Sergio Omar Saldaña-Zorrilla
Reducing economic vulnerability in Mexico. Natural disasters, foreign trade and agriculture.

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Reducing Economic Vulnerability in Mexico: Natural Disasters, Foreign Trade and Agriculture

Verringerung wirtschaftlicher Vulnerabilität in Mexiko: Naturkatastrophen, Außenhandel und Landwirtschaft

Eingereicht von:

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Dissertation

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Abstract:

The increasing frequency and economic losses from natural disasters within the framework of decreasing agricultural prices and trade liberalization is becoming crucial in increasing poverty in the Mexican rural economy. During the past two decades, the governmental withdrawal from supporting the agricultural sector with investments in physical, financial and logistic instruments continues to stress agricultural livelihoods, as current private mechanisms have not replaced them effectively. It has contributed to making the agricultural sector particularly vulnerable to a number of hazards as it has weakened economic agents’ response and impeded assets accumulation. This dissertation identifies economic vulnerability to natural and economic hazards in order to assess public and private coping capacity, and provides a conceptual framework and economic theory that supports the overall approach and employed methodologies. It is based on quantitative and qualitative research methods, and makes use of econometric analysis and stakeholders’ views aimed at finding feasible solutions. Further, this dissertation offers a spatial model that can support policy-decision-making for the creation of differential investments in productive infrastructure, as well as financial instruments to reduce current vulnerability and poverty throughout the national territory.

During the past two decades, over 80% of total economic losses from weather-related disasters occurred in the agricultural sector. In the same period, mean weighted agricultural prices have decreased over 50% in real terms, and since 1996 a trade deficit has persisted in this sector. Currently, the insufficient credit access, low coverage of crop insurance, as well as the near lack of investments to expand irrigation and further productive infrastructure is sharpening the vulnerability of rural livelihoods. These facts explain why this sector produces only 4% of the GDP despite employing over 20% of the national workforce. These facts undermine farmers’ expectations of future incomes within the community, stimulating rural-urban out migration, which usually cannot be absorbed by the urban economy in sight of the modest industrial dynamism of the recent years. This leads to the enlargement of the informal sector in large cities and migratory flows to abroad, among others.
Abstrakt:


CHAPTER 1: Introduction

Along with economic and institutional stressors, the occurrence of natural disasters is increasingly determining income and asset accumulation of vulnerable population in Mexico. This dissertation identifies and estimates the effect of natural hazards and some economic variables on poverty, as well as assesses the impact of current public and private strategies aimed at reducing economic vulnerability. Most of the workforce living in poverty in rural areas relies on agricultural livelihoods and they are increasingly affected by weather-related disasters. The insufficient physical and financial instruments to hedge the agricultural sector both from weather- and market-related risks contributes to the weakening response of farmers, the negative consequences of which expand to other regions.

During the period 1980-2005, over 80% of total damages from weather-related events affected the agricultural sector in Mexico. Though the contribution of the agricultural sector is only around 4% of GDP, it is the livelihood of over 20% of the national population. Trade liberalization, in Mexico since the mid of the 1980s, has not only resulted in a negligible increase in production, but also contributed to an increase of uncertainty with regards to small farm incomes, with the rise in imports and depressed prices of agricultural products.

This dissertation recognizes that natural disasters and trade liberalization are not the only factors contributing to poverty in this country, however it aims to prove that they are becoming economically crucial in maintaining and increasing structural poverty with their disruptive effect on the asset accumulation process. As confirmed in this dissertation’s analysis, it drives small-scale farmers out of business, and increases out migration from rural areas. The purpose of this analysis is to examine how natural disasters and adverse economic conditions affect agricultural livelihoods and the implications of these stressors upon the poor in the agricultural sector, in order to come up with suggestions to reduce their vulnerability. Special emphasis is given to the effects of these hazards on migration patterns. In addition, this project analyzes selected policy options (e.g. government-supported insurance schemes) to reduce the vulnerability of farmers. To further this aim, this work makes use of descriptive and econometric analyses, as well as stakeholders’ interviews.

1.1 Methodology

During the past two decades, the rising number of research work particularly in the natural sciences has been warning about the increasing pressure of natural hazards on human societies. So far, the economic sciences have given little attention to these studies. This dissertation presents an integral analysis of both natural and economic hazards as determinants of poverty and labor mobility, embracing social and policy aspects. The methodology includes both quantitative and qualitative methods. The review of existing economic and policy literature is mainly presented in chapter 2 to 4, which discuss evidence supporting this dissertation’s hypothesis and describe the process behind
economic vulnerability in Mexico. In chapters 5 and 6 a statistical analysis is introduced. The analysis was based on a survey of farmers and further stakeholders, as well as a spatial econometrics analysis of data from the 2,443 municipalities of Mexico. Data was gathered by the author from a number of sources, including national and international organizations, as well as those collected directly from the households and policymakers during the survey and country consultations carried out in 2003, 2004 and 2005. This analysis quantitatively validates the hypotheses presented in this text.

1.2. Outline

The conceptual framework of this dissertation, presented in Chapter 2, is based on the vast existing literature from both the natural and social sciences. It describes the basic mechanisms by which vulnerable societies tend to amplify the negative consequences from natural disasters given their usual weak coping and adaptive capacity. Coping capacity, as discussed, is in turn conditioned not only by natural hazards and market imperfections, but also a result of the original endowment modified by the historic process of wealth distribution, giving shape to the current entitlement system. In addition, the inherent capacity of the economic agents to adapt their structure and functioning in response to harmful events is closely conditioned by the institutional organization. Given the prevailing levels of poverty and vulnerability in Mexico, as discussed in Chapter 2, the current public intervention to strengthen coping and adaptive capacity of the exposed population is being exceeded

Considering the increasing tendency of frequent and severe natural disasters and the economic losses associated with them, together with the dropping agricultural prices presented in Chapter 3, this research warns of the most likely forthcoming increase in poverty if no implemented an effective strategy to reduce vulnerability. As the urban economy has experienced a very modest growth during the last two decades, it is unable to absorb the additional workforce released from rural areas. It has led to the proliferation of slums and to the currently fast growing informal urban economy. As both the uncertain agricultural incomes and the precarious urban jobs do not fulfill the expectation of the vulnerable population, increasing emigration to the USA is the usual response, particularly in the case of farmers living in remote regions. This trend is further verified both by the stakeholders’ survey and the spatial model.

Chapter 4 assesses current policy instruments for reducing agricultural vulnerability, identifying areas where public investments in productive infrastructure can greatly achieve progress in poverty reduction if combined with disasters mitigation works and expanding public-private insurance schemes. In addition, it analyzes possible improvements to policies and instruments for reducing economic losses, e.g., subsidized micro-insurance, and for reducing poverty and vulnerability in the agricultural sector. In light of the current comparatively low implementation of ex-ante instruments, this chapter underlines the need for a more active promotion of existing disaster mitigation instruments (e.g. funds for mitigation works) from the federal authority along with more participative action from the community and municipal authorities to propose projects. This chapter’s research is based to a large extent on a project the author carried out in 2003 for the World Bank and the Provention Consortium, which was complemented with a consultation with policymakers in Mexico. (Saldaña 2004a).
The current role of the government, the private market (e.g., insurers), the farmers and other stakeholders in dealing with the adverse outcomes from natural disasters and income uncertainty of small-scale farmers are still insufficiently interconnected, as verified by the views of the stakeholders presented in Chapter 5. This chapter identifies the problem of farmer vulnerability to natural disasters and trade liberalization, and examines the preferred policy responses from the point of view of stakeholders, including the farmers, the farmer cooperatives, the crop insurers, and the ministries and departments of the local and national governments. The dramatic governmental withdrawal of the previous two decades from supporting the agricultural sector with facilities for production and commercialization continues putting stress on rural livelihoods as no effective compensatory mechanisms have been successfully implemented. This fieldwork identified a clear need for a more profit-oriented production and expansion of coverage of individual and collective financing instruments to face external shocks. The chapter is derived from research the author conducted between 2004 and 2005 as part of a project for the START-IIASA Advanced Institute of Vulnerability to Global Environmental Change (Saldana 2006).

The great human and geophysical diversity of Mexico is reflected in its existing plurality of economic practices and natural hazards exposure. Chapter 6 applies spatial econometric analyses to assess the importance of natural disasters and depressed prices due to imports (or to simple low international prices), and analyzes their differential interaction with the diminishing income of vulnerable regions to stimulate out migration from municipalities highly exposed to natural hazards. During the past two decades, failing in implementing effective mechanisms for reducing risk to climatic and market variability is impeding accumulating enough physical and human assets in particularly in the agricultural sector. The negative effects of hazards in vulnerable regions have a spillover effect on neighboring regions. For that reason, direct public intervention is needed to allow asset accumulation. Derived from the migration model, one can observe that the segment more prone to emigrate is that with greater reductions in real incomes and more frequently affected from disasters. It reveals the role of expectations of future incomes in the configuration of migratory flows. Chapter 7 integrates the results of all chapters to provide conclusions of this work and presents a final discussion for future directions.

This dissertation’s analyses contribute to the current conceptual and empirical debate in economic and social sciences, as well as offer an integral methodology combining natural and social sciences for further studies of economic vulnerability in developing countries. The lessons derived from this analysis provide useful elements for the design and improvement of governmental policies concerning social and economic development. In addition, the desegregation of this analysis has the advantage of facilitating the design and evaluation of governmental projects at municipal, state, sub-national and national level.
CHAPTER 2: A conceptual framework of economic vulnerability

This introductory chapter is devoted to presenting the conceptual framework and background of this dissertation required to understand the dynamic of economic vulnerability first in general and further concretely in Mexico. This chapter quotes a number of research works relevant to provide elements for a solid discussion, an objective judgment of the problematic, and a grounded argumentation of this work’s hypothesis.

The chapter starts providing a review about different concepts and approaches of vulnerability (section 2.1) and economic vulnerability (section 2.2) towards defining this work’s concept of economic vulnerability. Further, we approach at briefly illustrate the structure of economic vulnerability and its functioning as dynamic and cyclic process. One interpretation of the complex process of multiple interacting stressors to economic vulnerability is expounded in section 2.3, emphasizing the role of assets, especially those of the poor in rural areas. This section also discusses poverty definitions, assess briefly poverty in Mexico, and provides some elements towards explaining historic facts defining entitlements and some issues of economic policy behind poverty in Mexico and concretely in the countryside. The need for taking into account concepts and patterns of agricultural growth and rural-urban migration in a strategy to deal with economic vulnerability is presented in section 2.4. Extern shocks tend to amplify due to structural weakness and interacting stressors, and are explicitly described along this chapter – summed up in section 2.5-, allowing us to leave the mere conceptual discussion to come out into assessing vulnerability and public-private response in Mexico, along with its tentative solution paths, in the forthcoming chapters of this research work.

2.1 Vulnerability

Vulnerability is the key concept to our approach, and we proceed now to expound definitions of vulnerability from different disciplines and perspectives relevant to the present work, their linkages to related concepts and, based on them, to propose a definition of economic vulnerability.

In a broad sense, vulnerability is incumbent upon two sides: unit of exposure and extern force(s). So, vulnerability can be initially defined as the susceptibility of a certain unit to a specific force, and risk can be expressed as the probability of an undesired derived outcome, based on the potential occurrence of harmful events and on the susceptibility to them among those likely to be exposed (Dielley and Boudreau 2001).
The way the sustainability science analyzes both elements included in these sides, as well as the complexity of their interrelations, provides excellent basis towards defining, further, economic vulnerability. So, for some scholars of the sustainability science, vulnerability is conceived, above all, as a coupled human-environment systems’ interaction, which posses a likelihood to experience harm due to exposure to a hazard (Turner et al. 2003). In this concept, hazards are understood as threats to the system, which act by means of perturbations and stressors. Perturbation is a major alteration in the system -of extern origin- generating exceeding effects to those the system can cope with, and stress is a continuous increasing pressure upon the system. The novel of this concept is that expands the analysis spectrum to embrace multiple stressors and the structure of hazard’s causal sequence as a complex of socioeconomic conditions and biophysical subsystems lying behind.

So, vulnerability does not involve merely active and passive factors, but rather dynamic objects and subjects in continuous motion. As pointed out in Turner et al. (2003), systems have different sensitivities to perturbations and stressors strongly linked to entitlements in the case of social units. Entitlements are essentially the system of legal and customary rights defining the access to the society’s resources.

Along with entitlements, other elements defining susceptibility of social units are coping and adaptive capacity. Coping capacity can be defined as the ability of a unit to respond to a harm occurrence as well as to avoid its potential affectation. Adaptive capacity is the ability of a unit to gradually transform its structure, functioning or organization to survive under hazards threatening its existence (Kelly and Adger 2000). Another concept contributing to vulnerability comprehension is resilience, which, borrowed from the ecology science, defines a system’s ability to return to a reference state after a disturbance and to maintain basic structures and functions despite disturbance (Turner 2003). However, as this concept has elements from both coping and adaptive capacity, this work maintains it out of the analysis in order to avoid conceptual overlapping.

Thus, the expound linked concepts –entitlements, coping and adapting capacity, and resilience- obligate us to incorporate social, economic, institutional, and cultural structures into the set of forces shaping units’ susceptibility in the vulnerability analysis, overcoming so the eventual limitations other frameworks do, i.e. risk-hazard and pressure-and-release models. Moreover, these concepts will be useful to the present work, since their implementation into our analysis may allow us to maneuver with existing structures in the country our case of study deals with, especially in the part concerning decision making.

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1 Risk-hazard models tend to consider impacts of hazards as a function of exposure to the hazard event and the sensitivity of the unit without clarifying how the units amplify or attenuate the impacts, as well as the role of multiple stressors in defining susceptibility. In the case of pressure-and-release models (PAR), they emphasize the conditionings of unit’s unsafe, including even ethnicity, class, etc. However, the PAR model does not incorporate biophysical subsystems interacting with the society.
Vulnerability analysis is increasingly being applied to different concrete matters using implicitly most of the above listed elements of vulnerability, but emphasizing the concrete area they deal with. For instance, some works on vulnerability to climate change underline the contribution of natural disasters mismanagement to increase vulnerability of human systems to natural hazards (Abramowitz et al. 2002); Works focused on concrete biophysical dimensions of vulnerability, i.e. water, emphasize, for instance, inadequate supplies of potable water and sanitation, and exposure to waterborne diseases of a given human settlement (Cocklin 2002). Other works on food security emphasize shortages in food supply due to extreme events (Liverman 1990). Approaches about dynamic vulnerability focus on, i.e., the extent to which environmental and economic changes modify the capacity of regions, sectors, ecosystems and social groups to respond to shocks (Leichenko and O’Brien 2001).

2.2 Economic Vulnerability

The rise of literature on vulnerability issues over the last two decades has demanded for an each time more specialized definition of vulnerability. For instance, social vulnerability conceives social entities as its units of analysis, aiming concretely at identifying the way human societies and individuals are prone to suffer from disturbances and stresses (Adger 1999). So, social vulnerability, as expound above, relies at a large extent on concepts like endowments and entitlements.

From its part, economic vulnerability is still sparsely defined, and one can find concepts which, though useful and valid, fail in describing vulnerability in its wide spectrum. There exists interesting views about economic vulnerability highly biased to the side of drivers, like those provided by some scholars of political economics in the context of international development. The germinal works on this matters of Todaro (1982) consider vulnerability as a situation in which least developed countries (LDC) find themselves in a dominance and dependence relationship vis-à-vis the developed countries. In this view concretely, LDC are said to be economically vulnerable to the decisions of rich nations in areas such as trade, private foreign investments, foreign aid, technological research and development, etc. This is a useful concept whose asymmetry component is closely interconnected with other concepts from the economics of development, like the center-periphery relations and terms of trade in the works of Raúl Prebisch (i.e. 1950 and 1973, respectively).

In-line-with the Todaro’s definition, the United Nations Conference on Trade and Development (UNCTAD) defines economic vulnerability as the structurally more exposed position of LDCs than most other developing countries to external economic shocks. Also, UNCTAD points out that economic vulnerability implies consequences of major global and regional economic and financial disturbances and increases in the prices of critical imports such as energy products; The typical export dominance of a single commodity or service sector makes their economies particularly vulnerable to adverse physical or economic shocks (UNCTAD 2001).
So, in the early 1990s, UNCTAD developed a first attempt to construct an index of economic vulnerability\(^2\), and in 1994 the Programme of Action for the Sustainable Development of Small Islands Developing States (SIDS) adopted an index of economic vulnerability, expected to demonstrate that SIDS were generally more vulnerable than other developing countries. So, the UNCTAD Economic Vulnerability Index was constructed as a composite indicator based on three fundamental dimensions: (1) the magnitude of external shocks beyond domestic control (measured through indicators of the instability of agricultural production and exports); (2) the exposure of the economy to these shocks (estimated through the share of manufacturing and modern services in the gross domestic product, and an indicator of merchandise export concentration), and; (3) the structural handicaps explaining the high exposure of the economy (taking into account economy’s smallness, measured by a proxy demographic variable) -UNCTAD 2003.

In the view of Briguglio (2002), a country can be economically vulnerable and yet register a relatively high GDP per capita. So, countries like the SIDS are particularly economically vulnerable due to their limited ability to exploit economies of scale, lack of natural resources, low diversified economy, dependence on narrow range of exports, and high dependence on imports of strategic goods, i.e. fuel and food. Notwithstanding, what essentially makes a country economically vulnerable in the definition of Briguglio, is its exposure to economic forces outside its control. Thus, the *peripherality* condition of an economy goes beyond geographic insularity and remoteness (leading to high costs and marginalization from world trade), but also includes inability to influence international prices (price-taker economies).

However, being vulnerable is not only a question of poverty and smallness of a country, as this work approaches. Vulnerability accrues to also countries of big population and large economies, whose vulnerabilities are less visible at a glance, and only through more detailed analysis exhibit differential vulnerabilities due to dualistic characteristics (Rodriguez 1980). So, above all, Latin American countries like Mexico, Brazil, and Argentina should not be considered as entirely vulnerable, but unequally vulnerable, whose rich and poor societies, high productive and left-behind economic sectors, etc. coexist at differential degrees of vulnerability (Rodriguez 1980, Colosio 1979).

More recently, economic vulnerability is being used to refer the extent to which macroeconomic policies can exhibit performance inconsistencies, sudden loss of net national product, and hence lead to economic crises, as result of underscored development of warning systems and economy’s inability to work with multiple equilibria (Yap 2002). The response to these types of vulnerabilities can consist on financial monitoring and modeling of early warning systems, as Kaminsky and Reinhart (1996) propose to concretely avoid economic crises originated in financial factors like the Asian one of 1997. However, these approaches do not address structural factors of the economy, and tend to reflect rather what this work calls risk and preparedness, instead of vulnerability and vulnerability reduction, respectively.

2.2.1 Coping and adaptive capacity

In defining economic vulnerability is crucial thus to consider approaches with imbedded structural factors. So, the implications of vulnerability to economic analysis are explicitly expound by Amartya Sen (1981) by relating entitlements and initial endowment in a coherent process where individual levels of vulnerability are conditioned by broader institutional structures, which sometimes reproduce or even amplify vulnerability given society’s capacity to provide opportunities. These views and concepts are inserted below both in our immediate concept of economic vulnerability as well as in further details in section three. Now, let us explain the concrete elements constituting coping and adaptive capacity in economic vulnerability.

I. Coping Capacity

The capacity to respond to a harmful event as well as to avoid its potential affectation of an economic agent is not only determined by its productive level, but also by its relative position within its society. Factors like entitlements, information availability and assets distribution in a society gives shape to this coping capacity.

i) Entitlements. Connected with this way of seeing vulnerability from the perspective of economic agents, Amartya Sen (1981) addresses vulnerability using entitlements. Entitlements are the package of goods and services, which an economic agent can obtain by means of trading their stakes under current regulatory conditions. In other words, there exists an intrinsic susceptibility in the way economic agents profits their assets. With a very similar meaning, Cannon (1994: 19) calls this vulnerability of livelihood resilience. In addition, entitlements also influence information availability, which plays a key role concerning economic vulnerability, since the common assumption of homogeneity of information among economic agents (as in the neoclassic approach of economics) does not usually apply in practice. Heterogeneity with respect to information possession makes considerable differences when taking decisions and in turn when obtaining incomes. Better informed economic agents are normally more able to identify the risk their asset implies and hence to take better decisions.

ii) Assets. Assets are a key variable to understand impoverishment in poor rural families (or households), which can be defined as the stock of wealth used to generate well being (Vatsa & Krimgold 2000). This concept is important when considering the effects of natural disasters, which can decrease the capital assets of households and businesses. Families have an initial asset, which generates an output. This output varies widely, depending on market price of the produced factor, and on the productivity of its use (profitability). As families pursue strategies to maximize their assets, they are in better position to enlarge their risk pool and reduce vulnerability.

II. Adaptive Capacity

The ability of a unit to gradually transform its structure and/or functioning to survive hazards affectation is interconnected with assets and entitlements as well in that of it influences economic agents’ ability to hedge from adverse events. Explicitly, adaptive capacity concerning economic vulnerability includes risk management and protection actions.
i) **Risk management.** Derived from options to deal with negative shocks, prevailing risk management capacity in a country is crucial in reducing vulnerability. Risk management is the set of pre- and post-disasters actions towards facing negative consequences of hazards (Freeman et al 2001). Pre-disaster actions include risk transfer (i.e. insurance), risk assessment (monitoring, mapping, etc.), mitigation works (i.e. infrastructure strengthening, etc.), and preparedness. Post-disaster actions include emergency response (aid, clean-up, etc), rehabilitation, rebuilding, and loss sharing (i.e. private-public, national-local).

ii) **Protection.** From its part, protection is a concept situated at the both sides of risk management phases (pre- and post-disaster). Protection is the network of awareness and emergency response for disaster and crisis state avoidance, initially based on various technical interventions usually known as preparedness. Preparedness is the management capability before a disaster occurs to provide an effective and efficient (prompt and due) reaction to face a disaster (Freeman et al 2001). Protection granted by governmental planning plus those from other social institutions are termed social protection, which acts complementary to self-protection (Cannon 1994).

In concordance with the conceptual discussion above expound and attempting to overcome dispersion and partiality of available definitions of economic vulnerability, this work defines economic vulnerability as the susceptibility of an economic agent to absorb extern shocks (hazards) negatively, given its assets possession and entitlements system (coping capacity), as well as its implemented risk management and protection measures (adaptive capacity).

Finally, reducing economic vulnerability consists basically on implementing the due changes in time to minimize negative effects from exogenous shocks upon economic agents’ assets by strengthening contractual elements in the society (entitlements and assets) and/or improving the risk management and protection strategies.

### 2.2.2 The cycle of economic vulnerability

Figure 1 below provides a very simple illustration of, first, the structure of economic vulnerability according to this work’s approach, as well as of some elemental cause-effect relations derived from hazard occurrence. Individual unit of analysis’ vulnerability is depicted in the diagram by three fundamental elements: Unit adaptability, public response, and probability of economic losses. Unit adaptability embraces coping and adapting capacity within the framework of society’s prevailing entitlements and assets distribution. The second pillar of economic vulnerability is public protection, understood as the set of social programs, antipoverty strategy, etc., constituting the social and redistributive policy, as well as the public mechanism of disasters avoidance, whose

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3 In fact, adaptability is the preferred term for this work though that word itself could seem to misrepresent its components, and perhaps better represented by terms like resistance, strength, etc. However, most literature of vulnerability uses it conventionally to represent system’s ability, competency or capacity of a system to adapt and respond to climatic stimuli. Also, see Schjolden, A. (2003), Kelly and Adger (2000), and Chambers (1989).
strength or weakness degree contributes to define economic vulnerability of both our unit of analysis as well as to the entire society –elements of risk management are marked with an asterisk in the diagram.

The share of assets at risk –out of units’ assets total value- defines the probability of economic losses. Assets at risk are the monetary valuable elements, i.e. capital stock, production of goods and services, and in general any form of assessable wealth, exposed to hazards at a given extent. Economic Vulnerability is the outcome of these factors together. To this extent of the diagram, all said elements are potential facts, which materialize until a hazard hit the system.

The hazard causes damages translatable into economic monetary losses, whose implications can be direct damages, like loss of public and private productive infrastructure, housing, etc. Also, such a loss of assets leads to indirect losses\(^4\), to productive disruption and, therefore, to decreasing incomes of private economic agents. The government, from its part, may decrease revenue from state-owned companies as well as because of decreased taxing basis (concerning basically income and consumption taxes) as a consequence of a potential reduction in economic activity. This process draws a vicious cycle as less income lead to less financial ability to invest in reducing vulnerability both at unit level, i.e. household, as well as at global level, i.e. economy, in reducing vulnerability. Unlike perturbations, stresses are linked to the unit’s resistance (discontinuous line) because, as above expound, they are understood as threats to the system, which act by means of continuous increasing pressure upon the system, and are associated at a large extent to structural conditions. Appendix 1 provides further elements to analyze the dynamic of economic vulnerability, suggesting a mechanism to maneuver with coping and adaptive strategies in order to reduce economic vulnerability under this work’s framework.

2.3. Drivers of economic vulnerability

So far, the basic elements shaping economic vulnerability have been here presented, and we turn now to explain the relevance of the hazards analyzed in the following chapters of this dissertation (natural disasters and trade liberalization). Considering that hazards are threats to the system, which act by means of perturbations and stressors, analyzing assets structure and their functioning along with the historic impact of the entitlements in this country is crucial to clarify why natural hazards and economic policy have been drivers of increasing vulnerability in Mexico.

\(^4\) Indirect losses are actually the share of unrealized production, which act by reducing GDP growth at the current year, whereas direct losses are not accounted into GDP growth reductions, since they are added value belonging to GDP accounting of past years (cfr. ECLAC 2002).
Figure 1: The structure of economic vulnerability and its cycle

Direct losses (public infrastructure, housing etc.)

Rebuilding, repairing, relief to the poor, etc. (*)

Assets at risk

A. Unit Adaptability

Coping capacity

Adaptive capacity

Entitlements
Assets

Risk Management
Protection

Unit’s risk financial options (insurance, risk pool, etc.) (*)

B. Public Protection

Social and Redistributive Policy

Governrn. Protection (awareness, monitoring, emergency response) (*)

Public financial options (risk-sharing, transfer, and mitigation) (*)

(*) Risk Management elements
2.3.1 Assets accumulation
Increasingly, scholars argue that poverty is not only a lack of income or consumption, but also a lack of assets (Haveman and Wolff 2000, Oliver and Shapiro 1990, Sherraden 1991). So, asset poor involve those households with insufficient resources to invest in their future or to sustain household members at a basic level during an economic disruption (Fisher and Weber 2004). There exists empirical evidence showing that wealth is more unequally distributed than income. For instance, Wolff (2001) points out that the top 20 percent of households in the USA earn 56 per cent of nation’s income and own 83 percent of national wealth. For that reason is crucial to identify households’ assets poor in order to, further, encourage assets accumulation.

Among other authors, Chambers (1989) cautions about the relevance of increasing assets in low-income families, since this improves human conditions beyond poverty just in terms of flows, but also structural vulnerability. He affirms that vulnerability is even more interlinked with net assets than poverty. For authors like Vatsa & Krimgold (2000), vulnerability is a broader and more dynamic concept, which involves the poor, but also households living above poverty line at risk of falling below in case of an income shock (new poor). Given that linkage, factors that obstruct an accumulation of assets are, in turn, impeding poverty reduction and putting additional population into poverty. For instance, losses from natural disasters or income reductions due to depressed agricultural prices impede rural households in accumulating assets, creating a vicious cycle of inefficient risk management strategy, low return, low consumption and low savings and investment (Vatsa & Krimgold 2000).

The role of assets protection in reducing poverty
A poverty reduction strategy possesses two sides. One consisting of irreducible actions aimed at providing short-term relief to families living in poverty (i.e. health facilities) and making affordable some long-term intangible assets (i.e. education). The other side is related rather to directly strengthen income generation, i.e. agricultural commercialization, reducing information asymmetries, productivity enforcement, etc. However, the latter side of the anti-poverty strategy in Mexico –as in most of the countries- is less actively promoted (Fisher and Weber 2004, ECLAC 2001, Attanasio and Szekely 1999). It is so partly because it implies actions falling outside the jurisdiction of mere poverty-related governmental agencies. It is so also because strengthening income generation is more complex and usually requires changes to the national socioeconomic structure and lot of political lobbying and willingness.

Programs aimed at reducing poverty tend to increase transfers, but they do not affect the long-term lack of assets in the current case of Mexico (Attanasio & Szekely 1999). Anti-poverty programs help to raise income or consumption but only in terms of flows. In addition, ECLAC (2001, p. 32) points out that social programs of poverty reduction in Mexico are merely of aid character, though if these programs were more substantial and long-term sustained, these additional resources could increase assets, as well as for instance improve ability to invest on education and other long term variables, which directly modify assets and in last instance income. For that reason, prevention/compensation mechanisms are required. In Mexico, such mechanisms have
been actively promoted by the State along the past 90 years, as part of the resulting social State implemented by post-revolutionary governments. That is the reason which motivated the present work to assess in chapter 4 the current network of social security in Mexico as well as the system of social programs in general.

2.3.2 Poverty and entitlements
Stressors, understood as continuous increasing pressure upon a unit, are analyzed in this section when approaching entitlements determinants in prevailing poverty in Mexico, i.e. the colonial legacy and industrialization patterns along the XX century. The following subsections are an attempt to define poverty for this work’s sake based on the vast conceptions and measurements of poverty in order to further present the most likely causes of structural poverty in this country.

Poverty
Defining poverty implies dealing with a very controversial paradigm. There exists no consensus about what issues are embraced by poverty. However, a point of agreement among the vast existing literature on poverty seems to be that poverty is a lack of opportunities to reach a basic minimum level of well being. In turn, well-being can also include several determinants, i.e., assets, infrastructure, social networks, institutions, human development, etc. This leads us to another point of agreement about it: poverty is a relative concept that deals with “minimums of well being” (as in SEDESOL 2002), “society’s hopes and aspirations to be fulfilled” (World Bank 2001), or “basic needs” (Todaro 2000), all they varying widely among and within societies.

Other concepts of poverty go beyond tangible factors and include rights issues, relationships, powerlessness, socioeconomic exclusion, and even loss of dignity (i.e. Elankumaran et al 2000). Nevertheless, this work will only focus on those more quantitatively measurable economic dimensions of poverty.

2.3.2.1 Income and Consumption measurements
Among measurements of poverty, there are two basic criteria: income and consumption. Income-based measurements of poverty embrace the total current monetary and non-monetary inflow a household obtains from different functional sources, including wages, salaries, dividends, rents, etc. The use of income-based measurements is advantageous in that of allowing identifying those economic activities to be strengthened to reduce vulnerability, tougher more subject to errors due to difficulties in incorporating non-

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5 A key argument in the current debate about development in developing countries is that income alone is an insufficient indicator of economic well-being. In response, various alternative supplementary measures have been proposed, including consumption-, income- and wealth-based indicators (SEDESOL 2002, Haveman and Wolff 2000, Slesnick 1993). The present work considers assets the ideal welfare measure. Despite recognizing that fact, this work approaches assets by household incomes in measuring economic vulnerability in chapter five. We did so because available statistics and data sources do not allow us to make assets’ quantitative analysis. Hence, quantitative analysis of economic vulnerability until assets level will be possible for only the individual municipalities that our case of study inquires through field work in chapter four.

6 For instance, infrastructure necessities in least developed countries consist conventionally on tap water and sanitation services, but in middle income countries like Mexico electricity is included as well.
monetary income, self-consumption and transfers. Consumption-based measurements consist of the total amount of monetary and non-monetary expenditure a household makes in all possible items. The advantage of using consumption-based measurements of poverty relies on the fact that it reflects smoothing strategies a household implement in response to sudden income fluctuations, i.e. family solidarity, aid, remittances (WB 2004).

2.3.2.2 Rural Poverty
The World Bank 2004 Report on Poverty in Mexico estimated income poverty in Mexico at 51.7%, and consumption poverty at 51.3% of the population in year 2002 (WB 2004). In addition, the country has clear gaps in terms of purchasing power. According to the Poverty and Social Development Indicators of the Mexico’s Country Assistance Strategy (WB 2002), inequity in power of consumption is dramatic: Consumer price index shows 219, compared to food price index 227 (1995=100). Consumption in terms of income distribution reveals also high inequity in Mexico: the lowest (poorest) deciles consume only 4% of income, whereas the highest one consumes 56.7% (INEGI 2000, WDI 2001).

However, both moderate and extreme poverty in Mexico is dramatic in rural areas. 74% of rural population lives in poverty -in urban areas it represents 36% (WB 2002). From its part, 20% of the Mexican population is reckoned to live in extreme poverty7, from which 65% in rural areas (WB 2004: 54). Also, the livelihood of 72% of the extreme poor in Mexico is agriculture (WB 2004: 54). Section 4 below presents a more detailed description about rural livelihoods and their links to vulnerability.

Education and jobs quality
Low education is, in turn, much more concentrated in rural areas: 73% of rural extreme poverty has no education or incomplete primary –compared to 51.3% in urban extreme poverty. Nevertheless, it is still risky trying to explain income differences by merely education asymmetries. For instance, based on a regression analysis, the WB staff in Mexico estimated the contribution of household characteristics to rural-urban income differences, and reckons that 35% of that difference is due to disparities in educational levels, but employment characteristics explains ca. 50% of that difference (WB 2004: 57). That analysis compared employment characteristics between remunerations from agricultural and non-agricultural activities, attempting to reflect differences in household’s living standard of being employed in industrial sectors relative to the agricultural ones.

Inequity and access to social healthcare
Inequity in rural areas has increased along the last decade. Based on the Gini coefficient8, rural expenditure coefficient increased from 0.41 to 0.48 between 1992 and 2002, reaching top bottom in year 2000 with a 0.56 coefficient (WB 2004). Also, despite the

7 Extreme poor is those population living below the food-based poverty line.
8 The Gini coefficient is a measure of income inequality developed by the Italian statistician Corrado Gini. The Gini coefficient is a number between 0 and 1, where 0 means perfect equality (everyone has the same income) and 1 means perfect inequality (one person has all the income, everyone else has nothing).
fact that over 25% of Mexican labor force works in agriculture, only 2.5% of total insured people by the Mexican Social Healthcare Institute (IMSS) work in this economic sector (INEGI 2003).

2.3.3 Entitlements behind rural poverty
As in other Latin American countries, poverty in Mexico is a complex issue with ancient causes (e.g. land tenure) but also explained by dynamic factors and processes (e.g. economic policy and extern shocks). The former corresponds to the so-called original endowment9 in the form of initial allocation of wealth -after the Spanish conquest in our case of study. Factors like the industrialization model undertaken during the 50’s and 60’s provides some elements to understand poverty increase in the countryside.

2.3.3.1 Historic land tenure: from colonial times to the post-revolution
On the one side, initial endowment during the colonial establishment margined indigenous population of wealth property, making them serve as slaves (Encomienda System) –even though some indigenous communities could work its arable land under permission and contributing to the colonial authority’s revenue. It worked in that way until the independence war (year 1810), when slavery was abolished, but even in spite of that fact, the most productive land were already appropriated and concentrated in very few hands. So, at this first stage of independent life, dispossessed but now free farmers had to continue being still highly exploited by semi-feudal productive systems. It was so basically because the resulting government of the independence war did not change the status quo of former wealth allocation derived from a sort of amnesty pact between insurgency, Catholic Church and colonial officials as pacification and independence condition (Alamán 1968). Mexican Revolution forced towards land redistribution (Aguilar & Meyer 1989), and a successful and gradual process was undertaken by the early post-revolutionary governments10 to improve conditions in the rural poor (Cosio 1991) and to eliminate Hacienda system. But from the end of the 1940’s, industrial policy in Mexico seems to have been reoriented in favor of the industrial sector (Tejo 2000: 10).

2.3.3.2 The rural-urban disjunctive in economic policy after the 1950s
The school of structural economics supported the reorientation from agricultural to industrial driven economy in Latin-America. Raúl Prebisch (1951), one of the initiators of economic structuralism points out that if one considers the high share of working population employed in agriculture in Latin America, one can understand that land tenure is only part of the big issue about economic development. For him, any solution about it must first take into account that there will not be any improvement in people standard of life, as long as exceeding workforce in agriculture is not eliminated and redirected it to higher productivity sectors. According to that efficiency approach, the sector expected to

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9 For further details about Endowment, and Endowment Effect, see John List (University of Maryland), and Daniel Kahneman (Homo sapiens vs. Homo economicus).
10 Post-revolution is conventionally considered the period between the end of the government of Alvaro Obregón –the last Caudillo-, in 1928, and the end of the Second World War in 1945, characterized land redistribution, expropriation of the oil industry and the begin of a model of economic growth based on imports substitution.
absorb such a displaced labor force was to be the Industry. So, the economic pivot would be the industry, which would become the most dynamic sector, able even to encourage agriculture by demanding increasingly raw materials (Figueroa 1991). Under these assumptions, agriculture would turn into an input provider for the Industry. Proof of that are policies to drag agricultural prices—especially those of primary goods—in order to encourage industry by means of making affordable industrial inputs. In practice, inability in sustaining such an industrial policy in the long-term in Mexico led to failing in turning theory into reality (Montserrat and Chavez 2003).

During the 1950s, the first scholars of modern economic development identified industrialization and urbanization as the main structural change a country should undergo in order to improve welfare and for economic growth (Lewis 1954, Fei and Ranis 1961). The core of that argument is that, historically, economic systems are composed of sectors characterized by a clear difference in factor endowments. In such case, it is possible shifting factors from less to more productive sectors. Historically, this shift has taken place from agricultural to non-agricultural activities, and labor is the most frequent factor in motion. This reallocation of factors leads also to a rise in efficiency of food production, creating thus an agricultural surplus, which in turn provides the basis for fast industrialization and, further, for growth and poverty reduction. In addition, the tendency of higher relative value of manufactured to agricultural goods, known as the Prebisch-Singer Theory of Terms of Trade (Prebisch 1950 and 1951, Singer 1950), is another crucial reasoning to base economic growth on Industry.

2.3.3 Urban capacity to absorb additional workforce
Contrary to theoretical expectations, labor transfers from rural to urban areas in Mexico have exceeded economic systems capacity of employment. The cost of urbanization is high when urban conditions are not appropriated to absorb additional workforce. Population in Mexico became prematurely urbanized in the sense that the share of urban population was greater than the current stage of development could support (Colosio 1979). Global crisis during the 70’s, oil crisis, high cost of public debt (due to the rise in international interest rates), along with wrong estimations on future country’s incomes, slow downed industrial production along the 1980’s, accompanied with an increasing carelessness about agriculture. As a result, the industry did not develop as expected and therefore was unable to absorb exceeding labor force, which in fact had been released from agricultural activities. Below in chapter 3, it is expound the state of the art of agriculture in Mexico, the process of trade liberalization gradually implemented from, roughly, 1986 and abruptly accelerated in 1994 when NAFTA started, as well as discusses the impact of trade liberalization on incomes and poverty in the countryside.

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11 Industry understood as the group of activities related to primary resources processing and manufactures.
12 For instance, the historic process of recognizing property titles to landlords in Britain embracing communal lands during the XVII and XVIII centuries forced to displace enormous masses of rural workers to urban centers to meet the increasing workforce demand from the increasing industrialization process. Marx, K. (1848), David Ricardo (1817).
2.3.4 Emigration as response to rural poverty

Lack of support for the countryside and agriculture, as well as inappropriate urban projecting in large cities in Mexico has contributed to increasing urban vulnerability after the 50’s. There are theories of rural-urban migration helpful to understand better the phenomenon of slums concentrations in urban areas (Lewis 1954, Fei and Ranis 1964, Todaro 2000), most of which find the labor market failure in the (1) incapacity of agriculture to reabsorb rural workers together with its respective low-income (productivity), and (2) insufficient industrial development in the cities. For Todaro (2000: 305), migration is primarily an economic phenomenon, which for the individual migrant can be a quite rational decision despite the existence of urban unemployment.

The Todaro model postulates that migration proceeds in response to urban-rural differences in expected incomes rather than actual earnings. That decision is taken in order to maximize their expected gains in life and, for a given time horizon the urban sector results more convenient. In that sense, as natural disasters reduces future incomes expectations from agricultural activities, it stimulates in turn slums growing as well. Empirical evidence in that way was found by this research work, and is presented in chapter 3 when discussing vulnerability in Mexico City, in chapter 6 when making spatial econometric analysis at municipality level, as well as verified in the stakeholders’ consultation in three communities in rural Mexico, presented in chapter 5 of this work.

In last instance, such failures in rural-urban incomes forecast have drawn a vicious circle of public inefficiency. As migrants from rural areas do not get employed in urban industrial activities, they are forced to engage in low-productivity tertiary activities. Also, large portion of this underemployed population becomes an obstacle to an efficient allocation of public resources, since the society is forced to provide large amounts of urban social infrastructure at the expense of directly public investments. For that reason, investments in agricultural productivity as well as in improving rural income can provide valuable solutions both in fighting poverty and in allocating efficiently society’s resources.

2.4 Agriculture as livelihood

Despite producing about 4% of GDP in 2002, the agricultural sector employs over 20% of the national population and its relative economic weight has declined permanently along the last five decades –in 1950 it provided about 18% of GDP. Agriculture is still the main livelihood of the poor in rural areas in Mexico (ECLAC 2001). However, agricultural income is increasingly complemented by income from low-salary activities. In general terms, poor rural population work in small-size rained agriculture, producing basic grains of fluctuating low prices, with inability –rather than aversion- to contract crop insurance.

The typical landholding in the Mexican agrarian system is the Minifundio, which is too small to provide the workers with levels of living much above the bare survival minimum. For that reason, holders of minifundios are forced to provide seasonal labor to latifundios, or even to other labor markets, working either as wage laborers in other agriculture activities in the nearby, or taking a job in non-agricultural activities in semi-rural areas. It happens regularly because agricultural incomes are so low, that it is not
enough even to subsistence. That fact was empirically verified by this dissertation’s field work, and is presented when analyzing subsistence farmers’ coping strategies in Southern Mexico. In sum, only 45% of total income of rural workers in Mexico is provided by agriculture, with a decreasing trend along the past 30 years (ECLAC 2001).

2.4.1 Off-farm activities as response to economic vulnerability
As land-tenure is smaller, a higher share of personal income must be obtained from alternative sources, as shown in an empirical study on the Mexican case carried out by De Janvry and Sadoulet (2000). Owners of two hectares or smaller properties earn only 23% from agriculture in year 1997, whereas holders owning more than 18 hectares earn at least 62% from this activity. Also the dependence from remittances and self-employment decreases as the size of land increases.

However, shifting economic activity (or migrating) may fall outside the coping capacity of a rural household, given that it use to lead to destruction of its livelihood, in many cases forcing to change unit’s livelihood permanently. The latter is relevant to the present work given that it makes visible that as agricultural income decreases, the coping capacity of the worst-off farmers comes to the end, and they have then either to share income source or even to shift activity. So, protection to rural households must not be thought as facilitating the transition from rural to urban economy, but rather strengthening rural incomes. For that reason, the present work includes work field with Mexicans farmers living in extreme poverty, and attempts at getting a realistic picture of their circumstances as possible, as well as to inquire into their coping strategies, in order to incorporate that learning to come up with stakeholders-based solutions.

