hand, this second approach is more restricted than the first approach, since information costs are only a subset of transaction costs. On the other hand, it gains in predictive power and precision since information, in contrast to other costs such as monitoring costs, can be rigorously conceptualized and incorporated in models of individual interactions (Bardhan, 1989).
b. Agrarian Institutions, Risk, and the Economic Rationale of Extended Household Formation

In small isolated communities, social norms dictate the behavior of individuals in smoothing their self-interest and personal claims on the one hand, and in creating some sense of duty and commitment, on the other hand (Scott, 1972). Opportunistic behavior arises due to increasing uncertainty and informational problems (Frank, 1988; Bardhan, 1989; Platteau, 1991). Under these new circumstances, it is reasonable to assume that individuals use cost-benefit valuation, and the incentive problem becomes a critical issue for contract enforcement (Popkin, 1979; Bardhan, 1989; Binmore, 1994). Cooperation emerges only if there are some net gains from cooperating with others.

Under the ideal situation of full information, the cost of risk for a risk-averse individual is traditionally measured by the difference between the expected risky income and its certainty equivalence. Considering agents with different endowments and degrees of risk aversion, it can be easily demonstrated that agents can mutually gain by pooling risk as long as their risky incomes do not covary (Newbery, 1989). In this sense, economic specialization and portfolio diversification will tend to lower the total costs of risk. This portfolio rationale holds even in the presence of aggregate risks because it allows for a faster rate of savings. Rosenzweig (1988) and Wade (1988) applied similar reasoning to explain the formation of extended households and village communities in risky environments. Less than perfectly positively correlated income across members and potential economies of scale can alone create strong incentives for people with different bargaining powers but the same goal to enter into a contractual relationship.
Since asymmetric information is inherent to the insurance problem, most studies on insurance contracts and institutions were done using the transaction cost cum asymmetric information approach. *Moral hazard* and *adverse selection* are two of the features of asymmetric information that have been extensively analyzed from both a theoretical and an empirical point of view. Contradicting Mace’s (1991) claim that the effects of imperfect markets and information must be offset by the existence of numerous forms of informal insurance, Tonwsend’s (1996) conclusion is that imperfect information does lead to the rejection of the perfect risk-sharing hypothesis, despite the apparent pervasiveness of risk-sharing arrangements.

Arnott and Stiglitz (1988) and Rothschild and Stiglitz (1990) have, in particular, developed a conceptual framework for studying the effects of imperfect information on insurance markets. They have proved formally that optimum market equilibrium, in the Pareto sense, exists only in the rare world of perfect information. Under imperfect information, individuals cannot perfectly observe each other’s actions. Moral hazard and adverse selection must be taken into consideration by contractual parties. In the classic case of an insurance contract involving an insurance agency and anonymous clients, the agency may decide to collect information on the clients and will, in this case, charge higher premiums. The agency can also provide incomplete insurance contracts and make contracts less attractive to the pool of high-risk clients (Rothschild and Stiglitz, 1976). Information asymmetries lead to higher insurance costs, and there are cases where information costs are so high that break-even contracts cannot be achieved.
In agrarian economies, agents attempt to write complex contractual arrangements reflecting the trade-off between minimizing the costs of moral hazard and adverse selection and maximizing the benefits of insurance. Due to their pervasiveness in developing countries, interlinked contracts are among the most studied arrangements. They can be described as *asymmetric* in the sense that they involve partners having different social status (Foster, 1988). Stiglitz (1974), Kotwall (1985), and Bell (1989) provide examples of such interlinked contracts when analyzing systems of sharecropping and tenancy contracts in developing countries.

Hayami and Otsuka (1993) described these types of contracts, in general, as organizations where “a landlord and his tenants, and permanent laborers as well, simultaneously enter into several contracts.” These contracts define the amount of risk shared by each partner. Tenants and laborers can thus benefit from consumption credit and production insurance from their landlord in exchange for their labor. Eswaran and Kotwall (1989) explain how these interlinked contracts result from the specification of property rights over capital and labor. The landlord has land and access to credit while tenants and laborers possess only their labor force.

In contrast, few studies have adopted the collective action approach, which puts more emphasis on the distributional and normative determinants of the behavior of interest groups. Olson (1965) defined interest groups as groups of people who are bound to each other by common goals. Within a collective setting, achieving common goals is equivalent to providing a public good, but this has the disadvantage of creating room for opportunistic behavior. Labor unions, professional associations, and any association organized around distributional
goals are examples of Olson's interest groups. Olson argued that divergences in interests and free-riding behavior, which tend to arise more frequently as the size of the group increases, are the causes of the efficiency losses that characterize so many interest groups.

The frontier between the transaction cost and collective action approaches is not always clear, however, because both deal with individuals having heterogeneous preferences and facing heterogeneous constraints. Most studies using the second approach have a strong focus on the political arena, where significant divergences in interest are frequently observed. Also, most studies focused their attention on the implications of Olson's redistribution-efficiency loss analysis for the growth of a nation. To my knowledge, in the microeconomics development literature only De Janvry and Sadoulet (1989) have explicitly used the collective action framework in addition to the transaction cost framework, to model contractual relationships between farmers and the state and their impact on the success of the Latin American Land Reform.

In the more egalitarian world of the extended family and the community, Pollak (1985) has used the transaction cost framework to study the insurance role of this family institution, but his work does reflect ideas conveyed by the collective action approach. According to Pollak (1985), because the transaction cost approach recognizes the importance of the family structure, it allows one to identify which activities can or cannot be efficiently carried out by the family and would, therefore, require the intervention of other private or parastatal institutions. His approach emphasizes the family's advantages in terms of incentives and monitoring as well as its disadvantages when the realization of economies of scale is constrained by the family governance structure.
Axelrod (1981), Chiappori (1988), Altonji et al. (1992), and Binmore (1994) showed that altruism is not a necessary condition for social transfers and, more generally, for contracts to take place. Instead, according to Sen (1967) and Coate and Ravaillon (1993), gains in increasing returns and specialization and insurance motives suffice to induce cooperative behavior from egoistic but rational members of a community.

3. Implications of the NIE for the Modeling of Household Insurance Arrangements

My study of family insurance institutions will follow closely the multi-agents framework developed by Polak (1985), Rozensweig (1988), Coate and Ravaillon (1993), and Axelrod (1988). It will try to incorporate the two approaches to the endogenous theory of institutions. However, contrary to Pollak (1985), I do not believe that asymmetric information constitutes a major problem within the context of a family.

In the absence of formal insurance markets, the traditional extended household in Africa is probably one of the most efficient insurance institutions as transaction costs, such as negotiation costs, can be minimized. Nevertheless, free-riding behavior still remains a possibility because the insurance service provided by members of the traditional extended household have the characteristics of a congestible and non-exclusive good. On the one hand, it is a congestible good because risk-sharing cannot insure households against shocks with an important aggregate component and, on the other hand, it is a non-exclusive good due to moral obligations. One can compare the household to a government’s safety net built with the objective of ensuring the welfare of everybody who is in need. As the scarcity of strategic
resources increases, conflicts related to distributional issues will become all but inevitable. In such a conflictive context, a household can persist only with strict norms of conduct imposed by the patriarch. Among the households surveyed, certain household chiefs come to forbid younger members to cultivate personal fields in order to prevent them from gaining in bargaining power. This is clearly an example of Olson’s redistribution-efficiency loss, which could explain why an extended household persists as an institution supplying insurance although it is unable to maintain a minimum level of food consumption for all members.

C. THE STATIC SEMI-COOPERATIVE MODEL OF HOUSEHOLD RISK-SHARING

1. Modeling the Extended Household as an Indigenous Insurance Institution

   a. The Extended Household in Burkina Faso

   In Chapter 2, I described two types of indigenous insurance contractual arrangements found in the region under study. The first type takes place among households within the village. These implicit contracts most often involve a household cultivator and a household herder, linked to each other by their ancestral master-slave relationship. I will focus my attention exclusively on the second type of contract, which structures relationships among nuclear families within an extended household. The nature of the family contracts as well the rules governing individual behavior make the extended household a more interesting case for the investigation of the issue of institutional change.
In the region under study and in most parts of West Africa, the household head has full control over the allocation of family labor and assets accumulated from one generation to the other. His objective is to ensure the survival and growth of the extended household. Nuclear families accomplish community tasks in exchange for an insurance service. Strict rules and norms of conduct restrict the definition of these contracts. They specify how much a nuclear family is supposed to contribute to the common pot and how much they can get in return.

Currently, inter-household and intra-household contracts are becoming less asymmetric as the household heads are losing their economic power to the benefit of the younger members of the household. Market penetration has given young people new opportunities to work outside the family sphere, allowing them to accumulate personal wealth and, meanwhile, to gain in bargaining power. The structure of an extended household tends to evolve towards an ensemble of economically independent spheres linked to each other by their transfers to the common pot and the share they get from this pot. If the strict rules governing individual contributions (labor and grains) have been relaxed, rules fixing one’s share of the common pot and moral conduct within the household still remain in order to guarantee the basic needs of every nuclear family.
b. Models of Intrahousehold Resource Allocation

The existence of households of various sizes and important variations in household ability to insure food consumption call for the use of an appropriate approach of intrahousehold resource allocation, where the formation and dissolution of social contracts can be represented. The household can no longer be viewed as a black box since individual preferences, constraints, and rules of conduct are critical in defining the outcome of the utility maximization problem.

Collective models of the household decision making process have been developed in recent years to counter the limits of the traditional unitary household model. A classification and detailed review of these models have been provided by Haddad, Hoddinott, and Alderman (1994, 1997). In fact, the collective models of household embrace two major groups of models, namely cooperative and non-cooperative models (Figure 4.1). Both recognize that decisions are made by individuals instead of a hypothetical social planner, and both leave the possibility for the individuals to decide between cooperating or not, depending on which option gives them higher utility. There are, however, fundamental differences between the cooperative and non-cooperative models.

---

1 Household is used here to describe any interaction involving more than two persons, such as families, clubs and communities.
Cooperation Models
* Different preferences
* Cooperative solution when utility of being together outweighs utility of being alone
* Joint constraints

Pareto Optimal Models
* Pareto efficient solution (Varian's definition):
  Bourguignon et al. 92; Chiappori 92

Nash-Bargaining Models
Max \( N = (U_m - V_m)(U_f - V_f) \)
* The decision results from a bargaining process (game theory):
  Horney and McElroy 88

Unitary Models
Max \( U(.) \) or Max \( W(U_1, U_2, \ldots) \)
* Single utility function (identical pref.)or welfare function (aggregated pref.), pooled resources: Becker 81; Singh et al. 89

* Noncooperative solution as a threat point
  Lungberg and Pollack 93

Noncooperation Models
Max \( U_i \) s.t. interlinked individual constraints

Source: Adapted from the Taxonomy of Models of Intra-Household Resource Allocation (Haddad et al., 1994)

Figure 4.1. Classification of Collective Household Models and Underlying Assumptions
The cooperative approach is based on two major assumptions. First, relationships among partners in the contract are assumed to be binding and enforceable. Second, household members decide jointly about the allocation of pooled resources. This approach can be further decomposed into two groups of models. The first group of models, best illustrated by the work of Bourguignon et al. (1992) and Chiappori (1992), does not make any assumption regarding the nature of the sharing rule governing the allocation of the final outcome. In that sense, it is the most general model of intra-household resource allocation, one that allows rigorous tests of alternative formulations. Chiappori's sharing rule simply states that within a household, egoistic or caring individuals need to agree only on what share of their individual budget ought to be spent on public goods.

Manser and Brown (1980) and McElroy and Horney (1981) Nash bargaining households are, in turn, embedded in the second group of more structured but less tractable cooperative household models, along with unitary models such as the Singh, Squire and Strauss' (1986) well-known model of the agricultural household and Becker's (1974) rotten kid problem. Indeed, Haddad et al. (1994) classified the unitary household as the most restrictive among all the collective models. In this simplest approach, the individual utility maximization problem results in demand behavior that depends only on the prices of goods and individual income.

In the less restrictive approach of Nash bargaining households, where households maximize a Cobb-Douglas joint utility function subject to a joint budget constraint, optimum demand functions are defined not only in terms of the prices of goods and pooled income, but also in terms of individual income. Individual control of his own resource endowments
determines the threat point, i.e., the point where partners cannot reach an agreement. Manser and Brown (1980) and McElroy and Horney (1981) defined this threat point as the individuals' reservation utility when leaving the household. Lundberg and Pollak (1993) argued that disagreements do not always lead to divorces or household break-ups and, therefore, tried to incorporate both approaches by using the cooperative framework to depict a married couple and using the non-cooperative framework, described thereafter, to specify the threat point.

In contrast to the cooperative approach, non-cooperative household models do not assume \textit{a priori} that contracts are binding and enforceable and that resources are pooled. Based on the non-cooperative principle, households are conceived by Carter and Katz (1997) as an ensemble of economically independent spheres, each one controlling its resource endowment, and the spheres are linked to each other by net transfers. Each sphere solves its personal utility maximization for the demand of a good exclusively consumed by the household and of a public good. This results in individual optimum demands for the goods conditional on the level of transfer household members will have to agree upon prior to solving their individual resource allocation problem. Outcomes are not always efficient in the Pareto sense because household members do not necessarily enter into a binding and enforceable contract. The equilibrium is a Nash equilibrium where none of the household members has an incentive to deviate. There are exit options when a member leaves the household because his utility outside of the family sphere outweighs his utility from being inside, or when he decides not to contribute to the voluntary provision of the public good (Carter and Katz, 1997).
Smith (1995) has extended Carter and Katz's approach by explicitly modeling the household's resource allocation problem as a two-stage decision-making process. In the first stage, cooperative households bargain over the level of transfer that will determine the resource constraint for the second stage of the process, where households decide unilaterally on the allocation of the resources they control. This innovative approach of intra-household allocation proved to be useful in understanding the decision-making process in detail, and to uncover the causal relationship between differences in individual responses to changes in their environment and the assignment of property rights within a household. It also shed light on the existence of allocative inefficiencies when household members see their opportunity set reduced due to the separate control over strategic resources and conflicts of interest.