Increasingly, rural incomes rely at a larger extent on transfers (from social programs, remittances, etc.) as part of income. At national level, remittances from nationals working abroad represented 1.2% of households’ total income in year 2002. However, remarkable differences arise when comparing among urban and rural, where it reaches 0.5% and 3.5%, respectively. Particularly relevant are remittances to the first rural quintile (poorest 20%), where remittances represents 20% of the income. That quintile is reckoned to obtain 53% of total income from remittances, social programs, and other transfers (WB 2004:75).

2.4.2 Agricultural growth and poverty reduction
Given current inequity conditions in Mexico, agricultural growth itself is not enough to reduce poverty in Mexico. In projecting towards reducing both economic vulnerability and poverty in the countryside is crucial to account for some structural patterns of agricultural growth, whose characteristic may help to maximize benefits from public intervention. Agricultural growth does not necessarily lead to poverty reduction in all the countries. Empirical studies shows remarkable progress in poverty reduction after agricultural growth under certain particular conditions: It depends on income structure and other distributional variables in a given country. The Ravillion and Datt (1996) results about India show that 85% of poverty reduction in the country for the analyzed period is explained by agricultural growth. Also, rural absolute poverty is negatively related to rural real incomes and the average crop yield, what is also an increasing function of food prices.
For Timmer (1997), agricultural growth and poverty reduction depend on equity state. If national growth were uniform (elasticity of connection = 1) in all income-ranges, then simple growth would generate poverty reduction at the national growth rate. But in practice, countries’ structure is no uniform. On the one hand, some countries have an elasticity-growth greater than 1 in high-income population, whereas less then 1 in the poverty, like agriculture in Pakistan (Adams and He 1995). On the other hand, countries with the inverse behavior would benefit even from neutral support policies to agriculture. In this sense, agricultural growth contributes to both growth and poverty reduction if (as discussed in Sarris 2001) the achievements of the initial productivity stimulus is allocated on economic agents who, in turn, make circulate this flow by investing/spending domestically on labor intensive domestic products. Timmer’s analysis (1997), based on rural and urban income by productive sector, shows that for countries with large income gaps, growth in agricultural activities is no more successful in poverty alleviation than growth in the non-agricultural economy. Mexico is situated in this case. Under that analysis, one must not be expected to achieve large progress in poverty reduction in Mexico by means of only improving average productivity in the countryside, but exclusively by aimed strategies. In that sense, one must admit that even when the current strategy to reduce natural disasters risk in the countryside and to support agricultural production provide valuable support, but it is not optimally contributing to reduce poverty given the current structure of the income in the Mexican countryside. To meet with that, support to reduce vulnerability to natural disasters in the countryside in Mexico must act discriminatory upon different economic agents. Public support (and subsidy) to increase productivity in the countryside must keep proportion with necessity degree. For instance, Chile has achieved a more equitant system to provide subsidy for crop insurance premiums, by supporting up to 80% of premium to those poorest farmers, whereas the support reaches at maximum 50% to farmers with more financial ability and better market information. By contrast, subsidy to crop insurance in Mexico has benefited relatively more to non-poor farmers, as criticized in chapter 4 when this work turns to assess the current disaster management strategy and concretely of AGROASEMEX, Fondos and FOPREDEN.

2.5 Final comments

The analysis of economic vulnerability implies dealing with a complexity of elements interacting on a given unit to deal with hazards, demanding a careful identification of what makes it vulnerable. A hazard, generally expressed as threats to a given system, affects depending on strengths and weaknesses of the unit, defining its coping and adaptive capacity. In the economic ambit, hazards can embrace abrupt perturbations derived from economic crisis, economic policy reorientation, among others, or can arise from relatively subtle stressors, like unequal entitlements and assets distribution, which makes continuous pressure upon the unit. In the natural ambit, hazards can also be subtle as well, as the case of continuous reduction in rainfalls, recurrent heavy winds and rains, etc., or more abrupt like their corresponding superlatives, i.e., droughts, hurricanes, etc.

Coping capacity in Mexico, understood as unit’s ability to respond to a given hazard to reduce its affectation, is being highly undermined by unequal access to society’s
resources and prevailing poverty conditions, more remarkably in rural areas. The impossibility of rural masses to accumulate assets seems to be contributing to reduce their capacity to cope with negative outcomes from natural disasters and current economic challenges. In addition, social programs in Mexico, though valuable, do not show clear signs of being contributing substantially to reduce economic vulnerability. In fact, even if the social policy works correctly in this country—tested further in chapter 4—prevailing entitlements and assets distribution systems seem to reduce their efficacy. Historic unattended social and economic demands continue threatening incomes, especially those in rural areas, whose negative effects can be observed in the increasing emigration tendency of the last years.

As outlined in the discussion on economic policy along this chapter, one has to admit that a country with real development aspirations cannot rely on agriculture to take off its economy. However, if the urban economy fails in providing enough employment to additional workforce arriving from the impoverished countryside, given low dynamism of the national industry—as over the past 20 years in Mexico—, an emerging policy to strength rural assets and manage disasters has to be more actively implemented. A country like Mexico, where a quarter of the national population relies on agricultural activities producing less than 4% of the national product, has to not only upgrade productive infrastructure to increase rural incomes, but also has to manage its disasters and market risk in a more efficient way. Even if hazards threats especially the poorest population, one has to also not misunderstand and label the poor as vulnerable, since population above the poverty line is as vulnerable as the poor: its main risk consists of falling below the poverty line after an extreme hazard.

So far this work has justified the need for investigating natural and economic hazards, and the next chapter attempts at presenting more substantially natural disasters and trade liberalization affectation over the past two decades in this country in order to identify the stakeholders and involved institutions. This chapter’s arguments concerning entitlements and assets and its relevance in shaping coping capacity will be complemented in chapter three, where adaptive capacity is more detailed addressed, assessing the scope of public intervention in social programs and risk management strategy. In general, chapters 2-4 are thought to gradually expand the spectrum of this vulnerability analysis to embrace multiple stressors and hazards’ sequence with a complexity of socioeconomic conditions and biophysical subsystems behind.
Appendix 2.1: The dynamic of economic vulnerability

Is high vulnerability responsible for low adaptability, or low adaptability the reason for high vulnerability? That question is the core of the discussion about how to assess the negative impacts of climatic events. It can be summed up in the following two positions: (1) the vulnerability-adaptability: identifying vulnerability in order to maneuver with adaptability measures; and (2) the adaptability-vulnerability, that is, studying adaptability to understand and further influence vulnerability. In this regard, supporters of the vulnerability-adaptability position (Kelly and Adger 2000, Chambers 1989) emphasize social vulnerability, and consider vulnerability to be causal variable in this relation, where being vulnerable influences the ability of the systems units to cope with external stresses. In this perspective people is considered as risk manager subject to a relative context and restrictions. The adaptability-vulnerability position considers adaptability to be an independent variable explaining vulnerability, where vulnerability is a residual of adaptive capacity after a given climatic event. As in the first position, interdependence between adaptability and vulnerability is present here as well, but the causal force in this case is adaptability. However, which position is right depends rather on at what side of the dichotomy one locates assets and entitlements. As pointed out by Schjolden (2003) when comparing adaptability in Norway and Mozambique, vulnerability and poverty are not equal, and calls for an analysis of adaptability indicators to make them relative to economic and social stressors. She includes assets and entitlements in Vulnerability, falling into Position 1. However, given that adaptive capacity is rather result of coping capacity, as seen in section 2, we have more reasons to associate entitlements and assets with adaptability than with vulnerability itself in this paradigmatic cause-effect relation. if one considers entitlements and assets to be part of adaptability, expanding this concept to embrace coping capacity, one can assess vulnerability in the form expound in this Appendix, making easier to quantify vulnerability.

In this approach, as observed, the level of economic vulnerability to shocks is permanently interacting, and therefore can be modified by means of strengthening or weakening one or more of its constituting elements. Figure 2 is a theoretical illustration of the dynamic of economic vulnerability. As one move from the origin (intersect 0) values on the axis increase, that is, all values on the axis are positive.

The right x-axis of the graphic represents extern shocks, which can be a perturbation or a stress in the form of a natural hazard, a sudden export restriction, etc. The upper y-axis represents the vulnerability level of a given unit of analysis. Extern shocks are independent of the vulnerability level of our unit of analysis, and so, a given extern shock can be corresponded by different levels of vulnerability; Hence, this relation is represented by a vertical line; we term quadrant I the area depicted by these two axes.
Lower y-axis represents the variable *Coping and adaptive capacity* is a function of adaptive (risk management plus protection levels) and coping capacity (entitlements and assets). Coping and adaptive capacity—hence CA—, related with the variable hazards on the right horizontal axis shapes quadrant II. The slope of the respective curve, $R$, is determined by entitlements and assets system; the higher the slope, the less favorable entitlements and assets system to our unit of analysis. Curve R in quadrant II is the relation between unit’s coping and adaptive capacity and hazards, which is a negative function: As hazards increases either severity or frequency, a lower CA level is related with them.
Left x-axis is the economic losses probability inherent to our unit of analysis, and is a variable representing the likelihood of having certain amount of economic losses as a consequence of a given shock affecting our unit given prevailing coping and adaptive capacity. Both CA and the economic losses probability axes shape quadrant III. The relation between CA and probability of economic losses is negative, since as unit’s CA decrease, the presence of economic damages is more likely to occur, represented by curve $L$.

Quadrant IV is depicted by the economic losses probability and axes. In the same way, economic losses probability contributes to increasing vulnerability, thus, the relation vulnerability-economic losses probability is positive$^{13}$.

The graph above illustrates vulnerability relations with an initial equilibrium, where none of the components of vulnerability reduce or increase vulnerability level. So, $V_0$ represents initial level of vulnerability, $S_0$ is the shock occurrence at a given magnitude, whose repercussions upon the unit is absorbed until the level $R_0$, the level the unit is able

$^{13}$ In last instance, the nature of vulnerability as potential event force our analysis to deal with, above all, probability terms.
respond to such a shock magnitude. To this extent, the effects of the shock have explored only unit’s non-monetary elements. Now, the resistance-protection level combined with the probability of economic losses is set at the level $L_0$. Now, curve $V$ reflects finally the combined consequences of the shock upon the system depicting unit’s vulnerability after passing by all its determinants. In this initial example, vulnerability level remains unchanged.

This vulnerability assessment is in line with position 2 described in section 3 above, given that vulnerability is result of a given level of coping and adaptive capacity, and its level can be estimated only derived from a concrete shock – where most vulnerability indexes use to fail. That is also the reason of the present work to prefer holistic to deterministic disasters models, as observed in chapter 6 of this work.

Now, figure 4 below shows the effects of the same shock but in this case the curve $R$, resistance, was displaced downwards (relative to the origin, $0^{14}$). That displacement can be result failures in risk management in a given community, less access to credit for reconstruction, etc. The curve $R'$ posses lower CA values for all shocks compared to $R$. The same shock implies thus a lower resistance-protection level, moving from $R_0$ to $R_1$, corresponding to lower CA levels for all kinds of hazards. Given the relation where reductions in unit’s CA increase the probability of economic losses (from $L_0$ to $L_1$, in this case), the resulting level of vulnerability increases from $V_0$ to $V_1$. The increase in vulnerability is thus the difference $V_1 - V_0$.

The same mechanism applies conversely for a displacement in the opposite direction of $R$. For instance, strengthening an element of the curve $R$ leads to reducing vulnerability levels, other things equal. The aim of the present work consists in identifying strategies that displace out the curve $R$, to thus reduce the probability of economic losses to, in last instance, reduce economic vulnerability. This dynamic will be explored in more detail and quantitatively developed in chapter 6, when modeling the effects of trade liberalization and natural disasters on rural economic vulnerability. If curve $R$ displaces from $R$ to $R''$, the extern shock of figure 4 produces less economic losses than those derived from $R$ and $R'$, given that $L_2 < L_0, L_1$. It leads to reduction in vulnerability relative to that derived from the same shock with lesser coping and adaptive capacity, as the case of $R$ and $R'$, moving down economic vulnerability to $V_2$. In this perspective, vulnerability is determined by CA.

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14 When we say downwards concerning curves displacement, we are keeping the reasoning of a typical x-y graph. Hence, saying downwards means only a move (displace) of the curve approaching zero, the origin.
Figure 4: The dynamic of economic vulnerability after strengthening coping and adaptive capacity

Something similar can be done if one makes improvements to the entitlements and assets system, like for instance increasing units income, access to better infrastructure, less information asymmetry, etc. It would imply changing the slope of R from R to R’, as seen in the graphic below. It reflects the fact that after improving assets and entitlements, the economic agent is better off to face a given hazard\(^{15}\). As observed, with the curve reducing its slope, the same hazard S\(_0\) from figure 2, is smoothed by a higher coping and adaptive capacity level, which compared to the previous state increased from R\(_0\) to R\(_1\). For the given curve of economic losses distribution, it produces a reduction in economic losses, depicted by the reduction of probability of economic losses from L\(_0\) to L\(_1\). Now, this effect reflected on the vulnerability curve represents a reduction in vulnerability level equal to the difference V\(_0\) – V\(_1\). In that way, improving assets and entitlements to our unit of analysis implies strengthening its economic vulnerability for a given hazard.

\(^{15}\) However, as the hazard increases, this capacity reduces approaching the previous levels, R.
Figure 5: The dynamic of economic vulnerability after strengthening entitlements and assets system

As analyzed in this appendix, improving risk management contributes to reducing the probability of economic losses for a given hazard. However, risk management and protection systems have a limit, where additional progress cannot be reached despite increasing investments at a constant rate. For that reason, there is a need to combine adaptability with actions to improve assets and entitlements, that is, with coping capacity. In that sense, reducing vulnerability is not a mere result of adaptability measures to face hazard impact, but implies a more robust strategy dealing with that hazard in a more complex context.
CHAPTER 3: Natural hazards and economic stressors

No cabe duda que es preciso superar el liberalismo del siglo XIX.

ORTEGA Y GASSET, La rebelión de las masas

This chapter explains the mechanism by means of which natural disasters and some past economic policy decisions have turned into hazards in Mexico. Natural disaster occurrence is increasingly producing severe damages to the so-called traditional agriculture, highly exposed to climatic events due to its predominating rainfed cropping practices as well as its high marginalization conditions, which together tend to amplify the negative effects from hazards. In the frame of the economic reforms implemented from the middle of the eighties, trade liberalization has led some economic sectors to increase more remarkably their exposure to international markets. It has been evidenced over the past two decades through prices drop of agricultural grains, the main crop of subsistence farmers. It has undermined their incomes given their limitations to increase neither productivity nor cropping land, as well as their inability to re-orientate production.


Figure 6: Frequency and economic losses from natural disasters in Mexico (1970-2000)

Section 1 describes the historical and spatial distribution of economic losses from natural hazards in Mexico.\textsuperscript{16} Section 2 analyzes the specific weight of natural disasters in the

\textsuperscript{16} It is more detailed analyzed in chapter four, which model it with coping- and adaptability-related variables.
agricultural sector, further discussed in Section 3, which assesses its influence on the poor and on rural-urban emigration in the country. Section 4 discusses the contribution of trade liberalization to increasing economic vulnerability in Mexico, and section five concludes presenting a balance of these hazards in shaping economic vulnerability.

3.1 Historical losses from natural hazards

Like Japan and Central America, the Pacific Cost of Mexico is located at the so-called Circum-Pacific-ring of fire of tectonic activity. Hurricanes are a regular hazard on both the Atlantic and Pacific Costs. Roughly speaking, the South of the country suffers of high floods frequency, whereas the North of droughts and of an ongoing desertification process. Over the past three decades, natural disasters in Mexico have increased both frequency and economic cost (see chart above). However, most that affectation has been due to weather-related disasters, responsible for ca. 80% of economic losses over the period 1980-2005 (see Table 1). As observed in the next section, the weight of hurricanes in total disasters losses is particularly remarkable as it has implied 68% of total losses over the same period.

Table 1: Losses from disasters in Mexico 1980-2005 (Losses in current USD mill)

<table>
<thead>
<tr>
<th>Disaster type</th>
<th>Direct losses</th>
<th>Indirect losses</th>
<th>Total losses</th>
<th>As % of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather</td>
<td>21,887</td>
<td>145</td>
<td>22,032</td>
<td>79</td>
</tr>
<tr>
<td>Geologic</td>
<td>4,044</td>
<td>517</td>
<td>4,561</td>
<td>16</td>
</tr>
<tr>
<td>Human</td>
<td>1,150</td>
<td>134</td>
<td>1,284</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>27,081</td>
<td>796</td>
<td>27,877</td>
<td>100</td>
</tr>
</tbody>
</table>


3.1.1 Hurricane

For its geographic location, Mexico can be hit at the same time by two independent cyclones, namely from the North Atlantic and the North Pacific. Alone between the period 1967-1977 Mexico suffered 57 hurricanes, which caused severe damages in particularly six states in the South of the country (CENAPRED 2001).

These hurricanes have mostly originated in the Caribbean Sea and the Central American Pacific Cost, moving into Mexican territory. Hurricane Paul in 1982 moved over the Pacific from El Salvador and Guatemala, upgraded from tropical storm in these countries to a 100 mph hurricane once in Mexican territory. Hurricane Pauline in 1997

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17 More deeply analyzed in chapter five
18 Over 1,000 fatal victims in Central America.
19 The Southeast of Mexico shares with Central America and Caribbean countries not only the above presented high hurricanes and earthquakes affectation, but also the fact that disaster-vulnerable population is highly poor. Affected population in Mexico are usually located in southeast states, which, like in Central American and Caribbean countries, are subsistence farmers without access to credit, low crop insurance coverage, and work small farms. However, most the times these countries are hit by the same hurricane, relative higher economic losses and calamities occur in Central America and the Caribbean compared to
caused floods and mudslides, whipping up strong waves and currents with devastating effects across the coastline of Oaxaca and Guerrero. Alone in Acapulco it killed over 200 people and caused over US$400 mill to public assets (see Table 2). This region’s uneven topography contributed to flooding and landslides following the hurricane. This calamity evidenced the rapid and wrong projected urbanization process in large coastal cities of the recent years, which has led to increase potential economic and human losses from extreme climatic events.

Table 2: Major hurricanes in Mexico, 1980-2005 (losses in current USD mill)

<table>
<thead>
<tr>
<th>Hurricane</th>
<th>Economic losses*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982</td>
<td>Paul</td>
</tr>
<tr>
<td>1988</td>
<td>Gilbert</td>
</tr>
<tr>
<td>1990</td>
<td>Diana</td>
</tr>
<tr>
<td>1993</td>
<td>Gert</td>
</tr>
<tr>
<td>1995</td>
<td>Opal</td>
</tr>
<tr>
<td>1997</td>
<td>Paulina</td>
</tr>
<tr>
<td>2002</td>
<td>Isidore**</td>
</tr>
<tr>
<td>2005</td>
<td>Emily</td>
</tr>
<tr>
<td>2005</td>
<td>Wilma</td>
</tr>
<tr>
<td>2005</td>
<td>Stan</td>
</tr>
<tr>
<td>Losses 1980-2000</td>
<td>18,968</td>
</tr>
</tbody>
</table>

* Period 1980-2000 are estimates of losses to exclusively public assets.
**Losses estimated at 50% total economic losses reported from Guy Carpenter in Mexico and the USA from Isidore, and in Central America and Mexico from Stan.

The 2005 hurricane season

Munich Re said the 2005 hurricane season to be the most costly of all time (MunichRe 2005). In turn, Mexico got severely damaged by hurricanes in that season, particularly on the Peninsula of Yucatan, where hurricanes Emily, Wilma and Stan hit within 3 months. Damages from Emily and Wilma accrued to mainly the tourist sector, whereas Stan hit mainly the poor in both urban and rural areas.

Emily made landfall on the Yucatan Peninsula on 18 July, provoking the evacuation of around 130,000 tourists from luxury beachfront hotels in the resort city of Cancun. The storm produced heavy rains and winds, demolishing buildings, triggering floods and affecting especially the tourism. Almost 3 months after, hurricane Wilma destroyed thousands of homes and hotels and flooded luxury hotels and resorts (Guy Carpenter 2006), whose economic losses were five fold higher than those from Emily, becoming Mexico’s ever most costly hurricane (see table above).
In October 2005, hurricane Stan passed over the Peninsula of Yucatan, but derived climatic events caused dramatic human and economic losses rather hundreds of kilometers to the South in especially marginalized areas. Hurricane Stan itself was not as damaging as its derived strong winds, floodings and mudslides on Chiapas, Oaxaca and Veracruz, killing 42 people and destroying assets of over one million of people, exceeding USD 1.5 billion in direct losses. In Guatemala the magnitude of Stan was higher in terms of human fatalities (1,400 dead), but lesser in economic losses, ca. USD 1 billion

3.1.2 Floods
Whereas flooding caused by rivers overflowing their banks occurs almost every year in Mexico (especially in summer time), flooding from heavy rainfall occur permanently, causing erosion, landslides, and severe damage to housing, agriculture, livestock and public infrastructure. This section comprises river overflowing and heavy rainfalls only as they are cause of flooding. Flooding is naturally less frequent in semi-arid regions, but however it can be particularly devastating when it does occur there.

Heavy rains alone rarely cause floods. Soil erosion caused by deforestation, inadequate agricultural practices, and increasing urbanization contribute to increasing the floods risk. Despite considerable invest in drainage infrastructure, Mexico City experience losses every year from flash flooding.

The occurrence of flooding is increasing in recently urbanized plain areas as change in land use broaden the capture of rainfall, producing flows that the natural basin cannot cope with. The loss from flooding in Mexico has been high. Alone between 1970 and 1990 more than 1,800 people died and about USD $7.7 billion in economic losses are estimated to be incurred (Gutierrez 1998) from over 1,000 floods events in Mexico.

In September 1998, floods and landslides strike Chiapas, turning into the worst disaster in Mexico after the 1985 earthquake. It devastated huge extensions in costal areas, and left some 800,000 people homeless (25% of Chiapas population), and caused more than 200 deaths. The most immediate problem was to reach the (isolated) areas affected for the flooding to provide aid relief and reconstruction to rehabilitate destroyed transport and telecommunication infrastructure. Other Mexican states affected by the torrential rain were Guerrero, Morelos, Oaxaca, Guanajuato and Nayarit, and they are also considered highly prone zones to landslides.

3.1.3 Earthquake
Historically, a number of large earthquakes have occurred within the Trans-Mexico Volcanic Belt, located approximately at 20° N latitude. This area runs from west to east, and its high tectonic activity is accompanied of active volcanic and faulting. Some of the largest earthquakes in recent history –like the 8.1 and 8.0 Richter degrees Michoacan and

20 However, losses in Mexico compared to national GDP are equivalent to 0.002%, while in Guatemala it reached 3.5% of GDP.
21 As in the arid region of Monterrey in 1998 (CENAPRED 2001).
22 With data from La Red.
Colima earthquakes in 1985 and 1995, respectively—originated in this region and spread across the Pacific coast (Currie et al. 2001).

Most seismic activity in Mexico is related to the active tectonic boundaries between the North America and the Pacific and Cocos plates (Currie et al. 2001, Bitrán 2001). A northern boundary that accommodates friction between the North America and Pacific plates runs beneath the Gulf of California and runs southward parallel to the Pacific coast of Mexico (WB-Guy Carpenter 2000). This area is part of the called *circum-Pacific Ring of Fire*, which draws a circle along Eastern Oceania’s Islands, Asian Pacific, and North and Central American Pacific costs.

Other significant earthquakes in the recent times have been originated in this area as well, like in January 30, 1973 (magnitude 7.5), November 29, 1978 (magnitude 7.8), March 14, 1979 (magnitude 7.6) and September 19, 1985 (magnitude 8.1) (CENAPRED 2000). In general, these earthquakes’ epicenters are located on seismic gaps, that is, on places where at least one strong earthquake has stunned in the past, but where no earthquake has taken place for a long time (John A. Martin 1988, WB-Guy Carpenter-IIASA 2000).

![Figure 7: Seismic map of Mexico. Primary source: CENAPRED, Ministry of the Interior of Mexico](image-url)

**Michoacan (or Mexico City) Earthquake**

As observed in Figure 7, CENAPRED has elaborated a Seismic Map of Mexico based on historic registers of major earthquakes in Mexico and on data of terrain acceleration from major earthquakes. The map shows four zones: Zone A represents areas without seismic activity over the last 80 years, which terrain acceleration is expected to keep fewer than 10%. Zone D is the area with high earthquake frequency, and its acceleration exceeds 70%. Zones B and C are mid-intensity regions.
Table 3: Earthquakes in Mexico 1980-2001 (losses in current USD mill)

<table>
<thead>
<tr>
<th>Earthquake</th>
<th>Dead</th>
<th>Direct losses</th>
<th>Indirect losses</th>
<th>Total losses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mexico City 1985</td>
<td>6,000</td>
<td>3,589</td>
<td>515</td>
<td>4,104</td>
</tr>
<tr>
<td>Colima 1995</td>
<td>0</td>
<td>21.1</td>
<td>-</td>
<td>21</td>
</tr>
<tr>
<td>Oaxaca, Puebla and Morelos, June 1999</td>
<td>15</td>
<td>151</td>
<td>0</td>
<td>151</td>
</tr>
<tr>
<td>Oaxaca, September 1999</td>
<td>35</td>
<td>153.6</td>
<td>1.4</td>
<td>155</td>
</tr>
<tr>
<td>Guerrero 2001</td>
<td>0</td>
<td>2.9</td>
<td>-</td>
<td>3</td>
</tr>
</tbody>
</table>

Data from CENAPRED (2001), Ministry of the Interior, Mexico.

In 1985, the Michoacan Earthquake caused severe damage and collapse of high-rise construction in Mexico City (located on Zone B) even despite its long distance from the epicenter. It is said to be so due to the fact that the period of vibration of deep lacustrine soils beneath Mexico City coincided with the fundamental period of many high-rise buildings (Singh and Suárez, 1987). This earthquake produced US$ 4, 104 in economic losses, the most costly earthquake during the analyzed period (see Table 3). This event generated relevant social and politic changes in some cases, and accelerated other existing ones (see box 1). Derived from a natural hazards survey from the World Bank, IIASA and Guy Carpenter of 2000, Mexico can expect a 6.5 Richter degree or greater earthquakes every two years, a magnitude 7.0 or greater about every two years, and a magnitude 8.0 or grater about every 33 years (WB-Guy Carpenter 2000).

Box 3.I: Political changes after 1985: triggered or catalyzed by the Michoacan Earthquake?

The 1985 Michoacan earthquake in Mexico City caused 89% of total geologic losses over the period 1980-1999 (over 4 US billion, ECLAC, CENAPRED 2001), and is considered point of break in Mexico’s recent history. Some authors affirms this amount could be imprecise, since original estimations of the Mexican government overinflated damage figures up to US$6bn as a lever to relax IMF conditions for reconstruction loans (Albala-Bertrand 1993:140, Proceso 1985). ECLAC estimates were more conservative (US$ 4.1bn.), but it was estimated based on officials losses assessments. By contrary, these authors presume the number of deaths to have been underestimated in order to avoid the army of undertaking the emergency control, as stated in Mexican law* (Castillo 1985). After the students’ genocide in 1968 in the Three Cultures Square in Mexico City, military intervention is believed to irritate civil society in Mexico, which had put additional tension to the disaster.

This earthquake undermined the image of the Federal government as warrant of national security in the country due to the delay and badly coordinated response (Monsivais 1987), as well as due to the governmental corruption evidenced through constructions approved by the authority despite not fulfilling buildings codes requirements (Castillo 1985, Ramírez 2005). Since this disaster, corruption started to be perceived in this
country beyond the economic burden and the public moral issue it is, but also as factor of risk to citizens’ life. The insufficient governmental preparedness and response to this disaster led the civil society to undertake rescue, cleaning up, and relief operations (Ramírez 2005, Monsivais 1987). It generated a collective feeling of absent state and led to crucial political transformations.

The political cost of such insufficient response was paid in the upcoming national elections in 1988. Most likely influenced by these events, the hegemonic PRI - the ruling party since 1929-, split. Corriente Democratica, an intern organization of PRI, joint the leftist PSUM party, which obtained a gigantic electoral triumph in 1988, which included dozens of seats in the federal congress and municipal governments (Rosenblueth 1991), and perhaps the presidency of the republic as well. PRI is widespread suspected of committed electoral fraud through the electronic votes counting system (Proceso 2003). In any case, that political change proved having contributed to the fast electoral growth of the opposition in the oncoming years as the congress reached a real multiparty representation six year later, leaving behind the one-party political system of the previous six decades.

Natural-social stunning events
Over 50% of Zone A (most prone to earthquakes) is located along Mexico’s poorest states: Oaxaca, Chiapas and Guerrero (see Figure 7), recurrently hit by hurricanes and floods as well. These states are historically characterized by having Mexico’s lowest per capita income, highest illiteracy rates, and worst health facilities in Mexico. Coincidently, all Guerrilla movements after the Mexican Revolution of 1910 have popped up on precisely these three states, i.e. Lucio Cabañas Guerrilla in Guerrero during the 1970s, EZLN Ejercito Zapatista de Liberacion Nacional in Chiapas since 1994, and EPR Ejercito Popular Revolucionario and ERPI Ejercito Revolucionario del Pueblo Insurgente in Guerrero and Oaxaca from 1995.

3.1.4 Volcanoes
As a result of the collision between the North America and the Pacific and Cocos plates, dozens of volcanoes are distributed along Mexican territory, but especially on the Trans-Mexico Volcanic Belt (Cordillera Neovolcánica, see 7), which defines the geomorphologic boundary between North and Central America.23 In fact, 14 of these volcanoes have erupted in recent history.

Chichonal
The most recent volcano eruption that resulted in catastrophic losses in Mexico was El Chichonal (State of Chiapas) in 1982, which completely destroyed eight communities and claimed 2,000 lives. The eruption lasted nearly six hours and caused severe damages to crops, cattle, and cultivable land within a 50-kilometer radius (Gutierrez 1998).

* Plan DN-III-E, Art. 42, Ley Orgánica del Ejército y Fuerza Aérea Mexicanos.
23 In geomorphologic terms, the Trans-Mexico Volcanic Belt defines the boundary between the North American Rocky Mountains-Sierra Madre Occidental system, and the Mesoamerican Sierra Madre del Sur- Sierra Madre de Chiapas.
Popocatepetl
Between 1993 and 1998, volcanoes Popocatepetl, Colima, Tacaná, and Everman have registered activity. According to seismographers from the National Autonomous University of Mexico (UNAM), a major eruption of Popocatepetl would affect thousands of people in settlements within a 20-30 kilometer radius (CENAPRED 2002). This volcano is being carefully monitored for preparedness sake, including evacuation measures for communities in the vulnerable area.24

3.1.5 Droughts
In Mexico only around 20% of harvested hectares is irrigated (ECLAC 2006, INEGI 2004). This fact reveals a high dependence of agricultural production from meteorological phenomena. Lack of water in form of droughts, forest fires, and high temperatures damaged over 36 million of crops hectares over the period 1970-2002 (Garcia and De la Parra 2002), which means 18 times total cultivated surface in Mexico in 2002. Alone in the 1980s, economic losses from droughts reached US$1.2 billion (CENAPRED 2001).

Weather dependence of agriculture
The graphic below shows the distribution of 6, 296 disasters (natural and anthropogenic) in Mexico occurred over the period 1970-2001. Over one third of them are events caused by excess of water (floods, heavy rains, storms, hurricane, etc., 2,208 reports), whereas lack of water represented 18% of total events. Floods are the most frequently reported event (blue bar, over 1,112 reports), followed by fires (828 reports) and frosts (407)25.

Although other natural disasters have damaged less spectacularly, they have been more frequent.26 Frost is the kind of phenomena which have damaged agriculture more permanently, accumulating MX$95, 910 million over the period 1979-1988, followed by hailstorms (MX$30,153 million) (CENAPRED 2001).

3.2 Hazard exposure of agriculture
Macroeconomic analyses tend to ignore crucial impacts of natural disasters on the economy. Though the agricultural sector in Mexico is small sector in GDP terms (4%, compared to 68% from services, 28% from industry27), this sector employs 68% of the population in extreme and moderate poverty in rural areas.28 Moreover, the Mexican

24 In large cities –such as Puebla, Cuernavaca, and Mexico City, over 40 kilometers away from Popocatepetl–, the effects of an eruption are likely to be limited to falling volcanic ash.
25 This data basis has been created by Desinventar (DesenRedando, La Red, Mexico, 2003) by collecting reports from media, especially from three Newspapers for the Mexican case: El Universal, La Jornada, and Excelsior. Given that fact, data arising from Desinventar must to be carefully employed, since in detailed analysis some data may be incomplete, leading to either over- or underestimate losses due to its journalist nature. However, it is helpful to get general pictures of disasters. It also provides good approaches on magnitudes and disaster frequency. Amount of losses are still controversial, since they vary widely from observation to observation, and rarely coincide with other sources.
26 In fact, most the increase in weather-related disasters may be linked to El Niño phenomena (Vatsa & Krimgold 2000: 131, CENAPRED 2001: 145)
27 Instituto Nacional de Estadística, Geografía e Informática (INEGI), Aguascalientes, Mexico.
28 Country assistance strategy of the World Bank Group for the Mexican United States, 2002
agriculture is highly vulnerable to weather-related disasters given current levels of rainfed agriculture. The 82 major weather-related events that have struck between 1980 and 2002 have damaged mostly agriculture disrupting rural incomes, as discussed across this section.

![Figure 8: Disasters in Mexico 1970-2000 by kind of event](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAAfAAAAAHCAYAAABsR0GkAAAAGXRFWHRTb2Z0d2FyZQBBZG9iZSBJbWFnZVJlYWR5ccllPAAAAyJpVFh0WE1MOmNvbS5hZG9iZS54bXAAAAAAADw/eHBhY2tldCBiZWdpbj0i77u/IiBpZD0iVzVN ME1iR0NODmlESG1S本事0iVzVdNamYlM0NDExNkZjInkiPziB2MS8/6gAAAASURBVAwWgBAMH2wBzBwM9BxgCgjQAOAOGA+gAAAAABJRU5ErkJggg==)


Every time a hurricane strikes, over 70% of total damages are located in agriculture. Thanks to reports from La Red (2003), we know that natural disasters affectation in agriculture over the past 35 years has affected mostly assets of poor and extreme poor farmers.

- In 1982, Hurricane Paul and floods caused MXS7.4 millions in direct losses to the agriculture, equal to 70% of total losses from this event.
- Floods in 1985 hit Mexico, and 85% of total losses were located in agriculture, damaging especially crops. In the same year, heavy rains caused losses at MXS$4,177 mill, 97% in agriculture (infrastructure and crops).
- In 1988, Hurricane Gilbert hit severely Peninsula of Yucatan and North-eastern Mexico, damaging the whole local economy. Losses in agriculture sector were especially acute, since it meant 86% of total losses (US $ 65 mill.). Along the
same year, three more hurricanes hit Mexico causing economic losses to crops

- Hurricane Paulina hit Oaxaca and Chiapas (the poorest Mexican states) in 1997,
  sparking off severe damages on the whole economic activity and housing, but
  88% of total losses are in agriculture and livestock.

- Agricultural losses from climatic events repeated in 1998 in these two states
  again, though more dramatically in Chiapas. Heavy rains caused landslides and
  avalanches from the southern mountains of Chiapas to the coast. This disaster
  buried dozens of communities, destroyed 712 Km of asphalted roads and over
  50% of rural roads of the state (3,600 Km.), 22 bridges, etc. Over 25% of total
  infrastructure of Chiapas was totally destroyed. Losses reached US $ 603 mill, too
  high for a poor state.29

- By 1999, heavy rains continued damaging agriculture in Southern Mexico.
  Several poor communities in the states of Puebla, Veracruz and Tabasco were
  severely affected by heavy rains. Inhabitants of these communities survive
  historically of agricultural activities, and 66% of total losses from these heavy
  rains accrued to rural infrastructure and crops of small-scale producers
  (MX$1,767 mill.).

3.3 Relative vulnerability of the poor

Though being poor does not necessarily imply being vulnerable, but poverty makes
individuals relatively more vulnerable to a given hazard. People worldwide living in
adverse economic conditions is less able to invest in all items, including those to manage
risk and increase disasters protection. Developing countries have historically been more
severely damaged compared to developed countries (Benson & Clay 2002: 11). On the
one hand, total economic losses tend to be higher in rich countries in absolute terms, but
compared to economy value, losses are much higher in developing countries (i.e.
Freeman and Mechler 2001). A given natural hazard with identical intensity can hit in
different degree two distinct countries. Differences in civil protection system, health
facilities and public financial ability (i.e. for reconstruction) make countries to absorb
hazards differently. For instance, the same hurricane hit the Dominican Republic and
Haiti in 2004, but it caused economic losses five fold higher in Haiti. Though both are
developing countries, but at different development stages. As Cannon (1994: 24-26)
points out, what turns a natural hazard into a disaster is not simply a question of money,
but also of economic and political system. The way countries structure societies
determines that similar hazard lead to very different impacts among societies.

3.3.1 Coping capacity of the poor

Given current entitlements, the poor is the most prone stratum to suffer of natural
disasters, especially in developing countries. The distribution of human assets in many
developing countries reveals high inequity. The most productive and safe terrains belong
to middle- and upper classes, whereas less productive and/or unsafe areas were left to the
poor. Most of the victims of Guatemala’s Earthquake in 1976 were poor (23,000 deaths),

29 Losses reached 9.3% of Chiapas GDP in 1998.
who lived in ravines and gorges, areas very prone to disaster in case of earthquake or
landslides. The river Oder, which divides Germany from Poland, overflowed in 1997
producing severe floods. Lack of maintenance of dykes and flood defenses, together with
poor people living along the river in the polish side, produced disgracefully notoriously
higher damages there than at the German side (Vatsa & Krimgold 2000). That reveals, on
the one hand, budgetary differences to mitigate disasters between these countries. On the
other hand, it reflects differences in living conditions within population in these countries
as in both countries assets of lower incomes people got more affected. Additional
evidence in the same way is found in Honduras with hurricane Mitch (Vatsa & Krimgold
2000), El Salvador Earthquake in 1986 (ECLAC 1986), Dominican Republic with
hurricane Georges (Butterfield 1998), the United States of America when hurricane
Kathrina hit in 2005 (O’Brien 2005), among others.

3.3.2 High losses-high adaptability regions versus high losses-low adaptability

As discussed in section 1.1, hurricanes Wilma and Stan affected the Yucatan
Peninsula and Chiapas in 2005, with relatively higher damage to assets of the poor.
Economic losses from Wilma exceeded USD 15,000 mill, while those from Stan in
Chiapas were at USD 3 mill. However, the adaptive capacity of affected population from
Wilma in Yucatan proved to be much higher, where over 50% were insured losses (Guy
Carpenter 2006). It was so especially due to the fact that most losses from Wilma took
place in Cancun, damaging luxury hotels and resorts. By contrast, losses derived from
Stan were totally uninsured, affecting basically assets of the poor both in marginalized
slums in urban areas (i.e. Las Americas in Tapachula) and in subsistence farmers regions
(i.e. Escuintla, Mapastepec, Cacahoatan). Facts like that is the motivation to assess
coping and adaptive capacity in that region, presented in Chapter 5 derived from a
fieldwork of the author to these municipalities in 2005.

3.3.3 Spatial distribution of agricultural losses

The map below plots 1,372 reported events on agriculture affectation in Mexico over the
period 1970-2001. The map is divided in states, and colors represent ranges of damages.
As observed, the most damaged state is Chiapas, followed by Oaxaca and Yucatan (in the
South), Mexico and Guanajuato (Center), and Jalisco, Tamaulipas, Sonora and Sinaloa
(North). Chapter 6 overlaps disaster affectation maps with distribution maps of income,
marginization and access to risk management instruments, showing that the South is
relatively the most vulnerable region in the country.

At a first sight, economic losses from natural disasters seem to be similar across the
national territory, but it produced dramatic effects on marginalized regions without access
to risk management instruments in mostly rural areas. Though the 1985 Michoacan
earthquake is considered Mexico’s all time most dramatic earthquake -losses reached
2.17% of GDP in year 1985-, but the huge differences in coping and adaptive capacity
between Mexico City and Chiapas has made the latter to absorb much more negatively
past hazards. The 2003 poverty report issued by the Mexican government points out that
Chiapas is now the poorest state of Mexico, both in terms of GDP per capita as well as in
social indicators. In addition, the development gap between Chiapas and the other states
of Mexico is continuously enlarging. Thus, the relevance of natural disasters lies on the
fact that they do not hit significantly upon the whole economy, but to the agricultural sector in highly marginalized regions with low coping and adaptive capacity. These hypotheses are quantitatively tested through the spatial econometric model presented in Chapter 6 of this dissertation.

![Figure 9: Damaged hectares due to natural disasters in Mexico by state (1970-2000)](image)


### 3.3.4 Emigration as response to disasters vulnerability in rural areas

Given adverse entitlements system and assets distribution, natural disasters affectation in the Mexican countryside tends to exceed rural coping and adaptive capacity and so to terminate rural livelihoods, triggering domestic rural-urban and abroad emigration. As an efficient strategy for agriculture and rural areas was not successfully undertaken during the 80's—discussed in chapter 2 and further in 4 and 5—, these rural workers have been migrating massively to especially large domestic cities, i.e. Mexico City, Monterrey, Guadalajara, and Tijuana, building irregular settlements (mostly slums) on areas very prone to natural disasters as well. Out migration from Mexico to other countries has increased over the past two decades. The Population Census of 1990 reports that 0.24% of Mexican population was residing abroad, whereas in the 2000 Census this figure rose to 0.41% (INEGI 2005).
3.3.4.1 Domestic migratory flows
In Mexico City, the most disaster-prone areas are populated by the poor. Socio-economic maps of Mexico City show the poor located along an area going from Southeast to Northwest, wide in the South and narrower as moving northwards (INEGI 2006), exactly on very prone areas to natural disasters, whereas richest areas run from Southeast to Northeast, that is, on the less prone areas to disasters. Figure 10 below relates zones at high risk to earthquake in Mexico City and slums location. Violet color represents areas whose underneath is the lake Tenochtitlán.

![Figure 10: Earthquake risk in Mexico City and slums distribution](image)
With data from CENAPRED and INEGI

The severe damage and collapse historically experimented on this area has occurred due to the accelerating vibration of deep soils beneath (resonance effect), as in 1985 when the Michoacan earthquake hit Mexico City. In red circles are represented slums and very poor areas, which are mostly located upon this high-risk area.

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30 Experts on demography use to name this socio-economic distribution as The Bell of Income, due to its geographic shape: poor from south-west to the north, each time narrower; rich from north to south-east, each time wider; and a mixture of middle, high and low income in the middle.
The nature of the Mexican economy is dualistic, since in general terms exists a modern urban capitalist sector geared toward capital-intensive of large-scale production, coexisting with a traditional rural subsistence sector geared toward labor-intensive of small-scale production. In the same way, this dualism is observed in the urban economy, which is divided into formal and informal sector. In Mexico, estimated share of urban labor force in the informal sector is 57%, and slums as percentage of population in Mexico City is reckoned to be 46 (ECLAC 2003a). This city concentrates over 20 millions people, the world second largest city in terms of population (after Tokyo, 26 mill.), and the world largest in terms of surface (4,986 km²) –INEGI 2005.

3.3.4.2 International migratory flows
About one-quarter of Mexico’s labor force is still employed in agriculture, and as conditions in the countryside continue to worse, rural workers do not have incentives to stop out migration not only to urban Mexico, but also to urban and rural USA (Robinson et al 1995). Mexico is the first country of origin of migrants to the USA, where nowadays 1 out of 3 migrants was born in Mexico, integrating the first majority migrating community in the USA as well as in 31 of the 50 states of the American Union (Center of Migration Studies of Washington 2003, US Census Bureau 2002).

3.4 Trade liberalization
In the previous sections was discussed the relevance of natural hazards to the agricultural sector and in turn to the rural poor in Mexico. This section discusses basic concepts leading to understand why trade liberalization turns into a hazard despite its high expectations of becoming source of benefits for even subsistence farmers. It presents, as well, empirical evidence of the increasing imports trend and decreasing agricultural prices undermining rural incomes.

3.4.1 Globalization and regionalization
Before starting explaining trade liberalization, let us clarify some key concepts lying behind, like globalization and regional markets. The idea of globalization can be first understood by simply language interpretation. Global is an adjective implying the earth globe. The dimensions of globalization are still polemic. Some authors opt to include only visible measurable aspects into the globalization concept, like flows of trade, capital and people across the globe. Others denote in addition a stretching of social relations and activities across regions and frontiers, implying cultural and symbolic dimensions (Held and McGrew 2000). In turn, these broader concepts use to include achievements of institutions and organizations of the international community dealing with global shared

31 15.6 millions People live alone in Distrito Federal, plus 5.1 in neighbour municipalities, which have been integrated to the metropolis. Sources: World Resources Institute 1996-1997: The urban environmental (New York: Oxford University Press) tab. 1.1; United Nations, World Urbanization Prospects. See Appendix B for income distribution.

32 A frequent questioning to globalization is about its innovation. Hellainer (1997) considers globalization to be not only a phenomenon of the modern age, but placed in the context of secular trend of world historical development. So, one can find similar globalization patterns connecting the second half of the 19th century (Victorian era of the English empire, la belle époque in France), with the Spanish colonialism in the centuries 17th and 18th (i.e. Galeon Manila-Acapulco-Cadiz) and even with the ancient Silk Route.
knowledge (i.e. UNESCO), international aid (i.e. Red Cross, Medecins Sans Frontiers, etc.), and even going beyond by including scopes from rather modern multilateralism (i.e. UNO, NATO, APEC, etc.). However, we prefer to limit this concept to just include trade, capital and people for this work’s sake. Some arguments criticize the spatial validity of denoting globalization the current stage of world economic integration, opting instead to call it regionalization. Castells (1996) points out that the world is rather passing by an increase in interregional relations. In terms of merely trade, the case of Mexico is more in line with that view.

Despite the current trade agreements between Mexico and over 40 countries, Mexican foreign trade continues very concentrated with USA. These trade agreements include the North America Free Trade Agreement (NAFTA), the Mexico-European Union Free Trade Agreement (MEUFTA), and the Mexico-Central America Free Trade Agreement (MCAFTA), among others. In addition, Mexico is member of the World Trade Organization (WTO) since 1986 (GATT that time) and is preparing negotiations for expanding trade agreements to the rest of the American continent by means of the FTAA (Free Trade Agreement of the Americas). For that reason, Mexico is usually considered one of the most opened world economies. However, ca. 90% of Mexican foreign trade value is concentrated with exclusively the USA (Saldana 2002). Beyond trade, other productive factors are highly concentrated with the USA as well, i.e. labor move and foreign direct investment. That fact is understandable if one looks at the relevance geographic aspects posses in factors mobility, what in turn seems to be the main limit of Mexico for going global.

3.4.2 Growing share of foreign trade in the economy

As the share value of the foreign trade compared to the whole value of the economy (GDP) increases, economies like the Mexican become more exposed to extern factors. Foreign trade expansion is conventionally said to have a positive effect on the economy as a whole (Franker and Romer 1999), especially when boosting exports (Micco and Perez 2001). Also, when foreign trade growths faster than the sum of the other components of the economy (consumption, investment and public sector expenditure), foreign trade becomes relatively more important in a weighted appreciation of the economy. Given that foreign trade is subject to international market fluctuations, which at a large extent volatize out of the scope of domestic measures, the country's exposure increases (Briguglio 2002), and small-scale economic agents turn into mere price takers.

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33 A conventionally admitted aspect of globalization is its growing magnitude or intensity of global flows such that states and societies become increasingly inserted in world systems and in networks of interaction based on continuously improving communications facilities.

34 In terms of flows of people (legal and illegal), the trend is very similar too. Unlike some negligible programs on temporary work, Mexico has not signed trans-boundary labor agreements with the USA, and despite that fact, over 90% of international emigration goes to that country.

35 Quiroz (2002) reckons that 60% of foreign direct investment in Mexico arose from the USA in 1995—the rest from Germany (5%), Japan (4.5%), etc. There is a widespread critic on the fact that most FDI in Mexico is comprised of investments of multinational companies in their existing branches in Mexico, rather than of new business implementation and incorporating new economic agents to the benefits of foreign trade (Dussel 2000). In addition, capital and exports concentration in very few hands is taking place after started trade liberalization in this country (Saldana 2002).
without much ability to influence on international prices. In this regard, the size of foreign trade of Mexico (exports plus imports) compared to GDP shifted from 43% before NAFTA implementation (1993) to 98% six years later (using data from INEGI 2000). It has stressed the Mexican agriculture as the rise of grains imports from the USA has led to lower prices.

3.4.3 Negative terms of trade
Another stressor to the countryside is the negative Terms of Trade both of the whole agricultural sector as well as of most crops within that sector. Incomes from exports depends both on the volume of these exports sold abroad and also on the price paid for them. The ratio between the price of a typical unit of exports and the price of a typical unit of imports is called commodity Terms of Trade. If the price of the country’s exports are falling relatively to the price of the products it imports, it should either to sell that much more of its export product (enlisting more of its scarce productive resources) or to contract debt at the amount of the net loss, merely to keep constant imported goods purchased in the past. When it succeeds, commodity terms of trade are said to deteriorate for a country. Todaro (2000: 466) conducted empirical studies about it, which suggest that relative primary-products prices have declined to manufacture goods at world level during the XX century. Between 1977 and 1994 the prices of non-oil primary products relative to those of exported manufactured declined by almost 60%. For reasons like that, countries depending on primary commodities to exports must sell greater quantities in order to purchase a given quantity of imports (generally manufactures). Given that in the short-run a quick expand of exports is usually not possible due to existing duties and other barriers to penetrate foreign markets, export amounts change only moderately, and in consequence a net loss from foreign trade appears necessarily in this kind of countries. Especially high is this risk for mono-crop countries. As Benson and Clay (2002: 23) point out, mono-crop regions must face vulnerability from not only natural disasters, but also those associated to world trade uncertainty due to non-diversified export products of primary commodities. In addition, the Prebisch-Singer thesis (Prebish 1950, Singer 1950) argues that there was and would continue to be a secular decline in the terms of trade of primary-commodity exporters due to a combination of low income and price-elasticity of demand. This decline resulted in a long-term transfer of income from poor to rich countries, says Prebisch, which could only be combated by protecting domestic manufactures industries through the so-called process of import substitution.

In order to reduce the vulnerability associated to negative terms of trade, the Mexican economy opted for reducing the ratio agricultural/industrial products. Roughly speaking, between 1945 and 1975 the Mexican economy applied a model of import substitution, but it was no longer sustainable due to self limits of the model as well as to world context. However, the Mexican economy has been conducting efforts towards vulnerability reduction by improving terms of trade. By 1974, Mexico has joined the ranks of the new industrialized countries (NIC’s), with manufactured goods representing over 50% of total exports and agricultural goods falling back to 39% -and to 4% in 2002. In addition, whereas oil exports represented 75% of Mexico’s foreign exchange earnings in 1980, by 2000 this percentage was reduced to only 18%, decreasing thus vulnerability to sudden oil prices reductions. It is true that vulnerability to negative terms of trade was reduced,
but the traditional rural economy increased later its vulnerability to imports due to trade liberalization, increasing natural hazards affectation, and the dismantling of public companies aimed at supporting adaptive capacity in the agricultural sector.

3.4.4 NAFTA and agriculture
Despite surprisingly significant increases in exports due to signed trade agreements, its gains have been unequally distributed in Mexico, whereas agricultural imports (mostly grains) have contributed to drive farmers out of business. It is so partly because of *per se* asymmetries in the country, and partly because of a public planning that has ignored (or underestimated) some crucial elements of the country’s vulnerability.

It might be risky to provide a judgment on the gains and losses of trade liberalization as a whole to the Mexican economy. Just 11 months after initiated NAFTA, a dramatic economic crisis hit the Mexican economy, making it hard to disentangle the effects of the trade agreement on the economy from other factors.

The impact of trade liberalization on the Mexican agriculture has received a lot of criticism even prior to the NAFTA implementation in 1994 (i.e. Calva 2004, Baffes 1998, Levy and Van Wijnbergen 1994, Burshifer et al 1992), as well as more positive judgments from others (see Serra 1993, Lederman et al 2003, Yunez-Naude and Barceinas 2003). It has also become a very controversial point in the Mexican political arena, especially regarding the liberalization of certain sensitive products for Mexico implemented from last January 2003 on due to its associated effects on small-scale farmers.

3.4.5 Unfair trade
The exposure to foreign markets volatility discussed in the previous section seems to be not as damaging as trade unfairness. Trade unfairness is driven mainly by trade partner countries, but it is influenced by domestic factors as well.

3.4.5.1 High subsidies in trade partner countries
There is an increasing pressure from the Mexican poorest farmers to force developed countries to make fair trade. Fare trade is focused on cutting back on subsidies in order to reduce damage they inflict on depressing prices and, in turn, on the income of poor Mexican farmers. By 2002, over 90% of total foreign trade of Mexico was held with the United States and the European Union. Farmers from these countries have gotten more than US$ 300 billion in subsidies every year, which allows industrial-size farms to produce more hectares of crops than needed for domestic consumption, and exceeding production is sold overseas at prices far below the international benchmark price (Saldana 2003). Usually, that exceeding production from rich and developed countries is big enough to drag down the world price of the commodity. On the one hand, farmers in developing countries like Mexico cannot compete with cheap imports, and in the other hand they cannot compete in foreign markets given depressed world price of the commodity. So, they loose both in domestic markets and have little chance of exporting. If one adds this problematic to the negative terms of trade of primary goods, one can
realize the adverse trade conditions farmers should cope with—not only from Mexico, but also from most developing countries.

High subsidies for agricultural producers from Mexico’s main trade partners make Mexican small farmers more vulnerable to imports rise. Small-farmers' discontent is growing in all developing countries. Not only Mexican farmers participated actively in the demonstrations against unfair trade at the Ministers Meeting of the World Trade Organization on September 2003 in Cancun, but also farmers from over 30 developing countries. More important, ministers of trade from most of these developing countries at the WTO have started supporting that discontent, and disagreed with moving towards a global liberalized trade in other industries (Round of Doha) as long as developed countries (centered in basically the USA, Canada, EU, and Japan) do not lift high agricultural subsidies. After the experience in Cancun, that discontent has become so generalized that forced the EU Commission, with its conditions, to negotiate with other blocks of industrialized countries an eventual subsidies reduction.

3.4.5.2 Domestic unfairness
Though the external framework and international trade legislation are crucial to define foreign agricultural trade, domestic factors might also become decisive. Macroeconomic stability plays a key role in agricultural vulnerability as well. For instance, Yuñez-Naude (2002) shows that a substantial share of the variations of domestic agricultural prices during 1980-1999 in Mexico were due to rather sudden exchange-rate fluctuations.

In addition to high subsidies, there is also an increasing discontent in Mexican agricultural producers because of dumping practices, smuggling, and trade triangulation. It contributes to increase imports, to depress prices, and, in last instance, to drive Mexican agricultural producers out of business, contributing to poverty and inequity in the countryside.

3.4.6 Increasing imports, decreasing prices in the agricultural sector
Overall, Mexican agricultural trade of balance has a deficit (see chart below), which may be greater if one could integrate smuggling into. After 1995, both agricultural imports and exports increased, but a slight deficit has been permanent. Most the increase in agricultural imports is due to grains, historically produced by subsistence farmers with low yields, and much more efficiently produced in the USA at lower cost. It has led to increase imports biased to grains, with a consequent impact in reducing mean crops prices.

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36 Trade triangulation is considered a kind of documented smuggling, since it consists of importing merchandise from a non-NAFTA country, but presenting false purchase bills from a NAFTA area country in order to get the tariff exemption agreed in NAFTA.
Prices drop of agricultural grains explains over 60% of the tendency observed in Figure 12 below. It is crucial given that grains like maize, beans and rice are the main crops of most subsistence farmers in this country (ECLAC 2003a, 2001a, WB 1994), undermining rural incomes of most farmers given their impossibility to increase neither their productivity nor cropping land.\(^{37}\) Graph 10.a plots mean weighted agricultural prices, which are estimations of the author based on registers of mean rural prices and production with data from SIACON (2005).\(^{38}\) It is made of the mean prices of crops weighted by their share production in the corresponding year at 2002 constant prices. Graph 10.b attempts at showing the net prices evolution after incorporating changes in mean yield –tons/hectare- over the same period. This graph thus plots weighted prices of a crop hectare in the country.\(^{39}\) As observed by the slope difference of trend lines between these graphics, the price decrease in terms of production volume ($/ton) is higher than those of cropping hectares ($/ha), given the incorporation of the yield increase over this period. It means that even if one includes the yield increase, prices trend has still decreased remarkably over this period, decreasing incomes of farmers unable to crop more intensively and/or extensively, sharpening poverty conditions, and stressing particularly those farmers more frequently affected by disasters.

\(^{37}\) More detailed expound in chapter 4 of this work

\(^{38}\) *Subsistema de Informacion Agricola*, Ministry of Agriculture.

\(^{39}\) Obtained by multiplying weighted production prices ($/ton) by weighted agricultural yield (ton/ha).
Finally, the economic policy reorientation implemented since the end of the 1980s has contributed to reduce farmers’ adaptive capacity as it has dismantled some crucial instruments aimed at supporting agricultural productivity. One has to admit that it has helped to reducing excessive paternalism and fiscal burden, but it has contributed to reduce the adaptive capacity of farmers to reorganize in light of current competition in the said context of globalization. This discussion has been left to the next chapter, which assesses public intervention in building adaptive capacity in this country.

### 3.5 Conclusions

The increasing frequency of natural hazards over the past 35 years in Mexico has implied increasing economic losses as well. Hurricanes and floods have been the most damaging disaster type, mostly affecting subsistence farmers, whereas earthquakes have mainly hit the urban poor. Most natural disasters in Mexico have caused destruction of rural assets at large extent in mainly marginalized regions. Though economic losses from extreme events have been higher in urban assets, the relative impact of disasters in marginalized rural areas is higher, contributing to increase rural-urban migration. Along with the higher exposure of agriculture to droughts, as the case that ca. 80% of agricultural surface in Mexico is rainfed, prevailing asymmetries in coping capacity and access to adaptive instruments in that regions is often observed, as for instance when comparing effects from hurricane Wilma and Stan in 2005 in Cancun and Chiapas, respectively, as well as among rich and poor countries sharing a same natural extreme event.

There exists *per se* a trend of the poor to settle on disaster-prone areas in urban Mexico, which more recently newcomers from the countryside have aggravated. Ironically, most these immigrants decided leaving their rural livelihoods as consequence of unfavorable conditions to improve agriculture-derived incomes due to a number of hazards, disaster occurrence among them.
Along with recurrent natural hazards in this country, current economic policy has contributed to stress agricultural livelihoods. The overall vulnerability of the Mexican economy has increased as the weight of foreign trade to GDP has increased as well. It has led to increasingly expose the economy to extern forces. Low prices of agricultural goods in Mexico’s main trade partners –most likely due to high subsidies-, has resulted in higher agricultural imports, pressing downwards agricultural domestic prices in the country. Rural incomes tend thus to decrease to those farmers without possibilities to either increase productive yield or to enlarge cropping area, like subsistence farmers. It is leading to reduce subsistence farmers’ ability to create a financial pool to face hazards their activities imply, drawing a vicious circle of low income, low coping capacity, lack of climate adaptive instruments (i.e. crop insurance, reserve fund), and higher disasters vulnerability. In virtue of these facts, an assessment of the public policy and its derived intervention seem to be the next step toward reducing economic vulnerability to these hazards, presented in the following Chapter 4. It analyzes the evolution of public intervention in improving coping and adaptive capacity through social programs and disaster management instruments, emphasizing the scope of loss sharing and risk transfer instruments.
CHAPTER 4: Assessment of vulnerability-related programs

Wenn wir in der Lage kommen, unsere Grundrechte verteidigen zu müssen, so ’dürfen’ wir weder Feindseligkeit noch Gleichgültigkeit vom Staat erfahren, sondern Wohlwollen!

KARL POPPER, Ministaat oder paternalistischer Staat?

This chapter explores current actions the government implements to reduce vulnerability to natural and economic hazards in Mexico. It begins presenting, in section 1, an overview of social programs implementation to strengthen access to opportunities of the poor. Along with that, section 2 analyzes the responsibility taken on by the government to absorb many of the losses from natural disasters (loss-sharing). The government rebuilds not only public infrastructure, but also housing and provides some relief to the poor after disasters. Loss-sharing has been based on a combination of ex-post instruments, like budget diversion, foreign credit, etc. From its part, risk-transfer has been based on mainly ex-ante instruments like insurance, mitigation, and more recently, contingent fund. Concerning agricultural and livestock activities, ex-post instruments are the most used, whereas disaster prevention measures keep relatively low, and consists of mostly insurance. The allocation of subsidies for agricultural insurance in Mexico after 1990 has led to less coverage compared to the 80s in terms of both area and producers. Mitigation works implementation is minor, whose trade-offs are also discussed in section 3. This chapter concludes in section 4 with a discussion on integrating risk-financing instruments to avoid them to render as mere transitory instruments to deal with poverty and inequity in the countryside, suggesting areas where public investments may produce greater effects in strengthening coping and adaptive capacity.

4.1 Social Programs assessment

In light of the high natural and economic hazards discussed in the previous chapters, the key issue is where exactly to allocate scarce public resources. This section proceeds to briefly assess the most relevant social programs related with economic vulnerability. Given the vast literature on social programs in Mexico (WB 2004, ECLAC 2003, Wodon and Velez 2000, among others), this section just summarizes their main results.

Governmental intervention to alleviate poverty

In sight of the current restrictions to redistribute wealth directly, the governmental intervention to reduce poverty and inequity limits mainly to social programs. Social programs are usually divided into broad and targeted policies. The former category is comprised of those programs for the general population devoted to social security, healthcare, education, housing, etc. Targeted policies consider exclusively a determined group. For our analysis’ sake, only policies targeted to the poor are addressed in this social programs overview. Roughly, around 13% of social spending (1% of GDP) is
being aimed at targeted programs to reduce poverty (WB 2004, Wodon and Velez 2000). Social programs to improve welfare include investments in human and physical capital as well as those aimed at increasing opportunities for the poor.

4.1.1 Investment in human capital of the poor

To this category belong programs to support education, health, and food access. PROGRESA is a set of projects to support education, health, and nutrition to poor households living in poor rural areas. LICONSA and TORTIBONO are food programs. They provide subsidized milk and tortilla (the base of Mexican nutrition), complemented with subsidized stores in poor rural areas through the program DICONSA. CONAFE is an educational program mainly oriented to the rural poor. IMSS-Solidaridad provides health services, designed to assist medical care in mainly remote communities. DIF is a program for family development, which includes support to poor families with small children through school breakfasts, food, communal centers for maternal care, and workshops, among others.

4.1.2 Investment in physical capital of poor areas

Programs to improve physical capital, i.e. housing, roads, schools, hospitals, etc., are being increasingly delegated to local governments. Currently, there have been governmental actions towards decentralization, like observed in federal budget distribution, which each time has increased budgetary shares to state governments. On that base, the building of physical social infrastructure has been transferred to local governments. Nowadays, it relies mostly on state and municipal governments. Though it has implied lesser clarity to assess the way local governments allocate their share, but this decentralization provides the poorest states the opportunity to increase their available resources to build a needs-based educational and health infrastructure, given the fact that they are supposed to have a better comprehension about local concerns. However, as criticized in Wodon and Velez (2000: 93), these allocations are in practice not based on need, but on past expenditures and existing costs. They add that Mexico’s decentralization process has taken place so rapidly, that local governments have not had time to fully adapt. In turn, physical infrastructure to mitigate natural disaster risk in poor areas reproduces these limitations as well, as further discussed in section 2. In turn, the hydro-agricultural project within this program has not fully clear achievements as water supply is administrated at municipal level as well. Municipalities are getting the resources with wide autonomy in its employment. For instance, impact on rural poverty reduction from irrigation works in agriculture seems to continue inestimable due to that fact.

4.1.3 Investment to increase income opportunities for the poor

Onerous investments in strengthening income of the poor are included in this category. Roughly, half of its fund is spent in the temporary employment program (PET), accounting for 7.44% of total expenditure on poverty in Mexico alone in 2002. This program is comprised of off-season temporary employment in poor rural areas. It is self-targeted through below-minimum-wage pay. According to some appraisals, the cost of increasing income one peso in the margin is 3.5 pesos by means of this program (i.e. Wodon and Velez 2000: 92).
In addition to its observation on education, Mexican government provides training and income support to the urban unemployed (PROBECAT). It is conventionally accepted that as one spends more on education, expected national future incomes tends to increase, but it is also accepted that funds allocation should be appropriately done (Rizzuto and Wachtel 1980, Card and Krueger 1996). Most appraisals on PROBECAT evidence this program to neither have achieved wages increments nor increased the probability of employment. Moreover, only less than 2 per cent of those in the poorest decile are reckoned to have access to this training program. Over half the budget to increase opportunities of the poor is devoted to this kind of programs, whose effectiveness has, so far, not proved to achieve substantial progress to poverty reduction (Rizzuto and Wachtel 1980).

4.1.4 Programs aimed at agriculture and rural development

In addition to targeted programs to exclusively the poverty in Mexico, there are some public programs to upgrade agricultural productivity and conditions in rural areas, what although obliquely, in last instance contributes to reduce poverty.

Economic liberalization: public intervention and trade

As part of the large reforms implemented over the last 15 years, agricultural policy has shifted towards less support and subsidies, aiming at the emergence of a private-sector-driven rural economy and largely liberalized markets. It has implied lesser public intervention in agricultural markets through dismantling state-owned companies for agricultural production and commercialization support. Over the 1990s, that economic reform included the dissolution of CONASUPO, BORUCONSA and LICONSA, the state owned companies responsible of providing grain storage, warranty prices and securities, freight, and commercialization services to the agricultural sector in general –whose negative impacts on farmers’ adaptive capacity to natural and economic hazards are further discussed in Chapter 5.

The increasing trade liberalization through implemented trade agreements, i.e. NAFTA in 1994, Mexico-European Union Trade Agreement in 2002, among others, has generated on the one hand, benefits for large-scale producers, mainly thanks to greater access to large markets (especially in the USA) and to a relative fast absorption of new technologies to increase efficiency. On the other hand, those producers less able to compete under such conditions have been stagnated, especially small-scale producers of domestically consumed and subsistence commodities, as described along the previous chapters.

Given the increasing social pressure to counteract that governmental withdraw, Mexican representatives from the opposition have been promoting a legal reform (Salinas 2004). After a heat debate within the federal congress and negotiations with the

40 CONASUPO (Compañía Nacional de Subsistencias Populares), spanish acronym of nacional Company for Popular Subsistence, was created in 1965 to support the countryside. In 1989, this company reduced intervention as withdrawn warranty prices for most agricultural prices. By 1993, remaining warranty prices were removed. Particularly remarkable is the case of basic grains as they are base of most rural economy. For further details, consult Perez-Haro (1990).
executive, on December 2001 was approved the Law for Sustainable Rural Development, which is an attempt to improve welfare in the countryside to reduce regional disparities (North-South) and foster agricultural production (DOF 2001, Art. 5). It brought the reorganization in most ministries and public agencies to give the Ministry of Agriculture a central role in coordinating measures to promote rural development.

Table 4: Ministry of Agriculture and Livestock: budget distribution (constant prices 2003, mill. of pesos)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alianza para el Campo</td>
<td>0</td>
<td>2,542</td>
<td>2,738</td>
<td>2,870</td>
<td>3,213</td>
<td>3,121</td>
<td>4,470</td>
<td>6,893</td>
<td>6,250</td>
</tr>
<tr>
<td>PROCAMPO</td>
<td>16,527</td>
<td>14,261</td>
<td>13,133</td>
<td>12,736</td>
<td>12,057</td>
<td>12,194</td>
<td>12,155</td>
<td>12,979</td>
<td>14,191</td>
</tr>
<tr>
<td>Marketing support</td>
<td>2,082</td>
<td>1,096</td>
<td>3,564</td>
<td>2,895</td>
<td>2,024</td>
<td>3,583</td>
<td>5,920</td>
<td>5,867</td>
<td>6,406</td>
</tr>
<tr>
<td>Temporary employment</td>
<td>0</td>
<td>0</td>
<td>522</td>
<td>604</td>
<td>834</td>
<td>1,037</td>
<td>1,116</td>
<td>1,154</td>
<td>1,800</td>
</tr>
<tr>
<td>Sanitary programs</td>
<td>1,389</td>
<td>229</td>
<td>288</td>
<td>287</td>
<td>300</td>
<td>285</td>
<td>392</td>
<td>361</td>
<td>871</td>
</tr>
<tr>
<td>Others</td>
<td>16,483</td>
<td>15,998</td>
<td>13,696</td>
<td>12,666</td>
<td>8,667</td>
<td>8,817</td>
<td>11,740</td>
<td>9,928</td>
<td>11,591</td>
</tr>
<tr>
<td>TOTAL</td>
<td>36,480</td>
<td>34,108</td>
<td>33,941</td>
<td>32,058</td>
<td>27,095</td>
<td>29,036</td>
<td>35,794</td>
<td>37,181</td>
<td>41,109</td>
</tr>
</tbody>
</table>

Source: Rosenzweig 2003, Cuenta de la Hacienda Publica Federal and Presupuesto de Egresos de la Federación. Deflated with the national consumer prices index, Banco de Mexico 2003.

As a result, budget allocation for the Ministry of Agriculture recovered substantially. By 1994, it accounted at 49,848 million (constant pesos of 2003), in 1999 dropped to 27,049 million, and in 2003 recovered to 41,109 million of pesos mainly derived from the reform. Set-aside for low-income producers of basic crops, PROCAMPO and Alianza para el Campo (AC) are also the main agricultural programs in terms of funds consuming (see Table above).

PROCAMPO support is provided on a per-hectare basis, which will be phased out in 2008. PROCAMPO is officially said to benefit currently 3 million producers, covering 90 percent of Mexico’s cultivated land. From its part, AC was introduced in 1996 to foster agricultural productivity through subprograms. Farmers must apply for a grant to get into one of these subprograms. Subprograms include: rural equipment, fertilization, irrigation, among others. Although this program is usually classified as poverty reduction program, there are some reasons to reclassify it as merely productivity encourager, since there is no evidence that AC contributes significantly to improve conditions of the poor (Rosenzweig 2003). However, the main limit of this program is that most farmers lack of enough resources to provide the guaranty financial solvency to get into. In a similar way, this eligibility limitation is present in Fondos as well, the crop insurance schema, described in the next section. After this overview to social programs, we turn now to describe the current natural disaster strategy in Mexico, analyzing the nature of its design

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41 Implemented since 1993 and 1996, respectively, by the Federal Ministry of Agriculture and Livestock (SAGARPA)
and reforms in the past three decades. Despite its relevance, there is to date no available integral assessment on instruments for natural disasters management in Mexico.42

4.2 Governmental actions to reduce vulnerability to natural disasters in Mexico

Given the prevailing levels of poverty, inequity, hazard exposure, and, in general, economic vulnerability in Mexico discussed along the previous chapters, the Mexican government is committed to assume risk from its population besides its own risk on public assets. There are three basic sources of risk if natural disasters occur: public infrastructure, insurance markets (as insurer of last resort), and aid to the poor (Mechler 2003). In the first category is the risk of loss to government buildings, including schools and hospitals, and infrastructure like roads, bridges, airports, etc., let us term it public assets risk. The second category focuses its attention not only on the poor, but also on the risk to agriculture, strategic industries, and to local governments: private assets risk. The third category consists of emergency response and providing elemental health and housing facilities after disaster to the poor: disaster relief. The Mexican government has a good financing capacity and response to cover losses from both public assets risk and disaster relief. However, private assets risk is still an insufficiently managed source of risk and, as above discussed, crucial in social terms.

Table 5: Public instruments for risk management financing to natural disasters in Mexico (2003, by type of asset at risk)

<table>
<thead>
<tr>
<th>RISK</th>
<th>Ex-ante Mitigation</th>
<th>Ex-ante Insurance</th>
<th>Ex-ante Reinsurance</th>
<th>Ex-post Reconstruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private assets FOPREDEN AGROASEMEX a) Subsidy to crop premiums contracting b) Advises Fondos FAPRACC a) Only for small-scale farmers b) Administered by Ministry of Agric.</td>
<td>AGROASEMEX For Fondos, b. For Private companies</td>
<td>FAPRACC (only for small-scale farmers)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public assets FOPREDEN</td>
<td>Hidalgo Insurance</td>
<td>Large Reinsurance Companies</td>
<td>FONDEN</td>
<td></td>
</tr>
<tr>
<td>Disaster Relief</td>
<td></td>
<td></td>
<td>- State governments - FONDEN - FAPRACC (wage compensation payments)</td>
<td></td>
</tr>
</tbody>
</table>

Bitran (2001) documents direct economic losses from natural disasters between 1980 and 1999, but without presenting the disaster management strategy. Kreimer et al (1999) assesses and projects exclusively the insurance markets, though crucial reforms to the insurance system have been left out with the course of the time. Guy Carpenter (2000) makes a hazards’ assessment and explains FONDEN, but in a limited fashion as it does not embrace neither agricultural insurance markets nor a number of instruments implemented after 1999 in the country.
The federal government has very developed and varied public instruments to reduce disaster risk in Mexico. For instance, subsidy to crop insurance premia is available by means of AGROASEMEX, the public crop insurance company; rebuilding of public assets is possible by the federal fund FONDEN; mitigation works can be undertaken by the federal-state shared fund FOPREDEN; and FAPRACC is a fund designed for rebuilding, mitigation and insurance to the poorest farmers. Table 5 summarizes the current public instruments responsible for risk management financing in Mexico, as well as its jurisdiction. Nevertheless, where are failing these instruments? To answer this question, let us briefly analyze their working mechanisms.

4.2.1 FONDEN

FONDEN (Fondo de Desastres Naturales) is a fund to permit access to governmental agencies to financial resources after a natural disaster occurs, both at municipal, regional (state) and federal level. The fund is an attempt to give priority to rebuild public assets involving poor families and is operated by the Ministry of the Interior (SEGOB) in close coordination with the Ministry of Finance and Public Credit (SHCP).

4.2.1.1 FONDEN budget

Since its establishment in 1996, FONDEN’s budget has varied widely because its payments have exceeded budget in most years, achieving to finance most economic losses of public assets (see Table 6 below). Given the brevity of FONDEN’s existence, it is still difficult to define with accuracy how much to set available for FONDEN from the federal budget, since public resources are scarce and all federal agencies struggle for more, relying still on lobby capacity at a large extent. Resources allocation is usually based on the criterion of employed amount over the previous fiscal year (SHCP 2002). Some years, budget is under the level of final requirement due to high loss from natural disasters, and vice versa for years when expenditures are considerably below budget targets. For that reason, resources redirection from other programs and also from other ministries have been diverted from other public sources (SHCP 2000) to observe the commitment, as seen in Table 6. FONDEN annual budget averages ca. US$ 350 million43, whereas economic losses of public assets averages US$ 486 in the same period, that is, 70% of losses to public assets were covered through this instrument.

Table 6: Indicators on Natural Catastrophes Financing in Mexico, selected years (mill. US$)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Losses</td>
<td>314</td>
<td>4,160</td>
<td>5</td>
<td>448</td>
<td>670</td>
<td>1,221</td>
<td>304</td>
<td>271</td>
</tr>
<tr>
<td>Losses/GDP</td>
<td>0.14%</td>
<td>2.25%</td>
<td>0.00%</td>
<td>0.10</td>
<td>0.14%</td>
<td>0.22%</td>
<td>0.05%</td>
<td>0.04%</td>
</tr>
<tr>
<td>FONDEN disbursements</td>
<td>--</td>
<td>--</td>
<td>195</td>
<td>431</td>
<td>463</td>
<td>427</td>
<td>531</td>
<td>73</td>
</tr>
<tr>
<td>FONDEN / Losses</td>
<td>--</td>
<td>--</td>
<td>3900%</td>
<td>96%</td>
<td>69%</td>
<td>35%</td>
<td>175%</td>
<td>27%</td>
</tr>
<tr>
<td>Loss/Pub. Exp.</td>
<td>1.16%</td>
<td>15.4%</td>
<td>0.00%</td>
<td>0.09%</td>
<td>0.12%</td>
<td>0.19%</td>
<td>0.04%</td>
<td>0.03%</td>
</tr>
</tbody>
</table>

With data from Ministry of Finance, Ministry of the Interior (CENAPRED and FONDEN), INEGI and WB

43 For further details, see Reglas de Operación del FONDEN 2002 (DOF 2002).
In terms of economic losses, 1985 was particularly damaging due to the Earthquake, whose losses reached current US$4,160 millions, which means 2.25% of GDP, also equal to 15% of Mexican public expenditure in 1985, as observed above in Table 6. Except for this disaster, historical losses have not exceeded 0.25% of GDP, even on 1999, when heavy rains hit state of Chiapas producing flooding and landslides, whose reconstruction implied resources allocation both on 1999 and 2000. It is remarkable that when the Michoacan Earthquake hit Mexico City in 1985, there was no financial instrument from the government to undertake reconstruction, which derived in the billionaire credit from multilateral financial institutions. If a natural disaster reaches the same level of economic losses today, FONDEN resources would be insufficient to finance rebuilding (max. historic budget US$ 531 mill.). In this scenario, average FONDEN resources would represent scarcely 10% of losses.

The kind of natural disasters paid for by FONDEN has varied over its existence. Drought was dominant in 1996, hurricanes in 1997, floods in 1998, and earthquakes and floods in 1999. FONDEN has been highly useful, and although its effectiveness does not attack causes of poverty, there is no doubt about its usefulness for immediate relief. FONDEN fashion is unique among risk management, since it eliminates on the one hand a number of formalities and financial transfers inside the public administration. On the other hand, it has led to a fast mechanism for public works coordination. This instrument also contributes to avoid automatically contracting extern debt and resources diversion from the social budget, bringing more stability to the public financing in this country.

4.2.1.2 Responsible for only public assets since 2003

However, given FONDEN insufficiency to deal with both public and private assets over its first 6 years of existence the Mexican government is decentralizing its resources to other public entities. From May 2003, FONDEN is responsible for financing exclusively public assets, whereas for private assets the involved ministry or public responsible agency. In turn, insurance contracting for their own assets is responsibility of each public entity (Ministry, organism, state and municipal governments, public enterprises, etc.).

4.2.1.3 Loss sharing

Currently, FONDEN operates on a decentralized manner in order to shift responsibility on natural disasters from the federation to state and municipal governments, aimed at encouraging local governments to identify and further undertake risk reduction measures. FONDEN provides matching funds through state trust funds (Fideicomisos Mixtos Estatales). The federal government continues assuming partial responsibility for local repairs and reconstruction. According to the FONDEN 2002 Rules for Working (Reglas de Operacion del FONDEN 2002), federal, state and municipal governments share the responsibility depending on the case. For instance, for roads and transport owned by state governments, the federal government is responsible for 50% of the losses, while, for municipal roads and transport, the federal government is responsible to cover only 30%. Nevertheless, due to high indebted outstand of most state

44 More detailed discussed in chapter 2.
45 Insurance options include the state owned insurance company Aseguradora Hidalgo, as well as a number of private insurance companies.
governments, reconstruction from natural disasters in Mexico is many times undertaken by using only federal resources.

4.2.2 AGROASEMEX

AGROASEMEX is the state-owned crop insurance company, which currently manages and grants subsidy for crop insurance premiums to farmers’ mutual arrangements of insurance (Fondos) and is also responsible for advising FAPRACC. Both individual farmers and Fondos get AGROASEMEX subsidy on contracted premiums with private insurance companies. AGROASEMEX acts also as re-insurer for private companies and for Fondos. Fondos are mutual funds arranged by farmers, which work mainly along low- and medium income regions of the country. Covered risks include drought, excess moisture (due to floods, heavy rains, etc.), frost, hail, fire, wind, and also plant infestations, impossibility to cultivate, non-germination, and livestock diseases, accidents, incapacity, and forced sacrifices. The products offered by Fondos are described in Table 7. These products have multi-peril coverage, aimed to hedge both yield and revenue-related risks. The advantage of Fondos is that cover not only natural and biologic disasters, but also those derived from yield variations due to changes in inputs costs, approaching thus to hedge from some economic hazards.

Table 7: Types of insurances operated by Fondos

<table>
<thead>
<tr>
<th>Type</th>
<th>Coverage</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insurance to investments</td>
<td>Amounts of investments on the crop</td>
<td>Technological equipment and infrastructure improvements.</td>
</tr>
<tr>
<td>Insurance to investments adjustable to living stock</td>
<td>Payable at the moment of the disaster certification</td>
<td></td>
</tr>
<tr>
<td>Insurance by plant</td>
<td>Hedges plant value to climate risks</td>
<td>An agreed price is stipulated</td>
</tr>
<tr>
<td>Insurance to expected harvest at agreed price</td>
<td>Pays indemnity for yield loss, adjusted to commercial price</td>
<td>i.e. per kilo</td>
</tr>
<tr>
<td>Insurance yield</td>
<td>Pays indemnity when realized yield is under trigger yield due to cost increment.</td>
<td>Insurance yield is an estimate of the long-run average yield based upon the actual production history for the insurance unit. 46</td>
</tr>
</tbody>
</table>

Source: AGROASEMEX 2002

Along the past 20 years, subsidies to agriculture in Mexico have been granted both directly (monetary payments per crop), and indirectly (price protection, preferential credit, insurance coverage). After started markets liberation in Mexico (GATT adherence on 1986), public policies have been leaving direct subsidies to agriculture, and indirect instruments of subside have been progressively implemented. As that have been occurring in general terms, the subsidies system for insurance contracting in agriculture

46 In the USA, for instance, the Crop Insurance Reform Act of 1994 authorized the Federal Crop Insurance Corporation (FCIC) to enlarge coverage up to 85 percent in certain circumstance, but its coverage typically ranges from 50 to 75 percent of the expected yield in 5 percent increments (Skees 2000).
have changed analogically. After two decades experimenting with insurance subsidies to agriculture, Mexican authorities realized that the former system was not longer sustainable, especially due to experimented corrupt practices (Hernández Trujillo 1997: 5, Wenner and Arias: 8) and inequities among insured producers when paying premiums. In its place, Mexican public crop insurance company (AGROASEMEX) have been withdrawing from directly insuring crops. It has transferred responsibility to Fondos, in order to make the government to work as exclusively technical advisor and liable of last resort (reinsurance). In general, although less governmental intervention in agricultural insurance has led to healthier public finances to the company, but it has implied less coverage of farmers and cropland over the past twelve years. This sub-section proceeds now to analyze the reasons for implementing these reforms to the crop insurance subsidy, to further compare its performance with the current system, emphasizing its implications in farmers’ adaptability to climatic hazards.

### 4.2.2.1 The crop insurance system 1961-1991

Although first agricultural insurance program in Mexico dates back from 1942, it was rather arrangements between mutual unions and private insurance companies. Until 1961 was formally created the first specialized public company for insurance crop, the National Crop and Livestock Insurance Company (ANAGASA). In practice, ANAGASA started operations until 1963, working with clients of state development banks, like Banco Ejidal and Banco Agrícola (later combined to form Banco Nacional de Crédito Agrícola - BANRURAL). Credit granting was conditioned to crop insurance contracting through ANAGSA. Policies covered multiple-peril, premiums were subsidized and cultivated area insured was large. Unfortunately, due to lax monitoring, actuarially unsound pricing, and fraud (filing of false claims), losses for ANAGASA were staggeringly high. Sometimes, indemnity payments represented up to 70% of the loan recoveries by BANURAL, the state-owned credit-conceding bank (Hernandez 1997: 2).

**High indemnities**

Hazell (1992) compares the experience of ANAGSA with its counterparts in selected countries, evidencing its relative negative financial results, presented in Table 8. Average payouts (indemnities plus administration costs) greater than average paid premiums mean net loss for the scheme. On one extreme, Brazil has high ratio costs to premiums (4.57), where indemnities payments explain most the deficit (4.29). On the other extreme, Japan 85-89 has very high administrative costs as component of its ratio costs to premiums (3.57 of 4.56). Mexico’s performance looks more similar to the Brazil tendency, since the ratio indemnities/premiums are extremely high (3.18) within the total cost (3.65). To achieve a ratio below 1 (as Canada, Japan 85-89, USA 99), some authors affirm it requires high investments in obtaining the right information for surveillance (Skees 2000, OECD 2000).

**Financial deficit**

Lack of surveillance led to misestimating risk, and therefore made distortions in premia pricing during the 80s (Wenner and Arias 2000). The allocation of subsidies for agricultural insurance in Mexico over that decade showed signs of bad management, which turned AGROASAMEX into a loss-making entity (Hazell 1992). ANAGSA had to face an extremely high number of claims for indemnification. The situation turned so
financially unsustainable, that ANAGASA was closed in 1988. Under such circumstances, a reform to the Mexican system was implemented. The reform incorporated some farmers’ self-initiative into the system to reduce public burden, which derived into mutual funds to hedge crops.

Table 8: Financial performance of Crop Insurance Schemes in selected countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Period</th>
<th>Indemnities/Premiums</th>
<th>Administration costs/Premium</th>
<th>Total Costs (Indemnities + Administration costs) / Premiums</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>75-81</td>
<td>4.29</td>
<td>0.28</td>
<td>4.57</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>70-89</td>
<td>2.26</td>
<td>0.54</td>
<td>2.80</td>
</tr>
<tr>
<td>Japan</td>
<td>47-77</td>
<td>1.48</td>
<td>1.17</td>
<td>2.60</td>
</tr>
<tr>
<td>Japan</td>
<td>85-89</td>
<td>0.99</td>
<td>3.57</td>
<td>4.56</td>
</tr>
<tr>
<td>Mexico</td>
<td>80-89</td>
<td>3.18</td>
<td>0.47</td>
<td>3.65</td>
</tr>
<tr>
<td>USA</td>
<td>80-89</td>
<td>1.87</td>
<td>0.55</td>
<td>2.42</td>
</tr>
<tr>
<td>USA*</td>
<td>1999</td>
<td>0.96</td>
<td>0.96</td>
<td>3.68</td>
</tr>
<tr>
<td>Canada**</td>
<td>98-99</td>
<td>0.48</td>
<td>0.07</td>
<td>0.56</td>
</tr>
</tbody>
</table>


4.2.2.2 The 1991 reform to crop insurance system

In 1991 was formed AGROASEMEX in order to replace and overcome ANAGSA problematic. Even prior to ANAGSA closure, some well-organized farmers realized disadvantages of ANAGSA from the 70’s when comparing premiums to real needs, and in 1978 was founded the first mutual insurance fund (*Fondo Común de la Coalición de los Valles del Yaqui y Mayo, CECVYM*). Real disaster level of these farmers was very low compared to average in the zone (Hernández 1997), and therefore insurance contracts with ANAGSA meant net financial transfer for them. This fund was created to reduce insurance costs, to offer technique support for members, to develop financial options (Gordillo 1988), as well as to reinvest remaining (residual of premiums minus indemnity payments after administration costs). These funds became the current *Fondos*, which have been supported since 1991 by the reformed crop insurance system. Hence, insurance funds *Fondos* are understood as the civil associations conformed by producers, who are self-assuming responsibility of insurance for their agricultural activities

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**Fondos budget**

Financial resources of *Fondos* consist of premiums funds (paid by farmers) plus governmental subsidy minus operation costs (reinsurance plus administration). Residual amounts after operation costs and indemnity payments are earmarked to either a contingent fund (to cover disasters exceeding contractual coverage) or to a social fund i.e. to purchase technological improvements for members. The main requirement to farmers to get into a *Fondo* is holding a profitable crop from a technical and financial perspective.