In summary, there are in total four different approaches to the modeling of intra-household resource allocation. Assumptions made regarding the individual decision-making process usually guide the choice of a specific approach. Chiappori (1997), however, strongly argued that the rejection of the unitary model in any case does not provide support for either one of the three remaining collective approaches. "The only way to support empirically the collective setting is to derive, from the collective framework itself, conditions that can potentially be, but are actually not, falsified by empirical observation (Chiappori, 1997)." In order words, Chiappori stressed the importance of constructing models with testable restrictions. Chiappori (1988) and Browning et al. (1994) have derived a Pareto household model based on an implicit sharing rule principle, which allows for complex income effects and the testing of standard restrictions imposed on the utility and demand functions.
Using the Canadian expenditures surveys (FAMEX), Browning et al. (1994) rejected the unitary hypothesis and supported predictions drawn from the Pareto cooperative household framework, which states that the sharing rule does yield an efficient outcome and that income distribution as well as differences in individual characteristics, such as age and wealth, do affect the collective decision. Udry's (1995) empirical results on the allocation of labor across household members in Burkina Faso do not, however, support the hypothesis of efficient intra-household resource allocation. These mixed findings suggest that the choice of the most appropriate household model and the testing of one approach versus another still remains a theoretically and empirically unsolved issue.

In this dissertation, my objective is not to test one household approach against another, but to choose among the existing approaches one that could explain and simulate the formation and dissolution of indigenous institutions. In rural Africa, nuclear families are traditionally organized in extended households, where relationships are binding and enforceable. Moral obligations and norms of conduct imposed by the household heads, on the one hand, and the threat of permanent exclusion from the extended household in case of non-cooperation, one the other hand, guarantee the enforceability of the contract. However, as household members can access new economic opportunities outside of the extended household and thereby gain progressive control over their personal endowments of labor and assets, certain decisions will fall within the individual spheres, while others will still remain a joint process.

Due to the combination of joint and unilateral decisions within the extended household, I will draw upon the semi-cooperative approach developed by Carter and Katz.
(1997) and Smith (1995), where a household is described as separate economies linked to each other by the voluntary provision of public goods. I will extended the original model by incorporating risk and the insurance service the extended household supplies by pooling the members’ risks together will be viewed as a public good. Human capital and assets are critical to the household’s welfare. I will, therefore, extend the model further by considering, in Chapter 5, the dynamics of capital formation and accumulation within the extended household and its individualized effects on household members.

2. The Static Version of the Non-Cooperative Model of Household Risk-Sharing

a. Formulation of the Model

Let’s consider two nuclear families 1 and 2 forming two separate sub-economies, in the sense that each family has full control on its resource endowment as is currently the case in African households. Each nuclear family is endowed with a certain level of labor and physical assets. In this model, both labor and assets are exogenously determined. Total family labor $T$ corresponds to the number of economically active people at a given time, and the family’s physical asset $K$ is the livestock accumulated over the years after the head of the nuclear family was given a herd from the extended household’s head at his birth. I assume that the family’s total labor can be allocated only by participating in household grain production and practicing off-farm activities outside of the extended household sphere. In short, the two nuclear households pool labor together to produce grains for household consumption and agree upon an *ex ante* share of the harvest.
Each family's total income \( y \) includes its share in grain production \( f(.) \) and off-farm income \( g(.) \). Grain production requires labor input \( L \) and a capital \( A \), which is the land owned and cultivated by the extended household. Similarly, off-farm activities require a capital \( K \) and labor input \( l \). Both production technologies are described by a Cobb-Douglas function. I also assume that agricultural and off-farm production technologies exhibit decreasing returns to scale in order to add an additional justification for the formation and break-up of the risk-sharing extended household. Grain production is subject to both multiplicative aggregate \( \theta v \) and idiosyncratic shocks \( \theta i \), while off-farm production is subject to multiplicative idiosyncratic shocks only. This is a reasonable assumption since most of the off-farm activities consist of trading and migration.

The production function for \( i, j=1,2 \) (with \( i \neq j \)) are formulated as follows:

\[
\begin{align*}
  f(A_j L_j + L_p \tilde{\theta}_j \tilde{\theta}_i) &= (L_j + L_p)^a A^b \tilde{\theta}_j \tilde{\theta}_i \\
  g_j(K_p L_p \tilde{\theta}_j) &= (K_p)^c (L_j)^d \tilde{\theta}_j
\end{align*}
\]  

(4.1) (4.2)

All incomes are allocated to household food consumption. The only decisions each nuclear family has to make concerns, on the one hand, the allocation of labor between the household production of food and off-farm production (trade, handicrafts, and cottage industry), and on the other hand, its share of household food production. Nuclear families form an extended household by writing a contract specifying \textit{ex ante} the amount of labor \( L \) allocated to agricultural tasks on common fields and their share \( \gamma \) of the latter. Contracts exist
only when nuclear households derive a larger utility $U$ from returns to scale in grain production and income diversification than their reservation utility $V$. Household and individual reservation utilities are specified as constant relative risk aversion utilities, and it is assumed that both nuclear families have identical degrees of risk aversion (Equation 4.3). This assumption can be easily relaxed in order to account for differences in initial endowments.

$$EU_j = E\left[ \frac{C_j^{1-\alpha}}{1-\alpha} \right]$$

(4.3)

The household risk sharing contract also specifies an *ex post* transfer rule $\eta$ that ensures a transfer of food from a surplus nuclear household to a deficit nuclear household. Households are actually depicted in a more egalitarian fashion than they are in reality, where social hierarchy still affects relationships among family members. Moral obligations imposed by the patriarch on younger members are implicitly introduced by making the transfer rule to be exogenously determined.

Let $C_1$ be family 1's and $C_2$ be family’s 2’s minimum food consumption levels. The transfer rule defines the amount of food that will be transferred from one family to another given their individual food levels at the end of the period, i.e., $y$. Family 1 will receive a transfer equivalent to its food deficit of $(y_1 - C_1)$ only if family 1's food surplus $(C_2 - y_2)$ is at least superior or equal to family 1's deficit. Otherwise, family 1 will receive only $(C_2 - y_2)$.
Transfers do not take place whenever both nuclear families are experiencing a deficit or surplus.

The indirect utility a nuclear household can obtain by leaving the extended household and becoming economically independent defines the exit option. This reservation utility, solution to the individual maximization problem when alone, is equivalent to self-insurance.

The extended household framework can be summarized as follows:

* The nuclear family \( j \)'s total stock of food at the end of a period (with \( i,j=1,2 \) and \( i \neq j \)) is:

\[
y_j = y_j + p \int f(A, \lambda_j + L, \theta_j) + p \int g_j(K, l, \theta_j)
\]  

(4.4)

* The nuclear family \( j \)'s expected utility function (with \( i,j=1,2 \) and \( i \neq j \)) is:

\[
EU_j = EU_j(y_j + \eta_j(y_j, \eta_j))
\]  

(4.5)

* The individual reservation utility \( EV \) is:

\[
EV_j = \max_{L, \gamma, \theta_j} EV_j[p \int f(0.5A, \lambda_j + L, \theta_j) + p \int g_j(K, l, \theta_j)]
\]  

(4.6)

The extended household's two-stage decision making process can then be formulated as a static and full-information Nash semi-cooperative game. In the first stage, nuclear families jointly choose the sharing rule that will govern the redistribution of common grain production. Then, conditional on their share of the extended household's harvest, each nuclear family
allocates its labor force between participating in common agricultural tasks and engaging in off-farm activities.

**FIRST STAGE OF THE EXTENDED HOUSEHOLD'S DECISION MAKING PROCESS:**
Both nuclear families make a joint decision concerning the share of common grain production given their respective exit option and an exogenously imposed *ex post* transfer rule.

\[
\begin{align*}
\max_{\gamma', \eta'} & \mathcal{W} = [U' - V'] [U' - V'] \\
\text{subject to:} & \\
E U_j & \geq E V_j, j = 1, 2 \\
\gamma' + \eta' & = 1 \\
\eta' + \eta' & = 0
\end{align*}
\]
SECOND STAGE OF THE EXTENDED HOUSEHOLD'S DECISION MAKING PROCESS:

Each nuclear family decides upon the allocation of its labor.

Nuclear family $j$ solves:

$$\max_{L_j, L_i} EU_j[(y_j(L_j, L_i) + \eta_j(y_j(L_j, L_i), y_i(L_i^*, L_i^{**}))/\gamma_j]$$

subject to:

$$L_j + L_i = T_j$$

In practice, the stage two of the decision-making process is solved first for the family $j$'s optimum labor contribution to household agricultural production as a function of the family $j$'s share of the common harvest and the family $i$'s labor contribution. That is, by plugging equations 4.5 and 4.6 in equation 4.11, one can derive the following first order condition to the unilateral maximization problem:

$$EU_j[y_j f_j(L) - p g_j + \eta_j L] = 0$$

The first order condition simply states that nuclear family $j$ will allocate labor to household grain production until the marginal returns from contributing labor to common household tasks equals the marginal return from engaging labor to off-farm activities outside of the extended household's sphere.
At equilibrium, the reduced form of the optimum labor contribution schedule derived from the first-order condition takes the following form:

\[ L^*_j = L_j(\gamma, \beta, \eta, \gamma_j) \]  

(4.14)

This optimum labor contribution can be, in turn, plugged in the objective function of the extended household (Equation 4.7), and the joint decision in stage one can be solved for the optimum sharing rule. The first-order of the joint maximization problem is as follows:

\[
\frac{EU_{\gamma} [p f + \gamma p f + p g + \eta_{\gamma_j}]}{EU_{\gamma_i} [-p f + (1 - \gamma) p f + p g + \eta_{\gamma_j}]} = -\frac{[EU_i - EV_i]}{[EU_i - EV_i]} 
\]

(4.15)

According to equation 4.15, the two nuclear families will agree upon a sharing rule that divides the surplus from cooperation (right hand-side of the equation) following the ratio of marginal net benefits occurring to each partner of the negotiation (left hand-side of the equation). In other words, the optimum outcome of the bargaining process is such that the division of surplus from cooperation equates the marginal rate of utility transfer between the two nuclear families. Figure 4.2 illustrates the solution concept. The optimum solution of the first-stage of the household’s joint decision corresponds to the intersection point between the utility frontier and the extended household’s utility curve. Nuclear households enter in a binding contract as the conflict point lies inside the negotiation set delimited by the utility frontier.
Figure 4.2. Solution to the First-Stage Bargaining Problem
It is important to notice that, if the sharing rule is assumed to be determined exogenously, by the household head for example, this two-stage decision making process can be reduced to the second stage non-cooperative problem. In that case, there will be an infinite number of contracts \((\gamma_i, \gamma_j, L_i, L_j)\) solution to the non-cooperative maximization problem. The first stage of joint decision guarantees indeed one unique solution.

In this model, multiplicative production risks introduce the possibility of conflicting outcomes; that is, the conflict point in Figure 4.2 falls outside of the negotiation set delimited by the utility frontier (Figure 4.3). Actually, Ott (1992) argued that the conflict point is irrelevant and the bargaining process cannot be justified when partners of the negotiation act in contexts characterized by complete information and certainty. The fact that one nuclear family’s fall back position \(EV\) (i.e., reservation utility of leaving the extended household) may be larger than the maximum cooperative outcome \(EV_{\text{max}}\) is sufficient to generate a conflict.

Solutions to the extended household two-stage decision-making process cannot be derived analytically from this optimization problem, which involves the resolution of two simultaneous individual expected utility maximization problems linked to each other by the contract \((\gamma_i, \gamma_j, L_i, L_j)\). An econometric estimation would have to solve a system of three reduced-form equations for the optimum sharing rule \(\gamma\), and labor inputs \(L_i\) and \(L_j\). Using reduced-form equations suffers from numerous shortcomings and does not guarantee the model’s identification. Solving numerically the semi-cooperative Nash game is a more satisfactory approach.
Figure 4.3. Conflict Outcome of The Extended Household's Joint Decision

\[ W = (EU^i - EV^i)(EU^j - EV^j) \]
The model is parameterized using household data collected in Burkina Faso from 1991 to 1994, and information from studies conducted by Carter (1990) and Zimmerman (1994) based on the Burkina Faso ICRISAT database. Optimum contracts \((y_i, y_j, L_i, L_j)\) are then found following a grid search over the three dimensional space \((y_i, L_i, L_j)\). Using this approach, I was able to explore the domain of existence of household risk sharing contracts given:

1. different degrees of inequalities in labor and asset endowments across nuclear households;
2. decreasing versus increasing returns to scale in agricultural production; and
3. different magnitudes and frequencies of income shocks.