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47 Ley General de Instituciones y Sociedades mutualistas, Art. 13; Ley sobre el Contrato del Seguro, Art. 40; Reglas Generales para la Constitucion, Operacion y Funcionamiento del los Fondos de Aseguramiento, de vida campesino, y conexos a la actividad agropecuaria (SHCP).
Premium subsidy does not have to exceed MXP 2,000 per hectare (ca. US$ 182), subsidizing between 25% and 45% of the premium \(^{48}\) (ROSPSA 2002: Art. 6).

In 1995 AGROASEMEX was re-designed to withdraw progressively from the sector as direct insurer. Between 1995 and 2001 AGROASEMEX insured both directly to individual farmers and indirectly by means of paying Fondos reinsurance, as well as acting as insurer of last resort for private companies. Given that natural disasters damage a large number of farmers in unison, private companies require re-insurance services. As the government is liable of last resort by acting as re-insurer, private companies can be covered when the ratio of indemnities over premiums exceed certain range. AGROASEMEX provides non-proportional re-insurance, which covers catastrophic events to private insurance companies at 50% when exceeding 120% of premiums fund.

During this public-private transition period, the surface coverage has decreased despite being a disasters period. By 1999, 37% of insured subsidized surface contracted premiums directly with AGROASEMEX, 34% via FONDOS, and the remaining 20% by private insurance companies. However, 14% of the national cultivated area \(^{49}\) (3 mill ha) was lost to disasters in 1999. Over 90% of these losses were uninsured, since the subsidy reached to less than ten percent of national cultivated area. From its part, both disasters frequency and economic losses increased dramatically during that period, as discussed in Chapter 3.

4.2.2.3 The 2002 reform to the crop insurance system

In 2002 the system was reformed again, which consisted of migrating AGROASEMEX to the second floor, that is, to operate as exclusively agricultural re-insurer, allowing the expansion of private insurance in the country. \(^{50}\) In this new scheme, AGROASEMEX does not operate directly as insurance company anymore. While AGROASEMEX supported directly 56% of insured crops in 2000, in 2001 it represented 7%, whereas private companies moved from 34% to 77%, respectively. The subsidy \(^{51}\) per hectare increased from 330 to 401 pesos, and average insured amount rose from 3,435 to 4,032 hectares (AGROASEMX 2002). \(^{52}\)

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\(^{48}\) Determined through a ranges classification of socioeconomic regions and type of crop –it includes 83 different crops.

\(^{49}\) The national territory has an extension of 197 million hectares, 11% of which (ca. 3mill ha) was cultivated in 1999.

\(^{50}\) Since 1995, Mexican government started a program to reform subsidies for crop insurance premiums by reducing costs of contracting insurance and, at the same time, encourage participation of social and private agents, which allowed to establish the National System of Rural Insurance (Sistema Nacional de Aseguramiento del Medio Rural), which involved AGROASEMEX, as well as social and private agents related to crop insurance (ROSPSA 2002). It led to latest reform of 2002 Further details: Reglas de Operación del Subsidio a la Prima del Seguro Agropecuario (2002). Diario Oficial de la Federación del 15 de marzo de 2002.

\(^{51}\) The subsidy is paid once the producer contracted either private insurance or hedge the crop through a established Fondo.

\(^{52}\) According to estimations from Hernandez (1997:8), average ratio of indemnity to reinsurance via Fondos accounts 13.06% for the period 1991-96.
By 2002, AGROASEMEX did not issue insurance contracts anymore, allocating 95% in subsidies to premiums which farmers contracted with private companies\(^{53}\), and the remaining 5% was spent in subsidies to Fondos\(^{54}\) (see table below). 68% of the subsidy value granted crops and the rest livestock\(^{55}\). On average, the subsidy accounts at 32.5% of the premium, and the average premium at MXP 468 for that year (AGROASEMEX 2003). The trend of average premiums indicates that while price of Fondos premiums decrease, the price of private companies’ premiums increases, stimulating farmers to better join Fondos system.

On average, Fondos are expanding especially due to its participation in basic (extensive) crops (i.e. maize, bean, wheat, potato, etc), whose insured amounts and premiums are lower. From its part, private insurance companies are being reducing participation in the basic crops segment, but expanding in livestock and intensive crops (fruits and vegetables). In 2002, 44.7% more livestock were insured compared to the previous year. That increment is explained by the expansion of private insurance companies, which tripled insured units and caught up most of the clients left by AGROASEMEX\(^{56}\).

4.2.2.4 Critics to the reforms

a) Paternalism. The discussed reforms to the agricultural insurance system in Mexico have been an attempt to overcome some of the deficiencies in private-sector response to farmers’ risk management needs. The 1991 reform achieved to leave behind insufficient design and projecting, since public sector subsidized insurance schemes had generally had little effect to encourage productive efficiency. In fact, in many cases they had made farmers less productive and gave rise to moral hazard. That design has been many times criticized because offering all-risk coverage, providing extremely subsidized premiums to non-poor farmers, and little willingness to crop variation in per se geographical areas at risk, seemed to contradict market efficiency.

b) Financial health and coverage. Under purely efficiency criteria, allocation of society’s resources into agricultural insurance in Mexico over the 80’s shows clear signs of inefficiency, as seen along this section. However, under a social perspective, it has meant less coverage (in both terms of area and producers). In the decades previous to the 90s, agricultural insurance was inefficient due to the above commented lack of surveillance, high moral hazard, and rent-seeking from some economic agents. After the reforms, the Mexican crop insurance system works with a financial surplus. However, in terms of covered area and insured farmers, the impact has been negative compared to that period. In the 80s, ca. 7 million crop hectares were covered by the insurance subsidy, whereas in the first three years of the present decade it accounts for less than a half of that (see Figure 13). In other terms, government subsidies to crop insurance premia have only been relevant to farmers in 10% of Mexico’s cultivated area during the 1990’s, whereas during the 1980’s the subsidy reached 40% of that area. In a broader perspective, by 2002 only

\(^{53}\) 7 private insurance companies participate in this system (AGROASEMEX 2002).

\(^{54}\) In 2003, the Fondos system consisted of 224 Fondos.

\(^{55}\) Livestock insurance available via Fondos offer coverage related to risks of sickness, accident, physical inability, whose coverage includes from transportation, establishment, and adaptation to new habitats.

\(^{56}\) Also, livestock coverage rose from 576 thousand heads in 1991 to 9.7 million in 2000.
25% of cultivated area got access to some financing (credit, loans and/or insurance). In sum, three-fourths of cropland in Mexico was out of institutional financial support and 90% uninsured.

![Diagram showing fiscal cost per hectare and average surface covered along decades.](image)

**Figure 13: Agricultural coverage of the subsidy along decades**

Source: AGROASEMEX 2003

00’s are estimations corresponding period 2000-2003

c) **Exclusion.** Compared to the crop insurance system of the past, Fondos work in a very decentralized frame, what also implies atomization and exclusion. One of the main negative characteristic of that is the high figure of farmers that cannot get into a Fondo. Due to their lack of solvency, they are usually rejected by existing Fondos, and can just expect some indemnity payments from the government only if their municipal authorities promoted FAPRACC, still exceptional in practice, as further discussed in the next section.

d) **Inequity.** Support for agricultural insurance premia is unequally earmarked, since there are relatively more resources spent on medium and large-scale farmers than on small farmers, evidenced in the distribution of insurance subsidy. In 2002, 95% of the subsidy went to premia contracted through private companies, conceding more weight to private sector in the insurance market on the one hand, but benefiting mostly to the less poor farmers on the other hand. The rest went to Fondos, made of farmers with a minimum of financial capacity. It might be justified if these beneficiaries were large-scale export-oriented producers, since, after all, it may act as counterweight to high subsidies to farmers in Mexico’s main trade partner, the USA –for a crop insurance comparison between Mexico and the USA, as well as with other trade partners of Mexico, see Appendix 1. Though it may contribute to enhancing coping capacity of the overall agriculture to the economic hazard dumping practices imply, but may be not a viable solution given its contribution to continue enlarging the gap between rich and poor farmers in the country.

In this context, the best option would be expand the crop insurance subsidy more actively and selectively based on a coordinated analysis, as well as to increasing investments in mitigation. Most important, before investing in mitigation works, a productive reorientation, i.e. crop diversification, crops change, etc., can exploit better
these risk-transfer instruments. For its design, FAPRACC has the virtue to pursue such a strategy; we turn now to analyze this instrument.

4.2.3 FAPRACC, crop insurance for subsistence farmers

Farmers without ability to contract insurance and without solvency to be members of a Fondo remain exposed to disasters. If they had access to credit they could probably manage agricultural risk better, but 85% of them have not access (INEGI 2003c). So, that risk has to necessarily be internalized. The Ministry of Agriculture implemented in 2003 a program to hedge these farmers indirectly in two ways: ex-post, paying indemnities after disaster, and ex-ante, subsiding crop insurance premiums. FAPRACC, Spanish acronym of Fund to Attend Damaged Population due to Climatic Contingencies, aims at covering these farmers.

4.2.3.1 Ex-post measures

Indemnities payment is done on the basis of disaster declaratory, which is made through meteorological measurements. Once exceeded certain climatic threshold, e.g. mm of rain, temperature ranges, etc. a disaster state can be declared. Afterwards, all damaged agricultural producers listed as low-income population are eligible to get the support (upon request). The authorities responsible for that initial selection are the state governments, which in turn request the resources to the Federal Ministry of Agriculture. This post-disaster support is temporal, since only corresponds to one event. Also, resources disbursement is shared by the federal and state governments at 70-30%, respectively (DOF 2003: Art. 7). The program includes direct support to agriculture, livestock, and fisheries, granting (1) per crop hectare, livestock unit, or damaged boat, depending activity; (2) by wage in case of mitigation works; and (3) for catastrophic insurance contracting, summarized in the figure below.

<table>
<thead>
<tr>
<th>Support</th>
<th>Unit</th>
<th>Maximum support</th>
<th>Unitary amount (MXP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Agricultural activity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. Annual crops</td>
<td>$/Ha</td>
<td>5 ha/producer</td>
<td>800</td>
</tr>
<tr>
<td>II. Perennial crops</td>
<td>$/Ha</td>
<td>5 ha/producer</td>
<td>800</td>
</tr>
<tr>
<td>III. Fruit plantations (including coffee, avocado and nopal)</td>
<td>$/Ha</td>
<td>5 ha/producer</td>
<td>Up to 5000</td>
</tr>
<tr>
<td>B. Livestock</td>
<td>Animal unit (depending on specie)</td>
<td>25 animal units</td>
<td>380 per animal unit for droughts, 850 otherwise</td>
</tr>
<tr>
<td>C. Fisheries</td>
<td>$/boat</td>
<td>1/producer</td>
<td>2230/boat</td>
</tr>
<tr>
<td>D. Aquaculture</td>
<td>$/Ha</td>
<td>2 ha/producer</td>
<td>1,110/ha</td>
</tr>
<tr>
<td>E. Others</td>
<td>Day-wage/producer</td>
<td>40 day-wages/producer</td>
<td>According to labor legislation</td>
</tr>
<tr>
<td>F. Catastrophic insurance contracting</td>
<td>$/ha or animal unit</td>
<td></td>
<td>100% premium price</td>
</tr>
</tbody>
</table>

Source: Diario Oficial de la Federacion (27 de mayo de 2003), complemented with DOF (2005)\(^{58}\)

\(^{57}\) Fondo para Atender a la Población Afectada por Contingencias Climatológicas

4.2.3.2 Ex-ante measures

Conditions for insurance contracting are responsibility of state governments, who in turn can request support for catastrophic crop insurance to the federal government, based on research conducted together with AGROASEMEX, as well as complemented with information from the Water National Commission (Comisión Nacional del Agua), as well as by interested producers. Beneficiaries must accomplish all requirements stated in Operation Rules of FAPRACC (DOF 2003: Art. 4), which in general demand being small-scale producer (in accordance to defined ranges). Agreed parameters of climate risks rule the insurance contract, and the eventual beneficiary of catastrophic crop insurance (Seguro Agricola Catastrofico) should renounce to additional benefits of FAPRACC in case a covered disaster occurs.

4.2.3.3 First FAPRACC experiences

Despite its novel design, FAPRACC less than 1% in insurance in 2003 (last available registers), whereas 99% on indemnities for reconstruction59. Though these indemnities were needed, but the penetration of insurance seems to still be low considering existing hazard exposure and individual economic vulnerability. That subsidy for catastrophic insurance contracting went to the State of Guanajuato, supporting 95,415 hectares, too low if one considers that it means 0.005% of uninsured crop area in Mexico.

Delay in indemnities payment

Given its very recent implementation, probably is too early to attempt to evaluate achievements, but however we could have an overview to some experiences. Zacatecas, a Center-North state of Mexico, has been suffering of extreme weather for the past 20 years, what varies from frosts to warm wave (range: +50 to -10 Celsius degrees), as well as from floods to droughts. For the last four years, the state has been declared in state of emergency at least once a year. In 1999, FONDEN provided MXP 27.2 million, from which 16.2 to wages and 11 for seeds distribution, but the resources were distributed with a one-year delay. In 2000 and 2001 succeeded the same delay: resources providing one year after emergency declaration 60. However, FAPRACC proved to do it not much better in 2003. In a recent assessment to FAPRACC elaborated by UNAM upon request from the Ministry of Agriculture, Gay and Conde, et al (2004: 5-6) criticize delays in indemnities payments to act negatively on re incorporating farmers to their agricultural activities.

4.2.4 Comparing FAPRACC and AGROASEMEX scopes

AGROASEMEX subsidy went to premium financing of mainly low and medium income farmers through Fondos. The main merit of AGROASEMEX consists then in hedging assets of non-extremely poor farmers at risk of falling below the poverty line in case of natural disasters. However, expanding cropland coverage is still the main

59 In 2003, federal budget authorized for FAPRAACC reached 300 million pesos (ca. US$26 million). This budget must add state disbursements, which may be additional 100 million pesos.
60 On 2003 due to frosts, Zacatecas requested resources to FONDEN and to FAPRACC, but given the fact that from May 2003 FONDEN is being responsible for exclusively public assets, the requisition was attended only by FAPRACC: Disbursed resources at MXP 19.8 million, from which, 13.9 from the federation and 5.9 from the state. Resources are said to be benefit 1,713 producers, equivalent to 6,356 ha
challange of AGROASEMEX Fondos’. From its part, FAPRACC merit lays on targeting subsistence farmers, but 99% of its budget went to reconstruction financing. Moving from transitory-effect ex-post measures to more prevention initiatives seems to be FAPRACC’s main challenge. In reaching that, a closer coordination with the Ministry of Social Development to carry on mitigation works in marginalized rural areas may lead to more substantial results. In 2003, FAPRACC budget represented roughly 50% of AGROASEMEX budget. In other terms, the proportion of public resources spent in ex-post to ex-ante instruments in rural areas was 2 to 1. Finally, these resources represent 15% of FONDEN average annual expenditure over the period 1996-2001, still a low number if one considers the relative higher affectation from natural disasters in rural areas.

Box 4.I: World Bank loan for disaster mitigation

In 2001, the World Bank conceded a US $404 mill loan to Mexico aimed at mitigating natural disasters to reduce the country's vulnerability, and to support rapid recovery when natural disasters occur. Funds from the loan are expected to finance emergency and reconstruction through FONDEN. The loan, to be disbursed over four years, is expected to finance disaster vulnerability studies proposed from the Ministries of Communications and Transportation, Agriculture, Livestock and Rural Development, Social Development, Public Education, Health, and Environment and Natural Resources, and the National Water Commission, especially those to provide improvements in land use, housing, insurance, road construction, farming practices and mapping. Complementary, the loan is expected to allow the government to assess viability of insurance and other financial instruments to manage disaster risk, in order to facilitate fast reconstruction and thereby rapid economic recovery. The loan has a five-year grace period with repayment in 15 years.

As discussed along this chapter, few disaster mitigation measures have been undertaken in the country over the past four years. The disasters expenditure has been mostly spent in indemnities payments. In that sense, fulfilling the main aim of this loan for disasters mitigation is being failing mainly due to the lack of local disaster risk identification in the country, making this loan to serve as mere short-term disaster relief.

4.2.5 PIARSE, productive reorientation

A relevant criterion-decision to maintain long-term subsidy to crop insurance is the differentiation between risk to natural disasters and risk of bad management (Skees 1999). In cases where crops were considered as bad or inefficient managed, insurer internalizes that risk by transferring it to the deductible. So, strong and close public surveillance is required in order to do not misuse this subsidy, evaluating land use, and to further redirect production from inappropriate agricultural practices. So, premiums and

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61 AGROASEMEX: 349.3 million pesos; FAPRACC 178.6 million of pesos; FONDEN 3,500 million pesos, average period 1996-2001.
deductibles can be reduced, decreasing in turn the burden for the government from subsidies to insurance premiums –or even from rebuilding-, reducing the burden to the taxpayer in last instance. For instance, poor grape producers in the state of Zacatecas have not been eligible to get FAPRACC indemnities despite high disasters affection given that droughts are disaster considered not that ‘natural’ given chronic drought state in this region. Instead, they are scheduled to be incorporated into a program for productive reorientation in order to change crop, adapting cropping to the comparative advantages in the region. After talking to Mexican authorities concerned to agriculture, in particular at the Ministry of Agriculture, they recognize that an agricultural insurance subsidy can become successful only if the public sector and producers undertake parallel structural changes. If farmers are to improve productivity by incorporating technological advances they need to be advised to decide for more economically rentable activities. The latter motivated the creation of PIARSE, a program for sustainable agriculture and productive reorientation in recurrent disaster areas. This program supports projects to change land use where natural disasters have been so recurrent, that productivity keeps permanently low (DOF 2003).

4.2.6 FOPREDEN

The Fund for Disasters Prevention, FOPREDEN (Fondo de Prevención de Desastres) is a federal fund to provide financing to mitigation works and research on mitigation, which has so far been underemployed. Resources granting is based on efficiency and feasibility analysis. Projects should be proposed by state governments, federal ministries and/or federal organisms to scientific reviewing committee (ARFOPREDEN, Art. 9) for further approval from the Assessment Council (Art. 11). In case of state-proposed projects, FOPREDEN contributes with 70% of the project cost, and the state pays the remaining 30%, whereas the contributions accounts at 50-50% for projects proposed by federal organisms (Art. 5). Projects are restricted to one per year by proposing entity and up to the budgetary top of the program. In 2005 its budget reached ca. 40 million USD, but only 25% of that budget was implemented (Puente 2005).

4.3. Public infrastructure: disasters mitigation and productivity enhancement

After a natural disaster occurs, damaged physical infrastructure is repaired, replaced or retrofitted in order to minimize negative impacts from natural disasters. This work considers physical infrastructure the stock of capital equipment in a country, including factories, farms, roads, schools, and other tangible assets. Damages or losses in public infrastructure tend to slow down economic growth as it is not repaired or rebuilt in time. In the case of the agricultural sector, it contributes to increase uncertainty along with depressed prices of agricultural goods, discusses in the previous chapters. Some concrete examples of long-term impact infrastructure destruction are Hurricane Fifi in Honduras, where roads and agriculture infrastructure got severely damaged without fast recover, as well as electricity supply in San Salvador, and marine resources in Nicaragua and Peru (Caballero & Zapata). In the case of Mexico, the proportion of aggregate losses from natural disasters to GDP (1 to 1 000) suggests that natural disasters produce low impacts

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63 Programa Integral de Agricultura Sostenible y Reconversión Productiva en Zonas de Siniestralidad Recurrente.
to the overall Mexican economy. However, the considerations explained along this work on agricultural vulnerability make us approach natural disasters as a factor of impoverishment. So, it is crucial to strengthen public infrastructure via mitigation works to make sure that public infrastructure resist disaster occurrence as much as possible as well as repairs are carried on prompt in case of high affectation.

### Box 4.II: Aversion to change and the endowment effect

Public projecting must consider attitudes heterogeneity among economic actors before implementing public policies for vulnerability reduction. Aversion to change is frequent especially when the situation does not reach yet critical points. In Mexico, initial allocations of wealth are a very illustrative origin of the problem, though not unique. As in the in the short-run, property and land tenure issues seem to still be far from a viable solution, options to reduce vulnerability must act even upon productivity. The economic neoclassical theory holds that initial allocations of wealth does not matter as long as markets allow people to trade their stakes (Coase theorem). Also, neoclassical theorists support the statement that the people should be considered as rational economic agents. On the contrary, “behaviouralists” say that the people not always get their complicated sums right (maximizing utility subject to a budget constraint).

Daniel Kahneman, awarded Nobel Prize on economics 2002, points out that in practice, people tend to judge their well-being relative to others, not in absolute terms; their actions depend on the way choices are represented; they fear loss more than they crave gain (prospect theory). In the same way, the “endowment effect” says that people place an extra value on things they already own. In that sense, although transferring labor from rural to urban areas seems to be economically viable, it implies high politic costs and traumatic social processes. In turn, even if we opt to promote crops-rotation in order to diversify the agricultural risk, it could not be successfully applied to all producers. As asymmetries about markets information makes clear differences among producers in both opportunities and desirability to expand trade, in a similar way not all producers might be determined to change crops and diversify markets, as usually recommended. John List, economist-researcher at the University of Maryland tested empirically the endowment effect and found that only more experienced traders (producers) are less prone to the endowment effect, and trade as keenly as neoclassical predicts. In this sense, we must consider, on one side, that producers in developed agriculture (or capitalist agriculture, as Rodriguez 1980 names it) are subject to work under market efficiency mechanisms, as well as to be expected to react to its incentives (included insurance contracting). But on the other side, we must to build particular strategies for traditional producers to reduce vulnerability to disasters, even if it seems to contradict market efficiency.

### 4.3.1 Disaster mitigation and productive infrastructure

There are three basic functions of public infrastructure: those related exclusively to keep or enhance productivity (i.e. roads, energy supply, etc.), to hedge from disasters
(i.e. regulators of river levels), and to both productivity and disasters (i.e. irrigation systems, green houses, etc.). Due to the duality of the latter function of public infrastructure, it is particular difficult to separate the amount of productivity-related investments from exclusively disasters mitigation works, as well as to separate their positive effects on productivity.

To date, there exists few documented evidence of exclusively disasters mitigation works in Mexico. It is so mainly due to the fact that mitigation is many times included into infrastructure works, and as that, its tasks rely increasingly on local governments (state and municipal) at a large extent, as commented in section 1 of this chapter. It occurs with disaster risk mitigation works derived from current disaster instruments (mainly FOPREDEI and FAPRACC) as well, where the initiative has been left to state authorities upon request from the municipalities.

4.3.2 Insurance versus Mitigation

The viability of investing in disaster mitigation works depends on a cost-benefit analysis over a time period horizon. Insurance covers the risk during exclusively a contracted period, and over this period the money seems to be lost without modifying risk exposure. From its part, mitigation is a one-time large disbursement that reduces or eliminates risk exposure for a usually long period of time. A detailed cost-benefit analysis should be carried on to discount maintenance costs, depreciation and other associated cost a public work implies, from the benefit of the mitigation, as well as potential shocks of demand (change in preferences, substitute commodities, etc) for the related commodity or economic activity. Changes in assets profitability to the involved economic activities in a given region could turn negative benefits from the mitigation investment within an efficiency analysis.

Mitigation is also limited because of increasing marginal costs. Constructing the perfect mitigation work, which reduces to zero the associated risk to disaster can also be cost-benefit negative than mitigate until certain point (where marginal cost = 0) and from that point transfer the remaining risk (Freeman et al 2002). Even, some mitigation works can also reduce the risk until i.e. 98%, but reaching 100% can cost more than the physic asset itself. After ensuring human victims protection, it would be more financially desired to lose the asset than reduce 100% the risk.

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64 Mitigation itself implies a risk. For instance, let us think on a mitigation work in a cotton cropping region, assuming also the availability of only two hedging options: mitigation and insurance. Mitigation investments at 40,000 USD are implemented to construct infrastructure to last for 30 years, eliminating risk from disasters. Alternatively, insurance premia accumulated over the same 30 years (at present value) cost 75,000. In such conditions mitigation is the best option, and in fact it is so given the available information. Now, suppose a demand shock, which run out of business cotton producers in the 7th year, due to i.e. trade barriers to continue exporting or prices drop. Additionally, suppose that after a productive reengineering assessment, the region’s productivity will not depend anymore of this kind of mitigation work. Now, let us assume that insurance were cost 20,000 USD at present value accumulated to the seventh year. Under these conditions, contracting insurance for only 7 years would be more opportune than investing in mitigation. Unexpected contingences like that are externalities for individual project evaluation.
4.4 Conclusions

Though there are remarkable efforts for moving from programs with transitory effects on incomes to more investments in improving assets of the poor, but improving its results requires a better oriented hazards management. Policy instruments to reduce economic vulnerability of the overall population to hazards are being increasingly implemented. The strategy to manage the increasing exposure of the agricultural sector to the ongoing trade liberalization process has recovered resources since 2002 after a significant drop over the 90s. But it is perhaps insufficient given the dismantling of crucial state-owned companies for agricultural support for production and commercialization and high subsidies in Mexico’s main trade partners. In addition, increasing occurrence and economic losses from natural disasters are threatening rural livelihoods as the current natural disasters strategy, though novel designed, implements few prevention measures. Though in 2003 the proportion of public expenditure in subsiding crop insurance to indemnities for reconstruction of farmers’ assets was 2:1, but that insurance coverage has not reach poor farmers and has reduced cropland coverage dramatically compared to the previous decades.

Subsidies to crop insurance premia have only been relevant to farmers in 10% of Mexico’s cultivated area during the 90s, whereas during the 80s the subsidy reached 40% of the area. In the 70s and 80s, agricultural insurance was inefficient due to a lack of surveillance, high moral hazard, and rent-seeking from some economic agents. In the current scheme the government does not insure directly, but is insurer of last resort to Fondos, mutual arrangements of farmers to manage self-insurance. Overall, the current crop insurance system presents a financial surplus, but 90% of cropland is uninsured. From its part, FAPRACC offers catastrophic insurance to subsistence farmers, but few state governments have contracted it so far, concentrating its expenditure in aid for reconstruction to farmers and leaving exposure to natural hazards unchanged. In general, expenditure in mitigation works has been minor.

Despite its sophisticated design, there is a relatively low resources allocation in disaster prevention measures, and disbursements to deal with losses have not brought clear contributions to vulnerability reduction of the poor over the past two decades. There is a widespread recognition among governmental officials responsible for social programs about the relevance of integrating a disaster reduction strategy to meet overall goals of poverty reduction strategies. However, the main operative challenge for their implementation consists in combining risk and vulnerability analysis at municipal level. As risk identification and vulnerability analysis at municipal level are the main legal requirements to apply for financial resources to carry on mitigation works and insurance, the success of the disasters vulnerability strategy in the country depends on promotion from the municipal authority at a large extent.

The contribution of investments in reducing vulnerability to natural disasters seems to be underestimated. In 2003, the expenditure on natural disasters management to the countryside represented less than 0.01% compared to that on social programs, as well as less than .02% compared to agricultural programs in Mexico. These proportions are
still low if one considers the relevance of natural hazards on incomes and, most important, on assets accumulation discussed along this dissertation, evidenced in the stakeholders’ interview in the next chapter and further tested through a spatial econometric model in chapter 6.
Appendix 4.1: International experiences on crop insurance systems

In many developed countries, it is difficult to identify if subsidies to contract crop insurance are aimed to help farmers to manage risk or if they are designed simply as subsidizing mechanism. Given the new conditions to get access to subsidies via prices and income support programs, some interest groups are moving to obtain extra-benefits from risk management and insurance programs. Insurance subsidies become then more important as a country moves towards agricultural price subsidies lifting, like the WTO Green Box Criteria discussed within the European Union. For instance, the Agriculture Directorate-General at the European Commission considers the aim of a risk management policy to not just provide income support, but useful to also reduce fluctuations in agricultural income (European Commission 2001: 74, COPA/COGECA 2002: 4).

Given that 88% of the Mexican Trade is with the USA, it is important to discuss how Mexico’s trade partners manage crop insurance subsidy, since decisions taken by them affect both the whole Mexican economy but specially the agricultural sector (Saldana-Zorrilla 2002: 161), under the current open-economy framework of the Mexican economy. Canada means 2% of Mexican total trade, followed by Germany (1.1%) and Spain (1%). In addition, this appendix describes briefly crop insurance systems in some developing countries to get a broader picture on how they manage their disasters risk under the restriction that very scarce resources imply.

USA

The 1996 Farm Bill removed traditional price and income supports to farmers in the USA. Instead, the crop insurance program expanded coverage from only covering losses from shortfalls in crop yield to cover losses in gross revenue (Skees 2000: 2). Solely in 2001, budget for crop insurance increased 40% compared to 1999. The crop insurance subsidy reached 3, 400 US million for that year in the USA, whereas in Mexico it did not exceed 32 million, 0.9% to the USA system. CAT coverage is totally subsidized, and the maximum subsidy accounts at 41.7% of premium price. Farmers in the USA can obtain a minimum level of insurance coverage (CAT coverage) for a nominal administrative fee (USD 60 in 1999). Crop insurance is used by 30-36% of farmers in the USA – and 69% makes use of a governmental program (Harwood 1999: Annex C1). Crop insurance subsidy embraces 75 different crops. CAT pays indemnities if yield crop is below 50% of average yield and covers 55% of a maximum fixed price. In addition, producers can contract other premiums to hedge 50-75% of crop’s yield through private insurance. Since 1994, the CAT system includes a complementary crop disaster assistance program for non-insurable crops, which transfers risk through private reinsurance companies (Harwood 2000).

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65 To make reference to this groups, Skees (1992) uses the term Rent-seekers, to mean those people who seeks the change the rules in a political economy so that they can obtain income streams from government.
66 Subsidies for Crop Insurance Premiums are the only ones allowed by the World Trade Organization.
67 However, some crops are excluded (e.g. citrus fruits, pears, peppers, plums and flax)
Canada

In Canada, three different programs provide basic coverage for yield and income risk in farming: the Crop Insurance Program (CI), the Net Income Stabilization Account (NISA), and the Agricultural Income Disaster Assistance (AIDA). Province governments are responsible for management and operation of the subsidy to crop insurance. The federal government provides 60% of funding and provinces 40% (1.8 US billion in 2000). Coverage varies between 70-90% of average crop yields over a 10 to 15 year period. Since its implementation, governmental support has represented 56% of total indemnities payments (OECD 2000: 37).

Canada experienced a failed incursion in implementing crop revenue-insurance programs. The Gross Revenue Insurance Plan (GRIP) provided indemnity payments to farmers based on the shortfall between market revenue and the target revenue for crops. The government financed 66% of the plan and farmers contributed with the rest. But over 4 years of implementation, the plan accumulated a 1 billion deficit. Some critics identify its failure in the lack of market orientation, moral hazard, and costly for taxpayers (Hume et al 1997).

Germany

Germany has no direct crop insurance subsidy, but pays indemnities to farmers in case of disaster transferring the risk to the derivatives markets. Based on the Chicago Board of Trade (CBT), the Warenterminbörse Hannover makes contracts of futures for agricultural commodities. The market includes potatoes, hogs, wheat, rapeseed, rapeseed meal and rapeseed oil. Nevertheless, the coverage seems to be still low in terms of traded volume. For instance, traded wheat and hogs (the most representative ones) in 1999 reached only 2% and 3.5%, respectively, of the market (EC 2001: 22)68.

Spain

In Spain, 40% of agricultural surface is covered by an insurance scheme, and the public subsidy to premium fluctuates between 8 and 45%. ENESA (Entidad Estatal de Seguros), the Public Insurance Agency at the Ministry of Agriculture, is responsible for establishing the parameters and for granting the subsidy. Insurance contracts are delivered to framers by means of participating private insurance companies. These companies integrate Agroseguro (Agrupación Española de Entidades Aseguradoras de Seguros Combinados S.A.), which manages the system, sets specific tariffs, conditions, pool premiums and the subsidy amount (OECD 2000: 37). Independent experts hired by Agroseguro assess and evaluate claims. Reinsurance is mainly provided by Consorcio de Compensación de Seguros, a public company –which also offers a broader reinsurance plan to private companies. Large international reinsurance companies reinsure the whole insurance system in turn. As most European Union countries, Spain has a long standing experience in mainly hail insurance, whereas futures, mutual funds and option markets are less implemented.

Chile

Chilean agriculture suffers of recurrent frosts, droughts and heavy rains. The Ministry of Agriculture established in 2000 the agricultural insurance, managed by Comite de Seguro Agricola (COMSA), and operated by private insurance companies.\(^69\) Crop insurance in this country embraces climate and market risks by means of the Red de Seguridad Agricola (Agricultural Security Net) and Fondo de Estabilizacion del Seguro Agricola (Stabilization Fund for Agricultural Insurance), respectively. The subsidy consists of financing 50% of net premiums on average, plus a fix fee (ca. US$ 36) per insurance contract. For small-scale producers, the subsidy covers 80% of the premium price; for medium 50%; and less than 50% for large scale farmers. The subsidy covers up to US$1,320 per farmer by agricultural season, covering most crops types, and it is expected soon to expand coverage to fruits, oilseeds, grapes, flowers, and livestock. The net weighted coverage of the subsidy is estimated at 54% in year 2001, and covered 26,214 hectares. US$ 400 mill were disbursed in premiums subsidies in 2001, similar compared to USD 350 mill in Mexico for that year, but too low in per capita terms - around one fifth of subsidy to Chilean farmers.

India

The National Agricultural Insurance Scheme (NAIS) was introduced in 1999 to replace the former Comprehensive Crop Insurance Scheme in India. NAIS covers all crops types, regardless cropping scale.\(^70\) Small-scale producers and marginal farmers are granted with subsidies at 50% of the premium, sharing the cost 50-50% State and Central Governments. The subsidy in premium is phased out over a five-year period. In 2001, 18 of 36 Indian states had joint the scheme. Livestock insurance is provided by the General Insurance Corporation of India, and covers either an agreed insured sum, or up to 100% of the animal’s market price. NAIS covered over 6 million farmers during the agricultural season 1999-2000, equivalent to US$14 million expenditure from governmental budget to support premiums.

Argentina

Only 7.7% of cropland is covered by insurance in Argentina (2 of 26 million hectares), and the government is not subsidizing crop insurance mainly due to budgetary constraints in the country exacerbated after the recent economic crisis in this country. 70% of existing insurance contracts cover exclusively hail, almost 29% multi-peril, and 1% livestock. Despite the fast growing of the crop insurance market during the last three years (annual 12%), insurance coverage is still expensive for producers: premiums cost fluctuates between 3 and 6% of production costs. For the last five years, increasing pressure from social and economic actors demand the government to implement crop insurance subsidy in light of the increasing risk associated to the adoption of enhanced technologies in the fast-growing Argentinean agriculture. The exports boom of agricultural goods (mainly soy bean) and livestock to China over the past three years has

\(^69\) COMSA is a small agency (five professionals plus three administration personal), which works together with a Technical Commission, integrated with representatives from the government, farmers, and insurance companies

\(^70\) Including food crops, oilseeds and horticultural crops.
generated unexpected revenues to the country, which is the main argument to give agricultural some subsidies in return.

**Uruguay**

Uruguay is a country without subsidies granting for crop insurance but with high coverage. During the 70s and 80s, self-insurance (*autoseguro agrícola*) had been the most employed crop insurance instrument. Self-insurance is a shared-risk pool funded by farmer’s arrangements. This instrument has been covering especially hail risk of mainly winter crops. The increasing disasters occurrence experienced over the eighties demanded more complex instruments to face that higher hazard exposure. It motivated the emergence of new insurance companies to leave behind the state monopoly in the crop insurance market (*Banco de Seguros del Estado*). Uruguayan government does not provide any subsidy so far, but however insurance coverage is greater in Uruguay than in most subsidized agricultural schemes in the world.
CHAPTER 5: Stakeholders’ views in reducing vulnerability

The purpose of this chapter is to examine how natural hazards and stressors derived from liberalized trade, affect agricultural livelihoods and the implications of these stressors upon the poor in the agricultural sector. Special emphasis is given to the effects of natural disasters on migration patterns. In addition, this chapter aims at assessing policy options to reduce the vulnerability of small-scale farmers (e.g. government-supported insurance schemes) within the framework of the governmental withdraw from directly subsidizing the agricultural sector over the past 18 years.

To further this aim, this part of the research makes use of stakeholders’ consultation and descriptive analysis in three communities in Southern Mexico, presenting how subsistence agricultural livelihoods cope with natural hazards and adapt to stressors derived from liberalized trade, suggesting stakeholders-based solutions. This chapter aims at verifying at local level part the conceptual discussion and aggregated description of the previous chapters. In addition, the empirical evidence from this field work provides grounding to specify the spatial model presented in chapter 6.

5.1 Introduction

The Mexican rural population lives predominantly in poverty and is vulnerable to a number of increasing hazards in terms of variety, recurrence and severity. Rural poverty is a complex issue with ancient causes (e.g. entitlements system) but can also be explained by recent changes and dynamic processes (e.g. economic policy and weather-related disasters). Analyzing the relations between rural poverty, natural disasters, trade and agricultural policies at national, regional and community levels is crucial in assessing vulnerability in a comprehensive manner. As discussed in chapter 2, vulnerability implies a coupled human-environment systems’ interaction, where hazards are considered threats to the system. There is an increasing number of scientific works underlying the relevance of analyzing these hazards as an interacting and integrated complex process, whose stressors and perturbations can be multiple and act simultaneously (Downing and Patwardhan 2003, O’Brien and Leichenko 2000).

This chapter presents empirical results about the exposure to hazards derived from stakeholders’ interviews and a survey in Southern Mexico, highlighting the complex processes lying behind rural vulnerability and identifying priorities to attend. The survey was undertaken between October 2004 and January 2005 in three rural communities in the state of Chiapas based on questionnaires applied to subsistence farmers, as well as

De los ranchos bajaba la gente a los pueblos; la gente de los pueblos se iba a las ciudades. En las ciudades la gente se perdía, se disolvía entre la gente. «¿No sabe ónde me darán trabajo?» «Sí, vete a Ciudad Juárez. Yo te paso por doscientos pesos... »

JUAN FULFO, Paso del Norte
face-to-face interviews with community leaders and local authorities. The purpose of this survey was to assess the perception of stakeholders regarding farmers’ vulnerability, to analyze their preferred coping strategies, to investigate the scope and role of public intervention in dealing with their hazards, and to find possible stakeholders-based solutions.

The core questions addressed in this chapter are: Do farmers perceive that natural disasters and trade liberalization are significantly affecting their incomes? What are the current roles of the government, the private markets (e.g., insurers), the farmers and other stakeholders in coping with the adverse outcomes from natural disasters and income uncertainty of subsistence farmers? Besides other factors, is disasters affectation influencing farmers’ will to emigrate? In their perception, how can the government contribute to reducing agricultural and disaster vulnerability, including public transfer schemes (poverty reduction and productivity support) and risk transfer and loss-sharing schemes?

This survey’s emphasis is in capturing a spectrum of coping strategies as response to the negative effects from natural disasters under the framework of trade liberalization and limited governmental facilities to agricultural production, commercialization, and financial services in Mexico. The coping strategies encompass both immediate responses, e.g. sources of non-farm income, post-disaster financing sources, and emigration plans, as well as those more structural and long-term strategies, like productive re-orientation and productive infrastructure improvement. Also, some open questions are included to investigate the need and viability of implementing crop insurance, mitigation measures and productive re-orientation to reduce the vulnerability to disasters under the framework of uncertain rural incomes. These open questions were also highly valuable in providing highlights into the effectiveness of public policies on improving livelihood conditions. These results also show how farmers’ coping and adapting strategies are being highly conditioned by past policy decisions, in some cases even hindering farmers from overcoming poverty and amplifying the negative effects of the natural disasters. The next section of this work presents a brief description of the hazard exposure and policy context in order to identify the main hazards and stressors affecting farmers’ in Mexico. Both the third and fourth section presents subsistence farmers’ consultation. The third section describes methodology, and presents hazard exposure of the three surveyed communities to natural disasters and unstable markets. Section four shows the main results concerning preferred coping and adaptive strategies to deal with hazards. In this section, current public instruments to deal with natural disasters are also expound and it assess their implementation in the agricultural sector in Mexico. The fifth section summarizes farmers’ answers to open questions, presenting their main suggestions to reduce vulnerability. Section six discusses the views of the community and farmer leaders, and local authorities concerning exposure in this region, as well as their suggestions to reduce vulnerability. Within these sections, a variety of research work is quoted in order to make the need for inquiring into precisely these aspects as part of this vulnerability assessment, more understandable. Finally, section seven presents some final remarks and concludes with an integral view of the exposure, suggesting a possible path for an integral, participative and viable vulnerability reduction in this region derived from the consulted stakeholders.
5.2 Background

Given increasingly adverse climatic conditions in Mexico most likely linked to climate change (Conde and Gay 1999), along with uncertain rural incomes derived from insufficient productive infrastructure, market uncertainty and price volatility (Eakin 2003), subsistence farmers are highly vulnerable and have increasingly been adopting off-farm coping strategies, such as out migration, urban informal employment, among others (ECLAC 2001). That is perhaps not a viable long-term solution to counteract the problem, but just an immediate relief. There is then a need for investigating feasible strategies to reduce that vulnerability taking into consideration these hazards in an integral manner.

If Mexico maintains current free trade conditions for agriculture, agricultural prices will likely be continuously depressed. In 1986, Mexico began a trade liberalization process. First, with the adherence of the country to the GATT (now WTO), and most important after NAFTA, agricultural prices have dramatically decreased, especially those of maize, the basis of Mexican agriculture. Despite the fact that low prices are an advantage to maize consumers, price drops have affected most farmers’ incomes given their technical and financial inability to change to more rentable crops (Yunez-Naude and Barceinas 2003).