**b. Parameterization of The Model (Base Case)**

1. **Production functions**

   Coefficients of the different production functions are econometrically estimated using the household data collected in Burkina Faso from 1991 to 1994:

   * **OLS estimation of the Cobb-Douglas agricultural production function \(f()\):**

     
     \[
     \text{Log(value of household grain production)} = 6.95 + 0.58 \times \text{Log(labor)} + 0.29 \times \text{Log(land)} \quad R^2=0.57
     \]

   * **OLS estimation of the Cobb-Douglas off-farm production function \(g()\):**

     
     \[
     \text{Log(value of household off-farm production)} = 7.19 + 0.17 \times \text{Log(labor)} + 0.46 \times \text{capital} \quad R^2=0.50
     \]
Table 4.1 reports values for the structure of income shocks, assumed to be normally distributed and estimated by Carter (1990) and Zimmerman (1994) using the ICRISAT Burkina Faso data set.

<table>
<thead>
<tr>
<th>Village-level shock $\theta_v$</th>
<th>$\theta_v = 0.75$</th>
<th>$\theta_v = 1$</th>
<th>$\theta_v = 1.25$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_j = \text{low}$</td>
<td>$\theta_j = 0.90$</td>
<td>$\theta_j = 0.80$</td>
<td>$\theta_j = 0.70$</td>
</tr>
<tr>
<td>$p = 0.20$</td>
<td>$p = 0.18$</td>
<td>$p = 0.24$</td>
<td>$p = 0.18$</td>
</tr>
<tr>
<td>$\theta_j \cdot \theta_v = 0.675$</td>
<td>$\theta_j \cdot \theta_v = 0.80$</td>
<td>$\theta_j \cdot \theta_v = 0.875$</td>
<td></td>
</tr>
<tr>
<td>$p = 0.06$</td>
<td>$p = 0.08$</td>
<td>$p = 0.06$</td>
<td></td>
</tr>
<tr>
<td>$\theta_j = \text{medium}$</td>
<td>$\theta_j = 1$</td>
<td>$\theta_j = 1$</td>
<td>$\theta_j = 1$</td>
</tr>
<tr>
<td>$p = 0.60$</td>
<td>$p = 0.24$</td>
<td>$p = 0.18$</td>
<td></td>
</tr>
<tr>
<td>$\theta_j \cdot \theta_v = 0.75$</td>
<td>$\theta_j \cdot \theta_v = 1$</td>
<td>$\theta_j \cdot \theta_v = 1.25$</td>
<td></td>
</tr>
<tr>
<td>$p = 0.18$</td>
<td>$p = 0.24$</td>
<td>$p = 0.18$</td>
<td></td>
</tr>
<tr>
<td>$\theta_j = \text{high}$</td>
<td>$\theta_j = 1.1$</td>
<td>$\theta_j = 1.2$</td>
<td>$\theta_j = 1.3$</td>
</tr>
<tr>
<td>$p = 0.20$</td>
<td>$p = 0.08$</td>
<td>$p = 0.06$</td>
<td></td>
</tr>
<tr>
<td>$\theta_j \cdot \theta_v = 0.825$</td>
<td>$\theta_j \cdot \theta_v = 1.2$</td>
<td>$\theta_j \cdot \theta_v = 1.625$</td>
<td></td>
</tr>
<tr>
<td>$p = 0.06$</td>
<td>$p = 0.08$</td>
<td>$p = 0.06$</td>
<td></td>
</tr>
</tbody>
</table>

$\theta_v, \theta_j =$ magnitude of income shocks
$p =$ probability

Source: Carter (1990) and Zimmerman (1994)

Table 4.1. Structure of Agricultural Income Shocks in Burkina Faso

(3) Household expected utility function

Household utility functions are specified as constant relative risk aversion utilities,

$$EU(c) = c^{1-R}/1-R,$$

where $R$ varies from 0.3 to 0.7.
c. Simulation Results

(i) Effects of Inequalities of Labor Supply and Assets on the Contract Space

Figure 4.4 presents a picture of the contract space given 14 different scenarios where levels of labor and capital vary across nuclear families. Scenarios 1 to 7 correspond to the base case, which uses parameters reported in the previous section. Scenarios 8 to 14 differ by the fact that all simulations are conducted using initial levels of labor and capital that are twice the levels in the base case. Tables 4.2 and 4.3 describe in more details, respectively, scenarios 1 to 7 and scenarios 8 to 14, by reporting the different ratios as parameters, the optimum contracts, and gains in utility from risk sharing. In Figure 4.4., the x-axis represents the ratio of nuclear family 1’s labor over family 2’s labor, while the y-axis reports the ratio of family 1’s assets over family 2’s capital. The lines passing through the different scenarios of optimum contracts delimit the domain of potential risk-sharing contracts on the bottom left corner, and the domain of conflicts on the upper right corner.

Scenarios 2 to 7 indicate that family 1, which has a larger labor force than family 2, will share risk with family 2 only if family 2 owns sufficient livestock to compensate for its relatively smaller contribution of labor force to common grain production. As a consequence, potential conflicts will lead to the existence of nuclear families which have a large labor force, or equivalently, a low dependency ratio, on the one hand, and nuclear families with low levels of labor and capital, on the other hand. The first group of nuclear families still have a strong ability to smooth out income shocks by developing risk diversification strategies, while the second group are likely to be constrained by both a small labor force and little livestock.
Figure 4.4. Space of Household Risk-Sharing Contracts: Simulation Results of the Base Case and for Initial Levels of Labor and Capital Twice the Levels in the Base Case
### Table 4.2. Household Risk-Sharing Contracts: Simulation Results of the Base Case

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Controlled Parameters</th>
<th>Characteristics of Optimum Contracts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ratio “Family 1’s labor available over family 2’s labor available”</td>
<td>Ratio “Family 1’s capital available over family 2’s capital available”</td>
</tr>
<tr>
<td>1</td>
<td>0.50</td>
<td>16.70</td>
</tr>
<tr>
<td>2</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>3</td>
<td>1.50</td>
<td>0.45</td>
</tr>
<tr>
<td>4</td>
<td>2.00</td>
<td>0.26</td>
</tr>
<tr>
<td>5</td>
<td>2.50</td>
<td>0.16</td>
</tr>
<tr>
<td>6</td>
<td>3.00</td>
<td>0.11</td>
</tr>
<tr>
<td>7</td>
<td>3.50</td>
<td>0.08</td>
</tr>
</tbody>
</table>
Observed characteristics of food deficit and food surplus nuclear households reported in Table 2.6 of Chapter 2 support this simulated result.

Furthermore, as one can see from comparing scenario 2 with scenario 7 in Table 4.2, decreasing returns to scale in both agricultural and off-farm production imply that nuclear families will gain in cooperating with each other only if the capital ratio increases at a faster rate than the increase in the ratio of labor contributions to household common tasks. As the two ratios of labor contributions and capital increase from scenario 2 to scenario 7, the optimum contracts stipulate that families 1 and 2 will progressively invest smaller proportions of their labor force in household agricultural production. Family 1 will decrease its labor contribution to household grain production from 25 to 15 percent, while family 2's small labor availability will be rapidly and entirely allocated to off-farm production. Indeed, with higher levels of labor and capital, it becomes more efficient for households to allocate their pooled resources to off-farm activities, which are not subject to aggregate agricultural shocks, and then buy grain on the market. These results have strong policy implications that go in the direction of the development of vital markets, such as financial markets, to facilitate capital accumulation at the household level and to ensure household supplies of food.

Another important finding can be drawn from the second set of simulations using initial levels of labor and capital twice the levels in the base case. As can be seen in Figure 4.4, larger endowments of labor and capital enlarge the contract space. This underscores the importance of capital accumulation at the household level for sustaining indigenous institutions, and it suggests that the probability for nuclear families to agree upon a risk-sharing contract is higher within larger households. At this point, it is important to remember
that if an extended household tends to accumulate more labor and capital as it becomes larger, it is also true that its size will be determined by the extent to which transaction costs, and in particular information costs, can be kept low. However, this model has not incorporated that dimension of the problem.

This simulation exercise has also brought new insight into the issue of equity in the allocation of resources within the extended household. One neoclassical pillar, namely the separability between economic efficiency and equity, no longer holds under the assumption of market incompleteness, and when norms of conduct tend to restrain the solution set. According to the figures of optimum share and gains in utility exhibited in Table 4.2, scenario number 2, under which the two nuclear families are perfectly similar, is the only one where the efficient solution is also the most equitable. For all the other scenarios, the efficiency condition carries important redistributive implications. For each optimum outcome, gains in utility from household risk-sharing differ significantly between the two nuclear households. Results of scenarios 2 to 7 show that family 2’s gains in utility from sharing risk with family 1 increase, while family 2’s gains remains close to zero. For example, in the case of scenario 4, family 1 invests up to 75 percent of its labor in producing grains for the entire household, receives in exchange 90 percent of the share of household production, while family 2’s optimum policy is to allocate all its relatively smaller labor force to off-farm activity. Because the off-farm production function exhibits stronger decreasing returns to scale than the grain production function, family 2 with a large capital endowment will benefit, at the margin, from pooling resources with family 1, which has an endowment of labor large enough so that family
2 does not have to work on common fields and can take full advantage of off-farm opportunities.

One can also argue that norms of conduct may lead to outcomes that are equitable but not necessarily efficient. Let us go back to scenario 4. If for moral reasons, the household head decides to impose a share of the household’s grain production that will equate both parties’ gains in utility, but that is greater than 75 percent, his decision will certainly affect family 2’s action. The two partners will still cooperate, but their actions will not lead to an efficient outcome.

(ii) Effects of Income Shocks on the Contract Space

Two sets of simulations are conducted to investigate the effects of exogenous income shocks on household risk sharing contract spaces. The first set simulates aggregate shocks with higher frequencies and higher magnitudes than in the base case. Results are shown in Figure 4.5 and Table 4.3. As expected, larger and more frequent aggregate shocks reduce dramatically the contract space as compared to the base case. There is, actually, no solution to scenarios 19 to 21, that is, despite family 1’s large endowment in labor force, family 2 does not gain in sharing risks with family 1 because of the high frequency and magnitude of the aggregate shocks affecting agricultural production. Large aggregate shocks also affect family 1’s labor contributions to the household’s production of grains, by limiting the latter to 25 percent only of the labor available instead of 75 percent as in the base case.

The second set of simulations, shown in Figure 4.6 and Table 4.4, differs from the previous one by using initial levels of labor and capital that are twice the levels in the base
case. In contrast to the previous case, higher levels of initial endowments in labor and capital allow nuclear families to derive gains by cooperating with each other despite important aggregate shocks and regardless of differences in their endowments. The contract space generated by this set of simulations is, as expected, larger than the contract space in the previous case but smaller than the one in the base case. It is also interesting to notice that, because of the magnitude of aggregate shocks and large endowments, nuclear families invest only a maximum of 15 percent of the labor force available in the production of grains for household consumption. Figures for the optimum share of common harvests indicate that this variable has become irrelevant because most of the household’s food supply comes from the purchase of cereals on the market with income generated by off-farm activities. In such a context, it is clear that nuclear family 2, which has the largest endowment of capital, will benefit the most from sharing risks with family 1. Indeed, family 2 can allocate its entire labor force to off-farm activities, still receive 50 percent of the common grain production, and it is only required to transfer to family 1 a quantity of food at least equal to its own surplus and at most equivalent to 1’s deficit.
Figure 4.5. Space of Household Risk-Sharing Contracts: Simulation Results of the Base Case and for Higher Frequencies and Magnitudes of Aggregate Shocks
## Table 4.3. Household Risk-Sharing Contracts: Simulation Results for Higher Frequencies and Magnitudes of Income Shocks

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Controlled Parameters</th>
<th>Characteristics of Optimum Contracts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ratio &quot;Family 1’s labor available over family 2’s labor available&quot;</td>
<td>Ratio &quot;Family 1’s capital available over family 2’s capital available&quot;</td>
</tr>
<tr>
<td>15</td>
<td>0.50</td>
<td>3.85</td>
</tr>
<tr>
<td>16</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>17</td>
<td>1.50</td>
<td>0.42</td>
</tr>
<tr>
<td>18</td>
<td>2.00</td>
<td>0.24</td>
</tr>
<tr>
<td>19</td>
<td>2.50</td>
<td>-</td>
</tr>
<tr>
<td>20</td>
<td>3.00</td>
<td>-</td>
</tr>
<tr>
<td>21</td>
<td>3.50</td>
<td>-</td>
</tr>
</tbody>
</table>
Figure 4.6. Space of Household Risk-Sharing Contracts: Simulation Results for Higher Frequencies and Magnitudes of Aggregate Shocks, and Higher Levels of Endowments in Labor and Capital
### Table 4.4. Household Risk-Sharing Contracts: Simulation Results for Higher Frequencies and Magnitudes of Aggregate Shocks, and Higher Levels of Endowments in Labor and Capital

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Controlled Parameters</th>
<th>Characteristics of Optimum Contracts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ratio “Family 1’s labor available over family 2’s labor available”</td>
<td>Ratio “Family 1’s capital available over family 2’s capital available”</td>
</tr>
<tr>
<td>1</td>
<td>0.50</td>
<td>3.84</td>
</tr>
<tr>
<td>2</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>3</td>
<td>1.50</td>
<td>0.46</td>
</tr>
<tr>
<td>4</td>
<td>2.00</td>
<td>0.26</td>
</tr>
<tr>
<td>5</td>
<td>2.50</td>
<td>0.17</td>
</tr>
<tr>
<td>6</td>
<td>3.00</td>
<td>0.12</td>
</tr>
<tr>
<td>7</td>
<td>3.50</td>
<td>0.08</td>
</tr>
</tbody>
</table>
Results from the last set of simulations underscore once more the importance of savings and, in general, the importance of human and physical capital formation and accumulation at the household level. Scarcity in vital resources definitely reduce the possibilities for individuals to co-insure each other in the absence of insurance markets. Abundance of family labor force allows an extended household to engage in risk diversification strategies. The extended household can allocate labor to either agricultural production or off-farm activities or both, depending on the relative degrees of scale economies exhibited by the different production functions. However, in the presence of important agricultural aggregate shocks, physical capital becomes a critical factor as it facilitates the household’s access to off-farm activities.