In addition, natural disasters are increasingly causing damages to Mexican agriculture, especially to subsistence farmers. Serious natural hazards include, roughly, droughts in the North of the country and flooding in the South. Weather-related events have caused 80% of total loss over the period 1980-2005, and agriculture has been the most damaged sector by these events. Data from the National Institute Statistics (INEGI 2005) indicates that in Mexico, ca. 80% of harvested hectares are rained. This fact reveals a high dependence of agricultural production from meteorological phenomena. In addition, rural credit granting, commercialization services and crop insurance are no longer facilitated from the government (as until the 80s), and private sector mechanisms are taking their place. However, subsistence farmers are often not eligible, as the case of credit granting, or their prices are unaffordable to them, such as crop insurance primes, storages, freight, etc. Remarkably dramatic is the reduction in insured cropping area after the government withdraws from providing direct crop insurance services to farmers (Hernández 1997, Wodon and Velez 2000). Whereas during the 80s insured cropping area reached 40%, during the present decade it dropped to only 10%.

As pointed out by Linerooth-Bayer and Vari (2004), the lack of a risk-sharing mechanism, i.e. cross-subsidization insurance from better-off farmers cropping in low-risk areas, along with insufficient incentives to promote loss-reduction incentives, i.e. risk mitigation works, contributes to amplify the negative consequences from extreme events. Following disasters, subsistence farmers get directly affected given their net losses in capital stock and incomes flows, it is costly to the government as recurrently has to spent in relief to the poor and infrastructure rebuilding, and less resources are thus available to undertake public investments in the agricultural sector as a whole.
5.3 Communities profile and hazards exposure

The selected communities are Cacahoatan, Escuintla and Cintalapa, located on the coast of Chiapas, the poorest state in Mexico, in the region known as Soconusco. The Soconusco region is located at the Pacific Ocean coast, bordering Guatemala, and is the gate of Mexico to Central America. Historically, the region has been highly affected by excess of moisture, and the most recurrent natural disasters have been (1) heavy rains; (2) winds; (3) hurricanes, and (4) landslides. The main crops in the region are coffee, maize and banana, which have suffered price reductions during the past 15 years. According to the Mexican National Council of Population, our three surveyed communities are classified as highly marginalized (CONAPO 2004). Also, 42% of the population in Cacahoatán and 50% in Escuintla and Cintalapa lives in extreme poverty according to estimations from the Ministry of Social Development (SEDESOL 2005). Both questionnaire description and communities profile below introduce to the further sub-sections presenting the main quantitative results from multiple choice questions investigating coping and adaptive strategies.

5.3.1 Questionnaire description

The questionnaire was applied in Spanish language, anonymous, and comprised of five sections: the initial section is on general information of the interviewees, i.e. age, land tenure, access to irrigation and credit, etc.; the second section is about natural disasters affectation, financial response and coping strategies; the third section inquires into issues of foreign trade, commercialization and crops diversification; out migration patterns and trends are investigated in the fourth section, and a final section of the questionnaire was left to questions concerning farmers’ suggestions to reduce vulnerability. The questionnaire asked both multiple-choice and open-ended questions. The total number of questions is 35, distributed in 6 pages (see Appendix 2). Average time to answer the questionnaire was 40 minutes. In cases when the farmer was analphabet (ca. 1 in 20), answers transcript was done. Two thirds of the questionnaires were distributed to groups of farmers at the end of the 2 forums we held in auditoriums belonging the city hall (in Cacahoatan and Escuintla). The rest was distributed house by house (in Cintalapa), where the questionnaire was just left and one hour later picked it up and helped to make questions more understandable when needed. The survey sample is comprised of 151 households, mostly small land holders, who rely heavily on self-consumption agriculture. A total of 66 questionnaires were applied in the community of Cacahoatán, 47 in Cintalapa, and 38 in Escuintla, which represents 15% of subsistence farmers’ population per community.

71 Concerning real decrease of maize and other crops during the past 15 years in Mexico, see the World Bank assessment on economic performance of Mexico after 15 years of NAFTA implementation (Lederman et al 2003).
72 Porcentaje de pobreza alimentaria municipal total.
73 Confidence interval of 95% for land size: 5.17 +/- 3.58, in other terms, P (1.59 < μ > 8.75).
5.3.2 Communities profile

Inhabitants of these three communities rely predominantly on subsistence agriculture cropping small farms. They make increasingly use of complementary sources of income as the farm size decreases.

5.3.2.1 Land property and tenure

The mean land size is 5.2 hectares, the mode is 0.1 hectares (13% of the sample), and 75% of interviewed farmers owns less than 5 hectares (see dotted line in Figure 14). In sight of these characteristics, one can consider that we are here dealing with mainly subsistence farmers.\footnote{By “subsistence farmer” we mean an agricultural unit that provides enough food for the farmer and his family but not enough surplus for regularly trading or to make significant investments to enlarge production scale. In this regard, FAO considers subsistence agriculture as “a cropping system where farm production of the land is predominately consumed by the farmer and his extended family” (Eaton and Shepherd 2001).}

Figure 14. Land distribution

However, land size distribution varies among communities. Cacahoatan has stronger small-scale farming: 98% of interviewed work 5 ha or smaller lands. Land size distribution in Cintalapa has more extreme values: 63% of interviewed hold less than 3 ha and the rest 9 ha or more. Finally, Escuintla’s land size distribution posses less extreme values, as seen in figure 15 below.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{land_distribution.png}
\caption{Land distribution}
\end{figure}
The predominant land tenure is *ejido* (80% of interviewed), which is a subtype of communal land, followed by private (13%). Eighty percent of the interviewed owned their land and 13% rented (see Appendix 3).

### 5.3.2.2 Age and sex

The mean age of the surveyed population is 43.7 years; 80% are 57 years old or younger. 72% are male and 26% female. The latter bias is due to the fact that in Cacahoatan and Escuintla the questionnaires were answered upon invitation to meet in a specified place. There came mostly men, since many women had to take care of the children at home. By contrast, in Cintalapa the questionnaire was delivered and picked up directly house by house, and in this case there was found an almost 50-50% sex proportion. After all, this bias to masculine may be even positive, since in this region men are the most involved in direct farming.

### 5.3.3 Communities exposure

The three surveyed communities have recurrent affectation from natural disasters, high marginalization conditions and subsistence agriculture is the predominant livelihood. Also, hard cropping conditions characterize these subsistence farmers, such as extremely small landholding, low technology usage, scarce access to credit and insurance, as well as they rely on mono-crop agriculture at a large extent.

### 5.3.3.1 Natural hazard exposure

In terms of natural disasters, historical registers show recurrent disasters affectation in the region, especially during the last fourth-month of every year. On September 1998, the communities of Escuintla and Cintalapa suffered of heavy rains and
flooding causing thousands of victims and millions of dollar in economic losses (CENAPRED 2001). Unlike these communities, Cacahoatan has less dramatic but more frequent natural disasters, experiencing economic losses from heavy rains on average once a year. In addition, in the last years this region has been experimenting unusual climatic conditions: drought years in coastal areas along with heavy rains in the mountains (Sierra Madre de Chiapas), which are turning more extreme.

These three communities are characterized by a warm humid climate, with rains during most of the year in costal areas and usually affected by hurricanes in summer and autumn and by summer-autumn rainy season in the mountains. For instance, on last October 2005, as consequence of hurricane Stan, nearly 600,000 people in the whole region Soconusco got directly affected by flooding and sudden river overflowing. High economic losses were especially reported in Escuintla, but also in Tapachula, Motozintla and Huixtla.

5.3.3.2 Exposure from low diversification

Mono-crop regions are, on the one hand, positive in that of exploiting local comparative advantages (as in the standard model of trade based on David Ricardo postulates –Krugman and Obstfeld 1997), producing scale economies, as well as due to the benefits derived from high specialization in the sense of the work division of Adam Smith, particularly emphasized by the economic neo-classical approach.

![Figure 16. High dependence from maize and coffee](image)

<table>
<thead>
<tr>
<th>Product</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>maize</td>
<td>46.36%</td>
</tr>
<tr>
<td>coffee</td>
<td>41.06%</td>
</tr>
<tr>
<td>beans</td>
<td>0.66%</td>
</tr>
<tr>
<td>cocoa</td>
<td>0.66%</td>
</tr>
<tr>
<td>chicken</td>
<td>0.66%</td>
</tr>
<tr>
<td>beef</td>
<td>0.66%</td>
</tr>
<tr>
<td>milk</td>
<td>0.66%</td>
</tr>
<tr>
<td>mango</td>
<td>0.66%</td>
</tr>
<tr>
<td>cattle</td>
<td>0.66%</td>
</tr>
<tr>
<td>maiz e</td>
<td>0.66%</td>
</tr>
<tr>
<td>seeds</td>
<td>0.66%</td>
</tr>
<tr>
<td>prod1</td>
<td>0.66%</td>
</tr>
</tbody>
</table>
On the other hand, mono-crop implies risk when the respective commodity markets turns highly volatile or price drops dramatically. As Benson and Clay (2002) point out, mono-crop economies must face vulnerability from not only natural disasters, but also those associated to world trade uncertainty due to non-diversified export products of primary commodities. The main agricultural products of the interviewed sample are maize (46%) and coffee (41%) –see Figure 16. The latter can be considered a vulnerable point to this group, given the decreasing prices of maize and coffee experienced during the last 15-20 years. Also, only 13% and 17% of the interviewed has access to irrigation and credit granting, respectively.

From the total interviewed in our three communities, 43% has an alternative source of income other than agriculture. Rural services are the main alternative activity (28% of alternative activities), which means working for other farms. The second alternative activity (16%) is construction activities, which usually means working as a building worker in the nearest urban area. The third alternative activity (12%) is remittances, 5% of the total interviewees listed this as an alternative sources of income. Most people that receive remittances have relatives abroad. They, themselves, have plans to emigrate from the community. Less important alternative sources of income are business, technical assistance and trade (see Figure 17).

![Figure 17. Sources of additional incomes](image-url)
Another observation concerning additional income is that as the farm size decreases, the dependence on agriculture derived income also decreases. Figure 18 shows graphs where on the horizontal axis the farm size, and the vertical axis the number of cases of the respective dependence on agricultural income. Farmers whose rely less on agricultural income are those with relatively small farms. As further addressed in section 3.4.2, this income structure is crucial after natural disasters affectation given subsistence farmers’ little access to credit granting. Thus, they have difficulties in replacing their lost in stock of capital and upgrading their capital goods (machinery, tools, etc.). Subsistence farmers cannot then crop more intensively after disasters –given their lack of access to credit- nor more extensively -given their full land usage. Their need to find an alternative job is thus greater on small farms.

**Figure 18. Importance of agricultural income at different production scales**

5.4 Farmers’ coping and adaptive strategies

In the sustainability science, an important component in vulnerability assessments is coping and adaptive capacity. Coping capacity can be defined as the ability of a unit to respond to a harm occurrence as well as to avoid its potential affectation, and adaptive capacity is the ability of a unit to gradually transform its structure, functioning or organization to survive under hazards threatening its existence (Kelly and Adger 2000). After persistent or major natural disasters, coping and adaptive capacity of the most vulnerable economic units is taken to the limit. If they do not have access to credit or to further mechanisms to re-activate their production or to restructure their productive processes towards less vulnerable conditions, as usually happens with subsistence
farmers after disasters, when their expectations of future incomes become pessimistic. The present section investigates preferred coping and adaptive strategies in these communities, exploring the scope of farmers’ coping strategies, like emigration (Section 4.1), family and neighbor’s solidarity and institutional financial support to cope with negative outcomes from natural disasters (4.2), expounding the main public financial instruments to deal with natural disasters in Mexico. Section 4.3 assesses the contribution of social programs in improving living conditions and expectations. Section 4.4 addresses farmers’ perception regarding foreign trade as stressor in the region. Section 4.5 analyzes potential benefits from productive re-orientation, e.g. crops diversification, as an adapting strategy.

5.4.1 Emigration

One of the main findings is that communities recurrently damaged by natural disasters but without formal financial mechanisms to respond tend to have more pessimistic expectations about future incomes. In turn, they consider out migration more seriously as a coping mechanism. These communities were even more pessimistic than those with lower assets. So, migrating is not a question of just poverty, but of expectations. Also, in these communities the presence of „travel agencies“ aimed at transporting emigrants to Tijuana (3,5000 km away from these areas) was stronger, which is the pass to cross the Mexican border to the USA, as evidenced in Cacahoatan, state of Chiapas.

Emigration as a coping strategy thus seems to correspond more to expectations of future incomes rather than to poverty itself. These findings provide empirical evidence to postulates on emigration by Todaro (2000). According to Todaro, migration is primarily an economic phenomenon, which for the individual migrant can be a rational decision despite the existence of urban unemployment. The Todaro model postulates that migration proceeds in response to rural-urban and national-international differences in expected income rather than actual earnings. That decision is taken in order to maximize their expected gains in life and, for a given time horizon the urban sector or jobs abroad, respectively, result more convenient. In other words, if coping and adaptive capacity of vulnerable economic agents is exceeded in their locations, they find emigration to higher income regions as their best alternative –even despite the presence of restriction to labor mobility and hard conditions to cross borders illegally in the case of international migration.

Emigration patterns

At national level, out migration in Mexico has increased over the past two decades. The Population Census of 1990 reports that 0.24% of Mexican population was residing abroad, whereas in the 2000 Census this figure rose to 0.41% (INEGI 2005). Currently, Mexico is the first country of origin of migrants to the USA, where nowadays 1 of each 3 migrants was born in Mexico (ca. 12 million), integrating the first majority migrating community in the whole USA and in 31 of the 50 states of the American Union (Center of Migration Studies of Washington 2003, US Census Bureau 2002).

The share of population living abroad in the municipality of Cacahoatan (0.53%) is clearly higher than the national average in year 2000, whereas the municipality of Escuintla has a lower level (0.36%), though both cases above levels of out migration in
the state of Chiapas (0.15%). Total emigration (domestic plus international) in Cacahoatan and Escuintla reaches 1.48% and 1.34%, respectively. 75

In general, 41% of the interviewed stated current plans to emigrate. The correlation between people with plans to emigrate and those affected by natural disasters is only 0.77. However, the correlation increases until statistically significant values in the case of the variables “number of natural disasters in the past 10 years” and “relatives migrated due to natural disasters.” In this case the correlation is 0.25, which is significant at the 0.05 level (2-tailed) (see Table 10 below).

The correlation coefficient between the variables “Plans to emigrate” and “Relatives living abroad” is 0.321, significant at the 0.01 level (2-tailed) under Pearson’s correlation test. However, the test of correlation of “plans to emigrate” shows higher values when tested with the variable “relatives migrated due to natural disasters”. The latter variable represents the presence of relatives which have used emigration as a coping strategy after loss of assets and/or productivity due to natural disasters. The value of the correlation test for these variables is 0.341, slightly higher than having relatives abroad in general.

These correlations provide empirical evidence that support: (1) natural disasters have increased emigration; (2) farmers’ plans to emigrate are influenced by the presence of relatives living abroad, but that influence is even higher if these relatives emigrated due to disasters, and (3) recurrent natural disasters in the past ten years together with relatives emigrated due to disasters increase the probability of farmers’ plans to emigrate. Emigration is thus an important coping strategy by people in these communities.

### Table 10: Correlations between plans to emigrate, disasters, and relatives living abroad

<table>
<thead>
<tr>
<th></th>
<th>PlansEmigr</th>
<th>RelatAbroad</th>
<th>RelatEmigrDis</th>
<th>MNatdis3</th>
</tr>
</thead>
<tbody>
<tr>
<td>PlansEmigr</td>
<td>Pearson Correlation</td>
<td>1</td>
<td>.321(**)</td>
<td>.341(**)</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.001</td>
<td>.001</td>
<td>.426</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>123</td>
<td>112</td>
<td>91</td>
<td>110</td>
</tr>
<tr>
<td>RelatAbroad</td>
<td>Pearson Correlation</td>
<td>.321(**)</td>
<td>1</td>
<td>.378(**)</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.001</td>
<td>.000</td>
<td>.600</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>112</td>
<td>122</td>
<td>93</td>
<td>109</td>
</tr>
<tr>
<td>RelatEmigrDis</td>
<td>Pearson Correlation</td>
<td>.341(**)</td>
<td>.378(**)</td>
<td>1</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.001</td>
<td>.000</td>
<td>.013</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>91</td>
<td>93</td>
<td>105</td>
<td>98</td>
</tr>
<tr>
<td>MNatdis3</td>
<td>Pearson Correlation</td>
<td>.077</td>
<td>.051</td>
<td>.251(*)</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.426</td>
<td>.600</td>
<td>.013</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>110</td>
<td>109</td>
<td>98</td>
<td>133</td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

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75 Own estimations with data from Sistema Municipal de Bases de Datos, INEGI (www.inegi.gob.mx). One must also take into consideration that official registers tend to hide migratory moves taking place in two stages, that is, migrants that first move on to domestic cities and after a while move on abroad.
Of the interviewed sample with plans to emigrate, 95.6% also gave a preferred place to emigrate. The most popular destination is the United States of America (USA), which was 15% of the total interviewed population, and 37% of the interviewed population with intention to emigrate (see chart below). One third of the total interviewed would recommend a relative to emigrate given the current conditions.

The interviewed were also asked whether they have relatives living abroad. To this question, 37.75 answered positively, of which 96% said they live in the USA, equal to 36% of the total. It reflects the clear concentration of Mexican emigrants in the USA.

Also, from the interviewed farmers with plans to emigrate, 83% and 92% did not have access to irrigation and credit granting, respectively, and 94% had no export crops.
5.4.2 Financing sources for disaster risk and vulnerability reduction

As discussed in Chapter 2, economic vulnerability is the susceptibility of an economic agent to absorb negatively exogenous shocks, given its assets possession and productive capacity, its level of knowledge and information, and its implemented options to avoid, manage, or smooth negative effects from a particular shock, under the framework of an entitlement system. Reducing economic vulnerability consists basically on implementing the due changes in time to minimize negative effects from exogenous shocks upon economic agents’ assets by strengthening constituting elements of vulnerability and/or improving risk management strategy (Saldaña 2004). In the concept of risk, the susceptibility of the exposed unit is something given, and for that reason risk reduction focus more in prevention, preparedness and in general in measures to reduce the probability of harmful outcomes, but which do not imply major changes to the exposed unit itself. However, vulnerability reduction embraces these measures and additionally integrates changes to the exposed unit, such as strengthening its coping and adapting capacity, which involves multiple socioeconomic interactions, i.e. entitlements systems, empowerment, assets distribution, as well as human-environmental relations, i.e. land use change, water management strategies, etc. The present sub-section focuses rather in risk reduction, what will be integrated in the last two sections into the broad vulnerability analysis.

5.4.2.1 Financing sources in surveyed communities

Given the variety of public financing sources to reduce disaster risk in the country presented in chapter 4, how important have they been compared to community-based
sources in the views of our interviewees? So, the questionnaire asked farmers about the importance of different financing sources to recover from natural disasters. The chosen options in order of importance to them are as follows (for further details on questionnaire contents, see Appendix 2):

a) Help of relatives from the community  
b) Governmental humanitarian aid  
c) Neighbor solidarity  
d) Possessions sale  
e) Help of relatives from other places in Mexico  
f) Help of relatives from abroad  
g) Governmental fund for property rebuilding  
h) Private Humanitarian aid (associations, donors, etc.)  
i) Land sale  
j) Communal loans  
k) Private loans  
l) Public loans  
m) Private insurance  
n) Public insurance  
o) Insurance fund (Fondos)  
p) Public subsidized Insurance  
q) Other

The interviewees evaluated their disaster financing sources by specifying from 1 to 5, where 1 means irrelevant and 5 very important. This ranking is shown in Figure 21 below. “Relatives in the community” was the most important post-disaster financing source, receiving the highest summed score (332), followed by governmental aid (270) and neighbor solidarity (266). Less important was the sell of property (207); governmental fund (173); the sell of land (170), and community loans (161). The importance of relatives living in the same community and aid from the government underlines the high dependence on ex-post financial instruments. Finally, the four types of available insurance –private, public, Fondos and subsidized- were ranked as the lowest disaster financing source.76 Also, governmental repair of public infrastructure was perceived as governmental aid by an important share of the interviewed.

76 Consider that no major natural disaster had affected this region between FAPRACC establishment in 2002 and the application of this questionnaire in January 2005. After the flood tragedy in September 2005, this community perception –about relevance of governmental support and public insurance- could have changed depending on the performed governmental response following this disaster.
5.4.2.3 Perception of responsibility to reduce vulnerability

As shown in Figure 22, the interviewed population perceived the government as mainly responsible for reducing vulnerability to natural disasters in the region. The Federal government was considered as most responsible even over the state government, with summed ranking of 601 and 550, respectively. That perception could be attributable to the fact that until the early 90s the Federal government centralized heavily the public intervention. In fact, such a perception does not contradict the current state of the risk management in Mexico, since the Federal government transfers most of the resources for disaster reduction to local governments (state and municipal). As discussed above, local governments are required to identify disaster risk and vulnerability under this system as condition to obtain federal funds to carry out prevention measures under FOPREDEN and FAPREACC. Derived from comments of farmers’ leaders and local authorities, we also found that in practice local governments do not make use of those available federal resources mainly due to the lack of concrete research on risk and vulnerability at state and municipality levels (further details in section 5 below).
Who should provide support to reduce vulnerability to disasters?

![Bar chart showing scores for various entities](chart.png)

**Figure 22: Views on responsibility to reduce vulnerability**

It is noteworthy that *Fondos* received a relatively low score, which may reflect the lack of promotion and uptake of *Fondos* insurance among subsistence farmers in this region. In a subsequent question, the interviewees were asked to specify which other authorities should be responsible. Most answered “municipality,” which reflects the explicit demand of these people to get municipal authorities more involved in the reduction of disaster vulnerability given that they know better the local concerns.

These results keep some similarities with the public survey in Hungary from Linerooth-Bayer and Vari (2004), which shows the strong presence of paternalistic views from the citizens about the state assuming responsibility of their well-being, and more concretely concerning flood risk reduction. As in the present study, Hungarian interviewees considered the central government as the main responsible rather than the own population living in disaster prone areas.

**5.4.2.4 Insurance versus credit granting in inhibiting out migration**

Having insurance appears not to make a difference in the intentions to emigrate. 71% of farmers with some percentage of crops insured still have plans to emigrate. However, access to credit seems to be relatively more important in lessening emigration plans. Only 28% of farmers with credit granting expressed a will to leave the community. It should be kept in mind, however, that the number of farmers with access to credit in the sample is 2.5 fold higher than that with insurance. Second, unlike farmers in commercial cropping, crop insurance seems to still be a less explored strategy among

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77 These results coincide with those from Saldaña-Zorrilla and Sandberg (2005), who found positive regression parameters of disasters recurrence and low credit granting in explaining emigration in a spatial econometric analysis at municipal level in Mexico. By contrast, insurance and poverty resulted not to be relevant in explaining spatial patterns of emigration for the said study.
subsistence farmers. In general, insurance is not considered an investment among farmers. Credit, from its part, is more tangibly perceived in improving assets position.\(^78\)

5.4.3 Scope of governmental social programs

Programs aimed at reducing poverty tend to increase transfers, but they do not affect the long-term lack of assets in the current case of Mexico (Attanasio & Szekely 1999). Assets can be defined as the stock of wealth used to generate well being (Vatsa & Krimgold 2000). This concept is important when considering the effects of natural disasters, which may decrease the capital assets of households and businesses. Families have an initial asset, which generates an output. This output varies widely, depending on market price of the produced factor, and on the productivity of its use (profitability). As families pursue strategies to maximize their assets, they are in better position to enlarge their risk pool and reduce vulnerability. For authors like Vatsa & Krimgold (2000), vulnerability is a broader and more dynamic concept, which involves the poor, but also households living above poverty line at risk of falling below in case of an income shock (new poor).

Despite recent efforts of anti-poverty programs in Mexico to raise income and consumption beyond mere flows, their contribution to strengthen assets is still controversial. ECLAC (2001, p. 32) points out that social programs of poverty reduction in Mexico are merely of aid character, though if these programs were more substantial and long-term sustained, these additional resources could increase assets, as well as for instance improve ability to invest on education and other long term variables, which directly modify assets and in last instance income.

Currently, a wide variety of programs in Mexico are aimed at increasing assets from different fronts. Social Programs are integrated into the coordinating strategy Contigo, which is managed by the Ministry of Social Development (SEDESOL) and encompasses projects to support education (i.e. CONAFE, INEA, DIF), health (i.e. IMSS-Solidaridad), nutrition to poor households living in poor rural areas (LICONSA, TORTIBONO and DICONSA), among others. However, the problematic of poverty in the country is profound –especially in rural areas, as here discussed- and some negative effects from the economic policy, discussed further, seem to exceed these efforts.

Most of the interviewed (79%) perceive that, in general, the governmental support does not reach its targeted population, and 53% of them would also encourage a relative to emigrate from the community (see Table 11 below). Surprisingly, encouragement to emigrate is higher (65%) in the interviewed population stating the opposite –that the support reaches its targeted population.

\(^{78}\) Regarding this aspect, the prospect theory (Kahneman and Amos 1979) provides some explanations about behaviors, which like this one, seem to be irrational at simple judge. However, according to this theory, some economic agents valuate assets more in function of their tangibility (as in this case insurance versus credit), security (e.g. trading with a small risk but with higher gains versus keeping secure low-income self-consumption), or immediate profit (long- versus short-return investments), rather than in function of pure gains.
Table 11. Governmental support reaches target population and encouragement to emigrate

<table>
<thead>
<tr>
<th>GovSupReach * RecomEmigr Crosstabulation</th>
<th>RecomEmigr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>GovSupReach 0</td>
<td></td>
</tr>
<tr>
<td>% within GovSupReach</td>
<td>46.2%</td>
</tr>
<tr>
<td>% within RecomEmigr</td>
<td>83.3%</td>
</tr>
<tr>
<td>% of Total</td>
<td>36.6%</td>
</tr>
<tr>
<td>GovSupReach 1</td>
<td></td>
</tr>
<tr>
<td>% within GovSupReach</td>
<td>35.3%</td>
</tr>
<tr>
<td>% within RecomEmigr</td>
<td>16.7%</td>
</tr>
<tr>
<td>% of Total</td>
<td>7.3%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>% within GovSupReach</td>
<td>43.9%</td>
</tr>
<tr>
<td>% within RecomEmigr</td>
<td>100.0%</td>
</tr>
<tr>
<td>% of Total</td>
<td>43.9%</td>
</tr>
</tbody>
</table>

The latter can be interpreted both as pessimism about the return of governmental supports on future incomes regardless of their perception of accountability about the public, as well as could suggest that current support is still insufficient to counteract current structural weakness in the countryside, and that emigrating seems to be a more viable coping strategy. As discussed below in section 5, farmers’ leaders and local authorities also see with some skepticism the achievements of social programs in light of current affectation from low productivity and depressed prices in the agricultural sector besides high disasters affectation and lack of financial and technical support. These facts suggest a more cross-sectional projecting and coordinated mobilization of resources between the rural development, disasters management and the social development strategies.

5.4.4 Foreign trade

Despite surprisingly significant increases in exports due to signed trade agreements, its gains have been unequally distributed in Mexico. In some cases, as in traditional agriculture, it has even contributed to drive producers out of business, as discussed in chapter 2.

5.4.4.1 Perception about NAFTA

The 62% of interviewed farmers expressing an opinion about the benefit from NAFTA perceived a negative impact. Only 14% considered the trade agreement as indifferent to their welfare, and only one farmer (0.66%) found the agreement positive.
5.4.4.2 Foreign competitors

As shown in Figure 24, most of interviewed farmers did not answer whether there is a particular country of origin of imports threatening their production and commercialization. However, 15% of the total believed Brazilian imports affected them. This answer is probably due to the fact that over 40% of interviewed farmers are coffee growers (mainly in Cacahoatan), and Brazilian coffee is competitor. The USA is considered the second country in this ranking (9%) mainly due to its maize imports, followed by Guatemala and Costa Rica due to coffee-, and Japan got a fourth place due mainly to its rice production. Finally, coffee and maize seems to be the most exposed crops to foreign competition in the surveyed region, whose vulnerability to fluctuations in world prices is higher compared to other crops. There is a demand –expressed both in the open questions as well as in the forums organized as part of the present project- for reducing uncertainty in their prices and improving access to both local and foreign markets.
Origin of imports competing with local production

Figure 24. Perceptions on origin of concurring imports

5.4.4.3 Exports, credit and emigration

Only 9% of interviewed farmers have reportedly exported their crops, but curiously none of them reports access to credit from banks. Only 16% of total interviewed farmers have some credit, but none of them has exported. In addition, only 2.2% of interviewed farmers rely on an export union, and only one-third of them have exported. So, neither credit granting nor export unions are crucial in supporting exports in the region. Exports appear to be due to the presence of intermediaries rather than to permanent financial / institutional mechanisms. From this perspective, credit serves self consumption and domestic-oriented production. In fact, 40% of exporter-farmers have plans to emigrate abroad.

5.4.5 Productive re-orientation as an adaptive strategy

As discussed in chapter 3, the theory of Terms of Trade provides valuable elements for understanding the relevance of adverse foreign trade conditions in increasing vulnerability in the agricultural sector. To adapt to negative terms of trade within the agricultural sector, productive reorientation seems to be the due response, which means both diversifying crops to reduce the probability of getting affected given sudden prices drops in the mono-crop, as well as moving to more rentable crops, that is, whose sale prices are relatively higher, with a more stable demand and suitable to regional environmental and climatic conditions. In this regard, Gay et al (2004) analyze the high vulnerability in a coffee production region in Southern Mexico to extreme climatic conditions, which is being increasingly affecting the region, and warns about the
low viability of growing coffee in these regions once internalized some negative effects of policy changes and market instability for this sector.

Given current trends of decreasing prices of traditional agricultural products, 58% of interviewed farmers have plans to diversify to higher profitability crops. As seen above, over 87% of farmers crop maize and coffee, whose prices have been decreasing over the past ten years. In counterpart, fruits and vegetables would have a higher profitability to the farmers in this region given favorable climatic conditions and relative prices.

Based on research carried out by the World Bank, fruits and vegetables were found to have higher comparative and competitive advantages to the Mexican agricultural sector, especially to export to North-America in the framework of the NAFTA. Even when freight and insurance costs are greater in the South to export to the USA and Canada, the relative greater water availability in the South make it still very rentable (Lederman et al 2003).

5.4.5.1 Crops Diversification and emigration plans

However, as stated by most interviewed farmers and local leaders of farmers’ unions, lack of coordination between farmers and authorities impedes to get the right information and knowledge to change crops. As shown in Figure 25, Escuintla has the most farmers with plans to change crop (77%). This may be due to their relatively higher proximity to markets through the Pacific Costal Highway, as well as to better information because of proximity to the municipality’s capital. Also, farmers from this community are less prone to emigrate: 38% compared to the 52% mean value. By contrast, Cacahoatan’s farmers have the lowest propensity to diversify crops (44%), and are the most prone to emigrate (58%). It follows encouraging crops diversification might improve expectations, and could help to increase rural incomes in the region and lesser out migration tendency.79

5.4.5.2 Crops diversification and foreign trade

Only 30% of interviewed farmers have chosen an additional new crop in order to diversify. Maize and coffee were their preferred options (27% of cases). Since maize and coffee prices have dropped, this choice could be interpreted that farmers fear more the risk of cropping something new more than they crave the gains. This choice can also be explained by the lack of available information among farmers concerning more viable crops. Farmers are conscious that maize and coffee are less profitable. Coffee and maize are planned to be phased out by 85% of farmers with plans to leave a crop, especially in Cacahoatan, which is located at the hearth of the coffee axis of Chiapas. That is particularly important in sight of the total elimination of tariffs to agricultural imports from Canada and the USA to take place by the end of 2008 in accordance with the NAFTA. This is not a big concern in the case of coffee, for which these trade partners do not represent competition, but for maize, where the USA has a much higher productivity and subsidies than Mexico, as remarked by Yunez-Naude (2001).

79 In this regard, it would be helpful monitoring prices for those suitable crops to this region in order to choose those crops which increase farmers’ incomes (moving to high-surplus crops) at the time of reducing risk to both price fluctuations and natural disasters.
5.5 Farmers expectations and suggestions to reduce vulnerability: open questions

The intent of the open-ended questions was to identify expectations in the sample communities, as well as to gain some insights into possible community-based solutions to reduce that vulnerability.

5.5.1 How are you expected to recover from next disaster?

Both poverty conditions and past post-disaster financing provided in the region seem to have created adverse incentives to decrease vulnerability. Responding to the question “how are you expected to recover from the loss from the next natural disaster,” 36% of the farmers who answered stated they expected governmental support, whereas 31% said they will work more intensively or look for better trade conditions (price improvements). Further, 22% said they had no plans, and most of these respondents hoped for God’s help. Only 3% expected to receive credit. Very few of the interviewed farmers mentioned insurance as an instrument to recover from disasters (see Figure 26).

Only a few interviewed farmers (3%) expected to reduce their potential loss from the next natural disaster because of current disaster prevention measures (especially warning systems). Only 2% of respondents maintained any of the following ways of preventing and recovering from the next disaster: indemnity payment from their insurance contracts, help and solidarity from the community, and reducing the risk by means of crop diversification.
The hope for governmental post-disaster financing is widespread, especially in farmers over 40 years of age. Credit and insurance were the expected response of farmers under 52 years of age. By contrast, crop diversification and prevention arise from relatively younger farmers, aged 29 on average.

![Figure 26. Expected financing sources to forthcoming natural disasters](image)

5.5.2 How would you suggest that the government reduces vulnerability to natural disasters in your community?

The answers to this open-ended question can be classified in four groups: those related to (i) mitigation works, (ii) insurance and credit granting, (iii) production factors, and (iv) warning systems.

(i) Mitigation works

Farmers in the community of Cintalapa insisted in the need for constructing a retaining wall at the edge of the Cintalapa River (see Figure 27 below). On average, this river overflows once in four years. The last overflow in 1998 washed away dozens of crops and buildings in the community, including houses, a school, and a hospital (picture 2). Farmers of this community complained in their questionnaires about the lack of response from the government about their demands for a mitigation work (e.g. to channel the river, retaining wall) to prevent the river from overflowing in the rainy season.
Many of interviewed suggested that they serve as voluntary workers to build the mitigation work. In such a case they would require only machinery and raw materials from the government.

There are concerns about the lack of continuity in mitigation works after a new public administration comes in office. Some farmers suggested direct governmental

Figure 27: Flood risk in Cintalapa, Escuintla. As seen in the picture, when rains in the highlands increase, the river flows through the rocky area (low-right side of the image), and inundates the community.

Figure 28: Devastated area by the Cintalapa River overflowing in 1999. Previously, there were dozens of houses in this area, which were washed away by the flow taking a number of human victims. The red dotted line shows the seven meters of land lost to the flow in the community Cintalapa.
assessment to identify assets at risk and to establish a fund and corresponding program to provide raw materials and technical support to retrofit, redesign, and/or strengthen weak infrastructure even after the administration changes. Some farmers reported on the visit of engineers to initiate public works, but they never got materialized. This may be due to the lack of continuity after changing public administration in the region.

(ii) Insurance

A frequent suggestion mainly in the community of Cacahoatan was insurance to reduce farmers’ asset vulnerability from natural disasters. However, some farmers expressed their willingness to establish micro-insurance only if the government pays 100% indemnity in case of disaster. This reflects a lack of understanding of Fondos and FAPRACC. If these farmers would have information about the existence of these instruments, they would not have to suggest its creation, but rather to improve their access to the funds.

(iii) Production and credit granting

Even though the three communities have humid climates, many perceived the climate to be changing, making rain falls increasingly unpredictable. Given the current lack of technical advice to change to crops with less intensive water requirements, irrigation is also considered a valuable measure to reduce vulnerability to droughts in the communities of Escuintla and Cintalapa. Improved seeds (resistant to heavy rains and wind) and machinery lending were suggested mainly by farmers with larger land extension, especially in Escuintla. Greenhouses and crop training were also suggested.

In line with opinions of farmers’ leaders, further discussed, farmers in these communities expressed concern about the lack of a rural development bank in the region to support investments in reducing their risk to disasters as well. In some cases, they suggested, it could replace even direct governmental intervention in crop insurance. In addition, there is a general perception in the interviewed farmers about the lack of competent personal involved in the implementation of rural development initiatives.

(iv) Warning systems

Lack of access to communication media means higher vulnerability. Most farmers living in coastal areas expressed feeling at risk because of their relative isolation from the main towns of the region and its associated lack of communication and warning in case of hurricanes and other weather-related disasters. Farmers living in low areas said to need warning systems, e.g. an alarm, to avoid disasters from heavy rains in the mountains resulting in river flows that threat on low regions, as in years 1999, 1998, 1995, 1988, and so on. Some farmers complained about the delayed governmental aid in their communities, as well as about complicated formalities to apply for support. Farmers also expressed their interest in training to form community disaster prevention brigades, which could also serve as rescue workers. One farmer suggested creating a municipal map of risks. Based on this map, the municipality should apply for state and federal resources to carry out mitigation works, to offer insurance schemes and to extend the awareness capacity in the region.

The rest of demands on the government to reduce disaster vulnerability includes expanding post-disaster aid and immediate relief to the poor, e.g. shelters, food, medical services, indemnity payments, raw materials for housing reconstruction, etc.
5.5.3 How should the government to improve agricultural incomes?

(i) To enhance demand and trade

Some farmers suggested a governmental strategy to connect farmers with enterprises in Mexico and abroad, making productive linkages forwards and backwards. Many farmers mentioned the need for increasing demand at better prices by food industries and supermarkets. For instance, one farmer suggested making a law to obligate supermarkets to buy local agricultural production, and not supply final consumers with imported products if they are produced in the region. Another farmer remarked that with such law, the productive chain could integrate local subsistence farmers into the economic dynamic.

Some interviewees suggested encouraging a food industry in the region, either private or state-owned. It could create more stable demand for agricultural products, could stabilize farmers’ incomes, and increase the ability to invest in mitigation to natural disasters. This would push downwards insurance costs (due to reduced expected risk), making insurance more affordable to the average farmer. The farmers thus recognized that so vulnerability to disasters can be tackled on two fronts: directly by promoting disaster strategies and indirectly by increasing opportunities to better and more stable rural incomes.

(ii) Subsidies to inputs, credit and commercialization

A number of farmers requested support from the government in the form of direct subsidies as well as indirect intervention in reducing input prices, such as herbicides, veterinary costs, machinery and tools, grain storage, seeds, and energy costs, among others. In Cacahoatan and Escuintla, improving the availability of credit was of especial interest to farmers with larger cropping land, and some interviewees expressed their disappointment due to the sudden withdraw of rural development banking in the region, suggesting the creation of a solid rural bank. Most of interviewed complained about the dissolution of CONASUPO, BORUCONSA and LICONS, the state owned companies responsible of providing grain storage, warranty prices and securities, freight, and commercialization services to the agricultural sector in general.

One farmer suggested market mechanisms to regulate the distribution of subsidies: to grant the subsidy both in high-offer season as well as during depressed demand times; to lift the subsidy when prices and/or demand go up. He also said that the government must complementary open the crop insurance market to foreign companies in order to get a more competitive insurance market providing cheaper crop insurance.

(iii) Foreign trade

In general, farmers view the reduction of imports as the solution to raising prices for their crops. Some farmers complain about smuggling, which decreases the price of traditional crops, such as maize, bean and rice. Some coffee growers also blamed the Mexican custom administration (federal government) for allowing coffee imports from non-NAFTA countries, like Vietnam, whose imports –they say- prevent them from supplying crucial clients, like Nescafe and some supermarkets.
(iv) Less price uncertainty

In general, farmers would like to see the government intervening more actively, for instance, to buy and sell in the agricultural markets in order to keep more stable prices. Some farmers suggest governmental arbitrage to keep crop prices stable, which, they say, could give them more certainty about diversification and investment decision-taking, especially in those crops with high investment requirements, e.g. coffee. Other farmers pointed out they do not benefit when prices go up due to the presence of intermediation and speculators (coyotes).

(v) Institutional support

There is a general desire for more government involvement in agricultural and rural development, with a more social oriented system of subsidies. Also, they consider the governmental support should embrace training to farmers to learn them to choose high-profitability crops.

Farmers also worry about lack of efficient self-organization, and urged the establishment of trade unions to reduce intermediation costs. They reported a lack of representation, as well as under-representation in the parliament and in governmental negotiations. Farmers appear to regard their leaders as inefficient and, perhaps, even worst, as corrupt.

5.6 Views of community leaders, farmers unions' representatives, and local authorities

This part of the survey consists of 25 interviews carried out in the three communities, in the capital of the state of Chiapas, Tuxtla Gutiérrez, and finally in Mexico City, in order to capture the views of community leaders, as well as of farmer unions leaders and authorities at the three administrative levels: municipal, state and national (see list of interviewees in Appendix 1). The interviews were face to face, recorded in audio tapes.

In general, authorities are aware about the relevance of hazards in the region, but they differ in their views about possible solutions depending on the group they represent, their administrative level, as well as on their geographic location. Leaders of farmers with higher incomes have much clearer views on the need for reducing their vulnerability to disasters and for improving trade conditions. In fact, they are obtaining some post-disaster financing from the government. In contrast, subsistence farmers’ leaders have little notion about the existence of these programs. In turn, farmers’ leaders at municipal levels suggested more ideas to reduce vulnerability than those at higher geographic jurisdictions.

5.6.1 Income uncertainty

INMECAFE

There is a common agreement between local authorities and leaders in coffee regions about the lack of governmental support to coffee growers. Since the dismantling of the Mexican National Institute of Coffee (INMECAFE) in 1989, which was a governmental agency aimed at supporting technologically and financially coffee growers as well as keeping prices stable, recurrent drops in coffee prices have affected incomes level in the region (see Box 1). In absence of affordable pesticides and crop insurance coverage, the presence of plagues and natural catastrophes have triggered farmers’
decision to abandon, first, coffee growing and, further, the countryside at all. As mentioned, low coffee prices—below production costs—along with low yield due to disasters has accelerated out migration in the region. The municipal director for rural development of Cacahoatan, Mr. Victor Alfonso, reckons that roughly 30% of coffee production in this municipality is lost due to natural disasters, which recurrently affects 3,000 local producers. In the view of local authorities, the absence of alternatives to cope with these undesired outcomes is what is devastating local agriculture.

**Box 5.1: INMECAFE, a dismantled support institution for coffee growers**

As in other important coffee producing countries like Brazil, Guatemala, El Salvador, Colombia, Uganda, Kenya and Indonesia, coffee regions in Mexico are located in highly marginalized regions. In Mexico, coffee is produced in twelve of the 31 states. Coffee plantations cover over 700,000 hectares, making Mexico the sixth largest coffee producing country in the world. The main producing states are Chiapas, Veracruz and Oaxaca (SIACON 2005), where more than 3 million people rely on coffee production as main livelihood (Emanuel, R. and Greenberg, J. 2000).

When coffee international prices started to soar during the 40s, the Mexican federal government implemented a strategy endeavored to encourage coffee exports. As part of these efforts, the government established the Mexican Institute of Coffee, INMECAFE (Instituto Mexicano del Café), a state owned company aimed to act as intermediary between producers, exporters, and merchants. During the 70s, the government tried to reduce the excessive debt burden of small-scale farmers to coffee merchants, and INMECAFE began by purchasing coffee directly from farmers, though it was unable to grant farmers with sufficient credit in time as coffee merchants did.

The liberal economic policy of the administration of Carlos Salinas de Gortari (1988–1994) led to the restructuring and further dismantling of INMECAFE in 1989, what left two options to small-scale coffee growers: either marketing their coffee through the local intermediaries (coyotes) or participating in small cooperatives, which failed in supplying them with credit and commercialization services. Currently, as most of Mexican coffee growers have no means to transport their production to export centers, they are forced again to make use of networks of local and regional intermediaries (Emanuel, R. and Greenberg, J. 2000).