D. CONCLUSION: Inequalities, Risk, and the Dynamics of Capital Accumulation

It is widely recognized that Sub-Saharan economies are characterized by high uncertainty, on the one hand, and increasing inequalities, on the other hand (World Bank, 1994). Despite this fact, few studies have simultaneously addressed the issues of risk and inequality. The causal relationship between these two variables still remains obscure although some economists have pointed out the positive correlation between them (Ravallion, 1988; Reardon and Taylor, 1996). Reardon and Taylor (1996) have, for example, estimated the effects of agro-climatic shocks on income inequality and poverty in the context of Burkina Faso. By regressing inequality and poverty indexes such as the Gini coefficients on a given number of risk indicators and household characteristics, they found that agro-climatic shocks
do increase income inequality as well as poverty if households are constrained in their ability to manage effective risks. Reardon and Taylor's (1996) findings actually provided some insights of the mechanisms in place and their results are consistent with our model. Carter (1997) and Zimmerman (1994) offered a more formal analysis of the interrelationship between risk and inequality. They derived a model of agent interactions, which predicts that in the absence of risk-sharing, there is a one-to-one mapping between individual risk exposure and his endowment of resources. Indeed, well-endowed households are more capable of developing effective risk-management strategies (portfolio diversification) and effective risk-coping strategies (savings depletion) as well. Moreover, using data from Burkina Faso, they estimated that a rural household in the Sahel, if socially and economically isolated, would face annually a 24 percent probability of falling below the food subsistence level. Therefore, there is clear evidence that risks increase inequality in the absence of social risk-sharing.

The semi-cooperative model of intra-household resource allocation developed in this Chapter 4 attempted to explain why despite their social benefits, traditional risk-sharing organizations cannot be sustained in agrarian economies that experience resource scarcity, high aggregate shocks and market penetration. Simulation results given different scenarios of unequal distribution of labor and physical capital across nuclear families, and given different scenarios of shocks, show that large aggregate shocks as well as limited endowments in vital resources significantly reduce the space of feasible risk-sharing contracts. When nuclear households can gain by forming an extended household and sharing risks with other families, efficient outcomes are achieved but they carry important redistributive implications.
The impact of risk on inequalities is reflected through the community's inability to achieve a collective provision of insurance services leaving some individuals better-off and some worse-off. Losers are predicted to be households with a limited endowment of capital and a high dependency ratio, while winners are households which have sufficient means to self-insure. Without market penetration and the development of off-farm activities, the latter will not enter in conflict with the extended household institution, but this does not guarantee that households will undertake efficient decisions regarding the allocation of their resources. These same inefficiencies could also be an outcome of norms of conduct imposed by the household head, that guarantee an equitable redistribution of the surplus within the extended household but, at the same time, raise the incentives to free-ride for household members who possess a strong bargaining power.

Intrahousehold resource allocation under uncertainty and indigenous institutions are two complex phenomena this Chapter has tried to dissect. Important conclusions have been drawn concerning the effects of wealth inequalities on risk-sharing. Results have also stressed the importance of human and physical capital accumulation for sustaining indigenous risk-sharing institutions and for insuring nuclear households against income shocks. However, because the model developed here is purely static, it does not allow an investigation of questions such as: What are the short-term and long-term effects of initial inequalities in endowments on the rates of capital accumulation across nuclear families? What are the effects of shocks on these same rates? Chapter 5 of this dissertation will address some of these issues by altering the present semi-cooperative model of intra-household resource allocation and making it dynamic.
CHAPTER 5

REDISTRIBUTION OF RESOURCES UNDER UNCERTAINTY AND THE
DYNAMICS OF INDIGENOUS RISK SHARING INSTITUTIONS

A. INTRODUCTION

In agrarian economies characterized by high uncertainty, extended households and
other village self-help groups were long known to be efficient substitutes (in the Pareto sense)
for formal insurance markets. Insurance services supplied by these indigenous institutions take
either the form of risk-sharing across individuals or intertemporal consumption smoothing.
Extended households represent a unique insurance institution as they integrate the two
dimensions of consumption smoothing. The vertically extended household composed of
intergenerational nuclear families provides savings opportunities while the horizontally
extended household allows for economies of scale in production, risk-diversification
strategies, and social transfers.

Gains from cooperation can explain the formation of organizations and institutions.
The efficiency-improving argument is, however, not sufficient to explain the pervasiveness,
or on the contrary, the decline of institutions such as the extended household in Sub-Saharan
Africa. Recent theoretical debates surrounding the issue of institutional changes and the lack

150
of empirical studies motivated my search for a dynamic framework that can be used to identify conditions under which an institution is sustainable or not.

In Chapter 4, simulation results of a semi-cooperative household show that the household’s initial endowments in labor and assets along with the magnitude of income shocks and the rules regarding the allocation of products from common labor determine the size of the space of feasible risk-sharing contracts. These results also suggest that the contractual rules embodying the extended household institutional design have important implications for the existence of contracts as well as significant redistributive consequences on the welfare of household members. Indeed, in most cases, individuals are sharing risks by agreeing upon a redistribution scheme that ensures transfers of resources.

The household model developed in this chapter attempts to extend these static results by looking at the intertemporal behavior of nuclear families interacting with each other within the extended household. Using a dynamic framework will allow one to formally capture the time dimension of risk sharing, that is, how household members accumulate assets over time in order to smooth their consumption. An analysis of the differential effects of intrahousehold resource allocation on individual saving/investment behavior and welfare will be carried out.

151
B. FROM "ALLOCATIVE EFFICIENCY-IMPROVING INSTITUTIONS" TO "REDISTRIBUTIVE INSTITUTIONAL CHANGES": A REVIEW OF THEORIES AND EMPIRICAL STUDIES OF INSTITUTIONAL CHANGES

1. The Theoretical Debate

Shirking is intrinsic to the behavior of rational and egoistic economic agents. It lowers the potential for collective actions by increasing transaction costs and offsetting the benefits of cooperation. North (1989) explained how rules and norms of conduct defining an institution can help to sustain it by restraining the opportunity set of individuals. This rules reduce the uncertain behavior of individuals by raising the costs of shirking. However, institutions do evolve over time. Neoclassical institutional economists such as North (1981) and Hayami and Ruttan (1985) emphasized changes in relative prices as the major source of institutional changes. They argue that, historically, population growth and technological innovations represent the major forces underlying changes in relative prices of resources. During its historical development process, Japan has experienced rapid population growth given a limited surface of land. This, in turn, has led to a cheap labor force and small labor-intensive small rice farms. This theory implies that institutions evolve in response to modifications of their environment and that only efficient institutions emerge and can be sustained.

In 1984, Akerlof provided a counter example to the efficiency-improving institutions argument by studying resource allocation under the Indian customs of caste. He demonstrated that institutions that are inefficient in the Pareto sense can persist when groups of individuals
can prevent other groups to deviate by imposing strong social sanctions. In addition, Bardhan (1989) criticized the *efficiency-improving institutions* approach for being too functionalist like Darwin's theory of evolution. This approach considers the process of institutional changes as a simple random process, while historians and political economists agree that institutions tend to evolve under the influence of a combination of complex forces and institutions evolve according to a path-dependent process. Inspired by the Marxist theory, which states that institutions result from confrontations between the dominant class and the working class regarding the allocation of production surpluses, Bardhan (1989) underscored the non-separability of allocative efficiency and redistributive implications of institutional changes. According to the same author, "this is particularly true when issues of collective action, bargaining power, class capacity, mobilization and struggle in the historical process are important (Bardhan, 1989)." In other words, the initial property rights has important allocative as well as redistributive implications and in the absence of complete markets and perfect information flows, individuals with bargaining power can reverse the rules of the game along with the initial redistribution process.

2. Lessons From Existing Empirical Studies on Institutional Changes

Most empirical studies on institutional changes have been conducted, as expected, by researchers in the areas of history-economics or political sciences. Furthermore, the few studies undertaken by economists to try to formally explain the process of institutional changes have used for the majority the *efficiency-improving institutions* framework. Up to today, redistributive institutional changes have been poorly studied. This is due to the recent
development of the concept and the difficulty of formulating clearly and formally concepts, such as bargaining power and "class capacity." Game theorists have tried to model the concept of bargaining power in cooperative games but this has led to complicated and, most often, untractable models of individual interactions.

To my knowledge, only two empirical studies have attempted to incorporate the two dimensions of efficiency and equity within the same framework in order to explain observed institutional changes in developing countries. The first of these studies was done by Zimmerman (1994), who used a dynamic model and data from Burkina Faso to show that differences in initial endowment in productive assets across households and endogenous income shocks suffice to induce the creation of a market for land and, consequently, a stratified land accumulation process. In an environment characterized by important production shocks and increasing pressures on land, only rich households can afford to accumulate land. This, in turn, allows them to improve their capacity to self-insure and to withdraw from existing social risk sharing arrangements leaving the poor uninsured. Zimmerman’s model carries important conclusions about the emergence of new agrarian institutions and their sustainability. In particular, it demonstrates that “who control resources and how they do so is important for both the equity and efficiency of the final allocative outcome.”

De Janvry and Sadoulet’s analysis of the effects of the Latin American Land Reform (De Janvry and Sadoulet, 1989) goes beyond Zimmerman’s study by endogenizing the set of rules and contracts defining an institution. They developed a framework integrating the transaction costs and collective action approaches to show how redistributive policies can modify the initial allocation of resources and, consequently, the initial structure of bargaining
power. Given new power, certain groups of individuals can change the rules of the game in their favor and resist to the processus of institutional changes, the redistributive policies were supposed to induce. Conversely to Zimmerman, De Janvry and Sadoulet showed that institutional changes are not necessarily ineluctable. If individual abilities for renegotiating risk sharing contracts were explicitly introduced in Zimmerman's model, one may be able to identify social risk sharing arrangements that would attract rich households, or at least delay their departure.

The model I developed thereafter is an attempt to extend Zimmerman's dynamic model of social risk sharing by including the possibility for the partners of the contract to renegotiate the terms of the contract. In Chapter 4, the extended household was modeled as a semi-cooperative game where nuclear families have to agree on a contract specifying their labor contribution to the production of food for the entire household and their share of the common harvest. In addition, the extended household is organized in such a way that risks can be shared through ex-post transfers and risk diversification strategies implemented by nuclear households whenever they invest in off-farm activities. These sharing and transfer rules are equivalent to a redistributive scheme which transfers risk and resources from the more endowed nuclear family to the poorer one. The model in this chapter simply adds the intertemporal dimension to the existing risk and resource redistribution scheme. However, to keep the dynamic model simple and tractable for existing computer capacity, the extended household contractual arrangement cannot be fully endogenized as it is specified in Chapter 4 of this dissertation. I will consider only the second non cooperative stage of the decision
making process and model the intra-household’s choice for the optimum saving/investment policy. Two different sharing rules will be investigated.

C. THE EXTENDED HOUSEHOLD VIEWED AS A STOCHASTIC AND DYNAMIC NON-COOPERATIVE GAME OF RISK AND RESOURCE REDISTRIBUTION

1. Formulation of the Model

Let consider an economy with two agents 1 and 2 having identical constant relative risk aversion utilities $u_{j,t} = c_{j,t}^{1-\alpha} / 1-\alpha$ with $j=1,2$. The two agents are endowed with a predetermined amount of good $s_{j,t}$ at the beginning of period $t$. Of his initial endowment, each agent decides of the amount $x_{j,t}$ he wants to invest and the remainder $(s_{j,t} - x_{j,t})$ is kept for today’s consumption. The amount of good available in the following year $t+1$ is $s_{j,t+1} = \gamma x_{j,t} + \epsilon_{j,t} f(x_{j,t})$, where $\gamma$ is the capital survival rate, $f(.)$ is the production function, and $\epsilon_{j,t}$ is an idiosyncratic shock affecting agent $j$’s production function. Agents can insure each other against idiosyncratic shocks by putting the quantities $(s_{j,t} - x_{j,t})$ in a common pot, of which each one received a predetermined share $k_{j,t}$, and $\sum k_{j,t} = 1$.

Each agent’s consumption in period $t$ is $c_{j,t} = k_{j,t} (s_{1,t} - x_{1,t}) + k_{j,t} (s_{2,t} - x_{2,t})$. I will define this sharing rule as rule A. If $c_{j,t}$ is less than the minimum consumption $c_{j,\text{min}}$, the agent $j$ will have to reduce his investment in order to cover his current consumption deficit. Transfers can take place between the two agents if one of them is unable to reach his minimum consumption. The two agents are engaged in a symmetric Nash game, where each player’s decision of $x_{j,t}$ will affect the other’s welfare $u_{j,t} (s_{j,t} - x_{j,t})$. 