In fact, the government in 1989 argued that the dismantling of INMECAFE was a decision based on cost-benefit analysis, which found negative net benefit from cropping coffee and onerous for the government, suggesting re-orientating local production. However, the latter has not been yet implemented, bringing some of the negative effects pointed out by farmers’ leaders and local authorities in this survey.

**Emigration from the countryside**

In general, for both local authorities and farmers leaders, variability in farmers’ incomes depends on climatic conditions as well as on economic policy. The latter shifted to less credit granting to farmers after agriculture began to contribute less to the national economy. As a consequence, currently approximately 50% of farmers’ sons are
immigrating to the USA, reckons Mr. Indalecio Flores, local leader of the National Confederation of Farmers (CNC\textsuperscript{80}). In the same street in Tapachula on which the headquarters of CIOAC\textsuperscript{81} –the main organization of subsistence farmers in the region- is located, six travel agencies make two trips monthly to the USA border, which means 400 members of this union leaving the country per month, mainly males. So, nowadays women are becoming the majority among members in this organization, cried Marco Suarez, CIOAC local chair.

5.6.2 Natural disasters

The flooding tragedy in 1998 affected 154,000 hectares of crops in the region, reckons CNC regional leader Indalecio Flores, from which farmers cannot yet recover. Also, municipal authorities in Escuintla affirm that this event damaged the regional economy at such a great scale that to date, 6 years after, economic activity still do not recover to pre-disaster levels. In addition, drought in coastal areas and hail in the mountains keeps extremely low yields, they state. Neither local authorities nor leaders in the region have contingent fund or have plan to establish one.

**Ignorance about public insurance and mitigations schemas**

Except for transnational companies, like *Del Monte*, *Chiquita*, and *La Moderna Tobaccos Co.*, private crop insurance is practically not contracted in the region. From its part, *Fondos* is an unused instrument among middle- and low income farmers in the region.

Without exception, local authorities ignored the existence of FAPRACC, and only some of them knew about FONDEN. However, these authorities in Escuintla believed its usage would eventually imply diverting money from the municipal budget. That may explain why municipal authorities in Escuintla have refused in the past attending farmers demands concerning disasters losses and have not undertaken vulnerability reduction measures –as a number of farmers remarked through the questionnaires.

In Cacahoatan, municipal authorities seem to have been comparatively more active in responding to natural disasters, and complain that federal government does not respond to their resources request to compensate crops losses due to natural events. One year before the interview, the municipality of Cacahoatan had requested to the Ministry of Agriculture (SAGARPA) funding to compensate farmers’ losses from heavy rains, but without response to that date, as pointed out Victor Alfonso, director of rural development of this municipality. When the interview explored the possibility of getting some support from AGROASEMEX, the governmental agency for crop insurance, municipal authorities expressed wondering if it still exists.

\textsuperscript{80} CNC is the Spanish acronym for National Farmers Confederation (Confederación Nacional Campesia) is a national organization grouping mainly middle and low incomes level farmers, affiliated to PRI, the political party which ruled Mexico between 1929 and 2000. CNC is one of the four sectors which integrate PRI, with a permanent quota of candidates to representatives and senators to the Mexican parliament, whose vote is considered base of the hard vote of this party, in other words, of the share of unconditional votes which goes to the party in every election.

\textsuperscript{81} CIOAC is the Spanish acronym for Independent Union of Agricultural and Peasants Organizations (Central Independiente de Organizaciones de Agricultores y Campesinos), which groups mostly subsistence farmers from highly marginalized regions, most of which linked to leftist organizations.
In fact, it seems to be a lack of due coordination between municipal, state and federal levels of government. One has to accept that the decentralization in Mexico has brought benefits in terms of administrative simplification, but currently some needs are still insufficiently addressed at local scale, as the case of the disasters strategy. Antonio Ruiz, Deputy Minister of Rural Development at the Federal Ministry of Agriculture, Livestock and Rural Development (SSDR-SAGARPA), points out the lack of interest of some state governments in adopting disaster prevention measures available through FAPRACC, among other vulnerability reduction instruments to the countryside. He also warned on the moral hazard derived from the dependence of post-disaster resources supply of some states from the federation. On the one hand, it has led to disincentive state investments in disasters mitigation, and, on the other hand, it has led to specialization of state governments in systemically demanding federal resources. So, if the federation has the due programs and available funds to reduce disaster vulnerability; but stakeholders at municipality level state they are not implemented; then state governments seem to be insufficiently active in dealing with this issue.

**Joint responsibility in reducing vulnerability**

All interviewed agreed the need for joint responsibility between farmers and government in reducing vulnerability to natural disasters. It has proved some success in past disasters events in Cacahoatán, where farmers could divert their grants from a governmental fund for loans (Apoyo a la Palabra) to finance recovery from natural disasters. However, only farmers granted with this subsidy were able to do that. Local authorities in this municipality believe that applying this kind of mechanism to prevention measures could be highly beneficial if extended to all agricultural producers. In cases where such mechanisms are not applied, the recovery from the next disaster will have to be requested again to the state and federal government, with high risk of no response, warned Mr. Gutiérrez. Complementarily, they emphasized the need for getting farmers more involved in finding solutions, since usually the municipality calls farmers for meetings to address agricultural issues and they usually do not attend.

**Responsibility to reduce vulnerability**

From its part, there is a common agreement that insuring common infrastructure would be very positive for all stakeholders. Also, when inquiring about who should be responsible for vulnerability reduction, all interviewees agreed that this should be both the exposed population and the authorities. They emphasized the need for more leadership from the federal government to encourage these measures, as well as to implement loans obtained from multinational financial institutions to reduce vulnerability, since federal resources to reduce disasters vulnerability do not reach this region despite being historically one of the most affected by natural hazards in the country.

**Crop Insurance after mitigation and credit for subsistence farmers**

Subsistence farmers’ leaders regarded crop insurance with some skepticism, and they showed in general more confidence in mitigation measures and credit. For instance, the state leader of CIOAC replied to our suggestions on expanding crop insurance penetration among CIOAC members, *people here scarcely have money to eat, thinking in*
contracting insurance sounds illusory. Instead of crop and property insurance, in past events community solidarity has been their key for reconstruction. Once we explained how FAPRACC can pay indemnities to subsistence farmers for lost crops, he considered the system as useful but insufficient, suggesting rather to undertake public works to mitigate disaster risk and facilitate access to credit. Once guaranteed that, we can start contracting crop insurance, he added. These arguments are consistent with those by Kunreuther and Linneroth-Bayer (2003) as they point out the contribution of disaster mitigation works in reducing insurance premium prices.

Experience with FAPRACC in a neighbour region

In Mazatán, a municipality in the region Soconusco but different from our three communities where we applied questionnaires to farmers, a leader of middle income farmers, Gilberto Santos, expressed that they have been making relatively more use of public post-disaster instruments. After the recent drought, losses of soy bean producers (without crop insurance) in his region were high, and SAGARPA was required to pay indemnities for economic losses based on FAPRACC. At that time, FAPRACC was in process of reimbursing the value corresponding 5 ha of crops to farmers owning up to 10 ha. It is valuable in that of alleviating a farmers’ part of debt contracted following disasters, though most of their investments are net loss and will take even years to recover. Also, he adds, subsidies to insure crops values have been effective in the past: when the price paid to the producer is below a minimum benchmark, the government (ministry of Agriculture) paid the difference (maize, soy bean, sorghum). He also reported the existence of the Fondo Belisario Domínguez, which contracts crop insurance with private companies (Seguros America and Seguros Tepeyac) and get premium subsidy from AGROASEMEX. Police covers up to 70% of losses. Mr. Santos also expressed sorrow due to the fact that neither he nor his represented farmers from his ejido are eligible to get into that Fondo given their lack of solvency.

5.6.3 Trade

Excessive intermediation

In the view of Marco Suarez, local leader of the subsistence farmers union CIAOC in Tapachula, in the past the (social) fight was for land, today it is for markets. Among CIAOC farmers, only ca. 30% of their cropping land is being productive, the rest has been abandoned, he reckons. In addition, Salvador Vazquez, Sheriff of ejido Tapachula, points out that failures in domestic markets, i.e. excessive intermediation levels, lead to unsustainable commercialization conditions of agricultural products.

Until the 80s, hundreds of local producers in Cacahoaatan exported over 20,000 ton of coffee yearly, but currently very few intermediaries corner all production and monopolize exports. There are only some exceptional coffee export unions in the region, which allow small coffee growers to export and to reduce intermediation levels. These are producers of organic coffee in the highlands, which work under the schema of the so called fair trade organizations, mainly supported by NGOs (Martínez 2002). Unless these

82 However, after the calamity in the region last September 2005, this recovery process must have been postponed again for some more years.
83 Established by soy and maize producers in a coastal region.
unions, which represent just a small farmers’ minority, foreign trade does not benefit others than speculators, said Gabriel Alvarez in Tapachula, farmers’ leader in Tapachula.

**Trade agreements and foreign competition**

In general, interviewees underline that imports from the USA are responsible of keeping low prices of maize and other grains in Mexico. Also, local authorities consider NAFTA to bring benefits in the region to exclusively coffee intermediaries in that of allowing them to access the USA and Canadian markets, but NAFTA implies only negative effects to farmers.

Among social organizations representing farmers in the region, OPEZ, the *Proletarian Organization Emiliano Zapata* by its acronym in Spanish language, holds that falsely designed economic policy has led the country to sign free trade agreements to the detriment of farmers. In their view, NAFTA has been responsible for increasing poverty, worsening Mexican agriculture as imports displace local agricultural products, and stimulating farmers to move to the USA. They oppose the eventual signature of FTAA, the *Free Trade Area of the Americas*, and suggest canceling the agricultural chapter of the NAFTA so long as NAFTA doest incorporates a chapter to allow free labor mobility.

Local authorities in coffee growing regions blame Vietnamese coffee of displacing domestic producers from domestic markets. At the end of the 80s, Vietnamese agricultural engineers visited the region to learn local coffee processes –that time this region was the world leader in coffee yield-, and they are now exporting coffee even to Nescafe Mexico, whose production aims to Mexico and USA markets. So, Vietnam and transnational companies make high profits from NAFTA as the former put its products and the latter triangulates markets.

In the case of vegetables, where the region has a comparative advantage, imports from Central America supply domestic markets, wasting so one important opportunity to improve domestic incomes. In general, authorities are aware about the need for more projects to orientate production to higher prices products, to add value to products and to crop more vegetables given regional comparative and competitive advantages.

**5.6.4 Crops diversification**

Crop diversification is considered clearly positive to local farmers’ leaders, but it does not make sense unless commercialization conditions turn favorable, as stated by Gilberto Santos, leader of farmers union “*Emiliano Zapata*” (adhered to the CNC). In the opinion of local authorities in Escuintla, there is a need for relying less on coffee production and to change to more rentable crops, i.e. vegetables, exotic fruits (as litchi and rambutan), etc. Although replacing coffee production means leaving behind a long-standing activity, as well as physical fix investments these plantations implies (the so called *head beaches*), i.e. shade trees to filter sun rays for coffee plants, but all stakeholders shown enthusiastic to re-orientate production.

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84 OPEZ is part of the ONP (*Organización Nacional del Poder Popular*), a social organization grouping workers, farmers and students.
As the Deputy Federal Minister of Rural Development, Antonio Ruíz, emphasized there is a need for making a productive reorientation based on identification of regions under desertification process. He points out that one cannot call natural disasters to the permanent droughts state in these regions, but typical natural conditions, and must rather adapt agriculture through changing to less water demanding crops. To achieve that, the Ministry of Finance is implementing the Program of Productive Reorientation in Recurrent-Drought Areas (Programa de Reconversión Productiva en Zonas de Desastre Recurrente\textsuperscript{85}), which works mutually excluding respect FAPRACC (summarized in section 5 above) and is expected to be adopted by more state governments in the country in the forthcoming months.

5.5 Suggestions to reduce vulnerability

Overall, there is a widespread opinion among governmental delegates to Chiapas and Soconusco that the failure of governmental intervention in reducing farmers’ vulnerability to market and disasters shocks is due to the passive attitude in farmers themselves, who rely too much on governmental paternalism and have almost no initiative towards reducing their own vulnerable conditions. Farmers’ leaders say that it is difficult to come up with initiatives given current low levels of education and adverse endowments. The former impedes them in getting right with solutions and the latter obstacles their initiatives, if any, in getting progress. Also, some governmental officials report the lack of interest of local leaders in promoting vulnerability reduction measures arising from either farmers or the government unless it brings them some personal monetary benefit.

Despite the above discrepancies, there is a common agreement about the need for more and better institutional support in three axes: (i) financial support, (ii) productive re-orientation, and (iii) replacing assistance paternalism by investments in infrastructure.

(i) Financial support

Financial support implies facilitating financial services, e.g. through a specialized bank or financial agency for agricultural production and rural development, providing credit to increase productivity and finance risk reduction measures. There is also a concrete need for seizing current agricultural funds to recover from natural disasters, but most important, to undertake prevention measures. Crop insurance coverage should expand in those crops more resistant to current adverse climatic conditions. On the other hand, replacing highly fragile crops is crucial before disbursing in crop insurance subsidies, what implies making good use of FAPRACC and FOPREDEN.

(ii) Productive reorientation.

Productive reorientation means both diversifying crops to reduce the probability of getting affected given sudden prices drops in the mono-crop, as well as moving to more rentable crops, that is, whose sale prices are relatively higher, with a more stable demand and suitable to regional environmental and climatic conditions. In this regard, most interviewees recommended on the one hand abandoning maize

\textsuperscript{85} Operated through the fund FINCA (Spanish acronym of Fondo de Inversión y Contingencia para el Desarrollo Rural) For further details consult: \url{http://www.sagarpa.gob.mx/sdr/progs2003/papir03.htm}
production due to its high production costs, low prices and yield, and on the other hand increasing fruits and vegetables production, where the region has more productivity and better access to markets. In addition, farmers’ leaders demand more public intervention to regulate agricultural markets in order to reduce dramatic price variability.

Also, there was a recurrent proposal from authorities to reduce unfavorable terms of trade: to add value to local agricultural products. That would make them less vulnerable to the trend of depressing primary goods prices. In this regard, farmers’ leaders rather suggest a law to connect local producers with retailers and the industry.

(iii) Paternalism vs. infrastructure

In the view of most local authorities, current reduction in paternalism from the government is beneficial in overcoming the absence of surveillance of the past. Paternalism has damaged beneficiaries because it has made them dependent on assistance and social programs, and this must change to make public intervention more productivity oriented. Public works in productive infrastructure is becoming too scarce and is insufficient in light of the seriousness of current issues affecting the countryside. Support to the rural poor is important in that of avoiding massive starvation in some regions, but it keeps them just above surviving levels due to the incapacity of resource flows contributing to enlarge or improve asset accumulation. Besides, most of the interviewees’ opinion considered that the government should make huge investments in productive infrastructure based on production and risk analysis, what certainly would generate positive externalities in farmers’ livelihoods.

5.7 Conclusions

This chapter presents results from a survey in rural Mexico, showing the variety of stressors and perturbations determining farmers’ vulnerability. Low rural incomes in this region are considered a result of a complex economic-climatic process, whose solution should embrace not only social programs and post-disaster aid, but also issues of inequity, productive reorientation and implementation of disaster prevention instruments. In the stakeholders’ views, there is also a widespread feeling concerning the absence of an effective and long-term sustainable strategy to strengthen the coping and adaptive capacity of subsistence farmers in this region to external shocks, which is an obstacle for accumulating assets. The survey analyzes farmers’ preferred coping strategies, and evidences that the absence of public intervention in an interconnected manner has limited its effectiveness. Stakeholders warn about the need of public intervention beyond poverty alleviation programs, which though perceived as valuable, but considered ineffective to solve local problematic in the long-run. There is a general agreement among the interviewed stakeholders about the increasing negative impacts from natural disasters, as well as about the contribution of the current economic policy in amplifying the negative consequences from weather-related events. From its part, despite its innovative and thorough design, public instruments to deal with disasters losses (e.g. FAPRACC and FOPREDEN) showed lack of penetration.

The survey presents evidence that vulnerability to disasters can lead to the collapse in the Mexican agriculture. The prevailing conditions of marginalization in this
region, along with insufficient government investments in infrastructure, limited credit granting, insufficient subsidies to crop insurance, and lack of investments in more rentable crops, greatly reduces the communities’ coping capacity when hazards strike, which in turn triggers migration.

The preferred farmers’ financing sources to cope with disasters in the region have been assistance from relatives and neighbors, as well as governmental aid. Pre-disaster financing instruments, such as savings and insurance, have not been used by these farmers. Local authorities expressed difficulties in accessing state and federal financial support after disasters, as well as showed ignorance concerning available federal instruments to reduce disaster vulnerability in the region. In general, the low implementation of public disaster prevention instruments in the surveyed region can be explained by the insufficient promotion from the federation and state government, but, most important, it is due to the scarce risk analysis carried out by the state government.

Given their increasing losses from disasters, farmers’ expectations of improving living conditions for the future are becoming increasingly undermined. As observed in answers to the questionnaires, those farmers most determined to emigrate are not necessarily the poorest ones, but their income expectations are more pessimistic given, in line with the spatial analysis in the next chapter 6. As vulnerability to disasters reduces farmers’ expectations of future agricultural incomes, it increases their wish to emigrate. Also, the availability of post-disaster credit is very low, and the transfer of public resources does not substantially reduce the farmers’ will to leave the community. In essence, the availability of rural credit is decisive in the farmers’ wish to abandon their agricultural livelihoods. Also, the lack of mechanisms to diversify crops seems to play a crucial role, as emigration is the preferred response of those farmers who are comparatively less prone to diversify their crops. Crop diversification appears to be the option most preferred by farmers with optimistic expectations; emigration is the preferred option for pessimistic farmers; working harder is preferred by the rest.

Non-agricultural income in urban areas is a recurrent coping strategy of small-scale farmers dealing with climatic extreme events. However, this strategy is limited by the scarce capacity of the urban economy to provide them with jobs. Reported off-farm income increases as land size is smaller, as farmers with bigger land extensions can crop more extensively to compensate hazards losses i.e. from natural disasters. However, small farmers are constrained by limited land. It forces them to look for off-farm jobs. Most stakeholders agreed that expanding access to credit, and thus to more efficient technologies, can contribute to crop more intensively even in small croplands, reducing farmers need for off-farm income. That is the reason most stakeholders consider subsidized credit to small landholders as a positive policy response. This may be complemented with technical assistance and orientation to crop more rentable products. For most consulted stakeholders, crop insurance was considered second only to the guaranteed access to credit.

Prevailing high intermediation levels for commercialization and credit are also considered crucial stressors to subsistence farmers in this region since the relevant state
companies were dismantled at the end of the 80s. After the withdraw of intervention of the government from directly providing commercialization and financial facilities to farmers, the indirect intervention which has substituted it has been insufficient given current trade conditions and hazard exposure. It has forced farmers to rely on depressed prices (even when benchmark prices soar) and costly credit from intermediaries.

There is a general agreement among farmers’ leaders and local authorities on the prejudicial effects derived from changes to the foreign trade policy implemented along the past two decades in the country. Current trade liberalization in Mexico is not perceived by surveyed farmers as an opportunity to export as they scarcely have means to commercialize. By contrary, it has meant more difficulties to even sell their production domestically. In sum, local stakeholders perceive the liberalization to foreign competition in the agricultural markets to just benefit a few intermediaries and to reduce job opportunities in urban areas as imports limits the expansion of regional industry as well.

Finally, there is a widespread demand from farmers for more active involvement by the authorities in promoting vulnerability reduction measures in the region. Governmental intervention should be more coordinated and anticipate negative outcomes from the prevailing uncertain trade conditions and increasing weather-related disasters in the region. This intervention should contribute to strengthening farmers’ adaptive and coping capacity through mechanisms aimed at facilitating assets accumulation, enabling favorable endowments and orienting to a more profitable production. Authorities, in turn, request more initiative from the farmers’ leaders. These initiatives should be based on an evaluation of communal needs in a realistic and inclusive manner beyond personal opportunism. Both farmers and authorities require a better understanding of local needs to optimize the allocation of public resources to reduce vulnerability to hazards, as well as increase the profitability of farm assets. All agree that this would improve farmer incomes and reduce poverty in this region of Mexico.
Appendix 5.I: List of interviewees

Farmers’ and community leaders and local authorities (2004-2005)

Mr. Marco Antonio Suárez Vargas
CIOAC - Independent Union of Farmers and Peasants Organizations (Central Independiente de Organizaciones de Agricultores y Campesinos)
Regional Delegate (Region Coast-Soconusco)

Mr. Juan Pérez Pérez
CIOAC - Independent Union of Farmers and Peasants Organizations (Central Independiente de Organizaciones de Agricultores y Campesinos)
State Chair (Chiapas).

Mr. Gilberto Santos Galicia
CNC - National Confederation of Farmers (Confederación Nacional Campesina)
Local farmers’ leader – Unión de Ejidos Emiliano Zapata

Ing. Indalecio Flores B.
CNC - National Confederation of Farmers (Confederación Nacional Campesina)
Regional Coordinator (Soconusco) - Liga de Comunidades Agrarias y Sindicatos Campesinos del Estado de Chiapas.

Lic. Celso Humberto Delgado
CNC - National Confederation of Farmers (Confederación Nacional Campesina)
National General Secretary

Mr. Pablo Velasco Alfaro
OPEZ - Organización Proletaria Emiliano Zapata (Proletarian Organization Emiliano Zapata)
Political Direction at the Council of the State of Chiapas

MVZ. Henar Galicia Negrete
SDR - Ministry of Rural Development, Government of the State of Chiapas (Secretaría de Desarrollo Rural)
Region Director of Rural Development in Soconusco at the

Ing. Juan Ignacio Pliego Tamayo
CDFCC - Commission for Development and Promotion of Coffee in Chiapas (Comisión para el Desarrollo y Fomento del Café en Chiapas)

Ing. Victor Alfonso
Municipality of Cacahoatán
Director of Agriculture
Lic. Josías Magdiel Santos Jiménez
Municipality of Cacahotán
Municipal Judge

Lic. Jorge Antonio Saldaña Ríos
Municipality of Cacahotán
Municipal Trustee

Ing. Gabriel de Jesús Álvarez Guzmán
Municipality of Escuintla
Deputy Director of Agricultural Encouragement

Mr. Salvador Vázquez Cárdenas
Sheriff of Ejido Tapachula

Mr. Porfirio Gutiérrez Verdugo
Sheriff of Ejido Cintalapa

Mr. Wilmar Sánchez
Deputy Sheriff of Ejido Cintalapa

Profr. Luis Guadalupe Morales Ángeles
Local leader in Ejido Cintalapa

Mr. Ricardo Gutierrez Morales
Leader of independent farmers in Cintalapa
Interviewed policymakers (2003)

Ing. Antonio Ruiz-García
SAGARPA – Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food
(Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación)
Deputy Minister for Rural Development

Ing. Victor M. Celaya del Toro
SAGARPA – Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food
(Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación)
Director General of Rural Development Studies

Lic. Salvador Mayoral
AGROASEMEX – State-owned Crop Insurance Company
Director General

Lic. Luis Francisco Mejía Piña
SEDESOL – Ministry of Social Development (Secretaría de Desarrollo Social)
National Coordinator of Social Programs

Lic. Hugo González Gutiérrez
FONDEN – Fund for Natural Disasters (Fondo de Desastres Naturales)
Director General

Lic. Ignacio Bermeo Juárez
FONDEN – Fund for Natural Disasters (Fondo de Desastres Naturales)
Legal and Operation Director

Ing. Roberto Quaas-Weppen
CENAPRED – National Center for Disasters Prevention (Centro Nacional de Prevención de Desastres) at the Ministry of the Interior.
Director General
Appendix 5.II: Questionnaire to small-scale farmers

Region: South Mexico.
State: Chiapas.
Municipalities: Escuintla and Cacahoatán.
Communities: Escuintla, Cacahoatán, and Cintalapa.
Main regional crops: coffee, cocoa, banana, maize, bean and sorghum.
Interviewer: Sergio O. Saldana-Zorrilla.
Date: December 1-22, 2004; January 4-25, 2005

Instituto Avanzado de Vulnerabilidad a Cambio Climático Global

Proyecto:
Reducir Vulnerabilidad Económica frente a Desastres Naturales y Liberalización Comercial en la Agricultura Mexicana

Cuestionario para pequeños agricultores
Por favor, procure contestar con letra de molde clara. Si requiere de más espacio, use el espacio que está hasta el final del cuestionario. Cualquier duda, por favor, no dude en preguntar. ¡GRACIAS!

Municipio:__________________________
Fecha:_____________________________
Principales cultivos regionales:____________________________________

1. INFORMACIÓN GENERAL

Sexo: M____ F____
Edad: ____________
Propiedad de su predio: Propia_____ Rentada_____ Otra____________________
Tenencia de la tierra: Privada_____ Comunal_____ Ejidal_____ Otra_________________
Acceso a irrigación: Si_____ No_____
Acceso a crédito: Sí_____ No_____
Tamaño del predio (hectáreas):_____________

1. Por favor, numere sus productos producidos (maíz, carne de puerco, etc.) por orden de importancia económica
1. _________________________________
2. _________________________________
3. _________________________________
4. _________________________________
5. _________________________________

2. ¿Qué parte de su ingreso total procede de la agricultura?
♦ Todo mi ingreso
♦ La mayor parte
♦ La mitad
♦ Menos de la mitad
♦ Sólo una pequeña parte
3. ¿De qué actividad no agrícola obtiene ingresos adicionales?

4. ¿Cuál considera usted el principal obstáculo para la generación de ingresos en su comunidad?

2. DESASTRES NATURALES

5. ¿En su punto de vista, qué tipo de desastre natural es el que más le ha afectado a usted su patrimonio e ingreso?

6. ¿Cuántas veces ha sufrido de desastres naturales en los últimos 10 años?

7. Por favor, califique en escala de 1 a 5 qué tan importante han sido para usted las siguientes fuentes de financiamiento de desastres naturales

<table>
<thead>
<tr>
<th>FUENTE</th>
<th>CALIFICACIÓN (1-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ayuda de los vecinos</td>
<td></td>
</tr>
<tr>
<td>Ayuda de familiares de:</td>
<td></td>
</tr>
<tr>
<td>a) la comunidad</td>
<td></td>
</tr>
<tr>
<td>b) otro lugar de México</td>
<td></td>
</tr>
<tr>
<td>c) el extranjero</td>
<td></td>
</tr>
<tr>
<td>(dónde residen? ____________)</td>
<td></td>
</tr>
<tr>
<td>Ayuda humanitaria:</td>
<td></td>
</tr>
<tr>
<td>a) gubernamental</td>
<td></td>
</tr>
<tr>
<td>b) Privada (asociaciones, donativos, etc.)</td>
<td></td>
</tr>
<tr>
<td>Aseguradoras:</td>
<td></td>
</tr>
<tr>
<td>a) privada</td>
<td></td>
</tr>
<tr>
<td>b) pública</td>
<td></td>
</tr>
<tr>
<td>c) privada subsidiada</td>
<td></td>
</tr>
<tr>
<td>d) fondo de aseguramiento</td>
<td></td>
</tr>
<tr>
<td>Fondo gubernamental para reconstrucción de propiedades</td>
<td></td>
</tr>
<tr>
<td>Préstamos:</td>
<td></td>
</tr>
<tr>
<td>1. Privados</td>
<td></td>
</tr>
<tr>
<td>2. Públicos</td>
<td></td>
</tr>
<tr>
<td>c) Comunales</td>
<td></td>
</tr>
<tr>
<td>Venta de propiedades</td>
<td></td>
</tr>
<tr>
<td>a) Animales, vehículos, herramienta, etc.</td>
<td></td>
</tr>
<tr>
<td>b) Tierra</td>
<td></td>
</tr>
<tr>
<td>Otro</td>
<td></td>
</tr>
</tbody>
</table>

8. ¿Cómo piensa cubrir los costos de recuperarse del próximo desastre natural?

9. ¿Dispone la comunidad de algún fondo contingente para enfrentar desastres?
Si sí, ¿Cómo funciona?
10. ¿Dispone usted actualmente de algún tipo de seguro agrícola? Si sí, ¿con quién lo tiene contratado?
   1. Aseguradora privada (sin subsidio)
   2. Aseguradora privada (con subsidio)
   3. Aseguradora pública
   4. Fondo de aseguamiento
   5. Otro _____________________________

11. ¿Qué parte de su área total de cultivo (%) se encuentra actualmente asegurada?

12. ¿Existen medidas de su comunidad para reducir riesgos, tales que hagan que los daños de un desastre sean más diferenciados, por ejemplo, diversificación de cultivos o patrimonio?

13. ¿Le otorgan crédito (o fiado) los comerciantes debido a un año de desastre?

14. En su opinión, ¿de dónde debe venir la ayuda para reducir la vulnerabilidad a desastres?
   (numere del 1 al 6 en orden de importancia)
   ____ Asistencia comunitaria
   ____ Asistencia del gobierno federal
   ____ Asistencia del gobierno del estado
   ____ Aseguradoras privadas
   ____ Fondos de aseguramiento no lucrativos
   ____ Otro (por favor, especifique) ________________________________

15. ¿Quien cree que debería ser responsable de proveer fondos para la recuperación del sector privado: los hogares y negocios mismos o el gobierno? Por favor, explique su respuesta

   3. COMERCIO EXTERIOR

16. ¿Alguna vez ha exportado? Si_____ No_____.
   Si sí, ¿directa o indirectamente? _________________ ¿A dónde? _______

17. Aproximadamente, ¿qué porcentaje del valor total de su producción se exporta?

18. ¿Forma usted parte de alguna cooperative exportadora?
   Si_____ No_____ Si sí, de cuál?

19. ¿Cuál es el costo promedio del flete para exportar su producto (por ejemplo, por contenedor, tonelada, trailer, etc.)?

20. País de origen de las importaciones que más compiten con sus productos en México (ordene por importancia)
   1) __________________
   2) __________________
   3) __________________

125
21. En su punto de vista, ¿cómo ha impactado su bienestar el TLCAN y otros acuerdos de libre comercio?

22. ¿Tiene usted planes de diversificar sus cultivos? Si _____ No _____ Si sí, ¿que planta produce (adicionalmente)? ______ _______ _______

23. ¿Qué cultivos planea usted abandonar? ______ _______ _______

24. ¿Alguna vez ha recibido asesoría gubernamental acerca de diversificación de cultivos? 
   Si _____ No _____ ¿A través de qué dependencia? ________________

25. ¿Qué recomendaría usted para mejorar la comercialización agrícola en su región?

4. MIGRACIÓN

26. ¿Ha imaginado alguna situación donde pudiera abandonar su comunidad (por ejemplo, si los precios siguen cayendo, desastres naturales, etc.)?

27. ¿A dónde iría?

28. ¿Han tenido que migrar o cambiar ocupación familiares o conocidos suyos debido a desastres naturales? Si sí, ¿a dónde han migrado o a qué han cambiado?

29. ¿Tiene familiares viviendo en el extranjero? Si _____ No _____ Si sí, ¿dónde?_________

30. ¿Tiene usted actualmente planes de emigrar de su comunidad? Si _____ No _____ 
   Si sí, ¿a dónde? Otra comunidad rural____ Zona Urbana ______ En México_____ En el extranjero_____ ¿A dónde exactamente?___________

31. ¿Cuál es la causa de su deseo de emigrar?

32. ¿Dadas las actuales condiciones, recomendaría emigrar a algún familiar?

5. PREGUNTAS FINALES

33. ¿Considera usted que el apoyo gubernamental realmente llega a su población objetivo y logra su cometido? Si_____ No_____ ¿Por qué?

34. ¿Qué le pediría al gobierno implementar en su comunidad para reducir su vulnerabilidad a desastres naturales?

35. ¿Qué le pediría al gobierno implementar para reducir la vulnerabilidad a fluctuaciones de precios agrícolas en su comunidad?

COMENTARIOS PERSONALES
Appendix 5.III: Communities profile

Table 12: Land size

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Table 13: Land tenure

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Table 14: Land property

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Figure 29: Land size distribution

Figure 30: Age distribution
Table 15: Relevance of post-disaster financing source for reconstruction

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<td>15. SellLand</td>
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</table>

Valid N (listwise) 58

Figure 31: Sex distribution
CHAPTER 6: Spatial model of incomes and migration

Mexico is a country of great human-environmental diversity. The disparities between the rich and poor are great. There are many municipalities vulnerable, especially in the southern part of the country, with a very high percentage of the population with incomes below the minimum salaries while some municipalities are relatively rich. In terms of vulnerability, in this dissertation defined as the susceptibility of an economic agent to absorb negative hazards, given its assets possession and entitlements system (coping capacity), and its implemented risk management and protection measures (adaptive capacity), we assess the effect of economic losses from natural disasters during the 1990's on the income level in 2000 at the municipality level. Mexico is in many places still dominated by agriculture and during the last 25 years weather-related disasters have accounted for about 80% of the economic losses in Mexico, with largest effects on the agricultural sector. In addition, this chapter tests empirically the negative effects of hazards in triggering out- migration. The chapter therefore mainly concentrates on factors related to agriculture. Control variables used during estimation are the degree of marginalization, assets, insurance, credit, irrigation, education, distance to major cities, incomes variation, changes in agricultural prices for the product mix, and spatial dependence.

6.1 Introduction

The negative impacts of natural disasters on household incomes are analyzed throughout the national territory at the municipality level, along with production limitations, trade-related hazards, and adaptive instruments. In the light of adverse trade conditions, recurrence of extreme climatic events, and lack of affordable instruments to hedge against disaster risk, municipalities of predominantly subsistence farmers cannot leave behind pre-existing marginalization conditions. It keeps them in a vicious circle with high vulnerability, insufficient disasters management instruments, and low incomes. As incomes expectations turn pessimistic to economic agents due to these hazards threatening future incomes, it also stimulates out- migration. During the period analyzed, the limited capacity of the rural economy to provide opportunities has also increased emigration flows remarkably from the most affected regions to large cities, as well as to the USA. It leads to a complex process which could be avoided if productive conditions and disaster prevention are strengthened.

Despite the increasing frequency and economic cost of natural disasters in Mexico (Saldana 2006), the economic impacts on incomes and migration have to date not been
formally addressed. Among the existing literature addressing the economic aspect of natural disasters in the whole country are the registering of disasters losses (Bitran 2001), and the assessment and projecting of insurance markets (Kreimer et al 1999). Further research is rather focused on very concrete issues, far from providing an integral view.

As natural disasters disrupt production and damage assets, it gives us reasons to presume them to turn into a significant external shock on incomes. However, as damages from disasters differ from country to country in terms of scale, damaged economic activities and coping capacity, the subsequent effect on the whole economic activity is still under debate within the disaster research community. For instance, Albala (1993) points out the negligible long-term impact of disasters on the economy in developing countries. Other authors find positive relations between frequency of natural disasters and economic growth (Dacy and Kunreuther 1969); however this conclusion ceases to be valid for Mexico as their analysis is limited to developed economies. Other works consider natural disasters to have a positive effect on the economy as the destruction is biased to the side of obsolete capital stock, pressing for adoption of more efficient technologies, pushing up average industrial productivity and, in turn, production (Skidmore and Toya 2002). However, we discard that approach because, as shown in Chapters 2-5 of this dissertation, the historically most affected population in Mexico lives in poverty and is mostly unable to get credit to upgrade their technology. In counterpart, some authors’ results show a negative economic development from natural disasters. Some of the case studies are however based on small islands, as well as small economies, like Dominica, Fiji, Vietnam and the Philippines (Benson and Clay 2000). Due to their size, these economies seem too small to be able to draw any conclusion for the Mexican case. Caballeros and Zapata (1995) asses the impact of natural disasters on economic performance, finding that relatively small Latin-American economies like Nicaragua suffer disasters’ effects at a greater scale and for a longer period compared to large and more diversified economies. In the case of Mexico, they state that the 1985 Mexico City earthquake did not have any noticeable long-term negative effects on macroeconomic variables, though it leaves non-major but frequent disasters events out of analysis.

We affirm natural disasters to have a negative impact on the economy, directly in certain economic sectors and regions, but with a damaging spillover effect expanding over other parts of the economy and the country. The present work does not analyze GDP growth given the negligible low proportion of average economic losses from natural disasters to GDP, 1:1000. In turn, most damages can be attributed to the agricultural sector, which contributes with less than 4% to total GDP. However, disaster losses are crucial to agricultural livelihoods and rural incomes, which involve around one-quarter of the nation’s population. Therefore, the present research analyzes household incomes instead of GDP and focuses the analysis on the agricultural sector instead of the overall economy. Depressed rural incomes might be due to the destruction of capital stock and productive disruption derived from natural disasters along with increasing pressure from economic stressors.

The present work provides a spatial econometric analysis to test the following hypotheses:

(1) High natural disasters incidence has a negative impact on income levels. In addition, prevailing adverse production-trade conditions and low access to risk
management instruments are spatially relevant in explaining spatial distribution of low-income regions, with spill over across municipalities.

(2) Recurrent natural disasters, along with lack of credit granting and decreasing incomes do stimulate out migration in Mexico. So, we attempt to prove that migration is not a question of poverty itself, but rather of incomes expectations. As recurrent disasters affectation and absence of financing reduce economic agents’ estimation of returns of future investments for a time horizon, they have more incentives to leave their communities.

(3) Spatial dependence is present. Given that we are looking for relevant relations between disasters affectation and income, we must take into account that the nature of natural disasters possesses a geographic conditioning across regions. In this case the absolute location of the municipality is of interest. Also, as a number of authors have pointed out, for instance in the economic growth literature regional growth may be dependent on the growth in other regions, giving more relevance to those regions geographically closer (i.e. Sandberg 2004, Le Gallo et. al. 2003, Fingleton 2003, Rey and Montouri 1999, Fujita and Krugman 1995, David 1984). In our case the location of a disaster struck municipality relative to the location of other regions/municipalities in geographical space matter. This phenomenon of spatial contiguity implies that municipalities influence each other and create spatial spillovers. In addition, geographic clusters of natural disasters occurrence across regions may be related to low income regions in Mexico. The use of spatial econometrics is therefore vital for correct estimation and for studies of these relations in more detail, identifying clusters of regions recurrently affected by disasters without financial measures for disaster prevention related to clusters of low income workers.

The rest of the chapter is organized in the following way. Section 6.2 consists of a discussion of vulnerability in general. Section 6.3 describes concretely the nature of vulnerability to trade, production and natural disasters in Mexico. The incomes model is introduced and estimated in section 6.4. In section 6.5 the emigration model is studied. Section 6.6 concludes the chapter with conclusions and a discussion.

6.2 Vulnerability

As abundantly discussed in Chapter 2, the approach of vulnerability of the present dissertation is based on Turner’s (et al 2003) concept of vulnerability. Though it may be erroneous to consider the poverty of the population as a synonym of being vulnerable to natural disasters, but in fact the most vulnerable population is usually the poor, whose assets destruction impedes them of improving welfare. A number of empirical research points in this direction that the poor are the worst-off to respond to natural hazards, like hurricane Katrina in the USA (O’Brien 2005), the tsunami in South-east Asia (WB 2005), El Salvador Earthquakes in 2001 and 1986 (ECLAC 2001, Moisa and Romano 1995), Honduras with hurricane Mitch (Vatsa and Krimgold 2000), and the Dominican Republic with hurricane Georges (Butterfield 1998), among others.

Increasingly, scholars argue that poverty is not only a lack of income or consumption, but also a lack of assets (Haveman and Wolff 2000, Oliver and Shapiro 1990, Sherraden 1991). Assets are the key variable to understand households’ impoverishment, which can be defined as the stock of wealth used to generate well-being (Vatsa and Krimgold 2000). This concept is important when considering the effects of natural disasters, which may decrease the capital assets of households and businesses and
subsequently reduce the possibilities for them to generate income/outcome. The output also varies widely, depending on market price of the produced factor, and on the productivity of its use (profitability). As families pursue strategies to maximize their assets, they are in a better position to spread their capacity to reduce their vulnerability. Among other authors, Chambers (1989) cautions about the relevance of increasing assets in low-income families, since this improves human conditions beyond poverty not only in terms of flows, but also structural vulnerability. He affirms that vulnerability is even more interlinked with net assets than poverty. For authors like Vatsa & Krimgold (2000), vulnerability is a broader and more dynamic concept, which involves the poor, but also households living above the poverty line at risk of falling below in case of an income shock (new poor). Factors that obstruct asset accumulation are, in turn, impeding poverty reduction and also putting additional population into poverty. As shown throughout the present chapter, losses from natural disasters act in a similar way as depressed agricultural prices in that of impeding rural households in accumulating assets. It creates a vicious cycle of inefficient risk management strategy, low productive levels, low savings and reinvestment, and increased economic vulnerability.

6.3 Vulnerability to natural, production and trade-related hazards in Mexico

Though social programs in Mexico have been well intentioned to tackle poverty, they seem to render as transitory resource flows, since poverty is a structural issue indeed explained by the way the entire economic structure works. As presented in Saldana (2006), the increased frequency of natural hazards over the past 35 years in Mexico has implied increasing economic losses as well. From its part, the current productive structure and trade-related hazards in the countryside have contributed to stressful living conditions, amplified by insufficient public response to anticipate their derived negative impacts. 50% of the total population in Mexico live in poverty, mostly concentrated to the rural areas, with shares as high as 74% of the population (WB 2002).

6.3.1 Natural hazards exposure

Weather related disasters have been the most recurrent, especially floods, hurricanes and droughts, responsible for 80% of economic losses during the period 1980-2005 in Mexico. They mostly affect the agricultural sector. Droughts are increasingly affecting the whole country, and in some regions in the north a process of desertification has started. This has consequences for the economy. Alone in 2005, the per capita agricultural GDP growth was negative, mainly explained by the severe hurricane season and rainfalls delay, reducing 34% of the cropping area (INEGI 2006). The most affected population is the small-scale rain-fed farmers of traditional crops, e.g. maize, beans, coffee (ECLAC 2006).

Over the past 15 years the irrigated area has been fairly constant covering only 24% of harvested area (INEGI 2006). This is another factor that makes agriculture highly vulnerable to climatic conditions. Alone during the past decade 14 million hectares were lost to natural disasters and less than 10% of that area was insured (La Red 2004).

86 Earthquakes and mudslides have been more destructive in urban areas, ironically damaging slums of immigrants from the countryside who, in many cases, left their agricultural livelihoods due to recurrent disasters affectation (Saldana 2004). However, labor transfers from rural to urban areas have historically exceeded economic systems capacity of employment, impeding solving significantly the poverty issue.
6.3.2 Production and trade-related hazards

Current adverse economic conditions are contributing to the stress of small-scale farming in Mexico. Between 1993 and 2004, per capita GDP growth in the agricultural sector was 0.3%, compared to 1.2% in the overall economy. In turn, low-income farmers represent 67% of total farmers, but contribute only 22% to the overall agricultural production. The deterioration of terms of trade of the agricultural sector, discussed in Chapter 3, seems to explain the long-term declining tendency of agricultural prices. Additionally, in the short-term the lower prices of agricultural goods in Mexico’s trade partners, most likely due to high subsidies, has resulted in higher agricultural imports, accelerating the downward trend of agricultural prices over the past 20 years. The high deficit in balance of trade in the agricultural sector (ca. 20% of traded value) is mainly explained by grains imports from the USA (ECLAC 2006). After the implementation of NAFTA, only a small share of the farmers, those with access to technology, has re-oriented their production to higher-priced exportable crops. Whereas exports of vegetables, mainly from tech-farmers, have grown significantly (9.6%) during the period 1994-2004, the exports of grain, cropped mainly by non-tech-farmers, have practically remained unchanged. However, grains imports grew 7% during the same period (ECLAC 2006).