156
The dynamic risk sharing game can be summarized as follows:

**Structure:** Infinite horizon, stationary, stochastic, two state variables.

**Time:** \( t = \text{years} \)
\[ t \in \{0, 1, 2, \ldots\} \]

**States:**
\[ s_{j,t} = \text{endowment of good of agent } j \text{ at the beginning of } t, \text{ for } j=1,2 \]
\[ s_{j,t} \in [0, \infty) \]

**Actions:**
\[ x_{j,t} = \text{amount of good invested by agent } j \text{ in year } t, \text{ for } j=1,2 \]

**Constraints:**
\[ 0 \leq x_{j,t} \leq s_{j,t}, \text{ for } j=1,2 \]
\[ k_j (x_{1,t} - s_{1,t}) + k_j (x_{2,t} - s_{2,t}) \leq c_{j,\text{min}}, \text{ for } j=1,2 \]

**Shocks:**
\[ \epsilon_{j,t+1} = \text{idiosyncratic shock affecting agent } j \text{'s production function, for } j=1,2 \]
\[ \epsilon_{j,t+1} \text{ are independently and identically distributed across agents and time with parameters } (0, \sigma_j^2).^{1} \]

**Equations of motion:**
\[ g(x_{j,t}) = s_{k,t+1} = \gamma x_{j,t} + \epsilon_{j,t+1} f(x_{j,t}) \]
where \( f(x_{j,t}) = x_{j,t}^\rho \), for \( j=1,2 \)

---

1. The model can be expanded to include the aggregate component of income shocks by introducing a correlation coefficient \( \rho \), ranging from 0 to 1, between the two idiosyncratic shocks.
Reward Functions under Sharing Rule A:

\[ u_{j,t}(c_{j,t}) = c_{j,t}^{1-\alpha} / 1-\alpha \]

where \( c_{j,t} = k_{j,t} (s_{1,t} - x_{1,t}) + k_{j,t} (s_{2,t} - x_{2,t}), \) for \( j = 1, 2 \)

Agent 1's current consumption is determined by his action \( x_{1,t} \), but also by agent 2's decision about how much he is going to invest.

Value Functions:

\[ V_{j,t}(s_{1,t}, s_{2,t}) = \text{value of the stock of good of agent } j, \text{ for } j = 1, 2 \]

Bellman's Equations Under the Sharing Rule A:

\[ V_{1}(s_{1}, s_{2}) = \max_{x_{1}, x_{2}} \left[ U_{1}(k_{1}(s_{1} - x_{1}) + k_{2}(s_{2} - x_{2})) + \delta EV_{1}(\gamma x_{1} + \epsilon_{1}(x_{1}) + \gamma x_{2} + \epsilon_{2}(x_{2})) \right] \quad (5.1) \]

\[ V_{2}(s_{1}, s_{2}) = \max_{x_{1}, x_{2}} \left[ U_{2}(k_{1}(s_{1} - x_{1}) + k_{2}(s_{2} - x_{2})) + \delta EV_{2}(\gamma x_{1} + \epsilon_{1}(x_{1}) + \gamma x_{2} + \epsilon_{2}(x_{2})) \right] \quad (5.2) \]

subject to the constraint that:

\[ k_{j}(s_{1} - x_{1}) + k_{j}(s_{2} - x_{2}) \geq C_{\min}, j = 1, 2 \]

2. The Nash Equilibrium

In a non-cooperative game, the outcome specifying the agents' optimum saving/investment policy \((x_{1}^{*}, x_{2}^{*})\) is a Nash equilibrium defined as follows:
Definition (Gibbons, 1992): For a pair of investment strategies \((x_1^*, x_2^*)\) to be a Nash equilibrium, \(x_1^*\) and \(x_2^*\) must satisfy

\[
V_1(s_1, s_2; x_1^*, x_2^*) \geq V_1(s_1, s_2; x_1, x_2^*) \tag{5.3}
\]

and

\[
V_2(s_1, s_2; x_1^*, x_2^*) \geq V_2(s_1, s_2; x_1^*, x_2) \tag{5.4}
\]

for every feasible pairs of strategies \((x_1, x_2)\).

That is, the optimum strategy for agent 1, \(x_1^*\), is the solution to the maximization of the value function \(V_1(s_1, s_2)\) given agent 2's best response, \(x_2^*(s_1, s_2)\); and reciprocally for agent 2:

\[
V_1(s_1, s_2) = \max_{x_1} \left[ U_1(k_1(s_1 - x_1) + k_2(s_2 - x_2^*), \gamma x_1^* + \epsilon_1 f(x_1), \gamma x_2^* + \epsilon_2 f(x_2^*)) \right] \tag{5.5}
\]

For \(j = 1, 2\), let \(\lambda_j(s_1, s_2)\) be the partial derivative of \(V_j(s_1, s_2)\) with respect to \(s_j\), or equivalently, the shadow price of the stock of good of agent \(j\). For \(j = 1, 2\), let \(\lambda_i^*(s_1, s_2)\) be the partial derivative of \(V_j(s_1, s_2)\) with respect to \(s_1\), or equivalently, agent \(j\)'s valuation of a marginal unit of the other agent's stock of resources. The six conditions characterizing the Nash equilibrium comprise the two partial derivatives for the value functions with respect to the strategy \(x\) and the four shadow values of agent 1 and agent 2's stock of resources.
The Nash equilibrium condition (5.6) simply state that, along the optimum path, agents $j$ will choose an amount $x$ such that the marginal utility from keeping $(s-x)$ for today's consumption equals the expected marginal utility of investing $x$ and consuming it tomorrow. The system to be solved includes six equations and six unknowns, namely two optimum investment policies and four shadow prices.

3. The Numerical Approach for Solving the Model

The infinite-dimensional functional equation model is solved the Chebychev polynomial projection method, which has been effectively used by Judd (1994), Rui (1995),
and Miranda and Rui (1997). The Chebychev polynomial projection method replaces the original infinite-dimensional problem with a finite-dimensional nonlinear rootfinding problem. It consists in solving the first-order Nash equilibrium conditions, by approximating the optimum strategies $x_1$ and $x_2$ and shadow price functions in equations (5.6), (5.7) and (5.8) with a $n^a$ degree Chebychev polynomial:

$$x_j(s_1, s_2) = \sum_{k=0}^{n^a} a_j^k (s_1, s_2)$$

$$\lambda_j(s_1, s_2) = \sum_{k=0}^{n^a} c_j^k (s_1, s_2)$$

This method requires that the equilibrium conditions be satisfied, not at all points $s$ in the stock space $S$, but rather at a finite $(n \times n)$ number of points "wisely" chosen $s_{11}, s_{12}, s_{13}, \ldots, s_{1n}$ and $s_{21}, s_{22}, s_{23}, \ldots, s_{2n}$, called the "collocation" nodes. The shock space is also discretized, but using Gaussian quadrature method, which replace the two-dimensional continuous shock space by a discrete random variable. A successive approximation algorithm is then used to solve the shadow price coefficients $b_j$ and $c_j$ and optimal investment rules. This algorithm basically computes the coefficients $b_j$ and $c_j$ by solving iteratively the system of $8(n+1)^2$ linear equations $x_j(s_1, s_2)$ and $\lambda_j(s_1, s_2)$.

D. SIMULATION RESULTS

1. Choice of the Parameters

For simplicity, the two nuclear families playing the risk sharing game are assumed to have identical constant relative risk aversion utility functions. The equations of motion and shock structures are identical. The following set of the program's parameters has been chosen.
and was kept constant for all simulations: $\delta = 0.9$ (discount value), $\beta = 0.5$ (production parameter), $\gamma = 0.9$ (capital survival rate). To gain a better understanding of the effects of production shocks, resource endowments, and the predetermined sharing rule on individual behavior, the model has been solved for four different scenarios under the sharing rule A (Table 5.1).  

The choice of the number of collocation nodes $n$ and the number of production shocks $m$ was of 8 and 2 respectively. The dynamic programming was carried out with MATLAB 5.1. It took a Pentium 133 megahertz up to one hour to reach the convergence criteria of $10^{-8}$.

<table>
<thead>
<tr>
<th>Parameters:</th>
<th>Scenarios Under the Sharing Rule A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>$\alpha$ (utility parameter)</td>
<td>0.2</td>
</tr>
<tr>
<td>$\sigma$ (shock volatility)</td>
<td>0.1</td>
</tr>
<tr>
<td>Agent 1's minimum stock</td>
<td>5</td>
</tr>
<tr>
<td>Agent 2's minimum stock</td>
<td>5</td>
</tr>
<tr>
<td>Agent 1's maximum stock</td>
<td>10</td>
</tr>
<tr>
<td>Agent 2's maximum stock</td>
<td>10</td>
</tr>
<tr>
<td>Agent 1's share $k_1$</td>
<td>0.50</td>
</tr>
<tr>
<td>Agent 2's share $k_2$</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Table 5.1. Parameters for Four Different Scenarios Under the Sharing Rule A

---

2 Recall that, in Chapter 4, individual shares of common production $\gamma = k_1$ and $(1-\gamma) = k_2$ result from the cooperative bargaining stage one of the extended household's decision making process. For simplicity, the dynamic model in Chapter 5 focuses only on the second noncooperative stage, taking thus $k_1$ and $k_2$ as given parameters.
2. Equilibrium Investment/Saving Strategies of Nuclear Families Under the Sharing Rule A

The nuclear family 1’s equilibrium investment strategy in scenario 1 is represented in Figure 5.1. Given the risk sharing rule imposed by the extended household organization and given a relatively small risk aversion and small production shocks, family 1’s optimum investment behavior is, as expected, to raise progressively the amount saved for future consumption as the amount of resources increases. It is important to notice that the amount saved by family 1 is equivalent to the amount it can subtract from the sharing scheme. The analogy with a consumption tax scheme is obvious.

In fact, the risk-sharing rule set up by most extended households in the region of study is similar to a consumption tax imposed by the household head to the younger members in order to redistribute resources from the wealthier to the poorer nuclear households. The amount saved for future consumption corresponds to the deductible and it is a function of the available stock, the other agent’s action, and the minimum level of consumption. Viewed as a tax redistributive scheme, this extended household’s risk-sharing rule creates, in a non-cooperative environment, an incentive for the agent to save relatively more of his current stock of resources whenever his stock is at its highest level and his partner’s stock is at the lowest (provided that the minimum level of consumption has been achieved for both agents). This behavior does not, however, affect the agents’ consumption because the game is symmetric and agents are in this scenario 1 identical. As expected, consumption increases smoothly as the stock of resources increases for both nuclear families (Figure 5.2).
In scenario 2, where both families are more risk-averse and face larger production shocks, the overall wealth accumulation behavior is the same as in scenario 1 (Figure 5.4). Due to more volatile production shocks, families have, however, to lower their savings below 4 units at lower levels of stock in order to maintain a minimum level consumption of 1 unit. Being more risk-averse and facing greater shocks give both agents incentives to save more at higher stock levels and force them to lower significantly their consumption to below 2.5 units (Figure 5.5). Agents' valuation of a marginal unit of their own resources also decreases significantly in scenario 2 as one additional unit of resource provides them with less utility when risks are higher.
Figure 5.1. Equilibrium Investment/Saving Strategy of Nuclear Families in Scenario 1
Figure 5.2. Equilibrium Consumption of Nuclear Households in Scenario 1
Figure 5.3. Shadow Price of Individual Stock of Resources in Scenario 1
Figure 5.4. Equilibrium Investment/Saving Strategy of Nuclear Families in Scenario 2
Figure 5.5. Equilibrium Consumption of Nuclear Households in Scenario 2
Compared to scenarios 1 and 2, the equilibrium levels of savings for the two nuclear families change dramatically under the effects of unequal allocation of initial resources in scenario 3. Figure (5.6) and (5.7) suggest that at low levels of stock, the poorer family 1 allocates most of its stock of resources to current consumption. On the other hand, family 2 (assuming that it has not left the risk-sharing scheme) has to invest more to ensure the extended household's present and future minimum consumption level of 2 units. The highest valuation of family 2's resources corresponds indeed to the lowest levels of his and his partner's stocks, i.e., when both families are closed of food deficit (Figure 5.8).