The productive structure of Mexican agriculture in some regions does not exploit local competitive advantages. Persisting cropping of grains (i.e. maize) in climatic and environmentally non suitable regions contributes to low productivity (Gay et al 2005). In addition, these crops have predominantly low prices, wasting opportunities to improve farmers’ incomes by changing to more profitable crops e.g. vegetables (ECLAC 2006).

Rural credit granting and commercialization services were facilitated by the government until the 1980s, increasing incomes uncertainty of farmers after their withdrawal. As part of the large reforms implemented over the past 20 years, agricultural policy has since then shifted towards less support and subsidies, aiming at the emergence of a private-sector-driven rural economy and largely liberalized markets. It has implied less public intervention in the agricultural market through dismantling state-owned companies for agricultural production and commercialization support. However, subsistence farmers are particularly susceptible to absorb negatively that withdrawal since they are often not eligible for private credit and the cost of key production and commercialization services turn unaffordable to them, e.g. freight, fertilizers, storages, and crop insurances. In fact, credit for the agricultural sector has decreased by 80% over the last ten years, representing only 2.5% of total credit (ECLAC 2006). Finally, high transport costs and bad roads have been crucial in dropping framers’ competitiveness. Freight costs in Mexico are higher than those of Mexico’s main trade partners. For instance, the average price of one ton-kilometer of terrestrial freight is 20% more expensive in Mexico than in the USA, 0.035 and 0.029 USD/ton-km, respectively (Moreno 2004).

6.3.3 Public intervention to reduce vulnerability

Despite the current availability of novel governmental instruments to prevent disasters in Mexico, the public disasters management has been mainly reactive and few

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87 Most likely due to their growing demand in the USA
projects to reduce the risk of future disasters have been carried out – discussed in Chapter 4. The government rebuilds not only public infrastructure, but also housing, and provides some relief to the poor after disasters. Loss sharing has been based on a combination of ex-post instruments, like budget diversion, foreign credit, etc. Risk transfer has been used on mainly ex-ante instruments like insurance, mitigation, and more recently a contingent fund and a catastrophe bond. However, there is a high concentration on ex-post instruments, mainly on rebuilding, and fewer resources have been invested in prevention measures. Unlike current insurance cross-subsidization in the UK (Linerooth-Bayer and Vari 2003), the Mexican government started reducing fiscal burden to farmers cropping in low-risk areas since the beginning of the 1990s, who in fact were subsidizing those farmers settled on high-risk areas through flat-premiums. Although the current subsidy system of crop insurance is financially much healthier than during the 1970s and 1980s, the insured cultivated surface in Mexico has decreased from 40 to 10% between 1990 and 2000. As discussed in Chapter 4, during the same period the damaged crops due to natural disasters doubled (Saldana 2006). Despite the sophisticated design of current disasters mitigation instruments, their resource allocation has been negligible over the past two decades. The contribution of investments in reducing vulnerability to natural disasters seems to be underestimated. In 2003, the expenditure on natural disasters management to the countryside represented less than 0.01% compared to that on social programs, as well as less than 0.02% compared to agricultural programs in Mexico. These proportions are still low if one considers the relevance of natural hazards on incomes discussed in this dissertation.

6.4 The incomes model

This section analyzes the contribution of economic and natural hazards in explaining low incomes regions in Mexico. Derived from our data analysis we observe that municipalities of predominantly low-income population tend to be most exposed to hazards and at the same time those with less favorable conditions to cope with them, shaping regions of high economic vulnerability. Attanasio and Szekely (1999) argue that income is a function of four elements: i) the stock of assets to produce income, ii) the usage rate of these assets, iii) the market price of the assets, iv) transfers to face shocks. In a similar fashion, our model tests the spatial dependence of a low income population on assets value (depicting stocks of assets), irrigation (depicting assets usage rate, and access to technology), agricultural prices variation (representing assets market price), distance to the nearest trading centre (influencing assets market price), economic losses from natural disasters (external shock), and low crop insurance coverage (the typical risk reduction instrument). Given the high dependence of agriculture on weather conditions underlining this work, the equation differentiates with a dummy variable between two economic sectors: agricultural and non-agricultural. The model controls for two particular forms of assets: human and social capital. The model uses the level of secondary education to depict human capital. More education is assumed to contribute to increasing labor productivity and business skills (see Barro and Sala-i-Martin 1995, Becker 1995). The municipal marginalization rate is used to depict social capital, as it embraces access

88 Though some models describing incomes include other relevant variables as well, i.e. monopoly degree (Kalecki 1954), relative prices structure (Robinson 1956), etc., but the corresponding data sets are not spatially available for this work’s spatial approach.
to public services, communal facilities, and social cohesion, among others. Social capital has a positive effect for generating incomes in that of a favorable collective framework facilitates individuals in using their physical and human assets.

The regression analysis is based on data at the municipal level. Mexico is a country comprised of 2,443 municipalities (INEGI 2000). Data sources regarding natural disasters are DesInventar, La Red, and CENAPRED. Data on household incomes, assets value, credit, geographic distances, insurance and irrigation is collected from the National Institute of Statistics and Informatics of Mexico (INEGI), corresponding to the registers from the agricultural and economic national census implemented in 1990 and 2000. Data on agricultural prices arise from SIACON, the Ministry of Agriculture and Livestock.

The base model is a standard linear formulation, estimated by Ordinary Least Squares (OLS):

\[ \text{LnLIP} = \alpha_0 + \beta_1 \text{LnFA} + \beta_2 \text{LnD} + \beta_3 \Delta PA + \beta_4 \text{LnDIST} + \beta_5 \text{LnINS} + \beta_6 \text{LnIRR} + \beta_7 \text{LnEDU} + \beta_8 \text{AGR} + \varepsilon, \quad (1) \]

Equation (1) is then expanded to include the two kinds of spatial dependence, thus making explicit the \( n \) municipalities of our case of study. The spatial models may then be expressed as equations (2) and (3), more detailed explained in Appendix 6.1.

\[ \text{LnLIP}_i = \rho C \text{LnLIP}_i + \alpha_0 + \beta_1 \text{LnFA}_i + \beta_2 \text{LnD}_i + \beta_3 \Delta PA_i + \beta_4 \text{LnDIST}_i + \beta_5 \text{LnINS}_i + \beta_6 \text{LnIRR}_i + \beta_7 \text{LnEDU}_i + \beta_8 \text{AGR}_i + \varepsilon_i, \quad (2) \]

\[ \text{LnLIP}_i = \alpha_0 + \beta_1 \text{LnFA}_i + \beta_2 \text{LnD}_i + \beta_3 \Delta PA_i + \beta_4 \text{LnDIST}_i + \beta_5 \text{LnINS}_i + \beta_6 \text{LnIRR}_i + \beta_7 \text{LnEDU}_i + \beta_8 \text{AGR}_i + \varepsilon_i, \quad (3) \]

\[ \varepsilon_i = \lambda C \varepsilon_i + \mu \]

\[ i = 1, 2, 3, \ldots, n \text{ (municipalities)} \]

Where \( C \) is a row-standardized first order contiguity matrix, \( \rho \) and \( \lambda \) are the spatial autoregressive coefficients, and \( \mu \) is a vector of i.i.d. errors with variance \( \sigma^2 \).

In addition to these specifications, included will also be a Spatial Durbin Model that in addition to equation (2) contains spatially lagged exogenous variables, and a model specification adjusted for structural change (the data divided in two subsets based on a category variable – in our case marginalization) to receive two parameter estimates for each variable. The variables names starting with \( \text{Ln} \) are expressed in logarithms. The variables included in the regression analysis are defined as follows:

\( \text{LnLIP} \), Low Income Population. This variable represents the municipal share of total workforce (from 12 years old) with incomes up to the two official minimum salaries in Mexico in year 2000. Roughly, it equals incomes below 3 USD a day. It is calculated based on the National Minimum Salary, which is the monetary estimation of incomes from current flows of resources accounting for salaries, wages, gains, and/or
entrepreneurial utilities as well as of net transfers from the government and relatives, among others. This (municipal) data gathering is done by INEGI every ten years by means of household level surveys.

**LnFA**, Fixed Assets Value. It is the 1989 aggregated value of municipal per capita physical fixed assets, i.e. buildings, greenhouses, machinery, etc. Data source is INEGI. In general, high per capita assets values are expected to be associated with lower levels of low household incomes, that is, with less poverty.

**LnD**,

Losses from Natural Disasters. This is the logarithm of the ratio economic losses from natural disasters (constant prices 2002) to population during the period 1990-2000. This variable concerns estimated per capita economic losses due to exclusively natural disasters, both direct and indirect. This estimation is done by complementary assessment agents: scientists networks (i.e. La Red), local and federal governments (i.e. CENAPRED), NGO’s, aid organizations, among others. In some cases, there is no estimation of monetary losses from disasters in our registers. However, I used registers of lost cropping area due to disasters to complement information blanks. This variable is relevant as it impedes increasing assets accumulation as well as reduces incomes inflows in the affected region for an uncertain period of time, especially of regions with lesser insurance coverage and other measures to cope with the losses.

**ΔPA**, Changes in Agricultural Prices. This variable represents the change in the mean weighted prices of crops by municipality, that is, change in pesos/ton between 1990 and 2000. It is calculated from a matrix obtained from multiplying the price of the over 440 different crops by their respective production volume by state. The latter are weighted by their respective participation in the total state production. This variable allows us to estimate the value of an average unit of agricultural production by state. This variable does not depict the declining agricultural prices themselves over the analyzed period, but those municipalities relatively more vulnerable given their production structure. High values of this variable mean improvements in production value over the 1990s in the municipal agriculture, the contrary for low values.

**LnDIST**, Distance to nearest trading center. The variable is calculated as the Euclidean distance between each municipality and the geographically closest major trading center. The 50 most important trading centers represents the main markets for agricultural producers either because its consumption or because through them their products get traded. Included are 25 state capitals, 12 maritime ports, the 8 most important border crosses (7 to the USA, 1 to Guatemala), and 5 other large cities. This variable allows us to account for the effect of the distance in dropping competitiveness to local production because of increasing transport costs and isolation from technological centers.  

---

89 I multiplied the mean weighted yield ton/ha of the agricultural production by the mean weighted price MXP/ton (with data from SIACON, Ministry of Agriculture) in order to obtain the mean weighted price of crop hectare, which was summed up to the registers of monetary losses. Turn to Appendix 6.4 for further details.

90 See list of selected cities in Appendix 6.1IV.
**LnINS**, Insurance. Share of municipal agricultural units with insurance in 1990. This variable represents the share of economic units, out of the total by municipality, with insurance at the census year. It represents in this model the preparedness degree of individual economic agents to respond to climatic events and trade uncertainty. Areas with high insurance coverage are expected to smooth income variability. This variable is comprised of private, government-subsidized and mixed schemes.

**LnIRR**, Irrigation. Share of agricultural units with access to irrigation infrastructure in 1991. This variable reflects the share of agricultural units which make use of irrigation infrastructure. The variable values range from 100 to 0; 100 if all agricultural units have access to irrigation infrastructure in a given municipality; 0 if they do not have any access to irrigation infrastructure.

**LnEDU**, Secondary level education. This is the share of municipal population 12 years and older who has absolved secondary studies. Education is assumed to enable a fast individual response to changing conditions, i.e. to natural disasters, price volatility, inputs prices changes, technological change etc.

**AGR**, Agriculture. This is a dummy variable to indicate whether a municipality has an agricultural sector or not. 47 of the 2,443 municipalities have no agricultural activities at all. Given that agricultural municipalities are predominantly rural and non-agricultural urban, including this variable enables us to adjust for the differences in rural-urban prices and remunerations.

### 6.4.1 The incomes model specification

We first estimate the model of equation (1) by OLS. The OLS residuals are then used to test for possible spatial dependence, and to provide guidance on how to proceed towards the final model specification. The model specification improved the goodness of fit from 57%, using OLS, to 70%, with ML-Durbin (Sq. Corr.). The regression results may be found in Table 16.

The OLS regression results, column 1, yield expected parameter estimates. However, the results are influenced by problems of heteroskedasticity and spatial dependence. Since the Lagrange Multiplier tests (LM) indicate that the spatial dependence problem may be solved by an error correction, thus the model specification of equation (3), we begin with this correction. The results corrected for spatial error dependence is presented in the second column. The parameter estimates stay mostly the same as one would expect from this simple error correction. The Loglikelihood increases significantly, but the common factor hypothesis (Burridge, 1981) is rejected. This means that the model is misspecified in its current form and that we need to include spatially lagged explanatory variables as well. The spatially lagged variables consists of spatial averages of neighboring, determined by the previously specified spatial weights matrix C, values for each observation. The parameter estimates of the spatially lagged explanatory variables are interpreted as the average influence that the neighbors have on the income level in each municipality. This model, the spatial Durbin model, is considered as an error model expressed as a lag model since it also has a lagged dependent variable.
included in the equation. The regression results without and with correction for groupwise heteroscedasticity are included in columns 3 and 4, respectively. In order to solve detected heteroscedasticity the data was categorized into two groups to decrease the overall variances by allowing them to deviate between two groups. The categorization was based on the notion of marginalization. This officially constructed categorization of the municipalities was then treated as dichotomous. Groups 0 contain those municipalities who are not marginalized and group 1 contain those who are marginalized.

The spatial lag dependence parameter estimate ($\rho$) is positive and significant and indicates that municipalities with a high (low) degree of low (high) income earning population tend to lie clustered together and spillover to each other since they are influencing each other in their incomes creation. The parameter estimates can be interpreted as elasticities thanks to the logarithmic scale. The group variances within each group are quite different from each other, as shown in column 4. This can be seen from the group variances directly, but also from the Likelihood Ratio test rejecting the null hypothesis of similar variances. Compared to the OLS regression model the spatial Durbin specification clearly improves the goodness of fit with an almost doubling of the Loglikelihood value.

<table>
<thead>
<tr>
<th>Variables/tests(*)</th>
<th>(1) OLS</th>
<th>(2) ML-Error</th>
<th>(3) ML-Durbin</th>
<th>(4) ML-Durbin, Het</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho$</td>
<td>0.350***</td>
<td>0.268***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\lambda$</td>
<td>0.775***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>4.088***</td>
<td>4.017***</td>
<td>3.224***</td>
<td>3.709***</td>
</tr>
<tr>
<td>LnFA</td>
<td>-0.070***</td>
<td>-0.047***</td>
<td>-0.054***</td>
<td>-0.042***</td>
</tr>
<tr>
<td>LnD</td>
<td>0.035***</td>
<td>0.035***</td>
<td>0.041***</td>
<td>0.028***</td>
</tr>
<tr>
<td>LnDIST</td>
<td>0.011***</td>
<td>0.008***</td>
<td>0.010***</td>
<td>0.002</td>
</tr>
<tr>
<td>LnINS</td>
<td>-0.012***</td>
<td>-0.011***</td>
<td>-0.008</td>
<td>-0.006*</td>
</tr>
<tr>
<td>LnIRR</td>
<td>-0.042***</td>
<td>-0.011***</td>
<td>0.000</td>
<td>-0.005*</td>
</tr>
<tr>
<td>LnEDU</td>
<td>-0.080***</td>
<td>-0.060***</td>
<td>-0.053***</td>
<td>-0.049***</td>
</tr>
<tr>
<td>$\Delta$PA</td>
<td>-0.001***</td>
<td>-0.001***</td>
<td>-0.001***</td>
<td>-0.001***</td>
</tr>
<tr>
<td>AGRIC</td>
<td>0.154***</td>
<td>0.045***</td>
<td>0.201***</td>
<td>0.163***</td>
</tr>
<tr>
<td>C_LnFA</td>
<td>-0.041***</td>
<td></td>
<td>-0.027***</td>
<td></td>
</tr>
<tr>
<td>C_LnD</td>
<td>-0.027***</td>
<td></td>
<td>-0.014***</td>
<td></td>
</tr>
<tr>
<td>C_LnDIST</td>
<td>-0.010***</td>
<td></td>
<td>-0.012***</td>
<td></td>
</tr>
<tr>
<td>C_LnINS</td>
<td>0.024***</td>
<td></td>
<td>0.009</td>
<td></td>
</tr>
<tr>
<td>C_LnIRR</td>
<td>-0.044***</td>
<td></td>
<td>-0.025***</td>
<td></td>
</tr>
<tr>
<td>C_LnEDU</td>
<td>-0.012</td>
<td></td>
<td>-0.015</td>
<td></td>
</tr>
<tr>
<td>C_$\Delta$PA</td>
<td>0.001***</td>
<td></td>
<td>0.001***</td>
<td></td>
</tr>
<tr>
<td>$C_\text{AGR}$</td>
<td>-0.474***</td>
<td></td>
<td>-0.46***</td>
<td></td>
</tr>
<tr>
<td>Gr. Variance 0</td>
<td></td>
<td></td>
<td></td>
<td>0.092***</td>
</tr>
<tr>
<td>Gr. Variance 1</td>
<td></td>
<td></td>
<td></td>
<td>0.009***</td>
</tr>
<tr>
<td>R2</td>
<td>0.57</td>
<td>0.28</td>
<td>0.70</td>
<td>0.41</td>
</tr>
<tr>
<td>R2adj</td>
<td>0.57</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sq.corr</td>
<td></td>
<td>0.55</td>
<td>0.71</td>
<td>0.70</td>
</tr>
<tr>
<td>LIK</td>
<td>891,70</td>
<td>1527,27</td>
<td>1332,71</td>
<td>1733,81</td>
</tr>
</tbody>
</table>
Controlling for marginalization

Now, let us disaggregate the model into two subsets of municipalities: marginalized and non-marginalized. Hence we allow the parameter estimates for the two categories to vary across space, cf. spatial heterogeneity. The model specification changes into:

\[
\ln LIP_{ij} = \alpha_{ij} + \beta_{1ij} \ln FA_{ij} + \beta_{2ij} \ln D_{ij} + \beta_{3ij} \Delta PA_{ij} + \beta_{4ij} \ln DIST_{ij} + \beta_{5ij} \ln INS_{ij} + \beta_{6ij} \ln IRR_{ij} + \beta_{7ij} \ln EDU + \beta_{8ij} AGR + \varepsilon_{ij},
\]

with the addition of similar spatial adjustments as mentioned above when necessary.

\(i = 1, 2, 3, \ldots, n\) (municipalities)

\(j = 0, \) if \(i\) is a non-marginalized municipality
\(j = 1, \) if \(i\) is a marginalized municipality

The marginalization index from the governmental National Council of Population (CONAPO) is used as a category variable in this model. The composite index integrates measures of access to health, housing conditions, access to public services (i.e. drainage, clean water, etc), among others.\(^{91}\) Its composition identifies the absence of enough individual and collective asset accumulation.

\(^{91}\) For details about the implemented methodology of the CONAPO marginalization index, see: http://www.conapo.gob.mx/publicaciones/indices/pdfs/006.pdf
Table 17: Spatial regression results of low income (ln2MS_00) by marginalization subsets

<table>
<thead>
<tr>
<th>Variables/tests(*)</th>
<th>(1) OLS</th>
<th>(2) ML-Error</th>
<th>(3) ML-Durbin</th>
<th>(4) ML-Durbin, Het</th>
</tr>
</thead>
<tbody>
<tr>
<td>ρ</td>
<td></td>
<td>0.257***</td>
<td>0.247***</td>
<td></td>
</tr>
<tr>
<td>λ</td>
<td>0.584***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>3.645***</td>
<td>3.513***</td>
<td>2.904***</td>
<td>2.933***</td>
</tr>
<tr>
<td>LnFA</td>
<td>-0.037***</td>
<td>-0.032***</td>
<td>-0.034***</td>
<td>-0.034***</td>
</tr>
<tr>
<td>LnD</td>
<td>0.023***</td>
<td>0.026***</td>
<td>0.033***</td>
<td>0.033***</td>
</tr>
<tr>
<td>LnDIST</td>
<td>0.012***</td>
<td>0.012***</td>
<td>0.012***</td>
<td>0.012***</td>
</tr>
<tr>
<td>LnINS</td>
<td>0.003</td>
<td>-0.017**</td>
<td>-0.019**</td>
<td>-0.019</td>
</tr>
<tr>
<td>LnIRR</td>
<td>-0.030***</td>
<td>0.001</td>
<td>0.019***</td>
<td>0.019***</td>
</tr>
<tr>
<td>LnEDU</td>
<td>0.045**</td>
<td>-0.019</td>
<td>-0.027</td>
<td>-0.026</td>
</tr>
<tr>
<td>APA</td>
<td>-0.001***</td>
<td>-0.001***</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>AGR</td>
<td>0.06</td>
<td>0.146***</td>
<td>0.212***</td>
<td>0.209***</td>
</tr>
</tbody>
</table>

NON-MARGINALIZED

| Constant           | 4.375*** | 4.36***      | 3.83***      | 3.85***            |
| C LnFA             | -0.055***| -0.055***    | -0.055***    |                    |
| C LnD              | -0.022***| -0.021***    | -0.021***    |                    |
| C LnDIST           | 0.007    | 0.007        |              |                    |
| C LnINS            | 0.047*** | 0.047***     |              |                    |
| C LnIRR            | -0.064***| -0.064***    | -0.064***    |                    |
| C LnEDU            | 0.130*** | 0.131***     |              |                    |
| C APA              | -0.001** | -0.001       | -0.001*      | -0.001**           |
| C AGR              | -0.466***| -0.459***    |              |                    |

MARGINALIZED

| Constant           | 165.64***| 1179.17***   | 1182.50***   | 766.35***          |
| C LnFA             | -0.022***| -0.023***    | -0.023***    |                    |
| C LnD              | -0.011***| -0.010***    | -0.010***    |                    |
| C LnDIST           | -0.012***| -0.011***    | -0.011***    |                    |
| C LnINS            | 0.004    | 0.003        |              |                    |
| C LnIRR            | -0.020***| -0.020***    | -0.020***    |                    |
| C LnEDU            | 0.001**  | 0.001**      |              |                    |
| C APA              | -0.489***| -0.470***    | -0.470***    |                    |
| Gr. Variance 0     |          |              | 0.032***     |                    |
| Gr. Variance 1     |          |              | 0.009***     |                    |
| Chow Test:         | 147.20***| 232.05***    | 118.31***    | 62.98***           |
| LnFA               | 0.86     | 0.65         | 0.17         | 0.10               |
| LnD                | 0.04     | 1.60         | 3.75*        | 1.85               |
| LnDIST             | 24.43*** | 34.58***     | 28.54***     | 17.32***           |
| LnINS              | 6.05**   | 1.98         | 1.60         | 0.77               |
| LnIRR              | 0.58     | 4.54**       | 12.77***     | 6.05**             |
| LnEDU              | 33.39*** | 3.57*        | 1.26         | 0.59               |
| APA                | 30.70*** | 0.02***      | 4.51**       | 2.32               |
As before let us begin with the OLS regression, presented in column 1 of Table 17. This time the results are not so clear-cut as before. Some of the coefficients do not have the expected signs and they also differ in magnitude between the two categories. According to the Chow test we may conclude that the two categories lead to significantly different outcomes. And for the individual parameter estimates we may conclude statistically significant differences for distance, insurance, level of education and price variation.

As was the case in the previous section, the LM tests indicate Spatial Error dependence. This problem addressed by the Spatial Error Model and the results are given in column 2. Once more we have an indication that this model is after all not the optimal one since the common factor hypothesis is again rejected. We therefore continue with the spatial Durbin model given in columns 3 and 4, with and without heteroskedastic correction. The groupwise variances are significantly different between the two groups and we will therefore concentrate on commenting on the results in the last column. The overall (the same for both categories) spatial lag dependence parameter ($\rho$) is positive and significant with a parameter estimate of about 0.25. The intercepts for the two categories, 2.93 and 3.85, show in a very simple way that the amount of people with incomes below 2 minimum salaries is very different in non-marginalized and marginalized municipalities. This difference is also confirmed by the Chow test.

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$AGR$</td>
<td>0.62</td>
<td>2.17</td>
<td>1.13</td>
</tr>
<tr>
<td>$C_{\text{LnFA}}$</td>
<td>9.76***</td>
<td>4.97**</td>
<td></td>
</tr>
<tr>
<td>$C_{\text{LnD}}$</td>
<td>3.21*</td>
<td>1.62</td>
<td></td>
</tr>
<tr>
<td>$C_{\text{LnDIST}}$</td>
<td>13.68***</td>
<td>7.27***</td>
<td></td>
</tr>
<tr>
<td>$C_{\text{LnINS}}$</td>
<td>10.77***</td>
<td>5.44**</td>
<td></td>
</tr>
<tr>
<td>$C_{\text{LnIRR}}$</td>
<td>22.77***</td>
<td>11.06***</td>
<td></td>
</tr>
<tr>
<td>$C_{\text{APAGEU}}$</td>
<td>26.46***</td>
<td>12.39***</td>
<td></td>
</tr>
<tr>
<td>$C_{\text{ΔPA}}$</td>
<td>8.91***</td>
<td>4.65**</td>
<td></td>
</tr>
<tr>
<td>$C_{\text{ΔAGR}}$</td>
<td>0.08</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.74</td>
<td>1.06</td>
<td>0.80</td>
</tr>
<tr>
<td>$R^2_{\text{adj}}$</td>
<td>0.73</td>
<td></td>
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<tr>
<td>$\text{Sc.corr}$</td>
<td>0.71</td>
<td>0.80</td>
<td>0.80</td>
</tr>
<tr>
<td>$\text{LIK}$</td>
<td>1477.03</td>
<td>1939.52</td>
<td>1808.95</td>
</tr>
<tr>
<td>$\text{AIC}$</td>
<td>-2918.05</td>
<td>-3843.04</td>
<td>-3547.89</td>
</tr>
<tr>
<td>$\text{Sig-sq}$</td>
<td>0.018</td>
<td>0.011</td>
<td>0.013</td>
</tr>
<tr>
<td>$\text{Hetersk. Marginalization}$</td>
<td>185.67***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Koenker Basset)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\text{Hetersk. Marginalization}$</td>
<td>2896.02***</td>
<td>526.77***</td>
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</tr>
<tr>
<td>(Spatial Breuch Pagan)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$\text{Lik. Ratio, Marginalization}$</td>
<td>327.26***</td>
<td>347.86***</td>
<td></td>
</tr>
<tr>
<td>$\text{Lm-Error}$</td>
<td>751.37***</td>
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<tr>
<td>$\text{LM-Error, Robust}$</td>
<td>519.58***</td>
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<tr>
<td>$\text{LM-Lag}$</td>
<td>308.25***</td>
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<tr>
<td>$\text{LM-Lag, Robust}$</td>
<td>76.47***</td>
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<tr>
<td>$\text{Common Factor (Wald)}$</td>
<td>504.62***</td>
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<tr>
<td>$\text{Lik. Ratio. weight matrix}$</td>
<td>924.98***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\text{LM on sp. Lag}$</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\text{LM on sp. Error}$</td>
<td>169.03***</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(*) *** if prob. < 0.001; ** if prob. < 0.01; * if prob. < 0.05; blank otherwise
In terms of goodness of fit, this model explains about 80%, and the Log likelihood value of 1983 is a clear improvement compared to the biased and inefficient OLS regression results which yielded a Log likelihood value of just 1477.

6.4.2 Results interpretation

In sum, the main determinants of incomes in our model are asset value, losses from natural disasters, prices and education. They seem to be spatially significant, especially higher in the agricultural sector, and crucial to determine incomes of both marginalized and non-marginalized regions. Expanding insurance, irrigation, education and favorable prices has a relatively stronger impact to reducing low-incomes across marginalized municipalities. From its part, reducing economic losses from natural disasters and shortening distances to main trading centers keeps relatively a higher impact in non-marginalized regions. One has to warn that that distinction may be rather attributable to the differential involvement in the monetary economy among these groups, thus to their production value.

The results from the global model, presented in table 16, shows that a 10% increase of fixed assets per capita reduces the share of low income population by 0.4% (column 4). That relation turns clearer when differentiating between marginalized and non-marginalized municipalities. As observed in table 17, the impact of fixed assets is relatively higher in marginalized municipalities.

The negative coefficient for fixed assets in the spatially lagged explanatory variables in Table 17, $C_{LnFA}$, suggests that municipalities with neighbors of higher levels of fixed assets in general have lower shares of low-income population. Thus they help decrease the number of poor people in municipalities close by. This is the case of both marginalized and non-marginalized municipalities.

The positive disaster parameter of natural disasters in the global model shows that $ceteris paribus$ reducing by 10% disasters losses may lead to reducing by 3% the share of people with low incomes. The impact of disasters is similar and positive for both marginalized and non-marginalized municipalities.

The spatially lagged explanatory variable of disasters losses, $C_{LnD}$, has a negative parameter sign. It follows that if the neighbors of municipality $i$ experienced heavy losses then that has a somewhat surprising stimulating spillover effect on the economy of municipality $i$ leading to reduced shares of low-incomes population. That effect may be explained by the benefit obtained if neighbors had losses but they did not. When analyzing marginalization, one can observe this relation to be stronger for non-marginalized municipalities, most likely due to their comparatively higher participation in the monetary economy. As non-marginalized municipalities have historically been less affected by natural disasters, this relation seems to be contributing to enlarging inequity in the country. To help reduce the share of low-income people we also find availability of insurance, irrigation and the share of people with secondary education helpful.

Most likely due to the progressive government withdrawal from subsidizing crop insurance in the country during the 1990s, the insurance variable shows low significance on explaining low incomes for year 2000 in the global model. The parameter estimates for insurance is not statistically different between the two categories, although the parameter estimate is slightly more significant for the marginalized municipalities.
From its part, a non-marginalized municipality surrounded by municipalities with low insurance coverage has a less poor workforce. This relation is similar to the one of disasters since these municipalities usually compete for markets and the net income losses tend to be lower in municipalities with better response and therefore faster productive reactivation. The relation in the opposite way suggests that if the neighbors of the non-marginalized municipality i have more insurance levels, it enlarges poverty in i. For sure, that is not a cause-effect relation but just a simple question of comparative response. A possible explanation may be that non-marginalized municipalities are rich enough to afford insurance while the parameter estimate for marginalized municipalities is insignificant. It follows that though non-marginalized municipalities are per se better off, and do not get affected by having neighbors comparatively less insured, whereas marginalized municipalities do not clearly benefit from having better insured neighbors.

As a whole, lacking irrigation increases the number of people living in poverty in a given municipality. The coefficient for irrigation is surprisingly significant and positive for the non-marginalized category but negative and significant for the other group. The positive coefficient may be explained by the need for irrigation to have an agricultural production at all in those municipalities but that are vulnerable to certain types of disasters which irrigation is not enough to counteract (i.e. floods). The analysis of the lagged explanatory variables shows that having neighbors with high degree of irrigation is good for both kinds of municipalities.

Just by comparing variables coefficients, the return on poverty reduction from increasing assets is the highest compared to the rest of the variables. However, among marginalized municipalities, assets value and lowering disasters losses imply practically the same returns. As the cost of implementing these strategies surely differs, the resulting less costly strategy at present value seems to be the economic criterion for decision in further research carried out at municipality level. Investing in loss reduction instruments which at the same time increase assets value and other favorable variables can maximize the overall benefit from public investments for poverty reduction. For instance, investing in a levies-channels-irrigation system might reduce losses from floods and droughts, increase assets value, expand irrigation coverage, reduce the average disaster risk in a given region and consequently reducing the corresponding insurance premiums with a parallel favorable spillover effect on neighbor municipalities. From its part, given the difficulties for an eventual renegotiation of the agricultural chapter of the NAFTA in the short term, one feasible mechanism to cope with declining agricultural prices is increasing competitiveness through moving to more profitable agricultural production sites, lowering transport costs as well as improving education for a better individual risk management among farmers.

In the global model, municipalities with increases in the value of their agricultural production –given the current prices structure- during the 1990s are associated to lower poverty levels. This fact is more relevant for marginalized municipalities. It suggests that a productive reorientation toward higher value cropping brings the most significant benefits among those more marginalized municipalities.

Education is very important in explaining low-income workforce, especially in marginalized municipalities. In turn, being surrounded by municipalities with high educative levels contributes to reducing poverty levels in marginalized municipalities. In non-marginalized regions, the spillover effect of neighbors with high educative levels is
less clear. However, one should be careful with this conclusion since the Chow test does not reject the null hypothesis of similar parameter estimates.

Municipalities with agricultural activities compared to those who have none, have a much higher share of low-income population. As deduced from the negative sign of the spatially lagged variable, being surrounded by agricultural municipalities is associated to reducing shares of low-income population, driven by the strong effect of high-incomes non-agricultural municipalities surrounded by low-incomes agricultural regions.

Overall, the further the location of a municipality is from a trading center the higher is its low-income workforce share. However, it is only significant for non-marginalized municipalities implying that increased distances to major centers increase the amount of low-income population. It may be reasonable to assume that municipalities that are marginalized are probably not influenced in a particularly high degree by being more distanced from the trade centers if one considers that they tend to rely less on trade and more on self-consumption as they are more marginalized. However, marginalized municipalities tend to benefit from having neighbors with shorter distances to trading centers. Thus, improving transport infrastructure might bring higher direct benefits to those non-marginalized, but with a positive spillover on marginalized municipalities.

The shown spatial impact of natural disasters on incomes level allows us to state them to be significant in impeding poor households going out of poverty. However, can we state that impact to be strong enough to accelerate out-migration?

6.5 The emigration model

Migration patterns of plants and animals are changing around the world in line with climate conditions (Gordo et al 200592, Pitelka 199793). In the recent history of the earth, the sensibility of human societies to climatic variations has been less studied compared to other species, mainly explained by the widespread adoption of sedentary means of productive organization. However, the increased occurrence and severity of natural hazards seems to be altering some human migratory patterns again. Most of the attention of the impact of climatic events on human migratory patterns has centered on geologic-anthropologic registers, e.g. Pleistocene out migration from Africa (McNobb 200594), and post glaciations out migration (Allen et al 1999). Less attention has been, however, conceded to analyzing impacts of climatic events on recent migratory flows.95

92 Gordo et al (32005) provides evidence that the spring arrival of long-distance migrants trans-Saharan birds is more likely to be influenced by climate conditions in wintering areas given their direct impact on the onset of migration and its progression.
93 Pitelka (1997) provides pre-historic and present evidence on plant migration. He emphasizes the contribution of human activities through habitat fragmentation to interfere in plant migration to adapt to global climatic change.
94 Based on an archaeological study of hominin colonization associated with the Early-Middle Pleistocene transition, McNabb (2005) points out that climate change and especially shifts in local aridity are explaining factors of migratory moves out of Africa. However, the Acheulean behavioral repertoire did not change much across Africa and Europe over a million years of time. It merely adapted to local conditions, he concludes.
95 Among the scarce research on this relation, McLemann (2006) examines the influence of natural environment on human migration and settlement patterns of rural population. He analyzes households’ response in a period of adverse climatic conditions in rural eastern Oklahoma during the 1930s. Focus was in those that adapted by migrating to rural California.
Through an out migration model I test the second hypothesis of this chapter, that is, recurrent natural disasters, along with decreasing incomes and lack of access to credit, have stimulated out migration over the past decade in Mexico. In addition, we show that migration is not a question of poverty itself, but rather of income expectations. As recurrent disasters incidence and absence of credit reduce economic agents’ current incomes as well as their estimations of returns of future incomes for a time horizon, they have more incentives to leave their communities. Migration is here thought of as an economic phenomenon that an economic unit implements to respond to harmful events.

**Emigration as response**

An important component in vulnerability assessments are coping and adapting capacities in response to hazards. Coping capacity can be defined as the ability of a unit to respond to a harm occurrence as well as to avoid its potential incidence, whereas adaptive capacity is the ability of a unit to gradually transform its structure, functioning or organization to survive under hazards threatening its existence (Kelly and Adger 2000). After persistent or major hazards, coping and adaptive capacity of the most vulnerable economic units is taken to the limit. If they do not have access to credit or to further mechanisms to re-activate their production or to restructure their productive processes towards less vulnerable conditions, their expectations of future incomes become pessimistic. The latter leads us to consider migration not as a mere function of poverty, but of dropped expectations.

Emigration can function as coping or adaptive strategy. According to this works approach, migration functions as coping strategy if after a disaster at least one member of an economic unit leaves the community and sends remittances. In such a case, a share of that emigrant’s income becomes subsidiary to the economic unit (at home), contributing this unit to subsist as agricultural livelihood. Having members abroad might even become an asset for a given economic unit if they return home frequently, bringing knowledge, education or innovative ideas to increase assets profitability. Unlike the previous example, migration functions as adaptive strategy if the economic unit has to disintegrate as that in its original location. In other words, emigration serves in such a case as a surviving alternative once the unit’s self coping capacity got exceeded. Something remarkable in this case is the inability of the system in which a given economic unit is located to provide assistance in order to maintain him in the community.

At the national level, out migration in Mexico has increased over the past two decades. The Population Census of 1990 reports that 0.24% of the Mexican population was residing abroad, whereas in the 2000 Census this figure rose to 0.41% (INEGI 2000). As currently about one-quarter of Mexico’s labor force is still employed in agriculture, and as conditions in the countryside are each time getting worse, rural workers do not

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96 Coping strategies include neighbors and relatives’ solidarity, off-farms jobs, access to credit, among others. Unlike solidarity support and off-farm jobs, credit is the strategy most capable of providing resources in the needed amount and time. Credit is also the only institutional coping strategy, as well as the one with more data availability. In Saldana (2006) the utility of coping strategies is investigated in its broad spectrum.
have incentives to stop out migration not only to urban Mexico, but also to urban and rural USA (Robinson et al 1995).

In absence of credit and other instruments to finance recovery, regions where natural disasters and adverse economic conditions occur more frequently tend to maintain low rates of capital accumulation, often even negative. It leads to, other things equal, reduced capital-labor ratio and in turn to decreased marginal product of labor (Barro and Sala-i-Martin 1995). Assuming salaries to be determined by the marginal product of labor, these regions tend to decrease mean salary. As other regions have higher salary levels, they stimulate the labor force to emigrate first to higher incomes regions inside the country (Krugman and Obstfeld 2006), and further abroad if these regions are unable to fulfill their future incomes’ expectations.

For Todaro (2000), migration is primarily an economic phenomenon, which for the individual migrant can be a quite rational decision despite the existence of urban unemployment. The Todaro model postulates that migration proceeds in response to urban-rural differences in expected income rather than actual earnings. That decision is taken in order to maximize their expected gains in life and, for a given time horizon urban areas might therefore be a rational alternative. In other words, if coping and adaptive capacity of vulnerable economic agents is exceeded in their locations to get their expected earnings, they find emigration to higher income regions to be their best strategy, even despite the presence of restriction to labor mobility and hard conditions to cross international borders.

As emigration determinants, our model includes changes in share of population earning up to 2 minimum salaries, access to credit, natural disasters frequency, cropping advantages, education level, and distance to the closest trading center. Unlike the previous model, we are here emphasizing disasters recurrence to underline the relevance of disasters repetition in influencing expectations. The empirical evidence of the previous chapter of this thesis shows that a municipality can register high economic losses but they may be due to just one major event affecting incomes but households do not necessarily perceive it as a threat for the future. If that is a low-frequency-disaster municipality, disasters are not necessarily altering future incomes expectations. For that reason, we use cumulated number of disasters reports instead of economic losses. Credit availability in those regions may counteract the chain-reaction triggered by recurrent disasters, regenerating expectations of future incomes. Access to credit is included to account for a representative (financial) coping strategy which may counteract reductions in the capital/labor ratio following disasters and improve expectations. An adverse productive structure is depicted through high ratios of (price-dropping) grains to (price-rising) vegetables, included in the variable GRAVE. Education level and distance to trading centers are included in order to examine the propensity to emigrate of the less educated population and the role of proximity to urban centers in facilitating out migration.

So, the model of emigration, EM, is shown in equation (5) below:

\[
\ln EM_i = \alpha_0 + \beta_1 \Delta LIP_i + \beta_2 \ln CRE_i + \beta_3 \ln NDR_i + \beta_4 \text{GRAVE}_i + \beta_5 \ln EDUCSEC_i + \\
+ \beta_6 \ln DIST_i + \varepsilon_i
\]  

(5)
The model variables are defined as follows:

*LnEM*, Emigration. This variable is an estimation of the share of municipal population 12 years and over which has emigrated between 1990 and 2000, according to the 2000 national household survey of INEGI.

*ΔLIP*, Low Incomes Population Increase. This variable depicts impoverishment increase. It is the increase between 1990 and 2000 in the percentage of municipal workforce with incomes below two minimum salaries (2000 constant prices). In fact, this variable does not reflect poverty itself, but the deterioration in individuals’ incomes. Indeed, the greatest incomes reductions took part in the less marginalized regions of the country (see Appendix 6.II) though their repercussions on emigration are greater among the most marginalized, as shown below.

*LnCRE*, Credit. It represents the number of agricultural units out of the municipal total with access to credit. This variable depicts the access of agricultural units to financing, which is crucial after natural disasters to rebuild and continue making use of their assets, as well as to face price fluctuation and in general incomes uncertainty. Credit access has a negative impact on emigration, most likely due to its virtue in re-stimulating expectations of future incomes within the same location as it allows continuity in assets usage.

*LnNDR*, Number of Disasters Reports. This variable is the count of natural disasters which have hit a municipality over the period 1990-2000, that is, the recurrence level of disaster affection by municipality. Regions with higher frequency of natural disasters are more prone to out migration. If instead, one runs the model with per capita economic losses from natural disasters, the coefficient is positive as well but statistically insignificant. Indeed, these two variables measure different things, since whereas the latter has a clear impact on incomes, confirmed in the low-incomes model, the former is capable of influencing the perception of natural disasters in the community. It is verified in Chapter 6, where communities with comparatively lower economic losses but more frequent natural disasters more interviewee have plans to emigrate. In contrast, in communities with even higher economic losses but less frequent disaster events, the wish to emigrate is smaller.

*GRAVE*, Ratio Basic Grains to Vegetables. It is the ratio of production in tons of the five main grains of the Mexican agriculture to the ten main vegetables. Given the structure of the Mexican agriculture, the grain producers are worse-off to compete by the remarked decline in price of grains and the dramatic increase in imports of the same commodities from the USA. From its part, the country presents clear comparative and competitive advantages in vegetables. High values in this variable mean weak trade competitiveness in a municipality, as well as low values mean even potential to export, as the country has clear advantage in vegetables compared to the USA and Canada (see Lederman 2003). Indeed, this variable may also depict a kind of intra-branch negative terms of trade, given the declining trend of the relative price of grains to vegetables along the past two decades in Mexico (ECLAC 2006).
\[ \text{LnEDU} \] and \[ \text{LnDIST} \] are the variables of secondary education and distance to trading centers as defined in the previous model.