Scenario 4 is similar to scenario in the sense that it introduces asymmetries in the game through the share of pooled resources. This situation where, everything else equal, one family receives 55 percent of the share of common products while the other receives only 45 percent can be due, for example, to differences in the number of dependents. It can also result from one family having a higher bargaining power than the other. When this in the case, the individual who receives the smallest share value, i.e., individual 1, has also the lowest incentive to contribute to the household's current consumption (Figure 5.9 and 5.10).
Figure 5.6. Equilibrium Investment/Saving Strategy of the Poor Family in Scenario 3
Figure 5.7. Equilibrium Investment/Saving Strategy of the Rich Family in Scenario 3
Figure 5.8. Equilibrium Shadow Price of the Rich Family's Stock of Resources in Scenario 3
Figure 5.9. Shadow Price of Resources of the Family With the Smallest Share of Current Pooled Consumption in Scenario 4
Figure 5.10. Shadow Price of Resources of the Family With the Biggest Share of Current Pooled Consumption in Scenario 4
2. Steady-State Savings and Consumption Within the Extended Household

Under the Sharing Rule A

Table 5.2 reports the steady-state means and variances of savings and consumption for the four different scenarios under the sharing rule A. It also reports the simulation results of the sharing rule B discussed thereafter. These values have been obtained by conducting a path analysis, which consists in repeating the simulation 5000 times for randomly drawn shocks and over a period of years. The means and variances of savings and consumption were then computed for each year. Figure 5.11, for example, represents the path taken by family 1's expected consumption in scenario 1. It indicates that expected consumption converges smoothly toward a steady-state value of approximately 1.82 units. In contrast, due to more volatile production shocks, the path taken by family 1's consumption in scenario 2 is more erratic and converges less quickly to the steady-state value (Figure 5.12). Despite the more or less volatility of the different paths and the rapidity with which they reach the steady-state, all paths do converge toward a stationary level after a period of 20 years. The steady-state values reported in Table 5.2 correspond to the values at year 50.
Figure 5.11. Individual Expected Consumption Path in Scenario 1
Figure 5.12. Individual Expected Consumption Path in Scenario 2
### Table 5.2. Steady-State Means and Variance of Stock of Resources and Consumption of Members of the Extended Household

<table>
<thead>
<tr>
<th>Scenario</th>
<th></th>
<th>Steady-State Stock of Resources</th>
<th></th>
<th>Steady-State Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Means</td>
<td>Variance</td>
<td>Means</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identical families</td>
<td></td>
<td>7.4895</td>
<td>0.0863</td>
<td>1.8264</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identical families</td>
<td></td>
<td>7.7275</td>
<td>0.4569</td>
<td>1.8848</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family 1 (poorer)</td>
<td></td>
<td>7.7121</td>
<td>0.4518</td>
<td>1.8801</td>
</tr>
<tr>
<td>Family 2 (richer)</td>
<td></td>
<td>7.7064</td>
<td>0.4514</td>
<td>1.8801</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family 1 (45% share)</td>
<td></td>
<td>7.7256</td>
<td>0.4481</td>
<td>1.6957</td>
</tr>
<tr>
<td>Family 2 (55% share)</td>
<td></td>
<td>7.7281</td>
<td>0.4431</td>
<td>2.0725</td>
</tr>
<tr>
<td>2'</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identical families</td>
<td></td>
<td>0.5253</td>
<td>0.0070</td>
<td>0.3784</td>
</tr>
<tr>
<td>4'</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family 1 (45% share)</td>
<td></td>
<td>0.4200</td>
<td>0.0460</td>
<td>0.4406</td>
</tr>
<tr>
<td>Family 2 (55% share)</td>
<td></td>
<td>0.6469</td>
<td>0.0101</td>
<td>0.3390</td>
</tr>
</tbody>
</table>

**SHARING RULE A (Consumption Tax):**

**SHARING RULE B (Wealth Tax):**
Higher degree of risk aversion and more volatile shocks in scenario 2 do affect positively the steady-state value of nuclear families' expected stocks of resources. The expected consumption in scenario 2 is consequently higher than in scenario 1, but more volatile. With respect to their expectations of future shocks, both nuclear families tend to save more in order to smooth their life-time expected utility.

Risk sharing and resource redistribution become more explicit in scenario 3, where the poor family is ensured the same level of consumption than the rich. However, inequalities in initial wealth lower the incentive for the richer family to invest more in future consumption. The steady-state expected stock of the richer household, i.e., family 2, is actually smaller than the poorer household's steady-state expected stock.

The same pattern of behavior is found in scenario 4, when nuclear households do not receive the same share of pooled resources allocated to current consumption although they have the same endowment. The steady-state expected stock of the family with the smallest share, i.e., family 1, is lower than the one of the family with the biggest share, and is also lower than the expected stock it would have achieved if the shares were, like in scenario 2, equal. As a consequence, the family with the biggest share benefits of higher but more volatile consumption. The steady-state expected consumption of family 2 with the biggest share is the highest in scenario 4 a compared to the value in the other scenarios, but it also suffers of the highest variance.
4. Resource Redistribution Rules and the Shirking Behavior of Members of the Extended Household

In 1976, Akerlof challenged the Arrow-Debreu general equilibrium model of perfect competition and the transaction-cost-cum-asymmetric-information theory of institutional change. He developed, indeed, a framework to show that seemingly inefficient institutions (in the Pareto sense) may persist in contexts where the costs of breaking social customs are unbearable.

Similar results can be derived using the non-cooperative household framework. These results are important because they can bring some new insights on the reasons behind the persistence of seemingly inefficient extended households. Under the assumption that it is economically and socially too costly for members of an extended household to claim their independence, it can be shown that some members will tend to shirk. This assumption is perfectly realistic for one can observe in the region of study households where elders still have the power to keep the family together.

In sections C.1 and C.2 of this chapter, we have seen that, everything else being equal, wealth inequalities and unequal redistribution of the household’s production give the richer member of the household or the one that receives the smaller share of common products, an incentive to invest/save less in the long run (Table 5.2). It was also pointed out that the sharing rule used is similar to a consumption tax since it affects directly the members’ current food consumption (equation 5.5). As such, the family who gets the smallest share of the household’s production (i.e., 45 percent in the scenario 4) is, equivalently, the one who is subject to the highest redistributive consumption tax (i.e., 55 percent).
To go further in exploring the effects of the household’s resource redistribution rule on individual behavior, let consider another sharing rule, one that affects wealth instead of consumption. Under this new sharing rule (let call it B as opposed to the previous sharing rule A), household’s members transfer, instead of current consumption, a percentage of their wealth differential defined as the difference between family member 1 and member 2’s stocks of resources at the beginning of period t. It is interesting to consider this additional sharing rule in the analysis because it provides stronger evidence on individual shirking behavior and carries important policy implications.

The Bellman’s equation for member j under scheme B becomes (with \( i,j = 1,2 \) and \( i \neq j \)):

\[
V_j(s_1,s_2) = \max_{\alpha_j} [U_j(s_j - (1-k_j)(s_j - s_i) - x_j) + \delta EV_j(\gamma x_j + \epsilon f(x_j), \gamma x_j + \epsilon f(x_j^r))] 
\]

\[
(5.9)
\]

The Nash equilibrium conditions for agents j (with \( i,j = 1,2 \) and \( i \neq j \)) are as follows:

\[-U_{ij}(s_j - (1-k_j)(s_j - s_i) - x_j) + \delta E_e [\lambda_{ij}(g_1, g_2) \frac{dg_j}{dx_j}] = 0 \quad (5.10)
\]

\[
\lambda_{ij}(s_1, s_2) = k_j U_{ij}(s_j - (1-k_j)(s_j - s_i) - x_j) + \delta E_e [\lambda_{ij}(g_1, g_2) \frac{dg_i}{dx_i}\frac{dx_j}{ds_j}] 
\]

\[
(5.11)
\]

\[
\lambda_{ij}(s_1, s_2) = (1-k_j) U_{ij}(s_j - (1-k_j)(s_j - s_i) - x_j) + \delta E_e [\lambda_{ij}(g_1, g_2) \frac{dg_i}{dx_i}\frac{dx_j}{ds_j}] 
\]

\[
(5.12)
\]
Similarly to rule A, the Nash equilibrium conditions under rule B simply state that, along the optimum path, agents 1 and 2 will choose an amount \( x \) such that the marginal utility from keeping \((s-x)\) for today's consumption equals the expected marginal utility of investing \( x \) and consuming it tomorrow.

The certainty-equivalent steady-state equilibrium savings/investment, shadow price of resources, and stock under rule B can, however, be easily derived from equations 5.10, 5.11, and 5.12, conversely to rule A:

\[
x_j^* = \left( \frac{1 - \gamma \delta k_j}{\delta \beta k_j} \right)^{\frac{1}{\beta - 1}}
\]

(5.13)

\[
\lambda_{ji}^* = \frac{(s_j^* - (1 - k_j)(s_j^* - s_i^*) - x_j^*)^{-\beta}}{\delta (\gamma + \beta x_j^* + \beta^{-1})}
\]

(5.14)

\[
s_i^* = \gamma x_i^* + x_i^{\beta^*}
\]

(5.15)

It is important to notice that the steady-state solutions for the stock of good and the optimum investment are consistent with the *golden rule*.

One can then show by doing a simple comparative static analysis that taxing wealth will tend to discourage investment:

\[
\frac{\partial x_j^*}{\partial (1 - k_j)} = \left( \frac{1}{\beta - 1} \right) \left( \frac{1 - \gamma \delta k_j}{\beta \delta k_j} \right)^{\frac{\beta}{\beta - 1}} \left( \frac{\beta \delta}{\beta \delta k_j^2} \right)
\]

(5.16)
The sign of the partial derivative of $x$ with respect to member $j$'s share or, equivalently, member $j$'s percentage of wealth tax is negative for $\beta$ less than one. That is, under the assumption that the production technology $f(x)$ exhibits decreasing returns to scale, increasing individual $j$'s contribution to the extended household or, equivalently, $j$'s redistributive wealth tax, will give $j$ an incentive to lower his savings/investment.

The non-cooperative household model under the sharing rule $B$ is solved with the same dynamic programming approach used previously. The objective is to compare the effects of the sharing rules on the investment behavior of members of an extended household. Only scenarios 2 and 4 are, therefore, reproduced here with the following set of parameters: $\delta = 0.9$ (discount value), $\beta = 0.5$ (production function), $\gamma = 0.9$ (capital survival rate), $\alpha = 0.4$ (degree of risk aversion), $\sigma = 0.2$ (shock volatility), $m = 2$ (number of production shocks), minimum stock of resources $= 0.01$, maximum stock $= 2$, member 1's share $k_1 = 45$ percent (equivalent to a wealth tax of of 50 percent, and $n = 20$ (number of Chebychev collocation nodes).

The members' optimum investment policies are shown in Figures 5.13 and 5.14. The equilibrium investment behavior for both members is very similar to the poor family's behavior under the sharing rule $A$ (Figure 5.6). Under the sharing rule $B$, the members' optimum policy is to reduce dramatically their investment at low levels of stock of resources. This rule being equivalent to a wealth tax, household members gain more by increasing their current consumption, which is not affected by the tax, than by delaying it. Furthermore, Figure 5.14 and results reported in Table 5.2 show that, everything else being equal, the nuclear family that has to contribute more to the extended household's pot (i.e., family 1),
prefers to allocate even more of its resources to today’s consumption. In the steady-state, family 1 has a lower level of savings and consumes more than family 2, which contributes less to the common pot.

This last result provides a new element about household’s members optimum consumption and investment behavior. That is, under both sharing rules, the member with the highest contribution will tend to lower his investment, but under the sharing rule B, the same member will also allocate more of his wealth to his immediate consumption to subtract part of it from future taxes. This does not necessarily make the other member of the household worse-off. The latter’s steady-state investment level is, indeed, higher than in the situation where both families are identical (scenario 2', Table 5.2). However, this apparent shirking behavior may threaten the extended household’s welfare in the long term as the aggregate stock of resources is smaller than expected.
Figure 5.13. Equilibrium Investment/Saving Strategy of the Family With the Smallest Contribution in Scenario 4' and Under the Sharing Rule B
Figure 5.14. Equilibrium Investment/Saving Strategy of the Family With the Largest Contribution in Scenario 4' and Under the Sharing Rule B
5. Individual Decision To Stay In Or Exit the Extended Household Risk-Sharing Scheme A

The previous analysis of individual saving/investment behavior has been done assuming that nuclear families are forming an extended household. One of the main objectives of this study is also to understand the process leading the break-down of an extended household. Although the exit option in the case of a non-cooperative household cannot be clearly defined as in the case of a cooperative bargaining household, it can be assumed that individuals are no longer interested in contributing to the collective setting when self-insurance provides them with higher utility. Nuclear household can self-insure by simply invest and deplete their capital over time according to their needs. The self-insurance option can be modeled as a one sector stochastic optimum growth model, with specifications of the utility function, and the equation of motion similar to the risk-sharing game. The one sector growth model can be solved using the same method of Chebychev polynomial projection. The equilibrium investment decision can then be used to compute the optimum reservation utility $V^*(s)$ of individuals who decide to self-insure.

In order to determine when it is no longer interesting for a nuclear household to abide by the collective risk sharing scheme, one can compare the utility of the nuclear family within the extended household under the sharing rule A with its reservation utility. Precisely, it consists in solving the following maximization problem:

$$V_j(s_1,s_2) = \max \left( \max_c [U(c_j) + \delta E_V(j(s_1,s_2)) ; V^*(s_j)] \right)$$  \hspace{1cm} (5.17)
Practically, the reservation utility is solved first, then for each state, the individual utility within the extended household is solved and compared to the reservation utility. Tables 5.3, 5.4, and 5.5 reported the results for respectively scenarios 1, 3 and 4 of the extended household. Results for scenario 2 are not reported because they are identical to results of scenario 1. This is simply due to the fact that the two players in the game are identical. The number 1 (0) in a cell indicates that the decision is to exit (stay).

The interpretation of the results for scenario 1 (Figure 5.3) is straightforward. Families being identical, one can expected that family $j$ will contribute to the collective insurance as long as both families are in identical states or whenever the other family has higher stock of resources. Since the game is symmetric, the same decision is taken by the other partner and both families will share risks only when they have similar stocks of wealth.
Table 5.3. Nuclear Family 1’s Decision to Participate or Not to the Extended Household Risk-Sharing Scheme A in Scenario 1

<table>
<thead>
<tr>
<th>Levels of Stock of Resources</th>
<th>Family 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S11</td>
</tr>
<tr>
<td>Family 2</td>
<td></td>
</tr>
<tr>
<td>S21</td>
<td>0</td>
</tr>
<tr>
<td>S22</td>
<td>0</td>
</tr>
<tr>
<td>S23</td>
<td>0</td>
</tr>
<tr>
<td>S24</td>
<td>0</td>
</tr>
<tr>
<td>S25</td>
<td>0</td>
</tr>
<tr>
<td>S26</td>
<td>0</td>
</tr>
<tr>
<td>S27</td>
<td>0</td>
</tr>
<tr>
<td>S28</td>
<td>0</td>
</tr>
</tbody>
</table>

0 = stay; 1 = exit
<table>
<thead>
<tr>
<th>Levels of Stock of Resources</th>
<th>Family 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S11</td>
</tr>
<tr>
<td>Family 2</td>
<td></td>
</tr>
<tr>
<td>S21</td>
<td>0</td>
</tr>
<tr>
<td>S22</td>
<td>0</td>
</tr>
<tr>
<td>S23</td>
<td>0</td>
</tr>
<tr>
<td>S24</td>
<td>0</td>
</tr>
<tr>
<td>S25</td>
<td>0</td>
</tr>
<tr>
<td>S26</td>
<td>0</td>
</tr>
<tr>
<td>S27</td>
<td>0</td>
</tr>
<tr>
<td>S28</td>
<td>0</td>
</tr>
</tbody>
</table>

0 = stay; 1 = exit

Table 5.4. The Poorer Nuclear Family 1's Decision to Participate or Not to the Extended Household Risk-Sharing Scheme A in Scenario 3
<table>
<thead>
<tr>
<th>Levels of Stock of Resources</th>
<th>Family 1</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S11</td>
<td>S12</td>
<td>S13</td>
<td>S14</td>
<td>S15</td>
<td>S16</td>
<td>S17</td>
<td>S18</td>
<td></td>
</tr>
<tr>
<td>Family 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S21</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S22</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S23</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S24</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S25</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S26</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S27</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>S28</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

0 = stay; 1 = exit

Table 5.5. The Decision of the Nuclear Family 1 With the Smallest Share of Pooled Consumption to Participate or Not to the Extended Household Risk-Sharing Scheme A in Scenario 4
Table 5.4 reports the decision of the poorer family. As expected, the poorer family's decision to leave is delayed because it benefits of sharing risk with the other family. Collective risk sharing allows this family not only to maintain a minimum level of consumption whenever its stocks are at their lowest levels, but also to accumulate in the long run, a steady-state expected stock higher than if it was alone. Results of the richer family have not been reported because they are identical to those in scenarios 1 and 2. Despite some incentives to accumulate less in the long run, the richer family does not necessarily prefer to exit the extended household faster. This is probably due to the fact that, everything else equal, wealth inequalities are not large enough to offset the insurance benefits the richer family can obtain by pooling risks with the other family.

In contrast, given equal initial wealth, the family which has the smallest share of pooled consumption will prefer to exit even if both families are in the same state (Table 5.5). This suggest that an unequal share of risks and resources, or equivalently, an unequal redistributive consumption tax, is more detrimental to the extended household than an unequal distribution of wealth. Stylized facts do support this result. In the sample of households surveyed in Northern Burkina Faso from 1991 to 1994, 13 out of 42 extended households have experienced, before the survey period, a partial or complete break-up due to conflicts around the distribution of common harvest. For example, nuclear families with a low dependency ratio have perceived as unfair the fact that they have to contribute more to the common pot. This is especially true during periods of important food deficits.

The objective of this chapter was to provide a dynamic view of risk sharing within the extended household. Nuclear families are engaged in a non-cooperative game, where they have to decide how much of their wealth is to be retained for pooled consumption and how much they can save, given predetermined shares of pooled consumption. Results show that when the families are identical, their saving and consumption behavior within the extended household is the same as if they were alone. In the short-run, families increase their savings as their stock of resources increases. That is, the wealth elasticity of savings is positive. Furthermore, risk-averse families tend to increase their savings when they expect large idiosyncratic shocks in the near future. One interesting result is that risk sharing does take place among differentially-endowed families. Whenever the poorer family does not have a stock of resources sufficient to satisfy its short-term food consumption, the richer family will adopt a saving policy that will ensure a minimum level of consumption for both himself and the poorer family. That is, for given low stocks of resources, the richer member of the extended household will behave as if he is highly risk-averse and will increase the amount saved in order to meet everybody’s short-term needs.

In the long run, however, unequal distribution of wealth does introduce an incentive for the richer household to accumulate less stock. An unequal sharing of the common pot can be even more harmful to the collective sharing agreement when it affects directly individual wealth. Everything else being equal, under an unequal wealth redistribution scheme, the
household's member who has to contribute the most will allocate more of his wealth to his own current consumption, thus threatening the long-term welfare of the entire household.

This issue of equity and incentive compatible arrangements has been extensively discussed by Farmer and Tiefenthaler (1995), who pointed out that this behavior is more prevalent in an environment characterized by the scarcity of vital resources and household heterogeneity. These results raise important questions about the appropriate development policy to reduce existing wealth inequalities.

In short, these results underscore the importance of both the initial allocation of wealth and the individual bargaining power for the welfare and sustainability of the extended household institution. The second element determines in fact the shares of pooled resources. To keep the dimensionality of the problem small so it could be solved with the existing computational capacity, it was not possible to include individual shares of the common pot as a decision variable. It would be, however, interesting to include the first stage of the extended household decision making process, where nuclear families bargain in a cooperative setting over the share of common labor. One could imagine a situation where the household head has a stronger bargaining power, which would enable him to maintain the cohesion within the extended household. The model could be further extended by introducing a third player into the game. This would open the research horizon to the analysis of the extended household's optimum size.
CHAPTER 6

CONCLUSION

A. SUMMARY OF THE RESEARCH FINDINGS

This dissertation on food insecurity and the evolution of indigenous insurance institutions emerged from the request by a savings and credit project that has been operating in Northern Burkina Faso of a study of the economics of the household in the region. The project was interested in evaluating the relevance and consistency of its intervention. Given its primary objective of improving the welfare of rural households, the project questioned whether its poverty-targeted intervention could be justified on efficiency and equity grounds.

In response to this request, the first step was to gain a better understanding of how these households are organized, what are their objective functions, and what constraints do they face in achieving these objectives. It soon became clear that, subject to frequent adverse income shocks, the household's primary objective is to secure a minimum level of consumption by developing efficient risk-management and risk-coping strategies.

According to standard neoclassical theories, full insurance and perfect consumption smoothing can be achieved by either trading commodities across time through saving and borrowing and, in general, through portfolio management or by trading commodities among
households across states of nature through risk sharing. In the absence of formal insurance and financial institutions, the extended household and community-level institutions combine these two dimensions of consumption smoothing to build up what was historically known as an efficient mechanism in the Pareto sense to survive in a highly risky environment.

Stylized facts reported in Chapter 2 show that, today, important variations in food consumption are observed across time and across households in the village under study. Contrary to conventional wisdom, transfers across households represent only a marginal part of the household's total transactions. Moreover, village informal organizations such as the rotating savings and credit associations known as *tontines*, and other solidarity networks are not as widespread as expected. Despite the insurance advantages of the extended household's mode of organization, there are nuclear and extended households that experience food deficit.

Traditional community insurance no longer seems to be efficient. A large share of households composed of a single nuclear family is, indeed, observed in all villages in the region under study. The majority of these nuclear households did not result from the breakdown of extended households following the Tchayanovian household life-cycle hypothesis. Instead, most extended households broke down due to conflicts regarding how to share common products during periods of food deficit.

This dissertation pursued, therefore, four objectives:

(1) to identify the determinants of food security at the household level;

(2) to evaluate the extent to which food consumption is insured against income shocks among households within a village;
(3) to develop a model of intra-household resource allocation under uncertainty that could offer one with a better understanding of the determinants of the formation and decline of indigenous risk-sharing institutions; and

(4) to analyze the effects of the break-down of indigenous risk-sharing institutions on household food consumption.

In Chapter 3, exploratory multivariate analyses were conducted to classify households along a consumption scale and to characterize the different groups of households according to their size, consumption level, sources of income, and endowment of labor and physical assets. This exercise allowed me to differentiate households which experienced food deficits from food surplus households and to identify endowments of labor and livestock as factors that are highly correlated with the household's level of food consumption. Compared to food deficit households, extended and nuclear households with a food surplus tend to have large endowments of livestock and of labor relative to the number of dependents. Human and physical capital are, indeed, two strategic resources for households that are involved in risk diversification strategies or for those households that cope with income shocks by depleting their savings.

It was important, in a second stage, to measure the extent to which observed facts deviate from the perfect insurance outcome predicted by the standard risk-sharing framework. Mace (1991) and Cochrane (1991) have developed a simple test of the perfect insurance hypothesis. Following their work, I derived a system of three simultaneous equations to endogenize both consumption and income decisions. I then estimated econometrically the
effects of idiosyncratic and aggregate shocks on consumption using household panel data. Estimation results reported in Chapter 3 show that the hypothesis of perfect risk sharing can be rejected at a 5-percent level. Household food consumption varies with aggregate shocks as well as with idiosyncratic income shocks. There is, however, evidence of some risk sharing for idiosyncratic shocks such as illness, and the extended household seems to offer better insurance than the village community.

Social scientists in the area of economic anthropology have been trying to explain these stylized facts by analyzing the welfare effects of institutional design and environmental changes induced by rapid population growth, increasing resource scarcity, and the introduction of new markets. Economists, in particular, have developed second-best theories and new concepts of institutional economics in order to explore the reasons why real life facts tend to deviate from the Pareto optimum outcomes of standard neoclassical economics. In parallel, new developments in the modeling of intra-household resource allocation have permitted a better understanding of intra-household decision-making process and an explanation of some seemingly irrational patterns of household behavior.

Based on recent studies on the economics of contracts, institutions, and intra-household resource allocation, especially studies by Zimmerman (1994), Smith (1995), and Carter and Katz (1997), I have attempted to derive a semi-cooperative model of household risk-sharing to show that the extended household, viewed as a risk-sharing and a resource redistributive institution, is not sustainable for certain environmental conditions and household characteristics.
In Chapter 4, numerical simulations of the static semi-cooperative model of household risk-sharing were performed in order to identify the domain of feasible extended-household risk-sharing contracts. Simulation results suggested that large aggregate shocks as well as limited endowments of labor and physical assets reduce significantly the space of feasible contracts. Nuclear households do improve their welfare when they participate in a risk-sharing arrangement. Contracts specifying the labor contribution and the sharing of common products tend to be established between two households having identical or complementary characteristics.

Furthermore, the comparative size of the equality in endowments across nuclear families is as important as the initial absolute level of the endowments in determining the existence and sustainability of a contract. Larger levels of aggregate wealth allow extended households to survive large aggregate shocks better. In contrast, wealth inequalities reduce the chances for nuclear households to agree on a risk-sharing arrangement. Moreover, large agricultural aggregate shocks and profitable off-farm activities tend to increase the incentive for nuclear families with large endowments in labor and capital to self-insure, thereby leaving the poorer nuclear families worse off. These results are consistent with Carter’s findings that, in the absence of risk sharing, there is a one-to-one mapping between risk and the household’s endowment in vital resources.

Since savings is an important dimension of consumption smoothing, Chapter 5 extended the analysis in Chapter 4 by looking at the dynamics of capital accumulation within an extended household. Dynamic programming results showed that, for a given risk and resource redistribution scheme, identical members of an extended household whose objective
is to maximize a life-time expected utility do gain in sharing risks. Unequal endowments of labor and physical capital and unequal distributions of common surpluses, however, create for the better-endowed member an incentive to either accumulate less resources in the long run or leave the extended household. The equitable sharing rule is, therefore, not necessarily Pareto efficient. This result is even more pronounced when the sharing of resources affects directly the member's wealth instead of his consumption.

B. POLICY IMPLICATIONS

1. Effects of Risk, Wealth Inequalities, and Poverty on Food Security

It is widely recognized that Sub-Saharan economies are characterized by high uncertainty, poverty, and increasing inequalities (World Bank, 1994). Few studies have, however, simultaneously addressed the three issues and, consequently, the causal relationships linking these factors remain obscure. Reardon and Taylor (1996) have estimated the effects of agro-climatic shocks on income inequality and on poverty in Burkina Faso by regressing inequality and poverty indexes on a certain number of risk indicators and household characteristics. These authors found that agro-climatic shocks increase income inequalities as well as poverty if households are constrained in their ability to manage risks effectively.

Carter (1991) and Zimmerman (1994) offered a more formal analysis of the interrelationships between risk and inequality. They derived a model of agent interactions under uncertainty, which predicts that in the absence of risk sharing there is a one-to-one mapping between an individual's risk exposure and his endowment in vital resources. Indeed,
well-endowed households are more capable of developing effective risk-management and risk- coping strategies. Using the ICRISAT Burkina Faso data, they estimated that a rural household in the Sahel, if socially and economically isolated, would face annually a 21 percent probability of falling below the food subsistence level.

My findings support and complement these earlier empirical results. Poverty determines the household’s ability to access external food markets (Tweeten et al., 1992). As such, the richer the households, the better they can cope with large aggregate income shocks. A larger aggregate endowment of resources also enlarges the space of feasible risk-sharing contracts. More than the level of wealth, however, it is wealth inequality that determines the degree of food security achieved by a village community. Given existing village institutions, wealth inequalities lower the chances for households to agree upon a risk-sharing arrangement. In the absence of risk-sharing, poorer households will face greater food insecurity. These results suggest that alleviating absolute poverty is a necessary but not a sufficient condition for food security. Alleviating poverty increases the household’s food purchasing power and allows households to cope with large income shocks. Redistributing resources from richer to poorer households is, in turn, important to mitigate the endowment effects.