### 6.5.1 The emigration model specification

As in the incomes model we begin with the OLS regression. There are clear indications of spatial dependence, dominated by spatial error dependence, and also heteroskedasticity. However, once again the spatial error model is not the correct one since the common factor hypothesis is rejected. This leads us to estimate a spatial Durbin model, adjusted for groupwise heteroskedasticity, grouped by the two categories of marginalization. The goodness of fit is initially 25\%, and 55\% (Sq.corr) after specification correction.

<table>
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<th>Variables/tests(*)</th>
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<th>(2) ML-Error</th>
<th>(3) ML-err, Het</th>
<th>(4) Spatial Durbin</th>
<th>(5) Spatial Durbin Het</th>
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<td>0,671***</td>
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<td></td>
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<td>0,698***</td>
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<td>0,679***</td>
<td>0,666***</td>
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<td>0,005***</td>
<td>0,005***</td>
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<td>0,107***</td>
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<td>4,02**</td>
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</table>
Controlling for marginalization

The data was for this estimation divided into two subgroups based on the categorization of marginalization, shown in Table 19. The test of the residuals from the OLS estimation points to a spatial lag model. For completeness, we also estimate a spatial Durbin model to capture exogenous spillovers.

Table 19: Spatial regression results of emigration by subsets of marginalization

<table>
<thead>
<tr>
<th>Variables/tests(*)</th>
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<th>(2) ML-Lag</th>
<th>(3) Spatial Durbin, Marg</th>
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<td>-0,005</td>
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<tr>
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NON-MARGINALIZED

MARGINALIZED

Chow Test: 21,90*** 87,02*** 112,19***
### 6.5.2 Results interpretation

Regions historically more frequently affected by natural disasters with relatively higher impoverishment and cropping price-declining products, register higher emigration rates. In addition, the higher emigration occurs in regions with higher educative levels from marginalized regions, confirming the presence of drain of population with higher human capital. The classical believe that reducing exceeding levels of workforce leads to increasing the marginal product of labor must be taken carefully in light of these results, given that the workforce remaining in the community is the least skilled. In addition, the distance is not a real obstacle to emigrate, given that most emigration arises from far communities.

The positive sign of $\Delta LIP$ suggests that those municipalities whose workforce experienced higher moves down from superior wages levels to below the 2 minimum salaries line are more prone to out migration. From the regression results, the larger the impoverishment over the 1990s, the greater the emigration rate between 1990 and 2000. This coefficient is higher across non-marginalized municipalities. Indeed, they experienced comparatively less changes and decreases in incomes. However, marginalized municipalities have usually so low levels of wealth that additional incomes decreases turn asymptotically smaller, but compared to their assets value even a small

<table>
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</table>
| Heter
d. Marginalization,
(Koenker-Basset) | 0.00 | 0.05 | 0.06 |
| Heterosk
Marginalization
(Spatial Breuch Pagan) |          |          |
| Lm-Error | 1151.86*** |
| LM-Error, Robust | 65.08*** |
| LM-Lag   | 1156.86*** |
| LM-Lag, Robust | 70.08*** |
| Lik. Ratio, weight matrix | 888.97*** | 801.86*** |
| LM on sp. Lag |          |          |
| LM on sp. Error | 9.40*** | 66.80*** |

(*) *** if prob. < 0.001; ** if prob. < 0.01; * if prob. < 0.05; blank otherwise
The relevance of **credit** in stimulating emigration is not statistically significant in the global model. As the case of insurance, agricultural credit availability has dramatically decreased along the 1990s (ca. 80%), reducing its connection with incomes. For the though insignificant but positive sign of credit along marginalized regions we have some reasons to presume lack of credit to stimulate workforce emigration given that they recur directly to out migration to cope with adverse conditions as they cannot account for credit as a feasible coping strategy.

However, we can observe a significant negative coefficient for the spatially lagged variable in Table 18. This means that having neighbors with comparatively higher credit access helps to maintain low emigration rates. As credit conventionally facilitates means to increase the risk pool, helping to smooth negative effects from hazards, a positive spillover effect from having neighbors with low losses may facilitate getting off-farm jobs in the nearby, and not to recur immediately to out migration.

Our results shows that high **disasters frequency** push people to move out from their municipalities, especially in non-marginalized regions. Other things equal, if the frequency of disasters increase by 10% the emigration rates rises 1% in that region. Out migration is limited by factors in the surrounding municipalities, captured through the negative coefficients of the corresponding spatially lagged variables in Table 18. For instance, a large number of disaster reports in surrounding regions influence people not to migrate, most likely due to the catch-up they can do, if they are less affected, after some producer prices of crops increases for scarcity.

In turn, the frequency of natural disasters tends to make non-marginalized population comparatively more prone to out migrate, especially due to their combined characteristics of higher educational levels, and therefore more skilled to build a coping strategy given the absence of credit and other alternative financing sources.

Though the ratio basic **grains to vegetables** \( (GRAVE) \) provides negligible results for the global model, the marginalization partition suggest that those non-marginalized regions cropping predominantly grains tend to significantly increase emigration levels. It is most likely explained by their greater involvement and participation in trade, whereas the most marginalized rely on self-consumption at a larger extent. Other things equal, a decrease of 10% in the ratio grains/vegetables in the less marginalized municipalities leads to a 3% decrease in out migration.

As observed, **education** is positively related with emigration. So, emigrants arise from regions with comparatively higher educative mean. It suggests that less educated population is less prone to implement migration to cope with hazards either because they are more averse to change residence, has less means to do it, or has a resignation position given the recent past hierarchical governmental organization, more remarkable upon marginalized population –in many regions still going on. The prevailing fatalistic way of life of most subsistence farmers with low educative levels, abundantly expound in Thompson (et al 1990), provides further grounding for these results.

In the marginalized municipalities, high out migration rates take place if they experienced remarkable increases in low-income population combined with high educative levels. Derived form the spatial Durbin model, for the non-marginalized
municipalities the amount of educated people within the surroundings reduces out migration. This could be because higher educated neighbors generate more economic activity and hence jobs in the region, or that the opportunities at home are already quite good.

One had expected marginalized people close to big cities to keep higher proclivity as their **distance** and transport costs tend to decline as one approach large cities. Surprisingly, marginalized population from regions farer from trading centers seems to be more prone to emigrate. In light of the relative low access to transport in remote marginalized areas, that fact reflects the crucial role of migration networks.

In sum, incomes lowering, disasters frequency and education proved to determine emigration with much sounder results than the rest of the variables in the global model. Roughly, the prototype of an emigration-prone municipality in this country may be result of the following characteristics combination: incomes substantially dropped over the past ten years, frequently affected by natural disasters, relatively more educated, marginalized, grains-intensive producer, and located in far regions with low access to credit.

**6.6 Conclusions**

The models approached in this chapter confirmed the hypotheses. Economic losses from natural disasters, along with the adverse addressed economic conditions in the agricultural sector, have thus a negative economic impact with a spillover effect across this country. In a similar way as regional growth may be dependent on the growth in other regions, so the negative effect of disasters on local incomes has spillover on incomes in other municipalities. Disaster effects are significant in explaining incomes along with possession and usage of assets, as well as with the availability of coping and adaptive instruments. The most vulnerable regions to natural disasters also experience an amplification of their negative consequences given their low insurance and irrigation levels, positively related with maintaining low-incomes. Having less vulnerable neighbors seems not to be a benefit for those more vulnerable. Derived from these evidences, it cannot be expected to get filtered some benefits from better- to worst-off population just by *laissez faire*. The current entitlements systems in the country may lye behind that. Strengthening risk transfer (e.g. insurance) and risk reduction (e.g. irrigation) instruments besides building a more favorable productive environment (e.g. productive reorientation) is particularly valuable for marginalized municipalities. Failing in these tasks seems to have been crucial in impeding sufficient physical and human capital accumulation during the 1990s, and probably over the present decade too since these conditions have not significantly changed.

From its part, enhancing terms of trade and transport infrastructure may greatly benefit both groups, but apparently more remarkably to the less marginalized as they are comparatively more involved in the monetary economy. Once reduced substantially the vulnerability to disasters and production of subsistence farmers, the next step should be to integrate them rapidly into the commercial agriculture. It may allow sharing more equally the benefits of any large investment in transport infrastructure and further trade facilities, as well as raising their incomes based on a more profit-oriented productive structure. It may allow them in accumulating assets and so to enlarge their risk pool to cope better with forthcoming hazards.
Emigration was proved in this model to be a result of expectations of future incomes. Emigration is a rational decision the economic agents take based on their own estimated future returns of their assets, accounting for expected net assets and incomes losses after internalizing available financial resources. Municipalities with higher emigration rates have been those with greater incomes decreases, each time more recurrently affected by natural disasters over the 1990s. The model suggests that expanding access to agricultural credit may reduce the stimulus to emigrate, most likely as it reduces the negative hazards impacts inside the affected region. The most significantly prone segment to out migrate is that with higher educative levels, marginalized and living far from trading centers, underlining the role of networks in facilitating labor mobility despite remoteness. As the current transport infrastructure is proving not supporting them sufficiently to compete as economic agent, they are using it rather to emigrate.

This works geographic identification of vulnerable regions may support public decisions for future investments in expanding crop insurance coverage, credit access, and promoting more public works in infrastructure in vulnerable areas. As observed in these models, the contribution of natural disasters to incomes is, by far, exceeding the current response to cope with that. In turn, the negative effects of unfavorable liberalizing policies cannot be counteracted just through aid for the poor. Finally, the current investments in education will continue rendering as a mere instrument for training potential emigrants as long as a reform to allow assets accumulation and consequently to reduce social polarization does not take place in this country.
Appendix 6.1: How to introduce spatial data into the econometric notation?

The transformation of relative location information of contiguity into a weights matrix is the most employed way to relate the observations to each other in a network. Measures of contiguity rely on knowledge of the size and shape of the observational units such as municipality polygons depicted on a map. With that we can define which units are neighbours (have borders that touch) or represent observational units in reasonable proximity to each other using longitude and latitude.

For the sake of simplicity, assume that we are dealing with a geographic area comprised of five-regions, as shown in the figure below:

Figure 32: Conceptual representation of regions’ contiguity

To construct the weights matrix, we record in each row of that matrix a set of contiguity relations associated with all regions, giving a value 1 to the $w_{ij}$ element if region $i$ borders to region $j$, 0 otherwise. All regions’ connections may finally be represented in the following matrix:
For instance, the element in the row 1, column 3 means that region 1 shares border with region 3, as seen in Figure 32, and so on for every element in the matrix \( W \). This matrix is symmetric and always has zeros on the main diagonal – because one region has no border with itself. To start applying this matrix, it must first be transformed to have row-sums of unity, conventionally called “standardized first-order” contiguity matrix (LeSage 1998), which can be denoted as \( C \):

\[
C = \begin{pmatrix}
0 & 1/2 & 1/2 & 0 & 0 \\
1/3 & 0 & 0 & 1/3 & 1/3 \\
0 & 0 & 1/2 & 0 & 1/2 \\
0 & 0 & 1/2 & 1/2 & 0 \\
0 & 0 & 0 & 0 & 0 \\
\end{pmatrix}
\]

We may now multiply \( C \) by a vector of observations of any variable - concerning the five regions of this simplified example- which we label \( y \) (5X5 matrix).\(^{97}\) The product \( (Cy) \) represents a new variable, equal to the mean of observations from contiguous regions, which we denote as \( y^* \), expressed as follows:

\[
\begin{pmatrix}
y_1^* \\
y_2^* \\
y_3^* \\
y_4^* \\
y_5^* \\
\end{pmatrix} = \begin{pmatrix}
0 & 0.5 & 0.5 & 0 & 0 \\
1 & 0 & 0 & 0 & 0 \\
0.33 & 0 & 0 & 0.33 & 0.33 \\
0 & 0 & 0.5 & 0 & 0.5 \\
0 & 0 & 0.5 & 0.5 & 0 \\
\end{pmatrix} \begin{pmatrix}
y_1 \\
y_2 \\
y_3 \\
y_4 \\
y_5 \\
\end{pmatrix}
\]

\(^{97}\) In our case of study model, both \( W \) and \( C \) matrices’ size is 2,443 by 2,443.
Equation (4) may also be expressed in linear form in order to explain changes in $y$ across space.

$$y = \rho C y + \varepsilon$$  \hspace{1cm} (5)$$

Where $\rho$ depicts a regression parameter and $\varepsilon$ represents the stochastic error of the model. The parameter $\rho$ shows the spatial spill over between neighbours in the data, reflecting the average influence of neighbouring on observations in the vector $y$. So, it enables us to estimate the share of total variation in $y$ explained by spatial dependence (LeSage 1998). The Spatial Lag model as in equation (5) is an appropriate solution when spatial correlation appears among observations of the dependent variable.

Now, we can add explanatory variables to shape our model, representing it with the traditional matrix notation $X\beta$. So, the model equation (5) can be modified as follows:

$$y = \rho C y + X\beta + \varepsilon$$  \hspace{1cm} (6)$$

The inclusion of a spatial lag is equivalent to include an endogenous variable on the right hand side of the equation in systems of simultaneous equations. This would not be a problem if $\rho$ was known, but most of the time $\rho$ must be estimates simultaneously jointly with the other regression parameters. This means that estimation using OLS is inconsistent. The solution is estimation through maximum likelihood or the instrumental variables approach.

Another kind of spatial dependence occurs when the residuals are spatially correlated with the dependent variable. This kind of dependence occurs when values of adjacent observations move in the same direction because they have common or correlated unobservable variables. That is, lack of independence of the error between observations –as in temporal econometrics- would lead to inefficient estimates if ignored. The Spatial Error Model (Cliff and Ord 1972) as in equation (6) by means of a partition of the stochastic term into two parts, together with a spatially weighted matrix. In the
case of spatial dependence present in the residuals we solve this problem by dividing the error term into two parts and incorporate the spatial error dependence in a similar way as before. The estimation method is maximum likelihood or generalized method of moments.

\[ y = X\beta + \varepsilon \]
\[ \varepsilon = \lambda C \varepsilon + \mu \]  

(7)

In (7), \( \lambda \) is the spatial autoregressive parameter, \( C \) is the weights matrix, and \( \mu \) is a vector of i.i.d. errors with variance \( \sigma^2 \).

A first step to test for presence of spatial dependence is to make exploratory data analysis to find indications of spatial autocorrelation, present in the data. We must thus test whether objects of similar values are more clustered than by mere coincidence. This is done using the Moran’s I test with a null hypothesis of no spatial clustering (Moran 1948, Cliff and Ord 1981, Upton and Fingleton 1985). The second step is to examine and solve for spatial dependence in the regression analysis. The classical estimation routine towards a proper model specification under the potential influence of spatial dependence is, for instance, Lagrange Multiplier tests, given in Florax et al. (2003). The initial model is estimated by means of OLS. The residuals are then used to test the hypothesis of no spatial dependence caused by an omitted spatial lag or by spatially autoregressive errors by use of two Lagrange Multiplier tests (the LM-lag test and the LM-error test), e.g., Anselin (1988) and Burridge (1980). When the hypothesis cannot be rejected (no spatial dependence is at hand) meaning that the results from the OLS may be used. However, in the event that the hypothesis is, by both tests rejected, a new model should be estimated. The proper model is indicated by the most significant LM test. In case that only the LM-lag test is significant, the next step would be to estimate a Spatial Lag Model, or, consequently, a Spatial Error Model if the opposite is indicated.
Appendix 6.II: The official minimum salary in Mexico, a biased welfare indicator

This paper model makes use of an income-based measurement of vulnerability, whose link with poverty addresses this appendix. Further, it analyzes the evolution of real incomes (1 minimum salary) over the 1990s and describes its spatial distribution across Mexico in 2000. We show that appearing reductions in number of people earning below one minimum salary is indeed not reflecting welfare improvements once considered the devaluation of one minimum salary over time.

Poverty

There exists no consensus about what issues embraces poverty. However, a point of agreement among the vast existing literature on this regard seems to be that poverty is a lack of opportunities to reach a basic minimum level of well being. In turn, well-being can include several determinants, i.e., assets, infrastructure, social networks, institutions, human development, etc. This leads us to another point of agreement: poverty is a relative concept of “minimums of well being” (as in SEDESOL 2002), “society’s hopes and aspirations to be fulfilled” (World Bank 2001), or “basic needs” (Todaro 2000), what varies widely among and within societies. Other concepts of poverty go beyond tangible factors and include rights issues, relationships, powerlessness, socioeconomic exclusion, and even loss of dignity (i.e. Elankumaran et al 2000).

Income and consumption criteria

Among measurements of poverty, there are two basic criteria: income and consumption. Income-based measurements of poverty embrace the total current monetary and non-monetary income a household obtains from different functional sources, including wages, salaries, dividends, rents, etc. Consumption-based criterions consist of the total amount of monetary and non-monetary expenditure a household makes in all possible items. The advantage of using consumption-based measurements of poverty relies on the fact that it can reflect smoothing strategies a household implement in response to sudden income fluctuations. The use of income-based measurements is advantageous in that of allowing identifying income components whose strengthening can help to reducing vulnerability. Though the Ministry of Social Development at the Federal Mexican Government (SEDESOL) elaborates both measurements, only data of income measurements are available at municipality level.

For these reasons and in sight of the present work’s aim, we make use of low-incomes criterion. As this measurement of poverty leaves out household’s assets, we include it in the model as explaining variable within the variable ‘marginalization’. The low-incomes line approached in this appendix is similar to the $1 per day standard criterion at Purchasing Power Parity (or absolute PPP dollar –Chan and Ravillion 2004). Given data availability, our low-incomes line is one official minimum salary, equivalent to average 2.3 US dollars during the period 1990-2000 (1990 constant prices), similar to the 2.1 exchange rate from the World Bank (1993 constant prices). This work’s low-income line consists of incomes equal or below 1 Minimum Salary (MS) by worker.

1. Minimum Salary across time and space

Before starting analyzing data, it is important to consider two facts. First, the aim of defining this low-income line in real terms is not to provide one more poverty measure
of Mexico, but to allow us to identify spatially municipalities with low incomes and decreasing incomes in real terms. Whereas low incomes and poverty may keep similar geographic distribution, but changes in real incomes over the 1990s may diverge. In addition, this analysis is not accounting for the entire population living with less than one absolute PPP dollar, but with those workers earning less than that: consider that usually one worker still has to share his earned dollar with the rest of the family. Indeed, this analysis deals with just income and not with poverty itself. Secondly, a 30% real depreciation of Mexican general minimum salary (GMS) took place during the period 1990-2000 according to the International Labor Organization (ILO 2005). We had to modify the original municipal data by transforming minimum salary (MS) from nominal to real terms in order to obtain comparable low-incomes shares over a ten-year horizon. The latter provides a more realistic picture of the share of workers below the low-income line. Since the ILO estimations tend to smooth the MS depreciation in Mexico to harmonize within Latin-American countries, we made our own estimations. According to this work’s estimations, the real MS depreciation reaches 39% (see Table below).

| (1) | (2) | (3) | (4) | (5) |
| Nominal MS (MXP/day) | Nominal Var. MS (year before) | Inflation rate (%) | Var. real MS (*) (%) | Real MS, MXP/day, (constant 1990) |
| 1991 | 10.79 | 18.03 | 25.02 | -6.99 | 7.82 |
| 1992 | 12.08 | 12.03 | 16.73 | -4.71 | 7.46 |
| 1993 | 13.06 | 8.08 | 10.45 | -2.37 | 7.28 |
| 1994 | 13.97 | 6.97 | 7.12 | -0.15 | 7.27 |
| 1995 | 15.85 | 13.42 | 24.02 | -10.59 | 6.50 |
| 1996 | 19.55 | 23.35 | 41.42 | -18.06 | 5.32 |
| 1997 | 24.30 | 24.33 | 23.34 | 0.98 | 5.38 |
| 1998 | 27.99 | 15.19 | 15.37 | -0.19 | 5.37 |
| 1999 | 31.91 | 14.01 | 18.00 | -4.00 | 5.15 |
| 2000 | 35.12 | 10.06 | 10.08 | -0.02 | 5.15 |
| Average | 19.43 | 14.74 | 19.65 | -4.91 | 6.46 |
| Var. 1990/2000 | 284.29 | -38.77 |
| Sum | 162.11 | 216.17 | -54.05 | 71.10 |

Elaborated with data from Comision Nacional de Salarios Minimos, BANXICO and INEGI

(*) Discounting annual inflation rate.

Whereas in nominal terms accumulated growth of GMS is 162% between 2000 and 1990, in real terms (discounting 216% accumulated inflation rate) it dropped 54%. Real MS at constant prices 1990 decreases nearly 40%. One can observe the dramatic fall in real value of minimum salary in 1995 and 1996 -column (4)-, which coincides with the Mexican financial-economic crisis started in 1994. Though the federal government increases minimum salary, these increments do not always keep proportion with prices increments, what explains its depreciation in real terms.
In addition, we found different results in shares of labor force earning 1MS when taking minimum salary in nominal and real terms. In nominal terms, the share of labor force with income below 1MS decreased by 22% over this period (poverty reduction), but if one uses real minimum salary, the share of national population with incomes below 1MS increases 13% (poverty rise)—see Table below.

Table 21: Changes in workers income below 1 Minimum Salary (1990/2000)

<table>
<thead>
<tr>
<th></th>
<th>Workers income &lt; 1 GMS (% of workforce)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>13</td>
</tr>
<tr>
<td>2000</td>
<td>22</td>
</tr>
<tr>
<td>Real 1990</td>
<td>41</td>
</tr>
<tr>
<td>Difference 2000/1990</td>
<td>-6</td>
</tr>
<tr>
<td>Difference Real 2000/1990</td>
<td></td>
</tr>
</tbody>
</table>

These estimations diverge with those from the World Bank’s PovcalNet. According to this on-line calculation tool, the percentage of national population living below the poverty line in Mexico in 1990 was 17%. The estimation for year 2000 from PovcalNet drops to 10%, contrasting with our rise to 41%. Two remarks may explain this fact: first, here we are dealing with exclusively workforce, whereas PovcalNet’s poverty line embraces total population. Secondly, given the increased labor market flexibility in Mexico since the end of the 80s (De la Garza 1990, De Buen 1989), employed people receives each time lower remunerations from usually eventual jobs—paid either by worked hours or even by hour-fraction. These changes in labor remunerations have been responding more to industries’ workforce requirements, pressing for short-term—if any—contracts, as well as to smooth unemployment rise. The observed syndicates’ weakening during this period was the key in achieving that (Perez 2002, Garabito 1995). One has also to account for the labor force growth over the 1990s, which has by far exceeded labor demand. As further explained, increases in jobs demand make pressure to reducing salaries, other things equal, in order to contain unemployment rise.

2. Distribution of employed population by salary levels

Figure 2 shows the aggregate picture of labor force by levels of salary. This graphic relates, on the x-axis, levels of salary with, on the y-axis, percentage of labor force. The curve presents accumulated values. The blue line represents incomes distribution in 1990, and the red line incomes distribution in 2000. Comparing these curves, one can observe an improvement, especially for low-salaries workers, as the curve displaces to the right. It reflects the fact that, for instance, in year 1990, 80% of national employed population was earning 2.9 MS, and for 2000 they achieved to earn up to 4.0 MS. In this perspective, this incomes distribution curves seem to have improved

98 This kind of salary flexibility fits with the neoclassical approach of labor markets, where wages adjust as the marginal productivity of labor in a perfectly competitive economy. This fact rise arguments to associate reductions in the capital/labor ratio with low salaries, as further applied in the next section. See Krugman and Obstfeld 2006 and Sala-i-Martin 2000.

99 Note that real salary depreciation is a plausible measure to employ exceeding labor force only in sectors with high elasticity of substitution labor-capital, further explained.
incomes for all cumulated percentiles of workers between 1990 and 2000 –in general measured by its displacement to the right. However, if one adjust salaries to inflation (as in the previous section), this distribution changes substantially. The red dotted line represents real incomes distribution in year 2000. Taking into account the ca. 40% depreciation of the minimum salary once adjusted for inflation, the leftwards displacement of the curve shows that if the minimum salary were adjusted for inflation, 80% of the national population has reduced incomes from 2.9 to 2.5 minimum salaries, and so on for other employed population shares. In addition, comparing earnings distribution curves of real 2000 and 1990 in Mexico, the real 2000 curve has a comparatively (to 1990) higher slope between 0 and 2 MS, representing a higher concentration of people below this threshold than before. Put in terms of a population pyramid of incomes, it is equal to an enlargement of the base.

Figure 33: Distribution of workforce remunerations by minimum salaries (cumulative)

3. Spatial distribution of low income

At national level, 41% of labor force earned less than 1 minimum salary in 2000, bringing down 13% of labor force from upper levels from 1990 to 2000. At state level, the 32 states of Mexico increased this share during the 1990s. Southern states register the highest shares of labor force earning less than 1 minimum salary (2 USD a day), remarkably high in Chiapas (71%), Oaxaca (65%), Veracruz (58%) and Guerrero (57%). The lowest percents correspond to states in the north of the country, namely those bordering the USA: Baja California (16%), Nuevo Leon (21%) and Coahuila (25%). From that fact, we deduce that this difference is influencing the northwards pattern of
domestic emigration during the 90s in Mexico. The states with highest increases in share of labor force earning below 1 minimum salary between 1990 and 2000 are Morelos (24%), Colima (22%), Nayarit (22%), and Veracruz (21%), located in the West and South of the country. Although these states have shares of low-income labor around the national mean, but this worsening along this period shows signs of vulnerability as putting additional population below the 2USD a day poverty line. Except for Veracruz, the change in the poorest Mexico’s states -Chiapas, Oaxaca, and Guerrero- show moderate increases, most likely because further incomes reductions seem to turn smaller as approaching the bottom. From its part, Veracruz presents both high share of low-incomes labor force (3rd. place) along with dramatic increase in low income labor force shares over this period (4th. place) –see chart below. As observed, low incomes characterize historically marginalized regions, but the highest decreases in incomes are taking place along non-extreme poor regions.

![Chart showing share of low income workforce in 2000 and change 2000/1990](chart.png)

**Figure 34: Share of low income workforce in 2000 and change 2000/1990**

4. Final comments

Roughly, the southern states register the highest shares of workforce with incomes below one minimum salary, whereas the north has the lowest. Besides, the highest per capita disasters losses regions, relative to insurance access, are located in the south, which may be explaining the northwards pattern of migration in Mexico. The real depreciation of the minimum salary of the 1990s was more noticeable in non-marginalized regions as they are more dependent of monetary incomes, but also because

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100 For an analysis on labor remunerations increase in the North of Mexico possibly linked with Maquiladoras in the framework of the North America Free Trade Agreement, see Lederman et al. (2003).
additional reductions in real incomes in marginalized regions imply small monetary variations. The highest increases in shares of workforce earning below 2 minimum salaries are in non poor states, surely explained by their higher value of their assets. These results warn about the relevance of strengthening the implementation of adaptive instruments of the poor but also of the non-poor but highly exposed, unless one does not wish to enlarge poverty.
Appendix 6.III Variables Maps

Figure 35: Percentage of agricultural units with insurance coverage

Figure 36: Percentage of agricultural units with credit access
Figure 37: Irrigation

Figure 38: Marginalization
Figure 39: Workforce below two minimum salaries in 2000 (%)  

Figure 40: Per capita economic losses from natural disasters (1990-2000, constant 2000)
Figure 41: Map of residuals from the incomes model using OLS

Figure 42: Map of residuals from the incomes model using Durbin
Appendix 6.IV: Notes concerning data basis and series construction

The natural disasters data used for this case of study are reports of disasters from LaRed and CENAPRED, complemented with extrapolations based on registers from other agencies. The integration and harmonization of these two data sources was made as follows:

1. It added reports of disasters from CENAPRED to LaRed data, trying to downscale state-level data to municipal level, when needed, by weighting with reference to particular criteria, depending on the case. It increased the data sampling in 20%, providing valuable data on mainly economic losses from disasters and damaged hectares of crops.

2. To make comparable monetary data, we transformed every observation regarding economic losses from disasters from current to year 2002 constant prices.

3. One filtered and left out observations regarding anthropogenic disasters, forest fires.

4. Observations at only state-level were distributed into municipalities by dividing state amounts by municipal population.

5. In order to enlarge the sample size of economic losses, those observations without registers of loss but with number of hectares were included by estimating their monetary loss. Area was transformed into monetary losses by multiplying it by mean weighted price per ton ($/ton) and further by average yield (ton/ha). The latter increased 40% the number of observation for the variable economic losses from disasters (L). Mean weighted agricultural prices were based on registers of mean rural prices and production from SIACON (Subsistema de Informacion Agricola, -SAGARPA 2004).


7. It estimated subtotals of each disasters-variable by municipality, so to get uniform series by municipality along decades in cumulated values.

8. It standardized data code based on the INEGI municipal code, to be used as key to join data basis under the GeoDa and Arc-View softwares. So can the software identify and add variables columns to the final data basis. Also, I saved separately every decade as ‘dbf’ file, which enables it to be read by GIS software.
9. Shape file and variables tables are joint, ready to start model specification. Variables in the joint shp file include: share of labor by income classes, domestic, international and general emigration, population, irrigation, insurance, credit, marginalization index, etc.

Table 22: Variables characteristics

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>DATA CODE</th>
<th>PERIOD</th>
<th>UNIT</th>
<th>GEOGRAPHIC AGGREGATION</th>
<th>OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LnLIP - Low Incomes Population</td>
<td>2MS_00</td>
<td>2000</td>
<td>% of workforce, logarithm</td>
<td>Municipality</td>
<td>2,443</td>
</tr>
<tr>
<td>LnFA - Fixed Assets</td>
<td>lnFA89p1</td>
<td>1989</td>
<td>Pesos per capita, logarithm</td>
<td>Municipality</td>
<td>2,443</td>
</tr>
<tr>
<td>LnD- Losses from Natural Disasters</td>
<td>lnLCS_P</td>
<td>1990-2000</td>
<td>Pesos per capita (constant 2000), logarithm</td>
<td>Municipality</td>
<td>2,443</td>
</tr>
<tr>
<td>ΔPA - Agricultural Prices Variation</td>
<td>Pa_Var</td>
<td>1990 / 2000</td>
<td>Pesos/ton (over 440 crops mean weight)</td>
<td>State (set to municipalities)</td>
<td>32 (2,443)</td>
</tr>
<tr>
<td>LnDIST - Distance to trading center</td>
<td>lnMind</td>
<td>1990</td>
<td>Meters, logarithm</td>
<td>Municipality</td>
<td>2,443</td>
</tr>
<tr>
<td>LnINS - Insurance</td>
<td>lnINS1</td>
<td>1990</td>
<td>Agricultural units with insurance (%),logarithm</td>
<td>Municipality</td>
<td>2,443</td>
</tr>
<tr>
<td>LnIRR - Irrigation</td>
<td>lnIRR1</td>
<td>1990</td>
<td>Agricultural units with irrigation (%),logarithm</td>
<td>Municipality</td>
<td>2,443</td>
</tr>
<tr>
<td>LnEDU - Education</td>
<td>Lned_s1</td>
<td>1990</td>
<td>% of 12 and older population with secondary, logarithm</td>
<td>Municipality</td>
<td></td>
</tr>
<tr>
<td>AGR – Agricultural</td>
<td>D_Agri</td>
<td>1990</td>
<td>0 if non-agricultural mun., 1 otherwise</td>
<td>Municipality</td>
<td>2,443</td>
</tr>
<tr>
<td>EM – Emigration</td>
<td>MIG_TOT</td>
<td>2000</td>
<td>% of 12 and older pop. outside birth municipality</td>
<td>Municipality</td>
<td>2,443</td>
</tr>
<tr>
<td>ΔLIP – Change in Low Incomes Pop.</td>
<td>Dif_2rms</td>
<td>1990/2000</td>
<td>Difference in % of pop. below 2 minimum salaries</td>
<td>Municipality</td>
<td>2,443</td>
</tr>
<tr>
<td>LnCRE – Credit</td>
<td>Ln_cred</td>
<td>1990</td>
<td>Agricultural units with credit access (%), logarithm</td>
<td>Municipality</td>
<td>2,443</td>
</tr>
<tr>
<td>LnNDR – Disaster reports</td>
<td>Ln_reps1</td>
<td>1990-2000</td>
<td>Number of disasters reports, logarithm</td>
<td>Municipality</td>
<td>2,443</td>
</tr>
<tr>
<td>GRAVE – Grains/Vegetables</td>
<td>Grave00</td>
<td>2000</td>
<td>Volume ratio (tn)</td>
<td>State (set to municipalities)</td>
<td>32 (2,443)</td>
</tr>
</tbody>
</table>
Table 23: List of municipalities selected as main trading centers cities

<table>
<thead>
<tr>
<th>municipality</th>
<th>City</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acapulco de Juárez</td>
<td>Monterrey</td>
</tr>
<tr>
<td>Aguascalientes</td>
<td>Morelia</td>
</tr>
<tr>
<td>Ahone</td>
<td>Nogales</td>
</tr>
<tr>
<td>Benito Juárez</td>
<td>Nuevo Laredo</td>
</tr>
<tr>
<td>Cajeme</td>
<td>Oaxaca de Juárez</td>
</tr>
<tr>
<td>Campeche</td>
<td>Paz, La</td>
</tr>
<tr>
<td>Celaya</td>
<td>Piedras Negras</td>
</tr>
<tr>
<td>Centro</td>
<td>Puebla</td>
</tr>
<tr>
<td>Chihuahua</td>
<td>Querétaro</td>
</tr>
<tr>
<td>Coatzacoalcos</td>
<td>Reynosa</td>
</tr>
<tr>
<td>Cuernavaca</td>
<td>Salina Cruz</td>
</tr>
<tr>
<td>Culiacán</td>
<td>Saltillo</td>
</tr>
<tr>
<td>Durango</td>
<td>San Luis Potosí</td>
</tr>
<tr>
<td>Guadalajara</td>
<td>Tampico</td>
</tr>
<tr>
<td>Guaymas</td>
<td>Tapachula</td>
</tr>
<tr>
<td>Hermosillo</td>
<td>Tepic</td>
</tr>
<tr>
<td>Hidalgo del Parral</td>
<td>Tijuana</td>
</tr>
<tr>
<td>Irapuato</td>
<td>Toluca</td>
</tr>
<tr>
<td>Iztapalapa</td>
<td>Torreón</td>
</tr>
<tr>
<td>Juárez</td>
<td>Tuxtla Gutiérrez</td>
</tr>
<tr>
<td>León</td>
<td>Veracruz</td>
</tr>
<tr>
<td>Manzanillo</td>
<td>Victoria</td>
</tr>
<tr>
<td>Matamoros</td>
<td>Xalapa</td>
</tr>
<tr>
<td>Mazatlán</td>
<td>Zacatecas</td>
</tr>
<tr>
<td>Mérida</td>
<td>Zapotlán del Rey</td>
</tr>
</tbody>
</table>
CHAPTER 7: Conclusions

Vulnerability to natural disasters and market uncertainty in Mexico is significantly contributing to the enlargement of poverty and inequity. The current hazards management implementation is insufficient to cope with their negative outcomes, and the unfavorable productive and entitlement structures contribute to their amplification in particular geographic regions and economic sectors. Despite its novel design, the lack of penetration of disaster prevention instruments is endemic among the poor, and persists in rural areas. Although natural disasters and current trade conditions affect mainly the agricultural sector in this country, their negative impacts spill over to other regions and sectors. It justifies a more active public intervention that in turn reduces inequity.

7.1 Hazards effects and public response

The present dissertation proves that the number of people living in poor conditions is aggravated by disasters losses and dropping prices of the regional commodity. This dissertation, consequently, warns of the risk of an even larger percentage of the population falling below the poverty line in the future, given the current trend of increasing frequency and economic losses from natural disasters, as well as the decreasing agricultural prices in the country.

The underestimation of the negative impact of climatic conditions is evidenced in the current social and productive expenditure distribution, which tends to ignore the protection of ex-ante assets of the most exposed population. Triggered by a vulnerable agriculture, the rural economy started a decomposition process during the past two decades, which has consequently stimulated out-migration to large cities and abroad. In order to counteract that process, this dissertation suggests not only expanding the coverage of disaster prevention measures, but simultaneously expanding productive infrastructure to boost productivity along with more favorable production projections (considering the relative price structure), and expanding credit access and risk-sharing mechanisms.

The liberalizing economic policy of the last two decades has largely contributed to increasing that vulnerability, as described in Chapters 2 and 3. Lack of investments to expand irrigation and further physical infrastructure, rural credit reduction, and the reduced share of insured farmers seem to counteract by far the current aid to the poor. In addition, the governmental withdrawal of support for the countryside with infrastructure and commercialization facilities, may not only have increased poverty in the country (as there have not been realistic options to replace its intervention), but also indicated a certain naïveté on the government’s part. In comparison, Mexico’s trade counterparts continue to support their own countryside, both in the form of facilities and subsidies, increasing the trade deficit in that sector, and thus joining together to drop agricultural prices and rural incomes in turn.
7.2 Stakeholders views

One of the main obstacles in carrying out public works to mitigate natural disasters losses is the current failed budgetary decentralization operation, as derived from the consultation with policymakers and authorities presented in Chapter 4. As it is mandatory for municipalities to identify their own disasters’ risk in order to apply for the corresponding federal fund, the incapacity of most of them in fulfilling that requirement leaves most of these resources unused. It follows that the obtained loans and funds aimed at disasters’ prevention are used mostly to finance current expenditure.

The empirical evidence from the stakeholders’ interviews presented in Chapter 5 shows that the complex economic-climatic process behind poverty is sharpened by pernicious political practices at the three administrative levels. The insufficient promotion of strategies from the federation and state governments fits with the asymmetric capacity among municipal authorities and results in a lack of action on the part of the authorities. The disaster reduction and productive re-orientation strategies are often unknown to local leaders and authorities in regions that are poor and frequently affected by natural disasters. In light of these facts, the preferred coping strategies of the affected community are often assistance from relatives and neighbors, complemented with governmental aid. After the initial shock of the disaster, no preventive action is mostly taken for future events. The lack of planning for future events creates a vicious circle of economic vulnerability which pushes this population into an increasing state of poverty.

The withdrawal of the government from supporting agricultural commercialization has not led to the expected emergence of efficient private market instruments, but to the proliferation of speculators and a number of trade intermediaries. Such conditions dissolve any possible benefit for farmers when agricultural prices soar. Something similar occurs with rural credit, currently commanded by informal loaners at dramatically high interest rates and disadvantageous granting conditions, evidenced in the surveyed communities of this dissertation. Communities more frequently affected by natural disasters and decreasing incomes during the past decade proved to be the most likely to view and implement out-migration as a coping strategy. Indeed, the communities more prone to emigrate are not the poorest ones of the sample. It suggests that the will to emigrate responds to negative expectations of future agricultural incomes rather than to poverty itself. However, the economic dynamism of the urban economy in the area is too modest to absorb them forcing them to emigrate farther, even encouraging emigration abroad, as can be seen in the migration model in Chapter 6. The dramatic proliferation in the last five years of bus companies in the surveyed region, exclusively offering trips to the Mexico-USA border support this trend. Ironically, Mexican migrants work predominantly in the agricultural sector in the USA, contributing to an increase in productivity by lowering labor costs and in turn boosting agricultural exports to Mexico.

According to stakeholders’ views, assets accumulation of individual households (both physical and human) along with building more favorable entitlements is crucial for reducing poverty in the region, and current social polarization in turn. More credit access and favorable market re-orientation based on crops diversification and rotation have been
shown to be the most effective instruments to increase expectations among surveyed farmers and thus to lessen migration. Nevertheless, the benefit of insurance could not be conclusively tested given its widespread absence. In addition, the overall prevailing mutual distrust among stakeholders and the institutions—most likely derived from a recent past of weak democracy—seems to be impeding the implementation of the right programs.

7.3 The model

The models presented in Chapter 6 confirm this dissertation’s hypotheses. Additionally, this modeling supports the decision-making process in issues concerning poverty, migration and disasters’ vulnerability by levels of geographic desegregation for the whole country. It analyzes the effect of relevant determinants of income: productive infrastructure, price structure, financing instruments, asset distribution and external shocks. Estimating the differential influence of hazards on the different municipalities of Mexico allows for a more accurate and impact-based public intervention. Forecasting the return of investments in a given municipality together with those in surrounding municipalities enables the setting of priorities based on the goal variables of the national development plan. The desegregation of the model allows analyzing the differential impact of a variable depending on the marginalization degree and location. It enables accounting for disparities between crucial dichotomies of the country: north-south, rich-poor, and rural-urban. As observed, the negative impact of the analyzed hazards is higher among particular regions and sectors. It can be counteracted by strengthening households’ coping and adaptive capacity based on moving to a more favorable productive structure and improving the access to financial, physical and human assets. Most likely due to the current entitlements system, better-off economic agents do not filter benefits to the others. It calls for additional and more selective public investments to close the increasing inequity gaps according to the corresponding poverty determinants.

In general, a marginalized population tends to be more vulnerable to weather-related disasters, whereas a non-marginalized population is somewhat more affected by economic stressors. The higher reliance on self-consumption among marginalized populations explains that relation. Their lesser involvement in the monetary economy makes their subsistence more vulnerable to climatic conditions, whereas adverse productive and trade conditions are an obstacle from enrolling into the commercial agriculture, as they are unable to obtain production exceeding their basic needs on a regular basis. It impedes them from accumulating assets significantly to overcome poverty. Investments in instruments for reducing disaster loss possess comparatively higher benefits in reducing poverty across most marginalized regions, whereas enhancing intra-branch terms of trade and lowering transport costs brings greater benefits to those less marginalized. A public intervention biased to boost the commercial agriculture and reduce disaster loss in Mexico may limit poverty enlargement and sustain the domestic food supply. But given the spillover effect of poverty in Mexico, it will not be translated into permanent sustainable poverty reduction unless combined with substantial achievements in protecting and accumulating assets of subsistence farmers and the poor community in general.
The most significantly migration prone population segments in Mexico are those with considerable income decreases and a large frequency of disasters in the last ten years. In addition, they have comparatively higher education levels and arise from marginalized isolated regions. In absence of a promising welfare horizon, the benefits of education in remote areas are frequently wasted given the lack of opportunities to make use of such a human capital, subsequently drained through emigration. Public investments in productive infrastructure, financial support, and projecting to build a more favorable trade environment in these regions may counteract that trend—and in turn, reduce social pressure in urban areas and impasses at the Mexico-USA border. Networks of migrant traders prove to be crucial for labor mobility, evidenced by the usual remote origin of migrants. As long as transport infrastructure does not become an effective input to boost trade and productivity in rural areas, it will continue serving just as infrastructure for wetbacks trading.

7.4 Further directions
During this research, the remarkable governmental concern about poverty and inequity in Mexico was obvious. However, at the same time, the prevailing excessive belief in market instruments and confidence in budgetary decentralization seem to reduce the scope of the public intervention. It has opened the floor to a diversity of views concerning solutions to cope with hazards, often leading to implementing mutually annulling actions among public agencies at the three administrative levels or, perhaps worse, not implementing any. This is understandable if one considers the current lack of an integral vision concerning natural hazards and economic stressors from both the scientific, as well as the policy-making community. The findings from the present dissertation regarding poverty and development confirm the need for further analysis addressing the coupled economy-nature relations based on a cross-section analysis. Mexico needs to actively implement multiple interconnected municipal projects (both rural and urban) for reducing vulnerability to natural and economic hazards coordinated by the social development authority. These should be carried out based on a transparent and stakeholders-inclusive mechanism so as to optimize economic resources and at the same time make sure that progress becomes compatible with equity.
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