The dynamic programming results highlight, however, the difficulty of establishing a redistribution scheme that is incentive compatible. In an environment characterized by uncertainty and resource scarcity, redistribution schemes used to level-off existing wealth inequalities give individuals an incentive to free-ride or shirk. The simulation results of the dynamic model of risk and resources redistribution in Chapter 5 have shown that, under
redistribution schemes equivalent to a wealth tax, richer households allocate more of their wealth to current consumption than they would if they were not taxed.

2. The Importance of Public Intervention

The break-down of indigenous risk-sharing institutions is not a problem by itself if all households have means to manage risks, sufficient food purchasing power, and access to well-functioning markets. For many rural households in the Sahel, none of these conditions is satisfied. It is important not to accelerate the decline of traditional institutions by introducing opportunities for individuals to free ride. The break-down of indigenous risk-sharing institutions presents, however, a compelling argument for public intervention. The public sector has a role to play, on the one hand, in setting up a safety net for the “losers” of the risk-sharing game and, on the other hand, in improving the functioning of markets, such as the financial market, that could supply households with substitutes for social insurance.

The recent debate on public welfare in industrialized countries, such as France and the United States, points out, however, the extreme difficulty of finding the optimal size for the safety net. Tweeten et al. (1992) argued that too large a safety net is likely to induce moral hazard behavior from both public and private constituencies and that too small a safety net cannot serve its purpose. Moreover, Cutler and Gruber (1996) showed that public insurance tends to crowd out private insurance, raising the question of finding an incentive compatible public insurance mechanism. In addition, more reforms are needed to alleviate the constraints and inefficiencies imposed by past government policies in Sub-Saharan Africa and in order to improve the household’s access to well-functioning markets.
3. The Sustainability of Development Programs Based on Indigenous Institutions

Many development programs have recently emphasized the importance of local participation. This came after a long history of program failures. Development projects were criticized for introducing exogenous elements into closed and fragile economies without a good understanding of the economies and without considering the actual interests of the beneficiaries. In contrast, the new fashion is to design and to build up development programs based on existing informal institutions. The idea is to ensure the sustainability of the development program by involving villagers and thereby their sense of responsibility.

One of the most widely known poverty alleviation program’s is the Grameen Bank in Bangladesh. Initially launched as a group lending project, the Grameen Bank is organized around the supply of loans to groups of five women, who are accountable to each other. The Grameen Bank’s significant success has been largely attributed to its founder’s knowledge of the household’s strategies and of informal financial markets (Khandker, 1993).

Following the Grameen Bank’s example, other development agencies have tried to introduce the group lending technology with more or less rigidity in different environments. In Sub-Saharan Africa, for example, the existence of informal saving and credit village associations and other informal self-help village institutions initially led many to believe that the group lending technology could be successfully implemented in this environment. Unlike Asia, Sub-Saharan agrarian economies seem to be experiencing more rapid and profound structural changes (Enswinger, 1992). In addition, wealth inequalities are apparently more pronounced.
This dissertation has highlighted the fact that all these factors do affect the sustainability of informal institutions. Simulation results precisely underscored the fragility of traditional risk-sharing institutions and the potential for important collective action problems whenever these institutions face resource scarcity, large income shocks, and an unequal distribution of resources. Traditional institutions evolve in response to changes in their environment. They persist because of the unbearable costs associated with breaking existing social rules, but they may not operate efficiently.

One can, in turn, question the sustainability of development programs that have been rigorously designed according to existing informal institutions but that have omitted consideration of, on the one hand, the flexibility and fragility of the latter and, on the other hand, the collective action problem inherent to many informal institutions. Integrating indigenous institutions in the design of development programs has undisputable advantages but this should be done with a good understanding of the dynamics of these institutions.

C. LIMITATIONS AND IMPLICATIONS FOR FURTHER RESEARCH

1. Problems From the Use of the Collective Household Approach and the Study of Dynamic Processes

This dissertation has been an attempt to identify causes of inequalities in food consumption in Sub-Saharan Africa and to improve our understanding of the dynamics of one of the most pervasive traditional risk-sharing institutions, namely the extended household. This task was far from easy as it involved the conceptualization and modeling of difficult
aspects of real life, such as risk and interactions among individuals. The challenge was also to find a good compromise between trying to draw a detailed picture of the dynamics of living systems and developing a tractable conceptual and empirical framework.

This dissertation has benefited from recent developments in the New Institutional Economics and the intrahousehold resource allocation field. The use of both the cooperative bargaining and non-cooperative household approaches based on previous studies by Smith (1995) and Carter and Katz (1997) allowed me to look into the black box. In addition, the approach of household decisions has raised questions of estimation and of the model's identification as discussed by Ross (1994) and Chiappori (1997).

In general, non-cooperative and bargaining models of intra-household resource allocation cannot be solved analytically. An econometric estimation of the individual demand for collective insurance or the probability of a risk-sharing contract to break down would have required the use of reduced-form equations. Ross (1994) showed that reduced-form equations derived from a non-cooperative model are similar to those based upon the unitary household model. In other words, the two approaches are observationally equivalent.

In addition, standard econometric techniques do not allow a rigorous analysis of dynamic phenomena (Lucas, 1976). I have, therefore, decided to solve the optimization problems numerically and to simulate them for different sets of parameters in order to analyze the effects of changes in the exogenous variables on the optimum outcomes. It was not, however, possible to rigorously validate the model by estimating the structural coefficients.

The difficulty of solving game-theoretic models has also limited the number of aspects of household decision making one could analyze. More precisely, the dimension of the model
had to be kept small for it to be computationally tractable. For similar reasons, I have focused my attention on the effects of risk, wealth inequalities, and resource redistribution, assuming that information flows perfectly within the extended household sphere. There are good reasons to support the assumption that information is perfect or nearly perfect within the family sphere. Nevertheless, this research can be easily extended to the study of larger communities and, in that case, one should allow for the existence of imperfect information.

2. Direction For Future Theoretical and Empirical Research on Intra-Household Resource Allocation and the Dynamics of Institutions

Chiappori (1997), who develops the “sharing rule” approach for analyzing intra-household resource allocation, wrote:

*In traditional, single-utility models, households are black boxes, formally identical to individuals. The first step has been to establish empirically that the black box was functioning in a more complex way than suggested by traditional models - and that the distribution of income mattered... The second step is to open the black box. Here the question is: can one define theoretically, and recover empirically, some kind of stable structural pattern that underlies (collective) household behavior?... In any case the most urgent task now is to test empirically the various collective models at stake (Chiappori, 1997).*

To answer Chiappori’s concern, the quantitative analysis used here can be taken one step further by validating the semi-cooperative household model with existing data. Although it requires relatively sophisticated computational techniques, the true coefficients of the structural dynamic model in Chapter 5 can be recovered with methods such as Maximum Likelihood Estimation that do not require the derivation of reduced forms equations.
(Miranda, 1995; Rui, 1995). The estimation approach of the structural coefficients will then enable one to derive testable hypotheses. Furthermore, this approach is consistent with the concept of rational expectations and opens a whole new perspective for applied research using repeated dynamic games.

While the modeling and analysis adopted here exhibit promising results, the dimensionality of the household model remains an important problem. Including the first stage of the extended household decision making in the dynamic model developed in Chapter 5 allows one to completely endogenize the cooperative bargaining process over the individual shares of risks and resources. One can then formally analyze the effects of changes in individual bargaining power on the sustainability of collective action. For example, it is interesting to estimate the degree to which endogenizing the share of common products can explain the pervasiveness of the extended household as a risk-sharing institution and the shirking behavior of members of the household.

One can also formally introduce self-insurance strategies, such as borrowing from formal financial institutions. The analysis of the relative costs of community-based insurance versus self-insurance can then be carried out by looking at the shadow prices of resources for different interest rates on loans.

Similarly, the introduction of asymmetric information and other agents into the game will certainly add new insights to the model. The household models in this dissertation have been solved under the assumption of perfect information about the distribution of outputs. Simulations in Chapter 5 have identified situations where moral hazard can occur due to the absence of contract enforcement mechanisms. The addition of imperfect information about
the distribution of individual outputs as well as will the strategic behavior of agents makes it possible to formally study the causal relationships between the design and evolution of an institution, on the one hand, and moral hazard behavior due to imperfect information, on the other hand. Issues such as the optimum size of the household and optimum interventions of the public authorities that minimize the agency and insurance costs can then be investigated. This will, however, add substantial complications to the estimation task that critically depends on existing computational methods.

Finally, it is important to look at the causal relationships among the distribution of human capital, the evolution of traditional insurance institutions, and food security at the household level. This dissertation has stressed the importance of the household's endowment of labor for consumption smoothing. Low dependency ratios give households more opportunities to secure their food supply as households can engage in risk-diversification strategies and take advantage of economies of scale in the production of public goods. This dissertation has not, however, consider human capital as a risk-management strategy. Yet, investing in human capital is a risk-management strategy commonly used by households in developing countries. More research is needed to rigorously evaluate the benefits of investment in human capital on household food security.
LIST OF REFERENCES


212


216


221


APPENDIX A

Results of Three-Stage Least-Square Estimation of the Perfect Insurance Model
### Three Simultaneous-Equations Model
(Number of observations = 42 extended households * 3 years)

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Equation one: Household consumption</th>
<th>Equation two: Household off-farm income</th>
<th>Equation three: Household livestock accumulation or sale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household consumption</td>
<td>+2.9280 (7.4411)</td>
<td>+1.0484 (4.2805)</td>
<td></td>
</tr>
<tr>
<td>Household off-farm income</td>
<td>+0.0008 (3.0072)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household livestock</td>
<td>+0.0015 (4.3666)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household crop income</td>
<td>-0.0018 (-0.6545)</td>
<td>-0.5199 (-2.1091)</td>
<td>-0.4415 (-2.7954)</td>
</tr>
<tr>
<td>Household borrowing or lending</td>
<td>+0.0022 (3.8731)</td>
<td></td>
<td>-1.7911 (-2.2449)</td>
</tr>
<tr>
<td>Household health expenditures</td>
<td>-4.9472 (0.8999)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household luxury expenditures</td>
<td>+1.9989 (2.5875)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household labor force</td>
<td>+1.4654 (2.0668)</td>
<td>-0.1110 (-2.4011)</td>
<td></td>
</tr>
<tr>
<td>Household level of asset</td>
<td></td>
<td></td>
<td>+5.9577 (2.8038)</td>
</tr>
<tr>
<td>Dummy for 1990</td>
<td>-7.8724 (-14.1034)</td>
<td>-0.1644 (-2.0543)</td>
<td>+1.8583 (2.9623)</td>
</tr>
<tr>
<td>Dummy for 1991</td>
<td>-5.3709 (-7.0675)</td>
<td>+1.8790 (1.0374)</td>
<td>+1.8935 (3.3481)</td>
</tr>
</tbody>
</table>

A/ Goodness of fit of the system: McElroy R-squared = 0.524

B/ Ho : \( \sum (Y_i - 0 \gamma_j + 0 \beta_j) = 0 \) and \( \theta = 1 \)

F-value = 93.694

(\() T\)-statistic

Table A.1: Results of Three-Stage Least-Square Estimation of the Perfect Insurance Model Using the Sample of Extended Households

225
### Three Simultaneous-Equations Model
(Number of observations = 68 nuclear families * 3 years)

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Equation one: Household consumption</th>
<th>Equation two: Household off-farm income</th>
<th>Equation three: Household livestock accumulation or sale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household consumption</td>
<td>+ 5.0153</td>
<td>+ 7.3656</td>
<td>(6.0309)</td>
</tr>
<tr>
<td>Household off-farm income</td>
<td>+ 0.0009</td>
<td></td>
<td>(1.1783)</td>
</tr>
<tr>
<td>Household livestock accumulation or sale</td>
<td>+ 0.0002</td>
<td></td>
<td>(0.1870)</td>
</tr>
<tr>
<td>Household crop income</td>
<td>- 0.0035</td>
<td>+ 2.2859</td>
<td>(2.4290)</td>
</tr>
<tr>
<td>Household borrowing or lending</td>
<td>+ 0.0018</td>
<td></td>
<td>(2.9273)</td>
</tr>
<tr>
<td>Household health expenditures</td>
<td>+ 2.1546</td>
<td></td>
<td>(0.5007)</td>
</tr>
<tr>
<td>Household luxury expenditures</td>
<td>- 0.4307</td>
<td></td>
<td>(0.8161)</td>
</tr>
<tr>
<td>Household labor force</td>
<td>+ 1.3669</td>
<td>- 0.1385</td>
<td>(2.7778)</td>
</tr>
<tr>
<td>Household level of asset</td>
<td>- 1.9889</td>
<td></td>
<td>(1.0234)</td>
</tr>
<tr>
<td>Dummy for 1990</td>
<td>- 7.1748</td>
<td>- 0.2341</td>
<td>(8.2109)</td>
</tr>
<tr>
<td>Dummy for 1991</td>
<td>- 5.0153</td>
<td>+ 0.9665</td>
<td>(6.0309)</td>
</tr>
</tbody>
</table>

A/ Goodness of fit of the system: McElroy R-squared = 0.289

B/ \( \sum_j (\gamma_j + \beta_j) = 0 \) and \( \theta = 1 \) F-value = 115.781

Table A.2: Results of Three-Stage Least-Square Estimation of the Perfect Insurance Model Using the Sample of Nuclear Families Organized Into Extended Households